

UK ABWR

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UK ABWR Generic Design Assessment

Generic PCSR Chapter 22 : Emergency Preparedness



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22.1 Introduction

The purpose of this chapter is to describe the requirements, facilities and approach for the response to conventional and/or radiation/nuclear emergencies. The approach is based on international guidance provided by the IAEA and on current UK emergency planning doctrine and legislation.

This chapter also gives an overview of safety systems, emergency facilities and features within other buildings that are required to support an adequate response to either conventional or radiation/nuclear emergencies at an operating ABWR.

This chapter covers emergency response facilities, equipment and systems currently envisaged for UK ABWR design built on a generic site, and as a result does not include details of site specific requirements due to geographic location, local requirements or regional differences. However, this chapter includes conceptual arrangements that will not be described further in the GDA but are considered as important piece of information in providing the Regulators with an early visibility of future developments expected during the site licence phase.

Further work on emergency preparedness is outlined including that necessary during early lifecycle phases. The information within this chapter is based on conceptual arrangements for UK ABWR unit built on a generic site. Future development work will be required in the site specific PCSR to further define the detailed requirements of Emergency Preparedness as the design progresses. The focus in GDA is as follows:

- Initial definition of on-site emergency facilities as part of an integrated site emergency response plan
- Design aspects that are specific to on-site accident management in bringing the reactor to a safe shutdown and in the mitigation of severe accidents.

It should be noted that the design is still underway in the accident management area and further details will be provided in future revision to this chapter, potentially in the site specific PCSR.

22.1.1 International Recommendations

The IAEA Safety Standard Series recognises that good planning and preparation in advance of any accident or emergency can substantially improve an organisations emergency response. One of the most important factors being integrated response plans within the different responding organisations to ensure clear lines of responsibility and authority.

The IAEA have established a number of documents on the subject of Accident Management and Emergency Preparedness that establish the detailed requirements for: common concepts and expectations; the clear allocation of responsibilities among all response organisations; well defined agreements between these organisations; and arrangements for co-ordinating an integrated response. Specifically these include GS-R-2 Preparedness and Response for a Nuclear or Radiological Emergency [Ref-1], GS.G.2.1 Arrangements for Preparedness for a Nuclear or Radiological Emergency [Ref-2] and NS-G-2.15 Severe Accident Management Programmes for Nuclear Power Plants [Ref-3].

GS-R-2 [Ref-1] lays out the principle goals and objectives of emergency response and preparedness, followed by establishing a threat grouping according to the related threats. This will assist in developing arrangements for each threat level. There are five threat levels within the grouping 1 being the highest and 5 being the lowest. An operational UK ABWR will be grouped as threat category 1 with the description being “Facilities, such as nuclear power plants, for which on-site events (including very low probability events) are postulated that could give rise to severe deterministic health effects off the site, or for which such events have occurred in similar facilities”.

The document also gives recommendations on functional requirements such as establishing emergency management and operations, taking mitigatory actions and keeping the public informed. More detail on these points is included in the Emergency Facilities and Response section.

The implementation of a structured accident management programme is another element of defence in depth for nuclear power plants. The concept of accident management is described in [Ref-3] and this is discussed further in Section 22.3. The focus of [Ref-1 and 2] is on the on-site emergency response organisation in achieving a long term stable state for the reactor following the very unlikely events of core damage accidents.

The interactions between the on-site and off-site arrangements become an important part of the overall emergency response organisation.

Other IAEA recommendations on emergency facilities are listed in GS-G-2.1 Appendix VIII [Ref-2]. This gives examples of recommended emergency facilities and locations such as the Control Room, Emergency Operations facility, Operational Support Centre and Technical Support Centre.

22.1.2 UK Requirements

UK Emergency arrangements have been formulated over many years taking into consideration learning and recommendations from both nuclear and non-nuclear events. National doctrine has been established to provide a framework for all civil defence arrangements under the Civil Contingencies Act [Ref-4].

Most recently learning and recommendations have been, and are being introduced into UK Nuclear Emergency Planning from the Fukushima Dai-ichi NPP event. The UK independent Regulator for nuclear safety and security, the Office for Nuclear Regulation (ONR) issued a final report in 2011 [Ref-5] which includes a number of recommendations for UK nuclear power plants.

The ONR have also reviewed and re-issued its Safety Assessment Principles (SAPs) for Nuclear Facilities in 2014 [Ref-6], following the issue of the Fukushima final report [Ref-5], along with supporting Technical Assessment Guides (TAGs)[Ref-7].

The Emergency Plan for the UK ABWR design will be developed, in the site specific PCSR in compliance with the statutory requirements including; the Control of Major Accident Hazards Regulations 1999 (CoMAH) [Ref-8], Radiation (Emergency Preparedness and Public Information) Regulations 2001 (REPPPIR) [Ref-9] and Nuclear Site Licence Condition 11 – Emergency Arrangements [Ref-10] (and the underpinning guidance).

The REPPIR [Ref-9] is the main set of regulations for nuclear power plants in the UK. The requirements under REPPIR [Ref-9] do not stipulate the facilities required on a NPP but they do require adequate on and off-site emergency plans to be written to deal with reasonably foreseeable radiation emergencies. These plans must work in conjunction with the regional and national arrangements and regional agencies must be consulted when writing the response plans. Response plans for radiation emergencies are also expected to fit within the broader resilience plans at national and local levels to give a robust command and control structure for all potential emergencies.

22.2 Emergency Facilities and Response

It is worth noting that the requirements and arrangements described in 22.2 are conceptual arrangements that is expected to develop further in the site specific PCSR.

A number of Emergency Facilities are proposed and are currently under further development for the UK ABWR, these will provide resilience, diversity and the ability of the site to respond to accidents and emergencies. The detailed roles and arrangements will be further developed in the site specific PCSR and will fulfil requirements under REPPiR [Ref-9], the nuclear site licence [Ref-10] and some of the recommendations in [Ref-5].

These site facilities will be supplemented by facilities local to the site and some more distant, this is shown in Figure 1 and indicates the key connections between the levels of response.

The remote siting of nuclear power stations creates some specific local issues in terms of geography and remoteness. The remote nature of the sites assists in lessening the impact of an event on any area of high population but does increase the response times for support such as Emergency Services.

To ensure this does not impact on any potential event at the site and impact on personnel and public safety an assumption has been made that the site Emergency Response and Facilities need to be able to stand alone for a longer period of time.

General requirements for such facilities are summarised as follows:

- Emergency facilities must be capable of dealing with simultaneous events on the unit
- Alternate or backup emergency facilities must be provided for key facilities this will allow control and management of an incident in the event that main or primary emergency facilities are unavailable
- Emergency facilities must be provided with secure and resilient power supplies that allow continued functionality after a loss of off-site power or station black out for a period of 7 days
- Key Emergency facilities will need to be self-supporting for a period of 7 days
- Services to the emergency facilities (e.g. heating, lighting ventilation, water and sewerage) must be resistant to the same initiating events as the building itself
- Services to the emergency facilities (e.g. food, water and sewerage) must be protected from contamination (radioactive, biological and chemical) so as to remain available whenever the facility is occupied.

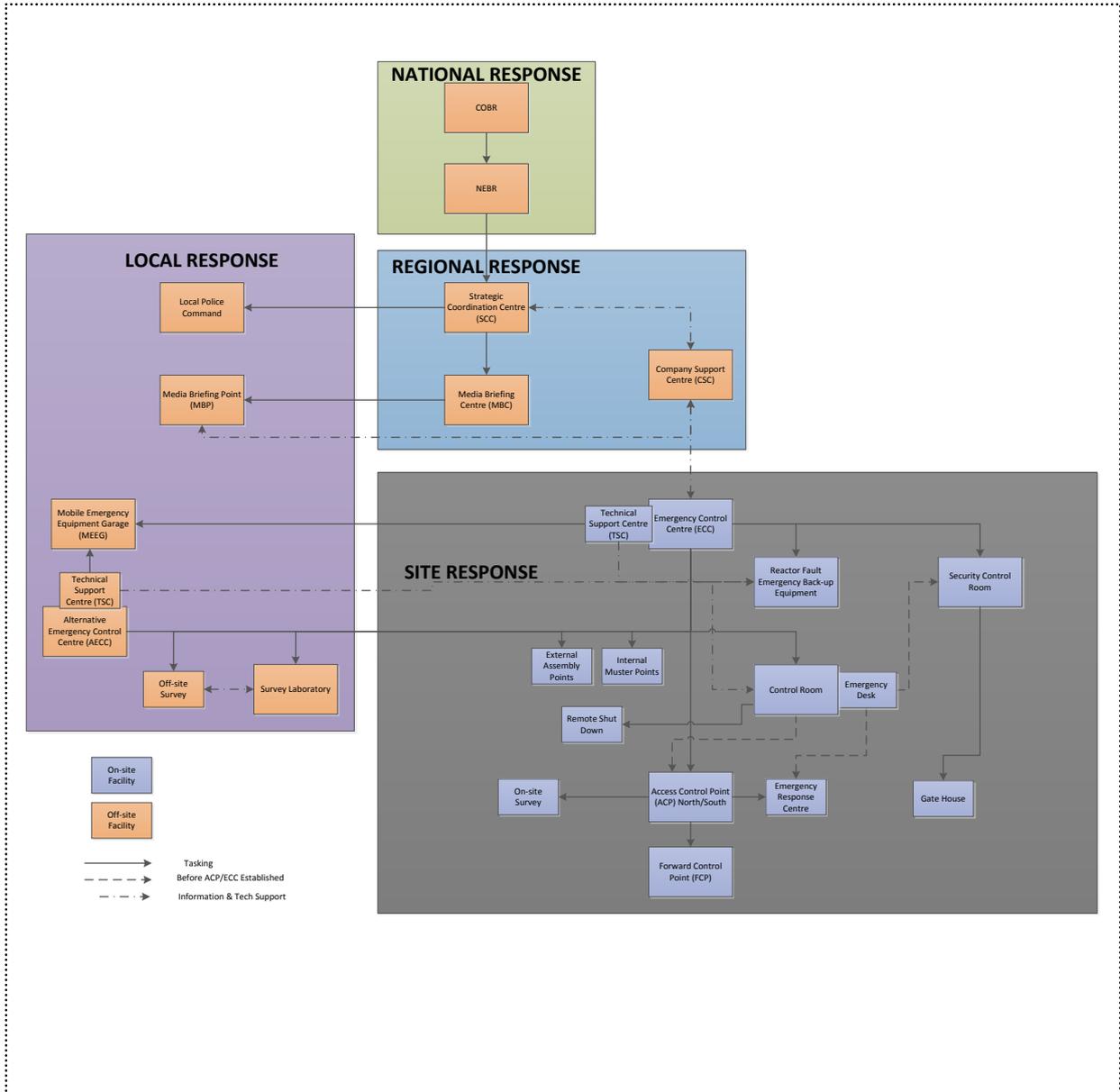


Figure 22.2-1: Conceptual Emergency Response Structure to be developed in the site specific PCSR

22.2.1 On-site emergency response facilities

On site emergency response facilities are split into two categories, the first being dedicated facilities which are separate facilities dedicated and only used for emergency response purposes. The second being emergency facilities within other operational facilities but which are used during an emergency, these are both described below.

22.2.1.1 Dedicated Emergency Facilities

Backup Building

For the UK ABWR, each unit has a dedicated Backup Building as a key mitigation/resilience measure for specific frequent faults, beyond design basis accident and severe accident scenarios. This building provides a number of accident management facilities and capabilities. The Backup Building will be located at such an elevation and/or position to minimise the likelihood of a coincident loss of safety function with the Reactor Building from extreme external hazards. Further details on the Backup Building and its functions can be found in Section 22.4 below. The Backup Building requirements are still under development in GDA with the key focus on accident management capability and capacity, other aspects will be developed further within the site specific PCSR.

Emergency Control Centre (ECC)

The ECC is the Strategic command centre for the response; it is not used unless required but will be staffed by a team of trained responders lead by the Emergency Controller who has strategic control of on-site response as well as providing information and advice to local agencies responsible for managing the off-site response. To assist in giving the correct instruction and guidance the Emergency Controller is supported by:

- Radiological expertise which has access within the ECC to Radiological Monitoring information to formulate off site countermeasure advice, on site radiological protection and give advice on authorising emergency dose levels
- An Information & Administration Team which will assist in accounting for staff and management of the flow and recording of information
- A Site Security Team to give advice and guidance on maintaining security of the site and response to a security event
- Liaison Officers from the local Emergency Services

The ECC will be physically connected to a Technical Support Centre which will house the Technical Support Team.

Technical Support Centre (TSC)

The TSC will be located adjacent to the ECC and will be populated by a Technical Support Team. The team will have access to plant data in the form of live display readings, manuals, drawings and emergency support processes. They will formulate advice and direction for the control room team to assist in controlling a reactor or plant event.

The TSC will have secure and reliable communications with the control room and outside sources of technical support.

The Backup Building will be located at such an elevation and/or position to minimise the likelihood of a co-incident loss of safety function with the Reactor Building from extreme external hazards. Further details on the Backup Building and its functions can be found in Section 22.4 below. The Backup Building requirements are still under development in GDA with the key focus on accident management capability and capacity, other aspects will be developed further within the site specific PCSR.

Access Control Point (ACP)

The ACP is a tactical centre that controls access to and from the site and event area during an event. It is staffed by a team of trained responders who will establish the access control process, a return monitoring and decontamination facility and a medical treatment centre.

Lead by an Access Controller who leads the tactical deployment of response teams and response to the event under the direction of the ECC.

There will be two Access Control Points to aid arrival and dispatch of emergency services and support teams. These may be used on their own or both may be mobilised at the discretion of the Site Emergency Controller (or equivalent) depending upon the situation. The ACPs will be protected from beyond design basis and severe accidents events and be able to support a number of personnel for up to 7 days.

This fulfils the requirement of an Operational Support Centre as detailed in the IAEA guidance.

Emergency Response Centre (Fire Station)

The Emergency Response Centre will house the Emergency Response Team and required response equipment. The Emergency Response Team will be the first responders to dispatch directly to the scene to assess and perform initial mitigation activities.

The initial response will be supported by further teams and emergency services arriving from other locations and controlled by the Access Control Point.

22.2.1.2 Emergency Facilities within other Operational Facilities

Control Room Emergency Control Area

Within the unit Control Room an area will be created as an Emergency Control Area; this will provide the Initial Emergency Controller (Shift Manager) an area to perform the strategic command of the event for the initial stages before handover to the Emergency Controller. The area will consist of dedicated phone lines, command boards, data displays and emergency procedures.

Forward Control Points (FCPs)

Due to the layout and size of the UK ABWR, fixed FCPs for each main reactor building are required to assist in the facilitation of responding teams. If the event is within the main reactor buildings and requires Breathing Apparatus (BA), teams dispatching to the reactor building under BA from the Access Control Point will have a reduced response time due to BA capacity. With the use of FCPs the response team can arrive at the FCP and then establish BA Control meaning that they can dispatch forward of the FCP in BA giving them more response time before being low on air. Additional mobile FCPs may be established as required for other facilities or areas of site if the need arises. These may be ad-hoc and the level of equipment and resources will be dependent on the requirements of the event.

22.2.2 Off-site Emergency response Facilities

Alternative Emergency Control Centre (AECC)

This provides an alternative control centre for the Emergency Controller, Technical Support Team and support staff to withdraw to if the main Emergency Control Centre is untenable.

It will have reduced capability but will still be capable of providing strategic control of the site. It will contain an alternative TSC and will continue robust and reliable communications with the Control Room for advice and support.

Survey Laboratory

The Survey Laboratory will be an off-site facility able to provide analysis of radioactive and environmental samples during an emergency situation. It will also house the perimeter radiation detection equipment and the analytical equipment necessary to process environmental samples.

Media Briefing Point and Marshalling Point (MBP)

The MBP will provide an area close to the site where the regional media can gather and be controlled. They will be provided with welfare facilities and briefing areas where they can receive press briefs relayed from the Media Briefing Centre.

Mobile Emergency Equipment Garage (MEEG)

This facility will be located a distance from the site and will be the location for numerous support vehicles and equipment for beyond design basis and severe accidents scenarios. It may be used as a marshalling point for arriving support onto the island before onward dispatch to the site.

22.2.3 Local/Regional Emergency Response

Strategic Coordination Centre (SCC)

The SCC is the Regional Emergency Control Centre which is under the control of the Chief Constable of Local Police and will work in conjunction with the UK Strategic, Tactical and Operational control model. The SCC is responsible for implementing the off-site plan for protecting the public. It will be populated by all the regional and national responding agencies and will formulate strategic focuses and actions including public advice. This facility is the Police Strategic Command Centre and provides the links into the government.

Media Briefing Centre (MBC)

The MBC is the regional media briefing facility and is usually co-located with the SCC. This facility will co-ordinate all media enquiries and requirements including press conferences and interviews.

Company Support Centre (CSC)

The CSC will be located at the utility headquarters and will manage the company response to an event. It will assist in relieving the Site Emergency team from Off-site pressures and will be the main interface with the SCC. It will support the site in any requests, helping to organise support functions and relief staff or support from other agencies as required.

22.2.4 National Emergency Response

Nuclear Emergency Briefing Room (NEBR)

The NEBR would house DECC's incident response team. The NEBR Incident Controller would be a senior official within DECC.

Other UK Government departments and the Devolved Administrations may be invited or may wish to send representatives to the NEBR.

The NEBR will support COBR and will maintain regular contact with ONR's Redgrave Court Incident Suite and the local Strategic Coordination Centre (via the Government Liaison Team).

Cabinet Office Briefing Room (COBR)

COBR is the The Cabinet Office Briefing Rooms (COBR) facility and is the physical location, usually in Westminster, from which the central government response is activated, monitored and coordinated. COBR provides a focal point for the Government's response and an authoritative source of advice for local responders. COBR would almost certainly be activated in the event of a domestic or overseas nuclear emergency.

22.3 Accident Management

The UK ABWR will be designed such that environmental release of any radioactive material from the plant during all modes of operation is minimised to acceptable levels. The design also has a variety of engineered features, strategies and procedures for responding to design-basis and beyond design-basis accidents. To support this Severe Accident Management Strategy is designed to prevent or mitigate a severe accident following failure of the design basis accident measures. The current suite of procedures and guidelines dealing with accidents of different level of severity is comprised of the following:

- **Abnormal Operation Procedures (AOPs)**
AOPs are used for postulated events that have been analysed and discussed in the design base analyses and are limited to a single initiating event following successful operation of the safety systems designed to respond to those events.
- **Emergency Operation Procedures (EOPs)**
EOPs are symptom-based procedures that focus on operations required before core damage occurs and includes multiple failure induced severe accidents which are low frequency scenarios.
- **Severe Accident Management Guidelines (SAMGs)**
SAMGs provide guidelines for preventing and mitigating accident scenarios in which severe core damage has occurred, reactor pressure vessel fails and containment integrity is challenged by the accident progression.

An overview of the above and a summary of the Severe Accident Management Strategy are provided in Generic PCSR Chapter 26 Section 26.3.4 “Strategies, Measures and Procedures for Severe Accident”. The Severe Accident Management Strategy will focus on preventing and/or mitigating severe accident progression, failure of nuclear reactor fuel and preventing containment failure to ensure no large amount of fission product is released to environment. This is done through the following strategies:

1. Core Cooling Strategy
2. Containment Control Strategy
3. Fission Product Release Control Strategy
4. Spent Fuel Pool Cooling Strategy
5. Hydrogen Control Strategy

22.4 Plant and Safety Systems

The general discussion of engineered reactor safety systems and their roles in dealing with a range of postulated events from design basis accidents, beyond design basis accidents and severe accidents is provided in a number of chapters in Generic PCSR. A general description of the design is provided in Generic PCSR Chapter 9 “General Description of the Unit (Facility)”. The fault studies are covered in Generic PCSR Chapters 24 “Design Basis Analysis”, in Generic PCSR Chapters 25 “Probabilistic Safety Assessment” and in Generic PCSR Chapter 26 “Beyond Design Basis and Severe Accident Analysis”. The information is thus not repeated here.

Following the Fukushima Daiichi accident, the relevant lessons learnt are implemented in the UK ABWR design. Some aspects, referred to as countermeasures, currently included in the UK ABWR design are discussed in Generic PCSR Chapter 28 Section 28.4 “Response to the Fukushima Accident”. Many of the safety measures are housed in the Backup Building providing an additional layer of accident management capability. The additional safety measures include the following:

- Alternative water source—via tanks adjacent to the building
- Backup Building Generator (BBG) for alternative AC power
- Alternative reactor depressurisation: Reactor Depressurisation Control Facility (RDCF)
- Alternative water supply to the Reactor Building: Flooder System of Specific Safety Facility (FLSS)
- Related control, instrumentation and auxiliary cooling
- Accident monitoring and control facilities

The Backup Building is designed with consumables enough to manage a severe accident for seven days and its content is still underway and its development will provide the focus for the future revision of this chapter during GDA. The basic design requirement for the Backup Building is described in [Ref-11]. Table 22.4-1 provides a route map of where the description of the corresponding SSCs / facilities related to the Backup Building can be found.

The instrumentation required for the measure and control of severe accidents are described in Generic PCSR Chapter 26 Section 26.3 “Severe Accident Analysis” and in the Accident Management Facility Basic Requirement Specification [Ref-11]. To further enhance the accident management capability in achieving the strategies listed in Section 22.3, the design is further equipped with mobile equipment.

Table 22.4-1 : Route map for GDA documents related to SSCs installed Backup Building

Main SSCs in Backup Bulding	Level 1 Documents		Level 2 Documents		
	Generic PCSR		Basis of Safety Cases (BSC)	Topic Report (TR)	
Backup Bulding (B/B)	Chapter 10.3.7 "Safety Claims and Design Principles for B/B"	Chapter 25 "Probabilistic Safety Assessment" including Lv1, Lv2, Lv3, etc. Chapter 28.4 "Response to the Fukushima Accident" Chapter 20.8 "Post Accident Accessibility" Chapter 27 Appendix B "List of Human-Based Safety Claim"	GA91-9201-0002-00105 "BSC on B/B Civil Design"	GA91-9201-0001-00102 "TR on Internal Event at Power Level 1 PSA" GA91-9201-0001-00103 "TR on Internal Event Level 2 PSA at Power" GA91-9201-0001-00122 "TR for Post Accident Accessibility" GA91-9201-0001-00034 "Human Factors Concept of Operations Report"	
FLSS Pump and FLSS Tank	Chapter 16.5.3.1 "Flooder System of Specific Safety Facility" Chapter 26.3 "Severe Accident Analsi"		GA91-9201-0002-00021 "BSC on Severe Accident Mechanical Systems"		GA91-9201-0001-00024 "TR on Severe Accident Phenomena and Severe Accident Analysis"
EECW and Air Fin Cooler	Chap.16.1.6 "Emergency Equipment Cooling Water System" Chapter 15.3 "Architecture - power supply and power distribution"		GA91-9201-0003-00623 "Accident Management Facility Basic Requirement Specification"		
Backup Building Generator (BBG) and Electrical Power Supply System	Chapter 15.4 "Electrical Equipment and Systems" Chapter 16.4 "Emergency Power Supply System"				
B/B Control Room and C&I system	Chapter 14.5.3 "Hardwired Backup System" Chapter 14.5.6 "Severe Accident C&I System" Chapter 21.5 "HMIs in the B/B Control Panel Room"		GA91-9201-0002-00029 "BSC on Hardwired Backup System" GA91-9201-0002-00110 "BSC on Severe Accident C&I" GA91-9201-0002-00062 "BSC on B/B HMI"		GA91-9201-0001-00058 "TR on Hardwired Backup System" GA91-9201-0001-00060 "TR on Severe Accident C&I"
BBG Fuel Oil System (BBGFO) and Fuel Tank	Chapter 16.4.2.2 "Backup Building Generator"				
B/B HVAC	Chap.16.3 "HVAC System"		GA91-9201-0002-00041 "BSC on HVAC System"		

22.5 Lifecycle Aspects

22.5.1 Emergency preparedness during Construction and Early Commissioning

During the earthworks, construction and the early parts of commissioning (before the receipt of fresh nuclear fuel on site), there is no radiological hazard capable of creating a radiation emergency event as there is no fissile material on site. During this period a Proportionate Site Emergency Plan will address conventional emergencies that may arise (including those associated with the management and use of sealed sources on the site) from a major construction site to commissioning testing.

22.5.2 Emergency preparedness from the receipt of nuclear fuel

Prior to nuclear fuel being brought to the site, a Full Site Emergency Plan will be developed with the necessary supporting organisations, facilities and equipment in place.

The following steps will be taken to develop such an Emergency Plan:

Hazard Identification and Risk Evaluation (HIRE)

The HIRE will be derived from the fault studies undertaken in support of the UK ABWR to identify those faults which have the potential for a radiation emergency.

Report of Assessment (RoA)

The RoA summarises the HIRE and provides the information necessary from Schedule 5 of REPPiR [Ref-9]. While the RoA considers a range of scenarios, one major purpose is to provide information on the size, shape and location of the area that may be affected by any reasonably foreseeable radiation emergency at a particular site.

Determination by ONR

Based on an assessment undertaken by ONR of the HIRE and RoA, and taking into consideration factors such as local population, social and geographical factors, the ONR will determine the size and shape of The REPPiR Off-site Emergency Planning Area, the area for which the Local Authority is required to prepare and demonstrate detailed emergency plans for the response to an event. This often coincides with the Public Information Zone where utility company will be required to give prior information about the potential radiation emergencies and actions to be taken.

Preparation of Plans

Based on this determination from ONR, the Local Authority will prepare the Off-Site Emergency Plan that covers the REPPiR Off-site Emergency Planning Area outside of the nuclear licensed site. Information and support to the local authority will be provided as necessary.

In parallel, On-Site Emergency Plan (including the organisation, resources, facilities and equipment) will be prepared and implement and arrangements to support local and national authorities.

22.6 References

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- [Ref-2] International Atomic Agency, 'Arrangements for Preparedness for a Nuclear or Radiological Emergency', GS-G-2.1, 2007.
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- [Ref-8] UK Health and Safety Executive, 'Control Of Major Accident Hazards', HSE Books 2015.
- [Ref-9] UK Health and Safety Executive, 'A guide to the Radiation (Emergency Preparedness and Public Information) Regulations', HSE Books 2001.
- [Ref-10] UK Office for Nuclear Regulation, 'Licence Condition Handbook', October 2014.
- [Ref-11] Hitachi-GE Nuclear Energy, Ltd., 'Accident Management Facility Basic Requirement Specification', GA91-9201-0003-00623 (AE-GD-0367), Rev. 0, April 2015