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UK HPR1000 GDA Project

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Pre-Construction Safety Report

Chapter 32

Emergency Preparedness

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32.1 List of Abbreviations and Acronyms

ALARP	As Low As Reasonably Practicable
CCA	Civil Contingencies Act, 2004
DEC	Design Extension Condition
DiD	Defence in Depth
ECC	Emergency Control Centre
EOP	Emergency Operating Procedure
EP&R	Emergency Preparedness and Response
GDA	Generic Design Assessment
IAEA	International Atomic Energy Agency
LC	Licence Condition
MCR	Main Control Room
NPP	Nuclear Power Plant
ONR	Office for Nuclear Regulation (UK)
OSC	Operation Support Centre
PCSR	Pre-Construction Safety Report
REPPIR	Radiation (Emergency Preparedness and Public Information) Regulations
RGP	Relevant Good Practice
RSS	Remote Shutdown Station
SAMG	Severe Accident Management Guideline
SQEP	Suitably Qualified and Experienced Person
TSC	Technical Support Centre
UK HPR1000	UK version of the Hua-long Pressurised Reactor

32.2 Introduction

The purpose of this chapter is to present the design information of Emergency Preparedness and Response (EP&R) for the UK version of the Hua-long Pressurised Reactor (UK HPR1000) Nuclear Power Plant (NPP).

The EP&R are primarily established to prepare for a radiation emergency and mitigate

the consequences in case of an occurrence by taking all reasonably practicable measures as required in UK legislation. EP&R is a key link of Defence in Depth (DiD) (the fifth and final level) applied in the design of the UK HPR1000 (see Pre-Construction Safety Report (PCSR) Chapter 4 Sub-chapter 4.4).

In addition, the EP&R will evolve as the NPP moves through its lifecycle. Once nuclear fuel has been received on site, a radiological release is conceivably possible. Therefore, EP&R applies to the lifecycle after the fuel is receipt of nuclear fuel on site. It will be reviewed periodically as required by *The Radiation (Emergency Preparedness and Public Information) Regulations* (REPPIR) *2019* Reference [1] and Safety Factor 13: Emergency planning in International Atomic Energy Agency (IAEA) specific safety guidance, *Periodic Safety Review for Nuclear Power Plants,* SSG-25 Reference [2]. Transport of radioactive substances is out of scope of Generic Design Assessment (GDA), Reference [3]. The detailed EP&R will be developed during the nuclear site licencing phase as well as those relating to the transport of radioactive substances.

32.2.1 Chapter Route Map

The ***Fundamental Objective*** of the UK HPR1000, which is presented in PCSR Chapter 1 Sub-chapter 1.6.2, is that: *The Generic UK HPR1000 could be constructed, operated, and decommissioned in the UK on a site bounded by the generic site envelope in a way that is safe, secure and that protects people and the environment.*

To underpin this objective**,** five high level claims (Level 1 claims) and a number of Level 2 claims are developed and presented in Chapter 1. This chapter supports the ***Claim 3.2.5*** derived from the high level ***Claim 3 and Claim 3.2***.

Claim 3*: The design and intended construction and operation of the UK HPR1000 will protect the workers and the public by providing multiple levels of defence to fulfil the fundamental safety functions, reducing the nuclear safety risks to a level that is As Low As Reasonably Practicable (ALARP).*

Claim 3.2*: A comprehensive fault and hazard analysis has been used to specify the requirements on the safety measures and inform emergency arrangements.*

This sub-chapter provides an overview of the claims and arguments based on the IAEA SSG-25 Safety Factor 13, Reference [2]. Descriptions for each argument to support the overall claim are contained in each section covering the individual argument. The IAEA preamble to Safety Factor 13: Emergency Planning states:

The design and operation of a nuclear power plant should prevent or otherwise minimise releases of radioactive substances that could affect the health of workers or the public or harm the environment. Emergency Planning for the possibility of such releases is a prudent and necessary action, not only for the operating organisation but also for local and national authorities.

The IAEA objective for the review of emergency planning is to determine:

Whether the operating organisation has adequate plans, staff, facilities and equipment for dealing with emergencies;

Whether the operating organisation's arrangements have been adequately coordinated with local and national systems and are regularly exercised.

The IAEA objective and other information presented in the *IAEA General Safety Requirements No. GSR Part 7*, Reference [4], have been reviewed and set out in a Claim, Argument and Evidence structure. In deriving the PCSR claim, it is important to note that the detailed review of the NPP design, at the GDA stage, has not been finalised and is therefore subject to further change. Therefore this chapter relies on the plant design and layout in PCSR Chapter 2 Sub-chapter 2.15 and aspects of other chapters. This is particularly important for EP&R with respect to internal arrangements of the future operator and external organisations, including the emergency services, local government and health services arrangements.

To support the Claim 3.2 and Claim 3, the resulting Claim 3.2.5 for PCSR Chapter 32 is presented in T-32.2-1.

The PCSR claim has been reviewed in order to formulate a list of arguments for use in the PCSR for the UK HPR1000 GDA submission to the Office for Nuclear Regulation (ONR). Additionally, the tasks and methodology in IAEA SSG-25, Reference [2], have been reviewed, in order to ensure that the list of arguments is complete according to the current level of detail within the design. Where tasks and methodologies are addressed by other PCSR chapters, a cross reference has been made. The IAEA tasks and methods of SSG-25 Safety Factor 13, Reference [2], are utilised here and modified to take account of PCSR.

This chapter aims to demonstrate that adequate EP&R are in place prior to receipt of nuclear fuel on site, and addresses how they are implemented and determines whether these correspond to good practice, so as to verify that there is no unacceptable gap.

There are five arguments based on IAEA Safety Factor 13: Emergency Planning in Reference [2] that supports Chapter 32. They are also listed in T-32.2-1.

The evidence to support the arguments will be developed in the nuclear site licencing phase. Examples of such evidence includes, hazard evaluation, consequence assessment, consequences report, operator's emergency plan and the detailed design and information of on-site emergency response facilities and resources.

T-32.2-1 Claim, Argument and Evidence Table

Claim		Argument		PCSR Links	Evidence
Claim 3.2.5	Emergency arrangements will be in place, prior to commissioning, that will be in accordance with up-to-date standards in the event of a release of radioactive substances.	Argument 3.2.5SC32-A1	Emergency arrangements adequately consider current safety analyses and accident mitigation studies.	Sub-chapter 32.5 and 32.6	The evidence will be developed in nuclear site licencing phase.
		Argument 3.2.5SC32-A2	Emergency arrangements include adequate on-site and off-site equipment and facilities, including the provision of technical and operational support centres and their communication systems.	Sub-chapter 32.4 (in general and structure in figure F-32.4-2) and Sub-chapter 32.5	
		Argument 3.2.5SC32-A3	Emergency arrangements include effective interaction with relevant off-site organisations.	Sub-chapter 32.3 (REPPIR requirement) and Sub-chapter 32.4 (figure F-32.4-1)	
		Argument 3.2.5SC32-A4	Emergency arrangements are tested and reviewed regularly and comprehensively, and lessons learned, are adopted in order to be effective when operations commence and maintained during the life of the plant.	Sub-chapter 32.3 (refer to details on training) and Sub-chapter 32.4 (refer to details on training)	
		Argument 3.2.5SC32-A5	Emergency arrangements are in accordance with current standards, methods and good practices.	Sub-chapter 32.3	

32.2.2 Chapter Structure

The structure of PCSR Chapter 32 is as follows:

a) Sub-chapter 32.1 Lists the Abbreviations and Acronyms:

This section lists the abbreviations and acronyms that are used in the PCSR Chapter 32.

b) Sub-chapter 32.2 Introduction:

This section gives a brief introduction of Chapter 32.

c) Sub-chapter 32.3 Applicable Codes and Standards:

This section describes the applicable codes and standards of Chapter 32.

d) Sub-chapter 32.4 Emergency Management:

This section describes the emergency management and the framework of emergency organisations and responsibilities.

e) Sub-chapter 32.5 On-site Emergency Response Facilities:

This section describes the basic functions of the main on-site emergency response facilities.

f) Sub-chapter 32.6 On-site Accident Management:

This section identifies the current accident management procedures.

g) Sub-chapter 32.7 ALARP Assessment:

This section presents the Relevant Good Practices (RGPs) of Chapter 32.

h) Sub-chapter 32.8 Concluding Remarks:

This section summarises the concluding remarks.

i) Sub-chapter 32.9 References:

This section lists the supporting references of Chapter 32.

32.2.3 Interfaces with Other Chapters

The interfaces with other chapters are listed in the following table.

T-32.2-2 Interfaces between Chapter 32 and Other Chapters

PCSR Chapter	Interface
Chapter 1 Introduction	Chapter 1 provides the Fundamental Objective, Level 1 Claims and Level 2 Claims, Chapter 32 provides chapter claims and arguments to support relevant high-level claims that are addressed in Chapter 1.
Chapter 2 General Plant Description	Chapter 2 provides a brief introduction to the emergency facilities of the plant.
Chapter 4 General Safety and Design Principles	Chapter 4 provides the concept of Defence in Depth and the selection of appropriate standards. EP&R are located at level 5 of defence in depth.

PCSR Chapter	Interface
Chapter 8 Instrumentation and Control	Chapter 32 provides emergency response functional description of Main Control Room (MCR), Remote Shutdown Station (RSS) and Technical Support Centre (TSC). Chapter 8 provides the design information of I&C systems related to emergency response.
Chapter 9 Electric Power	Chapter 9 provides the design information of communication systems which is related to emergency response.
Chapter 10 Auxiliary Systems	Chapter 32 introduces the emergency function of the MCR and TSC. Chapter 10 provides the design information of the DCL system for the MCR and TSC in section of the Sub-chapter 10.6.
Chapter 13 Design Extension Conditions and Severe Accident Analysis	Chapter 13 provides the basic strategy of Severe Accident Management Guidelines for emergency arrangements.
Chapter 22 Radiological Protection	Emergency preparedness including emergency operations, on-site accident management and emergency facilities is described in Chapter 32. Chapter 22 presents information of post-accident accessibility which is connected with emergency operations.
Chapter 30 Commissioning	Chapter 30 provides the information of commissioning which considers the requirements of EP&R.
Chapter 31 Operational Management	Chapter 31 presents the arrangement of the Emergency Operating Procedure (EOP) and the Severe Accident Management Guideline (SAMG) which shall be carried out by the operator in a radiation emergency.
Chapter 33 ALARP Evaluation	Chapter 32 demonstrates that the design of EP&R

PCSR Chapter	Interface
	can efficiently mitigate the accidental consequences and the risk levels of public and environment after accident are ALARP, which supports the ALARP demonstration addressed in Chapter 33.

32.3 Applicable Codes and Standards

For selection of applicable codes and standards, the statutory instruments in the UK are chosen, such as REPPIR, Reference [1]. The relevant requirements and guidance are chosen to provide the detailed information, such as *Licence Condition* (LC) 11, Reference [5], *Japanese Earthquake and Tsunami: Implications for the UK Nuclear Industry*，Reference [6] and the associated underpinning guidance. Relevant Good Practice recognised by UK regulators has also been selected along with the current versions of codes and standards. The IAEA safety standards are chosen to support the emergency arrangements of the UK HPR1000. The detailed principles for the selection of appropriate standards for this chapter are presented in Sub-section 4.4.7 of PCSR Chapter 4. The applicable codes and standards are listed in T-32.3-1.

The CCA, Reference [7], is the primary legislation supporting emergency planning procedures in the UK. The Act, constituted by three parts, defines the meaning of “emergency” as well as obligations of certain organisations, grants the government emergency power, and provides supplementary legislation in support of the first two parts. To support the CCA, there are some accompanying regulations of the CCA and supplementary documents, Reference [8], [9] and [10]. The definition of an emergency is relatively broad in the UK. A major incident may be declared by any emergency response organisation in Reference [11]. A release of radioactive substances outside a NPP requiring the off-site plan to be initiated would be potentially a major incident.

The licencee of each NPP site is required to establish adequate emergency arrangements and an operator’s emergency plan that contains the descriptions to manage emergencies arising from activities on site. These plans are to be submitted to, and approved by, the ONR in accordance with LC 11, Reference [5]. Approved arrangements must not be altered or amended unless ONR has approved such alterations or amendments. If emergency arrangements need assistance and cooperation with other persons, local authority or organisations, the licencee has responsibilities to consult with them on such arrangements.

Emergency exercises must be performed on a regular basis. All persons who have duties in connection with emergency arrangements are properly instructed in the performance and the precautions. There are some detailed expectations in *Safety Assessment Principles for Nuclear Facilities*, Reference [12], fundamental principle

FP.7 and accident management and emergency preparedness principle AM.1. These “adequate emergency arrangements” are expected to be detailed in the operator’s emergency response plans and associated preparedness documentation.

The REPPIR and its supporting guidance, Reference [1] and [13], aim to establish a legal framework for emergency arrangements, for the protection of the public from emergency exposures during a radiation emergency, and to ensure that relevant public those likely to be affected are supplied with the prior information specified in REPPIR before and during a radiation emergency.

The quantities of radioactive materials associated with specific NPP based on the UK HPR1000 design will be evaluated and compared with the limits provided in REPPIR during the nuclear site licencing phase. In the GDA stage, the regulations associated with operators are assumed to apply. REPPIR regulations set the responsibility for the production of the operator’s emergency plan with the operator and the off-site emergency plan is the responsibility of the local authority. REPPIR provisions have impose requirements on the operator and the local authority to ensure that the emergency arrangements mitigations remain in the state of readiness through drills, exercises and reviews conducted a regular basis, and countermeasures are developed for an emergency. These responsibilities mainly include：

a) Carrying out an evaluation of the hazards arising from the work undertaken on the premises to determine whether they have the potential to cause a radiation emergency.

b) Making a further assessment to evaluate a full range of consequences of such a radiation emergency.

c) Undertaking a review of its evaluation and making a further assessment if there is a proposal to change the work with ionising radiation.

d) Preparing and sending a consequence report to the local authority which should include a proposed detailed emergency planning zone.

e) Preparing an emergency plan where the evaluation shows that a radiation emergency may arise.

f) Reviewing and testing operator’s emergency plan.

g) Cooperating with the local authority and other employers.

h) Condition of implementing emergency plans and informing about the implementation.

i) Making a full assessment of consequences of any radiation emergency and effectiveness of the emergency plans after implementation.

j) Reference levels of effective doses in a radiation emergency.

k) Information to be provided to the public in an area covered by a detailed emergency planning zone and in the event of an emergency respectively.

l) Requiring employers to consult radiation protection advisors.

It is noted that REPPIR Regulation 18 in Reference [1] states that emergency workers should be given appropriate training and equipment. Nuclear Suitably Qualified and Experienced Person (SQEP) is a UK nuclear industry requirement. In addition, ONR LC10 (Training) requires the operator to provide suitable training for all emergency workers who have a responsibility for safety, Reference [5]. This will be undertaken for the operator of the UK HPR1000 prior to commissioning. The REPPIR and its supporting guidance may be updated in the future which may cause a revision to the emergency arrangements.

The UK government has issued nuclear EP&R guidance in Reference [14] to help local emergency planners, HM government departments, devolved administrations of Scotland and Wales and other agencies that carry out nuclear EP&R. The nuclear EP&R guidance is the primary source of guidance for local emergency planners to enable them to prepare effective plans. This document covers the guiding principles and phases of emergency management. The ONR has also issued lessons of the Fukushima accident on EP&R, which provides advice related to on-site emergency control, Reference [6].

REPPIR Regulation 11 and licence condition require the operator to co-operate with off-site organisations; the site has its own Emergency Planning Consultative Committee to meet these requirements.

The IAEA has established a number of requirements and safety guidelines on the subject of emergency management, including *GSR Part 7 Preparedness and Response for a Nuclear or Radiological Emergency*, Reference [4], GS-G-2.1 *Arrangements for Preparedness for a Nuclear or Radiological Emergency*, Reference[15], which establishes the requirements and guidance on infrastructure and emergency preparedness, and *Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency*, Reference [16].

To analyse the suitability of codes and standards that are applied to emergency preparedness topic area of the UK HPR1000, according to the principles and processes presented in *General Principles for Application of Laws, Regulations, Codes and Standards*, Reference [17], the relevant codes and standards have been collected, screened and assessed. To ensure the design requirements of the selected codes and standards used in the UK HPR1000 design can be applied adequately, the compliance analysis in the emergency preparedness topic area has been performed. Compliance analysis provides confirmation and justification of the design requirements of the main selected design codes and standards, where they have been applied and their compliance with the design of the UK HPR1000 in the emergency

preparedness topic area. According to the compliance analysis for codes and standards in the UK HPR1000 emergency preparedness topic area, the UK HPR1000 design is in compliance with the requirements.

T-32.3-1 List of Applicable Codes and Standards

No.	Standard No.	Title	Date Issued
1	No.703	The Radiation (Emergency Preparedness and Public Information) Regulations 2019	2019
2	No. SSG-25	Periodic Safety Review for Nuclear Power Plants, Specific Safety Guide	2013
3	No. GSR Part 7	Preparedness and Response for a Nuclear or Radiological Emergency, General Safety Requirements	2015
4	---	Licence Condition Handbook	2017
5	ONR-FR-REP-11-002	Japanese Earthquake and Tsunami: Implications for the UK Nuclear Industry	2011
6	---	Civil Contingencies Act 2004	2004
7	---	The Civil Contingencies Act 2004 (Contingency Planning) Regulations 2005	2005
8	---	The Civil Contingencies Act 2004 (Contingency Planning) (Amendment) Regulations 2012	2012
9	---	The Fit with Other Legislation, Revision to Emergency Preparedness Chapter 19	2011
10	ISBN 1 874447 42 X	Dealing with Disaster	2003
11	ISBN 9780717667284	Approved Code of Practice and Guidance For The Radiation (Emergency Preparedness and Public Information) Regulations 2019	2019
12	---	Nuclear Emergency Planning and Response Guidance	2015
13	Safety Guide No.GS-G-2.1	Arrangements for Preparedness for a Nuclear or Radiological Emergency	2007
14	General Safety Guide No. GSG-2	Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency	2011

32.4 Emergency Management

The UK HPR1000 operator will establish an on-site emergency response organisation, and define its obligations to perform on-site emergency response and co-operation

with local authorities according to the requirements of relevant regulations. An example of the relationship between the on-site and off-site emergency organisations is shown in F-32.4-1 which refers to Reference [14]. The detailed development and description of interfaces with each party and their responsibilities will be included in the specific operator's emergency plan. The operator's emergency plan is the responsibility of operators which will be ready before the receipt of nuclear fuel on site. The main requirements and duties within the operator's emergency plan include, but are not limited to, the following:

a) Specify the tasks and interfaces of emergency response organisations.

b) Co-ordinate the nuclear emergency response within the plant.

c) Undertake control measures to mitigate the accident consequences.

d) Monitor radiation on site, and, if necessary, off site.

e) Report and maintain close contact during the accident. Communicate conditions to national and local authority, emergency organisations, competent authorities, nuclear regulator, and designated government departments.

f) Cooperate and assist the local authority and emergency organisations in the nuclear emergency response through the planning stage and provide liaison personnel at the Strategic Coordination Centre, Reference [11].

g) Conduct emergency training, emergency response testing, review and revision of operator's emergency plan, and management of emergency facilities, equipment, and instruments to ensure the emergency response capabilities of the NPP.

h) Establish clear processes for transitioning from an emergency response to recovery situation including transition criteria and operator recovery actions.

A typical structure of the NPP nuclear emergency response organisation is shown in F-32.4-2. It consists of the Duty Controller and Deputy Controller of the NPP and several emergency response support groups including the operation control group, the technical support group, the maintenance service group, the radiological protection group and the administration and logistics group. The Duty Controller is responsible for leading of on-site emergency response and making command and decision for response activities based on the safety.

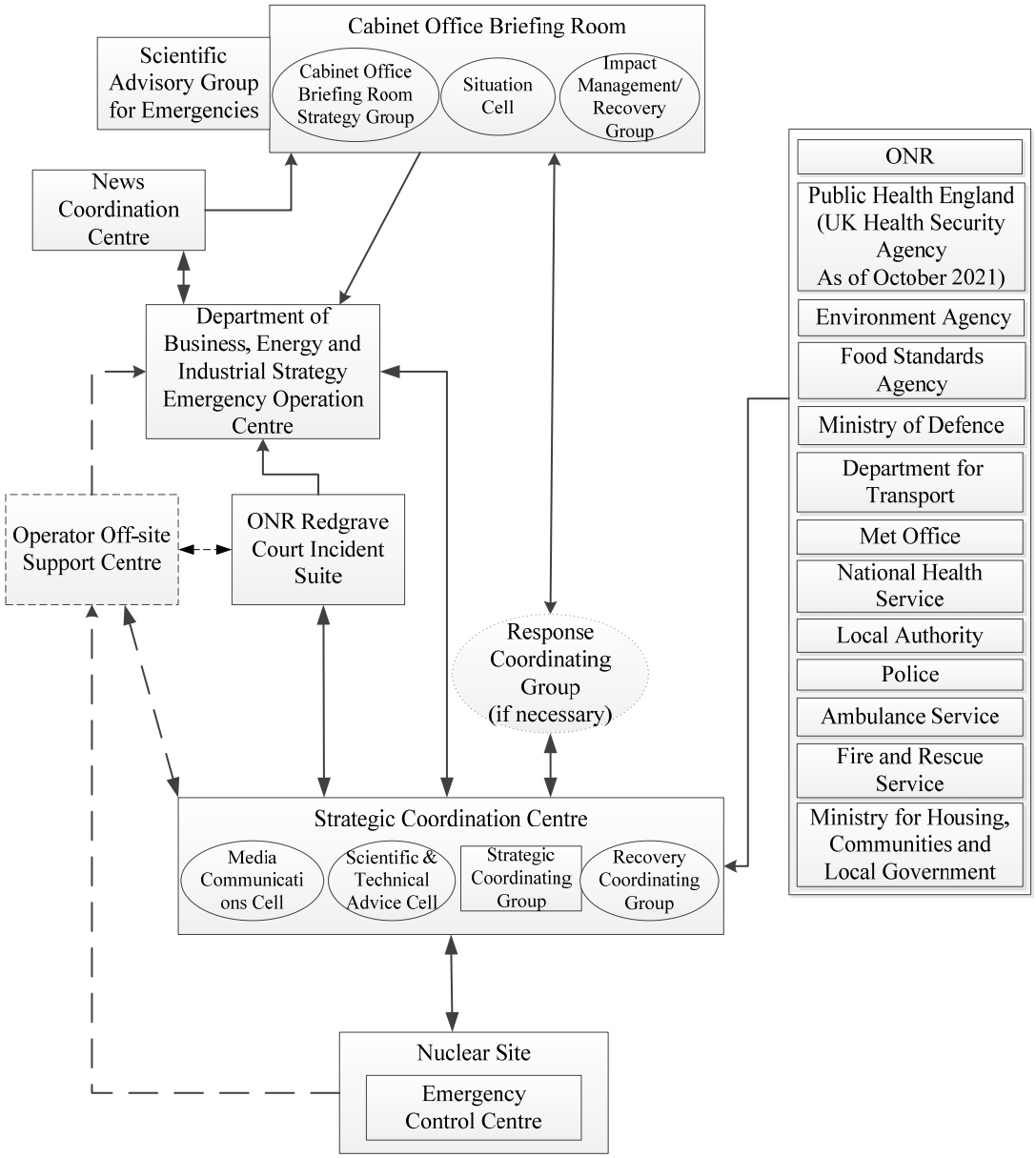
Each group is staffed with different duty-holders, for example the administration and logistics group consists of industrial safety personnel, fire fighters, occupational medical technicians and duty occupational medical and health physicists. The On-site Emergency Control Centre (ECC) is staffed with a Duty Controller, a Deputy Controller and several other members. When the emergency response activate, each emergency response group will assemble at specified location, and when these locations loss the habitability, they will move to On-site ECC. The range of work of

the emergency response groups cover communication, emergency operation, safety analysis, environmental monitoring, accident consequence evaluation, managing operations in a radiation emergency, mitigatory actions, security, logistics support, fire-fighting and medical aid.

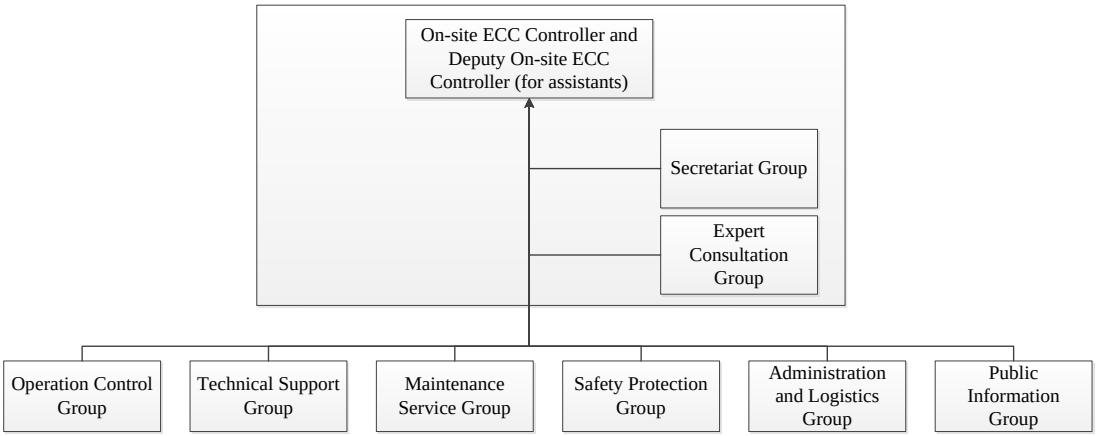
The staffing and qualification of the emergency response organisation will be described in operator's emergency plan, and detail in the emergency arrangements. In the UK, all emergency controllers, responders and control centre support personnel must be SQEP, Reference [5].

Emergency response personnel are trained to become competent in use of emergency equipment, emergency procedures, and communications equipment. Training, drills and exercises for emergency arrangements are conducted to demonstrate the overall response capability and capacity of the emergency organisations. These include arrangements for continuous refresher training on an appropriate schedule and arrangements for ensuring that personnel assigned to positions with responsibilities in an emergency response undergo the specified training. The personnel responsible for critical response functions participate in drills and exercises on a regular basis to ensure their ability to carry out their actions effectively, as per the requirement of Reference [4]. These will be described in the operator's emergency plan and in detail in the emergency arrangements. Records of training and exercises are maintained by the Human Resources Department. The detailed roles and arrangements will be further developed in the nuclear site licensing phase.

As required in REPPIR, Reference [1], before work with ionising radiation is carried out for the first time, i.e. nuclear fuel arrives on site, a hazard evaluation will be performed and written to identify and assess all hazards which could cause a potential radiation emergency. A full range of possible consequences of the identified radiation emergencies will be considered and assessed. Based on the hazard evaluation and the consequence assessment, the consequences report will be prepared and completed. The operator's emergency plan, amongst other things, forms part of the operational documentation and is subject to the same quality assurance programme and must comply with site conditions regarding record keeping. These tasks need to combine with specific site conditions and will be performed in the nuclear site licensing phase.



F-32.4-1 Example of the Relationship between NPP Emergency Organisation and Off-site Emergency Organisations[1, 2]



F-32.4-2 Example of the NPP Emergency Organisation Structure[2]

Note 1: According to the Reference [14], the Operator Off-site Support Centre provides additional support to On-site ECC. It is a facility located off-site. However, whether the Operator Off-site Support Centre will be founded or not will be determined in the nuclear site licensing phase. And the Operator Off-site Support Centre and its relations with other organisations are shown in dashed lines and box in this figure.

Note 2: The schematic diagram F-32.4-1 and F-32.4-2 will be changed as emergency planning arrangements for specific areas change. The precise operator support to the off-site emergency response arrangements will be formulated prior to commissioning.

32.5 On-site Emergency Response Facilities

This sub-chapter describes the basic functions of the main on-site emergency response facilities. In support of the on-site emergency management response arrangements, the UK HPR1000 operator's emergency plan will consider providing available emergency response facilities to coordinate and manage site actions. The main on-site emergency response facilities are described below as well as their preliminary general design requirements. It is noted that further design requirements for these facilities are still under development and will not be finalised during GDA. In terms of the plant layout, the locations of emergency facilities will be determined in the nuclear site licensing phase. Testing and maintenance of the emergency systems and equipment will be done periodically according to the manufacturer's specification and operator's emergency plan.

32.5.1 Main Control Room

The MCR is the workplace for the operation control group staff, where relevant functions in an emergency are carried out. The functions of the MCR are as follows:

a) Provide control measures for the operator to maintain or restore the safety status of the NPP.

b) Serve as the major facility for emergency response command before the On-site ECC becomes operational.

The MCR design ensures the effective delivery of its functions under internal and external hazards and meets the personnel habitability requirements throughout the duration of the postulated accidents. The design information of the MCR is presented in PCSR Chapter 8 Sub-chapter 8.13 and Chapter 10 Sub-chapter 10.6.11.

32.5.2 Remote Shutdown Station

The RSS design is such as to ensure that the reactor can be placed and maintained in a shutdown state, residual heat can be removed and essential plant variables can be monitored if there is a loss of ability to perform these essential safety functions in the MCR. The RSS has the same (duplicated) communications to the as On-site ECC and

the MCR. The design information of RSS is presented in PCSR Chapter 8 Sub-chapter 8.13.

32.5.3 On-site Emergency Control Centre

The On-site ECC is a strategic centre for control of the site and the workplace of the Duty Controller and ECC team to control and coordinate the emergency response to the extent that the on-site emergency response is efficiently managed and co-ordinated with the off-site emergency response. The On-site ECC is equipped with communication facilities with various functions, which all have interfaces to facilitate communications with on-site departments and facilities, other authorities as well as national and off-site emergency organisations.

The safety protection group, administration and logistics group, and public information group assemble in the On-site ECC when it is activated. The safety protection group provides the radiation protection advice and equipment, monitoring, controlling and evaluation of the doses of emergency workers, and other radiation protection work. The administration and logistics group organises and controls emergency response actions, including on-site radiation monitoring, emergency radiation control, security support, fire protection coordination, rescue, first aid, decontamination of injured personnel and medical emergency treatment. The Public information group collects the public feedback, provides the information of emergency response for off-site emergency organisation, and support the public communication of local authority.

The On-site ECC is located separately from both the MCR and the RSS to safeguard its function, ensure it will not interfere with other on-going response actions and can be secured. The On-site ECC design will satisfy the requirements for personnel habitability throughout the duration of the postulated accidents. The UK HPR1000 On-site ECC has been improved based on Fukushima lessons to ensure that the main structure has sufficient seismic capacity, Reference [6]. This improvement is in line with relevant good practice.

32.5.4 Technical Support Centre

During the emergency response phase, the TSC is the workplace for the staff of the technical support group where they initiate and implement emergency response actions. The staffs carry out the power plant status diagnosis, prediction and evaluation, radiological consequence evaluation and provide technical support to the operating personnel in MCR in an emergency from the TSC. The TSC is located above the MCR, and there is access between the two facilities. The design information of the TSC is presented in PCSR Chapter 8 Sub-chapter 8.13.

32.5.5 Operation Support Centre

The Operation Support Centre (OSC) is the facility where the staff of the maintenance

service group will assemble in an emergency situation to be assigned to, briefed and suitably equipped for performing various maintenance duties during the on-site and off-site emergency states. And it also stores some equipment and tools which are used for maintenance work.

The OSC are usually located in the on-site building and separate from MCR. It's usually not a specific emergency facility and has other functions for normal operation conditions. But this on-site building does not set up the habitability system. Therefore, when it loss habitability in a radiation emergency, the maintenance staff will move to The OSC standby point (an independent room) in the on-site ECC which have the habitability system to keep the habitability.

32.5.6 Communication Systems

The UK HPR1000 communication systems (see PCSR Chapter 9 Sub-chapter 9.7) are designed to provide reliable and efficient communications. Effective means of communication are provided throughout the NPP to facilitate safe operation in all modes of normal operation and to be available for use after all postulated initiating events and during accident conditions. Suitable and diverse means are provided to ensure that reliable and consistent information can be passed correctly and without delay to the interaction with organisations outside the plant, including the off-site emergency organisations. Testing and maintenance of the system equipment will be done periodically according to the manufacturer’s specification. The communication systems also include regular update checks on contact numbers and for NPP personnel, linked to personnel records.

32.6 On-site Accident Management

32.6.1 Emergency Operating Procedures

The EOPs denote an important part of NPP DiD concept (including Design Extension Conditions (DEC) A). It supports and guides personal activities in preventing and managing incident and accident conditions (see PCSR Chapter 31 Sub-chapter 31.4).

The EOPs are based on the state-oriented approach. The fundamental objective of an emergency operation is to ensure the six basic safety functions:

- Sub-criticality.
- Primary pressure and temperature.
- Primary water inventory.
- Steam generator integrity.
- Water inventory in steam generator.
- Containment integrity.

All the initial states of the plants are covered in the EOPs. Different human-system interfaces are also considered in the EOPs to minimise potential human or technical failures. The radiological protection issues under post-accident conditions are presented in PCSR Chapter 22 Sub-chapter 22.11.

The EOPs need to take account of developments in adjacent sites during construction and commissioning, particularly where the new site is co-located with an existing nuclear licenced site, whether fully operational or undergoing decommissioning. An incident, nuclear or otherwise, may have important implications for both sites. It is good practice to recognise this possibility at an early stage of development.

32.6.2 Severe Accident Management Guidelines

While the EOPs focus on protecting core integrity, the SAMG pays attention to ensure containment integrity and limiting the release of fission products to the environment. The SAMG, whose general objective is to reach a controlled and stable state, should cover all the DEC-B scenarios using realistic assumptions. Furthermore, the equipment required for severe accident mitigation should be qualified for the necessary conditions and mission time.

Severe accident scenarios considered in safety analysis are analysed based on realistic assumptions and dedicated severe accident mitigation measures are designed to mitigate the risk mentioned in PCSR Chapter 13 Sub-chapter 13.5. Operational guidance for severe accidents is described in PCSR Chapter 31 Sub-chapter 31.4. The arrangements will provide the framework for extending the response, but they will not be as detailed as those for radiation emergency.

32.7 ALARP Assessment

The following table summarises RGPs identified in Chapter 32, along with source legislation and guidance to meet the ALARP requirement for readiness of the emergency response.

T-32.7-1 Summary of Relevant Good Practice

Item	Relevant Good Practice	Source	Gap Analysis
1	Suitable training for emergency response workers and those called on during their normal duty to make an emergency decision. Although not defined precisely, it is RGP to provide a high standard of training at all levels of response, including refresher training.	REPPIR, Regulation 18.	No gap. The relevant description is presented in 32.3, 5th paragraph.
2	To keep plans up to date with experience of	REPPIR, Regulation	No gap.

Item	Relevant Good Practice	Source	Gap Analysis
	other accidents and changing practices.	12.	The relevant description is presented in 32.3, 6th paragraph.
3	A liaison person from the company, with sufficient seniority to advise is required to attend the Strategic Co-ordination Centre during the response.	REPPIR, Regulation 11.	No gap. The relevant description is presented in 32.3, 7th paragraph.
4	The maintenance of training records for SQEP.	UK nuclear industry requirement, also see Nuclear Resilience Coordination Committee for guidance notes.	No gap. The relevant description is presented in 32.4.
5	Adopting lessons learned from disasters, e.g. Fukushima.	Japanese Earthquake and Tsunami: Implications for the UK Nuclear Industry	No gap. The relevant description is presented in 32.5.3.
6	Emergency operations facilities should be remote from the reactor facility and depending on function may need to be off-site. Standby facilities should not be co-located with the main facilities as there is a risk that both could be put out of action – common mode failure.	IAEA No. GSR Part 7 Requirement 24.	No gap. The relevant description is presented in 32.5.
7	Public Information Centre should be off-site and have facilities for media/press conference and interface with public. This should be done in co-operation with the local authorities who have a statutory duty on this issue.	Generally accepted in emergency planning in UK. For dissemination of information: REPPIR, Regulation 21 and CCA.	No gap. The relevant description is presented in 32.5.3.
8	When producing press statements this should be agreed with the operator. This is an operational issue and strictly not GDA,	REPPIR, Regulation 21.	No gap. The relevant description is

Item	Relevant Good Practice	Source	Gap Analysis
	but it is worth mentioning as a new site is developed.		presented in 32.5.3.
9	Updating of emergency contacts for NPP staff should be done with the Personnel Department as they should have latest contact details, especially via payroll and salaries section. Maintaining current emergency contact details is tedious but essential for efficient response.	Generally recognised as a good emergency planning and general management process.	No gap. The relevant description is presented in 32.4.
10	It is important to review the EOPs more frequently during the construction phase and commissioning where the new site will be co-located with an existing nuclear facility, whether operational or undergoing decommissioning. Although a site-specific issue it needs to be recognised recognising during the GDA.	REPPIR, Regulation 12.	No gap. The relevant description is presented in 32.6.1.

This section complies with the source legislation and guidance. It is considered that the emergency preparedness complies with RGPs in this chapter. No gaps have been identified at this stage.

32.8 Concluding Remarks

In summary, the UK HPR1000 emergency arrangements will meet the requirements of the relevant UK legislation, regulations, guidelines and standards, and of applicable standards of international organisations such as IAEA, before commissioning.

The UK HPR1000 emergency facilities design has also considered the lessons from the Fukushima accident. The Emergency Preparedness Plan will include information necessary to comply with REPPIR regulations, Reference [1], in the nuclear site licensing phase. Future development work will be required in the nuclear site licensing phase to further define the detailed requirements of emergency preparedness as the design progresses.

32.9 References

[1] Health and Safety Executive, The Radiation (Emergency Preparedness and Public Information) Regulations 2019, No.703, May 2019.

[2] IAEA, Periodic Safety Review for Nuclear Power Plants, Specific Safety Guide No. SSG-25, March 2013.

[3] General Nuclear System Limited, HPR-GDA-REPO-0007, Scope for UK HPR1000 GDA Project, Rev. 001, July 2019.

[4] IAEA, Preparedness and Response for a Nuclear or Radiological Emergency, General Safety Requirements No. GSR Part 7, November 2015.

[5] ONR, Licence Condition Handbook, February 2017.

[6] ONR, Japanese Earthquake and Tsunami: Implications for the UK Nuclear Industry, Final Report, ONR-FR-REP-11-002, Rev 2, September 2011.

[7] Civil Contingencies Act 2004 Chapter 36, 2004.

[8] Cabinet Office, The Civil Contingencies Act 2004 (Contingency Planning) Regulations 2005, November 2005.

[9] Cabinet Office, The Civil Contingencies Act 2004 (Contingency Planning) (Amendment) Regulations 2012, April 2012.

[10] Cabinet Office, The Fit with Other Legislation, Revision to Emergency Preparedness Chapter 19, February 2011.

[11] Cabinet Office Civil Contingencies Secretariat, Dealing with Disaster, Revised Third Edition, ISBN 1 874447 42 X, 2003.

[12] ONR, Safety Assessment Principles for Nuclear Facilities, 2014 Edition, Revision 1, January 2020.

[13] Health and Safety Executive, The Radiation (Emergency Preparedness and Public Information) Regulations 2019 Approved Code of Practice and Guidance, ISBN 9780717667284, Second Edition, November 2020.

[14] UK Department for Business, Energy & Industrial Strategy, Nuclear Emergency Planning and Response Guidance, October 2015.

[15] IAEA, Arrangements for Preparedness for a Nuclear or Radiological Emergency, Safety Guide No.GS-G-2.1, May 2007.

[16] IAEA, Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency, General Safety Guide No. GSG-2, May 2011.

[17] China General Nuclear Power Corporation, General Principles for Application of Laws, Regulations, Codes and Standards, GHX00100018DOZJ03GN, Rev. H, October 2020.