



**Determination of the requirement for Off-site Emergency Planning and
Prior Information Areas for the Hunterston A Nuclear Licensed Site
Radiation (Emergency Preparedness and Public Information)
Regulations 2001**

Project Assessment Report ONR-COP-PAR-15-003
Revision 0
2 March 2016

© Office for Nuclear Regulation, 2016

If you wish to reuse this information visit www.onr.org.uk/copyright for details.

Published 03/16

For published documents, the electronic copy on the ONR website remains the most current publicly available version and copying or printing renders this document uncontrolled.

EXECUTIVE SUMMARY

Determination of the requirement for Off-site Emergency Planning and Prior Information Areas for the Hunterston A Nuclear Licensed Site: Radiation (Emergency Preparedness and Public Information) Regulations 2001

The Office for Nuclear Regulation (ONR) is responsible for regulating GB nuclear sites in order to protect the health and safety of employees and the public against risks of harm arising from ionising radiations. ONR's responsibilities include a legal duty, where it is concluded that there is a potential for a reasonably foreseeable radiation emergency (as defined in the Radiation (Emergency Preparedness and Public Information) Regulations 2001 (REPPIR)), to determine an off-site emergency planning areaⁱ (i.e. the area within which, in ONR's opinion, any member of the public is likely to be affected by such an emergency). In these cases, there is also a legal duty, under the same Regulations, for ONR to determine an areaⁱⁱ within which prior information is to be distributed to the public. A radiation emergency is defined in REPPIR as a reasonably foreseeable event where a person off-site is likely to receive a radiation dose in excess of the thresholds in REPPIR (typically an effective dose in excess of 5 mSv) in the 12 months following the emergency. It therefore constitutes an important component of the UK's overall emergency response framework.

This ONR Project Assessment Report (PAR) describes and explains the basis for its re-determination, in accordance with REPPIR, of the off-site emergency planning area and the area within which prior information is to be distributed to persons around the Hunterston A nuclear licensed site.

In relation to this area the responsible local authority is North Ayrshire Council. North Ayrshire Council is required to prepare an off-site emergency plan for the defined area with the purpose of minimising, so far as is reasonably practicable, radiation exposures to those likely to be affected by such an emergency. Such a plan reflects the potential need to implement appropriate protection measures such as sheltering and evacuation in order to reduce radiation doses to members of the public within all or parts of this area.

REPPIR requires operators who carry out work involving quantities of radioactive materials at or beyond that which it specifies, in this case Magnox Ltd., to undertake a Hazard Identification and Risk Evaluation (HIRE) in relation to their work with ionising radiations. The HIRE must identify all hazards on the site with the potential to cause a radiation accident and evaluate the nature and magnitude of the risks to employees and other persons (e.g. those who live or work nearby) arising from those hazards. REPPIR also requires operators to assess their HIRE and to submit a Report of Assessment (RoA) to ONR either prior to the start of the work with ionising radiation, following any relevant material change in this work, or within three years of the last assessment, whichever is the shorter.

Previous determinations by ONR for the Hunterston A site have concluded that a radiation emergency is reasonably foreseeable and have therefore specified an off-site local authority emergency planning area and prior information area represented by a single circular area around the site with a radius of 2.4 km. The size of this area was appropriate when the reactors were operational.

This re-determination has been undertaken in response to REPPIR submissions to ONR by Magnox Ltd. which conclude that there is no longer a reasonably foreseeable radiation emergency that could occur at the site. This is due to a significant reduction in the radiological

ⁱ ONR has historically used the term detailed emergency planning zone (DEPZ) to refer to the area it defined under REPPIR regulation 9 as requiring an off-site emergency plan. (The term is still used this way in some ONR guidance.) As the term is not used within REPPIR itself (although referred to in the related guidance), and to ensure legal clarity and avoid misunderstanding amongst stakeholders, this report refers to the 'REPPIR off-site emergency planning area' under regulation 9 rather than to 'detailed emergency planning zone' or 'DEPZ'.

ⁱⁱ This is sometimes, and has historically been, referred to as the Public Information Zone (PIZ) under regulation 16, but for the same reasons as given above is not used in this report. This report refers to the 'REPPIR prior information area'

hazard at the site when it ceased operation in 1990 and the subsequent removal of essentially all fuel elements from the site by 1995. In addition to this reduction in the radiological hazard, Magnox Ltd. have improved their technical assessment of possible remaining faults on site which could result in an off-site release of radioactive materials. This has included the removal of over estimates associated with the quantity of radioactivity material available for release and consideration of containment and fire mitigation measures that have also been put in place at the site. These have resulted in further decreases to the level of radiological hazard and risk presented by the site.

The Magnox Ltd. RoA/HIRE for Hunterston A concludes:

'...there are no reasonably foreseeable faults associated with the facilities in their current state, with work which is currently being carried out, or for any future planned work on the Hunterston A Site for which safety cases have been produced, that could lead to a public off-site dose of 3 mSv or greater.'

ONR has made an assessment of the operator's technical submissions in accordance with its regulatory processes, guidance associated with REPPiR itself, and the relevant ONR technical assessment guide. Following clarification and additional evaluation, ONR assessment agrees with Magnox Ltd. that there are no reasonably foreseeable faults that could lead to a radiation emergency at Hunterston A.

That being so, some aspects of REPPiR, principally REPPiR regulations 7(1), 9(1) and 16(1), relating to the requirements for an operator's emergency plan and the identification of off-site planning and prior information areas, no longer apply.

The recommendations of this report are that ONR write to:

- North Ayrshire Council and Magnox Ltd. to notify them that a REPPiR off-site emergency planning area is no longer required for the Hunterston A licensed site.
- North Ayrshire Council to notify them that there is no longer a requirement under REPPiR for the local authority to prepare an off-site emergency plan in respect of the Hunterston A licensed site, although the requirement remains in respect of the Hunterston B licensed site.
- Magnox Ltd. to notify them that the requirement to ensure the appropriate provision of prior information to the public is no longer required under REPPiR. This should be copied to North Ayrshire Council.
- Magnox Ltd. to notify them that there is no longer a requirement under REPPiR for an operator's emergency plan.
- EDF Energy, who operate Hunterston B, to notify them that there is no longer a requirement under REPPiR for the local authority to prepare an off-site emergency plan in respect of the Hunterston A licensed site, although the requirement remains for the Hunterston B licensed site.
- The Scottish Government, Nuclear Decommissioning Authority, Food Standards Agency, the Maritime and Coastguard Agency and the Scottish Environment Protection Agency of the outcome of this assessment and the removal of the REPPiR off-site planning and prior information areas for the Hunterston A licensed site, although the requirement remains for the Hunterston B licensed site.

Whilst this review removes the requirement for detailed emergency planning under REPPiR, in relation to the Hunterston A site, proportionate emergency arrangements for the protection of the public remain in the form of;

- i. local authorities have duties to make adequate emergency arrangements under other legislation such as the Civil Contingencies Act 2004;
- ii. operators have general duties under the Health and Safety at Work Act 1974 to ensure, so far as is reasonably practicable, the safety and welfare of employees and other persons; and

- iii. operators who hold a nuclear site licence are required to make and implement adequate arrangements for dealing with any accident or emergency (under site licence condition 11 attached to the nuclear site licence); and to prepare necessary contingency plans as required under the Ionising Radiations Regulations 1999.

These other duties are not directly affected by this determination, and, where ONR is the enforcing authority, ONR will continue to seek assurance that the operator remains compliant with these legal obligations, including any such provision and co-ordination of adequate off-site emergency arrangements as these other duties may require.

LIST OF ABBREVIATIONS

DEPZ	Detailed Emergency Planning Zone (Ref: REPPIR regulation 9(1))
EURATOM	European Atomic Energy Community
FED	Fuel Element Debris
FEPA	Food and Environment Protection Act 1985
FSA	Food Standards Agency
GB	Great Britain
HIRE	Hazard Identification and Risk Evaluation
IAEA	The International Atomic Energy Agency
ILW	Intermediate Level Waste
LC	Licence Condition
NEAF	Nuclear Emergency Arrangements Forum
ONR	Office for Nuclear Regulation
PAR	Project Assessment Report
REPPIR	Radiation (Emergency Preparedness and Public Information) Regulations 2001
RoA	Report of Assessment
SAPs	(ONR) Safety Assessment Principles
SAWB	Solid Active Waste Building
SILWE	Solid Intermediate Level Waste Encapsulation Plant
TAG	(ONR) Technical Assessment Guide

TABLE OF CONTENTS

1	REGULATORY CONTEXT	1
2	BACKGROUND	1
3	SCOPE	2
4	METHODOLOGY.....	3
5	ASSESSMENT OF TECHNICAL SUBMISSIONS.....	6
6	OFF-SITE EMERGENCY ARRANGEMENTS.....	10
7	CONCLUSIONS	11
8	RECOMMENDATIONS.....	12
9	REFERENCES	13

TABLES

TABLE 1 - MAGNOX LTD. ASSESSMENT OF HUNTERSTON A FAULT SCENARIOS (REFERENCE 3)	8
---	---

1 REGULATORY CONTEXT

The Energy Act (reference 1) requires the Office for Nuclear Regulation (ONR) to do whatever it considers appropriate for the purposes of protecting persons against risks of harm arising from ionising radiations from Great Britain (GB) nuclear sites, including:

- a) securing the health, safety and welfare of persons at work on GB nuclear sites; and
- b) protecting persons, other than persons at work on GB nuclear sites, against risks to health or safety arising out of or in connection with the activities of persons at work on GB nuclear sites.

ONR does this by providing regulation of the nuclear industry, holding it to account on behalf of the public, and, in particular, ensuring appropriate arrangements are in place to deal with a nuclear emergency.

ONR's responsibilities include a legal duty, where it is concluded that there is a potential for a reasonably foreseeable radiation emergency (as defined in the Radiation (Emergency Preparedness and Public Information) Regulations 2001 (REPPiR) (reference 2)), to determine an off-site emergency planning area. This is the area within which, in ONR's opinion, any member of the public is likely to be affected by such an emergencyⁱ. In these cases, there is also a legal duty under the same regulations for ONR to determine an area within which prior information is to be distributed to the publicⁱⁱ. A radiation emergency is defined in REPPiR as a reasonably foreseeable event where a person off the site is likely to receive a radiation dose in excess of the thresholds in REPPiR (typically an effective dose in excess of 5 mSv) in the 12 months following. It therefore constitutes an important component of the UK's overall emergency response framework.

This report sets out the outcome and justification for the determination of the revised off-site emergency planning and prior information areas for the Hunterston A nuclear licensed site, in accordance with the requirements of REPPiR (reference 2) regulations 9(1) and 16(1) respectively.

2 BACKGROUND

The UK nuclear regulatory system requires that every licensee must demonstrate to the regulator that it fully understands the hazards and risks associated with its operations and controls them appropriately. The regulator assesses the safety and security of the design and operation of nuclear plant to ensure that licensees' provisions are robust and that any risks are reduced so far as is reasonably practicable.

Magnox Ltd. is the company responsible for the decommissioning of the Hunterston A Nuclear Licensed site on behalf of the Nuclear Decommissioning Authority (NDA), a non-departmental public body in the UK which is responsible for managing the effective and efficient clean-up of the UK nuclear legacy.

The Hunterston A reactors ceased operating in 1990. Since that time, essentially all nuclear fuel elements have been removed from the site and so the level of radiological hazard and risk presented by the site has substantially diminished. REPPiR came into force in 2001, and the REPPiR off-site emergency planning area around the Magnox Ltd. Hunterston A site and the operating reactors at the EDF Energy Hunterston B site was determined at the time to be a circle of radius 2.4 km centred from the mid-point of the Hunterston B Power Station.

ⁱ ONR has historically used the term detailed emergency planning zone (DEPZ) to refer to the area it defined under REPPiR regulation 9 as requiring an off-site emergency plan. (The term is still used this way in some ONR guidance.) As the term is not used within REPPiR itself (although referred to in the related guidance), and to ensure legal clarity and avoid misunderstanding amongst stakeholders, this report refers to the 'REPPiR off-site emergency planning area' under regulation 9 rather than to 'detailed emergency planning zone' or 'DEPZ'

ⁱⁱ This is sometimes, and has historically been, referred to as the Public Information Zone (PIZ) under regulation 16, but for the same reason as given above is not used in this report. This report refers to the 'REPPiR prior information area'.

In relation to emergency planning, REPPiR requires the operator, in this case Magnox Ltd., to undertake a Hazard Identification and Risk Evaluation (HIRE) of all hazards arising from their work, with the potential to cause a radiation accident. The operator's assessment must be sufficient to demonstrate that all such hazards have been identified and the nature and magnitude of the risks to employees and other persons arising from those hazards have been evaluated. REPPiR also requires that operators submit a report of the assessment (RoA) of this HIRE to ONR prior to commencement of any work involving ionising radiation, following any material change, and at least every 3 years. REPPiR also makes provision for ONR to request additional information. In practice, it is usual for the HIRE itself to be requested to inform ONR's determination.

Where it is reasonably foreseeable that a radiation emergency (as defined in REPPiR) could arise, REPPiR requires ONR to determine areas within which, in its opinion, persons (including any member of the public) are likely to be affected by such emergencies. This then defines the area which local authorities are required to prepare an adequate off-site emergency plan (regulation 9(1)) and which operators are required to provide specified prior information (regulation 16(1)) to members of the public without them having to request it and make that information publicly available.

The off-site emergency plan, in cases where one is required, should include urgent countermeasures and other protection measures that are relevant, reasonably practicable, and proportionate to the radiological risk in the event of a reasonably foreseeable radiation emergency

In 2013 Magnox Ltd. submitted an updated RoA (reference 3) under regulation 6 of REPPiR in line with requirements under regulation 5 for operators to undertake a review at least every 3 years. This updated RoA takes into account the relevant material changes due to the cessation of electricity generation, removal of essentially all fuel elements from site (parts of two elements remained on the site and the solid ILW stored on the site potentially contains fragments from fuel elements damaged during past fuel handling operations), and improvements in the technical assessment of the remaining hazards on site which could result in off-site radiation doses. In this RoA Magnox Ltd makes the case that *"there are no reasonably foreseeable fault sequences associated with the facilities in their current state, with work currently being carried out, or for any future planned work on the Hunterston A Site for which safety cases have been produced, that could lead to a public off-site does of 3 mSv or greater."*

In addition to the information contained in the Magnox Ltd. RoA, ONR has also sought and assessed further information on the new Solid Intermediate Level Waste Encapsulation (SILWE) facility that commenced construction subsequent to the submission of the RoA.

This report sets out the outcome and justification for the determination of the revised off-site emergency planning and prior information areas for the Hunterston A nuclear licensed site, in accordance with the requirements of REPPiR regulations 9(1) and 16(1) respectively.

3 SCOPE

This report sets out the basis for, and conclusions of, the ONR assessment of the REPPiR off-site emergency planning and prior information areas relating to the Hunterston A nuclear licensed site. It has been undertaken in accordance with the guidance on REPPiR (reference 4) and the supporting relevant ONR supporting Technical Assessment Guide (TAG) (reference 5) which incorporates ONR's principles for determination of REPPiR areas, and related guidance.

ONR's principles recognise the learning that has emerged from global events such as occurred at Fukushima and the subsequent need to review the scope of off-site emergency planning. They also reflect ONR's commitment to high standards of nuclear safety at nuclear installations, and its continual efforts to seek improvements to standards and to the consistency and transparency of its decision making.

Provisions for the implementation of food restrictions are separate to the process of determining the REPPiR off-site emergency planning area on the basis that they are provided separately (Food and Environment Protection Act 1985 (FEPA)) and are under the legal jurisdiction of the Food Standards Agency (FSA). These provisions are therefore addressed by separate legislation other than REPPiR, may be exercised in a broader range of circumstances (i.e. not restricted to a radiological event), and are subject to existing planned implementation arrangements made by the FSA. They are therefore outside the scope of this report.

4 METHODOLOGY

4.1 ONR'S PROCESS FOR DETERMINING A REPPiR OFF-SITE EMERGENCY PLANNING AREA

This process requires that ONR:

- A. Conduct an initial independent technical assessment of the information provided by the licensee in their HIRE and RoA, seeking and using additional information as appropriate; and
- B. Where the potential for a REPPiR defined reasonably foreseeable radiation emergency exists, establish and consider any other relevant practical and strategic factors relating to the planning and practical implementation of protection measures to restrict public exposure so far as reasonably practicable (e.g. urgent countermeasures) for those persons who are likely to be affected by a radiation emergency.

Step A requires ONR to assess the operator's identification and characterisation of the likelihood, nature and magnitude of the radiation related risks that may result for a radiation accident. ONR also consider the operator's assessment of whether there is the potential for a radiation emergency to occur that is reasonably foreseeable. If this potential exists ONR will then consider the likely extent of any area within which the dose criteria contained within Schedule 1 of REPPiR may be met or exceeded. This indicates the minimum distance for further consideration in Step B, and is usually presented in the operator's RoA as a circle with a specified radius centred at the source of the potential accident.

Step B applies additional pragmatic, population (including vulnerable groups), geographic and practical factors to the ONR determination and requires dialogue with the relevant local authority. The nature of these factors is set out in detail in the relevant ONR TAG (reference 5). Whilst the determined REPPiR off-site emergency planning area, as a result of considering these additional factors, need not be circular, it cannot be smaller than that arising from the technical assessment under Step A.

ONR's principles relating to practical and strategic considerations (reference 5) emphasise that, in the undertaking of the determination, it is important to ensure that a sensible balance is achieved between the assessment of the technical report provided by the licensee and such additional practical and strategic considerations that, in ONR's opinion, are judged necessary in the interests of confidence in public safety. As a consequence, the extent of the REPPiR off-site emergency planning area represents a regulatory judgement of the significance of all of these factors, and is made on a case-by-case basis.

The factors that ONR's principles and associated guidance indicate should be considered are summarised as follows:

- local geographic, population and practical implementation factors;
- avoidance of bisection of local communities where sensible to do so;
- inclusion of immediately adjacent groups of vulnerable people;

- the need for the REPPIR off-site emergency planning area to provide for a credible emergency plan, for the purposes of public protection, in which the public will be confident;
- consideration of the implications of the extent of the REPPIR off-site emergency planning area in the context of an effective emergency response (e.g. dilution of resources (i.e. police, fire and ambulance) and potential dis-benefits associated with immediate/ urgent countermeasures);
- relevant international good practices; and
- other relevant site specific factors of which ONR are aware.

The starting point for the emergency planning areas is based on the most significant reasonably foreseeable event. Such an event could be caused by possible plant and equipment failures, breakdown of administrative arrangements, and potential unauthorised behaviour of employees or the public.

For events that are judged not to be reasonably foreseeable (e.g. extremely low frequency but potentially higher consequence events), the guidance associated with REPPIR recommends, as good practice, that local authorities should be capable of extending their emergency response beyond the REPPIR off-site emergency planning area should it be required. However, extended zones are not statutorily required under REPPIR, therefore such arrangements are not considered further in this determination.

Although the local authority off-site emergency plans include many protection measures to reduce radiation doses to members of the public, the most commonly referenced off site urgent countermeasures available in the early stages of a nuclear emergency are sheltering, evacuation and, in the case of operating nuclear power reactors, the administration of stable iodine tablets.

In determining a REPPIR off-site emergency planning area ONR acknowledges that the implementation of urgent countermeasures, for example rapid evacuation, can, in some circumstances, convey a risk of harm to individuals to whom they are applied. For example, see the report in the Lancet by Koichi Tanigawa et al. in relation to the urgent countermeasures taken following the Fukushima accident in Japan in March 2011 (reference 6). Within a REPPIR off-site emergency planning area, the local authority may expect some countermeasures to be applied immediately or urgently across at least a part of the area (normally that closest to the potential source of radiation). It is important that the area within which they are applied, in the event of an emergency, is targeted and proportionate in order to ensure that overall risks to those affected are reduced so far as is reasonably practicable.

4.2 BASIS OF ASSESSMENT

The REPPIR off-site emergency planning area must, as a minimum, include all of the area around the site within which a person (including members of the public) could receive an effective dose in excess of 5 mSv in the year following a reasonably foreseeable radiation emergency (or other dose criteria defined in REPPIR Schedule 1). When assessing the extent of exposure, REPPIR requires that operators assess the potential doses to members of the public from all exposure routes and, for this purpose, must disregard any health protection measures that may have been taken by the local authority, emergency services or the exposed persons themselves, during the first 24 hours immediately following the event.

The Hunterston A RoA (reference 3) provides a detailed description of the remaining radioactive substances on the site, (which exceed the levels specified in Schedule 2 of REPPIR). These include the following materials:

- Approximately 180 m³ of Sludges
- Approximately 12 m³ of Ion Exchange Resins
- Approximately 3.4 m³ of Desiccants

- Approximately 2140 m³ of Fuel Element Debris (FED) (including Magnox FED, graphite and steel)
- Approximately 100 m³ of Miscellaneous Contaminated Items
- Approximately 12 m³ of Miscellaneous Activated Components
- Approximately 0.3 m³ of Submersible Caesium Removal Units (SCRU)

In addition, the Hunterston A RoA (reference 3) indicates that radioactivity will also be present in certain structural materials, including:

- Approximately 3440 m³ of graphite moderator
- Approximately 8940 m³ of reactor internal materials (e.g. control rods, thermocouples, activated mild and stainless steel items; and
- Approximately 29200 m³ of bio shield, reactor and other plant

Magnox Ltd. notes that the activity associated with the structural material is substantially fixed within the structures and would be unlikely to contribute significantly to any release to the environment, even in the case of a severe accident.

As a consequence of the residual inventory, some (although not necessarily all) provisions of REPPiR will continue to apply until such a time as the total inventory of radioactive material held on the Hunterston A site falls below the levels specified in Schedule 2 and 3 of REPPiR.

4.3 STANDARDS AND CRITERIA

4.3.1 ACTS, REGULATIONS AND GUIDANCE

The relevant standards and criteria considered within this assessment are those contained within REPPiR (reference 2) and its associated guidance (reference 4). REPPiR is made under the Health and Safety at Work Act 1974 and implements the articles on intervention in cases of radiation emergencies contained in the European Council Directive 96/29/EURATOM - Basic Safety Standards for the Protection of the Health of Workers and Members of the Public against the Dangers from Ionising Radiation (reference 7).

4.3.2 SAFETY ASSESSMENT PRINCIPLES & LICENSE CONDITIONS

ONR's Safety Assessment Principles (SAPs) provide inspectors with a guiding framework for making consistent regulatory judgements on nuclear safety cases. Although the SAPs are not directly relevant to the assessment of REPPiR submissions, cognisance has been taken of SAP: AM.1 - Accident management and emergency preparedness (reference 8).

4.3.3 TECHNICAL ASSESSMENT GUIDES

The SAP principles are supported by a suite of internal Technical Assessment Guides (TAG), with the following TAG being relevant to this assessment:

- The technical assessment of REPPiR submissions and the determination of detailed emergency planning zones, ONR NS-TAST-GD-082 Revision 2, 2013 (reference 5). This TAG incorporates ONR's revised principles for determination of REPPiR off-site emergency planning areas.

4.3.4 NATIONAL AND INTERNATIONAL STANDARDS AND GUIDANCE

The following national guidance has also been considered and, where appropriate, has informed this assessment:

- A guide to the Radiation (Emergency Preparedness and Public Information) Regulations 2001 (reference 4).

ONR also notes the relevance of the following International Standards and Guidance:

- IAEA Safety Standard Series – Preparedness and Response for a Nuclear or Radiological Emergency GS-R-Part 7 (reference 9).
- IAEA Safety Standards – Arrangements for Preparedness for a Nuclear or Radiological Emergency GS-G-2.1 (reference 10).

5 ASSESSMENT OF TECHNICAL SUBMISSIONS

ONR has subjected Magnox Ltd.'s RoA (reference 3) and supporting documentation to expert and detailed technical assessment. A summary of Magnox Ltd.'s submissions and ONR's technical assessment of them are detailed in sections 5.1 and 5.2 respectively.

5.1 MAGNOX HIRE AND RoA

Hunterston A first operated in 1964 and ceased generation in 1990 when the second of the two reactors was permanently shut down. Reactor defueling and shipment of essentially all irradiated fuel elements from the site was completed in 1995.

Almost all the radioactivity which remains on the site is either radioactive waste arising from operations at the site or is contained in mostly structural material which will become radioactive waste as decommissioning of the site progresses.

In accordance with REPPiR regulation 5, Magnox Ltd. have undertaken a review of their HIRE and identified and assessed all hazards on site with the potential to cause a radiation accident.

As part of the HIRE, Magnox Ltd. reviewed the extant site safety case fault schedules to identify faults which exceeded the likelihood of occurrence of 10^{-5} per year or greater, and a public dose consequence of 5 mSv or greater for further assessment. In order to allow for cliff-edge effects, faults meeting one or more of the criteria were considered, rather than those that only met both. Magnox Ltd. also considered faults that were within two orders of magnitude of the frequency screening criteria.

Magnox Ltd has calculated the likely doses to a member of the public should any of the identified fault sequences occur. There are five faults, in three different site facilities, whose dose consequences are greater than 5% of 5 mSv. These sequences are described below. The consequences of the other reasonably foreseeable faults are less than these and are not assessed further.

5.1.1 FIRE IN THE SOLID ACTIVE WASTE BUILDING (SAWB)

There are five adjoining reinforced concrete bunkers in the lower level of the Solid Active Waste Building (SAWB) which were used to receive and store solid Intermediate Level Waste (ILW) arising during reactor operations. These bunkers have also been used for storage of waste during decommissioning of the station and are designed to provide shielding and containment for the long term storage of ILW. Bunkers 1, 2 and 3 were built in 1964 and bunkers 4 and 5 were added to the facility in 1980. Each bunker has a volume of 700 m³ and all walls, ceilings and floors are between 0.7 m and 1.6 m thick.

Bunker 1 contains Magnox Fuel Element Debris (FED) resulting from past processing of the fuel element casingsⁱⁱⁱ and contains almost all of the FED currently on site. Bunkers 2, 3 & 4 contain mainly graphite and metallic debris, which is not considered to be flammable, and a minimal amount of FED. Bunker 5 has been emptied but will be used during retrieval operations for sorting and boxing waste from bunkers 1-4.

If there was a fire within these bunkers, there is a possibility of an off-site release of radioactive material. The release of radioactivity would mainly be the result of the potential presence of fuel rod fragments within the bunkers rather than FED, which is less radioactive.

ⁱⁱⁱ Fuel Element Debris (FED) consists of the splitters or lugs removed from Magnox fuel elements before the spent fuel was sent to Sellafield for reprocessing.

The most significant fire is one that occurs in all of bunkers 1, 2 and 3 following a seismic event that also has the effect of reducing the containment afforded by the SAWB. Other faults associated with the SAWB include a fire in bunker 1 only and a third fault considers a fire in all of bunkers 1, 2 and 3 but without the damage to the building structure that would occur during a seismic event. All of these faults are identified as being beyond reasonably foreseeable.

Magnox Ltd. has considered other external faults including aircraft crashes, flooding and security events. The possibility of an aircraft crashing anywhere on the site is deemed to be credible but highly unlikely. The probability of this occurring and the impact being directly on the SAWB (which is the building containing highest radioactive inventory) is sufficiently low such that this fault is not considered to be reasonably foreseeable. In addition to this, in the event of an aircraft impact, the resulting fire would be bounded by a fire in all of bunkers 1, 2 and 3. The consequences of flooding which could lead to hydrogen deflagration coupled with a fire are also bounded by the same event. The Nuclear Site Security Plan considers that the likelihood of sabotage attack on the site is extremely low and that there are no areas at the Hunterston A site which contain equipment, systems or devices, or nuclear material, the sabotage of which could directly or indirectly lead to high radiological consequence. Therefore, if an attack did occur, off-site consequences are judged to be extremely low.

5.1.2 FIRE IN THE SOLID ILW ENCAPSULATION (SILWE) PLANT

It is the intention that solid ILW will be transported from the SAWB to the Solid ILW Encapsulation Plant (SILWE) in approved 3 m³ steel containers and the sealed containers will have connections which allow cement based grout to be pumped into them to encapsulate the waste inside. This facility had not been constructed at the time that the RoA was submitted, but has since begun initial stages of construction in 2015. Potential faults associated with operation of the SILWE plant had not been identified via Magnox Ltd. formal processes in order that they be considered during the review of the HIRE. However, hypothetical faults have been considered with some pessimism with the intention to bound potential faults. Magnox Ltd. states that it is not possible to claim for certain that no additional significant faults will be identified in the fault schedules included in any future safety cases.

The hypothetical bounding fault for the SILWE plant considers the release in the event that a fire engulfs an encapsulated ILW box. This fire is identified by Magnox Ltd. as the accident likely to lead to the most significant off-site radiation doses. No containment is claimed for the box, cell or the facility and it is assumed that the entire contents of the box are released.

5.1.3 DESSICANT FIRE

Desiccant is currently stored on ILW storage beds located in the reactor building. Desiccant is an inflammable compound which was used to remove tritiated water vapour from the reactor coolant. The strategy for the retrieval, processing and packaging of used desiccant has not been finalised and therefore faults related to this future desiccant work have not been specifically identified.

Within the information provided by Magnox Ltd. (reference 3), public doses were calculated for a bounding fault in which there is an airborne release of all of the radioactivity in all the desiccant on site as a result of a fire. Release from the desiccant would be as a result of the desiccant heating up and volatile radionuclides being driven off and not by the desiccant catching fire. No account is taken for building containment.

5.1.4 ASSESSED DOSES TO PERSONS OFF-SITE

Magnox Ltd. assessed the radiological consequences of these five faults using the Nuclear Emergency Arrangements Forum (NEAF) methodology (reference 11). Estimates of the likely radiation doses to a member of the public in the event that any of the relevant fault sequences identified in their HIRE occur are summarised in Table 1 below.

Table 1 - Magnox Ltd. assessment of Hunterston A fault scenarios (reference 3)

	Description of event	Public dose in mSv* at the site boundary (based on NEAF Methodology)**	Estimated fault scenario frequency
1	Fire in all of SAWB bunkers 1,2 and 3 caused by a seismic event, with reduced containment due to seismic damage to SAWB building.	3.0	$<5 \times 10^{-7}$ ($<3 \times 10^{-7}$)***
2	Fire in SAWB bunker 1 only, caused by a seismic event, with reduced containment due to seismic damage to SAWB building.	1.7	$<5 \times 10^{-7}$ ($<3 \times 10^{-7}$)***
3	Fire in SAWB all of bunkers 1, 2 and 3 where the SAWB building is not damaged by a seismic event.	0.3	$<5 \times 10^{-5}$ ($<3 \times 10^{-7}$)***
4	Fire in SILWE involving entire contents of an unencapsulated ILW container.	1.2 ⁺	Bounding reasonably foreseeable accident $<1 \times 10^{-5}$
5	Desiccant fire resulting in complete release of all radioactivity in the desiccant.	0.9 ⁺	$<1 \times 10^{-5}$

*Public dose – whole body effective dose received by an adult in the 12 months following the event

**Off-site dose consequences for each of the fault scenarios have been assessed by Magnox Ltd. for comparison with the threshold defined in REPPiR schedule 1

***An installed oxygen reduction system reduces significantly the likelihood of a SAWB fire during retrieval operations. The values shown in parentheses take account of this reduction

+Public dose calculated at a default value of 75 metres rather than at the site boundary.

5.1.5 CONCLUSIONS OF THE MAGNOX LTD HIRE AND RoA

Magnox Ltd. concludes that none of the events/faults described above could lead to a reasonably foreseeable radiation emergency as defined by REPPiR (i.e. all events/faults are deemed both not reasonably foreseeable and have likely public doses of less than REPPiR Schedule 1 dose thresholds in the following 12 months).

5.2 ONR TECHNICAL ASSESSMENT OF THE MAGNOX HIRE AND RoA

REPPiR and ONR guidance (references 2 and 5) specify that best-estimate analysis should be used by operators to calculate off-site dose consequences and that “evidence should be presented that unwarranted conservatism is not being used”. Some conservatism may be used in the calculation of off-site dose figures, for example to simplify analysis, but unwarranted conservatism can give rise to a disproportionately extensive emergency plan. Therefore, careful consideration has been given as to whether analysis undertaken by Magnox Ltd. for the fault scenarios identified in Table 1 is appropriate to support the conclusions of the RoA/HIRE and that these faults are not likely to lead to a reasonably foreseeable radiation emergency as defined in REPPiR.

ONR’s technical assessment (reference 12) of the Hunterston A RoA considers that the most significant fault that Magnox Ltd. has identified which could lead to off-site public dose consequences is associated with a seismic event leading to a fire in all of bunkers 1, 2 and 3 of the SAWB. ONR considers this fault sequence to be beyond reasonably foreseeable, especially when the oxygen reduction system is operating (reference 13). It is also

recognised that the inclusion of the temperature and hydrogen monitoring systems on bunker 1 gives increased assurance that a bunker fire fault is highly unlikely. However, as there could be a cliff edge effect (i.e. circumstances where a small perturbation in the initial fault condition potentially leads to a very significant change in the fault dose consequences) with this fault as the dose is more significant than other faults identified for the site, further consideration of this event was undertaken by Magnox Ltd (reference 14).

This further assessment concludes that *“no seismic event of a severity which is credible for a location in the UK would cause significant structural damage to the SAWB bunkers...”* The validity of these statements have been confirmed by the Civil Engineering Professional Lead for ONR (reference 13). In addition to this, the conditional probability of a resulting fire reduces the likelihood even further. This has provided greater strength to the frequency arguments presented by Magnox Ltd. and has provided assurance regarding the sensitivity and conservatism associated with the frequency calculations.

Magnox Ltd identifies the most significant reasonably foreseeable fault as being associated with hypothetical operations in the SILWE in which a fire engulfs an encapsulated ILW box. The release is based on the radioactive contents of one box, as it was believed that only one box would be processed in the facility at a time. However, since the submission of the Hunterston A RoA by Magnox Ltd., the operating philosophy of SILWE has developed. During operation there could now be up to 18 boxes in the facility the contents of which could potentially contribute to the source term of a release from a fire. Further assessment was therefore undertaken of Magnox Ltd.’s Pre-Construction Safety Report for the SILWE facility to further understand the likelihood and consequences of a fire occurring (reference 15). This has established that a fire that involves multiple ILW boxes in the SILWE facility is not realistic and that a hydrogen deflagration fault leading to a fire is also highly unlikely. Therefore ONR’s assessment agrees with the Magnox Ltd. conclusion that the hypothetical fault in which a fire engulfs one encapsulated ILW box is bounding for this facility and, although identification and assessment of this fault was not based on formal safety case assessment, it must be considered as part of the determination. Taking into consideration the additional frequency assessment of the SAWB fault, ONR agrees with Magnox Ltd.’s conclusion that this should be used as the most significant reasonably foreseeable event.

Magnox Ltd. has calculated the likely doses to a member of the public from each of the five potential faults (see Table 1) using the Nuclear Emergency Arrangements Forum (NEAF) methodology (reference 11). The NEAF methodology is a best estimate dose calculation approach where measured source terms are used to calculate dose arising from faults. The isotope that contributes most significantly to dose uptake is Cs-137 with lesser contribution from other isotopes including Sr-90 and Ru-106. This event results in an estimated effective dose of 1.2 mSv (Table 1) for an adult at the site fence. Child and infant doses are lower for fault scenarios considered as a result of NEAF dose factors that apply for the contributing isotopes. The dose routes considered in the NEAF approach include inhalation, cloud gamma and ground gamma. Dose routes that are excluded are ingestion and resuspension of particulates.

Noting the importance of the dose estimation in this determination, ONR also observed that Magnox Ltd. had made some simplifying assumptions regarding the habits of the exposed individuals during and post radiological release, and the impact of food restrictions on the dose calculations. ONR therefore sought further information to ensure that these did not undermine compliance with the requirements of REPPiR. Specifically, it is ONR’s opinion that Magnox Ltd.’s application of the NEAF methodology did not take sufficient account of doses resulting from ingestion, direct radiation exposure from ground deposition of radionuclides, and public occupancy in reaching the calculated off-site dose. In response to this, Magnox Ltd. provided a sensitivity study (reference 16) on different occupancy models, added appropriate dose contributions from ingestion doses, and ensured the estimated dose from direct radiation exposure due to ground deposition of radionuclides was assessed over the 12 months period required by REPPiR.

ONR’s assessment of these additional dose estimates undertaken by Magnox Ltd. has confirmed that they are suitable for comparison to REPPiR Schedule 1. The revised dose

estimate for the most significant reasonably foreseeable event, a fire in the SILWE facility involving the entire contents of an unencapsulated ILW container, is 2.3 mSv.

Since construction of the SILWE facility has commenced, the distance from the activity release point to the site boundary has been determined to be 55 metres compared to the 75 metres used in the original assessment. The maximum public dose from the hypothetical bounding SILWE fault has therefore been recalculated as 3.4 mSv at 55 metres (reference 17) to account for this difference. The dose estimate is based on an adult member of the public spending the first 24 hours at the site fence, and then at a nominal critical habitation for the rest of the year, which ONR considers to be conservative. The additional work undertaken by Magnox Ltd. supports the conclusion in the RoA that the hypothetical fault could not result in a reasonably foreseeable radiation emergency.

It is recognised that faults 1, 2 and 3 in Table 1 are considered by Magnox Ltd. to be beyond reasonably foreseeable and the remaining reasonably foreseeable events (faults 4 & 5) will result in likely worst case doses to members of the public of less than 5 mSv.

ONR concurs with the view of Magnox Ltd. that there are no reasonably foreseeable faults at Hunterston A for the plant in its current state that would give rise to a public dose in excess of the values of REPPiR Schedule 1.

Conclusion 1: ONR is satisfied that the technical submissions made by Magnox Ltd. demonstrate that members of the public are not likely to be exposed to doses in excess of the values of REPPiR Schedule 1 from a reasonably foreseeable radiation accident occurring at the Hunterston A site. I.e. A radiation emergency, as defined in REPPiR, is no longer judged to be reasonably foreseeable.

6 OFF-SITE EMERGENCY ARRANGEMENTS

ONR is satisfied that a radiation emergency as defined in REPPiR is no longer reasonably foreseeable at the Hunterston A site. This is as a result of the doses associated with such emergencies falling below the threshold for applicability of regulations 7, 9 and 16 of REPPiR (which relate to the requirement for an operator's emergency plan, the determination of an off-site planning area by ONR, the preparation by the local authority of a corresponding off-site emergency plan, and the provision of prior information by the operator).

Consequently, there are no longer legal provisions under REPPiR relating to the Hunterston A site for:

- ONR to determine a local authority off-site emergency planning area;
- the local authority to prepare an off-site emergency plan;
- the operator to provide prior information under REPPiR; and
- for the operator to prepare a REPPiR operator's emergency plan.

As the local authority is no longer required to prepare an off-site emergency plan under REPPiR, Step B of ONR's determination process (relating to the application of other practical and strategic factors to a planning area) is not required.

Although a radiation emergency is no longer reasonably foreseeable (and consequently a local authority off-site emergency planning area and a prior information area are no longer required by REPPiR specifically for Hunterston A), the radioactive inventory of Hunterston A continues to exceed the specified quantities set out in REPPiR Schedule 2. Consequently, under REPPiR regulations 5(1) and 5(2), the licensee continues to be required to review their HIRE and submit a RoA periodically or following a material change in the work with ionising radiation. Whilst not anticipated, should such a re-submission suggest any material increase in the risk profile of the site, ONR will make a further re-determination to consider

whether further measures under REPPiR to protect the public in the event of a reasonably foreseeable radiation emergency would be justified.

Although there is no longer a direct requirement under REPPiR for an operator's plan, or for the provision of prior information by the operator in respect of the Magnox Ltd. Hunterston A site, the operator will continue to have relevant legal duties under other legislation that are not directly affected by this determination.

Specifically, due to the location of the EDF Hunterston B nuclear licensed site adjacent to the Hunterston A site, the local authority will still have a requirement under REPPiR for a local authority off-site emergency plan in respect of the Hunterston B licensed site.

Similarly, nuclear licensees have general duties to ensure, so far as is reasonably practicable, the safety and welfare of employees and other persons; to make and implement adequate arrangements for dealing with any accident or emergency (under standard licence condition 11 attached to the nuclear site licence); and to prepare contingency plans under the Ionising Radiation Regulations 1999 as appropriate.

ONR, where relevant, will continue to deliver regulatory oversight of the other legal duties as they apply to Magnox Ltd.

Conclusion 2: As a result of ONR's conclusion that a radiation emergency is no longer reasonably foreseeable, there is no longer a requirement under REPPiR regulations 7(1), 9(1) and 16(1) for an operator's emergency plan, the identification of off-site planning and prior information areas by ONR, the preparation of a local authority off-site emergency plan, or for the provision by the operator of prior information to the public in respect of the Hunterston A nuclear licensed site.

7 CONCLUSIONS

This report describes ONR's assessment of Magnox Ltd.'s RoA for the Hunterston A nuclear licensed site and the consequential requirements (or otherwise) for REPPiR off-site emergency planning and prior information areas, which were previously prescribed as an area of radius 2.4 km in all directions from the centre point of the neighbouring Hunterston B Power Station.

The conclusions of this report are that:

- ONR is satisfied with the technical submission made by Magnox Ltd. which concludes that members of the public are not likely to be exposed to doses at or in excess of 5 mSv in the year following a reasonably foreseeable radiation emergency (or other relevant dose criteria in Schedule 1 of REPPiR).
- This is due to a significant reduction in the radiological hazard at the site when it ceased operation in 1990 and the subsequent removal of fuel from the site by 1995. In addition to this reduction in the radiological hazard, Magnox Ltd. have improved their technical assessment of possible remaining faults on site which could result in an off-site release. This has included the removal of over estimates associated with the quantity of radioactive material available for release and consideration of containment and fire mitigation measures that have also been put in place at the site. These have resulted in further decreases to the level of radiological hazard and risk presented by the site.
- As a result of ONR's conclusion that a radiation emergency is no longer reasonably foreseeable, there is no longer a requirement under REPPiR regulations 7(1), 9(1) and 16(1) for an operator's emergency plan, the identification of off-site planning and prior information areas by ONR, the preparation of a local authority off-site emergency plan, or for the provision by the operator of prior information to the public in respect of the Hunterston A nuclear licensed site;

- ONR's assessment does not affect the status of the REPPIR off-site emergency planning area for the Hunterston B nuclear licensed site (which reflects the residual potential for a reasonably foreseeable radiation emergency from the Hunterston B site), which will remain at a radial distance of 2.4 km, until such time as ONR determines otherwise, and the requirement for a local authority off-site emergency plan for the Hunterston B nuclear licensed site; and
- ONR's assessment does not affect the status of the REPPIR prior information area for the Hunterston B nuclear licensed site (which reflects the residual potential for a reasonably foreseeable radiation emergency from the Hunterston B site), which will remain at a radial distance of 2.4 km, until such time as ONR determines otherwise.

8 RECOMMENDATIONS

As a result of the conclusions of this report, it is recommended that ONR write to:

- Recommendation 1: North Ayrshire Council and Magnox Ltd. to notify them that a REPPIR off-site emergency planning area is no longer required for the Hunterston A licensed site.
- Recommendation 2: North Ayrshire Council to notify them that there is no longer a requirement under REPPIR for the local authority to prepare an off-site emergency plan in respect of the Hunterston A licensed site, although the requirement remains in respect of the Hunterston B licensed site.
- Recommendation 3: Magnox Ltd. to notify them that the requirement to ensure the appropriate provision of prior information to the public is no longer required under REPPIR. This should be copied to North Ayrshire Council.
- Recommendation 4: Magnox Ltd. to notify them that there is no longer a requirement under REPPIR for an operator's emergency plan.
- Recommendation 5: EDF Energy, who operate Hunterston B, to notify them that there is no longer a requirement under REPPIR for the local authority to prepare an off-site emergency plan in respect of the Hunterston A licensed site, although the requirement remains for the Hunterston B licensed site.
- Recommendation 6: The Scottish Government, Nuclear Decommissioning Authority, Food Standards Agency, the Maritime and Coastguard Agency and the Scottish Environment Protection Agency of the outcome of this assessment and the removal of the REPPIR off-site planning and prior information areas for the Hunterston A licensed site, although the requirement remains for the Hunterston B licensed site.

ONR will continue to seek assurance that, following the removal of the requirement for an operator's emergency plan and a local authority off-site emergency plan under REPPIR, the operator continues to make adequate provisions and maintains emergency arrangements for the Hunterston A nuclear licensed site. These include the residual emergency and contingency related legal requirements of the Health and Safety at Work Act, the Nuclear Installations Act and the Ionising Radiations Regulations 1999.

9 REFERENCES

- 1 The Energy Act 2013, Chapter 32.
Part 3, Chapter 1, 'The ONR purposes', paragraph 68(1).
Part 3, Chapter 4, 'Function of the ONR', paragraph 78, 'Principal function'.
The Stationery Office. December 2013. IBN 978-0-10-543213-5
- 2 Radiation (Emergency Preparedness and Public Information) Regulations 2001
- 3 Hunterston A Site: REPIR Hazard Identification and Risk Evaluation Report of Assessment. M/EF/HNA/REP/0002/13, October 2013
- 4 A guide to the Radiation (Emergency Preparedness and Public Information) Regulations 2001. L126. 2002. <http://www.gov.uk/pubns/priced/l126.pdf>
- 5 ONR technical assessment of REPIR submissions and the determination of detailed emergency planning zones, ONR NS-TAST-GD-082 Revision 2 2013. www.onr.org.uk/depz-onr-principles
- 6 Koichi Tanigawa et al. Loss of life after evacuation: lessons learned from the Fukushima accident. *Lancet*: Volume 379 Issue 9819 889-891, 10 March 2012
- 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 ionising radiation. *Official Journal of the European Communities* (1996) 39, No L159, 1-114
IBSN 0 11 915263 0
- 8 ONR Safety Assessment Principles for Nuclear Facilities, 2014 Edition, Revision 0. AM.1 Accident management and emergency preparedness.
- 9 IAEA Safety Standards Series (General Safety Requirements) No GS-R Part 7 dated November 2015. Preparedness and Response for a Nuclear or Radiological Emergency. ISBN 978-92-0-105715-0 http://www-pub.iaea.org/MTCD/Publications/PDF/P_1708_web.pdf
- 10 IAEA Safety Standards – Safety Guide No GS-G-2.1 2007. Arrangements for Preparedness for a Nuclear or Radiological Emergency. ISBN 92-0-109306 3. <http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1265web.pdf>
- 11 Nuclear Emergency Arrangement Forum (NEAF) 1989 Paper 1 Rev. 2 (November 2005), Preferred Assessment Methodology for Deriving the Radiological Consequences of Accidents for Emergency Planning Purposes
- 12 Fault Studies Assessment of Hunterston A HIRE Report. ONR-DFW-AR-14-009, December 2014.
- 13 File Note: Credibility of a seismic event leading to the structural collapse of the Solid Active Waste Building (SAWB) Bunkers 1-3 at the Hunterston A site, 12 January 2015.
- 14 Hunterston A Site: A Further Assessment of the off-site doses from a bunker fire. M/EF/HNA/REP/0001/15, December 2015.
- 15 Assessment Note: ONR Technical Assessment of Hunterston A Report of Assessment in relation to fire faults in the Solid ILW Encapsulation (SILWE) plant affecting the determination of the REPIR off-site emergency planning area, 2 March 2016.
- 16 Magnox Ltd. letter to ONR, Additional public dose estimates in support of Magnox Ltd HIREs. 22 May 2014

17 Magnox Ltd. email to ONR, HNA/51197: 2013 Hunterston A (HNA) HIRE Report – Clarification of the SILWE Bounding Fault for a mean distance of 70 m. 12 January 2016.