Sizewell 'A': REPPIR Regulation 6(4) Hazard Identification and Risk Evaluation: Report of Assessment

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Hazard Identification and Risk Evaluation Report of Assessment

Preface

The UK nuclear industry has a long history of safe operation. The safety standards used in the design, construction, operation and maintenance of nuclear installations reduce to a very low level the risk of accidents that could have a consequence for the general public. Nonetheless, prudence requires the preparation of plans for dealing with such events. The Nuclear Installations Act 1965 (as amended), which is used to control the activities on civil nuclear installations in the UK, requires that emergency arrangements are in place and are shown to be adequate. These regulations apply to Sizewell 'A' Nuclear Licensed Site.

The UK, as a member state of the EU, introduces legislation to implement Council Directives. To implement the articles on intervention in case of a radiation emergency in Council Directive 96/29/Euratom on the Basic Safety Standards Directive for the protection of the health of workers and the general public against the dangers arising from ionising radiation (the BSS96 Directive), the Radiation (Emergency Preparedness and Public Information) Regulations 2001 (REPPIR) and the Ionising Radiations Regulations 1999 have been made under the Health and Safety at Work Act 1974 (except REPPIR Regulation 17 which is made under the European Communities Act 1972).

The principal hazard to the public from most nuclear accidents will be the release of materials that emit ionising radiation. The risk to health from exposure to ionising radiation has been the subject of intensive study and research for many decades. The results of this work have been used by the International Commission on Radiological Protection (ICRP) as the basis for recommendations on the principles to be adopted for protection against ionising radiation and on a system of dose limitation, both for people exposed to radiation at work and for members of the public in the event of accidents.

Everyone is exposed continuously to natural sources of radiation. Many people receive additional low doses of radiation from artificial sources such as medical X rays. The principal harmful effect of small doses of radiation is to increase the possibility of cancer in later years, but very high doses can lead to other serious illnesses in the short term. Although a direct relationship between radiation dose and harmful effects has been observed only in people exposed to relatively high doses of radiation, for the purposes of radiological protection it is assumed that any dose of radiation, however small, carries with it some risk to health. In making its recommendation on annual limits of radiation dose to workers and members of the public the ICRP has used this cautious assumption.

The National Radiological Protection Board (a predecessor organisation to the Radiation Protection Division of Public Health England) specified Emergency Reference Levels (ERLs) using the ICRP recommendations on intervention. ERLs are levels of potential radiation dose to the public that would justify introducing a given countermeasure to stop people receiving such a radiation dose. The applications of the various countermeasures; evacuation, sheltering and the issue of stable iodine tablets, are based on these ERLs. In the event of an emergency, provision is required under current legislation for the following five aspects to be included in the emergency response:-

a) The control of the accident at the site.
b) The assessment of the actual and potential accident consequences and informing the relevant authorities and the public.
c) Introduction of countermeasures to mitigate the consequences as regards [i] individuals who could be affected in the short term and [ii] longer-term effects such as the contamination of food supplies, land and adjoining waters.
d) Information to the public affected or likely to be affected by the event [was Public Information for Radiation Emergency Regulations (PIRER) but now is REPPIR].
e) The return to normal conditions.

The Emergency Plan in place for Sizewell ‘A’ is currently approved as adequate to deal with the items above. The Emergency Plan is based on Fault Study Analyses and is drawn up against a Reference Accident for the site. Most accident sequences at a nuclear plant would be expected to develop slowly or gradually from some initiating fault. The first concern is always to avoid any exposure of the public to radiation and therefore to rectify the fault before there is any danger to the public outside the site. Nevertheless, as soon as the initiating fault occurs, the question of emergency action has to be considered and pre-determined actions that might eventually lead to notification of off-site agencies and the public would begin. Emergency actions to protect the public may therefore be initiated in circumstances where the accident does not develop to a stage that has significant off-site consequences.

The national response for dealing with a nuclear accident follows the key principles applied by Government in responding to any civil emergency. Firstly, the initial response should be at a local level where control of an accident and its most immediate effects can be dealt with effectively. Secondly, there should be a single lead department to co-ordinate the Government’s response at the national level. For nuclear emergency planning the lead department is the Department for Energy and Climate Change (DECC) with the Scottish Executive carrying out this function for nuclear sites located within Scotland.

Over the lifetime of Sizewell ‘A’ the Emergency Plan has been rehearsed and tested during numerous emergency exercises, both on- and off-site, to the satisfaction of the Office for Nuclear Regulation (ONR) (previously known as the Nuclear Installations Inspectorate (NII)), an industry Regulator. The Emergency Plans are regularly reviewed in consultation with the Emergency Services at Emergency Planning Consultative Committees.

SIZEWELL 'A': REPPIR Regulation 6(4)

Hazard Identification and Risk Evaluation Report of Assessment

1. Introduction

This document is the report to the Health and Safety Executive (HSE) of the Hazard Identification and Risk Evaluation for Magnox Ltd Sizewell 'A' Site as required under regulation 6(4) of The Radiation (Emergency Preparedness and Public Information) Regulations 2001 (REPPIR).

A Local Authority Off-site Emergency Plan is required under Regulation 9 of REPPIR if an assessment by the operator shows that it is reasonably foreseeable that a radiation emergency might arise. A radiation emergency is any event which is likely to result in any member of the public being exposed to ionising radiation arising from that event in excess of 5 mSv in the year following initiation. An event which has a probability of occurrence of 10^{-5} per year or greater is considered to be reasonably foreseeable. An off-site emergency plan is therefore only required if the site fault schedule shows that a fault is both reasonably foreseeable and would give rise to a dose consequence in excess of 5 mSv to a member of the public (calculated using the Nuclear Emergency Arrangement Forum (NEAF) methodology (Reference 1)). It is important to note that events with a dose, or frequency, a number of orders of magnitude lower than those guidance figures were considered in this HIRE Report of Assessment in order to explicitly screen for cliff edge effects that might otherwise exist if one were only to use a strict numerical definition of 'reasonably foreseeable'.

There is currently a REPPIR Off-site plan for the nuclear sites at Sizewell maintained by Suffolk County Council.

Section 2 gives the location and brief description of the site. Section 3 lists the major radioactive inventories on site. Section 4 describes the fault sequences that could lead to a release of radioactivity from site, and Section 5 describes routine radioactive discharges. Section 6 considers nuclear chain reactions. Section 7 describes the safety controls in place.

Section 8 provides detail on the population in the REPPIR Off-site Emergency Planning Area / Detailed Emergency Planning Zone (DEPZ), and Section 9 presents the implications of releases to the population. Section 10 gives a summary and presents conclusions.

2. Location and Environment

Schedule 5(a)[1]

The name and address of the operator or carrier

Magnox Limited

Berkeley Centre

Berkeley

Gloucestershire

GL13 9PB

Schedule 5(b)

The postal address of the premises where the radioactive substance will be processed, manufactured, used or stored, or where the facilities for processing, manufacture, use or storage exist or, in the case of transport, the postal address of the transport undertaking.

Magnox Limited

Sizewell 'A' Site

Leiston

Suffolk

IP16 4UE

Schedule 5(c)

The date on which it is anticipated that the work with ionising radiation will commence, or if it has already commenced, a statement to that effect.

Sizewell 'A' Site first operated in 1966. It has two Magnox reactors which powered two 325 MW turbines. The site ceased generation on 31st December 2006. The reactors were subsequently defueled and the site declared 'fuel free'.

The neighbouring site, Sizewell 'B', has one Pressurised Water Reactor (PWR) operated by EDF Energy.

Schedule 5(d)

A general description of the premises or place including the geographical location, meteorological, geological, hydrographic conditions and, where material, the history of the premises, except that in the case of transport a general description shall be given of either:

(i) the starting and end points of the journey and transhipment points, or

(ii) the criteria to be used for route selection.

Sizewell 'A' Site is located on the east coast of Suffolk at map reference TM474633, 52°12.7'N 1°37.2'E. The local authority is Suffolk Coastal District Council and the county council is Suffolk County Council.

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[1] Schedule headings given in bold and italics in this document reflect the headings of Schedule 5 of the REPPIR regulations.

Coastal erosion on this part of the coast is well documented. Research in support of the existing and planned nuclear power stations at Sizewell, including into how the local seabed and shore responds to waves under differing weather conditions, is on-going.

The area around the site is mantled by drift, although in places bedrock is present at the surface. The drift comprises boulder clay, peat, glaciofluvial deposits, and both marine and shoreface beach deposits. Several kilometres inland boulder clay deposits are more laterally extensive. The solid geology comprises Pleistocene and Pliocene Crag deposits overlying London Tertiaries and Cretaceous Chalk. The term "Crag" is used to describe the bedrock at the Sizewell site. This is a local word used to denote any shelly sand. At Sizewell, it comprises Norwich Crag overlying Red Crag. In addition to the solid geological strata, there exist superficial deposits including fill, beach deposits, alluvium and peat. The fill is variable in nature, and largely comprises re-worked Crag. It is thus predominantly sand, with silt, clay and gravels. In places, it contains construction debris. Further superficial deposits are found in the form of beach sands and gravels that lie to the eastern side of the Sizewell site. They include undulating ridges of fine sand that represent old storm beaches, beach material comprising flint pebbles and occasional patches of sand and man-made flood defences.

The surface layers of the ground around Sizewell ‘A’ Site are classified as Secondary Aquifers. The Chalk is a Principal Aquifer; however, due to the thickness of the clay above the Chalk there is no potential for vertical groundwater movement from directly below the site and down into the Chalk.

Measured water levels indicate a horizontal water table at an elevation of 0.7 metres AOD. The regional direction of groundwater movement in the Crag beneath the site is west to east, but may vary locally, depending on the geology. The natural direction and gradient will have been modified by the construction of the two Power Stations.

Annual average rainfall is approximately 575 mm, ranging from 400 mm in the driest years to about 780 mm in the wettest. Summer rainfall is often of a showery nature, falling over short periods. Winter rainfall tends to be less intense, frontal rainfall, falling over longer periods.

Sizewell ‘A’ Site is very exposed to the sea, being situated on the eastwards facing North Sea coastline. Winds from the north-east and south-east quadrants are subject to marine influences. The adjacent land is extremely flat, the shingle beach giving way after 200 – 300 m to the Minsmere marsh wetlands extending a further 5 km to the north and west. However, Sizewell is in the region of the UK furthest from direct Atlantic influence and the whole of this region is afforded some protection from rain-bearing Atlantic weather systems by the uplands of Wales and western England. The region is also one of the closest to continental Europe. Symptoms of this are occasional imported thunderstorms in summer and occasional very high wind chill in winter when winds of arctic or continental origin blow strongly southwards or westwards across the North Sea, making for relatively cold winters. This continental influence is moderated by the immediate proximity of the North Sea, keeping winter nights warmer and summer days cooler in coastal areas than the region further inland.

The prevailing wind direction is from the south-west.

3. Radioactive Substances on Site

Schedule 5(e)

In the case of an assessment by an operator, a description of any radioactive substance on the premises which is likely to exceed any quantity or mass specified in Schedule 2 or Schedule 3, as the case may be, which description shall where practicable include details of the radionuclides present and their likely maximum quantities.

Historically, the majority of the radioactivity present on site was contained in the irradiated nuclear fuel. However, all the nuclear fuel has now been removed from the site which has formally been declared fuel free.

Other radioactive material in the form of waste still remains on site, although the amount of radioactivity it contains is very much less than was present in the nuclear fuel. Radioactive waste can be categorised according to its level of radioactivity. There is both Intermediate Level Waste (ILW) and Low Level Waste (LLW) on site. Reference 2 details the type, quantities and activity levels of the radioactive waste at Sizewell ‘A’, and from that reference, potentially important inventories (accurate as at December 2014) include:

- solid and wet radioactive LLW (approximately 3,500 m^3)
- solid and wet radioactive ILW (approximately 750 m^3)

In addition to these sources, radioactivity will also be present by activation of structural materials. Structures that contain sufficient radioactivity to exceed the levels specified in Schedule 2 of the REPPIR Regulations include:

- graphite moderator (approximately 3,600 m^3 total, ILW)
- reactor vessel and internals – including insulation, diagrid, core restraint and support, gas and instrument ducts and nozzles, standpipes and charge pans, control rods, burst can detection pipework and thermocouples (approximately 1000 m^3 total, LLW & ILW).
- other structural materials – (approximately 31,500 m^3 total, LLW)

However, the activity is fixed in the structures and would be unlikely to contribute significantly to any release to the environment, even in the case of a severe accident.

Schedule 5(f)

In the case of an assessment by a carrier, a description of any radioactive substance which is likely to exceed any quantity or mass specified in Schedule 4 or Schedule 3, as the case may be, which description shall where practicable include details of the radionuclides present and their likely maximum quantities.

Not applicable.

Schedule 5(g)

Except in the case of an assessment relating to transport, a plan of the premises in question and a map of the environs to a scale large enough to

enable the premises and any features which could affect the general risk in an emergency to be identified.

Figure 1 shows the general location of the site, while Figure 2 comprises a map of the immediately surrounding area and shows the extent of the DEPZ.

Schedule 5(h)

A diagram and description of any single plant or enclosed system containing more than the quantity or mass of any radioactive substance specified in Schedule 2 or Schedule 3, as the case may be, or, in the case of the transport of more than the quantity or mass of any radioactive substance specified in Schedule 4 or Schedule 3, as the case may be, the nature of the containment for the radioactive substance, the type of vehicle and the means of securing the load within or on the vehicle.

Included as Appendix A.

4. Potential Hazard Sequences

Schedule 5(i)

Those factors which could precipitate a major release of any radioactive substance and the measures to be taken to prevent or control such a release and information showing the maximum quantity of radioactive substance which, in the event of a major failure of containment, would be released to the atmosphere including, in respect of premises, the identification of plant and other activities anywhere on the premises which could precipitate such release.

The design of the plant is based upon the fundamental requirement of safety, to minimise, so far as reasonably practical, radiological exposure, risk of plant failure and the initiation of abnormal operational events. Any nuclear plant licensed and commissioned in the UK must be justified by a safety case. This demonstrates that the plant is safe in normal operation, that the design is robust enough to ensure that any departures from normal operation do not immediately lead to accidents and that adequate provisions are made to intercept, recognise and mitigate the consequences of events that may develop into accidents.

Protective systems are installed which detect and deal with deviations from the operating norm, thus preventing the deviations escalating to major accidents. These systems are carefully designed to operate under fault conditions and by incorporating **redundancy**[2], **diversity**[3] and **segregation**[4] there are minimal dependencies between safety functions. Further mitigation action can be applied by operators to minimise the consequences of any deviation. Hence there is a philosophy of having defence in depth in all nuclear plant by preventing accidents, so far as is reasonably practicable, to ensure the safety of all people in and around the plant.

[2] Redundancy — In this context redundancy means there must be more than one system capable of doing the same job so that if one fails or is under maintenance there is another system available.

[3] Diversity — In this context diversity requires that the different systems are designed in different ways or work on different principles so that if there is a design or build fault on one system it does not affect the effectiveness of the others.

[4] Segregation — Systems must be segregated by either distance or engineered structures in such a way as to greatly reduce the likelihood that they could all be damaged by the same event.

The primary safety design principle for nuclear sites is to contain the radioactive material and to provide adequate radiation shielding. This can include using radioactive materials in a form that intrinsically retains radioactivity in the operating range of temperatures and environments, and providing extra containment barriers to restrict the release of any radioactivity that does escape from its normal state. These barriers can be passive or dynamic, e.g. pressure vessels or containment buildings, filtered ventilation systems, decontamination processes, facilities designed to allow work with radioactive material without it contaminating the normal working areas or the wider environment. Barriers of suitably dense material are used when radiation shields are required. The maintainability and fault tolerance of these safeguards are included in the design process.

Engineering Controls

All safety critical equipment is carefully designed, periodically reviewed against modern standards, well built, thoroughly tested and examined, operated under carefully considered written instructions, maintained according to a maintenance schedule and operated within specification by Suitable Qualified and Experienced Persons (SQEPs). The nuclear safety arguments for the equipment and its operation are prepared by SQEPs and subjected to careful review both internally and (for the more significant safety arguments) external to the Company. New equipment with the potential for significant safety implications or changes in the operating rules is considered by a Nuclear Safety Committee (NSC) containing external experts as well as Company representatives. All safety related papers and designs submitted to the NSC are subjected to rigorous Independent Nuclear Safety Assessment (INSA).

The fuel, its cladding, the reactor cooling circuit / primary circuit and its filtration system were designed to contain the vast majority of the fission products produced by the nuclear chain reaction that occurred when the reactors were operational. However, now that the site is fuel free, the vast majority of the aforementioned fission products are no longer present on site.

Systematic Analysis

The factors which could potentially lead to a major release of radioactivity are identified by a systematic review process. This process provides a comprehensive schedule of internal and external initiating events in which the probabilities and consequences of each are considered. This process highlights those areas of the plant or operations that require attention to enhance safety. Improvements can be aimed at reducing the likelihood of an initiating event or at detecting its onset and either preventing it developing or mitigating its consequences.

The first consideration is to avoid the initiating event occurring, or at least to minimise its likelihood, so far as is reasonably practicable.

Having done all that is reasonably practicable to prevent the initiating event from occurring, there may still be some identified events with the potential to develop into a major release. In these cases it will be necessary to provide further protection to enhance safety. The safety philosophy requires that the integrity of the protection provided be commensurate with the risks involved. Thus for potentially serious events there must be both redundancy and diversity in the methods used to identify the initiation of the fault and to bring the system back into a safe condition. These safety systems must also be segregated so that the likelihood of their all being damaged at the same time is reduced.

Detection and Mitigation

Faults are detected by monitoring parameters such as temperature, liquor and radiation levels (as appropriate) at various points in the reactor circuit, waste vaults and surrounding structures. If these parameters diverge beyond their accepted range then an alarm will be raised and appropriate remedial actions initiated. The operator actions and interventions to be carried out upon receipt of alarms are included in written instructions.

The majority of potential faults which are identified will not result in any release of radioactivity, by virtue of the prevention and protection provisions described above. For a significant release of radioactivity from a containment to be possible, it is necessary for failures to occur in each of the barriers between the hazardous radioactive materials and the outside environment. These barriers may include the nature of the material itself, the containment boundary and any secondary containment which might be present. Only when all of these barriers are breached can there be a potential for radioactive materials to be transported and dispersed into the environment.

Discussion on Hazards

Before final shutdown (31st December 2006), whilst in the power generating operating phase, the reference accident for off-site planning was a burst gas duct together with a single channel fire. This same fault provided the hot-gas release, reactor damage and widespread collateral damage and injury that dictated the current off-site planning arrangements.

Since the site has been declared fuel free, any faults that might have resulted in a radiological dose as a result of damage to, or exposure of, irradiated fuel can no longer occur. In addition, now that the reactor vessels are devoid of heat-producing materials, in an air atmosphere at no more than 5 psi above atmospheric pressure and close to ambient temperature, depressurisation faults with significant collateral damage and release of activity are no longer credible.

Therefore the planning assumption for both on-site and off-site emergency preparedness could be changed.

Safety Case

The review of the site Reference Safety Case, described here, is an exercise of data sourcing for input to this report of Assessment to the ONR of the Hazard Identification and Risk Evaluation (HIRE) for Sizewell ‘A’, as required by REPPIR. This HIRE report is not in itself a safety case, or a revision to the safety case, for the site.

The current Reference Safety Case for the site, the Post Defuelling Safety Case (PDSC, Reference 3), covers the period from its formal approval following the site being declared fuel-free, for a 10 year period. Over this period the site may be required to undertake safety case reviews, for example prompted by the commencement of substantial decommissioning activities, and the safety case will continue to be updated as appropriate within existing Site Licence Arrangements. It is judged that there is no fault condition associated with any decommissioning activity which might be proposed, which could result in a dose to a member of the public which might threaten the REPPIR criteria. This judgement is based upon knowledge of the radioactive inventory at Sizewell A and experience from other Magnox sites' decommissioning activities.

The PDSC is underpinned by a comprehensive fault schedule for potential faults that could result in a radiological dose. This involved a systematic review of the reactor vessels, pond, radioactive waste facilities and associated equipment to identify any possible accident sequences. The potential risks and hazards posed by the plant have reduced significantly since the Site was declared fuel free. In particular, faults involving nuclear fuel can no longer occur.

The PDSC demonstrates that all reasonable steps have been taken to reduce the likelihood of faults occurring, and it is demonstrated that the potential doses to the public in the event of credible faults are acceptably low.

The fault schedule that underpins the site Reference Safety Case has been reviewed using best estimate data. The public consequences have been assessed using the NEAF methodology and including additional dose pathways in order to ascertain whether any faults are both reasonably foreseeable and could give rise to a dose consequence in excess of 5 mSv to a member of the public. The results of that review are contained in Reference 4 and are summarised below.

Security Case

The site's Nuclear Site Security Plan is supported by a conservative radiological assessment, which also describes radiological consequences that are below those used in the context of the security plan but which could merit consideration under REPPIR. This radiological assessment has been screened for events, which are reasonably foreseeable and relevant to a local authority emergency plan, arising from potential unauthorised behaviour of employees or the public and which could result in radiological dose. As reported in Reference 4, the screening resulted in no requirement for public dose calculations which are in addition to those carried out as a result of the PDSC fault schedule.

Review Conclusions

Table 1 is based on the above reviews, and shows that there are no events, arising either from faults or unauthorised behaviour, that meet both the frequency of occurrence and dose consequence criteria. In addition, no event has a public dose consequence that either exceeds, or challenges, the 5mSv threshold. The largest public dose consequence relates to Fault Group B: 'Fire in HEPA Filter' at 4.4 µSv, some three orders of magnitude below the 5 mSv threshold.

Some of the scenarios considered use bounding inventories and so are not subject to cliff-edge effects, the consequence for those that are not based on the total inventory of a mobile material being released are so far below the threshold that it is considered that even if the assessment made is an underestimate, the threshold could still not be challenged. Figure 3 depicts these results graphically.

It should be noted that the implementation of the NEAF methodology employed to estimate the above doses applies at distances of 75 m or greater from the point of release. For the purpose of this report, 75 m is considered to be an appropriate approximation of the distance of each fault's point of origin to the site boundary.

The key dose contours for emergency planning (shown in Table 1) are:

- The 3 mSv dose contour. This is the lower ERL for shelter. Beyond this range no countermeasures, other than possibly food restrictions, are appropriate.
- The 5 mSv dose contour. This is the dose to the public that defines a radiation emergency.
- The 30 mSv dose contour. This is the upper ERL for shelter. Within this range the countermeasure of sheltering should be applied if practical.

In summary, from a review of the site's Reference Safety and Security Cases for on-going post defuelling operations it is considered that there are no events that could give rise to a reasonably foreseeable radiation emergency and no dose contours are met or exceeded.

5. Smaller Continuing Releases of Radioactivity to the Environment

Schedule 5(j)

Those factors which could precipitate a smaller but continuing release of any radioactive substance and the measures to be taken to prevent or control such releases to the atmosphere.

The main sources of gaseous discharges from Sizewell 'A' are the venting of the reactor vessels and the routine extract ventilation of contamination controlled areas. The main decommissioning activities which could potentially give rise to additional discharges are the retrieval, processing and packaging of dry intermediate level waste (ILW) and/or packaging of wet wastes such as resins and sludges.

Potentially radioactive liquid effluent has a number of origins. Liquid effluent will be produced during ILW retrieval and processing operations, cooling pond water treatment activities, and from other areas such as the radiation controlled area change facilities. This potentially radioactive aqueous liquid effluent is discharged to the North Sea after appropriate processing.

Under the Environment Act (1995), the disposal of radioactive waste on or from all nuclear Sites in England and Wales is regulated by the Environment Agency (EA), which exercises powers to grant or refuse applications for Permits under the Environmental Permitting Regulations (England and Wales) (2010). Within its powers under those regulations, the EA also implements relevant European legislation and UK Government policy objectives with regard to radioactive wastes.

Under any Permits which are granted, discharges are kept As Low As Reasonably Achievable (ALARA) by requiring the operator to use Best Available Techniques (BAT) to minimise the radioactive content of discharges and to control any other relevant factors so as to minimise the subsequent impact of those discharges. In addition, the Site must operate within any numerical discharge limits that are laid down in the relevant Permit. A Permit may specify separate discharge limits or advisory levels for individual nuclides and may set both short term (e.g. weekly) and long term (e.g. annual) limits or advisory levels.

The discharge limits are based on the minimum level of discharge the operator has justified in order to operate the plant in accordance with BAT. The headroom allowed between actual discharges and discharge limits is kept to the minimum necessary for normal operation of the plant.

Sampling, measurement and analysis of discharges are carried out by the operator and each month the discharges are reported to the EA. The equipment and methods used are subject to approval by the EA.

6. Unintended Self-Sustaining Nuclear Chain Reaction

Schedule 5(k)

Those factors which could give rise to an incident involving the initiation of an unintended self-sustaining nuclear chain reaction or the loss of control of an intended self-sustaining nuclear chain reaction and, in either case, the measures to be taken to prevent or control any such incident.

Since the Site has been declared fuel free, it is not considered credible that a self-sustaining nuclear chain reaction could occur at Sizewell 'A'.

7. Safety Controls

Schedule 5(l)

Information concerning the management systems and staffing arrangements by which the radioactive substance is controlled and by which the procedures are controlled.

<u>Management System</u>

The Sizewell 'A' Site Director is responsible as Agent of the Licensee for the safe operation and maintenance of all plant. He also has responsibility for ensuring that adequate numbers of staff are present on Site to defuel the reactors, to operate and test ancillary plant in a safe manner, and to decommission the Site; as well as ensuring that these staff are suitably qualified and experienced.

These staff are part of the Site Management system and are accountable to the Site Director for all aspects of work including compliance with the Nuclear Site Licence conditions. The greater part of the responsibility for controlling radioactive substances rests with the Radiation Protection and Waste Management and Environment Sections who are responsible to the Site Director.

Nominated managers are also responsible to the Site Director in their own right for ensuring that adequate maintenance and repairs are carried out on plant and equipment in order to keep them fit for their intended purpose.

There are managers responsible for providing a general support service for the operation of the Site in the areas of human resources and business issues. The Site Director is responsible for the safe, timely and economic delivery of the decommissioning work on the Site.

Staffing

Each Department has a team of personnel, all of whom are suitably qualified and experienced for the work which they are expected to perform.

The Site is permanently manned in such a way that the Site's emergency response can be set up immediately. Additional personnel are also available on call.

Procedures

The Quality Assurance arrangements are specified and described in the top tier of a three tier Quality Management System and define the requirements for procedures and instructions for the Site as a whole. The middle tier includes Management Control Procedures (MCPs) which control activities common to or involving all Departments where overall Site control is required, and benchmark roles which define competency requirements. Lower tier instructions detail the requirements for carrying out activities and are generally produced on a departmental basis.

Regulatory Control

The Nuclear Industry is regulated by the ONR and the EA, both of which have Site Inspectors assigned to each Site. These inspectors have the right to inspect any equipment or procedure at short notice, and the right to require the Company to provide information. The ONR can direct the shutdown of any process that it considers unsafe.

The ONR require that the safety of plant and operations is considered in a systematic manner at all stages from planning, building, operating and decommissioning and that the safety case is subject to both continuous review and formal periodic review.

Any significant changes in procedures, plant or management structure have to be approved by the ONR in advance, in accordance with Nuclear Site Licence arrangements.

Emergency Organisation

Sizewell 'A' Site has emergency arrangements in compliance with Site Licence Condition 11 that ensure that SQEPs are available to respond to any events that cause the reactors or other equipment to deviate from their normal operating conditions. The provision of emergency arrangements can further mitigate the probability of a major release of radioactivity to the environment.

The emergency plan is approved by the ONR and exercised regularly. Best practice in emergency planning for nuclear Sites is developed and promulgated by a number of organisations. The Nuclear Emergency Planning Liaison Group (NEPLG) led by the DECC, provides national guidance and co-ordination. The NEAF, chaired by the ONR, allows operators to share good practices. The Emergency Planning Consultative Committee (EPCC) provides a local forum for consultation.

8. Population

Schedule 5(m)

Except in the case of an assessment relating to transport, information about the size and distribution of the population in the vicinity of premises to which the report relates.

The current Sizewell Off-site Emergency Plan (reference 5) states that the population within the REPPIR Off-site Emergency Planning Area is approximately 7600. This is subject to significant variation in the summer months and other holiday periods. There are commercial premises and schools which draw additional persons (estimated to number up to 800) into the Emergency Planning Area for varying periods. Within 1 km of the Site there is the hamlet of Sizewell (a small number of properties and a few tens of residents), and a camping and caravan Site and a public house, with a transient population estimated to be up to 100.

In addition, on a normal day there may be around 770 persons on the adjacent Sizewell 'B' Power Station. During an outage, this might increase to 1300 during the day and 900 at night.

9. Implications

Schedule 5(n)

An assessment of the area which is likely to be affected by the dispersal of any radioactive substance as a result of any radiation emergency and the period of time over which such dispersal is likely to take place.

It is recognised that despite the careful and systematic manner in which nuclear operations are conducted and the multiple layers of protection, there remains the remote possibility of an accidental radiological release at Sizewell 'A'.

The extent of the region affected by any radiation accident depends on the nature of the accident and the weather conditions at the time. The nature of the accident determines the amount of radioactive material released; the isotopic composition of that release, and the chemical and physical form of the release. The weather conditions determine in which direction the activity moves and how rapidly it spreads out.

In light of the potential hazards that existed during the generation phase of the Site's lifecycle, a DEPZ extending to 2.4 km in all directions from the centre of the common reactor building existed. It was considered unlikely that any person beyond this zone would be exposed to a dose high enough to require prompt countermeasures to be applied. Following ONR assessment of the previous issue of this report and the equivalent document produced by Sizewell 'B', the DEPZ has since been amended so that there is now a larger, irregularly shaped REPPIR Off-site Emergency Planning Area (based on postcode boundaries), and a 1 km radius (centred on Sizewell 'B') for automatic countermeasures in event of declaration of an off-site nuclear emergency. Figure 2 shows these areas.

In the extremely unlikely event of a significant release of radioactive material from Sizewell 'A', the dose to the general public could be reduced by the appropriate imposition of countermeasures. These may include sheltering (which reduces the inhalation dose and cloud doses) and evacuation (which removes the people from the area to prevent exposure). Controls may be also applied to locally produced food under instructions from the Food Standards Agency. Since food production techniques can concentrate some radioisotopes, it is likely that food restrictions would be effective over a wider area than evacuation or shelter instructions.

The preparation of this report involves carrying out calculations designed to predict the distances out, from the source of the radiological release, to which urgent countermeasures may be appropriate to protect the public in the event of the identified faults. These distances are based on the Public Health England's Lower and Upper Emergency Reference Levels (ERLs) for avertable dose. The weather conditions assumed for these calculations were for a period with little sun and significant cloud cover (Pasquill category D) with an average wind speed of 5 ms^{-1} in a 'downwind' direction. This type of weather occurs about 50% of the time in the UK.

Table 1 shows the results of those calculations: no fault has a distance (or 'contour') at which the lower (3mSv) ERL for shelter is met or exceeded, and therefore the higher thresholds are similarly not met or exceeded.

Accidental releases from the Site could occur over periods varying from a few seconds to several days depending on the circumstances and the level of damage. Most faults leading to significant off-site release would be expected to continue for a matter of hours.

Schedule 5(o)

An assessment of the likely exposures to ionising radiation of any person or class of persons as a result of any radiation emergency.

Following removal of all nuclear fuel from Sizewell 'A', the Site's bounding fault is no longer "Exposure of irradiated fuel in the pond through complete loss of water", but 'Fire in HEPA filter'.

The following table summarises the Site's hazard reduction in terms of potential radiological dose consequences as a direct result of the changes in lifecycle phase over the last few years:

Lifecycle Phase	Bounding Fault	NEAF (Whole Body) Dose at Site Boundary (mSv)
Generation	(1966 – 2006) Burst Top Duct & Single Channel Fire.	467
Post-Operation & Defuelling (2007-2014)	Exposure of irradiated fuel in the pond through complete loss of water.	70
Defuelled (2014 +)	Fire in HEPA filter	0.0044

Therefore it is concluded that there are no reasonably foreseeable events associated with on-going operations at Sizewell ‘A’ that could lead to a dose to the public of 5 mSv or greater in the year following the event.

10. Summary and Conclusions

Schedule 5(p)

An assessment of the necessity for an emergency plan to be prepared by the operator or carrier.

The facilities at Sizewell ‘A’ Site are carefully designed, built, operated and maintained in order to ensure safe operation.

Assessments presented in this report demonstrate that it is not reasonably foreseeable that any event at Sizewell ‘A’ could lead to a radiation emergency, as defined by REPPIR i.e. a cumulative dose to a member of the public of 5 mSv or more in the year following the fault.

Since the reference fault during defuelling determined the extent of the current DEPZ; the current REPPIR Regulation 9 Off-site plan and associated DEPZ are now considered to be sufficient, but arguably excessive for Sizewell ‘A’.

To ensure that the HIRE continues to be valid, it will be reviewed in accordance with the REPPIR Regulations; either within three years of the last assessment, or whenever there is a change of circumstances that would affect the assessment.

11. References

1. Nuclear Emergency Arrangement Forum 1989 Paper 1 Revision 2; Preferred Assessment Methodology for Deriving the Radiological Consequences of Accidents for Emergency Planning Purposes. November 2005.

2. eMWaste stream report for SZA run 17DEC2014.xls (Microsoft Excel Workbook).

3. Sizewell A Site: Post Defuelling Safety Case – SZA/PMP/14/122, January 2015.

4. Review of Avertable Radiological Dose Assessments in Support of the REPPIR HIRE Report of Assessment, TR/SC/038, Issue 1, March 2015.

5. Sizewell Off Site Emergency Plan, Issue 3.1, 5th May 2014

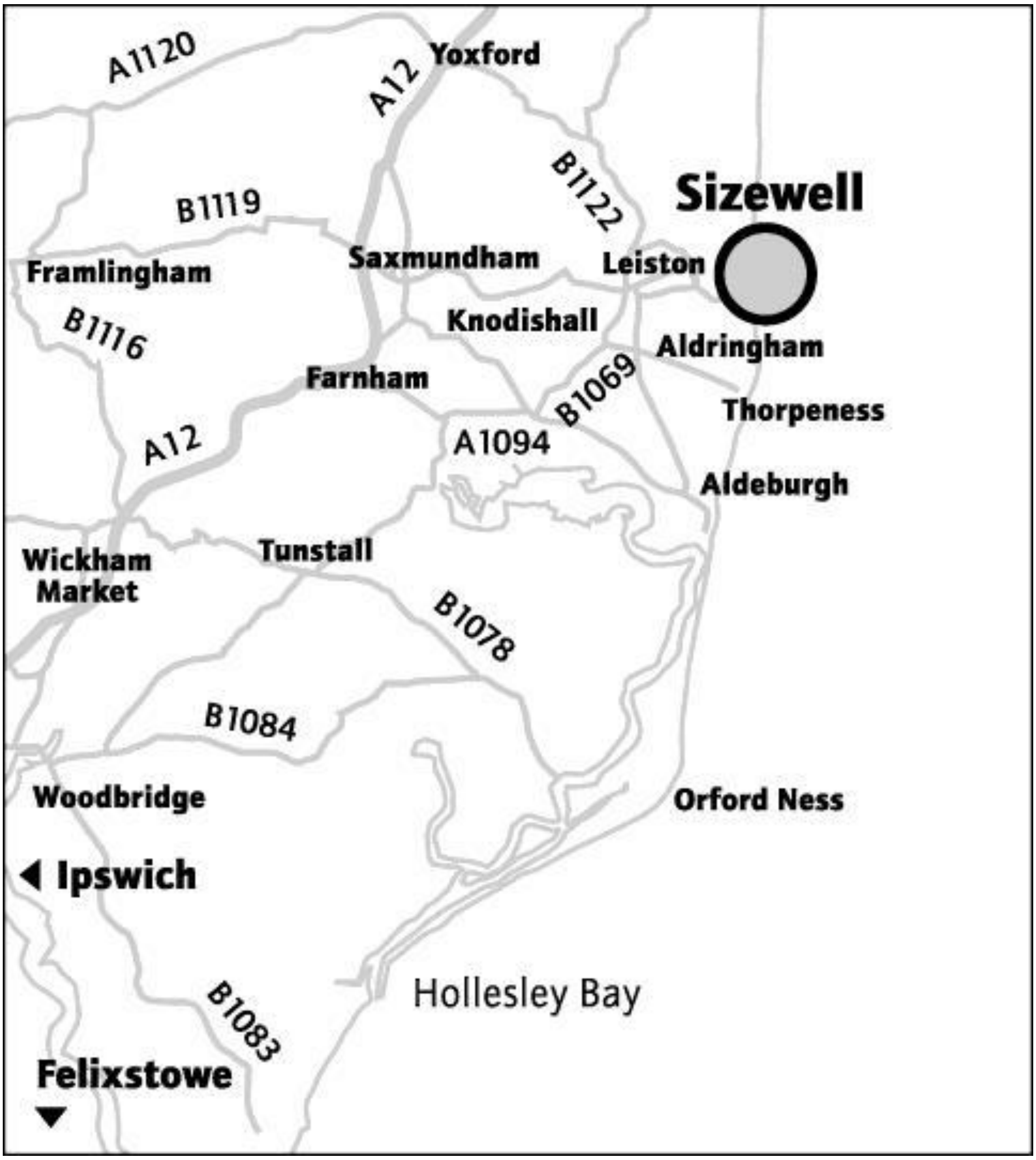


Figure 1 Location of Sizewell 'A' Site

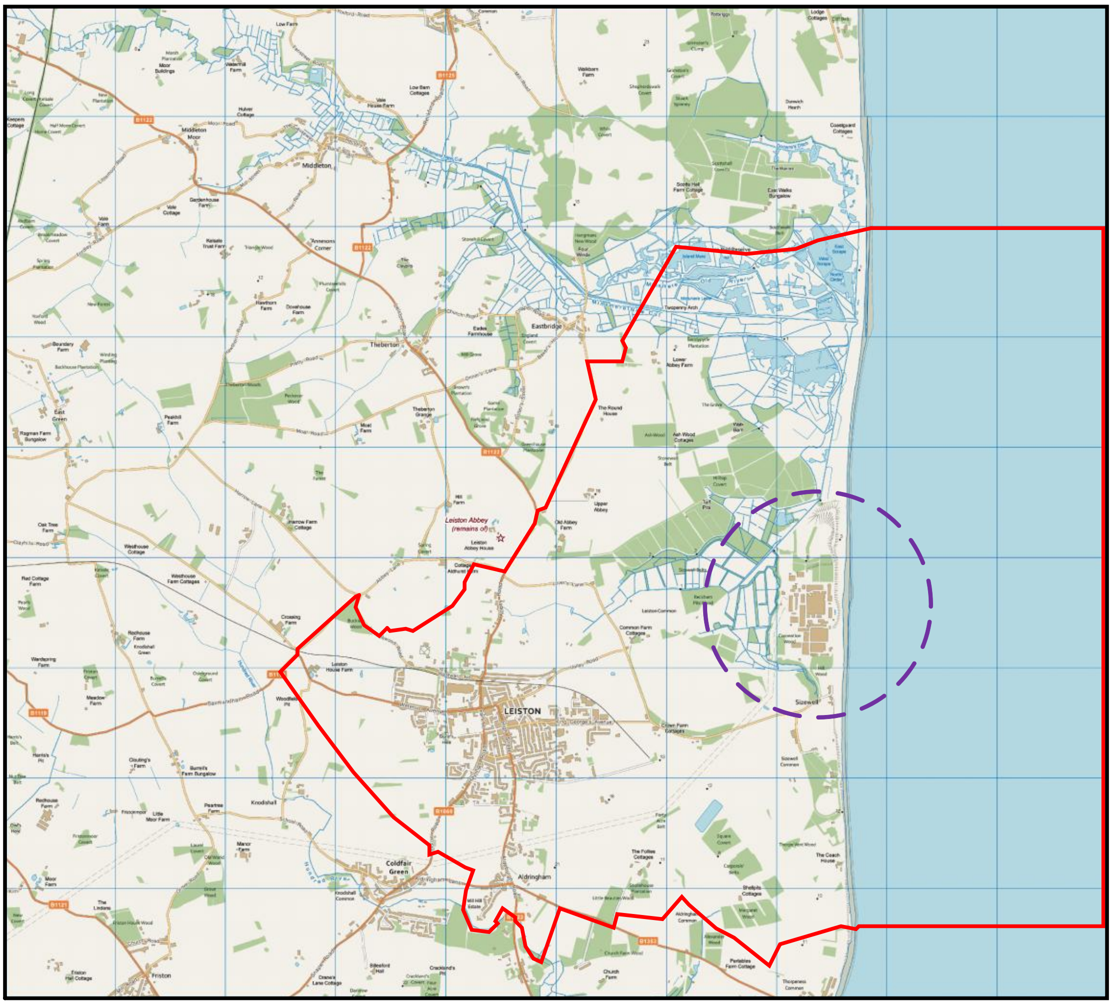
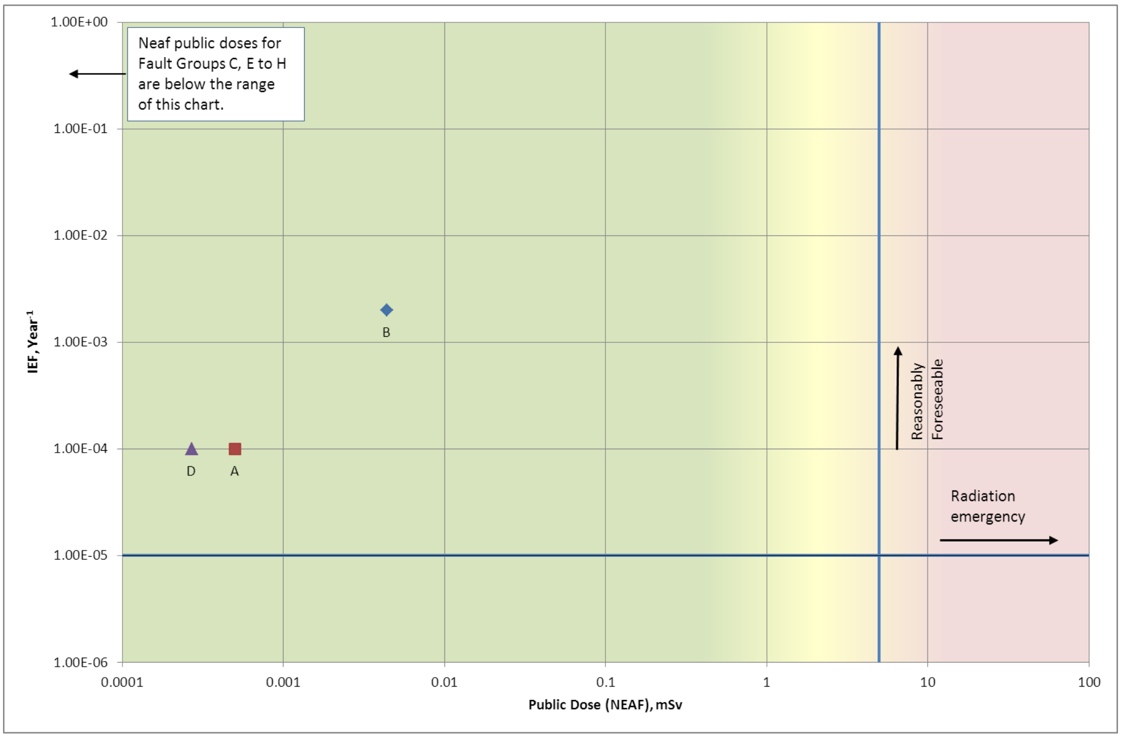


Figure 2 Map showing Sizewell 'A' Site and the current REPPIR Off-site Emergency Planning Area

Red line shows current REPPIR Off-Site Emergency Planning Area.

Also shown – purple dashed circle of 1 km radius (centred on Sizewell B) for Local Authority automatic countermeasures in event of declaration of an off-site nuclear emergency.



Key:

A	Failure of tanks and vessels in ETP & Pond resulting from seismic event.
B	Fire in HEPA Filter
C	Catastrophic failure, from unspecified cause, of the HCE vessel leading to a total loss of the active resin and Pond water to the SPF room and ETB, Operator absent
D	Operator error or equipment failure leads to mal-operation of the sulphuric acid valves and pumps, injection of sulphuric acid in the PWTP pipework and enhanced corrosion of the Magnox cladding of one irradiated fuel element
E	Fire in unlidded drum of LLW
F	Fire in ISO container containing LLW
G	Fire in waste storage processing facility
H	Failure of reactor or primary circuit containment

Figure 3 Public consequences from faults identified from a review of the Site's safety case

Table 1 Public consequences from faults identified from a review of the Site's safety case

Ref.	Description	Public Dose (Sv.)	3 mSv Contour (m)	5 mSv Contour (m)	30 mSv Contour (m)	IEF (/y)
A	Failure of tanks and vessels in ETP & Pond resulting from seismic event.	5.E-07	N/E	N/E	N/E	1.0E-04
B	Fire in HEPA Filter	4.4E-06	N/E	N/E	N/E	2.0E-03
C	Catastrophic failure, from unspecified cause, of the HCE vessel leading to a total loss of the active resin and Pond water to the SPF room and ETB, Operator absent	2.1E-10	N/E	N/E	N/E	1.0E-04
D	Operator error or equipment failure leads to mal-operation of the sulphuric acid valves and pumps, injection of sulphuric acid in the PWTP pipework and enhanced corrosion of the Magnox cladding of one irradiated fuel element	2.7E-07	N/E	N/E	N/E	1.0E-04
E	Fire in unlidded drum of LLW	7.5E-11	N/E	N/E	N/E	1.00E-02
F	Fire in ISO container containing LLW	7.5E-13	N/E	N/E	N/E	1.00E-03
G	Fire in waste storage processing facility	7.5E-11	N/E	N/E	N/E	3.0E-02
H	Failure of reactor or primary circuit containment	3.7E-10	N/E	N/E	N/E	1.3E-02

NB The critical individual (i.e. the person who would receive the highest dose, as listed in Table 1) is an adult in all cases.

Notes to Table 1

(i) The dose contours are measured from the source of the radiological release.

(ii) Data calculated using NEAF methodology, and extracted from Reference 4.

(iii) 3 mSv is the lower ERL for shelter. Beyond this range no countermeasures, other than possibly food restrictions, are appropriate.

30 mSv is the upper ERL for shelter. Within this range the countermeasure of sheltering should be applied if practical.

5 mSv is the definition of a radiation emergency.

(iv) N/E = "Not exceeded" – denotes that the fault does not exceed the stated dose.

(v) Public Dose is reported at the Site boundary and is calculated for the critical individual at the boundary between Sizewell 'A' and the neighbouring Sizewell 'B' Licensed Nuclear Site and should be considered indicative.

(vi) The fault numbering used in this report is (intentionally) not the same as used in the previous issue (as even similar-sounding faults might not be directly comparable).

Appendix A Diagram and Description of Radioactive Waste Facilities

This appendix lists plant associated with the storage or processing of radioactive waste. It includes a diagram, and description of any single plant or enclosed system that may contain more than the quantity or mass of any radioactive substance specified in Schedule 2 or Schedule 3 of the REPPIR Regulations.

Contents

Figures

PLEASE NOTE – Both Imperial and Metric units have been used in the production of this appendix, reflecting the actual figures and units referred to in the associated safety cases, drawings and plant item technical descriptions.

1 REACTOR BUILDINGS

1.1 Reactor Vessels

Sizewell A site maintains 2 shutdown gas cooled Magnox reactors, designated Reactor 1 (R1) and Reactor 2 (R2). The reactors are located within a single structure with a common equipment area located between them (see Figure A1 Cutaway Illustration of Sizewell A (excluding Turbine Hall)).

In simple terms each reactor consists of a spherical steel vessel, 4 1/8 in thick, and 63 ft 6 in in diameter. Each vessel has 8 penetrations for gas ducts, 241 penetrations for fuelling standpipes and various other small penetrations. Each vessel is surrounded by a concrete bioshield. Inside each vessel is a large graphite core which, during operation of the plant, would contain Magnox fuel elements.

The Site is now defueled and no Magnox fuel remains in the reactors or any other location on site.

1.2 Combustible Active Waste Void

Sizewell A has a Combustible Active Waste Void (CAWV) located between the primary and secondary biological shielding on the west side of Reactor 2. The CAWV is above ground.

Fire detection is provided by two smoke detectors located just below the roof level of the void. Fire suppression is via a manually operated breathable inert gas supplied from an installed bottle bank and delivered into the void via installed pipework.

1.3 Non-Combustible Active Waste Void

The Non-Combustible Active Waste Void (N-CAWV) is located between the primary and secondary biological shielding on the eastern side of Reactor 1.

The void is closed, and there is no forced airflow through the void.

1.4 Remote Handling Facility Disposal Void

The Remote Handling Facility (RHF) Disposal Void is a heavily shielded reinforced concrete compartment located directly beneath the RHF at the north side of the reactor common equipment area.

The void is connected to an active ventilation system and maintained at sub atmospheric pressure. Air extracted from the void passes through HEPA filters before being discharged to the atmosphere. Non-return dampers are fitted in the system to minimise the risk of contaminated air flowing back from the void should the extract fail.

1.5 Filter Spool Shielded Disposal Voids (No Longer Used)

The Filter Spool Shielded Disposal Voids (one per reactor) are situated between the reactor primary and secondary bioshield on the southeast and southwest of Reactor 1 and Reactor 2 respectively.

Historically, waste filter spools were disposed of into the voids, but later arisings were disposed of directly to the LLW Repository.

1.6 Flux Flattening Element and Reactor Equipment Shielded Disposal Voids

The Flux Flattening Element and Reactor Equipment Shielded Disposal Voids (SDV) (one per reactor) are located between the primary and secondary bioshield surrounding each reactor, northwest of Reactor 1 and northeast of Reactor 2.

2 POND BUILDING

2.1 Irradiated Fuel Cooling Pond

The Irradiated Fuel Cooling Pond (the pond) is on the north side of the Reactor Building. The pond is constructed above ground from reinforced concrete and sits on a concrete raft. Incorporated within the raft is an under-drainage system consisting of trenches and pipes which allow any water seepage from construction joints to be collected in sumps from which it can be monitored and discharged.

The pond is divided into five bays; one reception bay and one storage bay for each reactor, and a common despatch/skip hoist bay. The normal water depth is 22 ft 2 in.

The sectional walls separating the different bays are the same height as the external walls. During normal operation the bays are interconnected by apertures in the sectional walls. When it is required to isolate a bay, the apertures can be sealed by installation of removable log gates.

The pond is enclosed and roofed by a steel girder and cladding superstructure. By design the pond does not have forced ventilation, however natural ventilation is provided by louvres on north, east and west sides of the cladding superstructure.

At the north end of the pond the discharge shaft, which is totally enclosed and angled at 45°, connects the pond to the flask transit passage where fuel was formerly loaded into road transport flasks for despatch to Sellafield.

3 ACTIVE EFFLUENT TREATMENT PLANT (AETP) BUILDING

3.1 Splitter Vane Store (SVS)

The Splitter Vane Store consists of 6 identical stores located within shielded containment at the eastern end of the Effluent Treatment Plant Building) (see Figure A1 Cutaway Illustration of Sizewell A (excluding Turbine Hall)). The stores are predominantly above ground and consist of concrete cells on top of a concrete secondary containment tray. The six stores are linked by a ventilation system and an overflow system which is routed to Monitoring & Delay Tanks (MDTs).

3.2 Final Active Waste Tanks (FAWTs)

The Final Active Waste Tanks are located to the east of the Effluent Treatment Building, south of the adjacent SVS. Both tanks are manufactured from mild steel and are neoprene lined.

3.3 Sand Pressure Filter (SPF) Room

The Sand Pressure Filter Room is located within the AETP Building. The Sand Pressure Filter Room houses both the Pond and Effluent Treatment Plant Processing Units (with the exception of the Decarbonation Sump and Tower).

The Pond Treatment units consist of 4 sand pressure filters (designated 1-4), a Hydrogen-Cation-Exchange unit (HCE) and a De-Acidite Exchange unit (DA). A second HCE is not in service.

The original Effluent Treatment units consisted of 3 sand pressure filters (designated 5-7) and 2 settling tanks (SLT 1 and 2). All of these original units were constructed from mild steel and lined internally with a neoprene coating. The original 3 Effluent

Treatment sand pressure filters (SPFs) are no longer in service. SPF 7 was removed and replaced with a stainless steel vessel. SPFs 5 and 6 are removed from the system but the vessels remain in the SPF room. These were replaced with 3 stainless steel vessels (designated 8-10).

A resin transfer line exists, running from a sand/resin sump in the floor of the room to the WCT.

The settling tanks are no longer in service and remain empty, as settling capability is provided by the Wash Collection Tank.

3.4 Active Effluent Tank (AET)

The Active Effluent Tank (AET) is a neoprene-lined concrete tank with a concrete roof, located between the AETP Building and the Irradiated Fuel Cooling Pond. The tank is fitted with various level probes and level alarms.

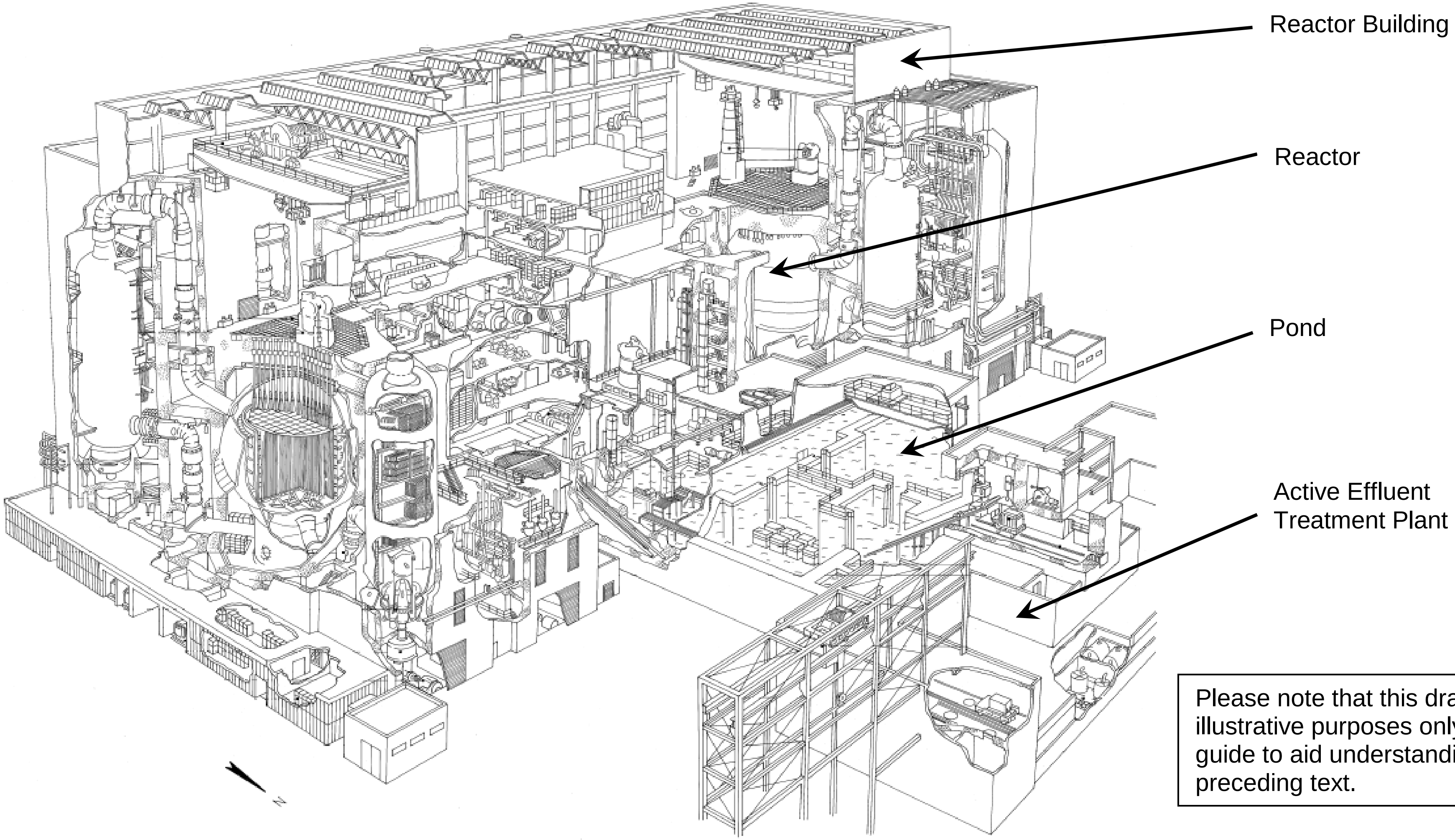
3.5 AETP Sub-basement Tanks

Various tanks are located within the sub-basement of the AETP. There are 4 Monitoring and Delay Tanks (MDTs) in service, and 2 further MDTs which are empty and isolated. In addition there is a Regenerant Neutralising tank (RNT), and a Wash Collection Tank (WCT). All the tanks are of concrete construction. The MDTs are lined with a cementitious coating, the WCT is neoprene-lined, and the RNT is lined with a glass-reinforced polymer.

All tanks are fitted with high-level alarms to prevent overflowing.

3.6 Final Monitoring and Delay Tanks (FMDTs)

The FMDTs are located between the AETP Building to the north and the Irradiated Fuel Cooling Pond to the south. The 2 concrete tanks are lined with a flexible cementitious coating and located underneath a concrete watertight roof. Both tanks are fitted with level probes and high level alarms.



Please note that this drawing is for illustrative purposes only, for use as a guide to aid understanding of the preceding text.

FIGURE A1 Cutaway Illustration of Sizewell A (excluding Turbine Hall).