Hunterston A: Response to EU Stress Tests following the Events at Fukushima, Japan

Following the nuclear accident at Fukushima in Japan, the European Union agreed on assessments for all of its 143 nuclear power plants, based on a set of common criteria. These criteria have been developed by ENSREG (the European Nuclear Safety Regulators Group) and have become known as 'Stress Tests'.

In response to the Stress Tests, operators of UK nuclear power plants have reviewed the resilience of their plants to extreme situations, in particular the loss of safety functions however caused, including the loss of electrical power or loss of ultimate heat sink for heat removal from the reactor or spent fuel storage areas.

This report details the results of the Stress Test for Hunterston A Site. It has been submitted to the Office for Nuclear Regulation (an agency of the Health and Safety Executive) who will review all UK submissions and prepare a summary national report. This will be reviewed by ENSREG who will report to the European Council in June 2012.

Issued by

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Contents

0 Executive Summary

This report forms the Hunterston A Site specific information and will be summarised in NP/SC 5014 Revision 1 Addendum 1 (Topic B). This report gives the outcome of a “stress test” or targeted reassessment of the safety margins for Hunterston A Site in the light of events that occurred at Fukushima. It follows the specification prepared by ENSREG.

Hunterston A Site comprises the remaining structures of defuelled and decommissioning Hunterston A nuclear power station, which when operational comprised two Magnox, gas cooled, graphite moderated, natural uranium fuelled reactors.

The reactors are defuelled and there is negligible fuel remaining on site, therefore there are no requirements for reactivity control, cooling or ultimate heat sinks. The reactors require minimal services to maintain their long-term physical integrity and there are no safety demands on site services. The fuel pond contains no significant amount of irradiated fuel.

Intermediate level waste (ILW) and low-level waste (LLW) are contained partly in purpose built storage facilities and partly in redundant process facilities.

All the major structures on site have been assessed against the design basis earthquake and found to be robust and to have an acceptable performance.

A Periodic Safety Review of the site was completed in 2010 and the safety cases of the Reactor Buildings and all the radioactive waste management facilities have been reviewed against modern standards. It is concluded that the facilities are robust to the challenges of extreme external hazards used in the analyses and retain their basic integrity for somewhat more severe events and combinations, with no cliff edge effects.

A series of workshops has been held to identify potential measures to enhance resilience in the event of external hazards or severe accidents, and those are being considered for implementation. The site will also be supported by enhancements proposed for central emergency support.

1 General data about site/plant

1.1 Brief description of the site characteristics

- location (sea, river)[1]
- number of units;
- license holder

The site, which contains two defuelled and decommissioning "Magnox" reactors, is on the eastern side of the tidal estuary of the River Clyde known as the Firth of Clyde, in North Ayrshire, United Kingdom. The location is shown in the figure to the right. Local areas of habitation are Fairlie (4.0km) and Largs (7.6km) to the North and West Kilbride (3.8km) to the South.

Magnox Limited is the Site Licence holder for the Hunterston A nuclear licensed site.

1.2 Main characteristics of the unit

- reactor type;
- thermal power;
- date of first criticality;
- existing spent fuel storage (or shared storage).

The Hunterston A reactor design is unique in that each reactor is raised up to a height of 10 metres above the ground to enable refuelling to take place from underneath. This meant that gravity assisted the process of used fuel removal, and avoided the need for lifting machinery to be inserted into the active core for on-load refuelling. When operating on line the 2 reactors had a capability of 180 MW each providing an overall output between 320 and 360 MW during the operation life.

<u>Reactor 1</u>

Reactor 1 is a defuelled Magnox reactor. When operating it contained natural metallic uranium fuel in cans of magnesium/aluminium alloy, known as Magnox. There were ten fuel elements per channel in a graphite moderator core with a large number of fuel channels. The core was cooled by forced circulation of pressurised CO_2 gas through the core transferring heat to boilers supplying steam to the turbine generators. The graphite reactor core and support structure is contained in a spherical steel pressure vessel, which is surrounded by the concrete bioshield and eight boilers, also known as Steam Raising Units (SRUs). The SRUs are isolated from the Reactor Pressure Vessel (RPV) and all other coolant and steam pipes have been cut and isolated. RPV of Reactor 1 is housed in a water-tight building. It is intended that at the end of the current Care and Maintenance Preparations phase of decommissioning the two Reactor Pressure Vessels, internal structures and associated plant will be put into a benign Safestore condition for the Care and Maintenance period of up to 100 years.

[1] Text and headings which are in a smaller font are relevant extracts from the ENSREG Stress Test documentation and not part of the Stress Test response.

Reactor 1 first went critical on 3rd February 1964 and was shut down at the end of life on 30th March 1990. It is currently defuelled with an air atmosphere with no requirement for cooling.

Reactor 2

Reactor 2 is the same design as Reactor 1 and is also defuelled. It first went critical on 17th July 1964 and was shut down at end of life on 31st December 1989.

Irradiated Fuel Cooling Ponds

This is referred to as the Cartridge Cooling Pond (CCP). It provided cooling and shielding of irradiated fuel elements discharged from Reactors 1 and 2 before they were transferred to fuel flasks for transport to the Sellafield reprocessing facility in Cumbria, UK. Defuelling of the reactors started on 16th August 1990 and the last fuel was sent off site on 8th February 1995. The CCP no longer contains fuel apart from two part elements, storage of which is covered by the current safety case. It is planned that these part elements will remain in safe storage prior to being removed from Site in early 2012. All pond skips have been removed and decommissioned. The CCP still contains water which shields the contaminated sludge remaining at the bottom of the pond and contamination in the surface layer of the concrete.

There is also an Acid Storage Facility (ASF) consisting of two double skinned stainless steel tanks held in concrete cells. The acid is ILW that resulted from the dissolution of pond skips.

Radioactive Waste Facilities

There is no high level waste (HLW) on site other than the part elements mentioned above which are to be removed from Site. Intermediate level waste (ILW) and low level waste (LLW) are contained in the original process buildings or in purpose built storage facilities.

These constitute:

- Solid Active Waste Building (SAWB): This constitutes five concrete vaults that contain ILW comprising irradiated graphite (1500m^3), magnesium alloy from cans (565m^3), miscellaneous contaminated items (100m^3), miscellaneous contaminated items (10m^3) and fuel element debris (80m^3). This waste is planned to be immobilised in robust engineered containers and transferred to the ILW Store (see below). This waste was generated during operation and subsequent decommissioning activities on the Site. The vaults are sized to provide radiological protection of operators from the ILW contained in the SAWB;

- Cartridge Cooling Pond: This contained irradiated fuel during operation, but only the two part elements referred to above now remain. The CCP contains some residual steel components, treated water, sludge and surface contamination. The total volume of sludge is estimated as 40m^3. This waste is planned to be immobilised in robust engineered containers and transferred to the ILW Store (see below). The ASF contains ILW that will be immobilised in robust engineered containers and transferred to the ILW Store;

- Low Level Waste Management Facilities: LLW is processed and stored in ISO containers prior to transfer to a Low Level Waste Repository off-site for disposal;

- Reactor Pressure Vessels: These steel pressure vessels are at ambient pressure and temperature and contain non-combustible irradiated metallic items including the control rods and the irradiated graphite core and its support structure. These components will be left in place for the Care and Maintenance period of decommissioning and processed during Final Site Clearance;

- Active Effluent Treatment Plant (AETP): There are two sets of treatment plant associated with the CCP. The AETP comprises the CCP sludge retention tanks (SRTs), miscellaneous SRTs and CCP final delay tanks. The AETP is being replaced by the Active Effluent treatment facility (AETF) comprising the Modular AETP (MAETP), replacement miscellaneous receiving tank (RMRT) and replacement delay tank (RDT). The new facilities (MAETP, RMRT and RDT) were designed and constructed to modern standards and are in good condition. This waste is planned to be immobilised in robust engineered containers and transferred to the ILW Store (see below);

- ILW Store: This is currently completing inactive commissioning but does not yet contain any ILW. This will be followed by active commissioning before the filling stage begins. A revised safety case will be produced for operation of the ILW Store. When operational it will house immobilised waste in robust engineered containers (currently $3m^3$ stainless steel boxes and drums to Radioactive Waste Management Directorate RWMD) requirements) in a safe and secure environment for long term storage until a final disposal route is available. It is a recent construction that has been designed and constructed to modern standards including external hazards at the 10^{-4} level.

The condition and safety case for all the above facilities was assessed as part of the recently completed 2010 Periodic Safety Review (PSR) and was judged to be fit for purpose until the next ten-yearly review and beyond, with no cliff edges, provided on-going inspection and maintenance regimes are continued. Appropriate inspection and maintenance regimes are specified in the Site's Maintenance Schedules. The Hunterston A Asset Management Plan is used as a forward flag to prompt future asset inspection/possible replacement of all the facilities on site. This is overseen by the System Engineering function.

1.3 Systems for providing or supporting main safety functions

In this chapter, all relevant systems should be identified and described, whether they are classified and accordingly qualified as safety systems, or designed for normal operation and classified to non-nuclear safety category. The systems description should include also fixed hook-up points for transportable external power or water supply systems that are planned to be used as last resort during emergencies.

1.3.1 Reactivity control

Systems that are planned to ensure sub-criticality of the reactor core in all shut down conditions, and sub-criticality of spent fuel in all potential storage conditions. Report should give a thorough understanding of available means to ensure that there is adequate amount of boron or other respective neutron absorber in the coolant in all circumstances, also including the situations after a severe damage of the reactor or the spent fuel.

As there is no fuel present in the reactors and as there is no possibility of criticality no reactivity control is required. The control rods remain in the core and will be disposed of during the final phase of decommissioning, known as Final Site Clearance.

Any quantities of fissile material are very small and do not require specific consideration with respect to criticality.

1.3.2 Heat transfer from reactor to the ultimate heat sink

1.3.2.1 All existing heat transfer means / chains from the reactor to the primary heat sink (e.g., sea water) and to the secondary heat sinks (e.g., atmosphere or district heating system) in different reactor shut down conditions: hot shut down, cooling from hot to cold shut down, cold shut down with closed primary circuit, and cold shut down with open primary circuit.

1.3.2.2 Lay out information on the heat transfer chains: routing of redundant and diverse heat transfer piping and location of the main equipment. Physical protection of equipment from the internal and external threats.

1.3.2.3 Possible time constraints for availability of different heat transfer chains, and possibilities to extend the respective times by external measures (e.g., running out of a water storage and possibilities to refill this storage).

1.3.2.4 AC power sources and batteries that could provide the necessary power to each chain (e.g., for driving of pumps and valves, for controlling the systems operation).

1.3.2.5 Need and method of cooling equipment that belong to a certain heat transfer chain; special emphasis should be given to verifying true diversity of alternative heat transfer chains (e.g., air cooling, cooling with water from separate sources, potential constraints for providing respective coolant).

As there is no fuel and therefore no heat generating source in the reactors no heat transfer mechanisms are required. The temperature of the reactor internals follows ambient temperature conditions.

1.3.3 Heat transfer from spent fuel pools to the ultimate heat sink

1.3.3.1 All existing heat transfer means / chains from the spent fuel pools to the primary heat sink (e.g., sea water) and to the secondary heat sinks (e.g., atmosphere or district heating system).

1.3.3.2 Respective information on lay out, physical protection, time constraints of use, power sources, and cooling of equipment as explained under 1.3.2.

As there is no fuel present in the CCP (other than the fuel fragments mentioned above) and therefore no heat generating source no heat transfer mechanisms are required. The temperature of the water follows ambient temperature conditions.

1.3.4 Heat transfer from the reactor containment to the ultimate heat sink

1.3.4.1 All existing heat transfer means / chains from the containment to the primary heat sink (e.g., sea water) and to the secondary heat sinks (e.g., atmosphere or district heating system).

1.3.4.2 Respective information on lay out, physical protection, time constraints of use, power sources, and cooling of equipment as explained under 1.3.2.

There is no reactor containment and hence no need for heat transfer. Containment for the components in the reactors is provided by the Reactor Pressure Vessels with no need for heat transfer as stated above.

1.3.5 AC power supply

1.3.5.1 Off-site power supply

1.3.5.1.1 Information on reliability of off-site power supply: historical data at least from power cuts and their durations during the plant lifetime.

The site electrical supplies are derived from an off-site 11kV sub- station. Supplies to this sub-station are derived from the District Network Operator (DNO) via two overhead grid lines. The DNO is solely responsible for the operation and maintenance of this equipment. Access to this equipment is also available to Hunterston A Site electrical personnel at all times. Voltage dips or short interruptions of the off-site power supply are experienced several times per year. Longer interruptions, sufficient to initiate the automatic starting of the back-up diesel generator, are typically experienced less than once per year.

1.3.5.1.2 Connections of the plant with external power grids: transmission line and potential earth cable routings with their connection points, physical protection, and design against internal and external hazards.

The system handover point is the outgoing cable terminations on the metering circuit breaker, with the DNO being responsible up to the terminating point and the site being responsible for the cable from the metering circuit breaker to the incoming isolator of the Hunterston A Site 11 kV Main Switchboard.

The 415V system is solidly earthed and all neutrals are bonded to common earthing bars, thus giving a neutral-to-earth path of very low impedance. The value of earth fault current is therefore comparable to the values of phase fault current that may occur. Sub-circuit protection consists of fuses and, in order that satisfactory discrimination of protection exists, overcurrent protection using inverse minimum time relays has been installed on the main feeders. Earth faults are cleared by the operation of fuses or the overcurrent relays.

1.3.5.2 Power distribution inside the plant

1.3.5.2.1 Main cable routings and power distribution switchboards.

1.3.5.2.2 Lay-out, location, and physical protection against internal and external hazards.

The main on-site electrical distribution system is 415V three phase with a limiting capacity of 3MVA, supplied via distribution boards located in the second floor of each Reactor Building. The Reactor 1 415V transformer supplies 19 circuits, 10 of which can also be switched to supplies from the other transformer. The Reactor 2 415V transformer supplies 18 circuits, 9 of which can be supplied from the other transformer. Low voltage auxiliaries of an important operational nature are duplicated and these alternative auxiliaries are fed from different transformer supplies to facilitate ease of changeover in the event of the failure of any section of the distribution system. The facility safety cases allow for the loss of of-site power for approximately three days. Recent investigations have shown that there are no significant safety consequences for longer periods as the only safety related systems that require electrical supplies are associated with monitoring for hydrogen in the waste vaults. The lower flammable limit for hydrogen in air is 4% and to protect against this a limit of 1.2% hydrogen in air is established via an Operating Rule. In addition environmental conditions of temperature and relative humidity are monitored in the reactor vessels. Any ongoing processes that have their power interrupted will stop in a safe state. This is supported by historical data that provide evidence of minimal change from the steady state of 0.03% hydrogen in air over the decommissioning period of the last ten years.

1.3.5.3 Main ordinary on-site source for back-up power supply

1.3.5.3.1 On-Site sources that serve as first back-up if offsite power is lost.

1.3.5.3.2 Redundancy, separation of redundant sources by structures or distance, and their physical protection against internal and external hazards..

1.3.5.3.3 Time constraints for availability of these sources and external measures to extend the time of use (e.g., fuel tank capacity).

In the event of a total grid loss, standby supplies are provided via diesel generators for the emergency lighting system and for the Emergency Control Centre via additional diesel generators that will automatically start and support the required operational demands. The emergency lighting generators run for 80 hours on a tank of diesel fuel. Battery chargers and associated battery supplies (240V and 110V) located on the seventh floor of each Reactor Building, support the short term emergency requirements. These batteries will provide support for 72 hours on full load. Facilities are available to make ad hoc connections for recharging the batteries.

1.3.5.4 Diverse permanently installed on-site sources for back-up power supply

1.3.5.4.1 All diverse sources that can be used for the same tasks as the main back up sources, or for more limited dedicated purposes (e.g., for decay heat removal from reactor when the primary system is intact, for operatio of systems that protect containment integrity after core meltdown).

1.3.5.4.2 Respective information on location, physical protection and time constraints as explained under 1.3.5.3.

There is no need identified in the safety case for a diverse back-up power supply.

1.3.5.5 Other power sources that are planned and kept in preparedness for use at last resort means to prevent a serious accident damaging reactor or spent fuel.

1.3.5.5.1 Potential dedicated connections to neighbouring units or to nearby other power plants.

1.3.5.5.2 Possibilities to hook-up transportable power sources to supply certain safety systems.

1.3.5.5.3 Information on each power source; power capacity, voltage level and other relevant constraints.

1.3.5.5.4 Preparedness to take the source in use: need for special personnel, procedures and training, connection time, contract arrangements if not in ownership of the Licensee, vulnerability of source and its connection to external hazards and weather conditions.

None of the electrical supplies are essential for nuclear or radiological safety, even for extended periods of loss.

1.3.6 Batteries for DC power supply

1.3.6.1 Description of separate battery banks that could be used to supply safety relevant consumers: capacity and time to exhaust batteries in different operational situations.

1.3.6.2 Consumers served by each battery bank: driving of valve motors, control systems, measuring devices, etc.

1.3.6.3 Physical location and separation of battery banks and their protection from internal and external hazards.

1.3.6.4 Alternative possibilities for recharging each battery bank.

The battery supplies are as indicated in 1.3.5.3 above.

1.4 Significant differences between units

This chapter is relevant only for sites with multiple NPP units of similar type. In case some site has units of completely different design (e.g., PWR's and BWR's or plants of different generation), design information of each unit is presented separately.

There are no significant differences between the reactors.

1.5 Scope and main results of Probabilistic Safety Assessments

Scope of the PSA is explained both for level 1 addressing core meltdown frequency and for level 2 addressing frequency of large radioactive release as consequence of containment failure. At each level, and depending on the scope of the existing PSA, the results and respective risk contributions are presented for different initiating events such as random internal equipment failures, fires, internal and external floods, extreme weather conditions, seismic hazards. Information is presented also on PSA's conducted for different initiating conditions: full power, small power, or shut down.

Following shut down of the reactors in 1989 and completion of defuelling, most of the potential faults that relate to an operating nuclear power station are no longer applicable at Hunterston site.

The safety cases for each of the waste management facilities do not include a PSA. The safety cases are based on the establishment of a fault schedule, the calculation of the radiological consequences for each of the faults using the Company's methodology and the calculation of the associated risk for each fault.

The results of these analyses show that that for all the radioactive waste facilities risks are consistent with national and international standards and are as low as reasonably practicable (ALARP). These analyses have also shown that there is no requirement for prompt operator action or for formal protective safety measures to prevent or mitigate any reasonably foreseeable fault or hazard. Sufficient engineered safety measures and procedures are provided to ensure that all radioactive materials stored within the facilities will remain appropriately shielded and contained. Should there be an off-site release of activity; the emergency arrangements described in Section 6 would be instigated.

This safety assessment will remain valid as long as the buildings and equipment of the radioactive waste facilities are maintained (and repaired as necessary) in accordance with the specified maintenance schedules and that the planned facility inspections and future Planned, Periodic Safety Reviews will demonstrate continued integrity of the shielding and containment structures and satisfactory operation of monitoring systems.

2 Earthquakes

2.1 Design basis

2.1.1 Earthquake against which the plant is designed

2.1.1.1 Characteristics of the design basis earthquake (DBE)

Level of DBE expressed in terms of maximum horizontal peak ground acceleration (PGA). If no DBE was specified in the original design due to the very low seismicity of the site, PGA that was used to demonstrate the robustness of the as built design.

Although the station was not originally designed to have a seismic capability it was designed to the conservative design codes of the time. The current safety case for the site has assessed the capability of the facilities to withstand a design basis earthquake. This design basis earthquake for Hunterston A Site is a peak horizontal free field ground acceleration of 0.164g at an annual probability of exceedence of 10^{-4}. The peak vertical acceleration is 2/3 of this. The design basis earthquake is defined by the envelope of the Principia Mechanica Limited (PML) hard site design ground response spectrum anchored to a horizontal zero period acceleration of 0.1g and a UK generic uniform risk ground response spectrum with a probability of exceedance of 10^{-4} per annum. The PML spectrum determines the overall spectral magnitude at low frequencies. The uniform risk spectrum dominates at higher frequencies. The ground response spectrum used in the assessment of capability is that for a hard site.

2.1.1.2 Methodology used to evaluate the design basis earthquake

Expected frequency of DBE, statistical analysis of historical data, geological information on site, safety margin.

No site specific seismic hazard study has been undertaken for the Hunterston site.

The uniform risk spectrum component of the design basis earthquake for the Hunterston A Site was derived from a probabilistic seismic hazard assessment whose input seismic source parameter distributions (b-value, activity rate, maximum magnitude, depth etc.) represent the characteristics of seismicity within the UK region as a whole. The seismic source is taken to be a 500km square zone centred around a generic site. In the absence of sufficient UK-specific strong motion records, ground motion spectral attenuation relationships were derived by regression analysis of earthquake records from regions elsewhere in the world considered to share tectonic similarity with the UK. The response spectrum used in the definition of the design basis event is that assessed to have a uniform probability of exceedance of 10^{-4} per annum.

The PML UK design response spectra are piece-wise linear (on a standard tripartite plot) response spectra derived by statistical analysis of strong motion earthquake records from elsewhere in the world conforming to the profile of expected UK events. This is again necessitated by a lack of suitable UK-specific strong motion records. These design spectra may be anchored to any zero period acceleration. For the purpose of defining the design basis event the spectrum has been anchored to a zero period acceleration of 0.1g in recognition of the international regulatory significance of that value.

The design basis earthquake is defined as the upper envelope of these two spectral components.

The methodology presented in the original safety cases for the facilities at Hunterston A Site was to use the design basis earthquake described above as input to simple finite element models of the structures. These safety cases were reviewed and modified as appropriate to take account of the site being defuelled. New analyses were carried out where required for new facilities built.

2.1.1.3 Conclusion on the adequacy of the design basis for the earthquake

Reassessment of the validity of earlier information taking into account the current state-of-the-art knowledge.

The UK as a whole is a region of relatively low-level and diffuse seismic activity. No specific geological or tectonic features have been identified that would suggest that earthquakes larger than those considered in the studies underpinning the Hunterston A Site design basis event are credible. Examination of the pattern of historical UK seismicity indicates that Hunterston A Site is situated in a region of low to moderate earthquake activity by UK standards. The use of a UK generic uniform risk spectrum within the definition of the design basis event is, therefore, considered reasonable in lieu of a site-specific hazard assessment.

Knowledge of UK seismicity has increased somewhat since the design basis was established and methods for seismic hazard analysis continue to advance. Nevertheless, it is considered that the design basis earthquake is a conservative representation of the prevailing seismic hazard for the Hunterston A Site at a 10^{-4} per annum exceedance frequency.

The seismic safety cases for the defuelled facilities concluded that they had the capability to withstand the seismic event. Recently a Periodic Safety Review (PSR) has been carried out and the conclusion drawn that although the seismic analyses of the facilities are not to modern standards they are adequate bearing in mind the very limited consequences should failure occur, due to the nature and activity of the wastes stored in the facilities.

2.1.2 Provisions to protect the plant against the design basis earthquake

2.1.2.1 Systems Structures and Components (SSCs)

Identification of systems, structures and components (SSCs) that are required for achieving safe shut down state and are most endangered during an earthquake. Evaluation of their robustness in connection with DBE and assessment of potential safety margin.

As the reactors and the pond are defuelled there are no systems or components providing protection to produce a safe shutdown state. The steel Reactor Pressure Vessels provide containment for the radioactive components of the core and the pond concrete structure provides containment for the pond water and sludge. The concrete vaults of the SAWB provide containment for the irradiated components. The ponds (including the water) provide radiation shielding to the operators from the sludge and other components. The concrete structure of the ILW Store will provide shielding to the operators from the packages once the store filling stage starts. All these facilities and others providing storage for intermediate level waste are designed to withstand the

DBE. The magnitude of earthquake leading to loss of integrity of each of the waste management facilities was considered in 1996 as part of the Long Term Safety Review of Hunterston A. The results of this analysis showed earthquake magnitudes of 0.17g or greater for all the facilities. The limiting plant items are the redundant SRUs (boilers) that are isolated from the RPVs; more recent analysis has shown, however, that the failure of the SRUs is acceptable and that there are no consequential concerns of their failure on other plant. The ASF is not seismically qualified and the safety case calculates a dose to the public of a few microsieverts following a seismic event.

Conservative assessments of the post-seismic radiological consequences are included in the Site Safety Case that was assessed as part of the PSR. The site risk from the design basis earthquake is shown to be well within the broadly acceptable range when assessed against Regulatory criteria and is ALARP.

2.1.2.2 Main operating contingencies in case of damage that could be caused by an earthquake and could threaten achieving safe shut down state.

Monitoring of the atmospheric conditions inside the reactor pressure vessels to give forewarning of any deterioration of integrity. This monitoring is to measure relative humidity levels so action can be taken to keep it below 75%. Any transient above 75% RH would only be of concern in the much longer term as any possible enhanced rate of metal loss would still be low. Civil inspections are carried out on the SAWB and the pond to give forewarning of any deterioration of integrity. The pond water depth is controlled between 6.1m and 7.3m to minimise normal operating doses to staff from the radioactive sludge remaining at the bottom of the pond; scheduled dosing with Sodium Hydroxide maintains the pH level at 11. No cliff edge consequences arise from short lived deviations.

The following key actions would be invoked in the longer-term:

Establish command and control of the event

Man the site Emergency Control Centre, or if not tenable establish an alternate command post.

Establish monitoring of key parameters

Establish ability to monitor hydrogen detection in Bunker 1 and relative humidity levels within the Reactor Pressure Vessels.

Carry out plant inspections and prioritise repair of damaged plant

Access for post-seismic plant inspection would be subject to expert assessment of the structural condition of the buildings and would be conditioned by radiological surveys. For the Hunterston A Site none of this would be on an urgent time-scale.

2.1.2.3 Protection against indirect effects of the earthquake

2.1.2.3.1 Assessment of potential failures of heavy structures, pressure retaining devices, rotating equipment, or systems containing large amount of liquid that are not designed to withstand DBE and that might threaten heat transfer to ultimate heat sink by mechanical interaction or through internal flood.

2.1.2.3.2 Loss of external power supply that could impair the impact of seismically induced internal damage at the plant.

2.1.2.3.3 Situation outside the plant, including preventing or delaying access of personnel and equipment to the site.

2.1.2.3.4 Other indirect effects (e.g. fire, explosion).

The indirect effects from failure of non-seismically qualified structures are shown in the facility safety cases to be acceptable. The seismic safety case for the design basis earthquake assumes that the earthquake causes an immediate loss of all incoming electrical power supplies to the site. No reliance is placed on restoration of those supplies for maintenance of essential safety functions. Loss of external power supplies is also considered in Section 5 below. The only other indirect effect could be a delay in personnel getting to site. This would only affect monitoring arrangements and would not affect the safety case. One indirect effect would be related to the neighbouring AGR site Hunterston B (licensee EdF) should there be an off-site release of radioactivity from those reactors. There are no specific operating contingencies required to maintain the plant in a safe condition following an earthquake at Hunterston A Site.

2.1.3 Compliance of the plant with its current licensing basis

2.1.3.1 Processes to ensure SSCs remain in faultless condition

Licensee's processes to ensure that plant systems, structures, and components that are needed for achieving safe shut down after earthquake, or that might cause indirect effects discussed under 2.1.2.3 remain in faultless condition.

The plant is subject to routine maintenance, inspection and testing as required by the Nuclear Maintenance Schedule, which lists those activities that are necessary to support the ongoing site safety case. This is implemented in accordance with Management Control Procedure (MCP) 19 “Management of Maintenance Work” and MCP 13 “Surveillance and Routine Testing of Plant Items and Systems”. Specific procedures include S-268 "Inspection and Assessment of Nuclear Safety Related Civil Structures to Comply with Site Licence Condition 28", whose scope specifically includes all significant civil structures and specifically includes structures claimed for seismic support. These inspections are carried out on at least five yearly intervals or following extreme weather events. In addition Systems Engineering Department carry out walkdowns of all facilities on an annual basis. Any changes to the plant or the safety case are controlled via MCP 99.

The ability of the facilities to continue to meet their integrity requirements is demonstrated by the civil inspections carried out in accordance with procedures under Licence Condition 28 arrangements. Planned System Engineering walkdown reports are completed frequently to a given programme.

At 10-yearly intervals, and in response to significant operating events, the safety of the plant is reviewed in a Periodic Safety Review (PSR). This reviews the plant against modern standards, operating experience and the effect of ageing. A PSR has recently been completed and the identified enhancements are being implemented.

2.1.3.2 Processes for mobile equipment and supplies

Licensee's processes to ensure that mobile equipment and supplies that are planned to be available after an earthquake are in continuous preparedness to be used.

As part of the emergency arrangements described in Section 6, provision is made for off-site surveys of potential radioactive contamination using off-road vehicles and monitoring equipment from Hunterston over a radius up to 15km. Similar equipment is provided by other nuclear sites and the UK Ministry of Defence from this radius out to 40km.

2.1.3.3 Potential deviations from licensing basis

Potential deviations from licensing basis and actions to address those deviations.

There are no potential deviations from the licensing.

2.2 Evaluation of safety margins

As part of the seismic safety case for the facilities, an assessment of the ability to withstand the design basis earthquake has been carried out. In addition an assessment of the seismic withstand of the various buildings has been carried out.

2.2.1 Range of earthquake leading to severe fuel damage

Weak points and cliff edge effects: estimation of PGA that would result in damage to the weakest part of heat transfer chain, and consequently cause a situation where the reactor integrity or spent fuel integrity would be seriously challenged.

There is no fuel present on site so this is not applicable.

2.2.2 Range of earthquake leading to loss of containment integrity

Estimation of PGA that would result in loss of integrity of the reactor containment.

There is no containment structure. The integrity of the radioactive waste facilities is considered in Section 2.1.2.

2.2.3 Earthquake exceeding the design basis earthquake for the plant and consequent flooding exceeding design basis flood

Possibility of external floods caused by an earthquake and potential impacts on the safety of the plant. Evaluation of the geographical factors and the physical possibility of an earthquake to cause an external flood on site, e.g. a dam failure upstream of the river that flows past the site.

In general no specific analysis has been carried out for this combination of faults. However, because of the ability of radioactive waste management facilities to maintain their containment integrity following an earthquake, it is judged that there would be no significant spread of contamination should a consequential flood occur. The relatively low magnitudes together with the anticipated mechanisms of UK earthquakes indicate that the potential for a significant tsunami resulting from a local earthquake is very low. Furthermore, the potential for local landslips into water or slippage of the river/sea bed leading to a local tsunami affecting the Site is also considered to be negligible. A more significant tsunami could credibly result from a distant earthquake, although this would still be small compared to that at Fukushima. In that case, however, the ground motion at the Site resulting from the earthquake would not be damaging. Thus, the potential for significant earthquake damage combined with significant tsunami-induced damage can be discounted.

The ILW Store has been designed in such a way that the concrete structure that provides radiological protection (and defence against flooding) will withstand a 0.25g peak ground acceleration earthquake.

There are no nearby bodies of stored water or water-retaining structures that are above the level of the Site. There are, therefore, no bodies of water that could be breached leading to site flooding following a design basis earthquake.

Localised flooding following a design basis earthquake could arise from failures of on-site non-qualified water sources. The potential for, and consequences of, such flooding (including the effects of spray) have been considered and a safety case demonstrated.

2.2.4 Potential need to increase robustness of the plant against earthquakes

Consideration of measures, which could be envisaged to increase plant robustness against seismic phenomena and would enhance plant safety.

Following the Fukushima event a series of workshops have been held within Magnox Limited to consider robustness of the site and its facilities against internal and external hazards and to look at the Site's emergency preparedness arrangements. Some areas for consideration were identified and these are currently being assessed.

No measures have been identified as necessary to increase the robustness of the radioactive waste facilities against earthquakes. The assessed risk from the consequences of the design basis earthquake is not sufficiently high to warrant expenditure on any practicable measures of improvement (i.e. the plant is considered already to meet ALARP criteria).

3 Flooding

3.1 Design basis

3.1.1 Flooding against which the plant is designed

3.1.1.1 Characteristics of the design basis flood (DBF)

Maximum height of flood postulated in design of the plant and maximum postulated rate of water level rising. If no DBF was postulated, evaluation of flood height that would seriously challenge the function of electrical power systems or the heat transfer to the ultimate heat sink.

The flood level for the 10^{-4} flood is 4.52m above ordnance datum (AOD) giving a flood depth above the general site ground level of 640mm. This is based on a 10^{-4} highest astronomical tide combined with a storm surge.

In defining the design basis flood levels for the Site no explicit account has been taken of potential tsunami risk. The tsunami threat is considered to arise primarily from large distant earthquakes. Any residual tsunami wave is expected to be small compared to that at Fukushima. At the 10^{-4} per annum exceedance frequency the risk from tsunamis will be bounded by the existing design basis sea levels considering extreme tide and surge combinations.

3.1.1.2 Methodology used to evaluate the design basis flood.

Reassessment of the maximum height of flood considered possible on site, in view of the historical data and the best available knowledge on the physical phenomena that have a potential to increase the height of flood. Expected frequency of the DBF and the information used as basis for reassessment.

Extreme tidal levels (highest astronomical tide) are based on long term observations for the River Clyde, transformed to provide tide predictions at coastal locations adjacent to the Site. The extreme combined tide and surge level has been derived from statistical analysis of long-term observations of surge levels coincident with high tide.

The methodology used to assess the consequences of the design basis flood was to establish the height water would need to reach to challenge the safety case and cause a release of radioactive material.

As part of the recent PSR carried out for Hunterston A Site (carried out every ten years) the ability of the facilities that contain radioactive waste to meet the safety case requirements with regard to the 10^{-4} flood has been assessed. The possible effect of climate change, in particular on flood level, over the next 10 to 15 year period was considered as part of this assessment. The conclusion reached by the PSR was that the design of the radioactive waste management facilities including height above datum and location of any penetrations was such that the 10^{-4} flood would not result in a spread of contamination and an adequate safety case was in place with no cliff edge effects.

3.1.1.3 Conclusion on the adequacy of protection against external flooding

Each of the Hunterston A Site radioactive waste management facilities has been assessed for the effects of the potential 10^{-4} per year site-wide flood.

The flooding safety cases for the defuelled facilities concluded that they had the capability to withstand the event and not release radioactive material.

Recently a Periodic Safety Review (PSR) has been carried out and the conclusion drawn that this case remains valid.

It should be noted that the duration of any flooding onto site would be limited by the drop in water level following the time of high tide.

3.1.2 Provisions to protect the plant against the design basis flood

3.1.2.1 Systems Structures and Components (SSCs)

Identification of systems, structures and components (SSCs) that are required for achieving and maintaining safe shut down state and are most endangered when flood is increasing.

No systems, structures or components are required for achieving or maintaining a safe shutdown state because the reactors are defuelled.

The key structures that provide protection against a DBF are the containment structures of the facilities that contain radioactive waste. Components that could provide paths for floodwater to enter the facilities are either at a height that are not affected by the DBF or are engineered to preclude water ingress.

It is therefore concluded that although the site may become inundated to a greater depth than the BDF, the key structures will remain water tight and any openings either impervious to ingress or above the water level. The key structures are obviously able to withstand the increased hydrostatic loading and failure from hydrostatic or hydrodynamic loading is considered not credible.

3.1.2.2 Main design and construction provisions

Main design and construction provisions to prevent flood impact to the plant.

The main protection of the facilities against flooding is provided by their height above sea level and significant openings into the facilities being at high level on the facilities.

3.1.2.3 Main operating provisions

Main operating provisions to prevent flood impact to the plant.

There are currently no provisions to prevent the flood impact identified. Many hours notice of extreme tides and surges would be expected. Precautionary actions could, therefore, be taken to mitigate the risk of flooding.

3.1.2.4 Situation outside the plant

Situation outside the plant, including preventing or delaying access of personnel and equipment to the site.

There are no immediate consequences of delayed access to site as all operations can be safely terminated locally. As the design basis flood is the result of high tides and storm surge there would be forewarning of the event. In addition the height of flooding would reduce with the receding tide. There are no other effects.

3.1.3 Plant compliance with its current licensing basis

3.1.3.1 Processes to ensure SSCs remain in faultless condition

Licensee's processes to ensure that plant systems, structures, and components that are needed for achieving and maintaining the safe shut down state, as well as systems and structures designed for flood protection remain in faultless condition.

The plant is subject to routine maintenance, inspection and testing as required by the Nuclear Maintenance Schedule, which lists those activities that are necessary to support the ongoing site safety case. This is implemented in accordance with MCP 19 "Management of Maintenance Work" and MCP 13 "Surveillance and Routine Testing of Plant Items and Systems". Any changes to the plant or the safety case are controlled via MCP 99.

At 10-yearly intervals, and in response to significant operating events, the safety of the plant is reviewed in a PSR. This reviews the plant against modern standards, operating experience and the effect of ageing. Such a review has recently been completed for Hunterston A Site. In addition when applicable, enhancements identified in response to operating experience from other sites have been implemented.

3.1.3.2 Processes for mobile equipment and supplies

Licensee's processes to ensure that mobile equipment and supplies that are planned for use in connection with flooding are in continuous preparedness to be used.

There is no mobile equipment or supplies identified in connection with flooding. With regard to accident management following the flooding event the only mobile equipment is associated with the off-site survey vehicles described in Section 2.1.3.2.

3.1.3.3 Potential deviations from licensing basis

Potential deviations from licensing basis and actions to address those deviations.

There are no potential deviations from the licensing basis with regard to the design basis flood.

3.2 Evaluation of safety margins

3.2.1 Estimation of safety margin against flooding

Estimation of difference between maximum height of flood considered possible on site and the height of flood that would seriously challenge the safety systems, which are essential for heat transfer from the reactor and the spent fuel to ultimate heat sink.

The concern with flood levels above the DBF is with regard to radioactive waste held within the facilities becoming mobile. As stated in Section 3.1.1.1 the flood level above Site ground level is 0.64m. The height above ground level that could allow water ingress to the radioactive waste facilities is:

- Reactor Pressure Vessels. The standpipe flanges at the bottom of the vessel are 12.65m above ground level;

- SAWB. The loading floor is 14.7m above ground level;

- CCP. The top of the pond walls are 4.57m above ground level. The access door to the ASF cells is 12.4m above ground level;

- ILW Store. The top of the continuous concrete structure that forms the shielding around the packages is 14.6m above ground level.

In general there is seen to be a margin of a few metres above the DBF level. As the structures involved were designed to operate at pressure or to provide radiological shielding, they are capable of withstanding small external hydrostatic pressures and are protected by their location and other structures on site from dynamic loads caused by debris. There are some concrete tanks at ground level, but these are all robustly sealed against ingress of flood water. Most of these tanks are redundant containing only non-active supernatant and the remainder contain limited inventory.

3.2.2 Potential need to increase robustness of the plant against flooding

Consideration of measures, which could be envisaged to increase plant robustness against flooding and would enhance plant safety.

No need to increase the robustness of the plant against flooding was identified by the recently completed Periodic Safety Review.

4 Extreme weather conditions

4.1 Design basis

4.1.1 Reassessment of weather conditions used as design basis

4.1.1.1 Characteristics of design basis extreme weather conditions

Verification of weather conditions that were used as design basis for various plant systems, structures and components: maximum temperature, minimum temperature, various type of storms, heavy rainfall, high winds, etc.

Each of the radioactive waste facilities has had safety cases produced against the extreme weather conditions of wind, rainfall, snow and ice, ambient temperature extremes and relative humidity. The recent Periodic Safety Review has reviewed the overall position with regard to these external hazards and come to the conclusion that an adequate safety case exists for each of the radioactive waste facilities.

4.1.1.2 Postulation of design basis characteristics

Postulation of proper specifications for extreme weather conditions if not included in the original design basis.

The latest environmental parameters for extreme weather conditions, including the effects of global warming, are given in a Company document.

4.1.1.3 Assessment of frequency

Assessment of the expected frequency of the originally postulated or the redefined design basis conditions.

Wind: The threat from extreme winds arises from the possibility that items such as roofing sheets or wall cladding could be released by the wind. This affects the weather tightness of buildings and can produce wind-blown missiles. It is possible that ventilation systems may be disrupted if vent stacks are damaged. No significant radiological release would occur as a result of short-term loss of building weather tightness and entry of rainwater or by interruption of ventilation provisions. Following any extreme weather episode the site would be assessed and repairs effected. It is judged that there will be no radiological consequence as a result of wind-blown missiles because all of the remaining ILW activity sources are within relatively massive structures (for radiological shielding purposes) compared with any wind-blown missile that could strike them.

Snow and Ice: Snow and ice could present a threat to the containment and shielding of the radioactive waste through the effects of structural overload. Snow and ice could also restrict access to the site. Assessments have concluded that the ILW is contained within robust structures that will not be disrupted by the consequential effects of outer building damage. None of the facilities require human intervention on a time scale (a number of days) that would be prejudiced by temporarily restricted access to site caused by roads blocked by ice or snow.

Humidity and Precipitation: Humidity and precipitation presents a potential threat to the containment and shielding of radioactive waste through the effects of corrosion or through transport of activity by water movement. Heavy rainfall that overloads the capacity of site drainage can also lead to local flooding, particularly of basement areas. Rainwater entry will be within the capacity of secondary containment systems and on a scale limited enough to allow for remedial action to be taken. The preventative measures required to maintain the water tightness of buildings are supported through civil structure inspection and maintenance regime.

Temperature: Extremes of ambient temperature will not affect the contents of any ILW storage locations, as they are in shielded containment structures in which conditions will only change very slowly. None of the facilities is dependent on services that might be disrupted by extreme high or low ambient temperature. No facilities require cooling water that might be affected by freezing water temperatures.

Lightning Strike: None of the facilities is of a construction type that would be vulnerable to fire or major structural damage as a result of lightning strike. Lightning strike could disrupt electrical supplies or even damage electrical equipment within buildings. However, loss of services is a tolerable event for all facilities. All buildings are provided with lightning protection in accordance with BS6651:1992 or the later BSEN62305:2006, which will provide adequate protection. Remedial and upgrading work on the lightning protection for all buildings was completed in March 2011 as a result of findings from the PSR.

4.1.1.4 Potential combinations of weather conditions

Consideration of potential combination of weather conditions.

The simultaneous occurrence of more than one type of extreme weather of severity corresponding to a 10^{-4} annual probability of exceedence has not been considered. Some combinations of less severe, more frequent events have been considered as part of the design process.

4.2 Evaluation of safety margins

4.2.1 Estimation of safety margin against extreme weather conditions

Analysis of potential impact of different extreme weather conditions to the reliable operation of the safety systems, which are essential for heat transfer from the reactor and the spent fuel to ultimate heat sink. Estimation of difference between the design basis conditions and the cliff edge type limits, i.e. limits that would seriously challenge the reliability of heat transfer.

Although no specific analysis has been carried out for the extreme weather conditions listed in Section 4.1.1.1 beyond the design values, the nature of the failure modes would be progressive for the concrete structures of the waste facilities.

4.2.2 Potential need to increase robustness of the plant against extreme weather conditions

Consideration of measures, which could be envisaged to increase plant robustness against extreme weather conditions and would enhance plant safety.

No increases in robustness have been identified as necessary.

5 Loss of electrical power and loss of ultimate heat sink

5.1 Nuclear power reactors

For writing chapter 5, it is suggested that detailed systems information given in chapter 1.3. is used as reference and the emphasis is in consecutive measures that could be attempted to provide necessary power supply and decay heat removal from the reactor and from the spent fuel. Chapter 5 should focus on prevention of severe damage of the reactor and of the spent fuel, including all last resort means and evaluation of time available to prevent severe damage in various circumstances. As opposite, the chapter 6 should focus on mitigation, i.e. the actions to be taken after severe reactor or spent fuel damage as needed to prevent large radioactive releases. Main focus in chapter 6 should thus be in protection of containment integrity.

5.1.1 Loss of electrical power

5.1.1.1 Loss of off-site power

5.1.1.1.1 Design provisions taking into account this situation: back-up power sources provided, capacity and preparedness to take them in operation.

5.1.1.1.2 Autonomy of the on-site power sources and provisions taken to prolong the time of on-site AC power supply.

5.1.1.2 Loss of off-site power and loss of the ordinary back-up AC power source

5.1.1.2.1 Design provisions taking into account this situation: diverse permanently installed AC power sources and/or means to timely provide other diverse AC power sources, capacity and preparedness to take them in operation.

5.1.1.2.2 Battery capacity, duration and possibilities to recharge batteries.

5.1.1.3 Loss of off-site power and loss of the ordinary back-up AC power sources, and loss of permanently installed diverse back-up AC power sources

5.1.1.3.1 Battery capacity, duration and possibilities to recharge batteries in this situation

5.1.1.3.2 Actions foreseen to arrange exceptional AC power supply from transportable or dedicated off-site source

5.1.1.3.3 Competence of shift staff to make necessary electrical connections and time needed for those actions. Time needed by experts to make the necessary connections.

5.1.1.3.4 Time available to provide AC power and to restore core cooling before fuel damage: consideration of various examples of time delay from reactor shut down and loss of normal reactor core cooling condition (e.g., start of water loss from the primary circuit).

As there is no fuel in the Reactors electrical power is only required for monitoring. The reliability of electrical power is considered in Section 1.3.5.1.1 above.

5.1.2 Measures which can be envisaged to increase robustness of the plant in case of loss of electrical power

Not applicable for Hunterston A Site as the reactors are defuelled.

5.1.3 Loss of the ultimate heat sink

5.1.3.1 Design provisions to prevent the loss of the primary ultimate heat sink

Design provisions to prevent the loss of the primary ultimate heat sink, such as alternative inlets for sea water or systems to protect main water inlet from blocking.

5.1.3.2 Effects of loss of the primary ultimate heat sink

Loss of the primary ultimate heat sink (e.g., loss of access to cooling water from the river, lake or sea, or loss of the main cooling tower).

5.1.3.2.1 Availability of an alternate heat sink

5.1.3.2.2 Possible time constraints for availability of alternate heat sink and possibilities to increase the available time.

5.1.3.3 Loss of the primary ultimate heat sink and the alternate heat sink

5.1.3.3.1 External actions foreseen to prevent fuel degradation.

5.1.3.3.2 Time available to recover one of the lost heat sinks or to initiate external actions and to restore core cooling before fuel damage: consideration of situations with various time delays from reactor shut down to loss of normal reactor core cooling state (e.g., start of water loss from the primary circuit).

5.1.3.4 Loss of the primary ultimate heat sink, combined with station black out (i.e. loss of off-site power and ordinary on-site back-up power source).

5.1.3.4.1 Time of autonomy of the site before start of water loss from the primary circuit starts.

5.1.3.4.2 External actions foreseen to prevent fuel degradation.

Not applicable for Hunterston A Site as the reactors are defuelled.

5.1.4 Measures which can be envisaged to increase robustness of the plant in case of loss of ultimate heat sink

Not applicable for Hunterston A Site as the reactors are defuelled.

5.2 Spent fuel storage pools

Where relevant, equivalent information is provided for the spent fuel storage pools as explained in chapter 5.1 for nuclear power reactors.

5.2.1 Loss of electrical power

As there is no fuel in the storage ponds electrical power is only required for monitoring.

5.2.2 Measures which can be envisaged to increase robustness of the plant in case of loss of electrical power

As there is no fuel in the storage ponds electrical power is only required for monitoring.

5.2.3 Loss of the ultimate heat sink

As there is no fuel in the storage ponds no ultimate heat sink is required.

5.2.4 Measures which can be envisaged to increase robustness of the plant in case of loss of ultimate heat sink

As there is no fuel in the storage ponds no ultimate heat sink is required.

6 Severe accident management

6.1 Organisation and arrangements of the licensee to manage accidents

Chapter 6.1 should cover organization and management measures for all type of accidents, starting from design basis accidents where the plant can be brought to safe shut down without any significant nuclear fuel damage and up to severe accidents involving core meltdown or damage of the spent nuclear fuel in the storage pool.

6.1.1 Organisation of the licensee to manage the accident

6.1.1.1 Staffing and shift management in normal operation

As Hunterston A Site is currently undergoing decommissioning activities to prepare the site for entry into care and maintenance, the staffing levels over and above the basic complement required for compliance are dependent on the projects being carried out at the time. Generally project work is carried out on a daytime working basis with little weekend working.

6.1.1.2 Plans for strengthening the site organisation for accident management

Arrangements have been produced for the management of emergencies on Hunterston A Site. The Hunterston A Emergency Plan is a document containing the site emergency arrangements and the arrangements for collaboration with external organisations, including the Regulators, the emergency services, local government and central government. The document is approved by the Regulator (ONR) and changes cannot be made to it without agreement. The on-site arrangements allow for the establishment of an Emergency Control Centre (ECC) staffed by at least an Emergency Controller, and Assistant Emergency Controller, an Emergency Administration Officer, an Emergency Health Physicist, an Emergency Technical Officer and an Emergency Communications Officer. In addition the Control Room, an Access Control Point and a Response Team are established. Members of these teams are on an emergency call-out rota and are contacted using a telephone voicemail system based upon a stand alone off site server. Additional telecommunications can be made independently through national landline telephone networks or cellular networks (MCP 18/2).

6.1.1.3 Measures taken to enable optimum intervention by personnel

The arrangements described above allow for the intervention of personnel to assess and mitigate emergency situations.

6.1.1.4 Use of off-site technical support for accident management

Technical support for an off site event is provided by an Emergency Control Centre (ECC) on the site and a Central Emergency Support Centre (CESC) located remotely in Gloucestershire. This dedicated facility is manned by a Controller, a Health Physicist and a Technical Officer each with a support team on a one-hour call out rota.

The remit of the CESC is to:

- Relieve the affected site of the responsibility for liaison with outside bodies on off-site issues in as short a time as possible after an accident;

- Take over for the affected site at an early stage the task of directing the off-site monitoring teams and assessing their results;
- Provide the requisite technical advice on off-site issues to all stakeholders in the Strategy Coordination Centre and those agencies represented in the CESC;
- Provide regular authoritative company briefings for the media on all aspects of the emergency;
- Co-ordinate advice and support from within the affected company and other parts of the nuclear industry to the affected station;
- Centrally manage the collation of all relevant information relating to the event (using appropriate means).

The CESC Controller has the full backing of the Company to take whatever steps are necessary, including using any resources required, to control the situation. The Technical Support Team in the CESC has access to the Company Drawing Office so can obtain and print systems diagrams and a range of experts to help analyse the issues on-site and formulate recovery plans. The CESC mobilises and coordinates the resources of the whole Company and cooperation from other nuclear companies. Radiation monitoring from 15km to 50 km is carried out by resources from other nuclear sites and Ministry of Defence sites.

The Hunterston Strategic Co-ordination Centre (HSCC) is established for liaison with the emergency services and the local authority that provided a number of health and welfare services. Secure telephone links (phone and fax) are provided by the telephone network at the CESC and the HSCC. In addition, a Media Briefing Centre (MBC) is established to provide information to the media.

6.1.1.5 Procedures, training and exercises

In accordance with arrangements agreed with the Regulator (ONR), training is given to Hunterston A Site and other Company personnel with an involvement in emergency arrangements. Exercises are held to demonstrate the arrangements. Once per year there is a Demonstration Exercise, observed by the Regulators, which involves external agencies such as local fire, police and ambulance services.

6.1.2 Possibility to use existing equipment

6.1.2.1 Provisions to use mobile devices (availability of such devices, time to bring them on site and put them in operation)

The Company shares a set of Beyond Design Basis Accident Container, maintained at a central UK location that can be transported to any affected site. These containers are equipped with Command and Control, fire fighting, reactor cooling and contamination control provisions and materials.

6.1.2.2 Provisions for and management of supplies (fuel for diesel generators, water, etc.)

As there is limited need for the provision of diesel fuel for generators and other supplies there are no special arrangements for their management at the site.

6.1.2.3 Management of radioactive releases, provisions to limit them

As there would be a much-reduced potential release from the stored radioactive waste, compared with releases from operational reactors, there are no special provisions.

6.1.2.4 Communication and information systems (internal and external).

In the event of an accident or natural disaster at a power station there is a need to be able to promulgate an alert and then to pass information into and out of the site. Particularly important communications paths are those between the site, the HSCC, CESC and the responding emergency services.

The Site's telephone system is designed to be resilient and function through any single point failure. In addition the site has at least one phone connected directly to the public system without passing through the Company exchange. Magnox also have voice links to the neighbouring EdF sites at Hunterston B.

6.1.3 Evaluation of factors that may impede accident management and respective contingencies

6.1.3.1 Extensive destruction of infrastructure or flooding around the installation that hinders access to the site.

There is a single access route to the Hunterston A Site. Should this road become impassable, there is an alternative route across neighbouring fields suitable for use by off-road vehicles.

6.1.3.2 Loss of communication facilities / systems

The Company has robust communications systems featuring diversity and redundancy. These include:

- A resilient Company Wide Area Network;
- Telephones that are independent of the Company exchanges with direct (copper) links to the Public Switched Telephone Network;
- The Nuclear Industry Airwave Service, designed to allow communication with off-site survey vehicles, can be used to make phone calls independent of the local PSTN;
- Cellular phones from diverse network providers.

6.1.3.3 Impairment of work performance due to high local dose rates, radioactive contamination and destruction of some facilities on site

In all exposure conditions including accident response, doses to personnel should be below dose limits (normally 20 mSv whole body dose) and must be

As Low as Reasonably Practicable (ALARP). In the event of a major accident at a nuclear site the higher REPPIR Emergency Exposures can be applied to informed volunteers. The role of the Health Physicist in the Emergency Control Centre (ECC) is to ensure the safety of all people on site.

Staff that are not responding to an accident will be subject to controls based on doserate, airborne contamination levels and other hazards, and may be evacuated from the site.

The ECC is positioned to minimise the likelihood that it would be damaged in an accident or affected by radiation. It would be subject to tenability checks, the Initial Control Dose limit being 10 mSv over the first 10 hours. After this period the situation would be reassessed in the light of the radiological conditions, availability of replacement staff, etc. Arrangements could be made to transfer the functions of the ECC to a facility off-site should the primary facility be declared untenable, including destruction and blocked access.

On-site survey and emergency team staff controlled from the Access Control Point (ACP) are subject to the normal dose limits but in the event of a major accident the higher REPPIR Emergency Exposures (whole body doses of 100 mSv for operations and 500 mSv for life saving) can be applied to informed volunteers. Health Physics monitoring provides information on the local dose rates allowing response teams to ensure their doses are minimised and Electronic Personal Dosimeters are used to monitor doses and enforce dose limits. If necessary, the on-site Alternative ACP, or other suitable facility, would be used.

Training is given on the use of appropriate Personal Protective Equipment, including breathing apparatus, and undressing/ decontamination processes, and use of these would not prevent appropriate remedial work being undertaken.

In some extreme instances high radiation levels could make access to the damage scene unachievable. If this were the case then remote access or the installation of the appropriate level of shielding would be required. If radiation levels remain high then working time would be limited, which could impair the recovery operation particularly if the operations required are time consuming. Under conditions of high local dose rates, contamination and destruction of some facilities the Company would be relying on the site Command and Control structures to manage the event making an accurate assessment of the situation and best use of available resource.

6.1.3.4 Impact on the accessibility and habitability of the main and secondary control rooms, measures to be taken to avoid or manage this situation

The site facilities used to manage emergencies are specifically designed to withstand external hazards and have redundancy. There are no operator actions necessary to control or limit radiological releases as the facilities are essentially passive safe. Therefore the inability to access the Site Control Room for a period of time (e.g. 24 hours) would not be critical.

6.1.3.5 Impact on the different premises used by the crisis teams or for which access would be necessary for management of the accident.

Key emergency response centres on site are the Emergency Control Centre (ECC) and Access Control Point (ACP).

For decontamination of returning teams there are a number of options including other shower facilities on site or, in the longer term, use of the emergency services mobile facilities.

6.1.3.6 Feasibility and effectiveness of accident management measures under the conditions of external hazards (earthquakes, floods)

The accident management arrangements are described in the Hunterston A Emergency Handbook and the Hunterston A Emergency Plan. These arrangements include the establishment of the emergency organisation, the facilities used, the roles and responsibilities of individuals, the procedures to be followed and the equipment available. The accident management measures provided at Magnox sites are intended to be flexible. Identified personnel have high levels of authority to utilise any resources available and technical advice is available from off-site facilities.

6.1.3.7 Unavailability of power supply

A description of power supplies is given in Section 1.3 and the consequences of loss of supplies are addressed in Section 5.

6.1.3.8 Potential failure of instrumentation

There is no permanently installed instrumentation required for emergency management.

6.1.3.9 Potential effects from the other neighbouring installations at site.

There are arrangements are in place to respond to emergencies on the neighbouring site of Hunterston B operated by the Licensee EdF. These arrangements include good lines of communication between the sites, the setting up of the site emergency response with a fully authorised command and control organisation. Procedures to muster staff in safe areas and provide stable iodine if required are in place.

6.1.4 Measures which can be envisaged to enhance accident management capabilities

Following the workshops mentioned in Section 2.2.4 above the items presented below and in Table 1 have been identified for further consideration.

Consideration HNA 1: Consideration will be given to enhancing the availability of beyond design basis equipment.
Consideration HNA 2: Consideration will be given to providing further equipment to facilitate operator access around the Site.
Consideration HNA 3; Consideration will be given to enhancing arrangements for command, control and communications.
Consideration HNA 4: Consideration will be given to updating and enhancing severe accident management guidance.

Consideration HNA 5: Consideration will be given to reviewing the fire safety case for ILW storage facilities to identify enhancements to the level of resilience.

6.2 Maintaining the containment integrity after occurrence of significant fuel damage (up to core meltdown) in the reactor core

Not required as there is no significant amount of fuel stored on site.

6.2.1 Elimination of fuel damage / meltdown in high pressure

Not required as there is no significant amount of fuel stored on site.

6.2.2 Management of hydrogen risks inside the containment

There is no fuel stored on site and no containment. It should be noted, however, that there are some very low probability events that could lead to the generation of hydrogen as a result of chemical reaction with Magnox debris in one of the waste storage vaults for which there is monitoring installed. There is considerable time available before intervention would be required and this has been fully dealt with within the safety case that has assessed the limiting case of disruption to the storage vault and concluded that the consequences are well within the Company release guidelines.

6.2.3 Prevention of overpressure of the containment

Not required as there is no significant amount of fuel stored on site.

6.2.4 Prevention of re-criticality

Not required as there is no significant amount of fuel stored on site.

6.2.5 Prevention of base-mat melt through

Not required as there is no significant amount of fuel stored on site.

6.2.6 Need for and supply of electrical AC and DC power and compressed air to equipment used for protecting containment integrity

Not required as there is no containment.

6.2.7 Measuring and control instrumentation needed for protecting containment integrity

Not required as there is no containment.

6.2.8 Measures which can be envisaged to enhance capability to maintain containment integrity after occurrence of severe fuel damage

Not required as there is no fuel on site and there is no containment.

6.3 Accident management measures to restrict the radioactive releases

The only accident management requirement other than normal emergency response arrangements relates to fires in the vaults. This guidance is provided via Company severe accident guidance.

6.3.1 Radioactive releases after loss of containment integrity

Not required as there is no containment.

6.3.2 Accident management after uncovering of the top of fuel in the fuel pool

Not required as there is no fuel in the fuel pond (CCP).

6.3.3 Measures which can be envisaged to enhance capability to restrict radioactive releases

No specific actions can be currently envisaged other than the items for further consideration given in Table 1.

7 Glossary

ACP	Access Control Point
AETF	Active Effluent Treatment Facility
AETP	Active Effluent Treatment Plant
AGR	Advanced Gas-cooled Reactor
ALARP	As Low As Reasonably Practicable
AOD	Above Ordnance Datum
ASF	Acid Storage Facility
CCP	Cartridge Cooling Pond
CESC	Central Emergency Support Centre
CO_2	Carbon Dioxide
DBE	Design Basis Earthquake
DBF	Design Basis Flood
DNO	District Network Operator
ECC	Emergency Control Centre
EdF	Electricity de France
ENSREG	European Nuclear Safety Regulators Group
HLW	High Level Waste
HSCC	Hunterston Strategic Co-ordination Centre
ILW	Intermediate Level Waste
LLW	Low Level Waste
MAETP	Modular Active Effluent Treatment Plant
MBC	Media Briefing Centre
MCP	Management Control Procedure
ONR	Office for Nuclear Regulation
PML	Principia Mechanica Limited
PSA	Probabilistic Safety Assessment
PSR	Periodic Safety Review
PSTN	Public Switched Telephone Network
RDT	Replacement Delay Tank
REPPIR	Radiation (Emergency Preparedness and Public Information) Regulations
RMRT	Replacement Miscellaneous Retention Tank
RPV	Reactor Pressure Vessel
RWMD	Radioactive Waste Management Directorate
SAWB	Solid Active Waste Building
SRT	Sludge Retention Tank
SRU	Steam Raising Unit
SSC	Systems Structures and Components

Table 1 Considerations identified for Hunterston 'A' Site

This is a consolidated list of the items to be considered arising from the Stress Test review.

No.	Section	Consideration
HNA 1	6.1.4	Consideration will be given to enhancing the availability of beyond design basis equipment.
HNA 2	6.1.4	Consideration will be given to providing further equipment to facilitate operator access around the Site.
HNA 3	6.1.4	Consideration will be given to enhancing arrangements for command, control and communications.
HNA 4	6.1.4	Consideration will be given to updating and enhancing severe accident management guidance.
HNA 5	6.1.4	Consideration will be given to reviewing the fire safety case for ILW storage facilities to identify enhancements to the level of resilience.