

**NUCLEAR REGULATORY AUTHORITY,
GHANA**



**DRAFT COMMISSIONING REGULATIONS FOR NUCLEAR INSTALLATIONS IN
GHANA**

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**NUCLEAR REGULATORY AUTHORITY (COMMISSIONING OF NUCLEAR
INSTALLATIONS) REGULATIONS , 2024**

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In exercise of the power conferred on the Minister responsible for Nuclear Regulatory Authority acting on the advice of the Board of the Authority by Sections 91 of the Nuclear Regulatory Authority Act, 2015 (Act 895), these Regulations are made this.... day of2024

General Provisions

Application

1. These regulations apply to nuclear installations as well as **commissioning** activities related to the life extension, refurbishment and modification of an existing nuclear installation.

The Nuclear Regulatory Framework

2. (1) Where in an application, in a matter concerning the technology to be employed by the applicant, the Regulations and applicable standards of the Authority are not sufficient to provide adequate assessment of that technology, current relevant regulations or standards of the country

(a) from which the technology is being imported,

(b) where the related applicable technology was developed, or

(c) in which the technology has been deployed and is being regulated effectively as determined by the Authority,

is applicable.

(2) Where under subregulation (1), the nuclear safety and security requirements of another country are to be applied, the applicant shall demonstrate to the Authority that the requirements to be applied, offer the same or better standards of safety, security, quality and reliability than would have been offered by the requirements of the Regulations and standards of the Authority.

(3) An applicant shall obtain the authorisation of the Authority, including specification of the conditions necessary for safety and security, before the applicant erects an installation or

the performs an activity that is not either explicitly exempted or approved by means of a notifice issued by the Authority.

Commissioning Programme

3. (1) An authorised person shall establish and implement a programme for the commissioning of a nuclear installation and shall ensure that the programme

(a) describes management systems and requirements for participating organisations;

(b) defines clear responsibilities for commissioning activities and oversight and specifies the interfaces between construction, commissioning and operating organisations;

(c) is structured to enable the objectives and methods of testing to be understood and to allow management control and coordination;

(d) outlines the testing and verification activities that must be performed to ensure that structures, systems and components important to safety are built as designed and meet the requirements of the facility design and safety analysis;

(e) verifies safety analysis assumptions and the presence of adequate safety and operating margins between design, safety requirements and normal operating conditions; and

(f) provides for tests to be conducted only if the nuclear installation falls within the range of assumptions made in the safety analysis and the licensing basis remains valid;

(g) includes provision of temporary utilities;

(h) identifies the security systems to be commissioned before nuclear fuel or material is brought onsite;

(i) documents the results of testing and verification activities, and identifies any impacts on or changes to the facility design basis;

(j) validates operating and surveillance procedures for which the commissioning tests provide representative activities and conditions;

(k) verifies operating and emergency procedures by trial use;

(l) provides for integrated system validation of control rooms and control areas;

(m) ensures personnel participating in commissioning activities are trained and qualified; and

(n) ensures a schedule, including milestones and regulatory hold points, and test results to be submitted for review are identified and communicated to the Authority.

(2) The authorised person shall

(a) submit the commissioning programme to the Authority for approval at least one year before the commencement of commissioning activities;

(b) ensure that for sites that are to contain multiple nuclear installations, the commissioning programme clearly identifies and tracks commissioning activities for each individual unit or module; and

(c) update the content of the final safety analysis report to reflect the commissioning results.

Management and Organization

Management system

4. An authorised person shall ensure that commissioning and related activities are developed and implemented under the control of the authorised person in the context of a management system that satisfies the requirements of the *Integrated Management Systems Regulations for Facilities and Activities* of the Authority.

Organisational responsibilities

5. (1) An authorised person shall

(a) be responsible for

(i) safety and security and shall oversee the organization, planning, execution and assessment of the commissioning programme; and

(ii) the construction, commissioning and operating organisations, which shall be part of the organisation of the authorised person or be provided by a contracted organization responsible for that scope of work;

(b) ensure that necessary resources are available to carry out the commissioning activities and to establish, implement, assess and continually improve commissioning activities;

(c) ensure, during and following commissioning, that

(i) the construction organisation constructs shall ensure that the Structures, Systems and Components have been constructed in accordance with the design and that quality assurance requirements have been satisfied; and

(ii) the commissioning organisation tests the Structures, Systems and Components to provide assurance that the nuclear installation has been properly designed and constructed and is ready for safe operation.

(2) The authorised person shall, in furtherance of commissioning, ensure that the operating organisation

(a) carries out operation and maintenance;

(b) satisfies itself that the systems transferred comply with the specified performance, design intent and safety case;

(c) satisfies itself through integrated system validation exercises that the human-machine system design and supporting mechanisms facilitate human performance in achieving safety and operational goals;

(d) accept responsibility for the transferred systems;

(e) becomes competent in the management and operations of the nuclear installation;

(f) ensure that there will be a sufficient number of qualified workers to operate the nuclear installation

(3) The authorised person shall ensure that

(a) the Structures, Systems and Components are operated by the operating organisation in accordance with the assumptions and intent of the commissioning programme, respecting the relevant operating limits and conditions that apply to each testing stage;

(b) the responsibilities of other participants including designers, manufacturers and supporting technical organisations are specified in appropriate documents;

(d) interface measures are

(i) identified and agreed upon with the commissioning organisation, operating organisation, construction organisation and any other organisational units performing the work; and

(ii) specified in management system documentation and in appropriate contracts; and

(e) interface control includes the assignment of responsibilities and the establishment of procedures for the identification, review, approval, release, distribution and release of documents that cross organisational boundaries.

Transfer of Structures, Systems and Components

6. An authorised person shall ensure that

(a) appropriate procedures are established for the transfer and ownership of the Structures, Systems and Components and the nuclear installation from the construction organisation and the commissioning staff of the non-authorised person to the operating organisation of the authorised person.

(b) the procedures established under paragraph (a) describe the detailed process steps, including responsibilities and authorities of the parties involved;

(c) before fuel-in-core testing, each system is put under the control of the operating organisation;

(d) before the transfer takes place, representatives of the organizations involved in the handover process carry out facility walk downs of the Structures, Systems and Components

(e) safety and security are maintained throughout the process of the transfer;

(f) after the transfer, any turnback for rework or repair remains, under the ownership of the operating organisation;

(g) the transfer of the Structures, Systems and Components and the nuclear installation are documented; and

(h) the commissioning records handed over to the records-management programme of the operating organisation and retained for the lifetime of the nuclear installation.

Qualifications and training

7. An authorised person shall ensure that

(a) personnel engaged in commissioning activities shall have appropriate training, qualifications and competence to perform their assigned tasks effectively and shall for that

purpose implement a training programme to provide for each person involved in the commissioning, training in

- (i) commissioning procedures;
- (ii) nuclear installation systems;
- (iii) the conduct of testing and maintenance of the nuclear installation in safe condition;
- (iv) procedural and design changes;
- (v) permanent and temporary modifications;
- (vi) work control and equipment isolation;
- (vii) interfaces of construction, design and operation with commissioning;
- (viii) test limitation boundaries in mechanical and electrical systems;
- (ix) the criteria for, and importance of, reporting incidents and deviations;
- (x) commissioning methods and techniques;
- (xi) safety culture;
- (xii) nuclear safety, industrial safety, fire protection, radiation protection and security;
- (xiii) design criteria, technology and operational limits and conditions, or the equivalent, for the nuclear installation;
- (xiv) environmental protection and waste management of spent fuel and radioactive waste; and

(xv) reactor start-up, regular operations, reactor shutdown and cooldown and handling of various transients, including accidents where applicable for every type nuclear installation, for operators of these activities, through full-scope simulator training methods;

(b) the training programme is systematically reassessed and improved by the authorised person, based on experience gained in commissioning, including any incidents and ensure the incorporation of the experience gained into the training material.

Performance measurement, assessment and improvement

8. An authorised person shall ensure that

(a) the commissioning activities that do not conform to requirements are identified, and corrective actions are taken for their resolution; and

(b) the experience and information gained from other commissioning projects are reviewed and considered for potential improvements by the authorised person, as applicable.

Emergency management

9. An authorised person shall ensure that

(a) an appropriate plan is drawn up for managing emergencies during commissioning;

(b) emergency management to address the radiological consequences of events are established from the time that nuclear fuel is brought to the site;

(c) each party involved in the commissioning programme is trained to cope with any anticipated emergency at the nuclear installation under commissioning; and

(d) test emergency response are established before the commencement of fuel loading.

Commissioning Tests

Test objectives

10. An authorized person shall ensure that

(a) testing is sufficiently comprehensive to demonstrate that the nuclear installation can operate in all the modes for which it has been designed;

(b) in developing test objectives, the safety functions of the Structures, Systems and Components are systematically reviewed to ensure that the safety requirements are met; and

(c) where it is impractical to conduct an onsite test of a component, the report of the testing of the component after manufacture is submitted to the Authority in addition to measures including computer simulation or analysis.

Test scope and methods

11. An authorised person shall ensure that

(a) tests that are necessary to demonstrate operability, safety and safety-related functions are fully performed and where a test cannot be performed to its fullest extent, the process by which the safety and design intent is satisfied is documented;

(b) the functional and performance requirements and parameters that clearly identify the approach used for each testing aspect are defined;

(c) the commissioning programme has provisions to ensure that there are no omissions in testing complex systems;

(d) tests are performed under the most realistic operating conditions practicable and support analytical tool validation;

(e) facility-level integrated tests are performed for every nuclear installation, irrespective of the availability of similar or identical tests from other single- or multi-unit nuclear installations and where integrated testing cannot be performed for safety reasons,

a technical argument is provided that includes acceptable testing alternatives to meet the objectives of the commissioning programme;

(f) for any offsite tests, the applicability of the tests at the component level and when integrated at the system and facility levels is documented;

(g) for the purpose of multi-unit nuclear installations,

(i) component- and system-level integration tests are conducted on-site for every unit in the nuclear reactor;

(ii) special provisions is made to ensure that the commissioning tests of a unit do not jeopardize the safety of another unit and that the provisions include safety analysis, of the operating unit, conducting a hazard assessment, obtaining specific written approval from the manager responsible for the operating unit and obtaining the required approvals from the Authority;

(iii) that have Structures, Systems and Components common to more than one unit, tests are conducted on each unit to provide assurance that the specified performance requirements of these Structures, Systems and Components satisfy the design intent of each unit.

Acceptance criteria

12. An authorized person shall ensure that

(a) the acceptance criteria

(i) for the commissioning by which the acceptability of the test results will be evaluated, are defined by the test procedures; and

(ii) is classified as either important to safety or not important to safety;

(b) the technical basis of the acceptance criteria, which is consistent with the safety, design and performance requirements, is documented in preparation for and before the conduct of the tests; and

(c) in cases where measured parameters do not directly relate to the acceptance criteria, analytical tools are used to demonstrate that the safety objectives are met.

Test procedures

13. An authorised person shall ensure that

(a) the commissioning tests are performed in accordance with the commissioning programme and authorised written procedures;

(b) preparation of test procedures, including their verification and approval, are documented;

(c) the test procedures, including acceptance criteria, are reviewed, verified and approved by the design, commissioning and operating organizations;

(d) test procedures establish actions for deviations from procedures, where test results fall outside the acceptance criteria or where unexpected events occur;

(e) deviations from approved test procedures are addressed according to the control change procedures of the operating organisation, leading to updated and approved procedures in accordance with the original commissioning programme;

(f) in case a deviation occurs, the tests only resume after any existing issue is resolved by the commissioning organisation and approved by the Authority;

(g) in cases where commissioning tests for safety systems require onsite regulatory oversight, the Authority is informed of these tests in a timely manner for the inspectors of the Authority to attend;

(h) competent personnel, as determined by the training and qualification programme of the applicant, and sufficient controls are established to validate the test procedures;

(i) in cases where the tests require the Structures, Systems and Components to be placed in a different configuration than the normal operating configuration, test procedures specific to the new configuration are developed by the authorised person; and

(j) the contents of the test procedures include the items shown in the Schedule.

Review, evaluation and reporting of test results

14. An authorised person shall ensure that

(a) the commissioning organisation

(i) reviews the test results to ensure that every deviation is resolved and that operating constraints, if any, are identified and documented; and

(ii) appoints persons who have the technical expertise to determine that the operational characteristics of the Structure, Systems and Components are captured, to review the interpretation of test data;

(b) formal reports for each test are prepared by individuals responsible for the tests, and approved by the commissioning organization;

(c) the commissioning organisation establishes measures that provide assurance that the nuclear installation design, operational and safety documentation are updated during the commissioning process to reflect the test results and resolution of deviations;

(d) where test results indicate that a change to the scope of subsequent tests is required, the commissioning organisation performs a documented assessment before proceeding with the remaining tests to ensure that the proposed changes do not

(i) fall outside the range of assumptions made in the safety analysis and do not invalidate the licensing basis;

(ii) invalidate the results of the previous tests;

(iii) adversely impact future tests in terms of scope, objectives and sequence; and

(e) the commissioning organisation in the performance of the documented assessment under paragraph (d), updates the commissioning documents with the nature of, and justification for, the proposed changes in accordance with the management system requirements.

Modifications

15. (1) An authorised person shall not without the permission of the Authority modify the approved arrangements for the commissioning of the nuclear installation.

(2) The authorised person shall ensure that

(a) modifications to test procedures and other related documents are authorised by means of a formal authorised person-approved process to control changes in documentation.

(b) appropriate reviews are performed, and formal approvals are obtained from the commissioning organization for modifications to the sequence of a test within a hold point or across hold points;

(c) the review provides a process for verifying that the prerequisites for the out-of-sequence test are met in order to ensure the test is performed safely;

(d) temporary modifications to an approved design configuration for the purposes of commissioning testing are controlled by the commissioning organization, with the oversight of the authorised person; and

(e) the commissioning organisation performs a review to ensure that safety implications are considered.

Testing phases and regulatory hold points

16. The authorised person shall ensure that

(a) tests are performed in phases and in a logical progressive sequence;

(b) where applicable to the type of nuclear reactor, the following commissioning test phases constitute the minimum regulatory hold points for the reactor start-up:

(i) Phase A, which is before fuel load;

(ii) Phase B, which is the stage before leaving the reactor shutdown state;

(iii) Phase C, which is in respect of the approach to critical and low power tests; and

(iv) Phase D, which is in respect of high-power tests.

(c) for each regulatory hold point, there is confirmation that the prerequisites established between the authorised person and the Authority, necessary for proceeding beyond the regulatory hold point are met;

(d) approval has been obtained from the Authority before progress is made beyond each regulatory hold point.

Rules in respect of the phases

17. (1) An authorized person shall ensure that in respect of

(a) Phase A, before fuel is loaded into the core, the operability, availability and performance of the Structures, Systems and Components that will secure the safety of the fuel in the core are tested, and appropriate tests of fuel handling equipment are completed;

(b) Phase B, which has to be successfully completed before approaching criticality,

(i) the fuel is loaded into the reactor safely, after confirming 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;

(ii) the reactivity control mechanism are available and in service and the reactor is kept mai subcritical throughout;

(iii) the automatic shutdown systems are, where possible confirmed to be available;

(iv) the reactor trip system against neutronic and process-related upsets is confirmed to be available;

(v) subcriticality checks are performed at regular intervals during fuel loading to determine safe loading increments for subsequent loading;

(vi) predictions of the behaviour of the core in terms of its reactivity are available for the evaluation of subcriticality margin;

(vii) acceptance criteria for the maximum permissible deviation of predicted values from measurements are defined;

(viii) tests on coolant flow, pressure, temperature and the performance of associated instrumentation and control mechanisms are conducted; and

(ix) fuel loading is supervised by certified representatives from the operating organisation;

(c) Phase C, which encompasses the performance of activities that cannot be performed when the reactor is in a subcritical state or shutdown state,

(i) the behaviour of the reactor at the stage of initial criticality is confirmed and subsequent low-power tests are conducted;

(ii) trip set points are verified to ensure that they are compatible with the demands of the tests scheduled in this phase;

(iii) the automatic shutdown systems are confirmed to be available for low-power shutdown;

(iv) radiological surveys and functional tests of radiation protection equipment are made;

(v) changes in reactivity are continuously monitored and evaluated so that the prediction of the point of criticality is continually checked;

(vi) the performance of the reactor core is commensurate with the design assumptions and predictions, and complies fully with the safety analysis report;

(vii) the reactor core is confirmed to be in proper condition to operate at higher power levels;

(viii) the characteristics of the reactivity control systems and shielding are commensurate with design assumptions and predictions, and comply fully with the safety analysis report; and

(ix) the integrated system validation is completed if it has not been conducted during earlier phases of commissioning;

(d) Phase D,

(i) systems behaviour at higher power levels, including activities that could not be carried out at the power levels in Phase C is demonstrated;

(ii) high-power tests are performed at various bulk power intervals, which where required by the licence are to be approved by the Authority;

(iii) tests are conducted, in accordance with the design, to demonstrate that the nuclear reactor is able to safely operate at a steady state under normal operating conditions.

(3) The authorised person shall, in furtherance of Phase D, ensure that

(a) the tests conducted, in accordance with the design, to demonstrate the capability of the nuclear reactor to operate safely under normal operating conditions, establish that the nuclear reactor is adequately equipped to

(i) mitigate or prevent Anticipated, Operational Occurrences escalating to more severe events; and

(ii) safely cope with the function of mitigating systems verified to operate in Design Basis Accidents; and

(b) a documented review carried out at the end of each high-power test to confirm that the operational limits and conditions are adequate and practicable and identify any constraints on the operation of the nuclear reactor.

Miscellaneous

Penalties

18. A person who contravenes any of the provisions of these Regulations commits an offence and is liable to penalty provision in Regulation 80 of the Basic Ionising Radiation Control Regulations.

Appeals

19. A person who is not satisfied with a decision taken by the Authority may appeal in accordance with sections 81, 82, 83, 84 and 85 of the Nuclear Regulatory Authority Act, 2015 (Act 895).

Intepretations

20. In these Regulations, unless the context otherwise requires ,

“Anticipated Operating Occurrence” means an operational process deviating from normal operation that is expected to occur once or several times during the operating lifetime of the nuclear installation but which, in view of the appropriate design provisions, does not cause any significant damage to items important to safety or lead to accident conditions;
“commissioning” means the process by means of which systems and components of facilities and activities, having been constructed, are made operational and verified to be in accordance with the design and to have met the required performance criteri;

“commissioning test” means testing to demonstrate that structures, systems and components perform within their design specifications;

“construction” means the process of manufacturing and assembling the components of a facility, the carrying out of civil works, the installation of components and equipment, and the performance of associated tests;

“Design-Basis Accident” means accident conditions against which a nuclear reactor is designed according to established design criteria, and for which the damage to the fuel and the release of radioactive material are kept within authorised limits;

“Integrated System Validation” means an evaluation, using performance-based tests, to determine whether the design of an integrated system, in the nature of hardware, software and personnel element, meets performance requirements and supports the safe operation of the facility;

“low power test” means tests performed at low power after nuclear fuel has been loaded into the nuclear reactor, with the objective of ensuring that the nuclear reactor core behaves as expected, and that the plant and its systems and the reactivity control systems in particular, operate as intended, and that it is safe to proceed to higher power levels;

“licensing basis” means a set of requirements and documents for a regulated facility or activity comprising,

- (a) the regulatory requirements set out in the applicable laws and regulations;
- (b) the conditions and safety and control measures described in the licence of the facility or of the activity and the documents directly referenced in that licence;
- (c) the safety and control measures described in the licence application and the documents needed to support that licence application;

“management system” means a set of interrelated or interacting elements, system, for establishing the policies and objectives of an organisation and enabling the objectives to be achieved efficiently and effectively;

“modification” means introducing changes to a system, structure or component so that it no longer corresponds to previous specifications;

“nuclear power plant” means a nuclear facility consisting of any fission-reactor installation that has been constructed to generate electricity on a commercial scale;

“operation” means all activities performed to achieve the purpose for which a facility was constructed. For nuclear power plants, this includes maintenance, refuelling, in-service inspection and other associated activities;

“plant modification” means an alteration of the safety-classified systems of an operating nuclear facility that calls for the reassessment of the design bases and safety requirements

of systems, the renewal of the design basis analyses, and considerable equipment acquisitions;

“project” means a unique process consisting of a set of coordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements, including the constraints of time, cost and resources;

“regulatory hold point” means a commissioning activity that requires approval of the Authority in order for commissioning to proceed; and

“Structures, Systems And Components” means a general term encompassing all of the elements, items, of a facility or activity that contribute to protection and safety.

SCHEDULE

(regulation 13 (j))

Contents of Test Procedures

The contents of test procedures include

- (a) **Introduction:** which is a summary of the main test objectives and of the safety aspects to be demonstrated and which should identify the system to be tested, indicate the anticipated test results and highlight the relationship between the test being carried out and the main phases of the commissioning programme;
- (b) **Test objectives and methods:** which is a statement of the objectives of the test and the means by which they are to be achieved, including step-by-step actions;
- (c) **Limiting criteria:** which is a statement of the applicable operational limits and conditions, including temporary ones, that must be adhered to in order to prevent damage to the reactor facility ;
- (d) **Prerequisites and initial conditions:** which is a statement that identifies the state of the relevant Structures, Systems and Components and other pertinent conditions that might affect the operation of the system to be tested including coordinating construction, commissioning, operations, verification activities, and hold points, and the precautions necessary to maintain the desired system configuration, particularly if different from the normal;
- (e) **Test conditions and procedures:** which is a statement that specifies (i) the way in which the system to be tested is required to be brought up to test conditions and details of the test procedures, preferably in a step-by-step format; and (ii) on the basis of safety analysis, any temporary changes or abnormal alignments of the system or of adjacent systems;
- (f) **Acceptance criteria:** which is a statement of the stated acceptance criteria and which wherever possible, should be quantitative as well as qualitative;

(g) **List of instrumentation and special test equipment:** which is a statement that specifies the special equipment and calibrations necessary to perform the test with appropriate accuracy and generate results that are clearly identifiable;

(h) **Staffing, qualification and responsibilities:** which is a statement of the staffing needs, qualification requirements and assignment of duties and responsibilities for conducting tests, including personnel required to oversee or witness;

(i) **Special precautions:** which is a statement that specifies the measures and actions necessary for the safety of personnel and the security of equipment;

(j) **Completion of test:** which is a statement by the responsible personnel that the test has been completed and the systems have been returned to normal conditions and specifies individually the removal of temporary changes or of any abnormal lineup, as steps in the test procedure;

(k) **Permanent records:** which specifies the information necessary for permanent records, including baseline data.

(l) **Identification, cross-referencing and distribution:** which is a statement that provides a unique identification system, which system could be one that uses reference numbering, including comprehensive cross-references to associated documents and a distribution list of those persons who should receive it;

(m) **Data collection and processing:** which is a statement of the measures for tabulating data and test results and which requires test sheets to be in standardized forms and which enables

(i) each sheet to be signed by the data collector;

(ii) chronological recording to be done, where desirable, for test data, date and time, among others; and

(iii) validation and verification of data pre-processing and post-processing by the data acquisition system;

(n) **Non-conformities:** which is statement of the measures established to manage any non-conformities identified as a result of the test; and.

(o) **Provisions for the techniques and methods of data analysis, including the analysis of measurement results:** which is a statement that confirms the verification and validation of the software used for data collection, storage and analysis before the test and provides for the documentation of the repeatability, accuracy and measurement uncertainty.