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Pre-Construction Safety Report

Chapter 30

Commissioning

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30.1 List of Abbreviations and Acronyms

ACPR1000	Advanced Chinese Pressurised Reactor
ALARP	As Low As Reasonably Practicable
CFT	Cold Functional Test
CFTRVO	Cold Functional Test with Reactor Vessel Open
CGN	China General Nuclear Power Corporation
CPR1000	Chinese Pressurised Reactor
EOP	Emergency Operating Procedure
FAT	Factory Acceptance Test
FCG3	Fangchenggang Nuclear Power Plant Unit 3
HFT	Hot Functional Test
HPR1000 (FCG3)	Hua-long Pressurised Reactor under construction at Fangchenggang nuclear power plant unit 3
IAEA	International Atomic Energy Agency
NOP	Normal Operating Procedure
NPP	Nuclear Power Plant
NSSS	Nuclear Steam Supply System
ONR	Office for Nuclear Regulation (UK)
OTS	Operating Technical Specification
PCSR	Pre-Construction Safety Report
RGP	Relevant Good Practice
SSC	Structures, Systems and Components
UK HPR1000	UK version of the Hua-long Pressurised Reactor

30.2 Introduction

‘Commissioning’ means the process during which plant components and systems, having been constructed or modified, are made operational and verified to be in accordance with design assumptions and to have met the appropriate safety criteria.

The role of commissioning is to collect evidence, and the evidence will be produced during the setup of the commissioning team and the performance of the

commissioning activities - not during the GDA process. This chapter only provides the requirements and arrangements for the commissioning. The objective of this chapter is to present an overview of the arrangements that will be set up to commission the UK version of the Hua-long Pressurised Reactor (UK HPR1000) nuclear power plant. These commissioning arrangements are used to support the fundamental objective of the Pre-Construction Safety Report (PCSR) and relevant PCSR claims.

To support the chapter claim, the commissioning work follows the strategy listed below:

a) Identifying Relevant Good Practice (RGP) based on UK context, deriving special requirement for the commissioning, comparing with these RGPs and identifying the gaps;

b) Fully deriving the requirements for commissioning, including site licensee commissioning arrangements and commissioning programme scope;

c) Planning and performing commissioning tests to validate the function of SSC;

d) Identifying and resolving any commissioning non-conformances.

30.2.1 Chapter Route Map

The ***Fundamental Objective*** of the UK HPR1000 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 3.3.14*** derived from the high level ***Claim 3***.

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.*

Claim 3.3*: The design of the processes and systems has been substantiated and the safety aspects of operation and management have been substantiated.*

Claim 3.3.14*: A commissioning programme is required to enable assurances to be given that the plant will be substantiated in a safe, efficient and informative manner.*

To support the Claim 3.3.14, this chapter developed three Sub-claims and a number of relevant arguments:

a) ***Sub-claim 1****: The commissioning programme, will contribute to the demonstration that the UK HPR1000, as built, will be capable of safe and*

reliable commercial operation throughout its life cycle, in accordance with the design intent, as claimed in the plant overall safety case.

The UK HPR1000 commissioning programme will be designed to:

1) ***Argument 1.1****: Demonstrate that adequate organisational arrangements are in place which support the change in risk associated with the change from inactive commissioning (non-nuclear testing, before first core loading) to active commissioning (nuclear testing, after first core loading), described in 30.4.1;*

2) ***Argument 1.2****: Verify, where possible, that the plant meets the design intent (in accordance with the design specification, as claimed in the plant overall safety case), described in 30.4.3;*

3) ***Argument 1.3****: Confirm the main design parameters, including compliance with applicable codes, standards and the UK HPR1000 quality assurance programme, described in 30.4.4.*

b) ***Sub-Claim 2****: The commissioning programme, will contribute to the demonstration that the UK HPR1000, as built, will be in compliance with the requirements of Reference [1].*

The UK HPR1000 commissioning programme will be designed to:

1) ***Argument 2.1****: Provide substantiation that the commissioning team are suitably qualified and experienced, described in 30.4.1;*

2) ***Argument 2.2****: Develop a comprehensive portfolio of plant baseline data to support the progression between commissioning activities and for comparison with future Examination, Maintenance, Inspection and Testing, described in 30.4.2;*

3) ***Argument 2.3****: Provide an opportunity to train/familiarise plant operating and technical personnel with plant SSC, Reference [2], described in 30.4.3;*

4) ***Argument 2.4****: Demonstrate, where commissioning provides a representative approach, the use of Operating Technical Specification (OTS), and so far as reasonably practicable procedures (including Normal Operating Procedure (NOP) and Emergency Operating Procedure (EOP), according to Chapter 31, and Emergency Preparedness, according to Chapter 32), described in 30.5.5.*

c) ***Sub-claim 3****: The commissioning programme, will contribute to the demonstration that the UK HPR1000, as built, will present inactive/active commissioning risks that are As Low As Reasonably Practicable (ALARP).*

The UK HPR1000 commissioning programme will be designed to:

1) ***Argument 3.1****: Consider any remediation required where design, programme*

or test changes are necessary, or where unexpected results (anomalies) are obtained, or adverse events occur, ensuring that systems are in place to manage the implications (for example, establish the reasons and devise resolutions where possible), described in 30.4.3;

2) ***Argument 3.2****: Demonstrate the safety functional and operational requirements of the plant, through a structured, systematic and progressive programme of activities (testing and inspection of plant Structures, Systems and Components (SSC)), described in 30.4.5 and 30.5;*

3) ***Argument 3.3****: Demonstrate that, so far as reasonably practicable, commissioning does not introduce additional hazards (for example, conventional and nuclear safety related), described in 30.5.6;*

4) ***Argument 3.4****: Demonstrate that commissioning risks arising are ALARP and justified, taking into account relevant good practice, described in 30.6.*

30.2.2 Chapter Structure

The general structure of this chapter is presented as below:

a) Sub-chapter 30.1 List of Abbreviations and Acronyms:

This section lists the abbreviations, acronyms that are used in the PCSR Chapter 30;

b) Sub-chapter 30.2 Introduction:

This section gives a brief introduction of PCSR Chapter 30.

c) Sub-chapter 30.3 Applicable Codes and Standards:

This section describes the applicable codes and standards.

d) Sub-chapter 30.4 Site Licensee Commissioning Arrangements:

This section describes the site licensee commissioning arrangements.

e) Sub-chapter 30.5 Commissioning Programme Scope:

This section describes the scope of commissioning programme.

f) Sub-chapter 30.6 ALARP Assessment:

This section presents the ALARP Assessment of this chapter.

g) Sub-chapter 30.7 Concluding Remarks:

This section provides the concluding remarks.

h) Sub-chapter 30.8 References:

This section lists the supporting references of this chapter.

30.2.3 Interfaces with Other Chapters

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

T-30.2-1 Interfaces between Chapter 30 and Other Chapters

PCSR Chapter	Interface
Chapter 1 Introduction	Chapter 1 provides the Fundamental Objective, Level 1 Claims and Level 2 Claims, Chapter 30 provides chapter claims, arguments to support relevant high level claims that are addressed in Chapter 1.
Chapter 4 General Safety and Design Principles	Chapter 4 provides the classification principles and selection principles of codes and standards. The commissioning tests design needs to consider these design principles.
Chapter 6 Reactor Coolant System	The arrangements and requirements for commissioning align with system design requirements.
Chapter 7 Safety Systems	
Chapter 8 Instrumentation and Control	
Chapter 9 Electric Power	
Chapter 10 Auxiliary Systems	
Chapter 11 Steam and Power Conversion System	
Chapter 23 Radioactive Waste Management	
Chapter 28 Fuel Route and Storage	
Chapter 20 Management of Safety and Quality Assurance and Safety Case Management	The organisational arrangements and quality assurance arrangements set out in PCSR Chapter 20 are implemented in the design process and in the production of this chapter.
Chapter 21 Reactor Chemistry	Chapter 21 provides the objectives for commissioning from the chemistry and material aspects. Chapter 30 provides the arrangements and requirements for commissioning according to these objectives.
Chapter 25 Conventional	Chapter 25 provides the requirements of conventional

PCSR Chapter	Interface
Safety and Fire Safety	safety and fire safety. Chapter 30 needs to consider these requirements.
Chapter 31 Operational Management	Chapter 31 provides the methodology of OTS, NOP and EOP, etc. The commissioning tests design needs to consider these documents.
Chapter 32 Emergency Preparedness	Chapter 32 provides the requirements of emergency preparedness. Chapter 30 needs to consider these requirements of emergency preparedness.
Chapter 33 ALARP Evaluation	Chapter 33 provides the approach of ALARP. Chapter 30 needs to consider these requirements.

30.3 Applicable Codes and Standards

The selection of codes and standards for the commissioning programme design of the UK HPR1000 follows the selection principles and selection process presented in Chapter 4 and Reference [3]. The selection of codes and standards for this chapter complies with the RGPs of international organisations or other countries acknowledged by the UK regulators.

Factors provided as below have been considered sufficiently when exploring the selection principles.

a) Design characteristics;

b) Regulatory expectations;

c) Requirements of the guidance issued by authority organisations;

d) Other considerations (e.g. relevant good practice and other experience).

Safety requirements, safety guide and standards of international organisations (e.g. International Atomic Energy Agency (IAEA)) used in the UK HPR1000 are the same as Fangchenggang Nuclear Power Plant Unit 3 (FCG3). So applying these standards do not affect the design of the UK HPR1000.

The following Safety Standards from IAEA are identified as RGP for commissioning:

a) IAEA, Safety of Nuclear Power Plants: Commissioning and Operation, IAEA Safety Standards Series No.SSR-2/2, Rev.1, 2016, Reference [4].

b) IAEA, Commissioning for Nuclear Power Plants, IAEA Safety Standards Series No.SSG-28, 2014, Reference [5].

The design of Commissioning Programme has been undertaken in accordance with IAEA Safety Standard Series No.SSR-2/2 (Rev.1) *requirement 25*, Reference [4], and

IAEA Safety Standard Series No.SSG-28, Reference [5].

30.4 Site Licensee Commissioning Arrangements

The responsibility for ensuring the safety functional requirements (see sub-claims), during the commissioning programme will rest with the site licensee, supported as required by the responsible designer. Hence, the site licensee commissioning arrangements given in this section are illustrative and will be developed as part of the commissioning programme during the site specific nuclear site licensing phase by the site licensee.

Commissioning of the UK HPR1000 is performed following handover from the construction phase and verifies that the design, manufacture, installation or construction, and operation of the plant behave according to their design intent, as claimed in the overall safety case.

30.4.1 Organisational Requirements

A suitable commissioning organisation will be developed, with appropriate arrangements, capability and experience to undertake commissioning (including inactive commissioning and active commissioning).

The programme is expected to include:

a) Commissioning terms of reference;

b) Review/approval of test procedures;

c) Review/approval of test results (whether to meet safety requirements, design intent and performance levels);

d) Identification and resolution of any commissioning non-conformances;

e) Quality management;

f) Nuclear regulatory compliance activities;

g) Resources, and;

h) Operational experience feedback database/lessons learned system.

30.4.2 Programme Documentation

The commissioning organisation documentation is a significant part of the design substantiation process and is expected to include:

a) Commissioning activity continuity, including activity (milestone/hold point) stage reviews;

b) Evidence that the design intent, as claimed in the plant overall safety case, has been met or, if any non-conformances have been identified, that these have been

satisfactorily addressed;

c) Confirmation that commissioning can proceed safely;

d) Input to the plant lifetime records data system, and;

e) An opportunity for regulatory assessment.

There are three kinds of important commissioning execution documents, as follows:

a) Phased Commissioning Reports

After one commissioning phase is completed, a phased commissioning report will be written to summarise all commissioning activities in this phase, in order to determine whether the next phase can be entered. The report will contain essential results of the commissioning phase concerned.

b) System Commissioning Programmes

System commissioning programmes are related to a system or to a group of systems, or to another particular scope of commissioning, which specifies, in detail, all tests and their sequence applicable to a particular system or function.

System commissioning programmes generally consist of three parts as follows:

1) System test description: clear descriptions of the tests list, purposes and principle;

2) Test conditions and logic: descriptions of the commissioning stages and platforms that tests are implemented, and the logical relations of different tests;

3) Test acceptance criteria: descriptions of acceptance criteria, including safety criteria and operational criteria.

c) Test Procedures and Test Reports

Test procedures are based on system commissioning programmes. They describe the test purposes, acceptance criteria, special precautions, initial conditions and the test methods. The test procedures also include proper checklists and signature blocks to control the test implementation and sequence.

The test procedures are generally divided into three categories:

1) Preliminary tests;

2) System functional tests in cold conditions;

3) System functional tests in normal operating conditions.

All tests should be performed in accordance with the approved test procedures. The test reports will be written at the end of the test, which includes the following

contents:

1) Summary of test objectives;

2) Conduct of the test, including initial and final state of plant, the actual limitations experienced, problems encountered and the actions taken to overcome them, including modifications to the plant or the procedures arising therefrom;

3) A concise description of any special test equipment used;

4) A summary of data collected and analyses of the data;

5) An evaluation of results, and;

6) Conclusions.

30.4.3 Design Substantiation

The commissioning programme will incorporate design substantiation for all SSC tests that are necessary to demonstrate that the plant meets the design intent, as claimed in the overall safety case.

The design substantiation approach and documentation will contain sufficient information about the design, function and expected performance of the safety significant SSC which support safe and reliable commercial operation. This will provide a clear, coherent and auditable reference to the commissioning related safety functional requirements, in combination with the associated plant configuration under which the safety case claims need to be demonstrated. This evidential design substantiation sometimes referred to as the ‘golden thread’ will include demonstration that:

a) Sufficient analysis and engineering substantiation has been performed to ensure that the operational plant SSC will be demonstrably safe and secure (e.g. demonstration through pre-commissioning and commissioning activities, including calculations, material certification, inspections, Factory Acceptance Test (FAT), handover tests of installation, flushing records, commissioning tests and qualified procedures);

b) According to Reference [2], personnel are suitably qualified and experienced (e.g. proof of qualification of designers, welder qualification records and Suitably Qualified and Experienced Person records for test team personnel);

c) Records of the identification and disposition of anomalous behaviour of the plant will form part of the commissioning acceptance, and;

d) Test results confirmed and the objectives have been achieved with no unexpected outcomes arising. The substantiation should ensure, so far as is reasonably practicable, that all necessary data has been obtained and analysed, and that a

technical evaluation has been completed. The evaluation of the test results must include a comparison with the acceptance criteria.

30.4.4 Classification of Commissioning Activities

Commissioning activities will be classified commensurate with their safety or nuclear safety significance, Reference [5], as reflected in the safety classification of the associated SSC, according to Chapter 4.

The quality assurance arrangements for commissioning activities will be established. There will be higher levels of quality assurance arrangements for the safety functions than for the non-classified SSC.

The Commissioning activities classification methodology will ensure that the SSC are systematically tested and operated commensurate with the related safety functional requirements that they perform. Records of their identification and agreed resolution will form part of the commissioning substantiation.

30.4.5 Activity Schedule

A commissioning activity schedule approach will be established, to meet the expectations of their permission regime and satisfy the site licensee's due process requirements, Reference [4].

The commissioning programme is expected to be designed by the site licensee, to provide appropriate activity based milestone/hold points, incorporating a structured, systematic and progressive phased approach for management of the commissioning programme. It is anticipated that it will include:

a) Key milestones and hold points, as justified in or assumed by the overall safety case;

b) Satisfactory completion (verification through demonstration and acceptance) of the acceptability of earlier test results, before releasing the key milestone/hold point to enter the next phase/stage of commissioning;

c) Tracking the demonstration and acceptance of commissioning related safety functional requirements, and;

d) Support to the site licensee by providing substantiation for moving from one milestone/hold point to the next.

30.5 Commissioning Programme Scope

The responsibility for the commissioning programme scope will rest with the site licensee, supported as required by the responsible designer. Hence, the commissioning programme scope arrangements given below are illustrative and will be developed as part of the commissioning programme during the site specific nuclear site licensing phase by the licensee.

The commissioning programme scope will incorporate a structured, systematic and progressive test programme, which provides the transition from construction to operation of the plant and includes all the activities required for confirmation and demonstration of the plant SSC operational and commissioning related safety functional performance requirements.

30.5.1 Programme Phases

The Commissioning test programme will group the commissioning into phases/stages with a logical sequence from inactive to active nuclear tests. The plant commissioning programme is split into two phases (inactive and active), given in T-30.5-1 UK HPR1000 Commissioning Programme Phases below:

a) Pre-operational Tests Phase (inactive commissioning);

b) Initial Startup Tests Phase (active commissioning).

The inactive tests (phase 1) will include:

a) Description and justification of the pre-operational test activities to demonstrate, so far as reasonably practicable, the safety claims, assumptions, procedures, design intent, as claimed in the overall safety case has been achieved;

b) Identification of gaps in demonstration of commissioning related safety functional requirements and anomalies which result from and could not be justified during design, manufacture, installation or construction, and;

c) Systematic validation of SSC.

The active tests (phase 2) will include:

a) Addressing potential shortfalls identified during inactive commissioning;

b) Use of test data ‘evidence’ from the inactive commissioning;

c) Description and justification of active commissioning to demonstrate that the tests can be carried out safely;

d) Justification that active commissioning tests will demonstrate, so far as reasonably practicable, the safety claims, assumptions, procedures, design intent, as claimed in the overall safety case, has been achieved, and;

e) Demonstration of completeness following active commissioning.

The test results of the previous phase/stage shall be reviewed before continuing to the next phase/stage, Reference [4]. This is required to ensure that:

a) SSC configuration/condition is defined, controlled and protected such that testing does not put the plant at an unacceptable risk;

b) It is acceptable to enter the next stage, Reference [6], and;

c) The status and implications for the commissioning plan of the next stage is clearly understood and modified in accordance with the conclusions of the previous test results or in recognition that some tests are not performed or finished.

The different phases/stages will include activities to progressively substantiate the design, gradually introducing more onerous steps, including:

a) Plant static and dynamic tests which contribute to the demonstration that the SSC' design, manufacture, installation or construction is acceptable, and;

b) Whole system/plant commissioning tests, which identify and confirm the SSC and whole plant operational characteristics and which are required to meet the design intent substantiation, demonstrating functionality, safety documentation commitments and acceptance criteria as claimed in the plant overall safety case.

30.5.2 Commissioning Phased Approach

The two overall commissioning phases are sub-divided into three test stages, with further sub-stages, as given in T-30.5-1 UK HPR1000 Commissioning Programme Phases below.

T-30.5-1 UK HPR1000 Commissioning Programme Phases

Phase	Stage	Sub-stage
Pre-operational Tests Phase (inactive)	Stage Ⅰ: Preliminary Tests Period	Initial Test of Structures, Systems and Components
	Stage Ⅱ: Functional Tests Period	Sub-stage Ⅱ.1: Cold Functional Test (CFT)
		Sub-stage Ⅱ.2: Preparation for Hot Functional Test
		Sub-stage Ⅱ.3: Hot Functional Test (HFT)
		Sub-stage Ⅱ.4: Preparation for First Core Loading
Initial Startup Tests Phase (active)	Stage Ⅲ: Initial Startup Tests Period	Sub-stage Ⅲ.1: First Core Loading
		Sub-stage Ⅲ.2: Pre-Critical Test
		Sub-stage Ⅲ.3: Initial Criticality Test and Initial Power Ascension Period
		Sub-stage Ⅲ.4: Final Power Ascension Period

In support of the overall commissioning programme, initial tests (before delivery to site), will be performed to support the demonstration of SSC performance, for example FAT contributes to the SSC commissioning design substantiation.

30.5.3 Content of Commissioning Phases

This Section provides a list of representative tests to be considered in the development

of the UK HPR1000 commissioning programme in accordance with the structure given in T-30.5-1 UK HPR1000 Commissioning Programme Phases.

Stage Ⅰ: Preliminary Tests Period

This stage consist of component tests (e.g. motor test, valve test and pump test), first startup of single system, Instrumentation and Control channel test, Reference [7], flushing of fluid system (e.g. Reactor Coolant System, Chemical and Volume Control System, Nuclear Circuit Cleaning (clean the reactor coolant system piping and main nuclear auxiliary systems by flushing water through safety injection lines and charging line into the reactor vessel), and Cold Functional Test with Reactor Vessel Open (CFTRVO).

Stage Ⅱ: Functional Tests Period

Sub-stage Ⅱ.1: Cold Functional Test

CFT includes the initial startup of fluid systems and associated support systems, and the primary circuit hydrostatic test. The objective of this stage is to obtain initial operational data of equipment, ensure compatibility of operation with interfacing systems and verify the functional performance of these systems.

Sub-stage Ⅱ.2: Preparation for Hot Functional Test

During this stage, which starts at the completion of CFT and finishes at the beginning of HFT, the objective is to complete the outstanding activities, such as:

a) Balance of the CFTRVO activities shall be performed;

b) Single system tests or special commissioning activities related to HFT;

c) Conventional Island shall be prepared for first startup during this stage, in order to get Conventional Island systems ready for HFT;

d) Pre-Service Inspection.

Sub-stage Ⅱ.3: Hot Functional Test

The Nuclear Steam Supply System (NSSS) HFT objective is to perform a series of integrated nuclear power plant commissioning tests of the plant and systems for all normal reactor temperature and pressure states from cold shut down conditions to hot shutdown conditions. A number of tests (such as the loss of offsite power tests and the first startup activities of Conventional Island) which, together with plant operating procedures enable the verification of NSSS and associated Nuclear Island auxiliaries up to hot shutdown conditions, prior to fuel loading, will be performed.

This includes the familiarisation and training of operating and technical personnel.

Sub-stage Ⅱ.4: Preparation for First Core Loading

During this stage, which starts at the completion of HFT and finishes at the beginning of First Core Loading, the objective is to set up the plant ready for First Core Loading, including activities such as final nuclear cleaning, establishing a radiologically controlled area, implementation of Fuel Handling and Storage System tests, making up boron water and other related commissioning activities.

Stage Ⅲ: Initial Startup Tests Period

Sub-stage Ⅲ.1: First Core Loading

The objective of this sub-stage is to ensure that the fuel is loaded into the reactor safely in accordance with the loading pattern in the design. First fuel loading shall be implemented under refuelling cold shutdown conditions, including precautions taken to avoid inadvertent boron dilution, fuel damage and misloading.

Sub-stage Ⅲ.2: Pre-Critical Test

The objective of this sub-stage is to ensure that the reactor is in a suitable condition to be started up and that all prerequisites for permitting the reactor to go critical have been met. With the core loaded and the reactor maintained in a subcritical condition, a series of performance tests should be carried out. These tests include checks on coolant flow rates, instrumentation, rod control mechanisms, automatic rod insertion and other important features of the primary circuit.

Sub-stage Ⅲ.3: Initial Criticality Test and Initial Power Ascension Period

The main tasks of this stage include initial criticality, reactor physics tests at zero power, turbine generator run-up test, transient tests (e.g. ramp or step load change test, load shedding test and reactor or turbine trip tests), and performance tests such as turbine (and reactor) loading is increased in incremental steps.

Sub-stage Ⅲ.4: Final Power Ascension Period

Transient tests are carried out to demonstrate that the integrated response of the plant to significant transients is acceptable. The main tasks of this stage include core conformity tests, feedwater flow and level control test of steam generator, transient tests (e.g. ramp or step load change test, house load operation test, reactor or turbine trip test), performance tests (e.g. determination of NSSS rated thermal output, steam generator moisture carryover measurement, steam generator design margin test, turbine generator performance guarantee test).

30.5.4 First Plant Only Test

Hua-long Pressurised Reactor under construction at Fangchenggang nuclear power plant unit 3 (HPR1000 (FCG3)) which is the reference Nuclear Power Plant (NPP) of the UK HPR1000 will perform the first plant only test such as reactor internals flow induced vibration tests.

30.5.5 OTS and Procedures

Where plant commissioning activities (e.g. configurations/conditions) allow, operating rules, Reference [8] and procedures will be observed from when core loading is started. Prior to this, OTS and, so far as reasonably practicable, NOP and EOP will be used when performing pre-operational tests (inactive commissioning) and initial start-up tests (active commissioning). Where this is not possible, for example, where commissioning activities do not provide representative activities, specific arrangements will be produced to support the demonstration of design intent.

Relevant operational and technical personnel, who support the Commissioning Programme, should be suitably qualified and experienced, including the use of OTS and the UK HPR1000 simulator. This approach will contribute to:

a) Operator substantiation of the OTS or the identification of changes that may be required, and;

b) Improvements to the operators' knowledge of plant SSC and valuable experience provided by engineering personnel, promoting the transfer and retention of knowledge and experience within the operational organisation.

30.5.6 Operational Experience Feedback/Lessons Learned System

China General Nuclear Power Corporation (CGN) has participated in the commissioning process of various nuclear power technologies which are mentioned in the Pre-Construction Safety Report Sub-chapter 2.3.

CGN has rich experience in commissioning of nuclear power plants. CGN has successfully completed commissioning of 4 units of M310, 14 units of Chinese Pressurised Reactor (CPR1000), 2 units of Chinese Improved Pressurised Reactor, 1 units of Advanced Chinese Pressurised Reactor (ACPR1000) and 1 unit of European Pressurised Reactor, Taishan NPP in China. CGN is performing the commissioning of 2 units of ACPR1000 and preparing the commissioning of HPR1000 (FCG3). At the same time, CGN also partly participates in commissioning of Olkiluoto 3 NPP in Finland and Flamanville 3 NPP in France.

CGN has continuously fed the commissioning and operating experiences into the experience feedback/lesson learned system. With the commissioning work developing, CGN will also input the experience of ACPR1000 and HPR1000 (FCG3) into the experience feedback/lesson learned system. All the experience, taking into account relevant good practices, will be used for reference in the development of the UK HPR1000 commissioning programme operational experience feedback/lesson learned system. This will be continuously updated with the latest experience during the UK HPR1000 commissioning.

30.6 ALARP Assessment

30.6.1 Scope of Relevant Good Practice

The following are deemed RGP for commissioning:

a) IAEA, Safety of Nuclear Power Plants: Commissioning and Operation, IAEA Safety Standards Series No.SSR-2/2, Rev.1, 2016;

b) IAEA, Commissioning for Nuclear Power Plants, IAEA Safety Standards Series No.SSG-28, 2014;

c) ONR, LC21: Commissioning, Nuclear Safety Technical Inspection Guide, NS-INSP-GD-021, Revision 4, March 2016;

d) ONR, LC23: Operating Rules, Nuclear Safety Technical Inspection Guide, NS-INSP-GD-023, Revision 4, March 2016;

e) ONR, LC24: Operating Instructions, Nuclear Safety Technical Inspection Guide, NS-INSP-GD-024, Revision 3, February 2016.

30.6.2 Consistency Review against RGP

T-30.6-1 Holistic ALARP Review against UK HPR1000

No.	RGP	The UK HPR1000 design
IAEA Safety Standard Series No.SSR-2/2 (Rev.1), Reference [4]		
1.	The operating organisation shall ensure that a commissioning programme for the plant is established and implemented.	The UK HPR1000 complies with No.SSR-2/2 (Rev.1). The commissioning programme will be established and implemented during the site specific nuclear site licensing phase, described in 30.4 and 30.5.
IAEA Safety Standard Series No.SSG-28, Reference [5]		
2.	Organisational arrangements should be put in place to achieve the safety objectives of commissioning in accordance with the commissioning programme.	The UK HPR1000 complies with this requirement, described in 30.4.1
3.	The documentation for commissioning should consist of the organisation and management documents for commissioning, the commissioning procedures and the reporting documentation for commissioning.	The UK HPR1000 complies with this requirement, described in 30.4.2

No.	RGP	The UK HPR1000 design
4.	The commissioning programme should cover all the activities to be performed on structures, systems and components to make them operable in accordance with the design intent.	The UK HPR1000 complies with this requirement, described in 30.4.3
5.	Structures, systems and components are classified in the design stage on the basis of their importance to safety. The classification provides an input in determining commissioning requirements, and requirements for methods, testing, inspections, reviews, qualification of personnel and records.	The UK HPR1000 complies with this requirement, described in 30.4.4.
6.	The commissioning programme should be implemented in stages and sub-stages in accordance with the text on the stages of commissioning (see paras 2.17–2.22) and on testing stages and sequences (see paras 4.28–4.60).	The UK HPR1000 complies with this requirement, described in 30.4.5–30.5.3.
7.	During commissioning, normal operating procedures, including those for operational periodic tests, should be widely used to validate the applicability of the procedures. The emergency operating procedures should also be validated in the commissioning programme, to the extent possible.	The UK HPR1000 complies with this requirement, described in 30.5.5.
8.	The responsibilities of the commissioning group should include, but are not limited to, the following: a) To record all the feedback of experience from commissioning; b) To establish a procedure to compile the lessons learned from commissioning activities, to draw conclusions and to determine the necessary corrective actions	The UK HPR1000 complies with this requirement, described in 30.5.6.
ONR Nuclear Safety Technical Inspection Guide NS-INSP-GD-021, Reference [9]		

No.	RGP	The UK HPR1000 design
9.	LC21 provides guidance on arrangements for commissioning.	The UK HPR1000 complies with these arrangements, described in 30.4 and 30.5.
ONR Nuclear Safety Technical Inspection Guide NS-INSP-GD-023, Reference [8]		
10.	LC23 provides guidance on arrangements for operating rules.	The UK HPR1000 complies with these arrangements, described in 30.5.5. The operating rules will be observed as far as possible during commissioning process.
ONR Nuclear Safety Technical Inspection Guide NS-INSP-GD-024, Reference [10]		
11.	LC24 provides guidance on arrangements for operating instructions.	The UK HPR1000 complies with these arrangements, described in 30.5.5. During the commissioning process, the test will be carried out as far as possible with reference to the operating instructions, in order to verify the operating instructions as much as possible.

30.6.3 Conclusions of ALARP Review

In Chapter 30, ALARP assessment of commissioning activities has been analysed from the aspects of organisation, documentation, personnel and schedule. It is considered that the approach adopted complies with international and the UK recognized RGPs in this chapter. In system chapters, the system design process will complete the ALARP assessment, taking into account the commissioning test scheme. As mentioned in section 30.5.6, CGN has rich experience in commissioning of nuclear power plants to ensure that the risks in the commissioning execution are controlled to the optimal level. Based on the above considerations, the risks of whole commissioning process (including test design and commissioning activities) are optimized. No gap has been identified at the moment.

30.7 Concluding Remarks

The processes of commissioning programme have been outlined in this chapter, and they will be continued during nuclear site licensing phase. This chapter provides adequate support for the argument, supporting the safety claim that has been made.

30.8 References

[1] The Stationery Office, Nuclear Installations Act 1965, 1965.

[2] ONR, Training and Assuring Personnel Competence, Nuclear Safety Technical Assessment Guide, NS-TAST-GD-027, Revision 4, July 2014.

[3] CGN, General Principles for Application of Laws, Regulations, Codes and Standards, GHX00100018DOZJ03GN, Revision F, August 2018.

[4] IAEA, Safety of Nuclear Power Plants: Commissioning and Operation, IAEA Safety Standards Series No.SSR-2/2, Rev.1, 2016.

[5] IAEA, Commissioning for Nuclear Power Plants, IAEA Safety Standards Series No.SSG-28, 2014.

[6] ONR, Safety Assessment Principles for Nuclear Facilities, SAP, 2014.

[7] ONR, Control and Instrumentation Aspects of Nuclear Plant Commissioning, Nuclear Safety Technical Assessment Guide, NS-TAST-GD-028, Revision 4, September 2016.

[8] ONR, LC23: Operating Rules, Nuclear Safety Technical Inspection Guide, NS-INSP-GD-023, Revision 4, March 2016.

[9] ONR, LC21: Commissioning, Nuclear Safety Technical Inspection Guide, NS-INSP-GD-021, Revision 4, March 2016.

[10] ONR, LC24: Operating Instructions, Nuclear Safety Technical Inspection Guide, NS-INSP-GD-024, Revision 3, February 2016.

[11] ONR, New nuclear reactors: Generic Design Assessment Guidance to Requesting Parties, ONR-GDA-GD-001, Revision 3, September 2016.

[12] GNS, Scope for UK HPR1000 GDA Project, HPR/GDA/REPO/0007, Revision 000, May 2018.