DEPARTMENT OF ENERGY & CLIMATE CHANGE

The Justification of Practices Involving Ionising Radiation Regulations 2004

The reasons for the Secretary of State's Decision as Justifying Authority on the Regulatory Justification of the Class or Type of Practice being:

"*The generation of electricity from nuclear energy using oxide fuel of low enrichment in fissile content in a light water cooled, light water moderated thermal reactor currently known as the AP1000 designed by Westinghouse Electric Company LLC*."

October 2010

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Executive Summary

1. This document sets out the reasons for the Secretary of State for Energy and Climate Change's decision as Justifying Authority on the Regulatory Justification of the class or type of practice being:

"*the generation of electricity from nuclear energy using oxide fuel of low enrichment in fissile content in a light water cooled, light water moderated thermal reactor currently known as the AP1000 designed by Westinghouse Electric Company LLC*"[1].

2. Regulatory Justification is a process required under the Justification of Practices Involving Ionising Radiation Regulations 2004[2], under which the Secretary of State must decide whether a new class or type of practice resulting in exposure to ionising radiation is justified by its economic, social or other benefits in relation to the health detriment it may cause.

3. The decision, set out in Chapter 1 with a summary of the reasons behind it, is that the class or type of practice is Justified under the Regulations.

4. The background to the decision is set out in Chapters 2 and 3 of this document. The information and evidence that the Secretary of State has taken into account , including responses to the public consultation on the Proposed Decision held between November 2009 and February 2010, is summarised in Chapters 4 to 9.

5. The decision will be taken by the making of Regulations by way of statutory instrument and this has been laid in draft in both Houses of Parliament.

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1 The AP1000 is a Pressurised Water Reactor (PWR), which is the most common type of nuclear reactor in operation throughout the world. More detail on the classification of nuclear reactors is set out in Annex A (Note on the Classification of Nuclear Reactors).

2 The Justification of Practices Involving Ionising Radiation Regulations 2004, Statutory Instrument 2004 No. 1769 http://www.opsi.gov.uk/si/si2004/20041769.htm

PART 1 – DECISION

Chapter 1: The Secretary of State's Decision

1.1 The Secretary of State's decision is that the class or type of practice being:

"The generation of electricity from nuclear energy using oxide fuel of low enrichment in fissile content in a light water cooled, light water moderated thermal reactor currently known as the AP1000 designed by Westinghouse Electric Company LLC"

is Justified under the Justification of Practices Involving Ionising Radiation Regulations 2004.

1.2 In this Chapter, the Secretary of State summarises the reasons for his decision.

Benefits and Detriments – A summary

1.3 The Secretary of State considers that the AP1000 is Justified by its economic, social and other benefits in relation to the health detriments it may cause. The evidence about these benefits and detriments which the Secretary of State has taken into account in reaching his conclusion is summarised below and in Chapters 4 to 9.

1.4 In reaching his decision, the Secretary of State has had to consider and balance benefits and detriments in areas which are not obviously comparable in their substance and effect. The Secretary of State has not found that this has been an obstacle to his making of a decision and considers that the benefits of the AP1000 will outweigh any detriments.

1.5 The Secretary of State sees a clear need for the generation of electricity by the AP1000 through the contribution it can make to securing the UK's energy supplies, helping the UK decarbonise and meet legal low-carbon obligations and benefiting the economy more widely. Both security of energy supply and the move towards low carbon electricity are issues of considerable national importance. An AP1000 will be able to produce large quantities of low carbon electricity over an extended period, giving it the capacity to make a significant contribution to a secure, low carbon electricity supply in the UK.

1.6 The Secretary of State is confident that there will be important economic benefits for the UK in the event that companies decide to invest in new nuclear power stations. Beyond the direct investment and employment necessary for the construction and operation of any AP1000, the Secretary of State is satisfied that the UK economy can benefit through the development of a globally competitive nuclear supply chain and improvement in the quality of a skilled UK workforce.

1.7 Against this, although there is potential detriment to health, safety and the environment from the AP1000, this potential is small, well understood and guarded against by an established regulatory regime, which actively and effectively works to keep detriments within acceptable limits. The Secretary of State considers that the risk of health detriment from the building and operation of AP1000s in the UK is very low. As a proportion of the overall radiation to which members of the public are exposed from all sources, including natural sources, the evidence he has reviewed suggests that the contribution from any AP1000 would be very small. The radiation dose which members of the public would receive from the normal operation of an AP1000 on an annual basis would be below detectable risk levels in the context of overall radiation exposure. The inherent safety features of the design combined with the UK's strong and effective regulatory regime will ensure that gaseous and aqueous emissions will be kept to a minimum and the risk of accidental release of radioactive or other harmful material will be reduced and mitigated. Any potential detriment to health which the AP1000 could cause would therefore be very small, and satisfactorily minimised.

1.8 The Secretary of State is satisfied that the licensing and planning regime would ensure that potential environmental detriment caused by any proposed AP1000 would be prevented or mitigated. The Secretary of State also considers that radioactive waste and spent fuel arising from any AP1000 built in the UK could be effectively managed to ensure that the potential risks or detriments from its handling, storage, transport or disposal are within acceptable limits.

1.9 The Secretary of State is therefore satisfied that the benefits of building and operating the AP1000 in the UK clearly outweigh the detriments.

Carbon Reduction – Chapter 4

1.10 The Committee on Climate Change (CCC) said in its first report that "*climate change resulting from CO_2 and other greenhouse gas emissions poses a huge threat to human welfare*". There is overwhelming evidence indicating that human activities are causing this global climate change. The burning of fossil fuels, changes in land use and various industrial processes are adding greenhouse gases, particularly CO_2, to the atmosphere. The UK Low Carbon Transition Plan published in 2009 (the LCTP) concludes that if climate change continues unchecked, the consequences for the UK of failing to control emissions will be severe, and across the world will be worse still.

1.11 The UK has signed up to binding international undertakings to reduce the emissions of CO_2 in the UK and, as the generation of electricity forms a substantial part of the UK's CO_2 emissions, it is important that the UK is able to generate large quantities of electricity from low carbon sources. By 2050 virtually all of the UK's electricity will need to come from low-carbon sources such as renewables, nuclear and fossil fuel plants fitted with carbon capture and storage technology (CCS).

1.12 Nuclear power has long been the UK's most significant source of low carbon energy, and can have a role to play in our energy mix, alongside other low carbon technologies, including renewables and CCS. The Secretary of State has noted the evidence of the significant consequences associated with climate change and is of the opinion that he must give this due weight when considering the benefits and detriments associated with the AP1000.

1.13 The Secretary of State considers that meeting the UK's carbon reduction targets is very important and that the AP1000's ability to assist with this by producing low carbon electricity is a significant benefit.

Security of Supply/Economics – Chapter 5

1.14 The reliable and affordable supply of electricity is essential to the daily lives of the population and the functioning of business. It is difficult to overstate the extent to which quality of life is dependent on adequate energy supplies. Both interruptions to supply and the increased costs which would result would have an adverse social and economic impact.

1.15 The Secretary of State considers that a secure, low carbon energy supply is of the highest national importance, and believes that a diverse mix of low carbon technologies will help to deliver energy security. Within such a mix, the AP1000, which can produce large quantities of low carbon electricity over an extended period, could make a significant contribution.

1.16 The AP1000 is capable of producing 1,100 MWe for a high proportion of its operating lifespan. Modern Pressurised Water Reactors (PWRs) have a strong reliability record and the AP1000 is expected to be capable of generating a large quantity of low carbon electricity at a high load factor over the course of its lifespan.

1.17 The Secretary of State is conscious that there are secure supplies of uranium, the fuel for the AP1000, in the world and that these are part of a stable market. The reactor's fuel also forms a low proportion of the cost of generation so the cost of generating electricity from an AP1000 is unlikely to fluctuate greatly even if the cost of uranium changes significantly.

1.18 The Secretary of State believes that, if nuclear power stations were not part of the UK's future energy mix, the UK could be exposed to an increased need to

import fossil fuels and would face significantly higher costs in meeting the transition to a low carbon generation economy.

1.19 The Government's policy is that it will be for companies to fund and build any new nuclear power stations. It is therefore for investors to determine whether the financing of any AP1000 nuclear power station provides sufficiently attractive returns. Although the economics of nuclear will vary in comparison with those for other forms of electricity generation depending on, for example, electricity market structures and changing gas and carbon prices, developments in the UK market have made clear that energy companies are investing significant amounts of capital in the prospect of new nuclear power stations. Recent reports continue to present nuclear power as economically competitive, although the economics of energy technologies are affected by market changes and a general increase in estimated costs for all technologies.

1.20 The Government has made specific arrangements for the storage and disposal of nuclear waste, under which owners and operators of new nuclear power stations will be required to have an approved Funded Decommissioning Programme in place before construction of a new nuclear power station can begin. The Secretary of State is satisfied that these measures will ensure that the owners and operators of new nuclear power stations will set aside funds over the operating life of a nuclear power station to cover the full costs of decommissioning and their full share of waste management and disposal costs. The Secretary of State is satisfied that these costs will not become a burden on UK taxpayers.

1.21 Beyond the direct investment and employment created by the nuclear power stations themselves, the Secretary of State is satisfied that the UK economy will benefit from any investment in new nuclear power stations which companies decide to make, through the development of a globally competitive nuclear supply chain and an increasingly skilled UK workforce. The Secretary of State is satisfied that the actions being taken by the Government and industry mean that the UK is well placed to take the best possible advantage of this opportunity.

1.22 The Secretary of State accepts that there is a potential economic detriment that could arise as a result of an accident at a new nuclear power station, including costs to be met from public funds. However, the risk of this is minimised through the robust regulatory regime in place. Any economic impacts will be mitigated through well established arrangements for third party compensation. The Secretary of State is satisfied that arrangements are and will continue to be in place to provide the insurance or other financial security required under the arrangements for third party compensation.

Radiological health detriment – Chapter 6

1.23 An important risk associated with the AP1000, as with all nuclear power stations, is the potential for detriment caused by the release of ionising radiation. However, this needs to be set in the context of overall levels of

radiation. The overall average annual dose to a member of the public from all sources of radioactivity is 2.7 millisieverts (a measure of dose and abbreviated as mSv) per year. Of this, about 84% is from natural sources, about 15% from medical procedures and about 1% from all other sources, including existing nuclear power stations.

1.24 Release of radioactivity from nuclear power stations is strictly limited by regulation. By law, the radiation to which members of the public are exposed from all sources, excluding natural sources and medical procedures, is limited to 1 mSv per year.

1.25 But the regulatory regime goes further than the legal 1 mSv limit. It requires operators to use BAT (Best Available Techniques) and ensure that the resulting exposures are below the statutory limits and as low as reasonably achievable (ALARA). A recommendation from the Health Protection Agency (HPA) that the radiation to which members of the public are exposed from a proposed controlled source, such as a new nuclear power station, should be no more than 0.3 mSv per year, is given effect by a Direction to the environment regulators. HPA further recommends that dose constraints lower than this should be set where this is appropriate.

1.26 HPA has said that a dose of 1 mSv per year is equivalent to an additional risk of fatal cancer of one in twenty thousand (0.005%) per year, and that a risk at this level is not detectable among normal background levels of cancer risk.

1.27 The annual 'Radioactivity in Food and the Environment (RIFE)' report produced jointly by the Environment Agency, Food Standards Agency and others, confirms that radiation doses received by members of the public are below the statutory dose limit of 1 mSv per year.

1.28 Under UK law, all employers are responsible for protecting their employees, as well as the public, against exposure to ionising radiations. The maximum occupational dose limit which applies to people at work is 20 mSv per year. The UK nuclear industry monitors and regularly reports exposure levels for its employees which show that it works well within the legal dose limits, and applies additional stricter constraints on dose. The Secretary of State is satisfied that employees of the nuclear industry are adequately protected.

1.29 The Secretary of State is aware of concerns about the findings of studies suggesting a link between nuclear power stations and a higher incidence of cancer. However, he is satisfied that the best evidence suggests that no such linkage has been demonstrated. In coming to this view he has given particular attention to the reports of the Committee on Medical Aspects of Radiation in the Environment (COMARE), a scientific advisory committee providing independent advice on all aspects of health risk to people exposed to natural and man-made radiation. In particular, its view is that there is no evidence for unusual aggregations of childhood cancers in populations living near nuclear power stations in the UK.

1.30 The Secretary of State is therefore satisfied that the regulatory regime will effectively limit and minimise the radiation dose and release of radioactivity from the AP1000 to very low levels. He is also satisfied that because the regime applies during and beyond the operational life of the nuclear power station, effective limits on radiological emissions will remain in place until the AP1000 has been fully decommissioned. He therefore considers that the health detriments associated with the operation of an AP1000 will be very low.

1.31 The Secretary of State does not consider that practices taking place overseas should be taken into account in a Regulatory Justification assessment. However, in response to concerns raised by respondents to the public consultation on the Proposed Decision he has considered the health detriment relating to uranium mining and considers that it is limited.

Radioactive Waste – Chapter 7

1.32 The generation of electricity by any AP1000 built in the UK would give rise to spent fuel, intermediate level waste (ILW), low level waste (LLW) and liquid and gaseous discharges, all of which contain differing levels of radioactivity. The Secretary of State recognises that the unnecessary introduction of ionising radiation into the environment is undesirable, and has considered the steps taken to limit the exposure of individuals to radiation from these sources.

1.33 Geological disposal is the way higher activity waste (spent fuel and ILW) will be managed in the long term. This will be preceded by safe and secure interim storage until a geological disposal facility (GDF) can receive waste.

1.34 The Secretary of State considers, based on scientific consensus and international experience, that despite some differences in characteristics, waste and spent fuel from AP1000s would not raise such different technical issues compared with nuclear waste from legacy programmes as to require a different technical solution.

1.35 The disposability assessment for the AP1000 conducted by NDA as part of the GDA process supports that conclusion and concludes that compared with legacy wastes and existing spent fuel, no new issues arise that challenge the fundamental disposability of the spent fuel and ILW expected to arise from operation of the AP1000. Given a disposal site with suitable characteristics, the spent fuel and ILW from the AP1000 is expected to be disposable.

1.36 The Secretary of State has noted that the length of time for the safe and secure on-site interim storage of spent fuel is contingent on a number of factors, but remains satisfied that interim storage of spent fuel and also ILW can and will be carried out in a way which causes a very low level of health detriment.

1.37 The Secretary of State is satisfied that a GDF would be able to, and would be required to, meet the strict dose limits and risk guidance level required by the UK regulatory regime. He has taken into account the fact that the Government

is considering steps to ensure that any GDF built in the UK would be introduced into the regulatory regime in a staged manner with the involvement of the regulators at an early stage. The Secretary of State is conscious that no GDF for spent fuel is yet operational anywhere in the world. However, in light of the findings of the disposability assessments and the progress being made in the implementation of geological disposal abroad, the Secretary of State is satisfied that it is technologically feasible to build a GDF which could contain both higher activity wastes arising from existing nuclear power stations and from any AP1000 which might be built in the future, with only very low levels of health detriment.

1.38 The Secretary of State, having considered the Government's approach to the selection of a site for the implementation of geological disposal, is satisfied that there is a robust process in place to identify a suitable site and is confident that one will be identified and that a GDF (or more than one if necessary) will be built.

1.39 The Secretary of State is satisfied that the LLW originating from any new nuclear power stations would not vary greatly from that of existing nuclear power stations, and expects that LLW from new nuclear power stations would be handled in a manner similar to current practice and in line with Government policy on LLW.

1.40 Liquid and gaseous discharges from nuclear power stations give rise to emissions of radioactivity into the environment. The levels of these discharges and the consequences for human health are considered in Chapter 6 (Radiological Health Detriment). In relation to these discharges the Secretary of State is satisfied that the regulatory regime is sufficiently robust to ensure that doses arising from such discharges will remain within limits and will be as low as reasonably achievable (ALARA).

1.41 The existing regulatory regime, which limits by law the radiation to which people can be exposed from nuclear installations, would apply to the management and disposal of radioactive waste from any AP1000 and from its decommissioning, as well as to activities during its operation. The Secretary of State is confident that this will ensure that the management and disposal of radioactive waste will give rise to only very low levels of health detriment.

1.42 The Secretary of State is satisfied that the regulatory regime will act to ensure that the release of radiation from the radioactive waste from any AP1000 remains within regulatory dose limits. In coming to this conclusion, the Secretary of State has given particular weight to the arrangements already in place to deal with waste from existing nuclear power stations, the effectiveness and transparency of the existing regulatory regime, and to the extensive powers that the regulators have to enforce compliance.

1.43 Considering all of the above and having taken into account the points made by respondents to the consultation, the Secretary of State is of the opinion that whilst there is a potential health detriment from the management and disposal

of radioactive waste arising from the generation of electricity from any AP1000 which is built in the UK he considers that the health detriment from such radioactive waste would be very small and would remain very small up to and beyond disposal.

Environmental Detriment – Chapter 8

1.44 The Secretary of State recognises that the construction, operation and decommissioning of an AP1000, as a significant infrastructure project, will involve potential detriment to the environment which must be addressed.

1.45 In making his Regulatory Justification decision, the Secretary of State has considered in detail some of the issues covered in the Appraisal of Sustainability (AoS) and Habitats Regulations Assessment (HRA) of the Revised Draft Nuclear National Policy Statement (NPS) published for consultation in October 2010, including radiological health detriment, radioactive waste, security of supply and climate change. In the case of other issues covered in the Revised Draft Nuclear NPS, including biodiversity, landscape and visual impact, air quality, water quality and flood risk, these can by their nature only be fully addressed at a site-specific level in connection with individual applications to build nuclear power stations and not as part of the high-level Regulatory Justification decision-making process.

1.46 The Secretary of State has considered the arrangements for processing applications for development consents for new nuclear power stations. In granting development consent, the Infrastructure Planning Commission (IPC) must generally act in accordance with the NPS and its supporting documents. These contain policy aimed at minimising and mitigating harm to the environment that could arise from the construction and operation of an AP1000. When considering an application, the IPC will also have the benefit of an Environmental Statement which details all the potential impacts of the development on the environment. The IPC will be able to attach conditions to a decision to mitigate damage to the environment from developments or aspects of developments which might otherwise not be environmentally acceptable.

1.47 The IPC can also decide not to grant consent where it judges that the adverse impact of a development, which could include the adverse environmental impact, outweighs its benefits. In cases where a development might cause environmental harm which could not be fully mitigated or avoided, this allows the IPC to take a decision, in light of the particular circumstances of the application, about whether the benefits of that development justify the environmental detriment it would cause.

1.48 The examination of an application for new nuclear development and the decisions as to whether or not to grant development consent will be taken in consultation with the Environment Agency and other regulatory bodies (including the Department for Transport, the Nuclear Installations Inspectorate and the Office for Civil Nuclear Security). The nuclear regulators will be

responsible for the site licence and environmental permits for the project and ongoing regulation in the event that development consent is granted. The Secretary of State believes that this will provide effective regulation of the environmental impact of any development. The Secretary of State is satisfied that the new planning regime for nationally significant infrastructure set up under the Planning Act 2008 and the proposed changes to this system announced by the Government in June 2010, will allow environmental considerations to be identified and addressed at an early state of the planning process, including through consultation with the regulators and the public, so that unsuitable proposals can be prevented and potential adverse impacts mitigated to the extent possible.

1.49 On balance, the Secretary of State considers that potential environmental detriments arising from the construction, operation and decommissioning of the AP1000 are likely to be avoided or adequately mitigated and that a decision to allow environmental detriment that cannot be avoided or mitigated will include a consideration of whether the benefits of the development outweigh the harm.

Safety and Security – Chapter 9

1.50 The risk of detriment from an accident or terrorist incident at an infrastructure project is something that must be taken into account, including for nuclear power stations. The Secretary of State acknowledges that the release of large quantities of radioactive material into the environment from such incidents could lead to significant adverse health detriments.

1.51 However, this potential detriment already exists for current nuclear power stations, and the risk of such incidents should be seen in the context of the regulatory regime which is intended to prevent accidents and protect against terrorist attack. The Secretary of State has therefore considered the advice of regulators and other advisory bodies on the measures in place. In particular, the Secretary of State notes that no events have occurred relating to a civil nuclear power station in the UK with off-site consequences or where all the safety barriers inherent in the design were breached.

1.52 The Secretary of State also notes the regulators' assessments under the Generic Design Assessment (GDA) process that there are at this stage no safety or security shortfalls that would rule out the construction of the AP1000 on UK licensed sites.

1.53 The Secretary of State further notes that the regulators are undertaking a more detailed assessment of the AP1000 as part of the GDA process and that before permitting the start of construction the HSE would have to be satisfied that the operators have taken all reasonably practicable steps to reduce the risk of accidents and their radiological consequences.

1.54 Under the security regime, nuclear licensed sites are required to have a security plan in place. This plan must be approved by the civil nuclear security

regulator, the Office of Civil Nuclear Security (OCNS), which has the power to direct at any time that the site adopt specific standards, procedures or arrangements or submit for approval a new or amended security plan; and has the power to compel the licence holder to take certain action. Under directions issued by OCNS, the Civil Nuclear Constabulary (a dedicated police force responsible for providing an on-site armed response force) carries out the roles and responsibilities assigned to it in the approved security plan.

1.55 The Secretary of State has confidence that the GDA and licensing processes will ensure that the regulators are satisfied with the safety and environmental implications of the AP1000 before site-specific proposals are approved for construction and operation in the UK. The Secretary of State is satisfied that the UK's effective and robust regulatory framework will ensure that industry minimises and manages safety and security risks during and beyond the operational life of any AP1000, and that this is supported by the nuclear industry's strong safety and security record in the UK. The effectiveness and efficiency of the regulatory regime is kept under continuous review and improvements are made where necessary.

1.56 The Secretary of State also notes that the Government and industry have an emergency preparedness framework in place to mitigate health effects in the unlikely event of any accidental release of radiation into the environment.

1.57 The Secretary of State acknowledges concerns about the possibility of diversion of nuclear material and the proliferation of nuclear weapons. The UK Safeguards Office (UKSO), part of the HSE's Nuclear Directorate, ensures that the UK complies with its international safeguards obligations, including those under the Euratom Treaty and the UK/Euratom/ International Atomic Energy Agency (IAEA) safeguards agreement.

1.58 Under this regime, the operator of any AP1000 would be subject to the same stringent safeguards provisions as existing operators, including inspection and verification by the international safeguards inspectorates of the European Commission and the IAEA. The Secretary of State believes that there is therefore no reason to think that the building of AP1000s in the UK would result in any significant rise in proliferation risk from the current low levels.

1.59 In summary, the Secretary of State is conscious of the extent of damage and health detriment that a release of radioactive material from an AP1000 would have. However, he has confidence in the regulatory regimes for safety and security of civil nuclear installations and materials in the UK. The regulatory bodies are all independent, experienced and held in high regard around the world. He is also conscious that the AP1000 includes inherent safety and security features, based on years of international experience with nuclear power stations and which will be subject to approval by the UK regulators. He therefore considers that the likelihood of an accident or other incident occurring at an AP1000 giving rise to a release of radioactive material is very small.

Secretary of State's decision

1.60 The Secretary of State believes that the significant potential benefits which he has set out in this document outweigh the potential detriments, which will in any case be minimised by an effective regulatory regime.

1.61 The Secretary of State has therefore decided that the class or type of practice being:

"*the generation of electricity from nuclear energy using oxide fuel of low enrichment in fissile content in a light water cooled, light water moderated thermal reactor currently known as the AP1000 designed by Westinghouse Electric Company LLC*"

is Justified under the Justification of Practices Involving Ionising Radiation Regulations 2004[3].

[3] As set out in paragraph 1.31 above the Secretary of State does not consider that he needs to consider practices taking place overseas as part of the Regulatory Justification assessment. However, in response to concerns raised by respondents to the public consultation on the proposed decision he has considered the health detriments associated with uranium mining, which he considers are small. Therefore, even if he is required to take these into consideration as part of the Regulatory Justification assessment of the AP1000 he considers that the extensive benefits still outweigh the detriments and the AP1000 is justified within the meaning of the Justification Regulations.

PART 2 – BACKGROUND

Chapter 2: Background, Regulation and Consultation

ICRP recommendations and EU legislation

2.1 Regulatory Justification is an initial, high-level process confined to the relevant class or type of practice under consideration. It is not a decision on whether to build new nuclear power stations. Nor is it an exercise in comparing the advantages of the different methods of producing energy or comparing different nuclear reactor designs. It is also a generic assessment, so issues relating to particular sites are not suitable for consideration under this process.

2.2 Regulatory Justification is based on the internationally accepted principle of radiological protection that no new practice involving exposure to ionising radiation should be adopted unless it produces sufficient benefit to the exposed individuals or to society to offset the radiation detriment it causes. This principle is derived from the recommendations of the International Commission on Radiological Protection (the ICRP)[4] in ICRP Publication 60[5] and reaffirmed most recently in ICRP Publication 103[6].

2.3 Article 6(1) of European Council Directive 96/29/Euratom of 13 May 1996 (the Basic Safety Standards Directive)[7] requires Member States to ensure that all new classes or types of practice resulting in exposure to ionising radiation are justified, in advance of being first adopted or first approved, by their economic, social or other benefits in relation to the health detriment they may cause.

UK Regulations

2.4 The requirements of Article 6(1), (2) and in part (5) of the Basic Safety Standards Directive have been implemented in UK law by the Justification of Practices Involving Ionising Radiation Regulations 2004[8], (the Regulations) which prescribe the process for Justifying a new class or type of practice. This

[4] The ICRP is an independent international body of experts which provides guidance on a range of topics relating to the protection of man from the harmful effects of ionising radiation http://www.icrp.org/

[5] ICRP Publication 60: 1990 Recommendations of the ICRP http://www.icrp.org/

[6] ICRP Publication 103: 2007 Recommendations of the ICRP http://www.icrp.org/

[7] Council Directive 96/29/EURATOM of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation (OJ L159, 29.6.1996, p.1) http://ec.europa.eu/energy/nuclear/radioprotection/doc/legislation/9629_en.pdf

[8] The Justification of Practices Involving Ionising Radiation Regulations 2004, Statutory Instrument 2004 No. 1769 http://www.opsi.gov.uk/si/si2004/20041769.htm

process is referred to as Regulatory Justification. A class or type of practice is "new" if no practice in that class or type was carried out in the United Kingdom before 13 May 2000, and the class or type of practice has not previously been found to be Justified by the UK Justifying Authority.

2.5 This means that before carrying out a practice that is "new" the class or type of practice to which it belongs must go through a Regulatory Justification process. This process will involve an assessment of the economic, social and other benefits associated with the class or type of practice as against its health detriment. If the assessments find that the benefits outweigh the detriments then a Regulatory Justification decision will be made that the class or type of practice is Justified.

2.6 On 9 November 2009 the Secretary of State made a determination under regulation 12 that the class or type of practice set out in paragraph 1.1 above was new.

Justification, Optimisation and Dose Limitation

2.7 Regulatory Justification is an initial, high-level assessment of the benefits and detriments of a class or type of practice. The Basic Safety Standards Directive requires it to be carried out before the class or type of practice is first adopted or first approved. It is therefore not intended as a substitute for, or a duplication of, more detailed examinations by regulators of reactor designs and of the impact on specific sites of proposals to build nuclear power stations. These further examinations will need substantially more detailed information than is needed for the Regulatory Justification decision. Justification is the first step in the radiological protection regime recommended by the ICRP. There are other ICRP principles (Optimisation and Dose Limitation) relevant to the approval of nuclear power stations, which are applied separately and after the Regulatory Justification process.

2.8 Optimisation of protection is a requirement to keep all exposures as low as reasonably achievable (ALARA), taking into account social and economic factors. Dose Limitation is the principle that the total dose to any individual from regulated sources in planned exposure situations (other than medical exposure of patients) should not exceed the appropriate recommended limits[9].

2.9 There will therefore be further regulatory and planning processes which will apply to reactor designs and nuclear power stations before, during and after construction and operation. These further processes will address more detailed issues about the design of the AP1000 including issues relating to proposed siting at a particular location. A decision that a class or type of practice is Justified under the Regulations does not mean that the reactor

[9] Council Directive 96/29/EURATOM of 13 May 1996 (OJ L 159, 29.6.1996, p.1) http://ec.europa.eu/energy/nuclear/radioprotection/doc/legislation/9629_en.pdf
ICRP Publication 60: 1990 Recommendations of the ICRP and ICRP Publication 103: 2007 Recommendations of the ICRP http://www.icrp.org/

design and the nuclear power station will pass through the subsequent processes successfully.

2.10 The ICRP has recommended that when considering whether or not a class or type of practice is justified, the decision maker should consider not only the practice itself, but all other practices that are integral to it. The Secretary of State has therefore considered the AP1000, but has also considered, to the extent appropriate, other integral features such as waste handling and disposal.

2.11 Information about independent regulators and advisory bodies in the UK which have a role in the Optimisation and Dose Limitation processes is set out in Annex B (Roles of Independent Regulators and Advisory Bodies in the UK).

2.12 Although the regulators prescribe actions and conditions with which the operator of a nuclear power station must comply, in the UK it is the operator, not the regulators, who is legally responsible for ensuring their activities comply with the regulatory regime.

Nature of a Regulatory Justification decision

2.13 A class or type of practice must be Justified before it is first adopted or first approved. The Justifying Authority is therefore likely to make his decision in advance of full information on the benefits and detriments of the practice which might emerge from operational experience.

2.14 In the case of this decision, for example, although the Secretary of State has the benefit of the information provided by the Nuclear Industry Association in its application to justify new nuclear power stations as well as advice from the regulators, other Government bodies and his technical advisers, the Regulatory Justification decision must be made in advance of having final information on how many AP1000s and associated waste facilities will be built in the UK. The decision is also made before all the detailed information about the AP1000 and associated waste facilities is available. This information will emerge at a later stage, including through further regulatory processes under Optimisation and Dose Limitation as set out in above. These further processes, including site assessments, planning and assessment of the technical aspects of the designs, are in place in order to ensure a fully effective regulatory process. Regulatory Justification is only the first of these processes

2.15 Some responses to the consultation expressed a view that no Regulatory Justification decision should be made until significantly more information is known about the AP1000.

2.16 The Secretary of State does not agree that he should not make the decision or should delay it until all information about the AP1000 is available. In making this decision now he is able to make informed assumptions about benefits and detriments based on the best information currently available, including

information arising from operational experience of similar classes or types of practice, and based on the expert opinion of regulators and others. He is also making the decision in the knowledge that there are further stages to the regulatory process which will continue after the decision has been made which in themselves provide additional and separate safeguards and where a positive Regulatory Justification decision does not guarantee success.

2.17 It is also the case that if new and important evidence about the efficacy or consequences of the class or type of practice comes to light, then there is provision under regulation 10 of the Regulations for the Secretary of State to reassess any Regulatory Justification decision.

Facilitative actions

2.18 The Government's view is that it is in the public interest that new nuclear power stations should have a role to play in the UK's future energy mix alongside other low-carbon sources, that it is in the public interest to allow energy companies the option of investing in new nuclear power stations and that the Government should continue to take active steps to facilitate this. The facilitative actions include Regulatory Justification, the Strategic Siting Assessment (SSA) and the Generic Design Assessment (GDA).

2.19 Regulatory Justification decisions are a necessary step in order for new nuclear power stations to be built. Nothing in the Regulatory Justification process is intended to pre-empt decisions in other processes related to new nuclear power stations, or vice-versa; each proposed action will be considered on its own merits, without prejudice to the others.

Strategic Siting Assessment (SSA)

2.20 The SSA process assessed nominated sites to determine whether they were considered to be potentially suitable for the deployment of new nuclear power stations by the end of 2025. It was carried out by the Government using exclusionary and discretionary criteria, which were publicly consulted upon. In coming to its view on the potential suitability of sites, the Government has also taken account of the Appraisal of Sustainability (AoS) and Habitats Regulations Assessment (HRA), the views of members of the public on the nominations and the advice of regulators and other specialists.

2.21 The proposed list of the sites considered to be potentially suitable for the deployment of new nuclear power stations by the end of 2025 is set out in the Revised Draft National Policy Statement for Nuclear Power Generation (EN-6) (the Revised Draft Nuclear NPS), which (together with the Overarching NPS for Energy, EN-1) will provide the planning framework for considering applications for nuclear development consent. Revised drafts of the Nuclear NPS, the Overarching NPS, the AoS and the HRA Reports are the subject of a public consultation, published in October 2010, and Parliamentary scrutiny[10].

[10] www.energynpsconsultation.decc.gov.uk

Generic Design Assessment (GDA)

2.22 GDA allows for generic technical aspects of designs for nuclear power stations to be considered ahead of applications for site-specific licences, permits and consents. GDA will only need to be undertaken once for a given design. It is a process that considers the designs in much greater detail than is required for a high level assessment such as Justification. The Secretary of State therefore considers that such a process is not required in order to carry out a Justification assessment. However, as this information is available the Secretary of State has regard to it in considering this Regulatory Justification decision.

2.23 GDA is being carried out by the nuclear regulators: the Nuclear Installations Inspectorate and the Office for Civil Nuclear Security (both part of the Health and Safety Executive) and the Environment Agency. The work of the regulators is coordinated through a Joint Programme Office.

2.24 Four applications were received for the assessment process: AECL's ACR-1000, Westinghouse's AP1000, Areva's EPR and GE-Hitachi's ESBWR. All met the eligibility criteria and were accepted by the regulators for the first phase of GDA, which finished in March 2008.

2.25 Following the withdrawal of AECL from the process and the suspension by GE-Hitachi of its involvement, regulators are now undertaking a detailed assessment of the two remaining designs. They expect to publish their findings in Summer 2011.

2.26 Further information about GDA is available on the regulators' joint website: UK Nuclear Regulators – New Reactor Assessment[11].

Departmental Responsibility, the Justifying Authority, Devolved Administrations and Statutory Consultees

2.27 The Department of Energy and Climate Change (DECC) is the Department responsible for co-ordinating the Regulatory Justification process across Government and is the policy lead for the Regulations. Before the creation of DECC in October 2008, the Department for Environment, Food and Rural Affairs (Defra) had this responsibility and published Guidance[12] on the application and administration of the Regulations. Before the creation of DECC the Department for Business, Enterprise and Regulatory Reform (BERR) was the Justifying Authority for Regulatory Justification in the context of proposals for new nuclear power stations. This responsibility has also now passed to DECC.

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[11] http://www.hse.gov.uk/newreactors/index.htm

[12] The Justification of Practices Involving Ionising Radiation Regulations 2004 (SI 2004 No 1769), Guidance on their application and administration, Version May 2008 http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

2.28 Under the Regulations[13], the Justifying Authority in the UK is the responsible Secretary of State, and the three Devolved Administrations (the Scottish Executive, the Welsh Assembly Government and the Northern Ireland Assembly) to the extent that they have competence in respect of the subject matter of a particular Regulatory Justification application.

2.29 The subject matter of this decision is nuclear energy. Nuclear energy is a matter which, under the devolution settlements, has not been devolved to any of the Devolved Administrations. Therefore, the Secretary of State is the sole Justifying Authority in this case and his decision is UK-wide. The relevant Secretary of State in the area of nuclear energy is the Secretary of State for Energy and Climate Change.

2.30 The Secretary of State has consulted with the Devolved Administrations in making this decision, in accordance with regulation 18(2) of the Regulations and the Concordat on the Implementation of the Justification of Practices Involving Ionising Radiation Regulations 2004[14] (the Concordat). The Concordat governs the working relations between the Justifying Authorities in a way which respects the devolution settlements. This makes provision for the establishment of a Justification Liaison Group (the JLG), made up of DECC and the Devolved Administrations.

2.31 Before making a Regulatory Justification decision, the Justifying Authority is also required to consult with statutory consultees: the Health and Safety Executive (HSE), the Food Standards Agency (FSA), the Health Protection Agency (HPA) (which incorporated the former National Radiological Protection Board), the Environment Agency (EA), the Scottish Environment Protection Agency (SEPA) and the Department of the Environment for Northern Ireland (the Statutory Consultees)[15].

2.32 The Justification Co- ordination Committee (the JCC) was established to help co-ordinate the views of the JLG, the Statutory Consultees and other experts. The JCC meetings are chaired by officials from DECC, and membership is made up of officials from the Devolved Administrations, the Statutory Consultees, the Department for Transport and the Department of Health. Minutes of the JCC's meetings are published on DECC's website[16].

Consultation Process

2.33 A consultation on a proposed process for the Regulatory Justification of new nuclear power stations[17] was published in May 2007 alongside a public

[13] The Justification of Practices Involving Ionising Radiation Regulations 2004, Statutory Instrument 2004No. 1769 http://www.opsi.gov.uk/si/si2004/20041769.htm

[14] http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/radioactivity/decc/legislation/justification/justification.aspx

[15] Regulation 18(1) of the Regulations http://www.opsi.gov.uk/si/si2004/20041769.htm

[16] http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just. aspx

[17] http://www.berr.gov.uk/files/file39199.pdf

consultation on the role of nuclear power in a low carbon UK economy[18]. Responses to the consultation informed the development of the approach to the application of the Regulatory Justification process to new nuclear power station designs.

2.34 A response to the consultation was published in January 2008 as Annex B to the White Paper on Nuclear Power[19]. A call for Regulatory Justification applications for new nuclear power station designs was published in March 2008[20]. This provided guidance on the level of information expected of applicants, which would enable the Secretary of State to assess the net benefit of the class or type of practice against the radiological health detriment.

2.35 A timetable of the consultation process up to the Secretary of State's decision is set out in Annex C (Consultation and Decision Timetable).

The Application

2.36 In June 2008, the Nuclear Industry Association (the Applicant) submitted an application for a Regulatory Justification decision in relation to the class or type of practice being: 'The generation of electricity from nuclear energy using oxide fuel of low enrichment in fissile content in light water cooled, water moderated thermal reactors using evolutionary designs.'

2.37 The application contained evidence by which the Applicant aimed to demonstrate that the net benefit of the proposed class or type of practice outweighed the radiological health detriment. The proposed class or type of practice included four specific new nuclear power station designs – currently known as AECL's ACR-1000, Westinghouse's AP1000, Areva's EPR and GE-Hitachi's ESBWR.

2.38 The application was considered by the Department which, in consultation with the JCC, identified a number of areas where the Applicant needed to provide additional information to support the application. The Department and the JCC also commented on the way in which the class or type of practice contained in the application was defined. On 30 October 2008, the Secretary of State issued a Notice[21] under regulation 16 of the Regulations requesting additional information. The Applicant provided the additional information in the form of a consolidated application (the Application)[22] on 27 November 2008.

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18 The Role of Nuclear Power in a Low Carbon UK Economy, Consultation Document, May 2007 http://nuclearpower2007.direct.gov.uk/

19 Meeting the Energy Challenge: A White Paper on Nuclear Power, January 2008 http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/white_paper_08/white_paper_08.aspx

20 The Justification of Practices Involving Ionising Radiation Regulations 2004, Guidance for applications relating to new nuclear power, March 2008 http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/ energy_mix/nuclear/new/reg_just/reg_just.aspx

21 The Justification of Practices Involving Ionising Radiation Regulations 2004, Consultation on the Nuclear Industry Association's Application to Justify New Nuclear Power Stations, Volume 1: Consultation Document, Appendix C (Request to NIA for further information) http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

22 The Justification of Practices Involving Ionising Radiation Regulations 2004, Consultation on the Nuclear Industry Association's Application to Justify New Nuclear Power Stations, Volumes 2 and 3

Consultation on the Application

2.39 A public consultation on the Application was published in December 2008[23]. The purpose of the consultation was to help inform the Secretary of State's consideration of the Application.

2.40 The consultation on the Application asked the following questions:

1	Do you agree with the Government's preliminary view that, following the application submitted by the NIA (the Applicant), the decisions by the Secretary of State and the Justifying Authority should be by reference to four classes or types of practice, based on: (a) The generation of electricity from nuclear energy using oxide fuel of low enrichment in fissile content in a light water cooled, water moderated thermal reactor known as ACR1000 designed by Atomic Energy of Canada Ltd; (b) The generation of electricity from nuclear energy using oxide fuel of low enrichment in fissile content in a light water cooled, water moderated thermal reactor known as AP1000 designed by Westinghouse Electric Company LLC of the USA; (c) The generation of electricity from nuclear energy using oxide fuel of low enrichment in fissile content in a light water cooled, water moderated thermal reactor known as EPR designed by AREVA NP of France and Germany; (d) The generation of electricity from nuclear energy using oxide fuel of low enrichment in fissile content in a light water cooled, water moderated thermal reactor known as ESBWR designed by GE-Hitachi of the USA; and that these qualify as new classes or types of practice. If not, why not?
2	Does the Application contain sufficient information to enable the Justifying Authority to make an assessment of: (a) these classes or types of practice; and (b) the preferred class or type of practice; in the Application? In either case, if not, what further information is needed?
3	Do you have any comments on the arguments or evidence in the Application? Are there any additional arguments or evidence which the Justifying Authority should consider?
4	Do you have any other comments on the Government's preliminary view of the classes or types of practice, on the approach preferred by the NIA, or any other options?
5	Do you have any comments on how best the Government might

[23] http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just. aspx The Justification of Practices Involving Ionising Radiation Regulations 2004, Consultation on the Nuclear Industry Association's Application to Justify New Nuclear Power Stations http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

	accommodate changes or developments of the named reactors in its classes or types of practice?
6	Do you have any suggestions about the way in which the Government proposes to engage with the public in the later stage of the consultation process?

2.41 The consultation on the Application closed on 25 March 2009.

Responses to the Consultation on the Application

2.42 196 written responses to the consultation on the Application were received. These came from a wide range of stakeholders including industry, Non Governmental Organisations, Statutory Consultees, Government bodies, local campaign groups, local authorities and individual members of the public.

2.43 The responses were published on the Department's website[24].

Consultation on the Secretary of State's Proposed Decision and Response to the Consultation on the Application

2.44 A further consultation on the Secretary of State's Proposed Decision was published on 9 November 2009[25].

2.45 This consultation reflected consideration of responses to the consultation on the Application and served as a response to it by the following means.

2.46 Responses to Questions 1, 4 and 5 of the consultation on the Application, which related to the definition of class or type of practice, were dealt with in the determinations[26] published alongside the consultation on the Proposed Decision.

2.47 Responses to Questions 2 and 3 of the consultation on the Application, which related to the evidence provided, were dealt with in Chapters 3 to 10 of the Proposed Decision document and the Proposed Decision document for the EPR (Volume 3 of the consultation). These Chapters form the basis of those in this document.

2.48 Responses to Question 6 of the consultation on the Application, which relate to public engagement, were dealt with in text, further updated as paragraphs 2.55 to 2.56 below.

2.49 The consultation on the Secretary of State's Proposed Decision asked the following questions :

24 http://www.decc.gov.uk/en/content/cms/consultations/open/nuclear/nuclear.aspx
25 http://www.decc.gov.uk/en/content/cms/consultations/reg_just_cons/reg_just_cons.aspx
26 http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just. aspx

1	Chapter 3 (Radiological Health Detriment) sets out the evidence on the potential radiological health detriment arising from the class or type of practice. It also sets out the Secretary of State's current views based on that information. Do you agree or disagree with the views presently held by the Secretary of State on these matters? Please state the reasons for your answer. Do you consider that there are any matters relevant to the potential radiological health detriment that are not referred to in this Chapter? If so, please state what they are, and explain how and why they are relevant, and state what conclusions you think should be reached in light of these matters.
2	Chapter 4 (Radioactive Waste) sets out the evidence on the potential detriment arising from the waste and decommissioning aspects of the class or type of practice. It also sets out the Secretary of State's current views based on that information. Do you agree or disagree with the views presently held by the Secretary of State on these matters? Please state the reasons for your answer. Do you consider that there are any matters relevant to the potential detriment arising from waste and decommissioning that are not referred to in this Chapter? If so, please state what they are, and explain how and why they are relevant, and state what conclusions you think should be reached in light of these matters.
3	Chapter 5 (Environmental Detriment) sets out the evidence on the potential environmental detriment arising from the class or type of practice. It also sets out the Secretary of State's current views based on that information. Do you agree or disagree with the views presently held by the Secretary of State on these matters? Please state the reasons for your answer. Do you consider that there are any matters relevant to the potential environmental detriment that are not referred to in this Chapter? If so, please state what they are, and explain how and why they are relevant, and state what conclusions you think should be reached in light of these matters.
4	Chapter 6 (Safety and Security) sets out the evidence on the potential impact of the class or type of practice in terms of safety and security. It also sets out the Secretary of State's current views based on that information. Do you agree or disagree with the views presently held by the Secretary of State on these matters? Please state the reasons for your answer. Do you consider that there are any matters relevant to safety and security that are not referred to in this Chapter? If so, please state what they are,

	and explain how and why they are relevant, and state what conclusions you think should be reached in light of these matters.
5	Chapter 7 (Carbon Reduction Benefit) sets out the evidence on the potential benefit through carbon reduction arising from the class or type of practice. It also sets out the Secretary of State's current views based on that information. Do you agree or disagree with the views presently held by the Secretary of State on these matters? Please state the reasons for your answer. Do you consider that there are any matters relevant to the potential benefit through carbon reduction that are not referred to in this Chapter? If so, please state what they are, and explain how and why they are relevant, and state what conclusions you think should be reached in light of these matters.
6	Chapter 8 (Security of Supply Benefit) sets out the evidence on the potential benefit through security of supply arising from the class or type of practice. It also sets out the Secretary of State's current views based on that information. Do you agree or disagree with the views presently held by the Secretary of State on these matters? Please state the reasons for your answer. Do you consider that there are any matters relevant to the potential benefit through security of supply that are not referred to in this Chapter? If so, please state what they are, and explain how and why they are relevant, and state what conclusions you think should be reached in light of these matters.
7	Chapter 9 (Economic Assessment) sets out the evidence on the potential economic impact of the class or type of practice. It also sets out the Secretary of State's current views based on that information. Do you agree or disagree with the views presently held by the Secretary of State on these matters? Please state the reasons for your answer. Do you consider that there are any matters relevant to the potential economic impact that are not referred to in this Chapter? If so, please state what they are, and explain how and why they are relevant, and state what conclusions you think should be reached in light of these matters.
8	Chapter 10 (The Secretary of State's Proposed Decision) sets out the Secretary of State's proposed decision that the class or type of practice is justified by its benefits in relation to the health detriment it may cause. Do you agree or disagree with the Secretary of State's proposed decision? Please state the reasons for your answer. Do you consider that there are any matters relevant to the proposed decision that are not referred to in this Chapter? If so, please state what

	they are, and explain how and why they are relevant, and state what conclusions you think should be reached in light of these matters.
9	Are there any other points which you wish to make?

2.50 The consultation on the Application closed on 22 February 2010.

Responses to the Consultation on the Proposed Decision

2.51 180 written responses to the consultation on the Proposed Decision were received. These came from a wide range of stakeholders including industry, Non Governmental Organisations, Statutory Consultees, Government bodies, local campaign groups, local authorities and individual members of the public.

2.52 While all responses have been considered, this document does not attempt to set out the Government's response to every single point raised in response to the consultation; instead, it concentrates on the key themes which arose from the consultation and the issues considered by the Secretary of State in coming to this decision.

2.53 The Government published the responses it received in the course of the consultation on the Department's website[27].

Secretary of State's decision

2.54 The Secretary of State has set out the evidence that he has taken into account in coming to his decision that the class or type of practice is Justified under the Regulations in Chapters 4 to 9. These include the material contained in the Application, responses to the consultation on the Application and to the consultation on the Proposed Decision, and other advice and information sought by the Secretary of State. The decision itself is set out in Chapter 1 of this Decision document.

Other issues

Public Engagement

2.55 As part of its consultation on the Application, the Department asked for suggestions on engagement with the public at a later stage in the consultation process. Responses received during the consultation period supported the holding of one or more public engagement events. There were no detailed suggestions as to the format of any public engagement events.

2.56 The Department held such an event on 19 January 2010, during the consultation period. A transcript of the event was published on the Department's website[28].

[27] http://www.decc.gov.uk/en/content/cms/consultations/reg_just_cons/reg_just_cons.aspx

Inquiry or other hearing

2.57 The Regulations[29] provide for an inquiry or other hearing as one of a range of possible steps which the Secretary of State can take if he considers it expedient to do so in connection with the exercise of any of his functions under the Regulations. A number of respondents said that a public inquiry chaired by someone independent of Government was needed to ensure an open and transparent decision.

2.58 The Secretary of State has set out his decision on the holding of an inquiry or other hearing in a separate document[30].

Reprocessing and Mixed Oxide Fuel

2.59 The Secretary of State's decision does not extend to the reprocessing of spent fuel from new nuclear power stations. In addition, the Secretary of State has only considered the benefits and detriments associated with the use of low enriched uranium as a fuel. He has not considered the effects of using mixed oxide fuel and his decision does not extend to the use of such fuel.

Overseas practices

2.60 The Secretary of State has considered whether practices which are integral to the practice of generating electricity from new nuclear power stations, but which occur outside the UK, should be taken into account in making his decision.

2.61 The recommendations of the ICRP and the EU legislation require each country to assess the benefits and detriments of a class or type of practice carried on within its own borders[31], and to enforce the conclusions from such assessments. This is consistent with the Secretary of State's powers under the Regulations, which give no authority to acquire information outside the UK for the purposes of making a UK Justification decision.

2.62 However, although the Secretary of State does not consider that any examination of actions outside the UK is necessary, as a number of respondents to the consultation on the Application raised concerns about uranium mining, this is considered to the extent possible in Chapter 6 (Radiological Health Detriment).

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28 http://www.decc.gov.uk/en/content/cms/consultations/reg_just_cons/reg_just_cons.aspx

29 The Justification of Practices Involving Ionising Radiation Regulations 2004, Statutory Instrument 2004 No. 1769 http://www.opsi.gov.uk/si/si2004/20041769.htm

30 Justification of Practices Involving Ionising Radiation Regulations 2004 – Secretary of State's decisions as Justifying Authority on the Regulatory Justification of new nuclear reactor designs currently known as AP1000 and EPR, October 2010 - Statement by Secretary of State on provision in Regulation 17(1) to hold an inquiry or other hearing http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

31 In addition the ICRP recommends that practices which are integral to the class or type of practice under consideration should also be taken into consideration.

Chapter 3: Overall Approach of the Application

Content of the Application

3.1 The Application[32] stated that it had followed the guidance issued with the call for applications[33] on how the process would operate and on the expected content of applications. In particular, it had provided information that would enable the Secretary of State to assess the net benefit of the class or type of practice against the radiological health detriment.

3.2 The Application stated that it had focused on the potential benefits of the delivery of low-carbon electricity and increased security of supply and that while there were other potential benefits it had not relied on these in demonstrating that the class or type of practice was Justified under the Regulations. The Application also sought to consider the full range of detriments that might be set against the stated benefits.

3.3 The summary at the end of the Application concluded that the benefits to be gained from the class or type of practice through security of supply and carbon reduction were very significant, and that, taking all other potential detriments into account, there was a major net benefit against which the potential radiological health detriment would be small.

3.4 The Application therefore concluded that the class or type of practice should be Justified under the Regulations.

Consultation approach to Class or Type of Practice

3.5 The call for applications sought information which could enable a single Regulatory Justification decision to be made in relation to a number of different designs, subject to the Secretary of State satisfying himself that all reactor designs falling within a proposed class or type of practice were sufficiently similar to be considered together as a single class or type of practice. In response to this, the Application sought Regulatory Justification for a generic class or type of practice being: 'the generation of electricity from nuclear energy using oxide fuel of low enrichment in fissile content in light water cooled, water moderated thermal reactors using evolutionary designs' and

[32] The Justification of Practices Involving Ionising Radiation Regulations 2004, Consultation on the Nuclear Industry Association's Application to Justify New Nuclear Power Stations, Volumes 2 and 3 http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

[33] The Justification of Practices Involving Ionising Radiation Regulations 2004, Guidance for applications relating to new nuclear power, March 2008 http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/ energy_mix/nuclear/new/reg_just/reg_just.aspx

provided evidence for four designs (ACR-1000, AP1000, EPR and ESBWR) deemed to fall within that class or type of practice.

3.6 The Secretary of State subsequently determined[34] that the Application should be treated as an application for four classes or types of practice. In this case, the Secretary of State is making a decision in relation to:

"*The generation of electricity from nuclear energy using oxide fuel of low enrichment in fissile content in a light water cooled, light water moderated thermal reactor currently known as the AP1000 designed by Westinghouse Electric Company LLC*."

3.7 The generic class or type of practice proposed by the Applicant meant that the main part of the Application provided evidence on the benefits and detriments of the practice on an almost entirely non-design-specific basis. However, detailed design-specific technical information on the AP1000 was provided in Annex 6B to the main part of the Application, which provided evidence to demonstrate that the AP1000 had the capability of providing the benefits and limiting the detriments described in the main part of the Application.

3.8 The Chapters which follow include brief summaries of points made in the Application. However, anyone wanting to follow the Application's arguments, evidence and supporting references in detail should read the Application in full[35].

[34] http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just. aspx

[35] The Justification of Practices Involving Ionising Radiation Regulations 2004, Consultation on the Nuclear Industry Association's Application to Justify New Nuclear Power Stations, Volumes 2 and 3 http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just. aspx

PART 3 – BENEFITS AND DETRIMENTS

Chapter 4: Carbon Reduction

Introduction

4.1 Decarbonising the UK economy and meeting our legal low-carbon obligations are important objectives. The Secretary of State has therefore considered the potential of the AP1000 to help achieve these objectives. This Chapter examines the content of the Application relating to the carbon reduction benefits claimed for the AP1000 and responses to the consultations on the Application and on the Proposed Decisions. It then sets out the Secretary of State's present view on the importance of reducing the UK's carbon emissions and the contribution which new nuclear power stations can make to this.

Guidance for applications

4.2 The guidance for Regulatory Justification applications for new nuclear power stations[36] said that applicants could provide information explaining how the class or type of practice would demonstrate its low carbon footprint, and that an application could cover:

- total emissions across the full life cycle;
- net contribution to UK's overall emissions;
- emissions from alternatives if the proposed designs were not deployed; and
- mitigation strategies, regulatory arrangements and related assurance to address pertinent detriments and risks.

[36] The Justification of Practices Involving Ionising Radiation Regulations 2004, Guidance for applications relating to new nuclear power, March 2008 http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

Summary of the Application

4.3 This is a brief summary of points made in the Application. Anyone wanting to follow the Application's arguments, evidence and supporting references in detail should read the Application in full.

4.4 The Application assessed the potential carbon reduction benefits of the class or type of practice.

4.5 The Application stated that nuclear power is a low carbon generating technology with emissions across the entire life cycle comparable to those from wind generation. The Application stated that, over their 60 year lifetime, a series of new nuclear power stations providing the same amount of electricity as the existing ones could save 1.7 billion tonnes of carbon dioxide (CO_2) compared with generating the same energy from gas-fired power stations. The Application stated that this is about three times the UK's current total annual carbon emissions.

4.6 The Application stated that, for these reasons, new nuclear stations would contribute significantly towards meeting the UK's carbon reduction targets and that this represents a major benefit from the practice[37].

AP1000 Design Specific Considerations

4.7 The Application stated that its conclusions on why nuclear technology is considered to be low carbon were based on non design specific factors[38].

Summary of responses to the consultation on the Application

4.8 Several respondents supported the role of nuclear in contributing to reducing carbon emissions. However, a number of respondents felt that nuclear should not play a part in the UK's energy mix and that investing in new nuclear power stations would divert investment from other low carbon technologies or energy efficiency initiatives and so undermine the development of a long-term sustainable solution for the UK's energy needs.

[37] The Justification of Practices Involving Ionising Radiation Regulations 2004, Consultation on the Nuclear Industry Association's Application to Justify New Nuclear Power Stations, Volume 2, Chapter 3 (Carbon reduction)
http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

[38] The Justification of Practices Involving Ionising Radiation Regulations 2004, Consultation on the Nuclear Industry Association's Application to Justify New Nuclear Power Stations, Volume 2, Chapter 1 Addendum, page 10
http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

Summary of responses to the consultation on the Proposed Decision

4.9 Responses were along similar lines to those to the consultation on the Application.

4.10 Some respondents agreed with the Proposed Decision's view that meeting carbon reduction targets is very important and that the AP1000's ability to help ensure low-carbon energy supplies is a significant benefit.

4.11 Some respondents questioned whether nuclear power is a low-carbon form of energy and whether the Government took into account carbon emissions throughout the nuclear fuel cycle.

4.12 Some respondents said that carbon reduction could be delivered more effectively and without risk by renewable energy or greater energy efficiency and that investment in nuclear would discourage investment in these sources and therefore reduce our ability to reduce carbon emissions.

Secretary of State's view

4.13 Climate change is one of the gravest threats the world faces and urgent action at home and abroad is required. The Committee on Climate Change (CCC) said in its first report that "*climate change resulting from CO_2 and other greenhouse gas emissions poses a huge threat to human welfare*"[39]. The Government is determined to use a wide range of levers to cut carbon emissions, de-carbonise the economy and support the creation of new green jobs and technologies. This will enable the UK to fulfil its ambitions for a low carbon economy, while also working towards an ambitious global climate deal that will limit emissions and create new international sources of funding for the purpose of climate change adaptation and mitigation.

4.14 The Secretary of State is satisfied that new nuclear power stations should be able to play a part in low carbon electricity generation.

Climate change and low-carbon energy

4.15 Human activities are causing global climate change. The burning of fossil fuels, changes in land use, and various industrial processes are adding greenhouse gases, particularly CO_2, to the atmosphere. There is now roughly 40% more CO_2 in the atmosphere than there was before the industrial revolution, and such high levels have not been experienced on earth for at least 800,000 years. The effects of these additional gases can already be seen (global average temperatures have risen by 0.75°C since about 1990) with consequences for both the environment and people's lives. The Low

[39] "Building a low-carbon economy – The UK's contribution to tackling climate change", December 2008. http://www.theccc.org.uk/pdf/TSO-ClimateChange.pdf, page xiii

Carbon Transition Plan (LCTP)[40], published in 2009, concluded that if climate change continues unchecked then the consequences for the UK will be severe, and that across the world the consequences of failing to control emissions would be worse still[41]. Action on climate change is urgently needed to prevent widespread human suffering, ecological catastrophe, and political and economic instability.

4.16 The Stern Review[42] of the economic impacts of climate change stressed the potential financial cost and highlighted the need for an urgent, co-ordinated international response to address this. It suggested that working to mitigate the problems of climate change immediately would cost about 1% of global GDP a year by 2050 with a range of +/-3% to take account of a number of variables. As a comparison, the Stern Review said that it could cost about 5% of global GDP a year in the long term if nothing is done, rising to as much as 20% if a wider range of issues such as health and the environment is taken into account.

4.17 The UK has legally binding targets under the Climate Change Act 2008[43] to cut emissions by at least 80% by 2050, and by at least 34% by 2020, with both targets being from a 1990 baseline. The LCTP notes that currently three quarters of the UK's electricity is generated using coal and gas. By 2050 the UK may need to produce more electricity than it does today, in some scenarios perhaps as much as 50% more, but must do so largely without emitting greenhouse gases. The UK will therefore need to transform its system so that virtually all electricity will by 2050 come from low-carbon sources such as renewables, nuclear and fossil fuel plants fitted with carbon capture and storage technology. Even if demand for electricity does not increase, the UK will still need new electricity generation capacity to replace nuclear and other power stations as they close. To achieve carbon emissions reductions, new generating capacity would need to be low-carbon.

Nuclear as a low-carbon source of energy

4.18 The Government is taking practical action on many different fronts to cut emissions from electricity generation, to ensure a diverse energy mix and to ensure that the UK moves towards low carbon sources of electricity generation. As part of tackling these challenges, the UK is also investing in energy efficiency and measures to reduce overall demand for electricity.

4.19 Nuclear power has long been Britain's most significant source of low carbon energy, and can have a role to play in our energy mix, alongside other low

[40] Low Carbon Transition Plan: National Strategy for Climate Change and Energy http://www.decc.gov.uk/assets/decc/white%20papers/uk%20low%20carbon%20transition%20plan%20wp09/1_20090724153238_e_@@_lowcarbontransitionplan.pdf

[41] LCTP, Chapter 1 (The challenge) http://www.decc.gov.uk/assets/decc/white%20papers/uk%20low%20carbon%20transition%20plan%20wp09/1_20090724153238_e_@@_lowcarbontransitionplan.pdf

[42] Stern Review on the Economics of Climate Change, 30 October 2006 http://www.occ.gov.uk/activities/stern.htm

[43] Climate Change Act 2008 (c.27) http://www.opsi.gov.uk/acts/acts2008/pdf/ukpga_20080027_en.pdf

carbon technologies, including renewables and carbon capture and storage (CCS).

4.20 The Secretary of State has taken into account the findings of various independent reports that have examined the carbon emissions from nuclear power stations. Such reports, known as life cycle analyses, typically examine the emissions for the complete nuclear fuel cycle, from mining of uranium, through processing, electricity generating and finally disposal of the waste.

4.21 The analyses that the Secretary of State has considered all show that nuclear has very low emissions when compared with fossil fuelled electricity generating technologies, and is comparable with renewable technologies, such as wind power. The table below presents the findings from a range of reports that have been reviewed. The differences in CO_2 emissions between studies are attributed to varying assumptions made for each study, and/or to the specific geographic location for the study.

4.22 The Secretary of State is satisfied that, throughout their lifecycle, the CO_2 emissions from nuclear power stations are low.

Life cycle carbon emissions for various technologies CO2 g/kWh

Organisation / Author	Nuclear	Wind	Gas	Coal (Lignite)	Hydro
British Energy[44]	7		400	900	
Vattenfall[45]	3	10	400	700	
CERI [46]	2		556	1048	
WEC[47]	3 – 40	8 - 15	400 - 500	850 – 1025 (1050 – 1350)	6 - 90
IAEA[48]	9 – 21	9 – 48	440 – 689	968 – 1309 (957 – 1342)	4 - 23
IPCC[49]	3 – 40	8 - 15	400 - 500	850 – 1025	6 - 90

44 British Energy / AEA (2009), Environmental Product Declaration of Electricity from Torness Nuclear Power Station: Technical Report, pp. 1. http://www.british-energy.com/documents/Torness_EPD_Report_Final.pdf

45 Vattenfall (2005), Life-cycle assessment: Vattenfall's electricity in Sweden, pp. 22. http://www.vattenfall.com/en/file/2005-lifecycleassessment_8459810.pdf

46 Jazayeri, Seyed, et al. Canadian Energy Research Institute (2008), Comparative Life Cycle Assessment (LCA) of Base Load Electricity Generation in Ontario, pp. 62. http://www.cna.ca/english/pdf/studies/ceri/CERI-ComparativeLCA.pdf

47 World Energy Council (2004), Comparison of energy systems using life cycle assessment: A special report of the World Energy Council, pp. 36. http://www.worldenergy.org/documents/lca2.pdf

48 Spadaro, Joseph V. et al. (2000). Greenhouse gas emissions of electricity generation chains: assessing the difference, IAEA Bulletin, 42/2/2000, pp. 19 – 24. http://www.iaea.org/Archives/templates/jsp/pages/pi/BulletinWeb_search.jsp?y_i=00s%2F2000%2FIssue+2#

49 R.E.H. Sims, R.N. Schock, A. Adegbululgbe, J. Fenhann, I. Konstantinaviciute, W. Moomaw, H.B. Nimir, B. Schlamadinger, J. Torres-Martínez, C. Turner, Y. Uchiyama, S.J.V. Vuori, N. Wamukonya, X. Zhang, (2007).

Organisation / Author	Nuclear	Wind	Gas	Coal (Lignite)	Hydro
				(1050 – 1350)	
ISA University of Sydney[50]	60 – 65	21	577 - 751	863 – 1175	15
Dones[51]	8 – 11	14 – 21	485 – 991	949 – 1280 (1060 – 1690)	3 - 27
NEEDS[52]	6	8	398	776 (921)	
SDC[53]	16		356	891	
Dones[54]	13	13	700	1190 (1210)	4
Weisser[55]	3 – 24	8 – 30	360 – 575	800 – 1100 (1100 – 1700)	1 - 34

Conclusion

4.23 The Secretary of State is conscious of the predicted impact of climate change on the UK.

4.24 Although Regulatory Justification is not an exercise in comparing the advantages of the different methods of producing energy, it is possible in assessing the carbon reduction benefit of nuclear power to compare its

Energy supply. *In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds), Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. pp. 283. http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter4.pdf

50 Bilek, Marcela, et al. ISA, The University of Sydney, Australia (2006). *Life-Cycle Energy Balance and Greenhouse Gas Emissions of Nuclear Energy in Australia: A study undertaken for the Department of Prime Minister and Cabinet of the Australian Government*. pp. 172. http://www.isa.org.usyd.edu.au/publications/documents/ISA_Nuclear_Report.pdf

51 Dones, R. et al. (2003) Greenhouse gas emissions from energy systems: comparison and overview. In *Paul Scherrer Institute Annual Report 2003 Annex IV*. pp. 38. http://gabe.web.psi.ch/pdfs/Annex_IV_Dones_et_al_2003.pdf

52 NEEDS: New Energy Externalities Developments for Sustainability Framework Programme 6 (2009). *Deliverable n° 6.1 – RS1a External costs from emerging electricity generation technologies.* pp. 12 – 48. http://www.needs-project.org/2009/Deliverables/RS1a%20D6_1%20External%20costs%20of%20reference%20technologies%2024032009.pdf

53 Sustainable Development Commission (2006). *The role of nuclear power in a low carbon economy. Paper 2: Reducing CO2 emissions – nuclear and the alternatives*. pp. 21. http://www.sd-commission.org.uk/publications/downloads/Nuclear-paper2-reducingCO2emissions.pdf

54 Dones R., Bauer C., Heck T. (2007). LCA of current coal, gas and nuclear electricity systems and electricity mix in the USA. *Proceedings of the 14th SETAC Europe LCA Case Studies Symposium, December 3-4, 2007, Gothenburg, Sweden*. http://gabe.web.psi.ch/pdfs/lca/Dones_etal-LCA_of_current_coal_gas_and_nuclear_electricity_systems_and_electricity_mix_in_the_USA.pdf

55 Weisser, D. (2007). A guide to life-cycle greenhouse gas (GHG) emissions from electric supply Technologies. *Energy, Volume 32, Issue 9*. September 2007. pp. 1543-1559 http://www.iaea.org/OurWork/ST/NE/Pess/assets/GHG_manuscript_pre-print_versionDanielWeisser.pdf

lifecycle carbon emissions against those of other technologies. Such comparisons show that nuclear, taking the whole fuel cycle into account, is a low carbon technology.

4.25 The UK is committed to international obligations to reduce the amount of carbon dioxide produced in the UK. The power and heavy industry sectors accounts for 35% of UK emissions[56] and the Secretary of State considers that reducing carbon emissions from this area constitutes an important part of the UK's carbon reduction obligations.

4.26 The Secretary of State has noted the conclusions of the UK Low Carbon Transition Plan on the significant threat associated with climate change, and is of the opinion that he must give this due weight when considering the impact of low carbon generation.

4.27 The Secretary of State considers that meeting the UK's carbon reduction targets is very important and that the AP1000's ability to assist with this by producing low carbon electricity is a significant benefit.

[56] The UK Low Carbon Transition Plan, National Strategy for Climate and Energy, 15 July 2009, page 9 http://decc.gov.uk/assets/decc/white%20papers/uk%20low%20carbon%20transition%20plan%20wp09/1_20090724153238_e_@@_lowcarbontransitionplan.pdf

Chapter 5: Security of Supply and other Economic Effects

Introduction

5.1 Secure energy supplies are essential to the UK. The Secretary of State has therefore considered the potential of the AP1000 to help achieve this security, and its more general potential economic effects. This Chapter considers the content of the Application relating to the effect on security of supply and other economic factors of the AP1000, and responses to the consultations on the Application and the Proposed Decision. It then sets out the Secretary of State's view on the advantage of investing in new nuclear power stations, including the benefit of increased security of energy supplies for the UK, and the other economic factors he has taken into account, including the potential economic impact of an accident at a new nuclear power station.

Guidance for applications

5.2 The guidance for Regulatory Justification applications for new nuclear power stations[57] said that an applicant should provide information that would enable the Secretary of State to undertake a high level assessment of the net economic, social or other benefits against the health detriments in relation to the operation of new nuclear power stations in the UK. As far as security of supply was concerned the guidance said that an application could cover:

- benefits and detriments associated with base load plant;
- vulnerability to fluctuations in availability of fuel; and
- value of a more or less diverse portfolio mix.

[57] The Justification of Practices Involving Ionising Radiation Regulations 2004, Guidance for applications relating to new nuclear power, March 2008 http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

Summary of the Application

5.3 This is a brief summary of points made in the Application. Anyone wanting to follow the Application's arguments, evidence and supporting references in detail should read the Application in full.

5.4 The Application addressed the potential economic impact of adoption of the class or type of practice on the UK economy. It stated that in doing so it did not rely on demonstrating an economic benefit, but instead presented evidence that the class or type of practice should not be expected to impose a detriment on the wider UK economy.

5.5 The evidence in the Application was drawn from the cost-benefit analysis of nuclear power generation and assessment of the long run costs of climate change mitigation[58] undertaken to support the White Paper on Nuclear Power in 2008 and stated by reference to this analysis that the risk of economic detriment was very remote. It did not seek to reproduce the investment appraisal undertaken by any company seeking to implement the class or type of practice in the UK.

5.6 The Application stated that the potential economic impact of new nuclear power stations was determined not only by the resource cost of the class or type of practice relative to alternative technologies, but also by the additional characteristics specific to nuclear technology. These included the benefits of avoided carbon emissions and increased security of supply, and the risk that developers or operators may become insolvent leaving unfunded waste and decommissioning liabilities.

5.7 The Application stated that, before taking into account any of the benefits of reduced carbon emissions and increased security of supply, the economic cost of the class or type of practice was finely balanced against that of the likely alternative of gas-fired generation. However, if the economic impact of these benefits was taken into account, adoption of the class or type of practice was highly likely to be beneficial for the UK economy.

5.8 The Application stated that new nuclear power stations represented the most cost effective means available within the generation sector of mitigating carbon dioxide emissions and were likely to be economic for developers given the policy commitments on facilitative actions and a long-term carbon price signal set out in the White Paper on Nuclear Power. In view of the capital-intensive nature of nuclear investment, it was also likely to be economic to undertake financial restructuring and for a successor to continue operation in the event of operator insolvency.

[58] The Nuclear Power Generation Cost Benefit Analysis, BERR, April 2007 http://www.berr.gov.uk/files/file39525.pdf

5.9 The Application stated that, to the extent that the electricity market is competitive and the economic cost of the class or type of practice is lower than for alternative electricity generating technologies, consumers can also expect to benefit on average via downward pressure on energy prices.

5.10 The Application stated that the strong regulatory regime in place ensured a very low risk of severe accident. This meant that the deployment of the class or type of practice would not be expected to impose any resulting economic detriment on the wider UK economy.

5.11 The Application stated that, as with other major infrastructure projects, the class or type of practice would bring significant socio-economic benefits to the local economy through long-term, high quality employment, the contribution of the additional workforce during outages, together with the benefits for local businesses and services to the nuclear power station and from the wider economic effect. The Application further stated that the construction of new nuclear power stations would bring major benefits to the UK construction and manufacturing industry[59].

5.12 The Application assessed the potential security of supply benefits of the class or type of practice.

5.13 The Application stated that new nuclear power stations could be expected to match or exceed the performance of the best current light water reactors and deliver high levels of performance in terms of reliable supply. This would help to provide large scale, reliable and secure electricity generation, achieve the diverse electricity generation mix sought by the Government and maintain electricity supplies in the event of disruption to fossil fuel imports.

5.14 The Application stated that new nuclear power stations could make a contribution by as early as 2017/2018.

5.15 The Application stated that sufficient uranium is available to fuel existing and potential new nuclear power stations; that nuclear power stations are relatively invulnerable to fluctuations in the availability of fuel; and that low fuel costs and predictable operating costs would act as a stabilising influence on UK electricity prices.

5.16 The Application stated that, for these reasons, new nuclear power stations would contribute significantly to the UK's energy security, and that this represents a major benefit from the class or type of practice[60].

[59] The Justification of Practices Involving Ionising Radiation Regulations 2004, Consultation on the Nuclear Industry Association's Application to Justify New Nuclear Power Stations, Volume 2, Chapter 7 (Economic assessment) http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

[60] The Justification of Practices Involving Ionising Radiation Regulations 2004, Consultation on the Nuclear Industry Association's Application to Justify New Nuclear Power Stations, Volume 2, Chapter 2 (Security of supply benefits) http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

AP1000 Design Specific Considerations

5.17 The Application did not propose any specific features of the AP1000, as opposed to new nuclear power stations in general, which would affect a high level assessment of the net economic benefits of the operation of new nuclear power stations in the UK.

5.18 The Application stated that the AP1000 does not have any specific features that might cause it to offer a lower security of supply than that described in the Application, that fuel can be provided by different suppliers thus keeping the market open and competitive and that the AP1000 would be available in the UK to provide the described benefits on the timescales needed to meet UK energy policy[61]. The Application stated that the nominal electrical power output of the AP1000 is about 1,100 Megawatts (MW)[62].

Summary of responses to the consultation on the Application

5.19 Several respondents said that the new class or type of practice would bring benefits to the UK economy through contributing to the security of the UK's energy supplies, investment in the nuclear supply chain and development of a nuclear workforce.

5.20 Some respondents felt that any money spent on new nuclear power stations would be better spent on other low carbon technologies or energy efficiency initiatives, which could better achieve security of supply.

5.21 While some respondents argued that uranium is a reliable, widely available fuel supply, others doubted its future availability.

5.22 Several respondents commented on the experience of new nuclear power stations currently being built in France and Finland, suggesting that this showed a tendency for cost increases and overruns.

5.23 A number of respondents expressed concern about costs arising from new nuclear power stations which they believed might fall to the taxpayer. Several respondents questioned the willingness of the commercial market to insure new nuclear power stations against the risk of accident, and said that the Secretary of State should consider the potential economic impact of an accident in coming to a Regulatory Justification decision.

5.24 Several responses argued that the Application did not contain sufficient information on the potential costs of decommissioning new nuclear power

[61] The Justification of Practices Involving Ionising Radiation Regulations 2004, Consultation on the Nuclear Industry Association's Application to Justify New Nuclear Power Stations, Volume 2, Chapter 2 (Security of supply benefits) http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

[62] The Justification of Practices Involving Ionising Radiation Regulations 2004, Consultation on the Nuclear Industry Association's Application to Justify New Nuclear Power Stations, Volume 2, Chapter 1, Table 1.2 http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

stations. They also expressed concern that the financing arrangements in place to meet the costs of decommissioning, waste management and disposal could amount to a subsidy to the nuclear industry and a burden on the taxpayer.

Summary of responses to the consultation on the Proposed Decision

5.25 Several respondents agreed with the conclusions in the Proposed Decisions and said that the new class or type of practice would bring benefits to the UK economy by contributing to the security of the UK's energy supplies. They argued that nuclear power stations are capable of providing reliable base-load electricity around the world and that there is no reason to conclude that the AP1000 cannot achieve similar performance levels of reliability and stability.

5.26 Several respondents also argued that the new class or type of practice would bring benefits through investment in the nuclear supply chain and development of a nuclear workforce and that if nuclear were unavailable, it would be significantly more costly to meet carbon reduction targets.

5.27 However, a number of respondents questioned the economics of new nuclear, and argued that it was not a cost effective means of generating electricity if the full lifecycle was considered, that security of supply could be better achieved by investment in renewable energy, energy efficiency, new technologies and decentralisation and that nuclear power stations would not be operational before the predicted energy gap.

5.28 Several respondents argued that the building of new nuclear power stations in France and Finland showed a tendency for cost increases and overruns, although another respondent said that there was a developing understanding of the causes of this from these projects and further experience to be gained from other new projects which will help with the building of new nuclear power stations in the UK.

Waste disposal and decommissioning funding

5.29 A number of respondents expressed concern about costs arising from new nuclear power stations which they believed might fall to the taxpayer.

5.30 These respondents argued that the costs of decommissioning, waste management and disposal had not been taken into account. They argued that the financing arrangements put in place by Government to meet these costs will not be effective as the costs of managing the radioactive waste will continue to rise and will continue after the profits to the operator from nuclear power have ceased. They were also concerned that an operator might become insolvent.

5.31 Some also argued that the system was itself a subsidy to the industry, or that nuclear power would be subsidised by way of a carbon price to the detriment of renewable energy.

Insurance

5.32 Several respondents questioned the willingness of the commercial market to insure new nuclear power stations against the risk of accident, and said that the insurance arrangements in place constitute a subsidy to the industry, that the taxpayer would ultimately have to bear the cost of an accident and that the Secretary of State should consider the potential economic impact of an accident.

Uranium supplies

5.33 Some respondents said that there is a reliable supply of uranium at a cost which is a small part of generating costs. However, a number of respondents doubted the future availability of uranium, and argued that increased demand worldwide could lead to supplies becoming more difficult and expensive.

Skills and supply chain

5.34 A number of respondents said that the employment opportunities offered by new nuclear are not unique, and that development of renewable energy would offer greater opportunities.

5.35 Some respondents argued that the UK does not have enough skilled workers to work on the decommissioning of existing nuclear power stations, or the building of new ones.

Socio-economic benefits

5.36 Some respondents said that any benefits to a local economy should be balanced by negative impacts on housing costs, tourism, losses of key workers and the costs of policing and health.

Secretary of State's view

5.37 Chapter 4 of this document sets out the economic and other benefits to the UK to be gained from new nuclear power stations through reduced carbon emissions. The Secretary of State also believes that investment in new nuclear power stations will increase the UK's energy security, and, by reducing reliance on energy sources with volatile prices, such as fossil fuels, would be likely to reduce the volatility of the wholesale electricity price, to the gain of consumers and the wider economy.

5.38 The reliable and affordable supply of electricity is essential to the daily lives of the population of the UK, and the functioning of business around the country. It is difficult to overstate the extent to which quality of life is dependent on

adequate energy supplies. Interruptions to supply, and the increased costs which would result, would have an adverse social and economic impact.

5.39 Interruptions to supply would mean that the economy would not be able to function normally and would impose significant economic and social costs, and significant disruption to people's lives. Increases in energy bills would also mean that economic costs of production would rise, increasing inflation and potentially increasing the number of people affected by fuel poverty.

Reliability of uranium supplies

5.40 Reliability in the fuel supply chain is a key element in achieving secure energy supplies. The Secretary of State therefore noted the concern among some respondents to the consultation on the Application about the finite nature of uranium and its future availability as a fuel supply and has considered this point further.

5.41 The majority of nuclear fuel is made from enriched uranium. The UK is not a uranium producer but uranium ore may be imported and stockpiled. Deposits of uranium are widely dispersed across a number of countries. Potential sources include countries that the UK does not currently rely on for fossil fuels and there are considerable resources available in OECD[63] countries, meaning that nuclear can therefore help spread the supply risks that could be associated with a particular fuel or region of the world[64].

5.42 The OECD's Nuclear Energy Agency (NEA) and the IAEA[65] have stated that, regardless of the role that nuclear energy ultimately plays in meeting rising electricity demand, the uranium resource base is more than adequate to meet projected requirements, and the Euratom Supply Agency[66] has expressed confidence that there are sufficient identified uranium resources to meet the current demand for about 100 years.

5.43 The OECD/IAEA Uranium 2009 report states that worldwide exploration and mine development expenditures in 2008 totaled about USD 1.641 billion, an increase of 133% compared to updated 2006 figures. This provides confidence that exploration is continuing and that new resources will be identified. The Euratom Supply Agency Annual Report 2009 acknowledged that uranium is mined in 18 countries, seven of which account for 90% of world production (Australia, Canada, Kazakhstan, Namibia, Niger, the Russian Federation and Uzbekistan). The relatively diverse geographical distribution of uranium resources and fuel fabrication activities allows confidence that the risk

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63 Organisation for Economic Cooperation and Development http://www.oecd.org/home/

64 Building a low-carbon economy – the UK's contribution to tackling climate change, Committee on Climate Change 2008 http://www.theccc.org.uk/reports/building-a-low-carbon-economy

65 OECD Nuclear Energy Agency and the International Atomic Energy Agency (2010) Uranium 2009: Resources, Production and Demand. http://www.oecdbookshop.org/oecd/display.asp?CID=&LANG=EN&SF1=DI&ST1=5KMD4HVHN4ZR
See also DECC (2009). *Energy Markets Outlook: December 2009*. pp. 112 – 119. http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/markets/outlook/outlook.aspx

66 Euratom Supply Agency (2010) Euratom Supply Agency Annual Report 2009. http://ec.europa.eu/euratom/ar/ar2009.pdf

of disruption is low, as the supply of uranium is not limited to one country or region of the world.

5.44 If global demand significantly affected the price of uranium, it would have only a limited effect on the cost of generation since uranium represents a much smaller part of the cost of electricity in nuclear power stations than the fuel for other forms of electricity generation[67].This was illustrated in 2007 when the spot price for uranium moved from very low levels where it had been for almost two decades to record highs and then subsequently fell back. Since raw uranium only makes up a small proportion (around 1.5%) of total nuclear generation costs, the movement had little effect on overall nuclear costs[68].

5.45 A recent report by Mott MacDonald[69] also highlighted nuclear's relative insensitivity to fluctuation in both fuel and carbon prices, compared with other technologies.

5.46 In addition, the amount of uranium required to produce a set quantity of electricity through nuclear generation will be lower for the AP1000 than for previous and existing designs. In their technical paper[70], Integrated Decision Management and the National Nuclear Laboratory (IDM–NNL) concluded that the amount of uranium required to produce a set quantity of electricity through nuclear generation will be lower for the AP1000 than for the UK's Magnox and AGR reactors as higher fuel burn-ups are reached. Increasing burn-up is a characteristic of improving PWR fuel design and manufacture, and will also be available to current PWR reactors[71].

5.47 IDM-NNL also advised that if the total electricity generated from existing UK nuclear power stations is compared with the lifetime operations of new nuclear power stations of a similar generating capacity, then the new nuclear power stations will generate twice as much electricity. This is because they are likely to operate for about 60 years, compared with 40 years for an existing nuclear power station, and because they will be expected to operate with a higher load factor[72].

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67 Tarjanne & Rissanen. Least-Cost Option for Baseload Electricity in Finland. The Uranium Institute 25th Annual Symposium, 30 August-1 September 2000: London. Tarjanne and Rissanen's paper found that "an increase in the uranium price causes only a slight increase in nuclear electricity costs, whereas for the natural gas alternative a rising trend of gas prices causes a major cost increase". http://www.world-nuclear.org/sym/2000/pdfs/tarjanne.pdf

68 Meeting the Energy Challenge: A White Paper on Nuclear Power, January 2008, paragraphs 2.29 – 2.42 http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/white_paper_08/white_paper_08.aspx

69 Mott MacDonald: UK Electricity Generation Costs Update http://www.decc.gov.uk/en/content/cms/statistics/projections/projections.aspx

70 Technical Advice to inform proposed Regulatory Justification decisions on new nuclear power stations, Authors: Gregg Butler, Grace McGlynn (IDM), Andy Worrall, Kevin Hesketh (NNL). http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx]

71 See paragraphs 6.72 to 6.74 for more detail on higher fuel burn-ups.

72 Load factor is the actual quantity of electricity produced by a nuclear power station over a specified period, relative to the quantity that would have been produced if the power station had operated continuously at its maximum output over the same period.

5.48 In view of this evidence the Secretary of State is satisfied that adequate uranium resources exist to fuel a nuclear power programme in the UK.

Security of electricity supplies

5.49 Reliable and affordable electricity supplies are essential for the UK. Today and in the future, the UK must be able to count on reliable supplies of energy for electricity, heating and transport.

5.50 Nuclear power has long been the UK's most significant source of low carbon energy. Since the 1950s, nuclear power has generated a significant proportion of the UK's total electricity, reaching a peak of more than one-quarter of electricity output in 1997.However, this proportion has since declined, and will decline further as all but one of the UK's nuclear power stations are due to close over the next two decades.

5.51 Over the same period, the decline in UK oil and gas production will make the country increasingly reliant on imports at a time of expected rises in global demand and prices, and when some major fields are in some of the most politically unstable parts of the world.

5.52 The 2009 Low Carbon Transition Plan (LCTP)[73] said that, even if demand for electricity does not increase, the UK will still need new electricity generation capacity to replace nuclear and other power stations as they close, and to achieve carbon emissions reductions new generating capacity would need to be low-carbon. The LCTP states that the UK needs to act now both to plan this low-carbon transition and to ensure secure energy supplies throughout the transition and beyond.

5.53 New nuclear power stations could be in operation for 60 years or more. The Secretary of State believes that nuclear power can make a significant contribution to our energy mix, alongside other low carbon technologies including renewables and CCS. This will reduce our dependency on imported fossil fuels and help maintain a diverse mix of electricity generating technologies with the flexibility to respond to future developments and therefore make an important contribution to the security of energy supplies.

5.54 Without taking such action, the UK would rely increasingly on imported fossil fuels and would have greater exposure to energy price fluctuations as global demand increases and to the risk of problems arising from one type of technology or fuel.

[73] UK Low Carbon Transition Plan, National Strategy for Climate and Energy, 15 July 2009, http://decc.gov.uk/assets/decc/white%20papers/uk%20low%20carbon%20transition%20plan%20wp09/1_20090724153238_e_@@_lowcarbontransitionplan.pdf

Revised Draft National Policy Statement for Nuclear Power Generation (the Nuclear NPS)

5.55 The Government considered these issues in the Revised Draft Nuclear NPS and associated documents published for re-consultation in October 2010[74]. As stated in paragraph 2.21, the Nuclear NPS, taken together with the Overarching Energy NPS, will provide the framework for considering applications for development consent for new nuclear power stations in England and Wales.

5.56 The Revised Draft Nuclear NPS and its associated documents stress the importance of security of supply in making sure the UK has reliable, affordable, secure supplies of energy to power homes and businesses. Having nuclear power in the UK's electricity mix will help to ensure a diverse mix of technology and fuel sources.

5.57 A significant amount of existing generating capacity is due to close (at least 22 GW in the next 10 to 15 years); either because it does not meet European emissions standards or because existing nuclear power stations are coming to the end of their scheduled lives. The security of the electricity system as a whole needs to be consistently maintained over time in order to accommodate fluctuations in the conditions that affect supply and demand of electricity throughout the electricity supply chain. This means that sufficient timely investment is required to accommodate growth in demand, replace retiring power stations and maintain the reliability of infrastructure throughout the supply chain.

5.58 Electricity cannot be stored in bulk, unlike some other fuels. Instead it must be generated at the time it is needed and in sufficient quantity so as to meet demands from users. It is therefore important to secure diversity of supply in electricity, with energy companies investing in a mix of technologies with different characteristics.

5.59 The characteristics of nuclear power are very different from those of conventional fossil fuel or renewables generation. Nuclear is a proven technology able to provide continuous low carbon generation, which will help to reduce the UK's dependence on imports of fossil. The AP1000 is capable of producing 1,100 MWe for a high proportion of its operating lifespan. Modern Pressurised Water Reactors (PWRs) have a strong reliability record and the AP1000 is expected to be capable of generating a large quantity of low carbon electricity at a high load factor[75] over the course of its lifespan.

5.60 The intermittent nature of some renewables, such as wind generation, means sufficient supplies of electricity cannot be guaranteed at any point in time, regardless of the amount of installed wind generation capacity. As large

[74] www.energynpsconsultation.decc.gov.uk

[75] Load factor is the actual quantity of electricity produced by a nuclear power station over a specified period, relative to the quantity that would have been produced if the power station had operated continuously at its maximum output over the same period.

amounts of wind power come on to the system over the coming years, the UK's need for electricity capacity will significantly increase to ensure there is sufficient back-up generation. There will therefore remain a need to maintain fossil fuel power stations, which offer the most cost efficient source of electricity generation that can be brought on line quickly when there is high demand and shut down when demand is low, thus complementing generation from nuclear and renewables.

5.61 The presence of nuclear in the mix allows extra scope in managing risks to energy security as it reduces exposure to the risks of supply interruptions and of sudden and large spikes in the electricity price, which can arise when the system is particularly dependent on a single technology or fuel.

5.62 The presence of nuclear in the electricity mix could also result in a reduced need for gas-fired power stations, and thereby reduce gas import requirements.

Investment

5.63 The Government has made clear that the construction, operation and decommissioning of new nuclear power stations is a matter for energy companies. New nuclear power stations will benefit from any general measures that are in place or may be introduced as part of wider reform of the electricity market to encourage investment in all forms of low-carbon generation. This includes the EU Emissions Trading Scheme and the Government's plans for a carbon price floor. It is therefore for investors to determine whether the financing characteristics of nuclear power provide sufficiently attractive returns, bearing in mind the electricity market.

5.64 The economics of nuclear will vary in comparison with those for other forms of electricity generation depending on, for example, electricity market structures and changing gas and carbon prices.

5.65 Recent reports carried out into the economics of nuclear and other low carbon technologies refer to significant changes in the economy and in the UK power generation marketplace, potentially affecting investment decisions either way. For example, a weakened economy may reduce costs of power plant, but if project finance is restricted then borrowing costs may be greater.

5.66 The reports also recognise the uncertainties associated with the cost of all electricity generation technologies and in particular new technologies such as offshore wind, carbon capture and storage and new nuclear. Mott MacDonald's June 2010 report 'UK Electricity Generation Costs Update'[76] notes that a large number of variables can significantly impact on the cost of a project, for example, commodity prices, supply chain bottlenecks and the ability of a developer to manage costs. The Mott MacDonald report also highlights the challenge in understanding how costs may change as new

[76] UK Electricity Generation Costs Update: A report by Mott MacDonald, June 2010 http://www.decc.gov.uk/assets/decc/Statistics/Projections/71-uk-electricity-generation-costs-update-.pdf

generation technologies move from being 'first of a kind' (FOAK) to nth of a kind (NOAK).

5.67 Mott MacDonald's findings suggest that any earlier nuclear power plant may be more expensive than gas CCGT generation. However, as new nuclear reaches nth of kind, the levelised costs of generation could fall by around one third. Based on DECC's central assumptions of future fossil fuel and carbon costs, Mott MacDonald projects that nuclear could have a "*levelised cost advantage versus the lowest cost fossil fuel options and it would be the least cost zero carbon generation option among the main technologies*." [77]

5.68 PB Power's "Powering the Nation Update 2010"[78] also notes market changes and cost uncertainties. That report indicates significant increases in price estimates for most technologies compared to their 2006 estimates[79]. Despite the increase in estimates for nuclear over the period, PB Power's report presents nuclear power as economically competitive.

5.69 However, developments in the UK market have made clear that energy companies are investing significant amounts of capital in the prospect of new nuclear power stations. So far, energy companies have announced plans to develop at least 16 GW of new nuclear capacity[80] [81] [82] [83], compared to a current installed electricity generating capacity of all types of about 80 GW[84].

Waste disposal and decommissioning funding

5.70 In view of concerns raised by respondents, the Secretary of State has considered the arrangements made to ensure that the costs of decommissioning and managing the waste from new nuclear power stations are met.

5.71 The Secretary of State recognises that most of these costs will be incurred after revenues from electricity generation have ceased. It is for this reason the Government's policy that operators of new nuclear power stations must set aside funds over the generating life of the power station to cover the full costs of decommissioning and their full share of waste management and disposal costs. The Energy Act 2008[85] creates a framework for the implementation of this policy and requires operators of new nuclear power stations to have a

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77 UK Electricity Generation Costs Update: A report by Mott MacDonald, June 2010, page 66

78 Parsons Brinckerhoff (trading as PB Power) Powering the Nation Update 2010 http://www.pbworld.co.uk/index.php?doc=528

79 Parsons Brinckerhoff, Powering the Nation (March 2006) http://www.pbworld.co.uk/index.php?doc=528

80 http://www.centrica.co.uk/index.asp?pageid=217&newsid=1783

81 http://www.edfenergy.com/media-centre/press-news/EDF_Energy_welcomes_Government_announcement_on_nuclear_sites.shtml

82 http://www.rwe.com/web/cms/en/216362/rwe-npower/more-/our-business/nuclear-power/, http://pressreleases.eon-uk.com/blogs/eonukpressreleases/archive/2009/04/29/1382.aspx

83 http://www.iberdrola.es/webibd/corporativa/iberdrola?cambioIdioma=ESMODULOPRENSA&URLPAG=/gc/prod/es/comunicacion/notasprensa/091028_NP_02_CentralNuclearUK.html

84 See also CBI report: Decision time: Driving the UK Towards a Sustainable Energy Future, July 2009 http://climatechange.cbi.org.uk/uploaded/CBI_DecisionTime_WEB.pdf

85 Energy Act 2008 (c.32) http://www.opsi.gov.uk/acts/acts2008/pdf/ukpga_20080032_en.pdf

Funded Decommissioning Programme (FDP) agreed by the Secretary of State before construction can begin. This framework will protect the taxpayer by ensuring that funds are available to pay decommissioning and waste management costs even in the event of the insolvency of the operator.

5.72 The costs for which the FDP will provide include the full costs of decommissioning and their full share of waste management and disposal costs, including safe, secure, interim storage for spent fuel.

5.73 To enable the Government to estimate the potential costs of waste management, disposal and decommissioning and to ensure that operators make adequate provision for their funding, draft FDP guidance[86] set out a means by which waste can be managed and disposed of and decommissioning carried out. This was termed the "Base Case". It built on existing policy and regulations for waste management and decommissioning and also made additional assumptions to ensure that it represented a realistic and prudent way to estimate the costs of and carry out these activities. Updated FDP guidance will be published later in 2010.

5.74 The Secretary of State is satisfied that the taxpayer will be protected from these costs now and in the future.

Skills and supply chain

5.75 New nuclear power stations have the potential to provide significant economic benefits to the UK. According to recent research, the civil nuclear industry currently employs 44,000 people[87]. Current plans by industry to build 16GW of new nuclear capacity by 2025 will create significant supply chain and job creation opportunities. Based on this build rate, employment of about 110,000-140,000 person years is predicted[88], which is three times the size of the requirements for the 2012 Olympics construction project.

5.76 It is estimated that 1,000 new apprentices and 1,000 graduates of science, technology, engineering and mathematics (STEM) subjects are required each year to 2025 to support existing operations and new build capacity, throughout the industry and supply chain. While meeting the skills requirements for new build presents a challenge, Government has put a framework in place to help ensure the sector gets the workers it needs. This includes improving science provision in schools, charging the Sector Skills Council with taking forward a training strategy, and the creation of the National Skills Academy for Nuclear to improve the specialist supply of skills.

5.77 UK contractors, manufacturers and engineers have gained extensive experience from the building, operation, maintenance and upgrading of

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86 Consultation on Funded Decommissioning Programme Guidance for New Nuclear Power Stations http://www.berr.gov.uk/files/file44486.pdf

87 Power People: The Civil Nuclear Workforce 2009-2025, Cogent, 2009 http://www.cogent-ssc.com/research/Publications/NuclearReportPowerPeople.pdf

88 Next Generation: Skills for New Build Nuclear, Cogent 2010 www.cogent-ssc.com/research/Publications/Renaissance2.pdf

nuclear power stations and facilities in the UK and abroad. One of the Government's objectives is to help create a globally competitive UK nuclear supply chain, focusing on high value added to support new nuclear power stations[89]. The Government is working with the supply chain and nuclear power stations vendors and operators to assist in this process, and has brought about a package of interventions to help UK suppliers, including establishing the Nuclear Advanced Manufacturing Research Centre to help improving the capacity, capability and quality of UK manufacturers.

Economic impacts of accidents

5.78 During the operation of a new nuclear power station, there would be a risk of an accident resulting in the unplanned release of radioactivity into the environment. Evidence suggests that the likelihood of such an accident in the UK is very low[90]. However, if an accident was to occur this could lead to adverse economic effects such as costs relating to damage to property, businesses, health and the environment.

5.79 The White Paper on Nuclear Power[91] considered the economic impact of a potential accident. Given the evidence suggests that the likelihood of accidents is very low, it did not estimate a monetary value that might be associated with such occurrences.

5.80 If an accident did occur, there is in place a well established international regime for regulating liability and compensation for third party damage. This regime is set out in the Paris Convention on Third Party Liability and the Brussels Supplementary Convention[92] and implemented in the UK by the Nuclear Installations Act 1965. Compensation would be available, in the first instance from the operator, for personal injury or property damage irrespective of whether the operator is at fault. Further, under this regime operators are required to have in place insurance or other financial security to ensure they can meet their liabilities.

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89 Manufacturing: New Challenges, New Opportunities, BERR, September 2008 http://www.berr.gov.uk/files/file47660.pdf

90 The Nuclear Power Generation Cost Benefit Analysis, BERR, April 2007 http://www.berr.gov.uk/files/file39525.pdf which states that: "The literature suggests a range for the probability of major accidents (core meltdown plus containment failure) from 2x10-6 in France, to 4x10-9 in the UK. The associated expected cost is estimated to be of the order £0.03 / MWh to £0.30 / MWh depending on assumptions about discount rates and the value of life; using the figure at the top end of this range would not change the results of the cost benefit analysis. Introducing risk aversion, the results of the cost benefit analysis in the central case would be robust for a risk aversion factor of 20 at the highest estimated value for the expected accident cost. For a summary of the relevant literature, see "Externalities of Energy (ExternE), Methodology 2005 Update", European Commission."

91 Meeting the Energy Challenge: A White Paper on Nuclear Power, January 2008, paragraph 2.66 http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/white_paper_08/white_paper_08.aspx

92 The Convention on Third Party Liability in the Field of Nuclear Energy of 29 July 1960 and the Convention of 31 January 1963 Supplementary to the Paris Convention.

5.81 In accordance with the UK's commitments under the Paris and Brussels Conventions, there will continue to be certain potential liabilities that may fall to the Government[93].

5.82 The Paris and Brussels Conventions were amended in 2004. The amendments (which are not yet in force) are aimed at ensuring that an increased amount of compensation[94] is available to a larger number of victims in respect of a broader range of nuclear damage. In particular, it will be possible to claim compensation for certain kinds of loss other than personal injury and property damage, including loss relating to impairment of the environment. The requirement for insurance or other financial security will be extended to cover these new liabilities, some of which cannot currently be fully covered by the private sector insurance market. The Government is currently exploring how this can be addressed. It is considering the options available, in particular providing cover from public funds in return for a charge to be paid by operators.

5.83 The Government intends to undertake a public consultation later in 2010 on implementing the changes to the Paris Convention, including the issue of financial security.

5.84 A terrorist incident resulting in unplanned release of radioactivity into the environment could lead to adverse economic effects of the kinds that might be suffered in the event of an accident. However, as in the case of accidents, the risk of a terrorist incident must be seen in the context of the robust regulatory regime in place to protect against such security threats and their consequences (see Chapter 6 (Radiological Health Detriment) and Chapter 9 (Safety and Security)).

Conclusion

5.85 Regulatory Justification is not an exercise in comparing the advantages of the different methods of producing energy. However, in assessing the economic benefit of nuclear power it is useful to compare its advantages against those of other technologies. Such comparisons show that nuclear has the advantages of secure fuel supplies and continuous generation, and is in relative terms a low-cost form of electricity generation which can yield economic benefits to the UK.

5.86 The reliable and affordable supply of electricity is essential to the daily lives of the population of the UK and the functioning of business around the country.

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[93] The principal operator limit is currently £140 million. The Brussels Convention requires operators' funds to be "topped-up" to a total of £300 million special drawing rights (about €350 million). The top-up funds are made up of public funds from the State where the installation is located and contributions from signatories to the Brussels Convention.

[94] In particular, the principal limit on operator liability has been increased to a minimum of €700 million under the revised Paris Convention. Above this cap, responsibility lies with the State (including contributions from other Brussels Convention States) for up to a further €800 million.

5.87 The Secretary of State has considered the potential benefit through security of supply, arising out of the operation of the AP1000. He is conscious that while demand for electricity generation in 2020 is likely to be similar to current levels at around 60 GW, at least 22 GW of the UK's existing generating capacity is due to close in the next 10 to 15 years.

5.88 In this context, the Secretary of State notes the ability of the AP1000 to generate 1,100 MWe of low-carbon electricity at a high load factor. He is also conscious that nuclear power is a proven and dependable technology that can be deployed on a large scale and that, because of the low price of uranium relative to overall generation costs, the generation cost of electricity by any AP1000 which is built in the UK is unlikely to fluctuate greatly, thus helping to contribute to stable electricity prices.

5.89 The Government's policy is that it will be for companies to fund and build any new nuclear power stations. New nuclear power stations will benefit from any general measures that are in place or may be introduced as part of wider reform of the electricity market to encourage investment in all forms of low-carbon generation. This includes the EU Emissions Trading Scheme and the Government's plans for a carbon price floor. It is therefore for investors to determine whether the financing of any AP1000 nuclear power station provides sufficiently attractive returns. Although the economics of nuclear will vary in comparison with those for other forms of electricity generation depending on, for example, electricity market structures and changing gas and carbon prices, developments in the UK market have made clear that energy companies are investing significant amounts of capital in the prospect of new nuclear power stations. The Secretary of State is therefore of the opinion that there are unlikely to be any economic disbenefits arising from the normal operation of new nuclear power stations.

5.90 The Secretary of State is conscious that the construction of any AP1000 in the UK will require substantial financial investment and that much of this investment could benefit UK businesses. He is therefore conscious that there are potential economic benefits to be considered as part of the Regulatory Justification process.

5.91 The Secretary of State is also conscious that there are benefits to consumers, especially the fuel poor, from limiting increases in the cost of electricity generation and he is of the opinion that the generation of electricity by the AP1000 would contribute to this.

5.92 In spite of the economic benefits that the Secretary of State considers should flow from the construction and operation of the AP1000 he is conscious of the economic detriment that could be suffered in the event of a significant nuclear accident or a terrorist incident. Although the economic detriments associated with either of these events occurring is potentially significant, the Secretary of State considers that the risk of these events taking place is low and minimised by the robust regulatory regime which exists in the UK. The Secretary of State therefore concludes that the risk of economic detriments falling on the

taxpayer as the result of an accident or terrorist incident is small and is outweighed by anticipated economic benefits.

5.93 The Secretary of State has also considered the funding arrangements for the management and disposal of radioactive waste, and is satisfied that there are robust legal and other provisions in place to ensure that the management and disposal of waste arising from any AP1000 that is built in the UK will not fall to the tax-payer.

Chapter 6: Radiological Health Detriment

Introduction

6.1 The nuclear reactions that take place in a nuclear power station create a high level of radioactivity in the reactor. Radioactivity occurs naturally in the environment but a nuclear power station creates much higher quantities that require careful management during and beyond its operational life.

6.2 The release of radioactivity into the environment from a nuclear power station could occur through the planned release of gaseous and liquid discharges, through an unplanned release of radioactive waste or as the result of an accident or terrorist incident.

6.3 This Chapter considers the content of the Application relating to the potential radiological health detriment from releases from the AP1000, and responses to the consultations on the Application and on the Secretary of State's Proposed Decision. It then sets out the Secretary of State's view on this potential detriment, on the effectiveness of the regulatory regime in place in mitigating this potential detriment and the potential detriment from the earlier states of conversion, fabrication and enrichment, and on other issues which have been raised.

6.4 The regulatory measures specifically intended to mitigate the potential radiological health detriment from radioactive waste are considered in Chapter 7 (Radioactive Waste).

Guidance for applications

6.5 The guidance for Regulatory Justification applications for new nuclear power stations[95] said that applicants should provide information explaining how the proposed type or class of practice may cause radiological detriment to human health, and that this should cover all aspects of the reactor lifecycle including, for example, fuel manufacture, waste management and disposal and transport. It said that an application could cover:

- health detriment to the general public, plant workers and other specific population groups;
- normal operation and accident conditions; and

[95] The Justification of Practices Involving Ionising Radiation Regulations 2004, Guidance for applications relating to new nuclear power, March 2008 http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

- a summary explanation of how design operation and mitigation strategies will reduce the risk and magnitude of accidental radiological exposures to below regulatory limits.

Summary of the Application

6.6 This is a brief summary of points made in the Application. Anyone wanting to follow the Application's arguments, evidence and supporting references in detail should read the Application in full.

6.7 The Application assessed the potential radiological health detriment to members of the public and employees from the class or type of practice through evidence on radiation doses and risks[96].

Ability to meet dose limits

6.8 The Application stated that new nuclear power stations of the class proposed, and their associated processes, would be capable of meeting all radiation dose limits and constraints imposed by UK regulators.

6.9 The Application stated that those employed as a result of the new class or type of practice would receive doses comparable with or lower than those currently employed in the nuclear industry or in other activities involving exposure to radiation.

6.10 The Application stated that, following Optimisation, the maximum level of additional dose to any member of the public per year would be around the same as the dose incurred in a return flight from the UK to New York, or through spending a week in Cornwall instead of somewhere with the UK average level of natural background radioactivity. It argued that this represented a very low level of radiological health detriment of 0.1 millisieverts (a measure of dose and abbreviated as mSv) or less.

Regulatory processes

6.11 The Application stated that applicable regulatory dose limits and constraints could easily be met and that this was the direct result of the mature status of the industry and, in particular, modern nuclear power station design, and the effects of both the national and international approaches to regulating this industry that have been refined over many years.

[96] The Justification of Practices Involving Ionising Radiation Regulations 2004, Consultation on the Nuclear Industry Association's Application to Justify New Nuclear Power Stations, Volume 2, Chapter 4 (Potential radiological health detriment) http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

Accident risk mitigation

6.12 The Application outlined the UK approach to nuclear safety regulation and said that it incorporated the principle that all reasonably practicable steps must be taken to prevent and mitigate nuclear and radiation accidents. The HSE's Nuclear Installations Inspectorate (NII) enforces this approach and guidance on the NII's approach to assessing safety is provided in its published Safety Assessment Principles (SAPs)[97]. The Application explained that calculations for Sizewell B[98] provided a reasonable indication of the very low level of risk posed by designs that are in line with the SAPs. The Application concluded that modern designs of new nuclear power stations, including the AP1000, have been developed to provide levels of safety comparable with or even higher than this.

6.13 The Application stated that the design of every facility required to implement the proposed new class or type of practice would have to meet stringent safety and security requirements, and that these requirements would ensure that the likelihood of accidents which could lead to significant releases of radioactive materials and hence possible radiological health detriments would be very remote.

Evidence of health effects around UK nuclear sites

6.14 The Application provided a review of the background to the international understanding of the relationship between radiation exposure and risks to human health and concluded that, while some uncertainties remained, the scientific consensus was sufficiently robust to support the conclusions on Regulatory Justification within the Application[99]. It also referred to concerns raised in the past over suggestions that there might be heightened levels of certain cancers in areas close to some nuclear sites.

6.15 The Application stated that these concerns had been the subject of extensive independent research over more than 20 years. The Application stated that in the UK, the Committee on Medical Aspects of Radiation in the Environment (COMARE)[100] had overseen this subject since its establishment in 1985. The Application stated that COMARE's 10th report was published in 2005[101] and that so far as nuclear power stations were concerned the conclusion of this report was unambiguous:

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97 The Safety Assessment Principles (SAPs) are explained in more detail in paragraph 6.90.

98 Sizewell B is the most recently built nuclear power station in the UK, and has an operating regime and technology similar to those likely to be used by new nuclear power stations.

99 The Justification of Practices Involving Ionising Radiation Regulations 2004, Consultation on the Nuclear Industry Association's Application to Justify New Nuclear Power Stations, Volume 2, Chapter 4 (Potential radiological health detriment) and Annex 3 (Supplementary notes on radiation) http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

100 See http://www.comare.org.uk/ and paragraphs 6.127 – 6.150 and Annex B (Roles of Independent Regulators and Advisory Bodies in the UK) of this document for more information on COMARE's role and recent reports.

101 http://www.comare.org.uk/documents/COMARE10thReport.pdf

"*We can, therefore, say quite categorically that there is no evidence from this very large study that living within 25km of a nuclear generating site in Britain is associated with an increased risk of childhood cancer*."

AP1000 Design Specific Considerations

6.16 The Application stated that current analyses showed that the AP1000 complied with the HSE's Basic Safety Objectives[102] and that the HSE concurred with this conclusion in its preliminary assessment under GDA. The Application confirmed that engineered safety features had been included in the AP1000 design to ensure reactor safety following extreme events, including seismic and weather-related (extreme winds and flooding), and "man-made" events, such as an airplane crash.[103]

6.17 The Application set out details of the technical features of the AP1000 which aim to prevent the release of radioactivity and exposure to radiation. The Application explained that the nuclear systems are located in the shield building / containment vessel and in the auxiliary building. These buildings are robust and shielded where necessary to ensure all radioactive substances are always secure. The shield building surrounds the containment vessel and, in conjunction with the internal structures of the containment building, shields the environment from radiation originating from within the containment building, that is, the reactor coolant system and other radioactive systems and components housed in the containment, and protects the containment vessel from external events such as tornados. The containment building prevents the uncontrolled release of radioactivity to the environment and provides shielding for the reactor core and the reactor coolant system during normal operations. The auxiliary building is a reinforced concrete structure which protects the safety-related equipment against the consequences of postulated internal or external events.

6.18 The Application explained that defence in depth is integral to the AP1000 design, with a multitude of individual plant features capable of providing for multiple levels of defence (defence in depth), resulting in extremely low core damage probabilities. Six aspects contribute to this as follows:

6.19 **Stable operation** In normal operation, this ensures stable and reliable operation by selection of materials, quality assurance during design and construction, well-trained operators and an advanced control system and plant design that provide substantial margins for plant operation before approaching safety limits.

[102] The Basic Safety Objectives (BSOs) are explained in more detail in paragraph 6.90.

[103] The Justification of Practices Involving Ionising Radiation Regulations 2004, Consultation on the Nuclear Industry Association's Application to Justify New Nuclear Power Stations, Volume 3 (Annex 6B) http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

6.20 **Physical plant boundaries** Release of radioactivity is directly prevented by fuel cladding, the reactor pressure boundary and the containment pressure boundary.

6.21 **Passive safety-related systems** The AP1000 uses advanced passive safety systems, rather than active safety systems. These require no operator actions to mitigate design basis accidents, and use only natural forces such as gravity, natural circulation and compressed gas to make the systems work. The number and complexity of operator actions required to control the safety systems are minimised; this approach eliminates the need for operator action rather than automating it.

6.22 **Diversity within safety-related systems** This diversity exists, for example, in the residual heat removal function. If multiple failures occur in the passive safety-related feature for removing decay heat, defence in depth is provided by an unrelated passive core cooling system.

6.23 **Non-safety systems** These reduce the potential for events leading to core damage by automatically actuating to provide a first level of defence to reduce the likelihood of unnecessary actuation and operation of the safety-related systems.

6.24 **Containing core damage** The design allows for flooding of the reactor cavity in the very unlikely event that other means of core cooling have failed.

6.25 The Application stated that the AP1000 would meet UK regulatory dose limits and constraints and that this was confirmed by the Environment Agency in its preliminary assessment under Generic Design Assessment (GDA)[104].

Summary of responses to the consultation on the Application

6.26 Some respondents said people were exposed to radiation from many sources which were not subject to any limitation and that it was clear that the benefit of nuclear power far outweighed the radiological risk.

6.27 However, a number of respondents expressed concern about how the effect of radiation on health was measured and questioned the relevance and adequacy of the ICRP system of radiological protection. Respondents also stated that the Application did not quantify the number of cancers which could arise from new nuclear power stations.

6.28 Several respondents felt that new nuclear power stations posed a greater risk to health compared to the previous generation of nuclear power stations because they were likely to be larger, operate for longer and produce more waste and waste of a higher radioactive content than existing designs. Some

[104] The Justification of Practices Involving Ionising Radiation Regulations 2004, Consultation on the Nuclear Industry Association's Application to Justify New Nuclear Power Stations, Volume 2 (Chapter 1 Addendum, pages 7 and 8) and Volume 3 (Annex 6B) http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

respondents questioned the sufficiency of information in the Application on the health impacts of the class or type of practice under consideration. In particular, some respondents felt that more information was needed on the expected discharges from new nuclear power stations, the types and biological activity of such discharges and how the operators of new nuclear power stations would ensure that legal limits and dose constraints were met. Some respondents referred to the lower dose constraints recommended by the Health Protection Agency (HPA) and referred to in paragraphs 6.105 to 6.107 below.

6.29 A number of respondents requested consideration by the Secretary of State of recent studies on the impact of radiation on health including the KiKK Study[105], the 2004 CERRIE Report[106] and the paper "ECRR Chernobyl: 20 years on – Health Effects of the Chernobyl Accident"[107]. In particular, a number of respondents expressed concern about the findings of the KiKK study and asked if a similar study had been carried out in the UK.

6.30 Some respondents felt that health risks should be considered on a site specific basis rather than at a national level.

6.31 There were calls for more information on the impacts on health of the whole nuclear cycle, including in relation to the mining of uranium, the maintenance of nuclear power stations over their lifetime and the management and disposal of radioactive waste.

6.32 There was concern among respondents about the health impacts of an accident at a new nuclear power station.

6.33 Some respondents also commented that Annex 3 (Supplementary Notes on Radiation) of the Application was not supported by references.

Summary of responses to the consultation on the Proposed Decision

6.34 Responses to the consultation in the main repeated those to the consultation on the Application.

General view

6.35 A number of correspondents said that as it was as yet unclear how many nuclear power stations there would be and of what size, and what radiation

[105] Commission on Radiological Protection (SSK). Assessment of the "Epidemiological Study on Childhood Cancer in the Vicinity of Nuclear Power Plants" (KiKK Study). Position of the Commission on Radiological Protection. SSK, Bonn, 2008 http://www.bfs.de/en/bfs/druck/Ufoplan/4334_KIKK.html

[106] Report of the Committee Examining Radiation Risks of Internal Emitters (CERRIE), 2004 http://www.cerrie.org/pdfs/cerrie_report_e-book.pdf

[107] ECRR Chernobyl: 20 Years On: Health Effects of the Chernobyl Accident, European Committee on Radiation Risk Documents of the ECRR 2006 No1. Edited by C.C. Busby and A.V. Yablokov. Published on behalf of the European Committee on Radiation Risk Comité Européen sur le Risque de l'Irradiation, Brussels by Green Audit, 2006. ISBN: 1-897761-25-2

they would produce, it was impossible to measure the detriment and therefore impossible to make a Regulatory Justification decision.

Regulatory regime

6.36 Some respondents agreed with the views set out in the Proposed Decision on the potential radiological health detriment arising from the proposed class or type of practice and agreed that the UK's robust regulatory regime and the inherent safety systems in place in the AP1000 design mean that any radiological health detriment would be very small.

6.37 Against this, others were not confident that the regulatory regime will be effective in ensuring that nuclear power station operators are able to keep dose levels within the limits set.

6.38 Some respondents said the cumulative effects of radiation exposure from all sources of radiation should be considered, and not just those from new nuclear power stations.

6.39 Some respondents requested clarification on how an individual's estimated radiation dose is calculated, and for more information on radiation dose monitoring and enforcement.

6.40 Some respondents questioned why a dose constraint of 0.1 mSv, as recommended by ICRP, was not being enforced.

Health studies

6.41 Some respondents opposed the Proposed Decision's reliance on COMARE's studies and the subsequent Bithell study. In particular some expressed the view that excess cancers usually occur within 5 to 10km of a nuclear power station and that actual cancer incidence would be statistically disguised in the larger 25km populations considered by COMARE.

6.42 A number of respondents argued that the Secretary of State should give more consideration to studies which came to different conclusions. In particular, a number of respondents urged the Secretary of State to take account of the findings of the KiKK study[108].

6.43 A number of respondents requested that the Secretary of State's final decisions be delayed until COMARE's review of the KiKK study has been published and subject to public examination.

Health detriment and ICRP model

6.44 A number of respondents expressed concern about how the effect of radiation on health is measured, and questioned the relevance, adequacy and

[108] A full list of the references to epidemiological studies referred to by respondents is set out in Annex E.

independence of the ICRP system of radiological protection and reliance on its use by the Health Protection Agency.

6.45 Respondents said that reliance on dose limits was misguided because there were no safe level of discharges from a nuclear power station, and that the system did not deal with the potential health detriment of low level ionising radiation. Specific concerns which it was claimed that the system did not deal with sufficiently included untargeted effects of radiation exposure (where the effect spreads to other cells from the original impact); genetic impact leading to cancers in future generations; the use of a single-blast Hiroshima model which does not allow for the effect of inhaled or internalised radioactive particles over time; the failure of the collective dose model to take account of the different levels of impact on certain sub-groups of the population, its assumption of a normal situation, and failure to take account of ingestion; the failure to take account of the secondary photo-electron effect and the invalidity of the concept of absorbed dose for some types of exposure since it fails to account for extremely large variations in ionisation density; the failure to quantify the number of cancers which could arise from new nuclear power stations.

Reactor designs

6.46 Several respondents felt that new nuclear power stations pose a greater risk to health compared to the previous generation of designs because they are likely to be larger and operate for longer, producing more waste and waste of a higher radioactive content.

Site-specific issues

6.47 Some respondents said health risks should be considered on a site specific basis rather than at a national level, raising site specific health concerns. In particular, clarification was requested on how the potential health detriments of a nuclear power station built in the UK would be monitored in the Republic of Ireland.

Uranium mining

6.48 Some respondents called for the impact on health of workers and the public of the mining of uranium overseas to be taken into account and provided evidence to support their argument that there was a high level of health detriment involved.

Responses of Statutory Consultees to the consultation on the Proposed Decision

6.49 The statutory consultees responded to the consultation as follows:

Health Protection Agency (HPA)

6.50 HPA said that Regulatory Justification was the first stage in following the fundamental principles of radiological protection, and that the remaining

principles of optimisation and limitation would then have to be followed to ensure that the radiological impact of any proposed nuclear build programme on human health was acceptable. HPA considered that the current regulatory regime governing nuclear activities in the UK (including regulations concerning planned discharges, the acceptable risk of accidents, emergency planning, waste disposal and management, and the impact on other EU member states) provided for adequate protection of human health.

Environment Agency (EA)

6.51 The EA agreed with the Proposed Decision that the proposed practice was Justified having regard to its net benefits and health detriments.

6.52 The EA said that it and the other nuclear regulators, specifically the HSE's Nuclear Directorate, had a crucial role in helping to ensure that the detriments arising from any new nuclear power stations would be small. Through the EA's work on Generic Design Assessment and in its regulatory role on specific permitting and licensing and site regulation, it would ensure that:

- public radiation doses from discharges and disposals of radioactive waste from any new nuclear power stations were within statutory dose limits and constraints and as low as reasonably achievable, and that the impact on the environment would be small; and

- the non-radiological impacts on people and the environment at new nuclear power stations would be minimised and acceptable.

6.53 The EA said that its response was without prejudice to its decisions on the Generic Design Assessment (GDA) of reactor designs or about any subsequent site specific applications by developers for relevant environmental permits.

Scottish Environment Protection Agency (SEPA)

6.54 SEPA said that the Environment Agency was better placed to provide comment and scrutiny on the Proposed Decision.

Health and Safety Executive (HSE)

6.55 HSE's NII noted that the AP1000 was currently undergoing Generic Design Assessment (GDA) by HSE's Nuclear Directorate and by the Environment Agency. HSE noted that it had reported the findings of its GDA Step 3 in November 2009 and had since embarked on Step 4 on which it intended to report in Summer 2011. At this stage, HSE's NII considered that its preliminary view that there were no safety or security shortfalls that would be so serious as to rule out the design's eventual construction in the UK remained valid.

6.56 HSE's NII welcomed the Proposed Decision's expression of confidence in the effectiveness of the existing regulatory regime.

Food Standards Agency (FSA)

6.57 The FSA said that it agreed with the Proposed Decision's position on the potential radiological health detriment arising from the proposed practice, and considered the generic information provided is sufficient to show in principle that the potential detriment should be acceptable.

6.58 If the new design was justified and a potential operator made an application for a new nuclear power station, the FSA would carry out an individual dose assessment as part of that application process. This would further refine the extent of potential detriment.

Secretary of State's view

Health detriments arising from radiation

6.59 The Secretary of State has considered the Application and the responses received to the consultations on the Application and on the Proposed Decisions. He also requested additional information to help inform this Decision, including a request for additional information from the Applicant by way of a Regulation 16 Notice (set out in Annex D).

6.60 The Secretary of State has first considered what radiological detriment to health might be expected from the AP1000, and its significance.

6.61 The main risk, as with all nuclear power stations, is the potential for release of material which emits ionising radiations[109]. This needs to be set in the context of overall levels of radiation. HPA, which regularly reviews the radiation exposure of the UK population, has calculated that the overall average annual dose to a member of the public from all sources of radioactivity is 2.7 millisieverts (a measure of dose and abbreviated as mSv) per year. Of this, about 84% is from natural sources, including cosmic radiation entering the earth's atmosphere from space, and radiation from the radioactive materials that occur naturally in soils and rock, about 15% from medical procedures such as X-ray equipment and about 1% from all other sources, including domestic smoke detectors and nuclear power stations[110]. There is no fundamental difference between the radiation that comes from naturally occurring materials and the radiation that comes from materials made radioactive in a nuclear power station, although the particular energy associated with the radiation (and therefore its potential to cause health detriment) may differ[111].

[109] Ionising radiation is any electromagnetic or particulate radiation which produces ion pairs when passing through a medium. (Chambers Dictionary of Science and Technology, Revised Edition, 1974)

[110] HPA-RPD-001 – Ionising Radiation Exposure of the UK Population: 2005 Review Authors: S J Watson, A L Jones, W B Oatway and J S Hughes Publication date: May 2005 ISBN: 0-85951-558-3 http://www.hpa.org.uk/web/HPAweb&HPAwebStandard/HPAweb_C/1247816567393

[111] HPA-RPD-055 – An Introduction to the Estimation of Risks Arising from Exposure to Low Doses of Ionising Radiation, Authors: S Mobbs, S Watson, J Harrison, C Muirhead and S Bouffler, Publication date: June 2009 ISBN: ISBN 978-0-85951-643-3 http://www.hpa.org.uk/webw/HPAweb&HPAwebStandard/HPAweb_C/1245052106074

6.62 The release of radioactivity into the environment from an AP1000 could occur through the planned release of gaseous and liquid discharges, through an unplanned release of radioactive material or as the result of an accident[112].

6.63 In 2009, HPA published a paper providing an introduction to the risks of exposure to low doses of radiation[113]. This explains that:

"*At high levels of dose there may be a substantial amount of cell killing, leading to obvious injury e.g. skin reddening, organ damage and even death. At low levels of radiation dose there will be no obvious injury. However, although cells have very effective mechanisms for the repair of DNA damage resulting from radiation exposure and other causes, some DNA damage is more difficult to repair and sometimes mistakes occur, called mutations. Some mutations can result in changes in the characteristics of cells and set them on the path towards uncontrolled proliferation and cancer. Exposure to radiation is not the only way in which a cell can receive DNA damage or be triggered to become cancerous: DNA damage can occur spontaneously, or from exposure to chemicals, and some cancers are associated with specific infections. Hence, the body will carry some cells with these mutations from other causes and subsequent ionising radiation exposure may increase the number of these mutant cells*."

6.64 HPA's paper also concludes that a low dose of radiation is one of the many factors that can lead to an increased risk of cancer but that cancer is a common disease and the additional risk resulting from very low doses of ionising radiation is proportionately very low.

6.65 The paper also explains that it is biologically feasible that radiation could cause mutations to genetic material which could be passed on to future generations, although there is no direct evidence of radiation-induced heritable effects in humans and this genetic risk is judged to be considerably lower than that of cancer.

6.66 In the event of an accident, the release of radioactivity into the environment could lead to adverse health impacts through direct exposure to high levels of ionising radiation or following increased contamination of air, land and water, which could lead in turn to ingestion via the water supply or food chain, potentially over a wide area. These consequences could potentially result in death, or in a range of cancers, burns and sensory impairment, depending on the scale of incident that occurred and in which part of the nuclear power station it occurred.

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[112] There can also be very small direct radiation doses (principally by gamma radiation) to people, plants or animals very close to the power station. In contrast, virtually all the dose to the power station workforce will be from direct radiation.

[113] HPA-RPD-055 – An Introduction to the Estimation of Risks Arising from Exposure to Low Doses of Ionising Radiation, Authors: S Mobbs, S Watson, J Harrison, C Muirhead and S Bouffler, Publication date: June 2009 ISBN: ISBN 978-0-85951-643-3 http://www.hpa.org.uk/webw/HPAweb&HPAwebStandard/HPAweb_C/1245052106074

6.67 This potential radiological health detriment already exists for current nuclear power stations, but is mitigated by a strict regulatory regime which covers both emissions associated with normal operation and limits the possibility that nuclear power stations built in the UK may release radioactive material as the result of an accident. Before considering the structure and effectiveness of the existing regulatory regime in mitigating such detriment, the Secretary of State has considered whether the potential radiological health detriment from the AP1000 and other new nuclear power station designs raise issues not covered by the existing regulatory regime.

Comparing radiological health detriment of the AP1000 with other nuclear power station designs

6.68 Although Regulatory Justification is not about comparing one design with another, the Secretary of State has considered how the potential radiological health detriment of the AP1000 compares with other nuclear power station designs, including existing nuclear power stations. When the Government published its consultation on the Application it referred to a paper by its advisers Integrated Decision Management (IDM)[114] which assessed similarities and differences between different types of nuclear power station. IDM (with contributions from the National Nuclear Laboratory – IDM-NNL) advised that the benefits and detriments of the different designs under consideration were broadly similar at the high level of assessment suitable to Regulatory Justification.

6.69 Several respondents to the consultations felt that more information was needed on the expected discharges from new nuclear power stations and how these would compare to discharges from existing nuclear power stations. The Secretary of State therefore asked IDM-NNL for further advice from the point of view of differences between the AP1000 and other new and existing designs.

6.70 IDM-NNL's detailed advice was published together with the Proposed Decision[115]. In summary, IDM-NNL's advice is that the differences between the AP1000 and other new nuclear power station designs, and existing designs, are limited and should make no significant difference from the point of view of detriment.

6.71 IDM-NNL examined the potential adverse health effects from the radionuclides in fuel used in nuclear power stations. They concluded that the toxicity of the fuel used in the AP1000 is similar to that of existing Pressurised Water Reactors (PWRs) and other proposed new PWR designs.

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[114] Advice on the influence of reactor technology on the definition of classes or types of practice for new build justification, Authors: Gregg Butler, Grace McGlynn (IDM) with input from Andrew Worrall and Kevin Hesketh (National Nuclear Laboratory)
http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

[115] Technical Advice to inform proposed Regulatory Justification decisions on new nuclear power stations, Authors: Gregg Butler, Grace McGlynn (IDM), Andy Worrall, Kevin Hesketh (NNL)
http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

6.72 A number of responses raised the issue of the higher burn-up levels of fuel in new nuclear power stations. New nuclear power stations are designed to extract more energy from the fuel than previous designs by using fuel with higher enrichment, and leaving it longer in the reactor with increased irradiation (burn-up) and increased power production. As a result of this the inventory of fission products and other long lived radionuclides in the fuel increases and this causes the fuel to remain thermally and radioactively hotter for longer.

6.73 The benefits of higher burn-up in fuel are that it reduces the amount of spent fuel that is produced per unit of electricity and reduces the cost of producing electricity by allowing an increased load factor to be achieved[116].

6.74 However, higher burn-up generally increases decay heat (the heat produced in the nuclear fuel after it has been removed from the reactor) and can require fuel to be cooled for longer in interim storage before its thermal output has reduced enough to be disposed of in a geological disposal facility. This point is relevant to the management of radioactive waste and is considered in Chapter 7 (Radioactive Waste). However, IDM-NNL conclude that increased burn-up is a feature of the development of PWR fuel, that by the time new nuclear power stations are operating, many existing PWR reactors are likely to be achieving the same burn-up level, and that there is very little difference between existing and new nuclear power stations when operating at the same fuel burn-up.

6.75 IDM-NNL's advice is therefore that the differences between the AP1000, other new reactor designs and existing designs are limited and should make no significant difference from the point of view of detriment.

6.76 The Secretary of State notes respondents' concerns about the issue of waste from the AP1000 having different properties from waste from existing nuclear power stations, but has not been presented with any evidence which would cause him to reach a different conclusion from the one set out in the Proposed Decision on the effectiveness of the existing regulatory regime in dealing with the operation of AP1000s or the waste they produce. The Secretary of State notes that any AP1000s built in the UK and all waste facilities associated with them will be subject to the same regulatory regime and the same dose limits. The regulatory regime is considered below.

UK Regulatory Regime

6.77 Because of the potential for significant health detriment associated with exposure to a high level of radiation, the emission of radiation from nuclear power stations, and from other stages of the process, is heavily restricted and emissions are kept at very low levels. These emissions are at all stages closely regulated and monitored in the UK by a regulatory regime.

[116] Load factor is the actual quantity of electricity produced by a nuclear power station over a specified period, relative to the quantity that would have been produced if the power station had operated continuously at its maximum output over the same period.

6.78 The measures taken to limit exposure to radiation are based on legal, regulatory or advisory limits and constraints on the level of radiation to which people can be exposed. They are therefore matters dealt with by the Optimisation or Dose Limitation processes referred to in paragraphs 2.7 to 2.12 rather than by the Regulatory Justification process itself.

6.79 However, the Secretary of State now considers the regulatory regime in order to inform himself fully on the issues relating to radiological health detriment, and in particular the structure and effectiveness of this regulatory regime in mitigating radiological health detriment to members of the public and employees of the nuclear industry.

Regulatory Regime – Role of the Regulators

6.80 The safety of nuclear power stations in the UK is secured mainly through the licensing regime established in the Nuclear Installations Act 1965[117] (the 1965 Act). This national regime exists within the international framework for nuclear safety established by the International Atomic Energy Agency (IAEA), and is compliant with International Conventions[118].

6.81 The UK regulatory regime for the protection of members of the public and employees from the health detriment of radiation exposure is jointly the responsibility of HSE's Nuclear Installations Inspectorate (the NII), the Environment Agency and the Scottish Environment Protection Agency.

6.82 HSE, through the NII, will continue to regulate the safety of nuclear power stations, as well as facilities for fuel fabrication and enrichment and waste management, throughout their lifecycle, by means of an established licensing and permissioning regime.

6.83 Within HSE, the nuclear licensing function is delegated to the NII, which therefore has the responsibility for granting licences and attaching appropriate conditions. NII's inspectors are appointed under the Health and Safety at Work etc Act 1974[119] (the 1974 Act). They administer the 1965 Act and deal with nuclear and radiological safety issues at licensed nuclear sites. Inspectors' activities include prior assessment of the safety of proposed nuclear facility designs and operational regimes, inspection of the implementation of the licensee's licence condition compliance arrangements and investigation of incidents and complaints.

6.84 The site licensing system has three parts, related to: the acceptability of the reactor design (which is being partly carried out through Generic Design

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[117] Nuclear Installations Act 1965 (c.57) http://www.opsi.gov.uk/RevisedStatutes/Acts/ukpga/1965/cukpga_19650057_en_1

[118] The International Convention on Nuclear Safety – http://www-ns.iaea.org/conventions/nuclear-safety.htm The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management http://www.iaea.org/Publications/Documents/Conventions/jointconv.html

[119] Health and Safety at Work etc. Act 1974 (c.37) http://www.opsi.gov.uk/RevisedStatutes/Acts/ukpga/1974/cukpga_19740037_en_1

Assessment (GDA)[120]); the prospective operator's capability; and site-specific issues. A site licence will define the site boundary and the nuclear-related activities which can be undertaken on site, list the conditions to which these activities are subject and provide for hold points during and after construction, at which NII may intervene, inspect, stop activity or require the shut-down of operating plant.

6.85 Before granting a nuclear site licence, the HSE's NII will have to be satisfied that:

- the nuclear power station is designed and operated so that there is adequate protection against exposure to radiation in normal and accident conditions to protect both employees and members of the public, including meeting statutory dose limits;
- sufficient levels of protection and defence are provided against significant faults or failures;
- accident management and emergency preparedness strategies are prepared; and
- all reasonably practicable steps have been taken to minimise the radiological consequences of an accident[121].

6.86 In carrying out its licensing assessment, HSE will also require the operator to ensure a high standard of flood risk protection, so that nuclear facilities can withstand predicted sea level rises. The NII will expect the operator to ensure protection against other effects of global warming, as well as potential extreme weather events, such as a one in 10,000 year flood risk[122].

6.87 The 1965 Act allows HSE to attach to each nuclear site licence such conditions as it considers necessary or desirable in the interests of safety or with respect to the handling, treatment or disposal of nuclear materials. HSE's NII has the power to add, vary or revoke conditions, so providing scope for the licence to be tailored to specific circumstances and the phase of the installation's life.

6.88 Licence conditions cover all the arrangements for managing safety, including the production of adequate safety cases for all operations, the appointment of competent personnel, safety training and supervision, handling and storage of nuclear material, control of organisational change, response to accidents and emergency planning arrangements.

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120 See also paragraphs 2.22-2.26 on the GDA process

121 See also 'Applying for a nuclear site licence for new nuclear power stations: A step-by-step-guide', 1 August 2008, HSE http://news.hse.gov.uk/2008/08/07/step-by-step-guide-to-applying-for-site-licence-published/

122 Safety Assessment Principles for Nuclear Facilities: EHA.4, EHA.11, EHA.12, EHA.14, EHA.15, ECE.23 http://www.hse.gov.uk/nuclear/saps/saps2006.pdf

6.89 With regard to enforcement, the 1965 Act and licence conditions themselves enable HSE to take a range of measures including:

- attaching conditions to a licence, and varying or revoking those conditions;
- varying a licence, to reduce the area of the licensed site;
- consenting to particular actions;
- approving particular arrangements or documents, generally to freeze them so they cannot be changed without HSE agreement;
- notifying the licensee that it requires certain information to be submitted, for example, a safety case;
- issuing specifications to require the submission of particular documents for examination, or specifying that something must be done in a particular way;
- issuing agreements in relation to particular plant or process modifications;
- directing the licensee to shut down particular operations; and
- revoking a nuclear site licence.

6.90 The NII provides guidance to its inspectors in the form of Safety Assessment Principles (SAPs)[123], which include numerical targets termed the Basic Safety Levels (BSLs) and Basic Safety Objectives (BSOs). The BSLs effectively form a cap on the level of radiological detriment from any facility that would be allowed to proceed. The BSOs form benchmarks that reflect modern nuclear safety standards and expectations.

6.91 The NII's guidance is also based on the "defence in depth" approach to safety. "Defence in depth" should provide a series of levels of defence (inherent features, equipment and procedures) aimed at preventing accidents and ensuring appropriate protection in the event that prevention fails. The levels of protection should prevent faults, or if prevention fails should ensure detection, limit the potential consequences and prevent escalation[124].

6.92 Granting of a site licence can take place well before the start of nuclear construction, but once granted, the licensee must obtain HSE's permission before starting such construction. In considering when to grant a licence, HSE looks at three main aspects of an applicant's proposals:

[123] http://www.hse.gov.uk/nuclear/saps/
[124] HSE Safety Assessment Principles for Nuclear Facilities 2006 Edition, Revision 1 http://news.hse.gov. uk/2008/08/07/step-by-step-guide-to-applying-for-site-licence-published/

- the overall nuclear safety case for the activities that are planned to take place following receipt of the licence (this will be likely to require less evidence than will be required to permit the start of nuclear construction);
- evidence that the siting aspects have been adequately considered; and
- evidence that the organisation and resourcing of the proposed licensee corporate body is appropriate to manage that stage of the project, and covering the arrangements needed to meet the licence conditions (normally all covered in a Management Prospectus).

6.93 The environment agencies are responsible for ensuring that new nuclear power station designs meet high environmental standards through using the best available techniques (BAT), consistent with the OSPAR Convention[125]. Through the GDA process, the Environment Agency is ensuring that the reactor designers address this requirement at an early stage. This ensures that the most modern techniques to minimise radioactive waste discharges[126] can be incorporated into the designs of the new nuclear power stations.

6.94 The application of BAT would ensure that discharges from new nuclear power stations constructed in the UK would not exceed those of comparable power stations across the world. Any new nuclear power stations will need authorisation from the relevant environment agency before making any discharges of radioactivity into the environment or disposals of radioactive waste under the provisions of the Radioactive Substances Act 1993[127] or, in England and Wales, the Environmental Permitting (England and Wales) Regulations 2010[128].

6.95 The Environment Agency and the Scottish Environment Protection Agency can both issue enforcement, prohibition and revocation notices where authorisation conditions are being contravened, or where there is risk of environmental harm.

6.96 The Environment Agency also requires operators to assess their discharges and disposals of radioactive waste and to report them to the Environment Agency. Operators are required to inform the Environment Agency about any circumstances where they may be failing to comply with the conditions of their permit, for example if they were failing to comply with discharge limits. Additionally, the Environment Agency can set “notification levels” on

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[125] Convention for the Protection of the Marine Environment of the North-East Atlantic http://www.ospar. org/html_documents/ospar/html/OSPAR_Convention_e_updated_text_2007.pdf

[126] The regulatory regime for liquid and gaseous discharges is considered in further detail in Chapter 4 (Radioactive Waste). See also the Statutory Guidance to the Environment Agency concerning the regulation of radioactive discharges into the environment, published by the Department of Energy and Climate Change in 2009: http://www.decc.gov.uk/media/viewfile.ashx?filepath=what we do/uk energy supply/energy mix/nuclear/radioactivity/dischargesofradioactivity/1_20091202160019_e_@@_guidanceearadioactivedischarges.pdf&filetype=4

[127] Radioactive Substances Act 1993 (c. 12) http://www.opsi.gov.uk/acts/acts1993/ukpga_19930012_en_1

[128] The Environmental Permitting (England and Wales) Regulations 2010 (2010 No. 675) http://www.opsi.gov.uk/si/si2010/uksi_20100675_en_1

discharges that require operators to notify the Agency where the levels are exceeded and to carry out a review of their performance with regard to the use of BAT to minimise discharges.

6.97 This regulation will continue throughout the operation of a nuclear power station. Operators would need to manage and incorporate into their business case the potential for any age-related deterioration in nuclear plant components, and the licensing authority would need to be assured of effective mitigating actions where necessary in order to allow the nuclear power station to continue operating.

6.98 In addition to the existing regulatory regime, in July 2009 the EU adopted a new Directive on Nuclear Safety[129]. The aim of the Directive is to ensure continuous improvement in the management of the health and safety risks associated with the management of civil nuclear facilities. HSE and DECC are working on a transposition strategy to ensure the effective transposition of the Directive obligations by June 2011. An initial scoping exercise has identified that most, if not all, the requirements of the Directive are already being met in the UK.

Regulatory Regime – Members of the Public

6.99 As stated, radiation occurs naturally in the environment. HPA, which regularly reviews the radiation exposure of the UK population, has calculated that the overall average annual dose to a member of the public from all sources of radioactivity is 2.7 mSv per year. Of this, about 84% is from natural sources, about 15% from medical procedures and about 1% from all other sources, including nuclear power stations[130].

6.100 By law the radiation to which members of the public are exposed from all sources, excluding natural sources and medical procedures, is limited to 1 mSv per year[131]. This limit applies to the cumulative effects of planned exposures and therefore takes into account the cumulative impact of having more than one source of radiation in a particular area. The radiation to which people living near a new nuclear power station are exposed is legally limited to 1 mSv per year, taking into account exposures from other nearby sites and any past controlled releases.

6.101 HPA, in its paper on the risks of exposure to low doses of radiation[132], states that a dose of 1 mSv per year is equivalent to an additional risk of fatal cancer

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[129] Council Directive 2008/790-final/Euratom on Nuclear Safety

[130] HPA-RPD-001 – Ionising Radiation Exposure of the UK Population: 2005 Review Authors: S J Watson, A L Jones, W B Oatway and J S Hughes Publication date: May 2005 ISBN: 0-85951-558-3 http://www.hpa.org.uk/web/HPAweb&HPAwebStandard/HPAweb_C/1247816567393

[131] This is through the Ionising Radiations Regulations 1999, Statutory Instrument 1999 No. 3232 (which includes all activities carried out under a nuclear site licence granted by the Nuclear Installations Inspectorate under the Nuclear Installations Act 1965) http://www.opsi.gov.uk/si/si1999/19993232.htm, the Environmental Permitting (England and Wales) Regulations 2010 http://www.opsi.gov.uk/si/si2010/uksi_20100675_en_1, and the Radioactive Substances (Basic Safety Standards) (Scotland) Regulations 2000 http://www.opsi.gov.uk/legislation/scotland/ssi2000/20000100.htm

[132] HPA-RPD-055 – An Introduction to the Estimation of Risks Arising from Exposure to Low Doses of Ionising

of one in twenty thousand (0.005%) per year, and that a risk at this level is not detectable among normal background levels of cancer risk.

6.102 In addition to the statutory dose limit, operators are required to use BAT to ensure that doses to members of the public are "as low as reasonably achievable" (ALARA). The environment agencies run monitoring programmes to provide an independent check on the impacts of radioactive discharges, and publish annual reports[133] which show that radiation doses to people living around nuclear sites remain well below the statutory dose limit of 1 mSv per year.

6.103 As well as the statutory limit of 1 mSv per year, HPA recommends that the radiation to which members of the public are exposed from a proposed controlled source, such as a new nuclear power station, should be no more than 0.3 mSv per year. HPA further recommends that dose constraints lower than this could be set where this is achievable.

6.104 HPA's recommendation is reflected in a Direction issued by the Secretary of State for the Environment, Transport and the Regions in May 2000 under the Environment Act 1995[134], and an equivalent Direction issued by Scottish Ministers to the Scottish Environment Protection Agency[135]. The Directions require the agencies to have regard to a maximum dose of 0.3 mSv per year to members of the public from any new source of radioactive discharges since 13 May 2000 and to have regard to a maximum dose of 0.5 mSv per year from any single site.

6.105 In July 2009, in response to the recommendations in ICRP Publication 103[136], HPA provided further advice to the Government on its recommended dose constraints[137]. This states:

"Previously, the NRPB recommended a maximum dose constraint for proposed controlled sources of 0.3 mSv y-1 [per year] noting that dose constraints lower than this could be set where such doses are readily achievable. HPA continues to recommend this approach but re- emphasises that the 0.3 mSv y-1 [per year] value is a maximum and that regulators should set lower, more challenging dose constraints where appropriate. At the design stage of new plant it is more straightforward to take measures to reduce

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Radiation, Authors: S Mobbs, S Watson, J Harrison, C Muirhead and S Bouffler, Publication date: June 2009 ISBN: ISBN 978-0-85951-643-3 http://www.hpa.org.uk/webw/HPAweb&HPAwebStandard/HPAweb_C/1245052106074

133 RIFE (Radioactivity in Food and the Environment) Reports, produced jointly by the Environment Agency, SEPA, DOENI and Food Standards Agency. See in particular Table S1 "Radiation doses due to discharges of radioactive waste in the United Kingdom, 2008" and Table S2 "Radiation doses due to all sources at major UK sites, 2008". http://www.food.gov.uk/multimedia/pdfs/publication/rife2008.pdf http://www.environment-agency.gov.uk/homeandleisure/110281.aspx

134 Environmental Permitting (England and Wales) Regulations 2010

135 The Radioactive Substances (Basic Safety Standards) (Scotland) Direction 2000

136 ICRP Publication 103: 2007 Recommendations of the ICRP http://www.icrp.org/

137 Application of the 2007 Recommendations of the ICRP to the UK. Advice from the Health Protection Agency. Doc HPA, RCE-12, 1–65, July 2009 http://www.hpa.org.uk/web/HPAwebFile/ HPAweb_C/1246519364845

exposures of the public than it is when measures have to be introduced to existing plant. Therefore, it is recommended that for new nuclear power stations and new facilities for the disposal of radioactive waste, regulators consider applying a more challenging dose constraint, taking into account the levels of protection that can be achieved internationally. HPA specifically advises the UK Government to select a value for the constraint for members of the public for new nuclear power stations and waste disposal facilities that is less than 0.15 mSv per year. Such a constraint would apply only to new plant as a design criterion and would not apply to existing facilities which should operate within current arrangements."

6.106 The process of reaching a Regulatory Justification decision is separate from the decision on whether to adopt the new constraint. However, as HPA published its advice after the consultation on the Application, the Secretary of State asked the Applicant to confirm that the AP1000 and the other new nuclear power station designs proposed in the Application would be capable of meeting a constraint for members of the public for new nuclear power stations and waste disposal facilities of less than 0.15 mSv per year, if such a constraint was to apply at some point in the future.

6.107 The Applicant responded that the AP1000 and the other proposed new nuclear power stations would be capable of meeting such a dose constraint, and indicated material in the Application that supported this case[138].

6.108 The Secretary of State noted that some respondents questioned why a dose constraint of 0.1 mSv, as recommended by ICRP, was not being enforced, and asked HPA for advice on this point. HPA explained that ICRP has made various further recommendations regarding dose constraints for different situations. For the control of public exposure from waste disposal, ICRP has recommended that a value of the dose constraint for members of the public of no more than 0.3 mSv a year would be appropriate. ICRP also considered the specific situation where there are planned discharges of long lived radionuclides to the environment which could lead to the build-up of activity in the environment and hence dose constraints being exceeded. If it is not possible to assess this possible build-up or it is very uncertain then ICRP suggested that it would be prudent to apply a dose constraint of 0.1 mSv in a year to the prolonged component of the dose attributable to the long-lived artificial radionuclides.

6.109 Therefore, ICRP does not have a general dose constraint of 0.1 mSv per year but rather an additional suggested constraint for use in these specific situations.

[138] The Secretary of State's request was made by way of a Regulation 16 Notice. Copies of the Notice and the Applicant's Response are set out in Annex D. The Response refers in particular to the Table on page 54 of Volume 2 of the Application http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

Regulatory Regime – Employees

6.110 The Secretary of State has considered the measures in place to protect employees of the nuclear industry.

6.111 The 2007 Recommendations of the International Commission on Radiological Protection (ICRP) retain the occupational dose limit given in ICRP 60[139] in 1990. These state that for planned exposure situations, that is, during the normal operation of a nuclear power station, the limit should be expressed as 20 mSv per year, averaged over defined five year periods, that is, 100 mSv over five years, without exceeding 50 mSv in any single year[140].

6.112 Under UK law, all employers are responsible for protecting their employees against exposure to ionising radiations. The Ionising Radiations Regulations 1999[141] require all employers to restrict doses so far as is reasonably practicable and to limit doses to 20 mSv in any calendar year unless the nature of the work makes this impracticable. In this event, the limit may be relaxed to 100 mSv over any consecutive five years with a maximum of 50 mSv in any single year, in accord with the ICRP Recommendations.

6.113 The UK nuclear industry works well within these dose limits, and applies additional stricter constraints on dose. British Energy, part of EdF S.A., operates the majority of the nuclear power stations in the UK and imposes its own dose restriction level of 10 mSv per year for everyone who works on its licensed sites. Any worker required to enter a radiation controlled area at such sites is issued with an electronic personal dosemeter which measures radiation dose and warns the wearer if pre-determined dose levels are exceeded. According to British Energy[142], compared with the legal limit of 20 mSv per year, the average individual dose received by all workers on British Energy sites in 2009 was 0.114 mSv and the highest individual dose received by such a worker was 8.709 mSv.

Effectiveness of the Regulatory Regime

6.114 The Secretary of State has considered the evidence for the effectiveness of the regulatory regime.

6.115 The UK regulatory regime is based upon the principle of independent regulators backed up by sanctions. A review by the International Atomic Energy Agency in 2006 concluded that the regulatory arrangements of HSE's Nuclear Directorate are mature and transparent, with highly trained, expert

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139 ICRP Publication 60: 1990 Recommendations of the ICRP http://www.icrp.org/

140 The National Radiological Protection Board stated in 1993 that there appeared to be no practical need for the five year averaging and recommended that the 20 mSv annual limit be observed (NRPB (1993). Occupational, public and medical exposure. Documents of the NRPB: Volume 4, No. 2). HPA has restated this view in its response to the 2007 Recommendations of the ICRP (Application of the 2007 Recommendations of the ICRP to the UK. Advice from the Health Protection Agency. Doc HPA, RCE-12, 1–65, July 20

141 The Ionising Radiations Regulations 1999 http://www.opsi.gov.uk/si/si1999/19993232.htm

142 http://british-energy.com/pagetemplate.php?pid=453#health

and experienced staff[143]. A second IAEA review in 2009 reiterated the earlier conclusions and recognised additional areas of good practice[144].

6.116 Where appropriate, regulators take enforcement action against failures to comply with the requirements of a nuclear site licence or with a site's environmental permits, and will prosecute where warranted. The UK has a strong safety record with no events having occurred relating to a civil nuclear power station with off-site consequences or where all the safety barriers that are an inherent part of the design were breached.

6.117 The Euratom treaty requires all EU countries to compare radiation doses received with the dose limits. For doses to the UK population, this is the responsibility of the Environment Agencies. Monitoring of radiation around nuclear power stations is carried out both by the site operators and by the environment agencies and other Government agencies, who run monitoring programmes of radioactivity in food and the environment near nuclear sites to provide an independent check on the impacts of radioactive discharges. The monitoring carried out on behalf of the regulators and Agencies is reported and published in the annual 'Radioactivity in Food and the Environment (RIFE)' report[145]. This report also includes an assessment of radiation doses received by members of the public for comparison with the regulatory dose limits. Recent reports show that these remain well below the statutory dose limit of 1 mSv per year.

6.118 The report is supplemented by the Food Standards Agency publishing provisional analytical results from its radiological monitoring programme on a six-monthly basis, which are later confirmed and interpreted on an annual basis in the RIFE reports[146].

6.119 In addition, the site operators have local stakeholder groups, many of which have meetings that are open to the public, where the operators present the results of their monitoring programmes and the resulting radiation doses. The monitoring that is carried out, together with separate work to determine the habits of those people who are likely to be the most exposed (the critical group) is sufficient to ensure that the public are properly protected from discharges and disposals of radioactive waste from routine operation. The regulators also attend the site stakeholder groups and together provide updates on safety and environmental matters including about operational events, reviews, assessments and findings.

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143 Integrated Regulatory Review Service (IRRS), IAEA, April 2006 http://www.hse.gov.uk/nuclear/regulatoryreview/

144 Integrated Regulatory Review Service (IRRS), IAEA, October 2009. www.hse.gov.uk/nuclear/regulatoryreview/

145 RIFE (Radioactivity in Food and the Environment) Reports, produced jointly by the Environment Agency, SEPA, DOENI and Food Standards Agency. See in particular Table S1 "Radiation doses due to discharges of radioactive waste in the United Kingdom, 2008" and Table S2 "Radiation doses due to all sources at major UK sites, 2008". http://www.food.gov.uk/multimedia/pdfs/publication/rife2008.pdf http://www.environment-agency.gov.uk/homeandleisure/110281.aspx

146 http://www.food.gov.uk/science/surveillance/radiosurv/rife/radsurv2009

6.120 Operators are required to report to the Environment Agency about the levels of discharges and disposals of radioactive waste. The reports are placed on the Environment Agency's Public Registers where they can be inspected by the public[147].

6.121 The regulatory regime has continued to develop. The establishment of the GDA process, run through a Joint Programme Office by the Nuclear Installations Inspectorate (NII), the Office for Civil Nuclear Security (OCNS) and the Environment Agency has facilitated generic consideration of reactor designs ahead of site-specific licence and environmental permit applications, has improved coordination between regulators, allowed identification of issues earlier when they are easier to resolve and has increased transparency through the publication of relevant material on the regulators' websites, including on regulatory issues about the designs raised by regulators with the vendors.

6.122 The work undertaken to date by the regulators as part of the GDA process has provided an overview of the fundamental acceptability of the AP1000 within the overall UK regulatory regime. The Secretary of State notes that at this stage HSE considers that its preliminary view, that there were no safety or security shortfalls that would be so serious as to rule out the eventual construction of an AP1000 in the UK, remains valid[148], and that this supports the Application's statement that the AP1000 would meet UK regulatory dose limits and constraints. He also notes that, in June 2010, the EA published a consultation[149] on its findings so far and that the EA's consultation documents state that in its view so far a Statement of Design Acceptability could be issued for the AP1000. The Environment Agency and the HSE continue to assess the AP1000 design, including its safety features, as part of the GDA process and intend to report on their final GDA assessments in Summer 2011.

6.123 The Secretary of State considers that the regulatory regime will ensure effective mitigation of the potential radiological health detriment from any AP1000 which is built in the UK. The effect of the regulatory regime is to provide confidence that any AP1000 built in the UK will be able to meet regulatory limits and will be robust against the risk of an accident or attack. This is supported by the strong safety and security record of the nuclear industry in the UK. The effectiveness and efficiency of the regulatory regime is under continuous review and improvements are made where necessary.

Studies on the impact of radiation on health

6.124 The Secretary of State considers studies on the impact of radiation on human health are potentially valuable information and is aware of differing views about the findings of such studies, notably the reports produced by the

[147] See http://www2.environment-agency.gov.uk/epr/index.asp for more information about the Environment Agency's public registers
[148] http://www.hse.gov.uk/newreactors/index.htm
[149] GDA Consultation document for the AP1000 nuclear power plant design by Westinghouse Electric Company LLC https://consult.environment-agency.gov.uk/file/1352806

Committee on Medical Aspects of Radiation in the Environment (COMARE), and the KiKK study[150].

6.125 Some respondents to the consultation on the Application said that the studies on the impact of radiation on health in Annex 3 (Supplementary Notes on Radiation) of the Application were not supported by references. The Applicant's response to a request through a Regulation 16 Notice for such references is at Annex D.

6.126 The Government's view is that new nuclear power stations would pose a very small risk to health. Following the consultation on the Application, the Secretary of State asked HPA to advise on whether studies referred to by the Applicant, respondents to the consultation on the Application, or any other studies, raised concerns which should be taken into account in this Decision.

6.127 ICRP Publication 103, published in 2007, upheld the system of radiological protection in ICRP Publication 60 published in 1990. HPA said that no information has been published since the recommendations in ICRP Publication 103 that has caused HPA to change its overall views on the control of exposures to ionising radiation.

6.128 In view of the recent detailed ICRP reviews of the health effects of ionising radiation and HPA's recent paper summarising the risks arising from exposure to low doses of ionising radiation[151], HPA did not consider that a further examination was appropriate.

6.129 Following the consultation on the Proposed Decisions, the Secretary of State asked HPA to review the position again, and to consider the studies referred to by respondents which came to different conclusions[152]. HPA replied that the studies listed had been considered by HPA and other scientific and medical bodies – for example, in HPA's response to the CERRIE report and in reports and statements by COMARE. Further details of HPA's views of the findings of these studies are given below and in Annex F.

6.130 HPA recognises that there are uncertainties in the estimation of radiation risk. However, HPA's interpretation of the studies cited is that they do not provide evidence that radiation risks have been substantially under-estimated.

6.131 The Secretary of State particularly noted respondents' concerns about the findings of the KiKK study and sought advice on these findings from COMARE. Annex B explains that COMARE is an independent scientific

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[150] Commission on Radiological Protection (SSK). Assessment of the "Epidemiological Study on Childhood Cancer in the Vicinity of Nuclear Power Plants" (KiKK Study). Position of the Commission on Radiological Protection. SSK, Bonn, 2008 http://www.bfs.de/en/bfs/druck/Ufoplan/4334_KIKK.html English translation starts after page xi of http://www.bfs.de/de/bfs/druck/Ufoplan/4334_KIKK_Zusamm.pdf

[151] HPA-RPD-055 – An Introduction to the Estimation of Risks Arising from Exposure to Low Doses of Ionising Radiation, Authors: S Mobbs, S Watson, J Harrison, C Muirhead and S Bouffler, Publication date: June 2009 ISBN: ISBN 978-0-85951-643-3 http://www.hpa.org.uk/webw/ HPAweb&HPAwebStandard/HPAweb_C/1245052106074

[152] A full list of the references to epidemiological studies referred to by respondents is set out in Annex E.

advisory committee which advises Government departments and devolved authorities on all aspects of health risk to people exposed to natural and man-made radiation[153].

6.132 The Secretary of State is satisfied that members of the committee are chosen for their independent medical and scientific expertise and recruited from universities and research and medical institutes and have never been drawn from the nuclear or electrical power supply industries and that it provides its advice on an independent basis.

6.133 COMARE has, for over twenty years, investigated the incidence of childhood cancer and other cancers around nuclear sites, starting with the Sellafield site in 1986. COMARE has published a series of reports on topics related to exposure to radiation. Its view is that there is no evidence for unusual aggregations of childhood cancers in populations living near nuclear power stations in the UK.

6.134 COMARE's tenth report[154], published in 2005, considered the incidence of childhood cancer around nuclear installations. These were divided into nuclear power stations and other nuclear sites. The results for the nuclear power stations supported the conclusion that "*there is no evidence from this very large study that living within 25 km of a nuclear generating site in Britain is associated with an increased risk of childhood cancer*".

6.135 COMARE's tenth report did however conclude that the situation for the other nuclear sites is more complicated. Studies confirmed previous COMARE findings of excess childhood cancers in Seascale near Sellafield, Thurso near Dounreay and around Aldermaston, Burghfield and Harwell. Historically, Sellafield is the UK nuclear site with the largest of all radioactive discharges. COMARE's fourth report[155], published in 1996, which concentrated on Sellafield and childhood leukaemia in Seascale, concluded that "*on current knowledge, environmental radiation exposures from authorised or unplanned releases could not account for the excess [of leukaemia and other cancers*]."

6.136 In its eleventh report[156], published in 2006, COMARE examined the general pattern of childhood leukaemia in Great Britain and concluded that many types of childhood cancers "*have been shown not to occur in a random fashion*". It also stated that "*The results of analyses […] suggest that there is no general clustering around nuclear installations*".

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153 See http://www.comare.org.uk/ and Annex B (Roles of Independent Regulators and Advisory Bodies in the UK) for more information on COMARE'S role and recent reports

154 Committee on Medical Aspects of Radiation in the Environment (COMARE) (2005). Tenth Report. The incidence of childhood cancer around nuclear installations in Great Britain. http://www.comare.org.uk/documents/COMARE10thReport.pdf

155 http://www.comare.org.uk/documents/COMARE1-6reports.pdf

156 Committee on Medical Aspects of Radiation in the Environment (COMARE) (2006). Eleventh Report. The distribution of childhood leukaemia and other childhood cancer in Great Britain 1969–1993. http://www.comare.org.uk/press_releases/documents/COMARE11thReport.pdf

6.137 A number of respondents to the consultation on the Proposed Decisions said that it was wrong to follow the advice of HPA and COMARE and that the Secretary of State should take more account of studies which come to different conclusions, in particular the KiKK study.

6.138 The KiKK Study, the results of the Kinderkrebs in der Umgebung von Kernkraftwerken (KiKK) study of childhood cancer in the vicinity of German nuclear power plants between 1980 and 2003 was published in 2008 by the German Childhood Cancer Registry (DKKR), based on data from and designed in consultation with the Federal Office for Radiation Protection (BfS)[157].

6.139 The KiKK study found that there was a correlation between the distance of the home from the nearest nuclear power station at the time of diagnosis and the risk of developing leukaemia before the fifth birthday. However, it also noted that the exposure to ionising radiation in the vicinity of German nuclear power stations was lower by a factor of 1,000 to 100,000 than the exposure to natural background and medical radiation, and that therefore the findings of the study could not be explained in the present state of radiobiologic and epidemiologic knowledge.

6.140 An analysis by the German Commission on Radiological Protection concluded that the design of the KiKK study was suitable for analysing risks according to distance but not for establishing a correlation with exposure to radiation from nuclear power plants. It pointed out that the natural radiation exposure within the study area, and its fluctuations, were both greater, by several orders of magnitude, than the additional radiation exposure from the nuclear power plants. The analysis concluded "*If one assumes that the low radiation exposures caused by the nuclear power plants are responsible for the increased leukaemia risk for children, then, in light of current knowledge, one must calculate that leukaemias due to natural radiation exposure would be more common, by several orders of magnitude, than they are actually observed to be in Germany and elsewhere.*"[158]

6.141 Following the KiKK study, COMARE requested that a reanalysis of the UK childhood cancer data used in COMARE's tenth report be carried out using the same methodology as the KiKK study as far as was possible. This reanalysis – the Bithell paper[159] – was published in December 2008. It showed that, for the UK, the conclusions of the COMARE tenth report remained valid when applying methodology closer to that of the KiKK study on the same dataset.

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[157] Epidemiological Study on Childhood Cancer in the Vicinity of Nuclear Power Plants (KiKK Study). http://www.bfs.de/en/bfs/druck/Ufoplan/4334_KIKK.html
English translation starts after page xi of http://www.bfs.de/de/bfs/druck/Ufoplan/4334_KIKK_Zusamm.pdf

[158] Commission on Radiological Protection (SSK). Assessment of the "Epidemiological Study on Childhood Cancer in the Vicinity of Nuclear Power Plants" (KiKK Study). Position of the Commission on Radiological Protection. SSK, Bonn, 2008 http://www.ssk.de/en/werke/2008/volltext/ssk0806e.pdf

[159] Childhood leukaemia near British nuclear installations: methodological issues and recent results, Bithell et al, Radiation Protection Dosimetry 2008 132(2): 191-197
http://rpd.oxfordjournals.org/cgi/content/abstract/132/2/191

6.142 The KiKK study gave the results on childhood cancer in the vicinity of 16 German nuclear power stations from a dataset established by the German Childhood Cancer Registry, which included over 1500 childhood cancer cases from 1980 to 2003. In comparison, the dataset used for COMARE's tenth report and the subsequent Bithell paper contained over 32,000 cases of childhood cancer from 1969 to 1993. This is a verified national database and is believed to be the largest national database on childhood cancer in the world. The size of the database used by COMARE therefore gives considerable confidence in the results of its tenth report.

6.143 COMARE is currently undertaking a further review of the incidence of childhood cancer around nuclear power stations, with particular reference to the KiKK study and COMARE's tenth and eleventh reports. This will be published as COMARE's fourteenth report later in 2010. COMARE is also keeping the incidence of childhood leukaemia and other cancers in the vicinity of Sellafield and Dounreay under surveillance and periodic review.

6.144 The Secretary of State asked COMARE to respond to the criticism that its tenth report investigated the incidence of childhood cancers within a 25km radius of nuclear power stations when it should have investigated smaller areas. COMARE responded that the radius was chosen, in part, to be in line with previous studies and would include either primary exposure to radioactive discharges or secondary exposure from re-suspended material. As well as examining childhood cancer incidence overall within a 25 km radius, the COMARE analysis looked for any increasing trend in incidence within increasing proximity to nuclear sites.

6.145 The Bithell paper's subsequent analysis of the same UK database used in COMARE's tenth report considered 5km, 10km and 25km radii. Although the methodology of this study was unable to exactly replicate that of the KiKK study due to data constraints, it looked for an effect nearer to the nuclear sites than in previous investigations. It restricted analysis to children under 5 years of age and followed the KiKK study by considering all nuclear power stations combined. None of the distances considered produced statistically significant results for increased incidence of childhood leukaemia and the results confirmed that the conclusions of the COMARE tenth report remained valid for the UK when applying the revised methodology.

6.146 COMARE's fourteenth report will consider a variety of distances, to keep in line with previous studies.

6.147 The Secretary of State is satisfied that the best evidence suggests that no appreciable linkage between nuclear power stations and a higher incidence of cancer has been demonstrated.

Regulatory Regime – ICRP

6.148 The Secretary of State noted that a number of respondents to both consultations questioned the relevance and adequacy of the International

Commission on Radiological Protection (ICRP) system of radiological protection which forms the basis of Regulatory Justification. The Government believes that using dose limits is the correct way to restrict the impact of radiation on individuals, and is in line with the position in other countries. Following both consultations, the Secretary of State considered the position with HPA.

6.149 Annex B explains that HPA incorporates the former National Radiological Protection Board and is an independent organisation which was set up by the Government to protect the public from threats to their health from infectious diseases, environmental hazards and radiation and that it does this by providing advice and information to the general public, to health professionals such as doctors and nurses, and to national and local government.

6.150 The Secretary of State is satisfied that HPA's advice, information and services are underpinned by evidence-based research, that it provides whatever advice and information is necessary to protect people's health and that it does so on an independent basis as required under the Health Protection Agency Act 2004. The advice provided by HPA is consistent with scientific reviews from the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) and other authoritative sources. HPA publishes its own scientific findings and reviews in the peer reviewed literature.

6.151 The system of radiological protection through dose limits recommended by the ICRP underpins the Basic Safety Standards Directive which is the basis for Regulatory Justification, and for the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources[160]. HPA therefore confirmed that the ICRP's system of protection has wide international acceptance as a basis for regulatory control.

6.152 HPA further explained that knowledge of the health effects of ionising radiation has been reviewed recently by the ICRP. In 2007, ICRP Publication 103[161] referred to the conclusions of ICRP Publication 60 (published in 1990) and concluded that " [ICRP's] *extensive review of the health effects of ionizing radiation has* […] *not indicated that any fundamental changes are needed to the system of radiological protection*". In its response[162] to the recommendations in ICRP Publication 103, HPA was in overall agreement with ICRP's position on the health effects of ionising radiation for the purposes of radiological protection.

6.153 Following the consultation on the Proposed Decision, HPA said that they continue to endorse the approaches adopted by the ICRP in developing an

[160] Sponsored jointly by the Food and Agriculture Organisation of the United Nations, the International Atomic Energy Agency (the IAEA), the International Labour Organisation, the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development, the Pan American Health Organisation and the World Health Organisation (IAEA 1996) http://www-pub.iaea.org/MTCD/publications/PDF/SS-115-Web/Pub996_web-1a.pdf

[161] ICRP Publication 103: 2007 Recommendations of the ICRP http://www.icrp.org/

[162] Application of the 2007 Recommendations of the ICRP to the UK. Advice from the Health Protection Agency. Doc HPA, RCE-12, 1–65, July 2009 http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1246519364845

internationally agreed system for protection against ionising radiation, and that the concerns raised by respondents[163] about the conventional approach to radiation risk have been considered in depth in an HPA publication of April 2010 "Risks from ionizing radiation"[164], which specifically examines the criticisms that have been made of the ICRP model.

6.154 HPA continues to assess recent findings and is at the forefront of research on radiation risks from external and internal sources of exposure. HPA endorses the approaches adopted by the ICRP in developing an internationally agreed system for protection in various situations of exposure, based on scientific analyses published by international bodies, principally UNSCEAR.

6.155 The Secretary of State asked HPA to respond in detail to the main points made in studies cited by respondents which dissent from the ICRP position. HPA's response on these points is at Annex F.

6.156 The Secretary of State notes respondents' concern about this issue, but has not been presented with any evidence which would cause him to change the conclusion reached in the Proposed Decision that using dose limits is the correct way to restrict the impact of radiation on individuals.

Number of new nuclear power stations

6.157 As stated in paragraphs 2.13 to 2.17, because Regulatory Justification is an initial, high-level assessment and a generic class or type of practice must be Justified before it is first adopted or first approved, the Secretary of State would not expect to take into account the number of nuclear power stations that could be built following a positive Regulatory Justification decision.

6.158 However, the Secretary of State, in the interests of addressing the concern that the number of nuclear power stations built might increase the risk of radiological health detriment to members of the public, asked HPA to review this position.

6.159 On the basis of HPA's advice, the Secretary of State has considered the potential collective dose to the public based on current data associated with the Sizewell B reactor, which has an operating regime and technology similar to the AP1000. A collective dose is the total of predicted individual doses over exposed populations and times and, when divided by the number of people, can be used to estimate a per-caput dose. The Secretary of State is satisfied that if 20 AP1000s were built, meeting the current regulatory constraints on doses to members of the public, then the annual per caput dose for the whole UK population would be at the microsievert (a level of dose and abbreviated as μSv) level or less – a thousand times less than the current annual dose limit for members of the public of 1 mSv.

[163] Supported by the epidemiological studies referred to by respondents and set out in Annex E
[164] HPA-RPD-066 :Risks from ionising radiation, Mobbs S F, Muirhead C R and Harrison J D, http://www.hpa.org.uk/Publications/Radiation/HPARPDSeriesReports/HPARPD066/

6.160 It is also the case, as previously noted (paragraph 6.100), that the regulatory regime takes into account the cumulative impact of having more than one source of radiation in a particular area.

6.161 The Secretary of State notes respondents' concern about this issue, but has not been presented with any evidence which would cause him to change the conclusion reached in the Proposed Decision that the number of new nuclear power stations to be built in the UK is not relevant to this Decision.

Estimating numbers of cases of health detriment caused by radiation from new nuclear power stations

6.162 The Secretary of State has noted that in response to the consultation on the Application the point was made that the Application referred to the system of dose limits used to assess the impact of radiation on individuals but did not estimate the number of people whose health would suffer as a result of building new nuclear power stations.

6.163 The Secretary of State is satisfied that using dose limits is the correct way to restrict the impact of radiation on individuals. The Secretary of State also thinks it is relevant to this issue that by law the radiation to which members of the public are exposed from all sources, excluding medical exposures of patients and natural background radiation, is limited to 1 mSv per year, that this represents a level of risk of cancer which would not be detectable among normal background levels of cancer risk and that doses are further reduced by the application of the As Low As Reasonably Achievable (ALARA) principle. However, the Secretary of State asked HPA for further advice on this point.

6.164 HPA replied that it is possible to estimate the number of cancers from a source of radiation. However, such calculations rely on uncertain assumptions and there has been no convincing demonstration of numbers of cases from exposure to environmental radiation at levels associated with the normal operation of nuclear power stations.

6.165 Further, the ICRP cautions against calculating numbers of attributable health effects in such circumstances, noting that "[the ICRP] *judges that it is not appropriate, for the purposes of public health planning, to calculate the hypothetical number of cases of cancer or heritable disease that might be associated with very small radiation doses received by large numbers of people over very long periods of time*"[165].

6.166 Although an estimate could be made of numbers of health effects, suitably caveated, HPA therefore considered that the health risks to individuals in the exposed population and the radiological implications of build-up of radionuclides in the environment are better addressed through the ICRP system of radiological protection based on dose limits.

[165] ICRP Publication 103: 2007 Recommendations of the ICRP http://www.icrp.org/

6.167 This approach is set out in detail in Guidance[166] published by the environment agencies, the National Radiological Protection Board (now incorporated in HPA) and the Food Standards Agency. The Guidance notes that it is not practicable to assess doses for each member of the public and that doses should be assessed by the use of per caput annual doses in an exposed population and in estimated critical group doses. The per caput dose is the collective dose (the total of predicted individual doses over exposed populations and times) divided by the number of people. Estimated critical group doses are for those members of the public who are representative of people receiving the highest doses due to where they live and their habits.

6.168 The Secretary of State has also considered the views[167] of his advisers – Integrated Decision Management and the National Nuclear Laboratory (IDM–NNL) – on this point.

6.169 IDM-NNL explain that radioactive discharges disperse, giving very small doses to large numbers of people over long periods of time and that it is possible to use the total of these doses (the collective dose) to calculate the hypothetical number of cases of cancer that might be associated with these doses.

6.170 IDM-NNL refer to a study[168] which used radioactive discharge data, based on a scenario, to calculate statistical fatalities and to their own further calculations using the data in the study. Their findings are that because collective doses largely consist of small doses of radiation affecting large populations over long periods of time, and because of the use of the Linear No Threshold assumption[169], the number of statistical fatalities calculated can, when expressed over a long period of time, appear significant. However, the individual doses on which these estimates are based are overwhelmingly at levels which are well below the legal limits in force.

6.171 The Secretary of State notes respondents' concern about this issue, but has not been presented with any evidence which would cause him to change the conclusion reached in the Proposed Decision. Although it would be possible for him to take into account an estimate of the number of cases of cancer which could arise from the building of new nuclear power stations, it is more meaningful, and more effective in terms of mitigating the potential radiological detriment to health from new nuclear power stations, to base his decision on the ICRP system of radiological protection based on dose limits.

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166 Authorisation of Discharges of Radioactive Waste to the Environment, Principles for the Assessment of Prospective Public Doses, Interim Guidance, Environment Agency, December 2002 http://publications. environment-agency.gov.uk/pdf/PMHO1202BKLH-e-e.pdf?lang=_e

167 Technical Advice to inform proposed Regulatory Justification decisions on new nuclear power stations Authors: Gregg Butler, Grace McGlynn (IDM) Andrew Worrall and Kevin Hesketh (National Nuclear Laboratory) http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

168 BNFL National Stakeholder Dialogue, Spent Fuel Management Options Working Group Report July 2002 Appendix 10 http://the-environment-council.org.uk/index.php?option=com_docman&task=cat_view&gid=67&Itemid=64

169 Under the Linear No Threshold assumption, no dose, however small, is without a corresponding risk. This assumption is not accepted by all authorities in the field, some of whom argue that below a certain level of dose there is no risk.

Site-Specific Issues

6.172 As set out at paragraphs 2.13 to 2.17, Regulatory Justification is an initial, high-level consideration of a new class or type of practice, in this case the AP1000. Further regulatory and planning processes before, during and after construction and operation will address any detailed issues about, for example, the proposed siting of an AP1000 at a particular location.

6.173 In relation to the specific concerns raised in relation to the Republic of Ireland, the potential health impacts of radioactive waste from nuclear sites in neighbouring countries are covered under the radiation protection aspects of the Euratom treaty. Under the terms of Article 37, each Member State is obliged to provide the European Commission with details of any plan for disposing of radioactive waste to determine whether the implementation of such a plan is liable to result in the radioactive contamination of the water, soil or airspace of another Member State. The Commission gives its opinion on such applications after consulting a committee of scientific experts which is set up under Article 31 of the Treaty. The Commission's prime responsibility is to judge whether the uniform basic standards for radioactivity levels can be respected in the neighbouring Member State(s) under the proposed plan.

6.174 In addition, Council Directive (Euratom 2009/71) Establishing a Community Framework for the Nuclear Safety of Nuclear Installations came into force in July 2009. The Directive aims to ensure that appropriate levels of safety are adhered to across all Member States. Consideration of any potential impact on the Republic of Ireland will be considered under those regimes and is not a necessary or appropriate consideration for the Regulatory Justification decision.

Overseas practices

6.175 As explained in paragraphs 2.60 to 2.62, the Secretary of State does not consider that he is bound to take practices outside the UK into account in making a Regulatory Justification decision. The recommendations of the ICRP and the EU legislation require each country to assess the benefits and detriments of a class or type of practice carried on within its own borders, and to enforce the conclusions from such assessments. This is consistent with the Secretary of State’s powers under the Regulations, which give no authority to acquire information outside the UK for the purposes of making a Justification decision and no powers to enforce any decision. In addition the UK Justifying Authority has no jurisdiction to assess the social benefits associated with a practice being conducted outside the UK.

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6.176 However, the Secretary of State notes that a number of respondents have raised the issue of overseas practices and therefore, to the extent that it is readily possible, sets out his views on the subject.

6.177 Some respondents noted that this issue was considered in the Reports which the Inspectors at the Sizewell B Public Inquiry, and the Hinkley Point Public Inquiries, Sir Frank Layfield QC and Michael Barnes QC, made in 1987 and 1990 respectively. The Secretary of State has considered these Reports[170], though he is mindful that these were planning inquiries and not inquiries into Regulatory Justification and therefore considered many issues that are out of the scope of a Regulatory Justification assessment.

6.178 In his Report, Sir Frank noted that he had heard evidence about the risks to the health of uranium miners from their exposure to radiation (although he also heard evidence that the risks were not greater than those to other underground miners); about the environmental damage caused by waste from uranium production; and about the violation of the rights of indigenous people affected by the mining.

6.179 Sir Frank noted that the only evidence given to the inquiry on these subjects was from those who criticised uranium mining and that no evidence was provided by Governments, regulators or companies concerned. The evidence was therefore "*to a large extent, untested, and gave only a partial account*". He also noted that the UK Government and other authorities had no jurisdiction in countries where uranium was produced. However, he concluded that security and cost in the supply of uranium were important and that "*the whole of the nuclear cycle should be taken into account in assessing the proposal for Sizewell B*" although, in recommending the granting of planning permission, he did not make his decision subject to any conditions relating to the mining of uranium.

6.180 In his report, Mr Barnes recommend that "*if future proposals are put forward for further nuclear facilities which would involve the importing of uranium the applicants should use their best endeavours to present information to any future inquiry on conditions for workers and the public in the countries concerned who might be affected by the mining and processing of uranium for the project*". However, in recommending the granting of planning permission, he did not make his decision subject to any conditions in this area.

6.181 The Reports in respect of Sizewell and Hinkley reflect the position that regulation is a matter for individual member states. Although there has been little detailed study of the subject in the UK or elsewhere in Europe, there is more information on the subject than was available at the time the Reports were made, and the Secretary of State has considered this, alongside information on the security of uranium supplies, which is covered in Chapter 5 (Security of Supply and other Economic Effects).

6.182 The United Nations established the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), staffed by scientists from member states, to assess and report levels and effects of exposure to ionizing

[170] Sizewell B public inquiry – Report by Sir Frank Layfield – Summary of Conclusions and Recommendations, HMSO, ISBN 0 11 411576 1, 1987. Hinkley Point Public Inquiries – Report by Michael Barnes QC – Inspector's Conclusions and Recommendations, HMSO, ISBN 0 11 413415 4, 1990

radiation, and, given the different position and procedures in different countries, to make comparisons between them.

6.183 UNSCEAR has been publishing reports on exposure to radiation from the whole nuclear fuel cycle since the 1970s. Its 2000 report, "Sources and Effects of Ionising Radiation" and in particular Annex C, "Exposures from man-made sources of radiation", covering exposure to members of the public and Annex E, "Occupational radiation exposures", covering exposure to employees of the nuclear industry[171], is relevant to this issue.

6.184 UNSCEAR's finding is that the dose rate to members of the public from uranium mining is low, and "*would be imperceptible from variations of the normal background dose rate from natural sources*"[172].

6.185 UNSCEAR's finding[173] is that "*The average annual effective doses to workers in the nuclear fuel cycle are, in most cases, larger than the doses to those in other occupations; for the fuel cycle overall, the average annual effective dose is about 1.75 mSv. For the mining of uranium, the average annual effective dose to monitored workers in countries reporting data was about 4.5 mSv [for the most recent period considered (1990 – 1994)], and for uranium milling operations, it was about 3.3 mSv. There are, however, very wide variations about these average values, with doses of about 50 mSv being reported in some countries*."

6.186 UNSCEAR's finding summarises detailed evidence presented in the report[174]. From this evidence it is clear that these high doses are exceptional. In only one country and period (uranium mining in Gabon in the period 1985 – 1989) is the average annual effective dose to workers recorded as being over 20 mSv, at 21.0 mSv. In all other countries the average annual effective dose to workers is consistently below 20 mSv, in most cases well below, and in most countries, including Gabon, the trend over the periods covered (from 1975 – 1979 to 1990 – 1994) is downwards.

6.187 Across the world, therefore, UNSCEAR reported the exposure of employees to radiation for uranium mining and milling as, with some exceptions, well below the recommended ICRP annual limit applied in the UK of 20 mSv (see paragraphs 6.110 to 6.113).

6.188 In August 2010, UNSCEAR published the first volume of its 2008 report[175], "Sources of Ionising Radiation", which includes as Annex B further consideration of "Exposures of the public and workers from various sources of radiation".

[171] http://www.unscear.org/unscear/en/publications/2000_1.html
[172] Annex C, paragraph 124 of UNSCEAR 2000 Report
[173] Annex E, paragraph 308 of UNSCEAR 2000 Report
[174] Annex E, Tables 3 and 4, from page 559
[175] http://www.unscear.org/unscear/en/publications/2008_1.html

6.189 On public exposure[176], UNSCEAR's finding was that an average annual effective dose of 25 microsieverts was still valid for the major producing countries.

6.190 On occupational exposure, UNSCEAR's finding[177] was that average annual effective doses have declined further since their previous report, from 4.5 mSv in 1990 – 1994 to 3.9 mSv in 1995 – 1999 and 1.9 mSv in 2000 – 2002 for uranium mining, and from 3.3 mSv in 1990 – 1994 to 1.6 mSv in 1995 – 1999 and 1.1 mSv in 2000 – 2002 for uranium milling.

6.191 The Organisation for Economic Co-operation and Development (OECD) conducted a study in 2000[178]. Although its purpose was to compare options for the management of spent fuel, this involved looking at the radiation exposure caused by uranium mining. The study found that the dose levels to employees, although higher than for other stages in the nuclear fuel cycle, remained at levels similar to the averages reported by UNSCEAR, and therefore well below the recommended ICRP annual limit applied in the UK of 20 mSv[179].

6.192 The study also found that doses to members of the public were "*low compared to the pertinent regulatory limits, and also insignificantly low compared with exposures from natural background radiation*"[180].

6.193 The findings of these studies are therefore that the radiation exposure caused by uranium mining is high compared with other stages of the fuel cycle but in the vast majority of cases low in terms of impact on employee and members of the public and well below regulatory dose limits. This is consistent with the advice from the Secretary of State's advisers Integrated Decision Management and the National Nuclear Laboratory (IDM–NNL) published alongside the consultation on the Proposed Decisions[181].

6.194 A further major source of information is a report by a Committee of the Australian Parliament, published in 2006 followed an inquiry by the Committee which heard evidence from supporters and opponents of uranium mining[182].

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176 UNSCEAR 2008 Report Annex B paragraph 161.

177 UNSCEAR 2008 Report Annex B paragraph 524 and 530.

178 Synopsis at http://www.oecdbookshop.org/oecd/display.asp?CID=sourceoecd&LANG=EN&SF1=DI&ST1=5LMQCR2KDC41
Full text at http://books.google.co.uk/books?id=ZRwYGX2MTWkC&dq='Radiological+Impacts+of+Spent+Nuclear+Fuel+Management+Options&printsec=frontcover&source=bl&ots=uXKyiwXbxB&sig=2ETRoE7zoRJSYFapY45ErkoJ8AU&hl=en&ei=AOD2SYOqNZTUjAef6OnVDA&sa=X&oi=book_result&ct=result&resnum=1#PPA71,M1

179 Table 16, page 45 of OECD Report.

180 Pages 61 – 62 of OECD Report.

181 Technical Advice to inform proposed Regulatory Justification decisions on new nuclear power stations Authors: Gregg Butler, Grace McGlynn (IDM) Andrew Worrall and Kevin Hesketh (National Nuclear Laboratory) http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

182 Report by the Parliament of Australia's House of Representatives Standing Committee on Industry and Resources "Australia's uranium – Greenhouse friendly fuel for an energy hungry world" November 2006, http://www.aph.gov.au/house/committee/isr/uranium/report/fullreport.pdf

6.195 On the basis of the evidence heard, the Committee concluded that the radiation exposure for employees of uranium mines was less than half the regulatory dose limit of 20 mSv a year and that the radiation exposure for members of the public was a small fraction of the public limit of 1 mSv a year[183].

6.196 The Secretary of State has also considered material from respondents which suggested that uranium mining is detrimental to the health and welfare of employees and of people living in the area. One respondent[184] to the consultations on the Application and the Proposed Decision provided the Secretary of State with "*a wide range of critical academic and environmental literature that addresses the detrimental downside of uranium mining*", supporting the argument that he should take uranium mining overseas into account in making his decision.

6.197 Material is provided by the same respondent from a number of countries where uranium is or was produced or processed.

6.198 **Australia** Material considered covers the regulatory process involved before uranium mining projects can be proceeded with, in particular the assessment of environmental impact; information about trade in uranium products; media reports of opposition to uranium mining from residents and environmentalists and media reports of criticisms that regulation is ineffective.

6.199 **Czech Republic** Material considered consists of media reports which focus on the experience of uranium mining under Soviet rule and earlier and the present cost and difficulty of dealing with the legacy of this.

6.200 **Former East Germany** Material considered, similarly to that on the Czech Republic, covers complaints from the German branch of the Friends of the Earth in the early 1990s about the regulatory arrangements after reunification for dealing with the legacy of uranium mining under Soviet rule (uranium mining in Germany ceased after unification).

6.201 **Spain** Material considered consists of a European Parliamentary Question from 2008 about health detriment suffered by those who worked as uranium miners between 1959 and 1981, suggesting that measures being taken to compensate them were inadequate, and the Commission's response, which refers to the regulatory regime under the Basic Safety Standards Directive and says that it remains for individual member states to implement the Directive.

6.202 **Russia** Material considered consists of media reports of the import into and transport of uranium products within Russia, of protests against these activities, and of the Russian Atomic Energy Agency's decision in 2006 not to sign new contracts for imports of depleted uranium from Europe for enrichment until the issue of its potential chemical danger was resolved. The

[183] Paragraph 1.39 and page 343 of Australian Parliament Report.
[184] Response from Dr David Lowry
http://www.decc.gov.uk/en/content/cms/consultations/reg_just_cons/reg_just_cons.aspx

media reports also quote the Russian Atomic Energy Agency as saying that there has not been a single road accident involving radioactive materials during the history of its transportation in Russia.

6.203 **USA** Material considered consists of media reports of surveys of old uranium mining areas as part of the environmental regulation of new proposals; legislation to compensate uranium miners whose health was affected before 1971; protests and legal challenges by opponents of uranium mining; and debates about the benefits and detriments of uranium mining. There is also material from a book describing the failure of a dam in 1979 which it is claimed resulted in the spread of radioactive material.

6.204 **France** Material considered consists of information published by CRIIRAD[185] on the radiological impact of activity involving uranium mines, and media reports of controversy over such activity, and of the actions of regulators.

6.205 **Canada** Material consists of reports of criticisms of uranium projects, and reports of regulatory activity.

6.206 **Niger** Material consists of reports of claims by CRIIRAD about the impact of uranium mining, and reports of opposition to these claims from the company concerned.

6.207 **Namibia** Material consists of reports of uranium mining projects and of , protests and legal challenges against them.

6.208 **Kazakhstan** Material consists of a speech made to the World Nuclear Association Annual Symposium 2004 in London. The speech reported the high level of uranium supplies available from Kazakhstan and sought to demonstrate that the country should be one of the key sources for supplying world nuclear energy with natural uranium.

6.209 Amongst the material presented there are details of opposition to uranium mining and other processes involving uranium in the countries concerned and that in some of these countries opposition reflects experience of a lack of robust regulation in earlier periods.

6.210 The Secretary of State, however, does not conclude from this that the uranium mining necessary to provide fuel for any new nuclear power stations to be built in the UK will involve any significant detriment to workers' and the public's health and welfare. Much of the material presented, in the Secretary of State's judgement, is evidence that uranium mining is subject to a robust regulatory regime as nuclear activities are in the UK (including intervention by regulators to remedy shortcomings) , and therefore supports the conclusions of the reports by UNSCEAR, OECD and the Australian Parliament.

[185] Commission de Recherche et d'Information Indépendantes sur la Radioactivité http://www.criirad.org/

6.211 It appears from the material presented and also from the UNSCEAR report that in some countries where regulatory regimes are less developed workers in the industry can in some cases be exposed to levels of radiation higher than would be acceptable in the UK. However, the Secretary of State is satisfied that overall the evidence presented by UNSCEAR, the OECD and the Australian Parliament is overwhelmingly to the effect that radiation exposure from uranium mining is at levels well below internationally agreed dose limits and that he has not been presented with any evidence which would cause him to question that view. So if the Secretary of State is wrong and overseas practices are a matter he should take into account in taking his decision he confirms that even having regard to them, he would be satisfied that limited health detriments arise from the mining of uranium.

Conclusion

6.212 Exposure to high levels of radiation has potentially significant health detriments. Low levels of radioactivity occur naturally in the environment but the nuclear reactions that take place in the AP1000 create a high level of radioactivity in the reactor. The by-products that result from these reactions are capable of giving off high levels of radiation and therefore require careful management during and beyond the operational life of a nuclear power station.

6.213 Extensive safety precautions are taken in order to protect those that work in nuclear power stations and members of the public from the health detriments arising from these by-products. The AP1000 has been designed to prevent the unplanned release of radioactivity during normal operations and in the event of accident, both through a system of protective barriers and through a system of defences to protect these barriers from failure. In addition to these inherent safety features any AP1000 that is built in the UK will be subject to the regulatory regime in place. This is internationally recognised as being mature and transparent, with highly trained and experienced inspectors.

6.214 Regulations require limitation of doses to employees of the nuclear industry and members of the public. By law, the radiation to which members of the public are exposed from all sources, excluding medical exposures of patients and natural radiation, is limited to 1 mSv per year. Further dose constraints provide that planned discharges from a single source cannot lead to doses to the public greater than 0.3 mSv per year, though a lower dose constraint of less than 0.15 mSv per year to members of the public has been recommended by HPA.

6.215 Having considered advice from the regulators on the health detriments of exposure to low levels of radiation, the Secretary of State is satisfied that compliance with the regulatory regime would ensure that any AP1000 would give rise to a very limited health impact on both workers and members of the public.

6.216 The Secretary of State has considered the information submitted by the Applicant about the AP1000, advice from the regulators based on many years of experience in regulating existing nuclear power stations and their assessments through the GDA process, advice from technical advisers, and the responses to both the consultation on the Application and the Proposed Decision document. He is confident that the specified dose limits and constraints are achievable. He is also satisfied that the AP1000 is capable of meeting the lower dose constraint of less than 0.15 mSv per year to members of the public recommended by HPA.

6.217 The Secretary of State is also confident that the design and safety precautions of the AP1000 are such that the chance of exposure to members of the public or employees at nuclear power stations of high levels of radiation arising from an accident at an AP1000 are very small.

6.218 The Secretary of State has confidence that, with many years of regulatory experience, the regulatory regime is sufficiently robust to ensure that the AP1000 is operated so that dose levels remain within the limits set. In coming to this conclusion he is conscious of the extensive powers that the regulators have to enforce compliance, including issuing directions requiring compliance and ultimately removing the licence to operate a nuclear power station.

Chapter 7: Radioactive Waste

Introduction

7.1 ICRP Publication 77[186] states that "*Waste management and disposal operations are an integral part of the practice generating the waste. It is wrong to regard them as a free-standing practice needing its own justification*."

7.2 The call for Regulatory Justification applications, therefore, asked that any application should take account of the radioactive waste to be produced by a class or type of practice[187].

7.3 The Secretary of State, in setting out in paragraphs 6.59 to 6.67 the radiological detriment to health that might be expected from the AP1000, noted that the release of radiation into the environment from nuclear power stations can occur through the unplanned release of radioactive materials and that this requires careful management during and beyond the operational life of the nuclear power station.

7.4 The Secretary of State noted that this potential radiological health detriment already exists for current nuclear power stations and that this is reflected in the regulatory regime, which applies to the management and disposal of radioactive waste from nuclear power stations. The Secretary of State's main concern when considering the management and disposal of radioactive waste is its potential detriment to health.

7.5 Alongside the consultation on the draft Nuclear NPS published in November 2009, a background paper entitled "The arrangements for the management and disposal of waste from new nuclear power stations: a summary of evidence"[188] was published. This summarised the evidence reviewed before reaching the preliminary conclusion set out in the consultation that the Government is satisfied effective arrangements will exist to manage and dispose of the waste that will be produced from new nuclear power stations in the UK.

7.6 A further consultation[189] on a Revised Draft National Policy Statement for Nuclear Power Generation (EN-6) (the Nuclear NPS) was published in October 2010. This included as an Annex a further statement on Radioactive Waste Management.

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[186] ICRP Publication 77: Radiological Protection Policy for the Disposal of Radioactive Waste http://www.icrp.org/

[187] The Justification of Practices Involving Ionising Radiation Regulations 2004, Guidance for applications relating to new nuclear power, March 2008 http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

[188] *The arrangements for the management and disposal of waste from new nuclear power stations: a summary of evidence*. November 2009. http://data.energynpsconsultation.decc.gov.uk/documents/wasteassessment.pdf

[189] www.energynpsconsultation.decc.gov.uk

7.7 The Secretary of State considered all this material in coming to his decision.

Guidance for applications

7.8 The guidance for Regulatory Justification applications for new nuclear power stations[190] said that applicants should provide information explaining how decommissioning and waste management and disposal would be dealt with, and that an application could cover:

- the nature and volume of radioactive waste that could be expected to be produced;
- features of the design that facilitate decommissioning; and
- mitigation strategies, regulatory arrangement and related assurance to address detriments and risks.

7.9 In view of the interest shown in responses to the consultation on the Application and the importance of the safe and secure management and disposal of radioactive waste, the Secretary of State decided to include this separate Chapter to allow full consideration of the potential radiological health detriment from radioactive waste from new nuclear power stations.

7.10 This Chapter considers the content of the Application relating to the management and disposal of the radioactive waste produced by the AP1000 and responses to the consultations on the Application and on the Proposed Decision. It then sets out the Secretary of State's view on the radiological detriment to health which might be expected to arise from radioactive waste, on the effectiveness of the regulatory regime in mitigating radiological health detriment from the different types of waste, their interim storage, transport and disposal, and on other issues which have been raised.

[190] The Justification of Practices Involving Ionising Radiation Regulations 2004, Guidance for applications relating to new nuclear power, March 2008 http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

Summary of the Application[191]

7.11 This is a brief summary of points made in the Application. Anyone wanting to follow the Application's arguments, evidence and supporting references in detail should read the Application in full.

7.12 The Application considered the impact of radioactive waste management and decommissioning in relation to Regulatory Justification of the class or type of practice[192].

7.13 The Application stated that the operation and eventual decommissioning of new nuclear power stations would add a relatively small volume of radioactive waste to that already requiring management and disposal in the UK.

7.14 Higher activity waste and spent fuel would be disposed of in a geological disposal facility (GDF). The Application stated that the impact on the size of such a facility would be determined principally by the quantity of additional spent fuel requiring disposal. It stated that using reasonable assumptions, a programme of 10 gigawatts (electrical) (GW(e)) of new generation could require an increase in the below ground "footprint" of a GDF of the order of 50% based on 60 years' operation of new nuclear power stations.

7.15 The Application stated that the types of waste created by the class or type of practice are similar to those already existing and for which management, storage and disposal measures already exist and have either been demonstrated or are in the course of being implemented under Government led processes. The Application stated that there is also considerable and growing international experience to build on. The Application stated that radioactive waste and spent fuel from new nuclear power stations could, if necessary, be stored safely for long periods until a disposal facility became available.

7.16 The Application explained that radioactive materials transport operations associated with the proposed new practice would be no different in nature from those for existing UK nuclear power stations, and that the arrangements to ensure high levels of safety would be similar. The quantities of material involved would represent only a small increment to the quantities of radioactive material already transported and for which the safety record is very good. The Application provided no design-specific information in this area, as it regarded such considerations as generic.

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[191] The Application followed the Government's guidance, and its consideration of radiological health detriment from waste is covered in Chapter 4 of the Application on radiological health rather than in Chapter 5 on radioactive waste and decommissioning. The references to detriment in Chapter 5 of the Application therefore do not include radiological health detriment.

[192] The Justification of Practices Involving Ionising Radiation Regulations 2004, Consultation on the Nuclear Industry Association's Application to Justify New Nuclear Power Stations, Volume 2, Chapter 5 (Radioactive waste and decommissioning) http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

7.17 The Application stated that decommissioning of nuclear facilities is well understood and that there is extensive and growing experience available.

7.18 The Application stated that the Government has made it clear that the nuclear liabilities costs – both of radioactive waste and spent fuel management, and for the decommissioning of any new nuclear power stations – would have to be met by the owners of the facilities and not by the taxpayer.

7.19 On this basis, the Application concluded that the detriment associated with the need to manage radioactive waste and to decommission any new nuclear power stations would be small in relation to the major benefits these power stations could provide to the UK.

AP1000 Design Specific Considerations

7.20 The Application, in the table of defining attributes relating to this design[193], stated that waste and spent fuel arising from the AP1000 would be compatible with UK waste disposal or interim storage plans.

7.21 The Application stated that the volume of LLW is anticipated to be comparable with or lower than that of operating PWRs worldwide.

7.22 The Application stated that a preliminary assessment by Nirex for the Government's 2007 consultation "The Future of Nuclear Power" indicated that the disposal of all the intermediate level waste (including that from decommissioning) and spent fuel from a 10GWe AP1000 programme could be accommodated within an approximately 50% increase in the below ground footprint of a UK facility[194].

Summary of responses to the consultation on the Application

7.23 A number of respondents queried whether new nuclear power stations can be Justified under the Regulations in the absence of further information on proposals for the long-term storage and disposal of spent fuel, the quantities and characteristics of spent fuel, the volume of waste that will be generated and the length of time for which the radioactive wastes will need to be managed.

7.24 Several respondents said that the AP1000 and the other designs under consideration would generate more waste, and waste of a higher radioactive

[193] Volume 2 (Chapter 1, Table 1.1) of the consultation at: http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

[194] Volume 2 (Chapter 1 Addendum, pages 10 and 11) of the consultation at: http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

content, than existing designs and requested clarification on the impact of using fuel with higher levels of burn-up on the design of any proposed GDF.

7.25 Many respondents felt that the Secretary of State should consider the ethical implications of leaving future generations to manage radioactive waste produced by new nuclear power stations.

Summary of responses to the consultation on the Proposed Decision

7.26 Some respondents agreed with the conclusions in the Proposed Decision. They agreed that the risk of health detriment from the management and disposal of radioactive waste arising from the generation of electricity from any AP1000 built in the UK would be small and would remain so up to and beyond disposal.

7.27 However, a number of respondents queried whether new nuclear power stations can be Justified under the Regulations. A range of concerns were raised in relation to the long-term storage, transport and disposal of radioactive waste and comments were made in relation to perceived delays in tackling legacy waste from existing nuclear power stations.

7.28 A view expressed by a number of respondents was that, as it was as yet unclear how many waste storage and disposal facilities there would be and of what size, it was impossible to measure the detriment and therefore impossible to make a Regulatory Justification decision.

Spent fuel

Spent fuel - Characteristics and quantity

7.29 A number of respondents raised concerns about the management and disposal of high burn-up spent fuel and argued that there is no experience to support the conclusions of the Nuclear Decommissioning Authority (NDA)'s disposability assessment that the AP1000 raises no new issues compared with existing nuclear power stations.

Spent fuel - Interim storage

7.30 Some respondents expressed concern about the possibility of on-site interim storage being required for around 160 years from the start of the nuclear power station's operation. Some respondents expressed particular concerns about the vulnerability of interim spent fuel storage facilities to terrorist attack or the risk of rising sea levels.

Spent fuel - Geological Disposal

7.31 A number of respondents noted that plans for geological disposal are in their early stages and disputed the Proposed Decision's confidence that a site will be found and a GDF built. Respondents questioned the technological

feasibility of a GDF capable of safely containing wastes over such long time scales. Several respondents questioned what would happen to waste expected to be stored on the site of a new nuclear power station if a GDF was never built.

7.32 Some respondents referred to the Committee on Radioactive Waste Management (CoRWM)'s 2006 recommendations on geological disposal and argued that it was not appropriate to extend its recommendations to support new nuclear power stations.

Intermediate Level Waste (ILW)

7.33 Many of the points around storage and disposal of spent fuel apply equally to ILW. Respondents to the consultation did not tend to deal with them separately and the position taken in the decision on spent fuel will apply to ILW where relevant.

Low Level Waste (LLW)

7.34 One respondent said that the Decision should recognise the difficulties likely to be encountered in implementation of the UK Nuclear Industry LLW Strategy.

Liquid and gaseous radioactive discharges

7.35 One respondent said that the Secretary of State should set out in more detail how the operation of new nuclear power stations can be reconciled with the objectives of the Convention for the Protection of the Marine Environment of the North-East Atlantic 1992 (the OSPAR Convention).

7.36 Some respondents expressed concern about air pollution from the release of discharges (both radioactive and non-radioactive) into the atmosphere from new nuclear power stations.

Transport

7.37 Some respondents said that increasing the amount of radioactive waste produced would increase the risk of an accident or terrorist attack during transportation.

Ethical considerations

7.38 A number of respondents said that any benefits from nuclear power would be short-term but that the detriments would be long-term and that it would therefore be irresponsible to create more radioactive waste in addition to that already created by existing nuclear power stations.

Responses of Statutory Consultees to the consultation on the Proposed Decision

7.39 The statutory consultees responded to the consultation as follows:

Health and Safety Executive (HSE)

7.40 HSE regulates the production and storage of radioactive waste and spent fuel on all nuclear licensed sites to ensure that the risk from these activities is as low as reasonably practicable. HSE is working closely with the Environment Agency through the GDA process to ensure that satisfactory arrangements can be implemented for safe interim storage and eventual disposal of radioactive waste and spent fuel from new nuclear reactors based on either of the two designs under consideration.

7.41 HSE also noted that the issues raised by the management of radioactive waste would be managed through the regulatory process.

Environment Agency (EA)

7.42 The EA said that a key consideration in coming to its view that the class or type of practice can be Justified was that the Decision is consistent with the strategy regarding disposal of spent fuel and ILW in a GDF. The EA said that continued commitment by the Government to secure a GDF is essential, not only to provide a disposal route for new build spent fuel and wastes but also because it is required for existing higher activity radioactive wastes.

7.43 The EA also said that there should be sufficient funds available to properly decommission nuclear power stations at the end of their generating lives and to dispose of the wastes, including spent fuel, created over the stations' lifecycles but not yet disposed of. It said that the Funded Decommissioning and Waste Management Programme submitted for each new station should be robust and is key to ensuring that future unfunded liabilities are not created.

Scottish Environment Protection Agency (SEPA)

7.44 SEPA said that the Environment Agency was better placed to provide comment and scrutiny on the Proposed Decision.

Health Protection Agency (HPA)

7.45 HPA said that although the radiological health detriment arising from the disposal of solid radioactive waste is in some cases difficult to quantify because of the long timescales before exposure may occur, the basic principle is that individuals and populations in the future should be afforded at least the same level of protection as the current generation. To implement this principle, HPA has developed advice on the radiological protection criteria for disposal of solid radioactive waste[195].

7.46 HPA supported the preliminary conclusion that satisfactory arrangements, from the viewpoint of public health, can be made with regard to the

[195] Radiological Protection Objectives for the Land-based Disposal of Solid Radioactive Wastes RCE 8, HPA 2009

management and disposal of radioactive waste arising from the new nuclear power stations. They agreed that, from a technical point of view, the waste arising from any new nuclear power stations will not require substantially different disposal techniques from those for legacy wastes and spent fuel from current nuclear power stations.

Food Standards Agency (FSA)

7.47 The FSA agreed with the Proposed Decision's view on the potential detriment arising from the waste and decommissioning aspects of the practice.

Secretary of State's view

7.48 The Secretary of State is of the opinion that while there is a potential health detriment from the management and disposal of radioactive waste arising from the generation of electricity from any AP1000 which is built in the UK, he considers that the health detriment from such radioactive waste would be very small and would remain very small up to and beyond disposal.

7.49 As is set out in Chapter 6 (Radiological Health Detriment), HPA, which regularly reviews the radiation exposure of the UK population, has calculated that the overall average annual dose to a member of the public from all sources of radioactivity is 2.7 mSv per year. Of this, about 84% is from natural sources, about 15% from medical procedures and about 1% from all other sources, including nuclear power stations[196]. By law, the radiation to which members of the public are exposed from all sources, excluding medical exposures of patients and natural background radiation, is limited to 1 mSv per year[197]. This limit, and HPA's recommendation that the radiation to which members of the public are exposed from a proposed controlled source should be no more than 0.3 mSv per year, also applies to the management and disposal of spent fuel and radioactive waste[198].

7.50 The work undertaken to date by the regulators as part of the GDA process has provided an overview of the fundamental acceptability of the AP1000 within the overall UK regulatory regime. The Secretary of State notes that at this stage HSE considers that its preliminary view, that there were no safety or security shortfalls that would be so serious as to rule out the eventual construction of an AP1000 in the UK, remains valid[199], and that this supports the Application's statement that the AP1000, including waste produced from it, would meet UK regulatory dose limits and constraints. He also notes that, in

[196] HPA-RPD-001 – Ionising Radiation Exposure of the UK Population: 2005 Review Authors: S J Watson, A L Jones, W B Oatway and J S Hughes Publication date: May 2005 ISBN: 0-85951-558-3 http://www.hpa.org.uk/web/HPAweb&HPAwebStandard/HPAweb_C/1247816567393

[197] This is through the Ionising Radiations Regulations 1999, Statutory Instrument 1999 No. 3232 http://www.opsi.gov.uk/si/si1999/19993232.htm, the Environmental Permitting (England and Wales) Regulations 2010 http://www.opsi.gov.uk/si/si2010/uksi_20100675_en_1 and the Radioactive Substances (Basic Safety Standards) (Scotland) Regulations 2000 http://www.opsi.gov.uk/legislation/scotland/ssi2000/20000100.htm

[198] The Environmental Permitting (England and Wales) Regulations 2010 and The Radioactive Substances (Basic Safety Standards) (Scotland) Direction 2000

[199] http://www.hse.gov.uk/newreactors/index.htm

June 2010, the EA published a consultation[200] on its findings so far and that the EA's consultation documents state that in its view so far a Statement of Design Acceptability could be issued for the AP1000. The Environment Agency and the HSE continue to assess the AP1000 design, including its safety features, as part of the GDA process and intend to report on their final GDA assessments in Summer 2011.

7.51 The generation of electricity in an AP1000 will result in spent fuel and radioactive waste in the form of intermediate level waste (ILW), low level waste (LLW) and liquid and gaseous discharges. Consideration is given to each of these waste streams below. In addition, in order to consider all the information about the AP1000, the Secretary of State has also considered the transport of radioactive waste and the handling and disposal of non-radioactive hazardous waste.

7.52 The Secretary of State notes that some respondents considered that it is not yet clear how many waste storage and disposal facilities there would be and of what size.

7.53 As explained in paragraphs 2.13 to 2.17, the Secretary of State considers that Regulatory Justification is a generic assessment and should not consider issues such as the number of individual nuclear power stations or other facilities which might be built. These issues are considered at later points in the regulatory regime. The AP1000, including its waste management and disposal operations, must be Justified before it is first adopted or first approved and before it has come into operation. In making this decision now, the Secretary of State is able to make informed assumptions about benefits and detriments based on the best information currently available, including information arising from operational experience of similar classes or types of practice, and based on the expert opinion of regulators and others. If new and important evidence about the efficacy or consequences of the class or type of practice comes to light, through other aspects of the regulatory regime or otherwise, then there is provision under regulation 10 of the Regulations for the Secretary of State to reassess any Regulatory Justification decision.

7.54 The Government's position is that any new nuclear power stations that might be built in the UK should proceed on the basis that spent fuel will not be reprocessed and that plans for, and financing of, waste management should also proceed on this basis. The Secretary of State has therefore not considered high level waste (HLW), which arises from fuel reprocessing, in this decision document.

[200] GDA Consultation document for the AP1000 nuclear power plant design by Westinghouse Electric Company LLC https://consult.environment-agency.gov.uk/file/1352806

Spent Fuel

Spent Fuel - Characteristics

7.55 Spent fuel is defined as "*nuclear fuel that has been irradiated in and permanently removed from a reactor core*"[201]. Spent fuel from currently operating nuclear power stations is not categorised as waste, because it still contains uranium and plutonium which could potentially be separated out through reprocessing and used to make new fuel.

7.56 The Government's view is that any new nuclear power stations that might be built in the UK should proceed on the basis that spent fuel will not be reprocessed. Therefore the spent fuel from new nuclear power stations would be treated as waste and disposed of in a GDF.

7.57 The Secretary of State has noted the view expressed by some respondents that the AP1000 would generate greater quantities of waste, and waste of a higher radioactive content, than existing designs.

7.58 As discussed in paragraphs 6.72 to 6.74, the latest generation of nuclear power plants are designed to extract more energy from the fuel by leaving it in the reactor longer for increased irradiation, otherwise known as "burn-up". The higher burn-up of the fuel will mean that comparatively fewer spent fuel assemblies will be required to be managed, but higher burn-up means that an individual spent fuel assembly will have a higher heat output and external radiation compared with a fuel assembly currently discharged from existing light water reactors (LWRs)[202].

7.59 One of the characteristics of increased burn-up fuel is that the inventory of long-lived radionuclides[203] in the fuel assembly increases. These long-lived radionuclides will decay causing the fuel to emit greater levels of gamma and neutron ionising radiation than is the case with legacy (lower burn-up) spent fuel and as a consequence to be thermally hotter. Therefore higher burn-up fuel will in general require longer periods of cooling in interim storage.

7.60 With regard to external radiation, immediately on discharge from the reactor, the heat output and radioactivity of spent fuel is dominated by the presence of short-lived radionuclides. The amounts of short-lived radionuclides produced are independent of fuel burn-up. Therefore in the short-term (up to about one month) there will be no significant difference in heat output and overall radioactivity between fuels discharged from a currently operating LWR (for example, Sizewell B) and any future new AP1000.

7.61 However, in the longer term (beyond about one month) as the short-lived radioactivity decays, heat output and radioactivity becomes dominated by

[201] IAEA Nuclear Installation Safety Net – Glossary http://www.iaea.org/ns/tutorials/regcontrol/intro/glossarys.htm
[202] More detail on the classification of nuclear reactors is set out in Annex A.
[203] A radionuclide is an atom that exhibits radioactivity. As radionuclides decay they release radiation. This rate of decay is known as the substance's half-life.

decay of longer-lived radionuclides. The concentration of longer-lived radionuclides in general increases with burn-up, the result of which will be an increase in heat output, gamma and neutron dose rates. It is calculated that at equivalent cooling times, the neutron dose rate from a fuel assembly irradiated to the higher burn-ups expected of an AP1000 will be greater (how much greater is dependent on the level of burn-up) than for a fuel assembly irradiated to burn-ups typical for a currently operating LWR. However, this is not significant for the management of the spent fuel since the total external dose rate from the spent fuel is dominated by the gamma radiation dose and not the neutron dose, which would contribute, at most (for example, for a burn-up of 60 gigawatt days per tonne of uranium (GWd/tU)), only 6% to the total external dose rate with the remainder being gamma. A study[204] on the safety of transport of 50 year cooled Sizewell B PWR fuel with an upper bound burnup of 60 GWd/teU has shown that the relevant International Atomic Energy Agency (IAEA) dose rate limits can be met by a combination of a 14cm thick stainless steel gamma shield surrounded by a 5cm thick neutron shield. Such shield configurations are quite typical of what is likely to be required for existing legacy vitrified HLW.

7.62 Based on scientific consensus and international experience, the Secretary of State considers that despite some differences in characteristics, waste and spent fuel from new nuclear power stations would not raise such different technical issues compared with nuclear waste from legacy programmes as to require a different technical solution.

7.63 The disposability assessment for the AP1000[205] conducted by the Nuclear Decommissioning Authority's Radioactive Waste Management Directorate (NDA RWMD)[206] on behalf of Requesting Parties[207] as part of the GDA process[208] supports that conclusion and has concluded that, compared with legacy wastes and existing spent fuel, no new issues arise that challenge the fundamental disposability of the spent fuel expected to arise from operation of the AP1000. This conclusion is supported by the similarity of the wastes to those expected to arise from the existing PWR at Sizewell B. Given a disposal site with suitable characteristics, the spent fuel from the AP1000 is expected to be disposable.

7.64 The Secretary of State has taken note of the Disposability Reports prepared by NDA, and believes it is appropriate to place weight on their conclusions,

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[204] AREVA Risk Management Consulting Ltd, *Study of the Transport of UK High Level Waste and Spent Fuel*, a report commissioned by Nuclear Decommissioning Authority, RMC Report No. R08 099(C), March 2010.

[205] http://www.nda.gov.uk/documents/upload/TN-17548-Generic-Design-Assessment-Summary-of-DA-for-Wastes-and-SF-arising-from-Operation-of-APPWR-October-2009.pdf

[206] See Annex B for details on the role of NDA RWMD

[207] The term "requesting party" is used in relation to the GDA process to identify the organisation requesting acceptance for a design through GDA. This request will normally originate from a reactor vendor, however this may also be done as a vendor/operator partnership.

[208] Through the GDA process the nuclear regulators are assessing the safety, security and environmental impact of nuclear power station designs, including the quantities and types of waste that are likely to arise, their suitability for storage, transport and their disposability. More information about GDA is available in Chapters 1 and 3 and at the joint nuclear regulators' new nuclear power stations website http://www.hse.gov.uk/newreactors/index.htm

together with the regulatory work of the EA and HSE through the GDA process. NDA is the organisation tasked with implementing geological disposal in the UK and is also responsible for issuing Letters of Compliance[209] confirming that proposals for conditioning and packaging of higher activity wastes will lead to compliant packages for transport and disposal as currently understood. As such, NDA is an expert in the field of radioactive waste management and the Secretary of State accepts its conclusions as being the most thorough and up-to-date analysis regarding waste from new nuclear power stations in the UK, available at the time of making this decision.

7.65 Geological disposal is the way higher activity waste (spent fuel and ILW) will be managed in the long term. This will be preceded by safe and secure interim storage until a GDF can receive waste. This will be taken forward under the Managing Radioactive Waste Safely (MRWS) process.[210] The Secretary of State considers this in further detail below.

Spent Fuel - Quantity

7.66 There is uncertainty around the quantity of spent fuel that might be produced by a new AP1000. The volume of spent fuel produced by a single AP1000 depends on a number of factors, including the reactor power output, its operational lifetime and various other operational considerations, including the reactor refuelling regime which affects fuel burn-up.

7.67 NDA, as part of its disposability assessment for the AP1000, has considered the potential impact on the size of a GDF of the disposal of spent fuel from a single new nuclear power station and from a 10 gigawatt (GW(e)) new nuclear programme. 10 GW equates to about nine AP1000 reactors. This enables the estimates of the impact of new build spent fuel on the underground footprint of a GDF set out in the Application to be updated.

7.68 NDA has estimated that an AP1000 operating for 60 years would give rise to an estimated 640 disposal canisters,[211] requiring an area of approximately 0.11 km^2 for the associated disposal tunnels. A fleet of nine such reactors would require an area of approximately 1 km^2, excluding associated service facilities. This area required for spent fuel from new AP1000s represents approximately 6% of the area required for legacy HLW and spent fuel per

[209] The Letter of Compliance (LoC) assessment process was established in the late 1980s (then known as the Letter of Comfort process). It gives confidence to site operators, regulators and stakeholders that wastes are being conditioned into passively safe forms that would also be compatible with plans for the development of a GDF. New packaging plants which first started to come on-stream in the early 1990s (notably those at Sellafield) are manufacturing passively safe and disposable waste packages. Application of the LoC process has given confidence that the waste packages are consistent with safety cases for transport, operations and ultimate disposal. www.nda.gov.uk/documents/upload/WNM-PP-011-Letters-of-Compliance-LoC-Assessment-Process-1-January-2008.pdf

[210] http://mrws.decc.gov.uk/

[211] The reference design currently being used by NDA for the purposes of estimating the costs of a GDF envisages spent fuel assemblies being packaged in copper canisters prior to disposal. The capacity of a copper canister is four PWR spent fuel assemblies. See page 71 of the MRWS White Paper for more on this.

reactor, and approximately 55% of the area required for legacy HLW and spent fuel for the illustrative fleet of nine AP1000 reactors[212].

7.69 The Government recognises that it is possible that there might need to be more than one GDF. For example, this could be necessary if the geology at potential sites was not suitable for a "co-located" GDF (i.e. a GDF containing all higher activity wastes) though the Government's preference is for a co-located facility should an available site prove suitable for this. With regard to the disposal of new build wastes, it is recognised that the size of any programme of new nuclear power stations will have an impact on whether all of the new waste could be emplaced in the same GDF as legacy waste. Hence, although the Government favours a single GDF for all higher activity wastes if that proves technically possible, it has not ruled out the alternative of there being more than one facility, and the site selection process in the MRWS process is designed to be sufficiently flexible to accommodate this.

Spent Fuel - Interim Storage

7.70 The Secretary of State is satisfied that interim storage would provide an extendable, safe, secure and environmentally sound means of containing waste for as long as it took to site and construct a GDF, and that this is based on experience in the UK and overseas of the interim storage of higher activity wastes in line with requirements for safety, security and environmental protection. The Secretary of State has further considered the arrangements for ensuring that spent fuel from new nuclear power stations is kept in safe and secure interim storage until a GDF is available.

7.71 The time that will be required for the safe and secure on-site interim storage of spent fuel prior to disposal is contingent on a number of factors.

7.72 The Government expects the operators of new nuclear power stations to optimise the interim storage requirements for radioactive waste, taking account of safety, security and environmental and the availability of a GDF. It should also ensure that the duration of interim storage is minimised and the waste should be disposed of at the earliest opportunity.

7.73 The scenario referred to in the consultation on the Proposed Decision, that on-site interim storage might be required for around 160 years from the start of the power station's operation, was based on an assumed station electricity generating life of 60 years, and the finding in NDA's disposability assessment that up to 100 years cooling might be required before spent fuel could be disposed of in a GDF. In light of the responses to the consultation, the Government has reviewed the assumptions which underpinned the scenario that on-site storage for 160 years might be required.

7.74 The NDA's disposability assessments were based on conservative assumptions. They assumed that each disposal canister is filled to its

[212] http://www.nda.gov.uk/documents/upload/TN-17548-Generic-Design-Assessment-Summary-of-DA-for-Wastes-and-SF-arising-from-Operation-of-APPWR-October-2009.pdf

maximum capacity of four fuel assemblies and that each assembly is irradiated to the maximum burn-up of 65GWd/tU. As a result the reports concluded that a cooling period of approximately 100 years would be required. The reports highlighted that this is an extreme scenario; and furthermore flagged that at this stage this was a reference position and there had been no attempt to optimise disposal arrangements in a GDF, which would enable earlier emplacement, or earlier transport off-site.

7.75 Hence this figure of 160 years was underpinned by some conservative assumptions. Alternative assumptions reduce the expected period of on-site storage considerably[213].

7.76 The storage periods prior to disposal estimated by NDA are not firm requirements. They will depend crucially on the actual level of burn-up achieved in the fuel. In their calculation, NDA had conservatively assumed that all fuel assemblies had achieved maximum burn-up. In reality fuel assemblies will experience a range of burn-ups with an average considerably lower than the maximum, and lower burn-up fuel will require shorter periods of cooling before reaching a suitable state ready for disposal.

7.77 The actual cooling time required will also depend in practice upon the designs of the disposal package, the final disposal concept and design and its geological setting, which will all offer scope for potential optimisation and which could shorten the required storage time. The NDA will undertake further research during the GDF design process. This will include optimising facility design and delivery.

7.78 Also, the storage period may also be shortened by mitigating actions which could reduce the heat load on each disposal canister. These include putting fewer fuel assembles, or a combination of lower and higher burn-up fuel assemblies, into each canister. In particular, further analysis conducted by NDA since the publication of its disposability assessments has estimated that the duration of storage of spent fuel after the end of power station operation could in principle be reduced to the order of 50 years through combining in disposal canisters fuel from the earlier years of operation with fuel from the later years of operation[214]. This assumes three fuel assemblies per canister at the maximum burn-up considered of 65GWd/tU or four assemblies per canister in the alternative case where the average burn-up is 50 GWd/tU.

7.79 On the basis of the NDA's current indicative timetable, a GDF is expected to be available to take spent fuel from new nuclear power stations from around

[213] Some of these alternative assumptions were discussed in *The arrangements for the management and disposal of waste from new nuclear power stations: a summary of evidence*. November 2009. http://data.energynpsconsultation.decc.gov.uk/documents/wasteassessment.pdf

[214] This information is extracted from a yet to be published report undertaken by the Nuclear Decommissioning Authority and commissioned by the Nuclear Industry Association. The report is expected to be published in late October or early November 2010 and will be available on the NDA web site at http://www.nda.gov.uk/ The report title will be Feasibility studies exploring options for storage, transport and disposal of spent fuel from potential new nuclear power stations.

2130, which is approximately 50 years after the likely end of electricity generation for the first new nuclear power station (on the basis that it begins operation in around 2018 and has an operational lifetime of 60 years). The Government will expect operators to ensure their waste is disposable when a GDF is anticipated to be available to accept the waste and notes that NDA has identified steps that operators can take to meet that requirement.

7.80 In light of the above, the Government has revised its position. The Government recognises that interim storage on-site might be required beyond 2130, particularly in the event that a GDF is not available to take the waste, but the Government does not expect interim storage to be required for as long as 160 years.

7.81 Moreover it is not necessarily the case that the whole interim storage period for the spent fuel and ILW produced by a new nuclear power station will be on-site. The Government's base case assumption that spent fuel will be stored on the site of the new nuclear power station until it is disposed of in a GDF. This is a prudent assumption in the absence of any firm proposals for alternative arrangements, such as regional or central stores, where ILW and spent fuel could be stored prior to disposal. However, the Government does not wish to preclude alternative arrangements, for example a central storage facility, if a site can be identified and the necessary regulatory and planning permissions obtained.

7.82 The UK has extensive experience of managing higher activity wastes and already manages spent fuel from the nuclear power stations currently operating[215] including spent fuel from the UK's only PWR, Sizewell B, which has been stored under water for more than 10 years.

7.83 With regard to experience overseas, a report from the OECD Nuclear Energy Agency[216] (the NEA) found that spent fuel has been safely and securely stored in OECD member countries for several decades and such storage could continue for many more decades, given proper controls and supervision as well as repackaging and periodic refurbishment of stores. The NEA also noted that stores of modern design have typically been licensed for periods of decades, in one case (the HABOG facility in the Netherlands) for a century. HABOG became operational in 2003 and will store HLW and spent fuel until 2130[217].

7.84 In the USA spent fuel has been safely and securely managed on arising sites for decades[218] and the US Nuclear Regulatory Commission has formally

[215] The United Kingdom's Third National Report on compliance with the obligations of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. http://www.hse.gov.uk/nuclear/meetings/spentfuel09/report.pdf

[216] The Roles of Storage in the Management of Long-lived Radioactive Waste, Practices and Potentialities in OECD Countries, 2006 http://www.nea.fr/html/rwm/reports/2006/nea6043-storage.pdf

[217] The IAEA Radioactive Waste Management Database – Netherlands Report http://newmdb.iaea.org/reportindex.aspx?ByCountry=NL&ByYear=7&RPart=11

[218] http://www.nrc.gov/reading-rm/doc-collections/commission/speeches/2008/s-08-023.html

expressed its confidence that spent fuel can be safely and securely stored on site, without significant environmental impact, for at least 100 years[219].

7.85 Modern nuclear power stations that are developed internationally include robust spent fuel storage arrangements[220]. Following discharge from the reactor the fuel is required to be cooled, initially in a water-filled pool, as is the case currently at Sizewell B and internationally. The minimum period for storing spent fuel under water is 9 to 12 months, after which dry storage can be considered[221] and internationally the storage of spent fuel in dry casks has become increasingly practised[222] [223]. Common practice for modern PWR designs is for fuel to reside in pool storage only for the period when it is hottest and then for it to be transferred to a dry cask storage system for the remainder of the time required to be stored on site[224].

7.86 Although there are currently no dry fuel stores for PWR spent fuel in the UK, there is considerable international experience which gives confidence that similar stores can be constructed and licensed for operation in the UK. Moreover, British Energy submitted an application in February 2010 for planning consent to construct and operate a dry fuel store at Sizewell B [225].

7.87 The Secretary of State has also considered the fact that the interim storage of spent fuel will be subject to the same regulatory regime (set out in Chapter 6 (Radiological Health Detriment)) as that covering existing nuclear power stations in the UK. The site licensing and permitting processes are intended to ensure that operators provide safe, secure and environmentally acceptable interim storage for spent fuel. Therefore, regulatory consent for the construction of a new nuclear power station will not be given unless the regulators are satisfied that the operator will be able to adequately provide for interim storage of the spent fuel produced by the new nuclear power station.

7.88 The Secretary of State is therefore satisfied that the interim storage of spent fuel can and will be carried out in a manner which causes a very low level of health detriment, and considers below the arrangements for ensuring the safe and secure disposal of spent fuel from new nuclear power stations.

Spent Fuel - Geological Disposal

7.89 In October 2006, following recommendations made by CoRWM[226], the then Government and the Devolved Administrations published a response[227]

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219 http://www.nrc.gov/reading-rm/doc-collections/commission/speeches/2009/s-09-012.html
220 Fukuda, et al. IAEA Overview of global spent fuel storage. IAEA-CN-102/60. 2003 http://www.iaea.org/NewsCenter/Features/UndergroundLabs/Grimsel/storageoverview.pdf
221 Storage and Disposal of Spent Fuel and High Level Radioactive Waste. IAEA. http://www.iaea.org/About/Policy/GC/GC50/GC50InfDocuments/English/gc50inf-3-att5_en.pdf
222 www.nrc.gov/reading-rm/doc-collections/fact-sheets/dry-cask-storage.html
223 Nuclear Waste Management Organisation Canada, 2008 Annual Report. http://www.nwmo.ca/annualreport
224 The Long Term Storage of Radioactive Waste. http://www-pub.iaea.org/MTCD/publications/PDF/LTS-RW_web.pdf
225 http://www.british-energy.com/pagetemplate.php?pid=488
226 www.corwm.org.uk

accepting CoRWM's recommendations that geological disposal, preceded by safe and secure interim storage, was the best available approach for the long-term management of existing and committed higher activity radioactive wastes. The response made a commitment to consult on a framework for implementing geological disposal as the next stage of the MRWS programme. The consultation was carried out in 2007. The MRWS White Paper[228], published in June 2008, then set out a framework for the implementation of this policy.

7.90 The Secretary of State recognises that CoRWM's 2006 recommendations were made in relation to the existing and committed inventory of higher activity wastes. A separate process was undertaken in relation to new build through the 2007 Consultation on the Future of Nuclear Power and the subsequent Nuclear White Paper in January 2008.

7.91 With regard to waste from new nuclear power stations, the White Paper on Nuclear Power set out the Government's view 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 MRWS Programme*"[229].

7.92 NDA's disposability assessment for the AP1000 supports that conclusion and has concluded that compared with legacy wastes and existing spent fuel, no new issues arise that challenge the fundamental disposability of the spent fuel expected to arise from the operation of the AP1000. This conclusion is supported by the similarity of the wastes to those expected to arise from the existing PWR at Sizewell B. Given a disposal site with suitable characteristics, the spent fuel from the AP1000 is expected to be disposable[230].

Geological Disposal - Regulatory Regime

7.93 The Secretary of State takes account of the fact that the Government has considered how to introduce a GDF into the regulatory regime.

7.94 In 2006 NDA was given responsibility for planning and implementing geological disposal, which enables NDA to take an integrated view across the waste management chain, with both long and short term issues addressed in planning and strategy development. Since then, NDA RWMD has been

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[227] UK Government and the devolved administrations, "Response to the Report and Recommendations from the Committee on Radioactive Waste Management (CoRWM)" (PB 12303) October 2006. http://mrws.decc.gov.uk/en/mrws/cms/home/What_is_the_Go/What_is_the_Go.aspx

[228] http://mrws.decc.gov.uk/

[229] Meeting the Energy Challenge: A White Paper on Nuclear Power, January 2008, page 99 http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/white_paper_08/white_paper_08.aspx

[230] http://www.nda.gov.uk/documents/upload/TN-17548-Generic-Design-Assessment-Summary-of-DA-for-Wastes-and-SF-arising-from-Operation-of-APPWR-October-2009.pdf

established, which will evolve into NDA's delivery organisation to implement geological disposal.

7.95 The Government is committed to strong and effective control and regulation of the GDF development process. NDA and its delivery organisation will be subject to the appropriate regulatory and planning processes. Government will look to early and continued involvement of the regulators, who will make clear their regulatory requirements to NDA's delivery organisation at an early stage. Regulatory processes for granting any necessary licences or authorisations will provide opportunity for input and assessment of public and stakeholder views. The Environmental Permitting (England and Wales) Regulations 2010[231], which partially replaced the Radioactive Substances Act 1993[232] in England and Wales, included new provisions which improve regulation of a potential GDF by enabling the Environment Agency to take a staged approach to permitting.

7.96 The development of a GDF will be subject to staged authorisation by the environmental regulator[233]. In February 2009, the EA and the Northern Ireland Environment Agency published detailed guidance, "Geological Disposal Facilities on Land for Solid Radioactive Wastes. Guidance on Requirements for Authorisation"[234].

7.97 The GDF will require a licence under the Nuclear Installations Act 1965[235], and the Government recognises that this may require legislative change. Work is in hand to develop the required legislation in the form of a modification to the Nuclear Installations Regulations 1971.

7.98 Operators will be required by the regulators to confirm that the specific wastes identified to be produced could be placed in a GDF in line with requirements for safety, security and environmental protection. This will be underpinned by advice from NDA based on their assessment of the disposability of the wastes that are proposed to be produced.

7.99 As referred to above, NDA has carried out, as part of the GDA process, a disposability assessment for the ILW and spent fuel expected to be produced by the AP1000. In the future, when reactor site-specific consideration is given to waste, a Radioactive Waste Management Case[236] will be required and detailed consideration of waste disposability will be addressed by NDA through the established Letter of Compliance assessment process. In cases where NDA has concluded that the proposed waste package is compliant with geological disposal and underpinning assessments, the NDA will confirm this

[231] The Environmental Permitting (England and Wales) Regulations 2010 (2010 No. 675) http://www.opsi.gov.uk/si/si2010/pdf/uksi_20100675_en.pdf

[232] Radioactive Substances Act 1993 (c. 12) http://www.opsi.gov.uk/acts/acts1993/ukpga_19930012_en_1

[233] MRWS White Paper, page 39 http://mrws.decc.gov.uk/

[234] http://publications.environment-agency.gov.uk/pdf/GEHO0209BPJM-e-e.pdf

[235] Nuclear Installations Act 1965 (c.57) http://www.opsi.gov.uk/RevisedStatutes/Acts/ukpga/1965/cukpga_19650057_en_1

[236] HSE, Environment Agency, SEPA, The management of higher activity radioactive waste on nuclear licensed sites. Part 1, The regulatory process, December 2007 http://www.hse.gov.uk/nuclear/ wastemanage1.pdf

by the issue of a Letter of Compliance[237]. The independent regulators will scrutinise the operators' and NDA's assessments, taking due account of all relevant work that has been carried out in GDA.

7.100 The Secretary of State is therefore confident that the regulatory regime will assist in ensuring that suitable steps are taken to progress the design, construction and use of a suitable GDF.

Geological Disposal - Technological Feasibility

7.101 The Secretary of State has considered the technological feasibility of the proposal for geological disposal.

7.102 The OECD NEA published a statement in 2008 which said that: "*The overwhelming scientific consensus worldwide is that geological disposal is technically feasible*". The NEA further noted that "*Releases from engineered barriers would occur over thousands of years after disposal and would be very small. Additionally these releases are diluted and slowed by the geological formation surrounding the repository and are further reduced by radioactive decay. The resulting potential radiological exposure in the biosphere would not represent, at any time, a significant increment above the natural background*"[238].

7.103 A number of geological disposal concepts, based on the use of multiple containment barriers, have been shown to be capable of meeting high standards of safety and security. Although no spent fuel GDF is in operation currently, programmes in Finland[239] and Sweden[240] are well advanced and plans are for each of these countries to have such a facility operational by about 2020, following underground research that is already being undertaken. Sweden has now identified a site at Forsmark and should submit applications for permits, including an environmental impact assessment and safety analysis, in 2010. The facility is planned to be ready for operations by 2023[241].

7.104 The specific technological challenges presented by spent fuel from new nuclear power stations have been examined by Posiva in Finland in the context of an Environmental Impact Assessment for the extension of its spent fuel GDF to accept fuel discharged from the EPR-type reactor under construction at Olkiluoto[242]. The assessments carried out show that the technology is available to provide suitable shielding to enable safe handling of

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[237] See footnote 209 and www.nda.gov.uk/documents/upload/WNM-PP-011-Letters-of-Compliance-LoC-Assessment-Process-1-January-2008.pdf

[238] Organisation for Economic Co-operation and Development (OECD), Nuclear Energy Agency (NEA), Moving Forward with Geological Disposal of Radioactive Waste, A Collective Statement by the NEA Radioactive Waste Management Committee (RWMC), NEA No. 6433, 2008 http://www.nea.fr/html/rwm/reports/2008/nea6433-statement.pdf

[239] www.nea.fr/html/rwm/profiles/Finland.pdf

[240] www.nea.fr/html/rwm/profiles/Sweden_profile_web.pdf

[241] http://www.skb.se/default 24417.aspx

[242] Posiva Oy (Finland) Environmental Impact Assessment Report: Expansion of the Repository for Spent Fuel, 2008. www.posiva.fi/en/nuclear_waste_management/required_permissions_and_procedures/environmental_impact_assessment_procedure

high burn-up spent fuel. They also show that existing engineered barrier technologies, as envisaged for the spent fuel from currently operating nuclear power stations, can be applied to the safe disposal of high burn-up fuel.

7.105 The assessments also show that, under the conditions relevant to the Finnish GDF, the long-term safety of the facility is robust in pessimistic scenarios, for example, where a number of failures of disposal canisters occur due to seismically induced rock movement. The disposability assessments carried out by NDA-RWMD for the requesting parties under the GDA similarly show that existing engineered barrier technologies can be applied to achieve the safe disposal of high burn-up fuel discharged from EPR or AP1000 reactors even using what are expected to be conservative calculations of disposal canister integrity.

7.106 The UK does not present special geological difficulties that would make successful implementation unlikely on a technological basis. The British Geological Survey undertook a review in support of the activities of the original CoRWM that concluded that at least 30% of the UK land mass has suitable geology for siting a deep geological disposal facility[243]. Similar support to CoRWM was provided by the Geological Society[244] [245]. Furthermore, CoRWM found that "*there is high confidence in the scientific community that there are areas of the UK where the geology and hydrogeology at 200 metres or more below ground will be stable for a million years and more into the future*"[246]. A 2008 report on geological disposal[247] carried out for the NDA found that a range of engineering solutions for implementing geological disposal of higher activity wastes has been worked up that covers a wide range of potentially suitable geological environments which could be suitable for hosting a GDF for higher activity waste in the UK.

7.107 The technology identified in disposal concepts that would be suitable for spent fuel from new nuclear power stations is already available in terms of engineered barrier designs and materials[248]. Therefore, the technology is expected to be available in an appropriate timeframe to be applied at a suitable site that becomes available through the site selection process described below and in the MRWS White Paper.

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[243] UK Nirex Ltd and British Geological Survey, "A note by the British Geological Survey and Nirex on the Suitability of UK Geology for Siting a Repository for Radioactive Waste", CoRWM document 1797, March 2006.

[244] Geological Society, Geoscience Verdict on Radioactive Waste Disposal, News release PR26/99, 1999 (CoRWM document 2026)

[245] Geological Society, Confidence in the Safe Geological Disposal of Radioactive Waste, 2006, CoRWM Document 2027. http://www.geolsoc.org.uk/gsl/site/GSL/lang/en/rwd

[246] CoRWM Report: Recommendations to Government. Page 106, paragraph 28 http://www.corwm.org.uk/Pages/Current%20Publications/700%20-%20CoRWM%20July%202006%20Recommendations%20to%20Government.pdf

[247] www.nda.gov.uk/documents/upload/Geological-Disposal-Options-for-High-Level-Waste-and-Spent-Fuel-January-2008.pdf

[248] Posiva Oy (Finland) Environmental Impact Assessment Report: Expansion of the Repository for Spent Fuel, 2008 www.posiva.fi/en/nuclear_waste_management/required_permissions_and_procedures/environmental_impact_assessment_procedure

7.108 In line with CoRWM's 2006 recommendations[249], the NDA will undertake further research during the GDF's development process in order to further refine concepts, improve understanding of chemical and physical interactions in a disposal facility, address specific issues raised by regulators, support development of site-specific safety cases and to optimise facility design and delivery.

7.109 In respect of external dose rate, the encapsulation, transport and emplacement of high burn-up spent fuel can be shown to be feasible using existing technology applied in the management of vitrified HLW. In particular, the relevant IAEA dose rate limits for transport can be met after interim storage by providing a combination of a 14 cm thick stainless steel gamma shield surrounded by a 5 cm thick neutron shield. Shield configurations based on these principles will be deployed in returning vitrified HLW from the UK to overseas fuel reprocessing customers. This HLW already has a much higher neutron dose rate than that calculated for any proposed new build spent fuel. Well-established methods exist for developing potential disposal facility designs to take account of heat generated by such wastes and the external radiation dose rate is less than that from materials such as vitrified HLW which are already managed safely under existing arrangements through storage awaiting final disposal at a GDF.

7.110 The Secretary of State considers that the scientific progress made with respect to geological disposal is such that it is technically achievable and is the safest form of long-term waste management.

Geological Disposal - Site Selection

7.111 The Secretary of State has considered the approach to the selection of a site for the implementation of geological disposal.

7.112 The Government is committed to a staged decision-making process for the implementation of geological disposal, as set out in the MRWS White Paper. Site selection is to be taken forward through voluntarism and partnership with potential host communities to share knowledge and address any local concerns openly and transparently.

7.113 The site selection process described in the MRWS White Paper will take a number of years to complete, due to the need for extensive technical investigations at any prospective site and the need to move at a pace consistent with maintaining public confidence. However, orderly progress is being made. The voluntarism process being applied draws on the most advanced programmes overseas, for example Finland, Sweden and France, all of which have agreed national programmes to start operating geological disposal facilities within the next 15 years.

7.114 The Government is committed to making the voluntarist and partnership approach to site selection work through the MRWS process. To deliver

[249] www.corwm.org.uk

geological disposal it is necessary to have effective project management, leadership from Government, clear responsibilities and accountabilities and a timeline and milestones against which progress can be measured. However this must be reconciled with an approach based on voluntarism. The programme relies on progress made in partnership with local communities and will move forward at a pace consistent with maintaining public confidence.

7.115 The Government recognises it has a responsibility to deal with long-term higher activity waste management and is committed to geological disposal as the technical solution, such that it will seek to develop alternative ways to implement that solution if the current framework ultimately proves to be unsuccessful in the UK.

7.116 The Government's preference is for a co-located spent fuel/HLW and ILW GDF[250], should an available site prove suitable for this. This concept would be designed to allow for the appropriate disposal facilities to be provided underground separately for spent fuel/HLW and ILW (and other materials that may eventually be declared as higher activity waste) but for essential infrastructure and services to be shared. For this approach to be confirmed, the site selection process must deliver a site with suitable characteristics and volumetric capacity sufficient to accommodate the aggregated wastes, and a satisfactory safety case must be developed for the co-located facility.

7.117 As the MRWS White Paper states, there is no reason why co-location should not be technically possible[251]. It notes however that research will be required to support the detailed design and safety case and that the final decision would be made in the light of the latest technical and scientific information, international best practice and site specific environmental, safety and security assessments. The MRWS White Paper also states that it would be possible to build more than one GDF, for example one for ILW/LLW and one for HLW/spent fuel (or indeed two facilities that each took some of each waste type). This could be necessary if the geology at potential sites was not suitable for a 'co-located' GDF.

Geological Disposal - Conclusion

7.118 The Government recognises the need to take account of developments in storage and disposal options, as well as possible new technologies and solutions. Future research and development may identify new options for dealing with some wastes, which under application of the waste hierarchy could reduce the amounts of waste requiring disposal. The NDA will also keep options such as borehole disposal of certain types of waste under review. The cost implications of the various options explored will be estimated by the NDA as part of its work programme and the Government will look to CoRWM to provide independent scrutiny and advice on the NDA research programme[252].

[250] MRWS White Paper, page 29 http://mrws.decc.gov.uk/
[251] MRWS White Paper, page 29 http://mrws.decc.gov.uk/
[252] MRWS White Paper, page 31 http://mrws.decc.gov.uk/

7.119 To improve visibility of progress on the MRWS programme, the Government has developed a clear timeline for the implementation of geological disposal while maintaining its commitment to voluntarism, and will provide annual reports to Parliament on the progress of the MRWS programme.

7.120 The management of waste throughout its lifecycle, including interim storage, packaging, transport and disposal, is and will continue to be subject to the regulatory regime. The regulatory regime will also assess proposals for a GDF to ensure that dose limits or constraints are not exceeded.

7.121 On the basis of the above evidence and information, the Secretary of State is therefore satisfied that geological disposal of spent fuel is technologically feasible, that there is a robust process in place to identify a suitable site, and that a GDF will be incorporated into the existing robust regulatory regime which limits radiological emissions and consequent harm to human health. He is also satisfied that suitable arrangements already exist for the safe and secure interim storage of spent fuel and that these will ensure that spent fuel is stored in such a way as to cause very low radiological health detriment until such time as it is emplaced in a GDF. The Secretary of State concludes therefore that spent fuel will be managed and disposed of in a manner which causes a very low level of radiological health detriment.

Intermediate Level Waste (ILW)

7.122 The Secretary of State has considered ILW, which is defined in the UK as waste "*with radioactivity levels exceeding the upper boundaries for low-level wastes, but which do not require heating to be taken into account in the design of storage or disposal facilities.*"[253]

7.123 ILW arises mainly from the reprocessing of spent fuel, from general operations and maintenance at nuclear sites and from decommissioning. ILW can include metal items such as reactor components, and sludges, filters and resins from the treatment of radioactive liquid effluents.

7.124 Legacy ILW is typically being managed through a process of conditioning and packaging into a passively safe and disposable form as soon as reasonably practicable and placed into interim storage. Conditioning is frequently achieved by encapsulation in cement or other suitable binder and packages are highly-engineered 500 litre stainless steel drums or higher capacity steel or concrete boxes. Unlike spent fuel, heat-generation is not an issue and there is not the same requirement for decay cooling before being placed in a disposal facility.

7.125 As with spent fuel, there is uncertainty over the quantity of ILW that is expected to be produced by a new nuclear programme. The total quantity of ILW produced by a new nuclear programme will depend on the size of the programme, but is expected to be small in comparison with the volumes of legacy ILW. The 2007 consultation on the Future of Nuclear Power contained

[253] MRWS White Paper, page 16 http://mrws.decc.gov.uk/

estimates by Nirex of the impact of a programme of new nuclear power stations equivalent to ten AP1000s would increase the volume of ILW by around 3%[254].

7.126 More recent work by NDA means it is now possible to update this estimate. The NDA's disposability assessments produced estimates for the lifetime ILW for the new nuclear power station designs being appraised in the GDA process[255]. For an AP1000 operating for 60 years, the volume of packaged ILW produced is estimated to be around 3,450m^3. NDA has considered the potential impact on the size of a GDF of the disposal of ILW from a single new nuclear reactor and from a 10GW(e) new nuclear programme. 10GW(e) equates to about nine AP1000 reactors.

7.127 For the AP1000, estimates of ILW volumes for disposal are subject to some variation depending on assumptions regarding packaging and conditioning technologies that might be adopted by future operators, but NDA has concluded that in all cases the necessary increase in the GDF "footprint area" is small, corresponding to approximately 65m of disposal vault length for each AP1000. This represents approximately 1% of the area required for the legacy ILW, per reactor, and less than 10% for the illustrative fleet of nine AP1000 reactors.

ILW - Interim Storage

7.128 Much of what has been said above about the interim storage and disposal of spent fuel applies equally to ILW from new nuclear power stations and is not repeated in this section.

7.129 As with spent fuel, geological disposal is the way ILW will be managed in the long term. This will be preceded by safe and secure interim storage until a GDF can receive waste.

7.130 The Secretary of State has considered the arrangements for ensuring that ILW from any new nuclear power stations is stored in safe and secure interim storage facilities until a GDF is available.

7.131 The regulatory framework described for the interim storage of spent fuel above applies equally to ILW from any new nuclear power stations. In the specific case of ILW arising from any new nuclear power stations, the regulators' GDA process has been initiated to give confidence that new nuclear power station designs will be compatible with UK licensing and other requirements.

7.132 The GDA and site licensing processes are intended to ensure that operators can provide safe, secure interim storage for ILW and therefore regulatory consent for the construction of a new nuclear power station will not be given

[254] The Future of Nuclear Power, page 135 http://www.berr.gov.uk/files/file39197.pdf
[255] http://www.nda.gov.uk/documents/upload/TN-17548-Generic-Design-Assessment-Summary-of-DA-for-Wastes-and-SF-arising-from-Operation-of-APPWR-October-2009.pdf

unless the regulators are satisfied with the operator's proposal for interim storage of the ILW produced by the new nuclear power station.

7.133 The NDA's strategy, published in March 2006, made a clear commitment to hazard and environmental risk reduction by ensuring that radioactive waste (whether HLW, ILW or LLW) is managed and converted into a passively safe form as soon as reasonably practicable and placed into interim storage[256]. This will continue to be the preferred strategy for handling ILW that arises in future from any nuclear power stations, in line with regulatory requirements.

7.134 The NDA has since conducted a detailed review of the status of existing storage capacity in the UK for higher activity radioactive waste, which included an assessment of storage regimes for solid ILW (raw and immobilised) across the UK on both NDA and non-NDA sites. It produced a number of findings and potential topics for NDA's future work programme.

7.135 The technology for storing ILW already exists and ILW conditioning and packaging is already being implemented in the UK. As of end-March 2009, some 45,000 ILW waste packages had been manufactured and were in safe and secure interim storage awaiting provision of a GDF[257]. These packages have been assessed through the Letter of Compliance process described in paragraph 7.64, to give confidence that they not only meet requirements for interim storage but also will be compliant with the needs of transport and disposal.

7.136 The ILW that has been packaged in the UK does not yet include ILW from the PWR at Sizewell B. However, conditioning and packaging technologies for ILW from PWRs are currently utilised in other countries (for example, the USA[258], Finland[259] and Switzerland[260]).

7.137 Decommissioning ILW, which is generally activated steel (for example reactor pressure vessel components), will be size-reduced and loaded into disposal containers. The technology for achieving this is not new and capacity to provide the necessary facilities will be provided with the new nuclear power station. The complete decommissioning of nuclear power stations has already taken place in the USA[261]. In the case of decommissioning wastes there may exist the option to transport the waste off-site to a GDF immediately without the need for on-site interim storage.

7.138 The Secretary of State is therefore satisfied that the interim storage of ILW can and will be carried out in a manner which causes a very low level of health

[256] NDA Strategy 2006 http://www.nda.gov.uk/documents/upload/NDA_Final_Strategy_published_7_April_2006.pdf
[257] NDA interactions with Waste Producers on plans for packaging radioactive wastes April 2008 to March 2009, Report no. NDA/RWMD/012, 2009
[258] http://www.em.doe.gov/pdfs/3rd%20US%20Rpt%20on%20SNF%20JC--%20COMPLETE%20REPORT%20-%2010%2013%2008.pdf
[259] www.stuk.fi/julkaisut/stuk-b/stuk-b96.pdf
[260] www.nagra.ch/g3.cms/s_page/83280/s_name/wastemanagementtoday
[261] www.connyankee.com/html/decommissioning.html

detriment, and considers below the arrangements for ensuring the safe and secure disposal of ILW from new nuclear power stations.

ILW - Geological Disposal

7.139 The NDA's disposability assessments referred to above also considered ILW from the new nuclear power station designs undergoing the GDA process. These assessments have concluded that, compared with legacy wastes and existing ILW, no new issues arise that challenge the fundamental disposability of the ILW expected to rise from the operation of the AP1000. The operational and decommissioning ILW that would be produced from new nuclear power stations would be very similar to that which is currently produced, or will be produced in the future, from Sizewell B and from LWR-type reactor systems operated in other countries, the safe and secure disposal of which has been extensively researched and, in the case of operational wastes, implemented in a number of countries (for example, Sweden[262], Finland[263] and France[264]).

7.140 The technology identified in disposal concepts that would be suitable for ILW from new nuclear power stations is already available in terms of engineered barrier designs and materials[265]. Given the similarity between the wastes from new nuclear power stations and legacy wastes, the same disposal technologies would be expected to apply. In terms of immobilisation and packaging, it is expected that the ILW waste packages currently in use would be acceptable for disposal in all potentially suitable UK geological settings.

7.141 Decommissioning wastes can be a significant source of long-lived radionuclides produced through neutron activation of materials used in the construction of the reactor. The understanding of activation processes and underlying research on their impact on safety cases can be used to guide material specifications that will reduce long-lived radionuclide production and therefore its significance on the long-term disposal safety case.

7.142 The Government has said that it favours a single GDF for all higher activity wastes however, as discussed above, the Government recognises that it might be necessary to build more than one GDF and the site selection process in the MRWS Programme is designed to be sufficiently flexible to accommodate this.

7.143 The Secretary of State is of the opinion that a disposal route will exist to deal with ILW arising from the AP1000 which would cause a very low level of health detriment.

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262 http://www.sweden.gov.se/content/1/c6/05/40/89/fc570cf2.pdf

263 http://www.stuk.fi/julkaisut/stuk-b/stuk-b96.pdf

264 http://www.french-nuclear-safety.fr/index.php/English-version/International-reports/Convention-on-Nuclear-Safety

265 Galson Sciences, Concepts for the Geological Disposal of Intermediate Level Radioactive Waste, Report for NDA, Report 0736-1, April 2008. http://www.nda.gov.uk/documents/upload/Concepts-for-the-Geological-Disposal-of-Intermediate-level-Radioactive-Waste-2008.pdf

Low Level Waste (LLW)

7.144 Low level waste (LLW) is the lowest activity category of radioactive waste, and was defined in the "Policy for the Long Term Management of Solid Low Level Radioactive Waste in the United Kingdom"[266] as: "*Radioactive waste having a radioactive content not exceeding four gigabecquerels per tonne (GBq/te) of alpha or 12 GBq/te of beta/gamma activity*".

7.145 LLW is generally made up of materials such as plastics, glass, metal, paper and soil that have become contaminated by contact with radioactive liquids or powders. Such materials derive from hospitals, research establishments and the nuclear industry. The majority of solid radioactive waste in the UK by volume is LLW.

7.146 Very low level waste (VLLW) is a subset of the LLW category of radioactive waste, covering miscellaneous waste arising with very low concentrations of radioactivity. VLLW is divided into two types: low volume VLLW and high volume VLLW. Low volume VLLW is defined as "*radioactive waste that may be disposed of to an unspecified destination, with each 0.1m^3 having less than 400 KBq total activity or single items with less than 40 KBq of total activity*". High volume VLLW is defined as "*having a maximum concentration of 4 MBq/tonne of total activity which may be disposed of to specified landfill sites*". The UK radioactive waste inventory[267] estimates that LLW makes up some 90% of the total volume of the UK's existing or committed radioactive waste but contains less than 0.0003% of the total radioactivity[268].

7.147 As with spent fuel and ILW, there is uncertainty over the quantity of LLW that is expected to be produced by a new nuclear programme but it is expected to be small in comparison with the volumes of legacy LLW.

LLW - Storage and Disposal

7.148 The "Policy for the Long Term Management of Solid Low Level Radioactive Waste in the United Kingdom" (the 2007 LLW Policy Statement), published in March 2007[269], outlines the priorities for managing LLW responsibly and safely, by:

- allowing greater flexibility in managing the wide range of LLW that already exists and will arise in the future;

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[266] Defra, Policy for the Long Term Management of Solid Low Level Radioactive Waste in the United Kingdom http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/radioactivity/waste/low/low.aspx

[267] UK Radioactive Waste Inventory as at 1 April 2007, NDA and Defra, March 2008

[268] Policy for the Long Term Management of Solid Low Level Radioactive Waste in the United Kingdom, by Defra, DTI and the Devolved Administrations, 26 March 2007, page 16 http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/radioactivity/waste/low/low.aspx

[269] Policy for the Long Term Management of Solid Low Level Radioactive Waste in the United Kingdom, by Defra, DTI and the Devolved Administrations, 26 March 2007 http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/radioactivity/waste/low/low.aspx

- maintaining a focus on safety, with arrangements supported by the independent regulators, including the Health and Safety Executive and the Environment Agencies;
- applying the waste hierarchy to seek to first minimise the amount of low level waste created before looking at disposal options, through avoiding generation, minimising the amount of radioactive substances used, recycling and reuse;
- creating a UK-wide strategy for managing low level waste from the nuclear industry;
- initiating a UK-wide strategy for the management of non-nuclear industry LLW; and
- emphasising the need to involve communities and the wider public in developing and delivering LLW management plans.

7.149 Among other things the policy set out that plans for the management of all radioactive waste, including LLW, must be developed by waste managers. These plans must be prepared in a form, and to a level of detail, suitable for consideration by the relevant regulatory bodies.

7.150 The NDA recently published the Low Level Waste Strategy[270] (the LLW Strategy) which was produced in response to the March 2007 Government policy statement on Solid LLW[271]. The LLW Strategy recognises the need for new fit-for-purpose waste management routes and seeks to encourage this, including making additional waste segregation services available to industry in order to minimise waste volumes going to the national repository. The necessary disposal routes must be available if the NDA is to progress the decommissioning and clean-up programme and it must be able to make full use of appropriate, safe and environmentally sound waste management options, including the waste hierarchy.

7.151 The storage and disposal of LLW will be subject to the same regulatory regime (set out in Chapter 6 (Radiological Health Detriment)) as that which covers existing nuclear power stations. Very low activity LLW (Very Low Level Waste – VLLW) is disposed of to conventional landfills where co-disposal arrangements are managed and authorised. Incineration is also used for some combustible waste, particularly clinical waste from hospitals. LLW/VLLW producers must hold authorisations under the Radioactive Substances Act

[270] http://www.nda.gov.uk/documents/upload/UK-Strategy-for-the-Management-of-Solid-Low-Level-Radioactive-Waste-from-the-Nuclear-Industry-August-2010.pdf

[271] Policy for the Long Term Management of Solid Low Level Radioactive Waste in the United Kingdom, by Defra, DTI and the Devolved Administrations, 26 March 2007 http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/radioactivity/waste/low/low.aspx

1993[272] or the Environmental Permitting (England and Wales) Regulations 2010[273]. High volume VLLW can only go to landfills that hold authorisations under the Act[274].

7.152 Before issuing a permit, the EA and the Scottish Environment Protection Agency (SEPA) must be satisfied that disposal can be carried out safely. The EA has published guidance on how it regulates disposal[275].

7.153 All nuclear licensed sites have a plan for the management of their LLW holdings and predicted future arisings that is part of a wider integrated waste management strategy. LLW management plans must take into account all current and anticipated future arisings of LLW, and their radiological and non-radiological properties. Such plans must be developed with appropriate regulatory and stakeholder involvement and should take into account current best practice. As a general principle, such plans should be developed and agreed with the regulatory bodies in advance of the production of any new LLW streams[276].

7.154 LLW storage and disposal technology is well established[277]. It is expected that LLW from new nuclear power stations will be handled in a manner similar to current practice and in line with Government policy on LLW. The LLW originating from new nuclear power stations will not vary greatly from that of existing nuclear power stations.

7.155 LLW storage is not a major feature of power station operations. Regulators discourage accumulation of waste at sites of origin if a disposal route is available. Therefore nuclear power station sites during operation place LLW in containers such as half-height isofreight containers (HHISOs) and send these for disposal when full. However, storage does take place in particular circumstances, for example at Dounreay where LLW is being stored in anticipation of a planned local disposal facility becoming available. Here LLW is packaged in HHISOs and stored in a specially constructed temporary storage facility above ground.

7.156 Most operational LLW is currently super-compacted to reduce its volume and sent for disposal at the LLW repository in West Cumbria, where it is packaged and encapsulated in cement and large steel containers. These are then placed in an engineered vault a few metres below the surface. Some LLW not

[272] Radioactive Substances Act 1993 (c. 12) http://www.opsi.gov.uk/acts/acts1993/ukpga_19930012_en_1
[273] The Environmental Permitting (England and Wales) Regulations 2010 (2010 No. 675) http://www.opsi.gov.uk/si/si2010/pdf/uksi_20100675_en.pdf
[274] See also Health Protection Agency: Radiological Assessment of Disposal of Large Quantities of Very Low Level Waste in Landfill Sites, May 2007 www.hpa.nhs.uk/webc/HPAwebFile/HPAweb_C/1194947322781
[275] Environment Agency, Guidance Note, Disposing of radioactive waste to landfill http://www.environment-agency.gov.uk/static/documents/Business/LLW_guidance_note_on_brand.pdf
[276] Policy for the Long Term Management of Solid Low Level Radioactive Waste in the United Kingdom, by Defra, DTI and the Devolved Administrations, 26 March 2007, page 7 http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/radioactivity/waste/low/low.aspx
[277] http://www.llwrsite.com/llw-repository-operations

suitable for existing disposal routes has not yet been disposed of and so will need to be disposed of in a GDF.

7.157 LLW produced from eventual nuclear power station decommissioning is a different issue from the management of operational waste. Larger volumes of waste will be produced, some of which will be VLLW in the form of lightly contaminated steel or concrete. In line with the 2007 LLW Policy Statement and the 2010 UK Strategy, NDA strategy is to minimise VLLW being consigned to highly engineered LLW disposal, where this is not necessary for such low activity material. During decommissioning, the VLLW that arises could be consigned to landfills, or other fit for purpose disposal arrangements, at existing or new locations, in line with the 2007 LLW Policy Statement. The management of LLW will be carried out in accordance with the waste hierarchy principles set out in the 2010 LLW Strategy. The objective of the Strategy is to ensure continued capability and capacity for the safe, secure and environmentally responsible management and disposal of LLW in the UK.

7.158 The Secretary of State is satisfied that the LLW originating from new nuclear power stations will not vary greatly from that of existing nuclear power stations, and expects that LLW from new nuclear power stations will be handled in a manner similar to current practice and in line with Government policy on LLW.

Liquid and gaseous radioactive discharges

7.159 The Secretary of State has considered liquid and gaseous radioactive discharges. These are planned releases of radioactive materials into the environment, either in liquid form into the sea or in gaseous form into the air. These planned discharges account for almost all of the radioactivity released by nuclear power stations.

7.160 The total radiation released through discharges must be within the dose limits set out in paragraphs 6.99 to 6.104 and the discharges are regulated by the Environment Agency under the Radioactive Substances Act 1993[278] or Environmental Permitting (England and Wales) Regulations 2010[279] to ensure compliance. Operators of licensed nuclear sites in England and Wales must have an authorisation or permit from the Environment Agency to cover discharges. These authorisations set out limits and conditions on discharges and disposals, including a requirement for operators to use best available techniques (BAT) to ensure that doses to members of the public are as low as reasonably achievable (ALARA). The Devolved Administrations have similar arrangements in place which are administered by their equivalent competent authorities (the Environment Agencies).

7.161 The Environment Agency in England and Wales is working with HSE through the GDA process to ensure that the need to meet high environmental standards is considered at an early stage of the regulatory process and that

[278] Radioactive Substances Act 1993 (c. 12) http://www.opsi.gov.uk/acts/acts1993/ukpga_19930012_en_1
[279] The Environmental Permitting (England and Wales) Regulations 2010 (2010 No. 675) http://www.opsi.gov.uk/si/si2010/pdf/uksi_20100675_en.pdf

the BAT are used to minimise radioactive waste and discharges. There are many technical developments in nuclear power station design, including those designs likely to be built in the UK, and operational practices that have reduced the amount of radioactive wastes produced; for example through the selection of materials, the segregation and recycling of effluent streams to enable more effective treatment and abatement, fuel design and improvements of the management of coolant chemistry. The technologies used in the UK for existing nuclear power stations and those proposed for new nuclear power stations are consistent with international best practice and have been, or will need to be, demonstrated to the relevant regulators as representing BAT. The application of the BAT principle will ensure that new nuclear power stations constructed in the UK will be designed to ensure that doses to members of the public are as low as is reasonably achievable.

7.162 The UK has committed to the objectives of the OSPAR Convention 1992[280] and the OSPAR Radioactive Substances Strategy[281] both of which aim to reduce discharges in to the marine environment of the North-East Atlantic Region to levels where the additional concentrations above historic levels, resulting from such discharges, are close to zero.

7.163 It is important to note that while the objectives of the OSPAR Convention ultimately aim to reduce the concentrations in the marine environment they do not prohibit the future development of the nuclear sector and the building of new reactors. OSPAR's Radioactive Substances Strategy acknowledges the need to take account of what is achievable and focuses on the delivery of the Convention's objectives through the application and use of BAT and Best Environmental Practice (BEP).

7.164 It is also important to bear in mind that, as any AP1000 built in the UK will be operated at a time when existing, earlier reactors which give rise to greater discharges are being or have been phased out, it is likely that the overall detriment to health arising from liquid and gaseous discharges from nuclear power stations as a whole will be reduced. Additionally, this Regulatory Justification decision does not allow for the reprocessing of spent fuel from AP1000s which again will significantly reduce the levels of discharges as compared to the current levels.

7.165 These factors are reflected in the UK's Strategy for Radioactive Discharges first published in July 2002 and updated in June 2009[282]. The revised Strategy reaffirms the Government's commitment to the progressive reduction of: radioactive discharges and discharge limits; human exposure to ionising

[280] Convention for the Protection of the Marine Environment of the North-East Atlantic 1992 http://www.ospar.org/html_documents/ospar/html/OSPAR_Convention_e_updated_text_2007.pdf

[281] The Radioactive Substances Strategy starts on page 16 of the 2003 Strategies of the OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic: http://www.ospar.org/html_documents/ospar/html/Revised_OSPAR_Strategies_2003.pdf#namedest=radioactive_substances

[282] http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/radioactivity/government/discharges/strategy/strategy.aspx

radiation arising from radioactive discharges; and concentrations of radionuclides in the marine environment resulting from radioactive discharges. Additionally, the Strategy provides an assessment of the position reached since 2002 and the projected discharges during the period covered by the OSPAR Radioactive Substances Strategy – 2006-2030.

7.166 The Strategy forms the UK's national report for the next OSPAR Ministerial meeting in 2010 as well as being the delivery mechanism for meeting the objectives of the OSPAR Convention.

7.167 The Secretary of State acknowledges that new nuclear power stations will continue to make liquid and gaseous discharges which will require continued regulation and is satisfied that there is an effective regulatory regime in place to ensure that such discharges will remain within discharge limits agreed with the regulators.

Transport of Radioactive Waste

7.168 The Secretary of State has considered the transport of radioactive waste and the measures in place to prevent detriment to health arising from it.

7.169 Regulation of the safety of radioactive material transport by road, rail and sea in Great Britain (GB) is currently carried out by the Department for Transport (DfT), HSE, the Office of Rail Regulation and the Maritime and Coastguard Agency. The DfT exercises its statutory powers of enforcement on behalf of the Secretary of State for Transport. Transporters of nuclear material outside of civil licensed nuclear sites also have to be approved by OCNS, the security regulator for the UK's civil nuclear industry[283], and transport security plans are required to be in place before the transport of certain nuclear materials can take place.

7.170 In particular the Secretary of State notes that experience in the UK and overseas shows that spent fuel can be, and is currently, transported safely and securely. The UK has decades of experience of transporting radioactive wastes in a safe and secure fashion. Any radiological consequences resulting from accidents or incidents during the transport of irradiated nuclear fuel have been categorised by the Health Protection Agency as none or extremely low[284].

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[283] See Annex B and Chapter 9 (Safety, Security and Safeguards) for more detail on the role of the OCNS.

[284] Harvey, M.P. (August 2010). HPA-CRCE-003 - Radiological Consequences Resulting from Accidents and Incidents Involving the Transport of Radioactive Materials in the UK - 2009 review. Page 19. http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1279888868216
Harvey, M.P. (July 2009). HPA-RPD-056 - Radiological Consequences Resulting from Accidents and Incidents Involving the Transport of Radioactive Materials in the UK – 2008 Review. Page 19. http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1248766807377
Harvey, M.P. and Hughes, J.S. (January 2009). HPA-RPD-048 - Radiological Consequences Resulting from Accidents and Incidents Involving the Transport of Radioactive Materials in the UK – 2007 Review. Page 25. http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1232436508409
Hughes, J.S. and Harvey, M.P. (December 2007). HPA-RPD-034 - Radiological Consequences Resulting from Accidents and Incidents Involving the Transport of Radioactive Materials in the UK - 2006 Review. Page 26. http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1204286185596

7.171 Radioactive wastes are transported in accordance with GB[285] legislation[286] based upon International Atomic Energy Agency (IAEA) regulations and in accordance with European Agreements and Directives. The packaging requirements for material containing radionuclides are dependent upon the radionuclide specific activity of the material, its form (solid, liquid or gas) and the total quantity of activity in the consignment.

7.172 In the disposability assessments undertaken on designs undergoing the GDA process, NDA has assessed the higher activity wastes that are likely to be produced from an AP1000 and concluded that these are in principle no different to those associated with existing designs for which transport and disposal routes form part of the current GDF development.

7.173 Spent fuel from new nuclear power stations will be transported in a shielded transport flask designed to reduce external dose rates to the low levels[287] required by the transport regulations and to provide containment of the radioactive material both during normal transport conditions and conditions representing transport accidents involving fire and impact. The transport of spent fuel from existing nuclear power stations also meets these transport regulatory requirements.

7.174 Experience in the UK and overseas shows that spent fuel can be, and is currently, transported safely and securely. In respect of external dose rate, the Secretary of State notes that the packaging and transport of high burn-up spent fuel can be achieved in accordance with the transport regulations using existing technology after a period of interim storage.

7.175 ILW packaging arrangements are already being implemented in the UK for legacy wastes. NDA is developing transport containers that will meet transport regulatory requirements in order to give confidence that these wastes can ultimately be transported to a GDF. Similar arrangements would also be applicable to ILW generated from the operation and decommissioning of new nuclear power stations.

Hesketh, N., et al (April 2007). HPA-RPD-021 - Radiological Consequences Resulting from Accidents and Incidents Involving the Transport of Radioactive Materials in the UK - 2005 Review. Page 22. http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1194947393377
Hughes, J.S. et al (July 2006). HPA-RPD-014 - Review of Events Involving the Transport of Radioactive Materials in the UK, from 1958 to 2004, and their Radiological Consequences. Page 23. http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1194947346295

285 Legislation in Northern Ireland falls under The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment (Amendment) Regulations (Northern Ireland) 2006 www.opsi.gov.uk/sr/sr2006/20060525.htm

286 The current requirements are prescribed in the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (CDG 2009), radioactive material is Class 7. http://www.opsi.gov.uk/si/si2009/uksi_20091348_en_1

287 Dose rate limits are prescribed in the transport regulations. See International Atomic Energy Agency, Regulations for the Safe Transport of Radioactive Material, IAEA Safety Standard TS-R-1. www-pub.iaea.org/MTCD/publications/PDF/Pub1225_web.pdf

7.176 LLW transport[288] methods are well-established by both road and rail. LLW is routinely transported in packages that are designed, certified and transported by industry as permitted in the transport legislation. DfT has regulatory oversight and verifies the system operated by industry, backed by enforcement powers, to ensure that LLW transport packages meet the prescribed requirements of the transport regulations.

7.177 The Secretary of State agrees that radiological health detriment from transport of waste arising from nuclear power stations will be subject to the robust regulatory regime and consequently will be very low. He also acknowledges that the potential consequences of an escape of this waste material such as might result from an accident or terrorist attack are very significant. However, he considers that the risks of transporting nuclear materials are very small and there is an effective regulatory framework in place that ensures that these risks are minimised and sensibly managed by industry.

Handling and disposal of non-radioactive hazardous waste

7.178 Although Regulatory Justification is an assessment of radiological health detriment, in order to consider all the information about the AP1000 the Secretary of State has also considered the handling and disposal of non-radioactive hazardous waste.

7.179 Non-radioactive wastes are produced from operating and maintaining both the "conventional" side of the new nuclear power station and the "nuclear island", and this includes some non-radioactive hazardous wastes, such as waste pond water, laboratory chemicals, and lubricating and fuel oils, which need safe management and disposal.

7.180 Hazardous waste is waste with one or more properties that are hazardous to health or to the environment[289]. Categories or generic types of hazardous wastes as well as the properties of hazardous waste are listed in the European Commission's Hazardous Waste Directive[290]. Controls are implemented by the Hazardous Waste Regulations[291].

7.181 The volumes of non-radioactive hazardous wastes produced by new nuclear power stations is expected to be small in relation to the total volumes of such wastes produced in the UK. The 2007 Nuclear Sector Plan Environmental Performance Report[292] notes that the existing nuclear sector produced around 27,000 tonnes of this waste, of which around half was asbestos, which is not expected to be generated in new nuclear power stations. This is very small in relation to current UK hazardous waste arising from all sectors of around 6.4 million tonnes.

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288 http://www.llwrsite.com/UserFiles/File/OperationalStrategy/InitialOperationalStrategy-January2009.pdf (Section 5.3 Transportation).
289 http://www.environment-agency.gov.uk/business/topics/waste/32200.aspx
290 http://eur-ex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31991L0689:EN:HTML
291 http://www.opsi.gov.uk/si/si2005/20050894.htm
292 http://publications.environment-agency.gov.uk/pdf/GEHO1208BPDD-e-e.pdf

7.182 The treatment and disposal of waste is regulated by the UK environment agencies in order to ensure the protection of the environment and human health[293]. Non-radioactive hazardous wastes will be managed according to regulatory requirements and current practices and will be disposed of promptly using established disposal routes.

7.183 Amounts of non radioactive hazardous waste arising from reactor construction and decommissioning are expected to be broadly equivalent to those arising from any major infrastructure or power construction or demolition project and amenable to the normal waste minimisation techniques. The construction of a new nuclear power station is likely to require a specific Site Waste Management Plan as with any other large construction site.

7.184 No substantial on-site treatment is expected to be required for the management of non radioactive hazardous wastes other than segregation of wastes dependent upon disposal route and safe storage pending commercial disposal. Based on existing nuclear power station sites, wastes would be disposed to commercial recycling and disposal routes at the nearest practicable facility in the same way as wastes from any other site.

7.185 The Secretary of State is satisfied that new nuclear power stations would not be expected to contribute significantly to the amount of hazardous non-radioactive wastes or requirements for future disposal capacity.

Conclusion

7.186 The generation of electricity by any AP1000 built in the UK would give rise to spent fuel, ILW, LLW and liquid and gaseous discharges, all of which contain differing levels of radioactivity. The Secretary of State recognises that the unnecessary introduction of ionising radiation into the environment is undesirable, and has considered the steps taken to limit the exposure of individuals to radiation from these sources.

7.187 Geological disposal is the way higher activity waste (spent fuel and intermediate level waste) will be managed in the long term. This will be preceded by safe and secure interim storage until a GDF can receive waste.

7.188 The Secretary of State considers, based on scientific consensus and international experience, that despite some differences in characteristics, waste and spent fuel from AP1000s would not raise such different technical issues compared with nuclear waste from legacy programmes as to require a different technical solution.

7.189 The disposability assessment for the AP1000 conducted by NDA as part of the GDA process supports that conclusion and concludes that compared with legacy wastes and existing spent fuel, no new issues arise that challenge the

[293] http://www.environment-agency.gov.uk/business/topics/waste/32180.aspx

fundamental disposability of the spent fuel and ILW expected to arise from operation of the AP1000. Given a disposal site with suitable characteristics, the spent fuel and ILW from the AP1000 is expected to be disposable.

7.190 The Secretary of State has noted that the length of time for the safe and secure on-site interim storage of spent fuel is contingent on a number of factors, but remains satisfied that interim storage of spent fuel and also ILW can and will be carried out in a way which causes a very low level of health detriment.

7.191 The Secretary of State is satisfied that a GDF would be able to, and would be required to, meet the strict dose limits and risk guidance level required by the UK regulatory regime. He has taken into account the fact that the Government is considering steps to ensure that any GDF built in the UK would be introduced into the regulatory regime in a staged manner with the involvement of the regulators at an early stage. The Secretary of State is conscious that no GDF for spent fuel is yet operational anywhere in the world. However, in light of the findings of the disposability assessments and the progress being made in the implementation of geological disposal abroad, the Secretary of State is satisfied that it is technologically feasible to build a GDF which could contain both higher activity wastes arising from existing nuclear power stations and from any AP1000 which might be built in the future, with only very low levels of health detriment.

7.192 The Secretary of State, having considered the Government's approach to the selection of a site for the implementation of geological disposal, is satisfied that there is a robust process in place to identify a suitable site and is confident that one will be identified and that a GDF (or more than one if necessary) will be built.

7.193 The Secretary of State is satisfied that the LLW originating from any new nuclear power stations would not vary greatly from that of existing nuclear power stations, and expects that LLW from new nuclear power stations would be handled in a manner similar to current practice and in line with Government policy on LLW.

7.194 Liquid and gaseous discharges from nuclear power stations give rise to emissions of radioactivity into the environment. The levels of these discharges and the consequences for human health are considered in Chapter 6 (Radiological Health Detriment). In relation to these discharges the Secretary of State is satisfied that the regulatory regime is sufficiently robust to ensure that doses arising from such discharges will remain within limits and will be as low as reasonably achievable (ALARA).

7.195 The existing regulatory regime, which limits by law the radiation to which people can be exposed from nuclear installations, would apply to the management and disposal of radioactive waste from any AP1000 and from its decommissioning, as well as to activities during its operation. The Secretary of

State is confident that this will ensure that the management and disposal of radioactive waste will give rise to only very low levels of health detriment.

7.196 The Secretary of State is satisfied that the regulatory regime will act to ensure that the release of radiation from the radioactive waste from any AP1000 remains within regulatory dose limits. In coming to this conclusion, the Secretary of State has given particular weight to the arrangements already in place to deal with waste from existing nuclear power stations, the effectiveness and transparency of the existing regulatory regime, and to the extensive powers that the regulators have to enforce compliance.

7.197 Considering all of the above and having taken into account the points made by respondents to the consultation, the Secretary of State is of the opinion that whilst there is a potential health detriment from the management and disposal of radioactive waste arising from the generation of electricity from any AP1000 which is built in the UK he considers that the health detriment from such radioactive waste would be very small and would remain very small up to and beyond disposal.

Chapter 8: Environmental Detriment

Introduction

8.1 The Regulations, the Basic Safety Standards Directive and the ICRP do not specify that a Regulatory Justification decision needs to consider the impact of a class or type of practice on health or the environment beyond that caused by the release of radiation.

8.2 However, the Secretary of State has taken the view that he should consider this wider impact so as to satisfy himself that he has considered all the ways in which the AP1000 might involve potential detriment, and responded to people's concerns in this area.

8.3 Such potential detriment might include environmental impacts related to: flood risk; the quality or availability of water resources; coastal change; air quality; noise levels; traffic levels; biodiversity and geological conservation; landscape; amenities and cultural heritage; and pressure on local services.

8.4 This Chapter considers the content of the Application relating to the environmental impacts arising from the AP1000, and responses to the consultations on the Application and on the Proposed Decision. It then sets out the Secretary of State's present view on the measures being taken by the Government and regulators to avoid or effectively mitigate any environmental detriment arising from the construction, operation and decommissioning of the AP1000.

Guidance for applications

8.5 The guidance for Regulatory Justification applications for new nuclear power stations[294] said that an application could cover the non-radiological effects of the proposed practice on people and the environment (including water, air, chemicals, light, thermal, noise, landscape, animal health, flora and fauna) and the radiological effects on flora and fauna.

[294] The Justification of Practices Involving Ionising Radiation Regulations 2004 (SI 2004 No 1769), Guidance on their application and administration, Version May 2008 http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

Summary of the Application

8.6 This is a brief summary of points made in the Application. Anyone wanting to follow the Application's arguments, evidence and supporting references in detail should read the Application in full.

8.7 The Application assessed the potential environmental benefits and detriment that could result from the development of new nuclear power stations, and considered relevant features of the class or type of practice in these respects. The Application stated that a detailed environmental impact assessment would be required as part of the planning process. It provided an overview of the environmental impacts that would be addressed during any consenting process in the UK to ensure that there are no unacceptable environmental impacts. The Application considered the potential scale of these impacts. The Application stated that environmental impacts of new nuclear power stations would be comparable with, or less than, those of other forms of large scale electricity generation, and that they would be properly mitigated, and kept to a minimum.

8.8 The Application stated that the potential industrial (that is, non-radiological) health detriment from new nuclear power stations would be very low and similar to, or lower than, those resulting from other major industrial activities.

8.9 The Application stated that new nuclear power stations would meet all applicable standards and regulations. The Application stated that, for these reasons, the overall environmental impacts and hence the associated detriment from new nuclear power stations in this area would be small.

8.10 The Application stated that the impact of climate change, such as more severe or unpredictable weather patterns and rising sea levels, would not materially affect the very low risks from new nuclear power stations as reactor technologies are robust enough to withstand extreme events. The Application explained that operators are obliged to fund flood risk management and coastal protection defences as required by the regulators[295].

AP1000 Design Specific Considerations

8.11 The Application concluded that the environmental impacts of new nuclear power stations, including the AP1000, would be comparable with or less than those of other large-scale electricity generation and would be properly mitigated and kept to a minimum in compliance with all applicable standards and regulations. The Application provided evidence to show that the AP1000

[295] The Justification of Practices Involving Ionising Radiation Regulations 2004, Consultation on the Nuclear Industry Association's Application to Justify New Nuclear Power Stations, Volume 2, Chapter 6 (Environmental impacts) and Chapter 8 (Other considerations). http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

design meets the generic claims on environmental impacts set out in the Application[296].

Summary of responses to the consultation on the Application

8.12 Several respondents felt that the Application should be supplemented with more information on the environmental and socio-economic impacts of new nuclear power stations, including in relation to their impact on biodiversity, the duration of identified environmental impacts and the potential cumulative environmental impact over the long term, including on the marine environment.

8.13 Several respondents raised concerns about the threat of sea level rise and uncertainties about long term climate change, and how this would impact on the location of new nuclear power stations.

8.14 Several respondents felt that the environmental impacts of an accident at a new nuclear power station would be greater than at an existing nuclear power station, on the grounds that new nuclear power stations would be larger and use higher burn-up fuel.

Summary of responses to the consultation on the Proposed Decision

8.15 Some respondents agreed with the Proposed Decision's conclusions that the potential environmental detriment of the proposed class or type of practice will be effectively mitigated by the planning regime, which, together with the permitting and licensing regimes, will ensure that additional assessment of environmental impacts at a site specific level will take place.

8.16 Several respondents felt that the Secretary of State had not given sufficient consideration to local site specific environmental impacts of new nuclear power stations and their construction, which some argued would be particularly pronounced from their usual location in remote rural and coastal areas; that, without full consideration of all environmental impacts, the full detriment from the class or type of practice could not be assessed, and that the environmental detriment from a new nuclear power station was not comparable to that from other forms of generation due to the radiation produced.

8.17 A number of respondents expressed concern that the new planning regime introduced by the Planning Act 2008 would not allow for a full assessment of the site specific environmental impacts of a new nuclear power station.

[296] The Justification of Practices Involving Ionising Radiation Regulations 2004, Consultation on the Nuclear Industry Association's Application to Justify New Nuclear Power Stations, Volume 3, (Annex 6B) http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

Responses of Statutory Consultees to the consultation on the Proposed Decision

Environment Agency (EA)

8.18 The EA said that it and the other nuclear regulators, specifically the HSE's Nuclear Directorate, had a crucial role in helping to ensure that the detriments arising from any new nuclear power stations would be small. Through the EA's work on Generic Design Assessment (GDA) and in its regulatory role on site specific permitting and licensing and site regulation, it would ensure that:

- public radiation doses from discharges and disposals of radioactive waste from any new nuclear power stations were within statutory dose limits and constraints and as low as reasonably achievable, and that the impact on the environment would be small; and
- the non-radiological impacts on people and the environment at new nuclear power stations would be minimised and acceptable.

8.19 However, this response was without prejudice to its decisions on the GDA of reactor designs or about any subsequent site specific applications by developers for relevant environmental permits.

Scottish Environment Protection Agency (SEPA)

8.20 SEPA said that the EA was better placed to provide comment and scrutiny on the Proposed Decision.

Food Standards Agency (FSA)

8.21 The FSA said that it agreed with the Proposed Decision's position on the potential radiological health detriment arising from the proposed practice, and considered the generic information provided was sufficient to show in principle that the potential detriment should be acceptable.

8.22 If the new design was Justified and a potential operator made an application for a new nuclear power station, the FSA would carry out an individual dose assessment as part of that application process. This would further refine the extent of potential detriment.

Secretary of State's view

Government approach

8.23 The Secretary of State acknowledges respondents' concerns about the potential environmental impact of constructing new nuclear power stations.

8.24 As stated in paragraph 2.13 to 2.17, Regulatory Justification is an initial, high-level assessment and a class or type of practice must be Justified before it is first adopted or first approved. The Secretary of State does not therefore consider it appropriate to take into account site-specific environmental issues,

where information would mostly not be available until the project stage, and which are addressed by site specific assessment processes, such as the planning, site licensing and environmental permitting systems.

8.25 However, the Secretary of State, in the interests of addressing these concerns, has considered how the environmental impact of new nuclear power stations would be assessed and regulated before, during and beyond operation.

8.26 The Government believes that the environmental impacts of new nuclear power stations would not be significantly different to those of other forms of electricity generation and that they are manageable, given the legal and regulatory requirements in place in the UK and Europe to assess and mitigate the impacts.

8.27 However, the Government also believes that the high-level environmental impacts of any new nuclear power station should be addressed at national level, in addition to site-specific environmental assessments.

Legislative and Regulatory background – the Nuclear NPS

8.28 As part of the Nuclear NPS, the Government undertook a detailed Strategic Siting Assessment (SSA) process to assess sites that are potentially suitable for the deployment of new nuclear power stations by the end of 2025, and a strategic level Appraisal of Sustainability (AoS) incorporating the requirements of the Strategic Environmental Assessment Directive.

8.29 The SSA was carried out by the Government using exclusionary and discretionary criteria which were publicly consulted upon. In coming to its view on the potential suitability of sites, the Government has also taken account of the AoS and Habitats Regulations Assessment (HRA), the views of members of the public on the sites that were nominated and the advice of regulators and other specialists.

8.30 The list of the sites that have been assessed by the Government at a strategic level and are considered to be potentially suitable for the deployment of new nuclear power stations by the end of 2025 are set out in the Revised Draft Nuclear National Policy Statement (NPS), which, with the Nuclear AoS and the HRA Reports, was published for public consultation in October 2010[297]. These are revised versions of the documents in the light of a previous consultation that was held on earlier drafts between November 2009 and February 2010.

8.31 The Planning Act 2008[298] was introduced to provide a more efficient, transparent and accessible planning system for nationally significant infrastructure projects in the transport, energy, water and waste sectors. Key aspects of the Act include the establishment of a series of NPSs to provide the

[297] https://www.energynpsconsultation.decc.gov.uk/
[298] Planning Act 2008 (c. 29) http://www.opsi.gov.uk/acts/acts2008/ukpga_20080029_en_1

planning framework for decisions, and a new decision making body, the Infrastructure Planning Commission (IPC), to consider and decide on nationally significant infrastructure project applications.

8.32 The Government announced in June 2010 its intention to amend the Planning Act 2008 and abolish the IPC. In its place, the Government envisages that a Major Infrastructure Planning Unit (MIPU) will be established within the Planning Inspectorate. Once established, the MIPU would hear examinations for development consent and would then make a recommendation to the Secretary of State, who would take the decision. The Government intends that NPSs would continue to provide the policy framework for decisions under these new arrangements.

8.33 These proposed reforms require primary legislation. Until such time as the Planning Act 2008 is amended, the IPC will continue as set out in that Act. As a result, the Revised Draft NPSs, and this document, refer to the IPC.

8.34 The Nuclear NPS, taken together with the Overarching National Policy Statement for Energy (EN-1) will form the primary basis for decisions taken on individual development consent applications for the construction of new nuclear power stations in England and Wales.

8.35 Among other things, the Nuclear NPS and EN-1 will provide the planning policy for the IPC on issues such as the need for new nuclear power and the assessment of environmental impacts that may result from the construction, operation and decommissioning of new nuclear power stations. It will also list the sites that have been deemed to be potentially suitable for the deployment of new nuclear power stations by the end of 2025. This will help to make the decision-making on applications more efficient. It will also help identify and address environmental concerns at an early stage of the planning process.

Appraisal of Sustainability (AoS)

8.36 The Planning Act 2008 provides that an NPS should contribute to the achievement of sustainable development[299], and requires that an AoS be carried out before an NPS can be designated[300]. The IPC will take account of the information contained in the AoS about issues of sustainability at national and site-specific level.

8.37 The main purpose of an AoS is to assess the potential environmental and sustainability effects of implementing a proposed NPS. If potential significant likely adverse effects are identified, an AoS can make recommendations for avoiding or mitigating such adverse effects to improve the sustainability of the NPS. The revised draft Nuclear NPS has been subject to an AoS incorporating the requirements of the Strategic Environmental Assessment (SEA) Directive[301]. The AoS assesses the Revised Draft NPS as a whole and each

[299] Section 10(2) of the Planning Act 2008 http://www.opsi.gov.uk/acts/acts2008/ukpga_20080029_en_1
[300] Section 5(3) of the Planning Act 2008 http://www.opsi.gov.uk/acts/acts2008/ukpga_20080029_en_1
[301] Required under European Directive 2001/42/EC on the assessment of the effects of certain plans and

site listed in the Revised Draft NPS has been subject to an appraisal of sustainability.

8.38 The AoS of the Revised Draft Nuclear NPS[302] has been developed through a number of stages including a scoping consultation and liaison with statutory consultees, the relevant regulators and other Government departments. It has also been consulted upon publicly and updated in light of responses.

8.39 The AoS found that the Revised Draft Nuclear NPS is likely to have beneficial effects in meeting the Government's climate change and security of supply objectives.

8.40 Possible adverse effects on internationally important nature conservation sites were identified. The relative significance of the effects and the effectiveness of any mitigation measures will have to be determined in any subsequent project level Environmental Impact Assessment (EIA) and with individual development consent applications.

8.41 The AoS has identified key inter-relationships between biodiversity and other sustainability effects. These are most notable in relation to flood risk management, health and well-being and sustainable communities.

8.42 The AoS has identified the potential for interactions and cumulative adverse effects in relation to water quality, habitat loss and coastal squeeze on European designated sites where there are clusters of potentially suitable sites for new nuclear power stations. Potential impacts on soil structure and quality may affect the soil water regime which in turn may affect terrestrial habitats. These issues will need to be considered in project level Habitats Regulations Assessments (HRA) produced by the IPC on the basis of information in the applications.

8.43 The AoS has also found that the effects associated with the management of hazardous wastes, including radioactive wastes, could affect sustainability[303]. The significance of these effects will be determined through site level studies as part of the project level Environmental Impact Assessments produced by applicants and project level HRAs.

8.44 The AoS has identified potential positive effects on local employment. This might be especially relevant where there is the potential for cumulative positive effects for economic development at the regional level.

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programmes on the environment http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2001:197:0030:0037:EN:PDF

302 DECC 2009, Appraisal of Sustainability: Radioactive and Hazardous Waste, EN-6 Draft National Policy Statement for New Nuclear Generation, p25. http://data.energynpsconsultation.decc.gov.uk/documents/aos/wastematrices.pdf

303 Planning for New Energy Infrastructure: Appraisal of Sustainability of the draft Nuclear National Policy Statement: Main Report, Chapter 6: Radioactive Waste, Spent Fuel and Hazardous Waste www.energynpsconsultation.decc.gov.uk

8.45 The AoS has also identified potential minor positive effects for some species and habitats around sites where spent fuel is stored and disposed of, because safety and security controls will lead to the exclusion of human activity and development. This has been evident on existing Nuclear Licensed Sites in the UK[304].

Habitats Regulation Assessment (HRA)

8.46 The Government has carried out an HRA on the Revised Draft Nuclear NPS in accordance with the Habitats Directive[305]. HRAs were also carried out for each nominated site. The findings of the HRAs for each of the nominated sites are set out in the HRA Site Reports[306]. The IPC will take account of the findings of the Habitats Regulations Assessments.

8.47 The purpose of assessing the Revised Draft Nuclear NPS in this way is to identify the potential for adverse effects resulting from the construction, operation and decommissioning of new nuclear power stations, in line with the policies and proposals contained in the Revised Draft Nuclear NPS, on the integrity of Natura 2000 sites.

8.48 The HRA Site Reports have detailed, as far as is possible on the basis of the current strategic-level information, the nature of the concerns at each site and the types of avoidance and mitigation measures that should be considered.

8.49 The Nuclear NPS is a plan for the purposes of the Habitats Directive[307]. The Government has assessed this plan and has concluded that the potential for adverse impacts on the integrity of Natura 2000 sites cannot be ruled out. In line with the requirements set out in Article 6(4) of the Habitats Directive the Government considered potential alternatives to the plan and nominated sites, and concluded that there are no alternative plans that would better respect the integrity of European sites and deliver the objectives of this plan[308]. Accordingly, the Government has presented a case for Imperative Reasons of

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304 Environment Agency (EA)The Environment Agency's Assessment of BNFL's 2002 Environmental Safety Cases for the Low-Level Radioactive Waste Repository at Drigg. NWAT/Drigg/05/001 (Version: 1.0) (2005).

305 The European Directive (92/43/EEC) on the Conservation of Natural Habitats and Wild Flora and Fauna (the Habitats Directive) protects habitats and species of European nature conservation importance by establishing a network of internationally important sites designated for their ecological status. These are referred to as Natura 2000 sites or European Sites (which is the term used in the main HRA Report and throughout all the Site HRA Reports), and comprise Special Protection Areas (SPAs) (as classified under the EC Birds Directive 1979), Special Areas of Conservation (SACs), candidate Special Areas of Conservation (cSAC), and European Offshore Marine Sites (EOMS) designated under the EC Habitats Directive. For the purposes of the Nuclear NPS HRA – all SAC cSAC SPA pSPA EOMS and Ramsar sites are referred to as European sites. It is Government policy to treat Ramsar sites, designated by the Ramsar Convention on Wetlands (1971) and potential SPAs (pSPAs) as if there are fully designated European Sites for the purpose of considering any development proposals that may affect them. Planning Policy Statement 9 Biodiversity and Geological Conservation; Government Circular: Biodiversity & Geological Conservation – Statutory Obligations and their impact within the planning system (ODPM, 2005); Technical Advice Note (TAN) 5 Nature Conservation and Planning (WAG, 1996).

306 www.energynpsconsultation.decc.gov.uk

307 Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (OJ L 206, 22.7.1992, p. 7)
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1992L0043:20070101:EN:PDF

308 Planning for New Energy Infrastructure: Appraisal of Sustainability of the draft Nuclear National PolicyStatement: Main Report

Overriding Public Interest (IROPI)[309] which sets out the rationale for why the plan should proceed given the uncertain conclusions reached at the assessment stage of the HRA.

8.50 The conclusions of the HRA including the examination of alternative plans and the IROPI case are set out in the Main HRA Report. Development consent applications submitted to the IPC constitute projects for the purposes of the Habitats Directive. The Secretary of State notes that the IPC must assess them accordingly, taking into account the findings of the plan level HRA and more detailed project level HRAs.

Environmental Statements

8.51 All proposals for projects that are subject to the European Environmental Impact Assessment Directive (the EIA Directive)[310], including new nuclear power stations, must be accompanied by an Environmental Statement from the applicant describing the aspects of the environment likely to be significantly affected by the project[311].

8.52 The EIA Directive specifically refers to effects on people, fauna and flora, soil, water, air, climate, the landscape, material assets and cultural heritage, and the interaction between them. Under the EIA Directive, an Environmental Statement should describe the likely significant effects of the proposed project on the environment, and also of the measures envisaged for avoiding or mitigating significant adverse effects[312].

8.53 When considering cumulative effects, the Environmental Statement should provide information on how the effects of the applicant's proposal would combine and interact with the effects of other development, including projects for which consent has been sought or granted, as well as those already in existence[313].

8.54 When considering an Environmental Statement, the IPC should satisfy itself that likely significant effects have been adequately assessed, and should request further information where necessary. The IPC may also take account of other evidence, for example from the AoS and HRA Reports or local authority development plans, on such effects and potential interactions to help reach decisions on proposals and on mitigation measures that may be required.

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309 www.energynpsconsultation.decc.gov.uk

310 Council Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment, amended by Directives 97/11/EC and 2003/35/EC

311 Statutory Instrument 1999 No. 293 The Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999 http://www.opsi.gov.uk/si/si1999/19990293.htm

312 See Circular 02/99: Environmental impact assessment for further information on the preparation and content of an Environmental Statement http://www.communities.gov.uk/documents/planningandbuilding/pdf/155958.pdf

313 For guidance on the assessment of cumulative effects, see, for example, Circular 02/99: Environmental impact assessment http://www.communities.gov.uk/documents/planningandbuilding/pdf/155958.pdf or Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions http://ec.europa.eu/environment/eia/eia-studies-and-reports/guidel.pdf

8.55 The Secretary of State believes that potential adverse impacts can be best mitigated or avoided by integrating the AoS and EIA process and the emerging design of a development as early as possible in this way.

Other considerations

8.56 New nuclear power stations will have long lifetimes with operation expected to last for around 60 years and decommissioning for around 30 years. Applicants must provide information to the IPC to show that they have considered the impacts of climate change and appropriate adaptation measures when planning the location, design, operation (including safe and secure interim waste storage) and where appropriate the decommissioning of the site[314].

8.57 The IPC also needs to be satisfied that, having regard to regulatory and other constraints, nuclear power stations are as durable and adaptable as they can be (including taking account of natural hazards such as flooding), subject to the need to ensure the safety and security of the power station. The IPC should also satisfy itself that the applicant has taken into account consideration of good design, and the design of the project should seek to mitigate environmental impacts such as those from noise, vibration and transport[315].

8.58 Under the Planning Act 2008, the IPC must also have regard to any local impact report submitted by a relevant local authority, any relevant matters prescribed in regulations, and any other matters which the IPC thinks are important and relevant to a decision.

8.59 The IPC will be able to attach conditions to a decision to mitigate damage to the environment from developments or aspects of developments which might otherwise not be environmentally acceptable.

8.60 The IPC can also decide not to grant consent where it judges that the adverse impact of a development, which could include the adverse environmental impact, outweighs its benefits. In cases where a development might cause environmental harm which could not be fully mitigated or avoided, this allows the IPC to take a decision, in light of the particular circumstances of the application, about whether the benefits of that development justify the environmental detriment it would cause.

Monitoring the likely effects of the Nuclear NPS

8.61 The Government has set out how it will monitor the effects of the Nuclear NPS. This has been published in the Revised AoS main report for consultation. Final details of this monitoring will be set out in the post-adoption statement, which will be published at the same time as the Nuclear NPS is designated. If unforeseen adverse effects are identified, the Government could

[314] Section 10(3)(a) of the Planning Act 2008 http://www.opsi.gov.uk/acts/acts2008/ukpga_20080029_en_1
[315] Section 10(3)(b) of the Planning Act 2008 http://www.opsi.gov.uk/acts/acts2008/ukpga_20080029_en_1

seek to establish the cause and consult with the relevant regulators to determine what action might be required.

Environmental Regulatory Regime

8.62 In considering an application for development consent, the IPC should focus on whether the development is an acceptable use of the land, and the impacts of that use, rather than the control of processes, emissions or discharges themselves. The IPC should work on the assumption that the relevant pollution control regime will be properly applied and enforced. It should act to complement, but not seek to duplicate it.

8.63 The IPC will consult with the nuclear regulators (the Environment Agency, the Office for Civil Nuclear Security, the Department for Transport and the Nuclear Installations Inspectorate) as it will need to be satisfied that the necessary licences, authorisations and permits to manage and control the impacts of the development have been or are likely to be issued in due course.

8.64 Issues relating to non-radioactive discharges or emissions, air quality, water quality, noise and nuisance such as dust and litter are controlled by relevant regulatory authorities such as the Environment Agency and local authorities. The disposal of radioactive waste is regulated by the Environment Agency under the Environmental Permitting regime. When an operator applies to the Environment Agency for an Environmental Permit, the Environment Agency requires that the applicant demonstrates that processes are or will be in place to meet all relevant Environmental Permit requirements. In considering the impacts of the project, the IPC may consult the Environment Agency on any management plans that would be included in an Environmental Permit application. Where possible, applicants are encouraged to submit applications for Environmental Permits and other necessary consents at the same time as applying to the IPC for development consent so that the imposition of conditions can be consistent across the planning and permitting regimes.

8.65 Through the GDA process[316] regulators are also working to ensure that the need to meet high environmental standards is considered at an early stage and that the most modern techniques to minimise radioactive waste – including discharges to the environment – can be incorporated into the designs of new nuclear power stations. The application of the principle of BAT (Best Available Techniques) in England and Wales will ensure that discharges from new nuclear power stations constructed in the UK will not exceed those from comparable nuclear power stations across the world.

8.66 The Secretary of State is satisfied that the existing legislative and regulatory regime will continue to function effectively under the new planning regime and that the planning process will take regulators' views into account.

[316] See paragraphs 2.22–2.26 and http://www.hse.gov.uk/newreactors/index.htm

Regulatory Regime – Environmental Impact of an Accident or Terrorist Incident

8.67 The Secretary of State acknowledges respondents' concerns about the impact on the environment of an accident at a nuclear power station. The Secretary of State, however, has not seen any information which would cause him to depart from the Government's view that the risk of an accident can be managed through arrangements for design and regulatory and corporate governance for the nuclear industry. The UK's nuclear safety regime and the security requirements in place to minimise the risk of an accident or terrorist incident is considered by the Secretary of State in detail in Chapter 6 (Radiological Health Detriment) and Chapter 9 (Safety and Security).

Regulatory Regime – Climate Change and Flood Risk

8.68 The Secretary of State has taken the advice of the Environment Agency and the Nuclear Installations Inspectorate about concerns about climate change and potential flood risk generally and has also taken specific advice in respect of the nominated sites. These issues will be looked at in detail as part of the planning process and the Secretary of State has confidence that this will ensure that any risk is limited.

8.69 The regulators are satisfied that protections are in place to ensure that only suitable sites achieve development and operational consent. This will be reviewed in detail as part of the planning and licensing stage and as part of the Flood Risk Assessment that applicants for development consent must undertake. Should sites achieve development consent, their capacity to withstand potential climate change will remain under consideration throughout the life of the nuclear power station.

Non-Radiological Health Detriment

8.70 The Regulations, the Basic Safety Standards Directive and the ICRP do not specify that a Regulatory Justification decision needs to consider the impact of a class or type of practice on health beyond that caused by the release of radiation.

8.71 However, in the interests of considering all the information relevant to the AP1000, the Secretary of State has considered its potential non-radiological health detriment.

8.72 The Nuclear AoS [317] assesses the impact on human health and well-being of the Revised Draft Nuclear NPS as a whole and at each of the potentially suitable sites for the deployment of new nuclear power stations by the end of 2025. This assessment includes consideration of non-radiological health detriment from new nuclear power stations.

8.73 The AoS has identified potential positive and negative effects for health and well being from new nuclear power stations. It states that the operation of new

[317] www.energynpsconsultation.decc.gov.uk

nuclear power stations is unlikely to be associated with significant noise and air quality effects (although there may be localised effects from transport activities during construction and from construction itself) and that the subsequent effects on human health are unlikely to be significant.

8.74 In common with other major industrial processes the construction, operation and decommissioning of new nuclear power stations could impact on health care provision, for example by placing demand on health monitoring services.

Conclusion

8.75 The Secretary of State recognises that construction, operation and decommissioning of an AP1000, as a major infrastructure project, will involve potential detriment to the environment, and that this potential detriment needs to be addressed.

8.76 The Secretary of State has considered in detail in other Chapters of this document some of the issues covered in the AoS and HRA of the draft Nuclear NPS, including radiological health detriment, radioactive waste, security of supply and climate change.

8.77 In the case of the other areas considered, including biodiversity, landscape, air quality, soils, water quality and flood risk, these can by their nature only be effectively addressed at a site-specific level in connection with individual applications to build nuclear power stations.

8.78 Such site specific matters are not suitable considerations in making a Regulatory Justification decision. In any event there are other site specific assessment processes that exist, such as the planning, permitting and licensing systems, which will ensure that any environmental detriment caused by the construction of an AP1000 will be minimised. The Secretary of State is conscious of the UK's obligations under EU law with regard to the environment and is confident that these processes will ensure that any environmental damage is kept within limited and acceptable levels.

8.79 The Secretary of State has considered the arrangements for processing applications for development consents for new nuclear power stations. In granting development consent, the IPC must generally act in accordance with the NPS and its supporting documents. These contain policy aimed at minimising and mitigating harm to the environment that could arise from the construction and operation of an AP1000. When considering an application, the IPC will also have the benefit of an Environmental Statement which details all the potential impacts of the development on the environment. The IPC will be able to attach conditions to a decision to mitigate damage to the environment from developments or aspects of developments which might otherwise not be environmentally acceptable.

8.80 The IPC can also decide not to grant consent where it judges that the adverse impact of a development, which could include the adverse environmental

impact, outweighs its benefits. In cases where a development might cause environmental harm which could not be fully mitigated or avoided, this allows the IPC to take a decision, in light of the particular circumstances of the application, about whether the benefits of that development justify the environmental detriment it would cause.

8.81 The IPC will make its decisions following consultation with the Environment Agency and other regulatory bodies. The Secretary of State is satisfied that the existing regulatory regime will continue to function effectively under the new planning regime, both before and after decisions are taken.

8.82 The Secretary of State is satisfied that the planning regime being set up under the Planning Act 2008 for major infrastructure will allow environmental considerations to be identified and addressed at an early stage of the planning process, including through consultation with the regulators and the public, so that (together with the environmental permitting and site licensing regime) unsuitable development can be prevented and potential adverse impacts mitigated. The Secretary of State is therefore satisfied that any environmental detriment arising from the construction, operation and decommissioning of the AP1000, outside those factors considered elsewhere in this document, will be effectively mitigated.

Chapter 9: Safety, Security and Safeguards

Introduction

9.1 The International Commission on Radiological Protection (ICRP) is clear that accident prevention should be the first safety priority of both designers and operators[318], and provides guidance[319] on the regulatory framework for dealing with "potential exposure" (radiation exposure that is not certain to occur, but to which a probability of occurrence can be assigned). The guidance says that:

"*The first step in regulation in the context of potential exposures is that of establishing a duty on the operating management to conduct assessments of the expected frequency and possible consequences of events, such as accidents and major errors of design and operation, that might give rise to doses substantially higher than those in normal conditions*. […]

"The second stage is that of regulatory review. Depending on the likely scale of the problems posed by the events giving rise to potential exposures, the regulatory agency should establish a procedure for reviewing the operators' assessments. […]

"Compliance with risk limits and constraints has to be judged from the results of assessments of the quality of the design, operation and maintenance of the plant and equipment and the quality of the management arrangements."

9.2 The release of radioactivity into the environment from an accident or terrorist incident at a new nuclear power station could lead to significant adverse health and long-term environmental impacts through direct exposure to high levels of ionising radiation, or from increased contamination of air, land and water, which could lead in turn to ingestion via the water supply or food chain, potentially over a wide area depending upon the scale and nature of the incident.

9.3 As explained in Chapter 6 (Radiological Health Detriment), the potential health consequences of an accident could include a range of cancers, burns, sensory impairment and even death and would depend upon the scale of what occurred and which part of the nuclear power station it occurred in.

9.4 The Secretary of State has therefore considered the potential detriment from an accident or incident at an AP1000.

[318] ICRP Publication 60: 1990 Recommendations of the ICRP http://www.icrp.org/
[319] ICRP Publication 64: Protection from Potential Exposure: A Conceptual Framework http://www.icrp.org/

9.5 This Chapter considers the content of the Application relating to issues of safety and security raised by the AP1000, and responses to the consultations on the Application and the Proposed Decision. It then sets out the Secretary of State's view on the effectiveness of the regulatory regime in place to minimise the detriment to health which could arise from an accident or a terrorist attack at a nuclear power station.

Guidance for applications

9.6 The guidance for Regulatory Justification applications for new nuclear power stations[320] said that an application could include information on accident and terrorism mitigation strategies, safety and non-proliferation.

Summary of the Application

9.7 This is a brief summary of points made in the Application. Anyone wanting to follow the Application's arguments, evidence and supporting references in detail should read the Application in full.

9.8 The Application outlined the UK approach to nuclear safety regulation and said that it incorporated the principle that all reasonably practicable steps must be taken to prevent and mitigate nuclear and radiation accidents.

9.9 The Application explained that there are a range of measures in place which would minimise the risks of malicious acts against nuclear power stations. The Application pointed to the robust and comprehensive regulatory framework that requires physical protection measures (such as access controls), armed response requirements, computer system security and checks on personnel reliability. The Application noted that the UK's Office for Civil Nuclear Security (the OCNS) has concluded that the security risks of new nuclear power stations can be appropriately managed.

9.10 The Application stated that the potential vulnerability of nuclear power stations to terrorist or other malicious threat is further reduced by the fact that they are amongst the most robust civil structures in the world, and have a multi-layered defence.

9.11 The Application stated that there would be little change to existing very small proliferation risks. The Application stated that there is an effective regulatory framework already in place to prevent any diversion of civil nuclear materials away from the UK's nuclear facilities and that this would be applied to any new nuclear power stations[321].

[320] The Justification of Practices Involving Ionising Radiation Regulations 2004, Guidance for applications relating to new nuclear power, March 2008 http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

[321] The Justification of Practices Involving Ionising Radiation Regulations 2004, Consultation on the Nuclear Industry Association's Application to Justify New Nuclear Power Stations, Volume 2, Chapter 8 (Other considerations) http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

AP1000 Design Specific Considerations

9.12 The Application stated that the AP1000 safety analyses already performed gave a good indication that the design would meet UK regulatory Basic Safety Levels[322] for accidents.

9.13 The Application stated that the design facilitated construction, maintenance and operation thereby improving industrial safety considerations.

9.14 The Application stated that the design provided for multiple levels of defence for accident mitigation and featured the use of advanced passive safety systems. The Application confirmed that engineered safety features had been included in the design to ensure reactor safety following extreme events such as earthquake, extreme winds, flooding and aircraft crash.

9.15 The Application did not propose any specific features of the AP1000 which would impact on a high level assessment of proliferation risks arising from the operation of new nuclear power stations in the UK[323].

Summary of responses to the consultation on the Application

9.16 Some respondents said that the nuclear industry had a good safety record and that the Application had demonstrated that the benefits of the class or type of practice outweighed the detriments.

9.17 A number of responses expressed concern about the safety of new nuclear power stations and the risk of an accident or terrorist attack. Some respondents felt that the potential consequences of an accident meant that new nuclear power stations could not be Justified under the Regulations.

9.18 Several respondents felt that before a Regulatory Justification decision could be made, more information about the measures in place to reduce proliferation was needed. Some respondents said that new nuclear power stations in the UK would weaken the Non-Proliferation Treaty[324] by promoting the development of nuclear power in other countries and so increasing the associated risk of proliferation.

Summary of responses to the consultation on the Proposed Decision

9.19 Some respondents agreed with the Proposed Decision's conclusions on safety and security, and in particular agreed that the risk of an accident can be

[322] The Basic Safety Levels are explained in more detail in paragraph 6.90.

[323] The Justification of Practices Involving Ionising Radiation Regulations 2004, Consultation on the Nuclear Industry Association's Application to Justify New Nuclear Power Stations, Volume 2 (Chapter 1, Table 1.1) and Volume 3 (Annex 6B) http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

[324] http://www.iaea.org/Publications/Documents/Treaties/npt.html

managed through arrangements for design and regulatory and corporate governance for the nuclear industry.

9.20 However, a number of respondents expressed continuing concern about safety and security in the nuclear industry, saying that the Proposed Decisions understated the risk of an accident or terrorist attack, particularly when new stations were being built next to existing ones, and that the consequences of an accident or incident would be worse for nuclear power stations, waste stores and transport than for other infrastructure, and worse for the AP1000 because it would release more radioactivity than existing nuclear power stations.

9.21 Some respondents said that the potentially long lasting consequences of an accident at a nuclear power station were such that new nuclear power stations could never be Justified.

Regulation

9.22 Some respondents said there was a lack of openness within the industry on safety and security issues, and a failure by the regulators to enforce the operators' compliance with safety and security regulations.

9.23 Some respondents questioned whether the possible restructuring of the nuclear regulator would improve regulatory effectiveness and independence.

Generic Design Assessment

9.24 Some respondents referred to concerns about the safety of the AP1000 raised in the course of the GDA process and took the view that GDA should be finalised before a Regulatory Justification decision is made.

Proliferation

9.25 Some respondents disagreed with the Proposed Decision's assessment of the proliferation risks associated with civil nuclear expansion, and said that new nuclear power stations in the UK would weaken the Non-Proliferation Treaty by promoting the development of nuclear power in other countries and so increasing the associated risk of proliferation now and in the future.

Responses of Statutory Consultees to the consultation on the Proposed Decision

Health and Safety Executive (HSE)

9.26 HSE considered that the Proposed Decision's views accurately reflected the UK's robust security regulatory regime and also the arrangements for ensuring the application of international safeguards measures in the UK.

Food Standards Agency (FSA)

9.27 The FSA explained that in the event of a nuclear incident or accident it would be the lead Government Department with regard to food safety. As such it works closely with the regulatory bodies and the nuclear industry to reduce the likelihood of such an event occurring and to improve the possible response to such an event were it ever to happen. Given this the FSA agreed with the Proposed Decision that the risk can be managed through arrangements for design and regulatory and corporate governance for the industry.

Secretary of State's view

9.28 The Secretary of State acknowledges that some respondents' concerns about the impact of an accident or incident lead them to question the view set out in the Proposed Decision documents that the risk of an accident can be managed through arrangements for design and regulatory and corporate governance for the nuclear industry. The Secretary of State has therefore considered the measures in place to prevent accidents and protect against security threats such as terrorism.

Safety Regulatory Regime

9.29 The regulatory regime governing the safety of nuclear power stations and nuclear transport is considered in more detail in paragraphs 6.80 to 6.123.

9.30 The Secretary of State has considered the reference by some respondents to concerns about the safety of the AP1000 raised in the course of the GDA process and the view of some respondents that GDA should be finalised before a Regulatory Justification decision is made.

9.31 As has been set out at paragraph 2.22 above, GDA examines the AP1000 in greater detail than is required by Regulatory Justification. However, the Secretary of State considers it useful to have regard to the information that has come out of the GDA process in order to place himself in the best position to consider the Regulatory Justification of the AP1000.

9.32 The regulators have not said the designs are unsafe, but that changes may need to be made before they are submitted for site-specific licensing. They have made clear in their response to the consultation on the Proposed Decision that their assessments had not revealed any safety or security shortfalls that would be so serious as to rule out the AP1000's eventual construction in the UK. The Secretary of State therefore considers that the raising of these concerns by regulators is evidence that the regulatory regime is functioning effectively and that he can be confident that these concerns would be satisfactorily addressed before the regulators would allow an AP1000 to be constructed.

9.33 The regulators will continue to assess the AP1000 as part of the GDA process and have made clear that new nuclear power stations will not be built if they are not satisfied through GDA and the site-specific process.

9.34 Before giving permission for the start of construction, the HSE would have to be satisfied that, among other things, several levels of protection and defence are provided against significant faults or failures, that accident management and emergency preparedness strategies are prepared and that all reasonably practicable steps have been taken to minimise the radiological consequences of an accident.

9.35 As explained in paragraphs 2.13 to 2.17, legislation requires a Regulatory Justification decision to be taken before a class or type of practice is adopted or approved. It is an initial, high-level process, and not intended as a substitute for the detailed examination of reactor designs which is made through the regulatory process, including GDA. It would therefore not be right to delay a Regulatory Justification decision until the GDA process was completed.

Security regulatory regime

9.36 The security of the civil nuclear industry in the UK is regulated by the HSE's Office for Civil Nuclear Security (OCNS) in accordance with the Nuclear Industries Security Regulations 2003[325], which reflect international obligations and guidelines[326]. The OCNS is responsible for approving security arrangements within the industry and enforcing compliance. It also undertakes security vetting of nuclear industry personnel with access to sensitive nuclear material or information. The OCNS carries out routine and no-notice inspections of site security arrangements and requires operators to improve their systems where changes are found to be necessary[327].

9.37 There are understandable restrictions placed on the publication of the details of actions taken to protect nuclear sites, but operators of new nuclear power stations will be required to take robust measures to protect them, and their associated waste management facilities, against the risk of theft and sabotage. Such measures will form part of their "licence to operate" through the regulatory requirement to obtain approval of, and maintain arrangements in accordance with, a security plan. This requirement will be closely monitored and enforced by the OCNS through its inspection regime.

9.38 UK civil nuclear security legislation reflects international best practice, and operators of nuclear sites are required to have in place a security plan

[325] Statutory Instrument 2003 No. 403, The Nuclear Industries Security Regulations 2003 http://www.opsi.gov.uk/si/si2003/20030403.htm

[326] Following a review, (Review of the Nuclear Industries Security Regulations (NISR) 2003, led by the Department of Trade and Industry and which closed on 1 December 2006) the Nuclear Industries Security Regulations 2003 were found fit for their current purposes.

[327] See "A Consultation on the Restructuring of the Health and Safety Executive's Nuclear Directorate", June 2009 http://decc.gov.uk/en/content/cms/consultations/hse_restruct/hse_restruct.aspx, Annex C (Roles of Independent Regulators and Advisory Bodies in the UK) and http://www.hse.gov.uk/nuclear/ocns/

approved by OCNS. The appropriate security standards, procedures and arrangements described in the security plan for the site are required to be in place before any nuclear material, spent fuel, radioactive waste or other radioactive material is introduced into any building on that site and before nuclear fuel is loaded into the reactor core.

9.39 There are a number of specific measures in place to minimise the risks posed by terrorism. These include:

- a comprehensive assessment process for identifying risks at each nuclear facility;
- an independent security regulator (the OCNS) which carries out frequent inspections and requires operators of nuclear plant to carry out counter-terrorism exercises;
- the Joint Terrorism Analysis Centre which monitors the terrorist threat levels to the UK (including the civil nuclear industry)[328]; and
- armed police officers from the Civil Nuclear Constabulary (CNC) working alongside civilian security personnel protecting nuclear power stations. The CNC's mission is to defend and protect those sites to which it is deployed, with a view to denying unauthorised access to nuclear materials and, if necessary, recover control of any nuclear material which may have been lost to unauthorised persons.

9.40 The OCNS is satisfied with arrangements to guard against terrorism and believes that allowing new nuclear power stations to be built would be unlikely to increase the risks of terrorist attack.

9.41 Further, the Secretary of State notes that the Government and industry have an emergency preparedness framework in place to mitigate health effects in the unlikely event of an accidental release of radioactivity into the environment. This framework includes detailed site-specific plans for each nuclear facility. Detailed plans must provide for:

- the control of any accident on the site;
- assessment of actual and potential accident consequences, and alerting the relevant authorities and the public; and
- introduction of countermeasures to mitigate the consequences of the accident; and return to normal conditions.

9.42 The plans are tested regularly through exercises, some of which involve the Government and simulated media involvement[329].

[328] http://www.mi5.gov.uk/output/joint-terrorism-analysis-centre.html
[329] http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/issues/

9.43 The effectiveness and efficiency of the regulatory regime is under continuous review and improvements are made where necessary.

Proliferation

9.44 The Secretary of State acknowledges concerns about the possibility of diversion of nuclear material and the proliferation of nuclear weapons.

9.45 The UK Safeguards Office (UKSO) is part of the Nuclear Directorate of the HSE. It ensures that the UK complies with its international safeguards obligations, including those under the Euratom Treaty[330], the UK/Euratom/International Atomic Energy Agency (IAEA) safeguards agreement[331] and the UK's Additional Protocol agreement. It does this by working with the industry and inspectors from the European Commission and the IAEA to make sure that the safeguards measures applied are both effective and efficient[332].

9.46 The operators of new nuclear power stations will be subject to the same stringent safeguards provisions as existing operators, including inspection and verification by the international safeguards inspectorates of the European Commission and the IAEA.

9.47 The Secretary of State has noted concerns that building new nuclear power stations would make it harder for the UK to press for the abandonment of nuclear power world-wide in the interests of non-proliferation. But the Government does not accept that pressing other countries to forego nuclear power is an effective or legitimate approach to non-proliferation. Rather, multilateral action is needed to support and strengthen the weapons non-proliferation regime through the Nuclear Non-Proliferation Treaty (NPT)[333], under which signatories which are non-weapons states have a right to the peaceful development of nuclear power. As signatories of the Non-Proliferation Treaty, all potential new nuclear states would also be obliged to submit all nuclear material to IAEA safeguards and prevent proliferation. Moreover, the 5-yearly NPT Review Conference, held in May 2010, reaffirmed international commitment to non-proliferation and the right to peaceful uses of nuclear energy.

9.48 The Secretary of State believes therefore that there is no reason to think that the building of new nuclear power stations in the UK would result in any significant rise in proliferation risk from the current low levels.

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emergency_plan/response/response.aspx

330 http://eur-lex.europa.eu/en/treaties/dat/12006A/12006A.htm

331 http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc263.pdf

332 http://www.hse.gov.uk/nuclear/safeguards/index.htm

333 http://www.iaea.org/Publications/Documents/Treaties/npt.html

Conclusion

9.49 The Secretary of State is conscious of the significant detriments to health and the environment that could result from an accident or terrorist attack at a new nuclear power station. However, the scale of potential damage must be seen in the light of the robust regulatory regime which exists in the UK to prevent accidents and protect against security threats including terrorist attacks. The Secretary of State is also conscious of the good record of the nuclear industry in the UK and the regulatory regime which governs it.

9.50 The Secretary of State has also considered the proliferation risks associated with the nuclear material related to an AP1000. He is satisfied that any AP1000 that is built in the UK will be required to have in place suitable practices to allow for safeguarding of such nuclear material.

Annex A: Note on the Classification of Nuclear Reactors

1. There are several different groups into which nuclear reactors can be divided, based on their technical features, and different individual designs within each group. The diagram below sets out in summary form one possible classification of thermal nuclear reactor designs into groups. This information is set out in greater detail in advice the Government has received from its technical advisers[334].

2. All the reactor designs in the Application relate to light water cooled, water moderated thermal reactors. Water can include "light water" and "heavy water". "Light water" means H_2O, or water as generally understood. "Heavy water" is D_2O where D is deuterium, an isotope of hydrogen with a neutron added to the nucleus.

3. The nuclear reactor designs in the Application all function by bombarding Uranium-235 with neutrons so that the atom splits ('fission'), producing fission products, extra neutrons and heat. This process is most likely to occur if the neutrons are moving in a particular speed range, when they are referred to as "thermal neutrons". The extra neutrons produced by fission are moving at much higher speeds and are slowed to 'thermal' speeds by using a "moderator" (for example: light water, heavy water, graphite), thus making further fission of U235 atoms more likely. The heat given off when Uranium-235 atoms splits heats the "coolant" (the liquid circulating through the core of the reactor so as to transfer the heat from it) which is, through various means, turned to steam which then drives turbines which generate electricity.

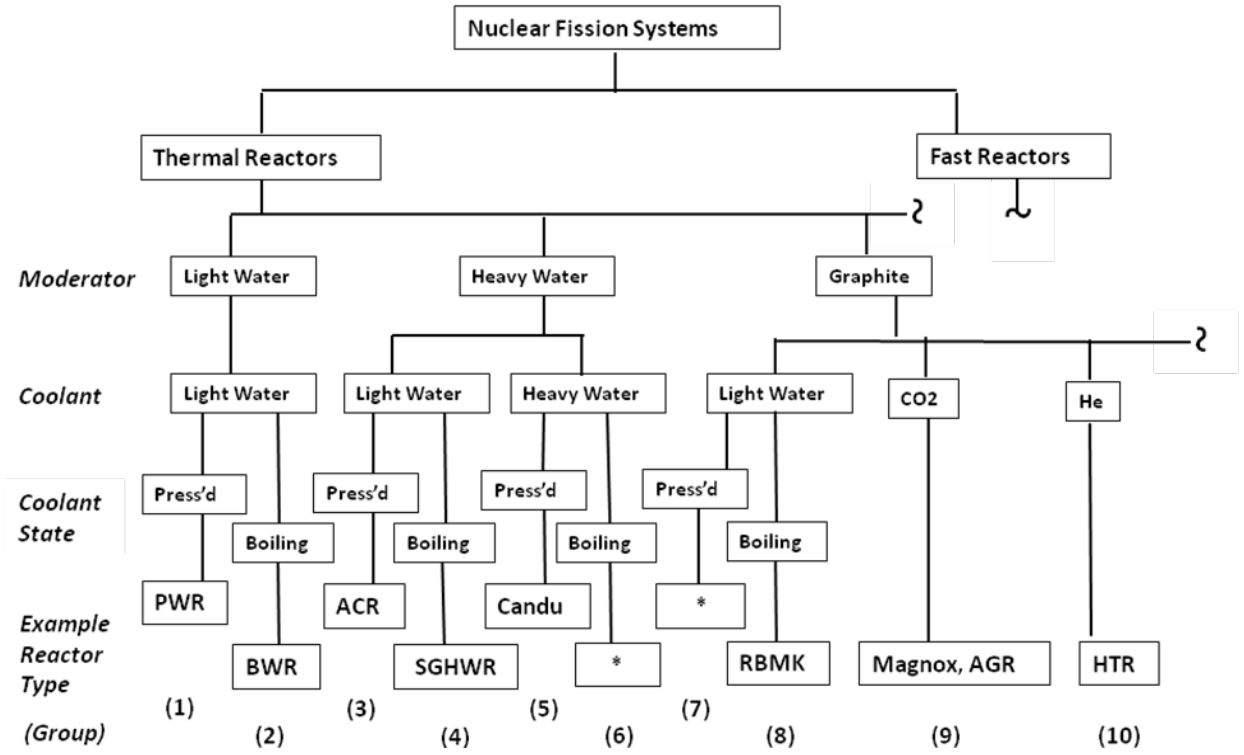
4. Of the four reactors in the Application, two, the AP1000 and the EPR, are Pressurised Water Reactors (PWRs). PWRs are shown in the diagram as Group 1. This is the most common type of nuclear reactor. It uses light water as both coolant and moderator. The design is distinguished by having a primary cooling circuit which carries water through the core of the reactor under very high pressure so that it cannot boil. Heat is then transferred to a secondary circuit in which steam is generated to drive the turbine.

5. One of the reactors in the Application, the ESBWR, is a Boiling Water Reactor (BWR). BWRs are shown in the diagram as Group 2. This is similar to the PWR,

[334] Advice on the influence of reactor technology on the definition of classes or types of practice for new build justification, Authors: Gregg Butler, Grace McGlynn (IDM) with input from Andrew Worrall and Kevin Hesketh (National Nuclear Laboratory) http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_just/reg_just.aspx

but there is only a single circuit. The coolant turns to steam which drives the turbines, and the turbines are part of the reactor circuit.

6. One of the reactors, the ACR-1000, is an Advanced CANDU Reactor (ACR). The ACR is shown in the diagram as Group 3. This uses light water as a coolant and heavy water as a moderator.



* Power reactors have not yet been developed in Group 6 (heavy water moderated, boiling heavy water cooled) and Group 7 (graphite moderated, pressurised light water cooled)

Annex B: Roles of Independent Regulators and Advisory Bodies in the UK

1. The **Environment Agency** is the leading public body for protecting and improving the environment in England and Wales. It has pollution control powers, being responsible for the regulation of radioactive waste disposals, including discharges; abstraction from, and discharges to, controlled waters, including rivers, estuaries, the sea and groundwaters; assessment and where necessary, clean-up of contaminated land; disposal of conventional waste; and certain flood risk management matters[335].

2. The **Scottish Environment Protection Agency**[336] and the **Department of the Environment, Northern Ireland**[337] perform similar functions in Scotland and Northern Ireland.

3. The **Nuclear Installations Inspectorate** (NII), part of the Health and Safety Executive's Nuclear Directorate (ND)[338], has responsibility for the safety regulation of nuclear facilities in Great Britain. The NII regulates nuclear power stations by means of a licensing and permissioning regime. A site cannot have a nuclear installation on it unless the user has been granted a site licence by the HSE. The NII, acting for the HSE, has the power to attach to the nuclear site licence conditions in the interests of safety and also with respect to the handling, treatment and disposal of nuclear matter providing for the general requirements for safety on the site. This regime enables the NII to provide regulatory oversight of the operator's safety-related activities throughout the lifecycle of the plant including design, siting, construction, commissioning, operation and modification through to completion of decommissioning.

4. The **Office for Civil Nuclear Security** (OCNS) [339], also part of HSE's Nuclear Directorate, is the regulator for security at all civil licensed nuclear sites. It is responsible for regulating the arrangements for the protection of these sites, including all nuclear and other radioactive material held on the sites, for the protection of sensitive nuclear information, sensitive nuclear material in transit to and from these sites and for the vetting of all people who have access to these sites, nuclear material and sensitive nuclear information.

335 http://www.environment-agency.gov.uk
336 http://www.sepa.org.uk
337 http://www.doeni.gov.uk/
338 http://www.hse.gov.uk/nuclear/nsd1.htm
339 http://www.hse.gov.uk/nuclear/ocns/

5. The Environment Agency, the Nuclear Installations Inspectorate and the OCNS are currently assessing designs for new nuclear power stations through the Generic Design Assessment (GDA).

6. The **UK Safeguards Office** (UKSO) is part of the Nuclear Directorate of the HSE and oversees the application of nuclear safeguards in the UK. Nuclear safeguards are measures to verify that States comply with their international obligations not to use nuclear materials (plutonium, uranium and thorium) for nuclear explosives purposes.

The UKSO works with the UK nuclear industry and others with safeguards reporting requirements, and safeguards inspectors from the European Commission and the International Atomic Energy Agency (IAEA), to make sure that the safeguards measures applied are both effective and efficient[340].

7. The **Food Standards Agency** is an independent Government department set up by an Act of Parliament in 2000. It is responsible for protecting the public's health and consumer interests in relation to food, by assessing the potential detriments in the form of what radiological doses members of the public could be exposed to as a result of routine operational discharges of radioactive material[341].

8. The **Department for Transport** manages the UK regulatory regime for transport of radioactive materials. This is based on the IAEA Regulations for the Safe Transport of Radioactive Materials[342].

Roles of advisory bodies in the UK

9. The **Nuclear Decommissioning Authority** (NDA) is responsible for delivering safe, sustainable and publicly acceptable solutions to the challenge of nuclear clean-up and waste management[343]. It is responsible for decommissioning legacy nuclear facilities, the interim storage of legacy nuclear waste and implementing geological disposal, and acts as a single point of accountability and strategic overview of the whole waste management chain at national level. As part of this role the NDA Radioactive Waste Management Directorate (RWMD) is providing companies proposing nuclear reactor designs with disposability assessments for wastes predicted to arise from the operation and decommissioning of new nuclear power stations for submission to the regulators as part of the GDA process. The NDA RWMD will evolve into the delivery organisation for the geological disposal facility.

340 http://www.hse.gov.uk/nuclear/safeguards/index.htm
341 http://www.food.gov.uk/
342 http://www.dft.gov.uk/
343 http://www.nda.gov.uk/

The NDA has recently published a position statement entitled "Management of Wastes from New Nuclear Power Stations Position Statement"[344] which sets out a position statement on the NDA's work on the geological disposal of higher activity waste from new nuclear power stations.

10. The **Health Protection Agency** (HPA) is an independent organisation which was set up by the Government to protect the public from threats to their health from infectious diseases, environmental hazards and radiation. It does this by providing advice and information to the general public, to health professionals such as doctors and nurses, and to national and local government[345].

HPA has recently published a report entitled 'An Introduction to the Estimation of Risks Arising from Exposure to Low Doses of Ionising Radiation'[346] which aims to provide an introduction to the risks from exposure to low doses of radiation and explain the derivation of the radiation risk factors used in radiation protection.

HPA incorporates the former National Radiological Protection Board.

11. The **Committee on Medical Aspects of Radiation in the Environment** (COMARE) is a scientific advisory committee providing independent advice on all aspects of health risk to humans (both adults and children) exposed to natural and man-made radiation. The Committee has produced 13 major reports since its establishment in November 1985 covering a range of subjects from the incidence of childhood cancers through to the health effects and risks associated with UV sunbeds.

The Committee was established in response to the final recommendation of the report of the Independent Advisory Group chaired by Sir Douglas Black in 1984, which had been commissioned to investigate reports of a high incidence of leukaemia occurring in young people living in Seascale, close to Sellafield. A number of the COMARE reports have followed on from this work, with requests to investigate the incidence of childhood cancers at specific locations. These requests have often been prompted by concerns from the general public.

Members of the committee are chosen for their independent medical and scientific expertise and recruited from Universities, and Research and Medical Institutes. Members have never been drawn from the nuclear or electrical power supply industries. The Committee provides independent advice to all

[344] Management of Wastes from New Nuclear Power Stations Position Statement, 24 February 2009 http://www.nda.gov.uk/documents/upload/RWMDPP01-Management-of-wastes-from-new-nuclear-power-stations-position-statement-February-2009-v1.pdf

[345] http://www.hpa.org.uk/

[346] HPA-RPD-055 – An Introduction to the Estimation of Risks Arising from Exposure to Low Doses of Ionising Radiation, Authors: S Mobbs, S Watson, J Harrison, C Muirhead and S Bouffler, Publication date: June 2009 ISBN: ISBN 978-0-85951-643-3 http://www.hpa.org.uk/webw/HPAweb&HPAwebStandard/HPAweb_C/1245052106074

Government Departments and Devolved Authorities, and is responsible for assessing and advising them on the health effects of both ionising and non-ionising radiation. It is also asked to assess the adequacy of the available data and recommend the need for further research as required[347].

[347] http://www.comare.org.uk/

Annex C: Consultation and Decision Timetable

Step	Regulatory Justification Process	Indicative Timetable
1	Department published public consultation on nuclear power, and technical consultation on Regulatory Justification.	May 2007
2	Department published response to technical consultation on Regulatory Justification.	January 2008
3	Department announced call for applications and published guidance on Regulatory Justification.	March 2008
4	Department received consolidated application from the Nuclear Industry Association (NIA).	November 2008
5	Public consultation on the NIA's application.	December 2008 – March 2009
6	Department considered comments received, sought further information as necessary, and prepared Proposed Decision documents. Each Proposed Decision document sets out the Justifying Authority's assessment of the benefits and detriments of the class or type of practice.	April – November 2009
7	Determinations by the Secretary of State on class or type of practice published on Department's website.	9 November 2009
8	Public consultation on the Secretary of State's Proposed Decisions as Justifying Authority on the Regulatory Justification of the New Nuclear Power Station Designs currently known as the AP1000 and the EPR published on Department's website.	9 November 2009 – 22 February 2010
9	Public engagement event	19 January 2010
10	Decision published / Statutory Instrument laid	October 2010

Annex D: Regulation 16 Request to the Applicant for Further Information, and the Applicant's response

Office for Nuclear Development
Department of Energy & Climate Change
3 Whitehall Place
London SW1A 2HD
www.decc.gov.uk

To:
Nuclear Industry Association
Carlton House
22a St James's Square
London
SW1Y 4JH

NOTICE UNDER REGULATION 16 OF THE JUSTIFICATION OF PRACTICES INVOLVING IONISING RADIATION REGULATIONS 2004.

On 4 June 2008, the Nuclear Industry Association ("the applicant") submitted an application to the Secretary of State for BERR for the Justification of certain types of New Nuclear Power Stations under the Justification of Practices Involving Ionising Radiation Regulations 2004 (the "Justification Regulations").

On 27 November 2008, the applicant submitted a revised application to the Secretary of State for DECC, on which the Secretary of State published a consultation on 17 December 2008.

The Secretary of State for DECC, in exercise of his powers as the Justifying Authority under Regulation 16 of the Justification Regulations, hereby requires the Nuclear Industry Association to submit, within 28 days of today's date, the information requested in Annex A to this notice.

The information should be sent to the Justification Assessment Centre at justification@decc.gsi.gov.uk

Failure to comply with this notice, or provision of false or misleading information may amount to an offence as specified in Regulation 24 of the Justification Regulations, punishable by fines or imprisonment.

The recipient shall, within 14 days of the receipt of this notice, inform the Justifying Authority of any grounds upon which they believe the Notice ought to be varied or withdrawn.

Owen Jenkins
For and on behalf of the
Justifying Authority.

20 May 2009

Annex A

a. The Health Protection Agency's draft advice to Government on the application of the International Commission on Radiological Protection states :

"*Previously, NRPB (National Radiological Protection Board) recommended a maximum dose constraint for proposed controlled sources of 0.3 mSv y-1 noting that dose constraints lower than this could be set where such doses are readily achievable. HPA continues to recommend this approach but re-emphasises that the 0.3 mSv y-1 value is a maximum and that regulators should set lower, more challenging dose constraints where appropriate. At the design stage of new plant it is more straightforward to take measures to reduce exposures of the public than it is when measures have to be introduced to existing plant. Therefore, it is recommended that for new nuclear power stations and new facilities for the disposal of radioactive waste, regulators consider applying a more challenging dose constraint, taking into account the levels of protection that can be achieved internationally. HPA specifically advises the UK Government to select a value for the constraint for members of the public for new nuclear power stations and waste disposal facilities that is less than 0.15 mSv per year. Such a constraint would apply only to new plant as a design criterion and would not apply to existing facilities which should operate within current arrangements*."

Any Justification decision will take account of the dose constraints which apply at the time of the decision. The process of reaching a Justification decision will be separate from the process of the Government considering its response to HPA's advice. However, the applicant is asked to confirm that the designs within the proposed practice would be capable of meeting a constraint for members of the public for new nuclear power stations and waste disposal facilities that is less than 0.15 mSv per year, if such a constraint was to apply at some point in the future, and to explain why it considers this to be the case.

b. The applicant is asked to provide references for Annex 3 on pages 14 – 19 of Volume 2 of its application.

NIA response to Notice Under Regulation 16 of the Justification of Practices Involving Ionising Radiation Regulations 2004: 20 May 2009

a. The Health Protection Agency's draft advice to Government on the application of the International Commission on Radiological Protection states:

"Previously, NRPB (National Radiological Protection Board) recommended a maximum dose constraint for proposed controlled sources of 0.3 mSv y^{-1} noting that dose constraints lower than this could be set where such doses are readily achievable. HPA continues to recommend this approach but re-emphasises that the 0.3 mSv y^{-1} value is a maximum and that regulators should set lower, more challenging dose constraints where appropriate. At the design stage of new plant it is more straightforward to take measures to reduce exposures of the public than it is when measures have to be introduced to existing plant. Therefore, it is recommended that for new nuclear power stations and new facilities for the disposal of radioactive waste, regulators consider applying a more challenging dose constraint, taking into account the levels of protection that can be achieved internationally. The HPA specifically advises the UK Government to select a value for the constraint for members of the public for new nuclear power stations and waste disposal facilities that is less than 0.15 mSv per year. Such a constraint would apply only to new plant as a design criterion and would not apply to existing facilities which should operate within current arrangements."

Any Justification decision will take account of the dose constraints which apply at the time of the decision. The process of reaching a Justification decision will be separate from the process of the Government considering its response to the HPA's advice. However, the applicant is asked to confirm that the designs within the proposed practice would be capable of meeting a constraint for members of the public for new nuclear power stations and waste disposal facilities that is less than 0.15 mSv per year, if such a constraint was to apply at some point in the future, and to explain why it considers this to be the case.

NIA Response

1. We confirm that designs within the proposed practice (and also their associated waste management and disposal facilities) would be capable of meeting a dose constraint for members of the public set at 0.15mSv per year. This statement is supported by the information provided within the application and summarised in the paragraphs below.

2. In para 4.8 the application describes the current dose constraint relevant to a new UK nuclear facility (set at 0.3mSv per year) as a "useful parameter" in describing the maximum individual public dose (and health detriment) from new facilities developed in the UK as part of the new practice. As explained below, this number was not chosen because it is a precise prediction of the possible doses but as a useful yardstick which envelopes all possible doses.

3. Para 4.9 (referring back to 4.5) explains that, for the purposes of justification, it is only necessary to show that the radiological health detriments are small when compared to the benefits of the proposed practice, which the application argues are very significant. Since regulatory dose limits and constraints are set at levels where health risks are relatively small, they provide a convenient yardstick against which to test this. However, as para 4.9 goes on to explain, it would be potentially misleading to use these figures as representative of the levels of dose that would arise after the application of the optimisation principle and, for this reason, indicative figures for the effects of optimisation are also provided. The evidence on this is summarised in the Table referred to from para 4.98 of the application.

4. Post-optimisation doses resulting from normal reactor operation provided in this Table are:

- a figure of 0.015mSv/y as a "worst case" estimate from the Hinkley Point C Public Inquiry report; and
- a figure of "less than 0.01mSv/y" from the German Government's assessment for inland nuclear stations.

5. In the Addendum to Chapter 4 of the application (see response to Q5) we stated that these values were "indicative of the (post-optimisation) doses that could result from the proposed new class of practice". Both figures are at least 10 times lower than the 0.15mSv/y figure.

6. The same Table provides similarly low post-optimisation dose estimates for members of the public for all of the waste management facilities associated with the proposed new practice.

7. Finally, we note that HPA's consultation on the possible future reduction of this UK dose constraint makes it clear that the reduction is not related to any change in their assessment of health risks associated with radiation but relates to their view on the ease with which new facilities should be able to meet this lower level of dose.

b. The applicant is asked to provide references for Annex 3 on pages 14 – 19 of Volume 2 of its application.

NIA Response

1. Annex 3 to the Application is entitled "Supplementary Notes on Radiation" and was included to provide a general, high level background description of our understanding on the relationship between radiation and health detriments. Given this, it is inevitably based on a significant body of scientific research carried out, peer reviewed and published over many years.

2. In the Summary at the beginning of the Annex it is explained that our understanding of the health effects of ionising radiation is based on this type of international scientific research which is overseen by independent bodies. However, the only specific work referred to in the Summary (as important examples of this work) is the body of research on workers and also on those exposed to radiation through the Hiroshima and Nagasaki bombs.

3. In the main body of the Annex reference is made to other research. This includes work on the “linear no threshold” relationship, research into non-cancer health effects, BNFL worker research, the work of COMARE, the emergence of the so-called Gardner hypothesis and some recent work in Germany commonly referred to as the KiKK Study.

4. In our response to the request for references we have therefore included not only the details of work relevant to specific examples cited in the Annex but also what we judge to be other “foundation” references within this large body of published and peer reviewed scientific work on the health effects of exposure to ionising radiation.

5. Finally we note that the justification application does not rely directly on these individual references. Instead, as stated in the Summary to Annex 3, it argues that the scientific understanding of the link between radiation dose and potential health detriment is sufficiently well understood that, at the levels of dose assessed for the new practice, any remaining uncertainty could not be so significant as to affect a justification decision.

Annex E: References to epidemiological studies provided by respondents to the consultation on the Proposed Decision

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Epidemiological Quality Inspection of the KiKK Studies Ordered by the Federal Office for Radiation Protection (**BfS**)
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Chris Busby Wings of Death: Nuclear Pollution and Human Health Green Audit, Aberystwyth 1995 ISBN: 1-897761-03-1
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Annex F: Advice from Health Protection Agency (HPA) on main points made in studies cited by respondents

Non-targeted effects of radiation exposure

1. There is growing understanding of the role of stem cells in the process of carcinogenesis and in the cellular interactions that maintain these cells in tissues. ICRP is currently reviewing data in this area, considering tissue radiosensitivity in terms of cancer induction, and the location of stem cells as targets for short range emissions.

2. The location of stem cells is currently taken into account in calculating doses from internal emitters in the respiratory and alimentary tracts and in the skeleton (ICRP, 2007). The extent to which radiation damage to other cells may be important remains to be determined. There are suggestions that such non-targeted effects may add to the radiation response, or conversely, may be protective. The United Nations Scientific Committee on Atomic Radiation (UNSCEAR 2008) has reviewed data on non-targeted effects of radiation and concluded that knowledge and understanding of these processes are insufficiently developed to inform judgments on dose- response at low doses. This conclusion was also reached by ICRP (2007) and endorsed by HPA (2009).

3. As noted by ICRP, human epidemiological studies remain the primary source of quantitative risk data and all contributing processes should be accounted for adequately. However, uncertainties remain on the mechanisms operating at low doses and the associated risks.

NOTE project (Non-targeted effects of ionising radiation)

4. HPA scientists are participating in collaborative European projects on low dose radiation effects, including NOTE which has provided valuable insights into the complexity of non-targeted effects (Goodhead 2010).

5. The work of this multipartner research project was the subject of a recent special issue of Mutation Research (Salomaa et al. 2010). The conclusions, as noted above, are that further work is required before the implications of these phenomena can be assessed, particularly whether there should be any requirement to take them into account in assessing risks to health. The uncertainty arises only at low doses for which there is no direct epidemiological evidence and any effects are as likely to be protective as to

increase risk (Goodhead 2010, Averbeck 2010). The risks at low doses will, however, remain low.

Internalisation of radioactive particles

6. ICRP (2007) discusses the issue of dose averaging within tissues at low doses, particularly in the case of radionuclides with short range emissions for which energy deposition may be highly heterogeneous so that only a proportion of cells within a tissue are hit. However, considering the stochastic nature of radiation induced cancer and hereditary effects, it is not clear that this heterogeneity is of significance in circumstances in which both energy deposition and target cells are randomly distributed within a tissue. The UK Committee Examining Radiation Risks of Internal emitters (CERRIE) commissioned a review of data on the carcinogenicity of radioactive particles relative to more uniform irradiation. The available evidence from animal and in vitro studies indicates that the use of average dose to tissues will provide a reasonable estimate of risk from radioactive particles, within a factor of three (Charles et al. 2003, CERRIE 2004). This conclusion is supported by human data for plutonium-239 induced lung cancer and Thorotrast (thorium oxide particles) induced liver cancer and leukaemia.

7. Follow-up studies of the A-bomb survivors provide the best single source of information on radiation-induced cancer and other health effects. These risk factors apply to short, homogeneous, high external doses of gamma radiation at a high dose rate. An important recent publication is the third analysis of cancer in UK radiation workers, exposed to low doses of radiation over many years (Muirhead et al. 2009). The results show a clear dose-response relationship, consistent with the extrapolation of A bomb risk factors to low doses. There are only a few epidemiological studies on internal emitters in which there are individual estimates of exposure that can be used to provide reliable estimates of risks. The best direct evidence of risks from internal emitters comes from studies of lung cancer following exposures to radon in mines and homes, bone cancer in radium exposed patients and workers, and liver cancer and leukaemia in patients given injections of Thorotrast (Harrison and Muirhead 2003, see below). The risk estimates from these studies are consistent with those from the A-bomb survivor study when account is taken of the greater effectiveness of alpha particles in causing cancer.

Secondary Photoelectron Effect (SPE)

8. Busby and colleagues have suggested mechanisms whereby doses from radionuclides deposited in living tissue may be more harmful than assumed in current assessments. First, Busby (Busby 1995; Busby 1996; Busby and Scott Cato, 2000) proposed the second event theory in which radionuclides with sequential decays would cause targeted damage to cells. Examples are strontium-90 decaying with its daughter, yttrium-90, and sequential emissions from radioactive particles. Edwards and Cox (2000) re-examined the proposals and concluded that a small effect was plausible (less than a factor of 2) but not the large effect that has been suggested. Animal and human data

support this conclusion (WHO 2001, Krestinina et al 2005, Sokolnikov et al 2008).

9. More recently, Busby (Busby 2005, Busby and Schnug 2007, Tickell 2008) suggested that the toxicity of uranium may have been substantially underestimated because, as a high Z element, it may convert natural background gamma rays into short range photoelectrons. Pattison et al (2009) have examined claims that enhancement by uranium particles could be as large as a factor of 500 – 1000, and concluded that the increase around microparticles could be up to a factor of three. Eakins et al (accepted by Rad. Prot. Dos.) obtained similar results and concluded that the additional energy deposition will be small compared with the energy deposited by alpha particles and of negligible biological significance.

10. Similar considerations apply to the suggestion that soluble forms of uranium might concentrate within cells, bind to DNA, and enhance the effect of natural background photon radiation. The extent of direct association with DNA will be important only for consideration of energy deposition from very short range emissions, such as Auger electrons. Increased biological effectiveness could result from photoelectric events that take place in close proximity to DNA. However, calculations by Humm and Charlton (1988) showed that the effect will be small or negligible for bromine (Z = 35) and even smaller for iodine (Z = 53). The effect will be of less biological significance for uranium (Z = 92) because the higher Z element produces relatively long range secondary radiation.

11. There is no evidence from animal experiments of unusually high toxicity of uranium (WHO, 2001). Ellender *et al*. (2001) compared the effect of plutonium-239, americium-241 and uranium-233 in mice at cumulative average skeletal doses of 0.25 – 0.3 Gy, 0.5 – 1 Gy and 1 – 2 Gy. For both bone cancer and myeloid leukaemia induction, ^{233}U was considerably less effective than ^{239}Pu and ^{241}Am. Concerns over the toxicity of depleted uranium have led to a number of reviews; the Royal Society (2001, 2002), for example, discounted any association between DU and reported medical problems.

European Committee on Radiation Risk (ECRR)

12. The European Committee on Radiation Risk (ECRR) has no formal links to official bodies. ECRR (Green Audit, 2003) disagrees with the ICRP risk factors and considers that, in particular, risks from inhaled and ingested radionuclides are grossly underestimated. Most of these issues date from more than 5 years ago and were explicitly addressed by CERRIE (2004) and, more recently, by ICRP (2007). In both cases, it was concluded that there was not enough evidence to support these differing views. HPA (then NRPB) has also reviewed the ECRR (Green Audit, 2003) report and disagrees with the ECRR views. HPA response is available on the website and the summary statement is reproduced here:

"*A critical examination of the ECRR report has been undertaken by NRPB staff. The cited epidemiological studies have been investigated in detail by NRPB staff and previously by other experts; their conclusions are generally different from those reached by ECRR. The methodology proposed by ECRR for estimating radiation risks from internal emitters is arbitrary and does not have a sound scientific basis. Furthermore, there are many misrepresentations of ICRP, misunderstandings, inconsistencies and unsubstantiated claims in the ECRR report. The ECRR report therefore provides no scientific basis for changing protection standards*."

13. The French Institut de Radioprotection et de Sureté Nucléaire (IRSN) also reviewed the ECRR (Green Audit, 2003) report. The resulting IRSN (2005) report covers much of the same ground as CERRIE (2004), addressing issues recognised by ICRP (2007) and reviewed by Harrison and Day (2008). IRSN (2005) concluded that the ICRP methodology is the best approach currently available for the control of radiation exposures. Like HPA, IRSN (2005) considered that ECRR (2003) proposals for modification of the ICRP methodology for calculation of effective dose are poorly founded and unhelpful. Also in agreement with IRSN, HPA is fully supportive of the need for more research to understand radiation risks at low doses, including risks from internal emitters. Interesting findings are emerging on non-targeted effects of radiation, including genomic instability and bystander effects (ICRP 2007, Harrison and Day 2008, Goodhead, 2010). Epidemiological studies identifying non-cancer effects of radiation exposure, particularly cardiovascular disease (UNSCEAR 2008, ICRP 2007), will need to be followed by mechanistic studies in order to understand the possible implications for risks at low doses. HPA and IRSN will continue to be actively involved in research on radiation risks as well as the development of international standards.

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Annex G: List of acronyms and abbreviations

ALARA	As Low As Reasonably Achievable
AoS	Appraisal of Sustainability
BAT	Best Available Techniques
CCC	Committee on Climate Change
CCS	Carbon capture and storage
CERRIE	Committee Examining Radiation Risks of Internal Emitters
CO_2	Carbon dioxide
COMARE	Committee on Medical Aspects of Radiation in the Environment
CoRWM	Committee on Radioactive Waste Management
DECC	Department of Energy and Climate Change
EIA Directive	Environmental Impact Assessment Directive
EN-1	Draft Overarching National Policy Statement for Energy
EN-6	Revised Draft National Policy Statement for Nuclear Power Generation
GDA	Generic Design Assessment
GDF	Geological Disposal Facility
GW(e)	Gigawatts (electrical)
HLW	High Level Waste
HPA	Health Protection Agency
HRA	Habitats Regulation Assessment
HSE	Health and Safety Executive
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
ILW	Intermediate Level Waste
IPC	Infrastructure Planning Commission
IROPI	Imperative Reasons of Overriding Public Interest
JCC	Justification Co-ordination Committee

JLG	Justification Liaison Group
KiKK	Kinderkrebs in der Umgebung von Kernkraftwerken - study of childhood cancer in the vicinity of German nuclear power plants
LLW	Low Level Waste
MWe	megawatt electrical
mSv	millisievert
NDA	Nuclear Decommissioning Authority
NEA	Nuclear Energy Agency
NIA	Nuclear Industry Association
NII	Nuclear Installations Inspectorate
NPS	National Policy Statement
OECD	Organisation for Economic Co-operation and Development
OSPAR Convention	Convention for the Protection of the Marine Environment of the North-East Atlantic 1992
PWR	Pressurised Water Reactor
SSA	Strategic Siting Assessment
UKSO	United Kingdom Safeguards Office
UNSCEAR	United Nations Committee on the Effects of Atomic Radiation
VLLW	Very Low Level Waste
µSv	microsievert

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