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**ANNEX II**

**Instrument for Nuclear Safety Cooperation**

**AAP 2016**

**IRAN**

**TERMS OF REFERENCE**

Version 1.00

3 June 2016

**Project INSC IRN3.01/16 Lot 2**

**EuropeAid/138091/DH/SER/IR**

**Support to the Bushehr nuclear power plant operator to perform the stress tests exercise according to the INRA Requirements**

**Project total budget: €2.000.000**

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# BACKGROUND INFORMATION

## Partner Country

The Islamic Republic of Iran.

## Contracting Authority

The European Union (EU), represented by the European Commission (EC).

## Country Background

The Partner country of this Action is Iran.

On 14 July 2015, the E3/EU+3 (China, EU, France, Germany, Russia, UK and USA, with the High Representative of the Union for Foreign Affairs and Security Policy) and Iran reached an agreement on a Joint Comprehensive Plan of Action (JCPoA), the full implementation of which will ensure the exclusively peaceful nature of Iran's nuclear programme.

The JCPoA includes the necessary verification to ensure the exclusive civil nature of the Iranian nuclear programme as well as specified areas for civil-nuclear cooperation. In particular, Annex III of the documents provides a detailed description of the future cooperation in civil nuclear cooperation which largely is covered by activities funded by the EU under the Instrument for Nuclear Safety Cooperation.

The EU has a special responsibility as the leader of the negotiations that have produced the JCPoA. Annex III of the JCPoA provides for cooperation in the field of nuclear safety which covers, *inter-alia*:

* Support to the regulatory authority;
* Creation of a Nuclear Safety Centre;
* Training and tutoring activities;
* Emergency Preparedness and Response and Severe Accident management capability;
* Nuclear safety assessment (including stress tests) and studies;
* Safe management of nuclear and radioactive wastes.

The EU has considerable experience in the implementation of nuclear safety projects supporting regulatory authorities in third countries as a result of the previous TACIS (Technical Assistance to the Commonwealth of Independent States) and Poland and Hungary: Assistance for Restructuring their Economies (PHARE) programmes and now under the INSC (i.e., Armenia, Brazil, China, Russia, Turkey, Ukraine and several other countries such as Jordan, Morocco and Vietnam) and is able to ensure effective cooperation with the Iranian Nuclear Regulatory Authority (INRA).

## Current situation in the sector

*Nuclear power programme*

Iran has one nuclear power plant in operation at Bushehr on the Persian Gulf. It comprises one unit, the Bushehr Nuclear Power Plant BNPP-1, the main components of which are based on the VVER[[1]](#footnote-1)-1000 V-320 design. The plant was constructed in 1994 by the nuclear power equipment and service export company Atomstroyexport of Russia and has the model designation V-446. It deviates considerably from the standard V-320 design due to the requirement to take over and make maximum possible use of the Unit 1 structures and the equipment already existing at Bushehr. These structures and equipment remained after two partly constructed Siemens KWU 1300 MW PWRs were abandoned in 1979 following the Islamic revolution. Unit 1 was already substantially completed (around 85%) at the time, while Unit 2 was approximately half complete. The completion of Unit 1 by Atomstroyexport in 2006 presented significant challenges related to the need to adapt the main VVER components to the retained Siemens KWU parts and equipment as well as the need to verify and in some cases upgrade the abandoned Siemens components, many of them having little or no technical documentation.

The plant has a higher seismic rating than the standard VVER V-320 design due to the high seismicity of the region.

Despite problems and delays during commissioning, mainly caused by the failure of one of the main circulation pumps from the original German supply, the unit entered commercial operation in September 2013. Initially the plant was operated mainly by Russian personnel. Following training of Iranian operational staff in Russia, the operation was taken over by Iranian operators under the supervision of Russian experts until the end of 2015.



The plant is owned and operated by the Bushehr Nuclear Power Plant (BNPP) Operation Company, a subsidiary of the Nuclear Power Production & Development Company of Iran (NPPD), which was established in 2004, from the former Nuclear Power Plant Division of the Atomic Energy Organisation of Iran (AEOI). NPPD remains a subsidiary of AEOI in charge of the nuclear power plant development in Iran.

Following the Fukushima accident, the vendor country (Russian Federation) has performed in 2012 a post-Fukushima safety re-evaluation for BNPP-1. The resulting 'stress test report' was claimed by the vendor country to be performed in compliance with the ENSREG stress test specification, but was not yet submitted to any regulatory review in Iran. Subsequently, the vendor country recommended NPPD ordering a specific set of mobile equipment for BNPP-1, which will be supplied to BNPP-1 relatively soon. NPPD has started a design project for the corresponding implementation measures.Plans to construct a second unit at Bushehr have been under discussion with Russian Federation and a contract has been signed in 2015. The reactor will be a VVER-1000 V-392 and will not need to be adapted to the abandoned structures of the original Siemens KWU Unit 2. These structures will be removed and the plant will be constructed from scratch as a standard V-392.

Iran plans for further expansion of nuclear power capacity include Bushehr phase II, for which a contract has been signed with Nizhny-Novgorad Atomenergoproekt – Atomstroyexport (NIAEP-ASE) for the construction of two further VVER-1000 units. Further plans include two more VVER-1000 at Bushehr, four at another site not yet specified and two Chinese units at a site on the Makran coast on the Gulf of Oman. There are also plans for the construction of an indigenous design of LWR of 360 MWe capacity at Darkhovin, on the Karun River, close to the border with Iraq, on the site where the construction of two French 910 MWe PWRs had been abandoned after the revolution in 1979.

Iran has also developed indigenous capacity for the fabrication of nuclear fuel for the Tehran Research Reactor and the IR-40 reactor located at the Arak site. This would also allow the provision of fuel for the planned power reactor at Darkhovin and potentially for the Bushehr Nuclear Power Plant, although a significant amount of development would be needed to allow indigenous production of VVER fuel elements.

*Nuclear regulation*

The legislative and statutory framework for regulating nuclear facilities and activities in Iran is provided primarily by the Atomic Energy Organization of Iran (AEOI) Act (1974) and the Radiation Protection (RP) Act (1989). These Acts are supplemented by related lower tier legislation to provide for the control of nuclear, radiation, waste and transport safety.

Iran has yet to accede to a number of important International Conventions in the area of nuclear safety, in particular those concerned with Nuclear Safety, the Safe Management of Waste and Spent Nuclear Fuel and Civil Liability for Nuclear Damage. These Conventions are currently under consideration by the Government of Iran.

The Atomic Energy Organization of Iran Act of 1974 establishes the Atomic Energy Organization of Iran and its field of activities. These activities include the use of nuclear energy and ionising radiation in industry, agriculture and service industries, establishing nuclear power plants and related fuel cycle and desalination facilities, establishing the required scientific and technical infrastructure for these activities, and coordinating and supervising all nuclear energy related matters in Iran.

AEOI is defined as the competent regulatory authority by both the AEOI and RP Acts. AEOI delegates its responsibilities for regulatory functions to the Iran Nuclear Regulatory Authority (INRA), which is a part of AEOI and is authorised by AEOI to:

* develop and issue regulations and guides for nuclear and radiation safety
* perform safety assessments
* issue (as well as suspend/revoke) licences related to the siting, design, construction, commissioning, operation and decommissioning of nuclear and radiation facilities
* undertake inspection, supervision and enforcement activities.

INRA is also responsible for regulation in the area of nuclear safeguards and security. INRA comprises four departments for discharging its regulatory functions:

* National Nuclear Safety Directorate (NNSD)
* National Radiation Protection Directorate (NRPD)
* National Nuclear Safeguards Directorate (NNSG)
* Development of Standards and Regulations Directorate

INRA has developed and implemented a management system for its activities on the basis of ISO and IAEA standards.

The safety of nuclear facilities, including the Bushehr Nuclear Power Plant (BNPP-1) as well as a number of research reactors in Iran, is regulated and supervised by NNSD, which is responsible for developing the related policies, safety principles and criteria, regulations and regulatory guides that are applied as a basis for its regulatory actions.

With regard to the completion of BNPP-1, a licensing procedure was developed by NNSD for the reconstruction, commissioning, operation and decommissioning of the plant. The procedure took due account of INRA requirements and internationally accepted recommendations such as those issued by the IAEA, as well as the safety standards applicable in the vendor country (Russian Federation). Specific features of the design and operating characteristics and unusual or novel design measures of the BNPP-1 have also been considered. The compliance of the plant with the applicable safety requirements, on the basis of the safety documentation submitted by the operating organisation (NPPD), was supervised by NNSD. VO "safety", a Technical Support Organisation (TSO) to the Russian Federation regulatory body, Rostechnadzor, was contracted to provide technical support to NNSD for the BNPP-1 licensing and supervisory activities.

Due to the sanction regime, the INRA lacks international exchange and networking that will strengthen its position in particular by capacity building and peer review.

## Related programmes and other donor activities

A close working relationship will be maintained between the Commission and the future EU Delegation in Iran.

The Commission will coordinate its activities with the other international donors through the Joint Commission established under the JCPoA and possibly the IAEA Technical Cooperation Department.

For a coordinated and efficient implementation of the post-Fukushima nuclear safety stress test activities in Iran, the EC has adopted the so-called '2+2' approach for INSC project IRN3.01/16:

* In Lot 1 of the project, a Contractor will support INRA, the Iranian Nuclear Regulatory Authority, – among other topics – in performing the review of the operator's self-assessment report and in establishing the Iranian National Stress Test Report.
* In Lot 2 of the project, another Contractor will support NPPD, the operator of BNPP-1, – among other topics – in reviewing and completing as necessary the stress test self-assessment.

Therefore, some meetings at the interface of these two lots will be common to Lot 1 and Lot 2.

# OBJECTIVE, PURPOSE & EXPECTED RESULTS

## Overall objective

The objective of this project is to review the post-Fukushima nuclear safety stress test self-assessment of the Bushehr Nuclear Power Plant NPP-1, in full compliance with the INRA stress test specification, perform a gap analysis and complete as necessary the self-assessment.

## Purpose

The main purpose of the project is to review (against the INRA methodology) the self-assessment report that has been produced by the nuclear power plant operator of Bushehr during the stress tests exercise.

Considering the accident at the Fukushima nuclear power plant in Japan, the European Council of March 24th and 25th declared that "the safety of all EU nuclear plants should be *reviewed, on the basis of a comprehensive and transparent risk assessment ("stress tests")* and subsequently opened this European risk and safety assessment for voluntary participation of neighbouring countries.

A "stress test" is defined by ENSREG as a targeted reassessment of the safety margins of nuclear power plants in the light of the events which occurred at Fukushima: extreme natural events challenging the plant safety functions and leading to a severe accident.

This reassessment is to be performed in the form of a self-assessment and consists of:

* an evaluation of the response of a nuclear power plant when facing a set of extreme situations envisaged under the following section "technical scope" and
* of a verification of the preventive and mitigative measures chosen following a defence-in-depth logic: initiating events, consequential loss of safety functions, severe accident management.

An important element for conducting the stress test is the availability of the plant safety documentation and corresponding safety analysis that are typically included in the plant safety analysis report (SAR) and other documents.

A specific element to be considered will be the existing report on the post-Fukushima safety re-evaluation for BNPP-1, as performed by the vendor country in 2012.

Furthermore, and as second priority, the design of implementing measures for mobile equipment to be used in accident management is to be reviewed.

## Results to be achieved by the Contractor

The results to be achieved by the Contractor are:

* Existing report on the post-Fukushima safety re-evaluation for BNPP-1, as performed by the vendor country, reviewed;
* Detailed methodology for the stress tests; Self-assessment stress tests report drafted and submitted to the regulatory authority;
* Final self-assessment stress tests report approved by the regulatory authority,
* Design reviewed of mobile equipment to be used in accident management (as second priority).

# ASSUMPTIONS & RISKS

## Assumptions underlying the project

An implementation and development of the project activities requires commitment of all the project stakeholders in delivering the required input data in format, quality and time, as well as a strong cooperation in decision making during the course of the project.

The main assumptions are that the following main commitments are being granted by the designated stakeholders:

* The Contractor to provide project organisation chart and communication lines with project’s stakeholders. All details upon the organisational arrangements to be used are subject for the discussion and agreement during the Kick off Meeting at BNPP.
* BNPP to make available the relevant information and documentation related to project objectives especially to provide Contractor with the results of currently available analyses and studies relevant to Stress Test;
* BNPP to make available current version of SAR, any relevant studies, design documentations, safety analysis, etc. A comprehensive list of safety documentation available at BNPP shall be prepared by the plant and handed over to the Contractor during the project kick-off meeting;
* All information which during course of the project will be handed over to the Contractor, as well as the project results, shall be treated as confidential and shall not be under any circumstances be handed over to any third parties without prior written permission of BNPP.

## Risks

The risks associated with the project implementation are:

* Availability of required and adequate data/analysis in due time needed for the stress tests;
* Availability of BNPP personnel to perform the self-assessment tasks;

The above risks are planned to be mitigated through a close monitoring of project implementation.

# SCOPE OF THE WORK

## General

### Project description

This project is aimed to support NPPD, the Operator of Bushehr NPP, in reviewing and completing as necessary the post-Fukushima nuclear safety stress test on the basis of the INRA methodology.

The "stress test" is defined by ENSREG as targeted reassessments of the safety margins of nuclear power plants in response to external hazards like earthquakes, floods and extreme weather conditions, and in view of a loss of safety functions (loss of power, loss of ultimate heat sink) potentially leading to nuclear fuel damage, and requiring (severe) accident management. A technical specification describing the scope and methodology for the stress tests was developed by the European Nuclear Safety Regulators Group / Western European Nuclear Regulators Association ENSREG/WENRA. The reassessment exercise was performed in stages. Firstly, for all nuclear power plants in the EU the NPP operators performed self-assessments by analysing the response of each of their nuclear plants to these hazards, by analysing the consequences of a loss of safety functions, and by assessing their accident management in place. This was documented in Self-Assessment Stress Test (SAST) reports. In a second stage, the national nuclear regulators and their TSO’s reviewed the operator’s self-assessment reports, and subsequently prepared the regulator’s summary National Stress Test Report. Finally, the National Stress Test Reports were subjected to an international peer review, implemented by peer review teams set up by ENSREG and comprising experts from different European regulatory authorities and the European Commission. After finalisation of the National Stress Test Reports, National Action Plans (NAcP) were prepared by the national nuclear regulators. The implementation of the NAcPs is followed-up on a periodic basis by ENSREG and the European Commission. The National Stress Test Report and the National Action Plans were made publicly available.

The INRA Technical Specification which is to be followed by BNPP for performing the stress test is attached to this ToR as Appendix 2.

The INRA contents and format of the Stress Test Report to be followed is attached as Appendix 3.

### Geographical area to be covered

Bushehr Nuclear Power Plant and Tehran - Iran.

### Target groups

The Atomic Energy Organisation of Iran and the concerned Departments under its authority:

* The Nuclear Power Production & Development Company of Iran (NPPD), which is the operating organization of the Bushehr Nuclear Power Plant BNPP-1;/The Bushehr Nuclear Power Plant’s operator (BNPP)
* The operator's Technical Support Organisation Tavana

## Specific work

The contents of the various project tasks is described in the subsections below.

Task 0 addresses activities of project management, and the other tasks are technical tasks.

The tasks 1 to 4 are related to the stress test self-assessment and are basically to be implemented in sequential order. They are of first priority, and shall have overriding priority over task 5 in terms of project resources (man-days to be spent) as well as project schedule. It is expected that most project resources will be spent on task 2. Task 1 shall begin immediately after project start. The tasks 1 to 4 shall be completed as soon as possible, preferably within 12 months, but not exceeding 18 months.

Task 5 on reviewing the design of mobile equipment for accident management is of second priority. It shall be submitted to an overriding priority to the tasks related to the stress test self-assessment (tasks 1 to 4), in terms of project resources as well as project schedule.

All information handed over to the Contractor during the course of the project, as well as the project results, shall be treated as confidential and shall not be under any circumstances be handed over to any third parties without prior written permission of BNPP.

### Task 0: Project Management

Objective of the task

The objective of this task is to manage all tasks, both technically and administratively, in an effective manner ensuring that its objectives are fully met within the foreseen schedule and budget.

The Contractor shall be responsible for managing the project in compliance with the instructions and requirements regarding project management as specified in further detail in these Terms of Reference (ToR). The Contractor is responsible for the overall management of the project and for preparing and/or issuing all documents and reports related to contractual and financial matters, including deliverables, cost statements and invoices, requests for contractual amendments, etc. The Contractor is responsible for preparing the detailed work plan, identifying technical interfaces within the project, input/output information, meetings and workshops, establishing the inception, progress, technical and final reports.

Activities to be performed in the task

The task shall include the following activities:

*a) Contractor*

At the initial (inception) stage of the project the Contractor shall:

* Establish a Joint Working Group consisting of the project managers and coordinators from all parties involved, as well as technical experts of the Contractor and the consortium partners who will be involved in the project implementation activities on a daily basis.
* Establish the Steering Committee with representatives from EC, the Contractor, and the Project Partner/End User.
* Organise an inception (kick-off) meeting not later than two months after the contract's date of entry into force. The inception meeting shall address organisational aspects; ascertain project implementation strategy, interaction patterns, necessary input information, schedule of input information supply and delivery submission, etc. In the interest of conducting an efficient inception meeting, it may be preceded by technical meetings, possibly per task, in order to update and to validate work plan and project implementation schedule.
* Develop a detailed project work plan, implementation schedule, working procedures and a project-specific Quality Assurance Plan (QAP), in agreement with the End User. The QAP includes, inter alia, the definition of
  + project organisation, responsibilities, interfaces
  + document control
* The following documents shall be submitted to the End User before the inception meeting:
  + work plan and project implementation schedule
  + draft of the Quality Assurance Plan
  + full list of project Key Performance Indicators (see Section 8.1 and Appendix 1)
* Based on the inception meeting results, the Contractor shall elaborate the Inception report including the detailed work plan with project implementation schedule, risk analysis and project Quality Assurance Plan.

During the project phase

s following the inception period the Contractor shall:

* Organise progress meetings and task meetings to enable timely and effective oversight and monitoring of project progress, both in terms of its quality and compliance with the project schedule and objectives.
* Issue project reports according to the reporting requirements (see Section 7).
* Organise a final meeting to evaluate the work performed (in particular, in terms of its main outcomes and their sustainability), disseminate the outcomes more widely and identify the need for and nature of future cooperation.

*b) End User*

In order to fulfill this project task, the End User shall:

* Delegate appropriately qualified personnel to participate actively in the project meetings, in the Joint Working Group and in the Steering Committee.
* Review and agree on the project work plan, implementation schedule, Quality Assurance Plan and list of project Key Performance Indicators.
* Organise the local aspects of the inception meeting and progress meetings and final meeting.
* Provide all required and available inputs, documents, information, etc. for achieving the best results during project implementation.
* Provide inputs to the meeting minutes, inception report, progress reports, individual tasks reports and final report.
* Review and approve the Inception report, progress reports, individual task reports and the Final report.

Expected deliverables

* Minutes of inception and progress and finalmeetings
* Inception report, including the consolidated detailed Project Work Plan, the detailed Project Schedule and the Project Quality Assurance Plan (QAP)
* Progress reports
* Task reports (see also below)
* Final report

### Task 1: Development of the detailed methodology for the Stress Test

Objective of the task

The objective of this task is to review the available self-assessment against the INRA Stress Test specification, to perform a gap analysis and develop as needed a detailed methodology that shall enable NPPD to complete the self-assessment report

Stress test methodology

NPPD – and eventually its technical support organisation – will review the SAST report, in cooperation with the Contractor, and consistently with the ENSREG/WENRA recommended format and content.

In summary of the INRA Stress Test specification, the methodology shall focus on the following main topics:

1. Earthquakes, Flooding and other Extreme Weather Conditions

For each of the external event, analyse:

1. Design basis

* + Provisions to protect the plant against DBE
  + Plant compliance with current design basis

2. Evaluation of the margins

* + Weak points and any cliff edge effects according to earthquake severity.
  + Provisions can be envisaged to prevent these cliff edge effects or to increase robustness of the plant (modifications of hardware, modification of procedures, organisational provisions...).
  + Range of earthquake severity the plant can withstand without losing confinement integrity.

1. Loss of off-site power (LOOP)

* Short description of design solution for LOOP
* Evaluation how the design cope with the LOOP, i.e. time constrains, etc.
* Provisions for the on-site power supply time prolongation

1. Station blackout (SBO)

1. Loss of off-site power and loss of the ordinary back-up AC power sources

2. Loss of permanently installed ordinary and diverse back-up AC power sources

* + provisions for this situation
  + Battery capacity, duration and possibilities to recharge batteries in this situation
  + Time constraints for SBO
  + Provisions foreseen to arrange exceptional AC power supply from transportable or dedicated off-site source
  + Identification of possible Cliff edge effects and provisions to cope with those

1. Ultimate heat sinks (UHS)

1. Loss of primary UHS, i.e. access to water from the river or the sea

2. Loss of primary and alternate UHS

For each of the situation, indicate:

* Time limitations for restoration of the function
* Design provisions
* External provisions foreseen to prevent fuel degradation
* Identification of possible Cliff edge effects and provisions to cope with those

1. Loss of primary UHS with SBO

* Time limitations for restoration of the function
* Design provisions
* External provisions foreseen to prevent fuel degradation
* Identification of possible Cliff edge effects and provisions to cope with those

1. Severe accident management

1. Adequacy of present organizations, operational and design provisions

* + Organization and arrangements of the licensee to manage accidents
  + Procedures and guidelines for accident management
    - Full power states
    - Low power and shutdown states
  + Hardware provisions for severe accident management
  + Accident management for events in the spent fuel pools
  + Evaluation of factors that may impede accident management and capability to severe accident management in multiple units case

2. Margins, cliff edge effects and areas for improvements

* + Strong points, good practices
  + Week points, deficiencies (areas for improvements)

3. Possible measures to increase robustness

* + Upgrading of the plants since the original design
  + Ongoing upgrading programmes in the area of accident management

4. New initiatives from operators and others, and requirements or follow up actions (including further studies) from Regulatory Authorities: modifications, further studies, decisions regarding operation of plants

* + Upgrading programmes initiated/accelerated after Fukushima
  + Further studies envisaged
  + Decisions regarding future operation of plants

The detailed requirements for each of the topics outlined above are described in the ENSREG Stress Test specifications. The specific methodology to be developed in this task shall provide comprehensive guidance in order to adequately address each of the requirements above, taking into account the specific situation of BNPP-1. It shall make optimal (but critical) use of all available input documents on BNPP-1.

Activities of the task

The task shall include the following activities:

*a) Contractor*

The Contractor shall:

* Oversee and assess the specific situation in Iran for conducting the stress test Self-Assessment for the Bushehr NPP. With the cooperation of NPPD, consider the inventory of the available plant safety documentation and corresponding safety analyses in sufficient detail and in function of the specific needs of the stress test Self-Assessment.
  + Available are for instance: the Safety Analysis Report, the EOPs, the BDBA Control Manual (event oriented procedures), and a level 2 PSA (with a report mainly indicating results obtained with the severe accident code SOCRAT, boundary conditions and initial conditions, and which was so-far not submitted to any regulatory review in Iran). All mentioned documents are available in English. SAMGs are not available.
  + Consider the existing 'stress test report' for BNPP-1 (available in English) as performed in 2012 by the vendor country (Russian Federation), and perform an independent detailed review. This document might for instance have a reduced scope. It has not yet been submitted to any regulatory review in Iran.

Perform a gap analysis on all these input documents in order to identify and address in an early stage potential issues in terms of availability (in English) and status (verification and validation) of adequate and complete plant data, safety analyses, specific calculations and results.

* In support of NPPD, develop a detailed stress test methodology to be proposed to and agreed with NPPD. It shall propose specific approaches to fill all the identified gaps, and contain detailed guidance for performing the Bushehr NPP stress test self-assessment and for drawing up the SAST report, systematically covering all the elements of the INRA stress test specification. It shall address, inter alia,:
  + General considerations:
    - Data and documentation: Specific and unique Bushehr NPP plant characteristics (and possible implications on the detailed methodology for performing the stress test), documented safety analyses and underlying calculations; availability in English;
    - Carefully plan for a chapter 1 of the SAST report on site and plant description (as BNPP is a unique design), to ensure that accurate, consistent and sufficient information is provided in a structured way, setting from the start a common English vocabulary and common SSC denominations for the rest of the report, avoiding poor translations and subsequent confusion, avoiding the need for subsequent major revisions, and serving the purpose of the stress test. As many experts and future peer reviewers are not familiar with the – in several aspects unique – design of BNPP, the importance of this descriptive part shall not be underestimated.
    - A pragmatic approach to handle the different languages – if any. In the interest of efficiency and good configuration control, the emerging chapters of the SAST report should be planned to be directly developed in English.
  + Definition of the detailed scope of the assessment, including assessment objectives, the status of the plant to be considered (setting the plant reference date), the initial operating states of the plant to be considered, plant challenges to be assessed, aspects to be reported, level of detail of site and plant description.
  + Definition of a detailed and specific technical assessment methodology required for the development of each of the different chapters of the SAST report, in accordance with the INRA stress test specification. This shall describe, in summary, how to perform the evaluation of the response of the BNPP when facing a set of extreme situations - initiating events - loss of safety functions from any initiating events - severe accident management issues. This shall also address, inter alia, relevant working hypothesis, technical definitions (e.g. safe shutdown, fuel damage in core or fuel pool, cliff edge effects, etc…).
  + An additional chapter with the main conclusions and an action plan with the list of identified (decided or possible) improvement measures following the outcome of the stress test (hardware and software modifications, further studies, decisions regarding operation of plants, indication of their implementation timescale).

The developed stress test methodology shall take full advantage of previous experiences and lessons learned from conducting the EU stress tests, and of the existing 'stress test report' for BNPP-1 performed in 2012 by the vendor country.

* Support NPPD in presenting and discussing the detailed stress test methodology in an early stage with INRA (and its Contractor in the framework of INSC project IRN3.01/16 Lot 1), and implement updates as needed.
* In support of and in agreement with NPPD, develop a work plan for the implementation of the detailed stress test methodology, systematically covering all the elements of the INRA requirements, defining separate work packages / working groups as appropriate, outlining the (possibly iterative) development process in terms of roles and responsibilities, interaction mechanisms, mutual review, integration into one coherent SAST report, milestones, planning of further interactions with INRA on the SAST report. It shall also address (inter alia):
  + Capabilities of NPPD and other supporting organisations to which it has access in view of the development of the SAST report, and an assessment of any specific need for subcontracting selected parts of these activities
  + For each work package, definition of the role and responsibilities of the different actors (within NPPD and its supporting organisations, the Contractor's consortium members, possible subcontractors)
  + Proposals for filling any identified gaps (e.g. regarding the existing 'stress test report' for BNPP-1 performed in 2012 by the vendor country, or regarding input data, specific analyses and calculations)
  + Translations into English, where necessary
  + Support NPPD in addressing an effective and efficient version control, and the harmonisation of parts of the SAST that are developed by different authors/organisations. The drafting language should be English from in the beginning, avoiding the need for constant translations, poor efficiency and delays.

A preliminary version of the work plan, indicating the proposed role and responsibilities of each of the Contractor's consortium partners, shall be included in the Contractor's technical offer. In a first approach, plan for a major involvement of the Contractor in drafting all the chapters of the SAST report, except the first chapter with general data about site / plant (for which a substantial review is to be foreseen).

*b) End User*

In order to fulfill this project task, the End User shall:

* Establish a detailed inventory of relevant documents (including the existing 'stress test report' for BNPP-1 as performed in 2012 by the vendor country) and available plant data, plant safety documentation and safety analyses (specifying the level of validation), in function of the specific needs of the stress test Self-Assessment (e.g. in the plant’s Safety Analysis Report), and indicating their availability in English. Provide the inventory and the documents to the Contractor. Indicate known gaps, if any.
* Agree with INRA on a plant reference date.
* Cooperate with the Contractor in elaborating, discussing and endorsing the gap analysis and the detailed stress test methodology.
* With the support from the Contractor, present and discuss the detailed stress test methodology in an early stage with INRA, and implement updates as needed.
* Cooperate with the Contractor in elaborating, discussing and endorsing the detailed work programme. In particular, share with the Contractor relevant information regarding NPPD's (and its supporting organisations') capabilities to develop the various parts of the SAST report, and help indicating any gaps and particular needs.
* Review and endorse the task deliverables.

Expected deliverables

* Review results and gap analysis of all input documents, and in particular of the existing 'stress test report' for BNPP-1 as performed in 2012 by the vendor country
* Detailed methodology for the Stress Test self-assessment
* Work plan for the stress tests self-assessment
* Task report containing the description of the activities performed and results obtained (including working documents, minutes of meetings and proceedings of workshops, presentations and training material).

### Task 2: Support to NPPD in preparation of the Self-Assessment Stress Test report

Objective of the task

The objective of this task is to support NPPD with the preparation of the Self-Assessment Stress Test report.

This task is the main task of the project.

Self-Assessment Stress Test report

The SAST report shall be drawn up according to the INRA recommended Format and Content (see Appendix 3). A summary overview of its structure in given below.

The first part of the report shall briefly describe site characteristics:

* location (sea, river)
* number of units
* license holder

The main characteristics of each unit shall be reflected, in particular:

* reactor type
* thermal power
* date of first criticality
* presence of spent fuel storage (or shared storage of the fuel).

The main characteristics of systems for providing or supporting safety function, in particular for:

* Reactivity control
* Heat transfer from the reactor to the ultimate heat sink
* Heat transfer from spent fuel pools to the ultimate heat sink
* Heat transfer from the reactor containment to the ultimate heat sink
* AC power supply
* Batteries and DC power supply

The SAST report shall also reflect scope and main results of the PSA.

The report shall formally consider and reflect the status of the plant as it is currently built and operated on a reference date to be agreed with INRA. The analyses shall consider the plant in the most unfavourable operational states that are permitted by Technical Specifications (Operational Limits and Conditions). Severe accident scenario analyses should also consider the use of non-classified equipment as well as a realistic assessment whether their use is possible in accident conditions. The analysis shall consider simultaneous impact on the reactor and spent fuel storage, as well as the possibility of deterioration of conditions of the site surrounding area. It is to be assumed that the site is isolated from delivery of heavy materials for 72 hours by road, rail or waterways. Portable light equipment can arrive to the site from other locations after the first 24 hours.

The report shall reflect three main aspects:

* Provisions taken in the plant design basis, the plant conformance to current design requirements.
* Regulatory basis for safety assessment and regulatory oversight (national requirements, international standards, licensing basis already used by other countries, etc.)".
* Safety margins and robustness of the plant beyond its design basis
* Any potential for modifications likely to improve the considered level of defence-in-depth.

For this purpose, provisions shall be listed that are capable of avoiding the extreme scenarios defined in the stress tests technical specifications, complemented where appropriate by results of dedicated plant walk downs / engineering judgements and/or calculations / analyses.

The analysis in the report shall identify and reflect the following elements:

Provisions of current design basis:

* the means to maintain the three fundamental safety functions (control of reactivity, fuel cooling, confinement of radioactivity) and support functions (power supply, cooling through ultimate heat sink), taking into account the probable damage done by the initiating event and any means not credited in the safety demonstration for plant licensing.
* possibility of mobile external means and the conditions of their use.

Provisions for situations beyond design basis and severe accident management:

* the time before damage to the fuel becomes unavoidable. Indicate time before water level reaches the top of the core, and time before fuel degradation (fast cladding oxidation with hydrogen production).
* if the fuel is in the spent fuel pool, the time before pool boiling, time up to when adequate shielding against radiation is maintained, time before water level reaches the top of the fuel elements, time before fuel degradation starts.

The plant design, engineering and safety documentation referenced in the SAST report shall be characterised as:

* validated in the licensing process
* not validated in the licensing process, but gone through licensee's QA program
* none of the above.

Activities of the task

The task shall include the following activities:

*a) Contractor*

The Contractor shall:

* Support NPPD with the preparation of the SAST report, according to the work programme established in the previous task. The work programme contains actions for NPPD and its supporting organisations, for the Contractor and his consortium members, and possibly also for subcontractors.
* Jointly with NPPD, analyse the possibility of any provisions that are able to avoid the extreme scenarios that are foreseen by the stress tests technical specifications. The analysis should be complemented, where necessary and appropriate, by results of dedicated plant walk downs / engineering judgements and/or calculations / analyses, if necessary.
* Support NPPD in monitoring the overall progress in the different safety analyses and the development of the SAST report, address any issues detected, advise and agree with NPPD on issue resolution, and update the work programme accordingly.
* In case of subcontracting external experts, manage the entire subcontracting process, including a detailed monitoring and follow-up of the subcontractor(s) and their deliverables.
* Review all parts of the emerging SAST report, inter alia, by
  + reviewing for relevance, accuracy, completeness
  + verifying clarity, consistency, readability
  + providing the Contractor's expertise in the review of the respective studies / calculations / research results available for Bushehr NPP, to ensure that properly validated studies / calculations relevant for the stress test are duly considered in the SAST report as supporting documents / justifications.
  + organising cross-readings
  + holding review meetings with NPPD and other actors, as appropriate.

At least one full round of review and update shall be completed before transmitting the draft SAST to INRA for comment.

*b) End User*

NPPD (possibly together with its supporting organisation) plays a major role in this task. As licensee and operator of the Bushehr NPP, NPPD is the overall responsible for the SAST report and its development process. This activity will require a major involvement of NPPD’s human resources.

In order to fulfill this project task, the End User shall:

* Develop the SAST report in cooperation with the Contractor and all the other actors involved, according to the work programme established in the previous task. The work programme contains actions for NPPD and its supporting organisations, for the Contractor and his consortium members, and possibly also for subcontractors.
* Particular attention shall be devoted to the site and plant description as well as specific plant data and safety analyses for which the End User has the best knowledge and expertise. The End User shall therefore be the main author of Chapter 1 'General Data about site/plant' in the SAST report, and shall validate all such data in other chapters.
* In cooperation with the Contractor, monitor the overall progress in the different safety analyses and the development of the SAST report, address any issues detected, advise and agree with the Contractor on issue resolution and updating the work programme.
* Review and validate all parts of the SAST report.
* Agree with the Consultant on the draft SAST report, and approve it.
* Review and endorse the task deliverables.

Expected deliverables

* First version of the Self-Assessment Stress Test report
* Results of the reviews performed
* Task report containing the description of the activities performed and results obtained (including working documents, minutes of meetings and proceedings of workshops, presentations and training material).

### Task 3: Support to NPPD in presentation of the Self-Assessment Stress Test report to INRA

Objective of the task

The objective of this task is to support NPPD in its presentation of the Self-Assessment Stress Test report to INRA.

Activities of the task

The task shall include the following activities:

*a) Contractor*

The Contractor shall:

* Support NPPD in the presentation of the Self-Assessment Stress Test report to INRA (and its Contractor in the framework of INSC project IRN3.01/16 Lot 1). This should be achieved via preparation of a two-day workshop during which NPPD and the Consultant experts will present the results of the joint work to INRA.
* Share with NPPD the responsibilities for the workshop logistics and workshop materials development. A two-day workshop shall be arranged in Iran (e.g. at NPPD premises). The first day will be dedicated to the presentation of the Self-Assessment Stress Test report and its results, and the second day will be dedicated to a discussion of the results.
* From a logistical point of view, the Contractor and NPPD share the responsibility for the workshop. The Contractor is responsible for:
  + Preparation and distribution of the workshop agenda
  + Presentation of the methodology developed for the Stress Test implementation
  + Presentation of the work and analyses performed in the framework of the Stress Test
  + Preparation of the Workshop hand-outs and for their distribution among workshop participants
* After the workshop discussions, and jointly with NPPD, review and – if necessary – consider comments received during the workshop in view of updating the Self-Assessment Stress Test report.

*b) End User*

In order to fulfill this project task, the End User shall:

* From a logistical point of view, the Contractor and NPPD share the responsibility for the workshop. NPPD is responsible for:
  + Presentation of the Self-Assessment Stress Test report results
  + Overview of safety justifications, analyses and other materials used in the Self-Assessment Stress Test report as reference documents
  + Overview of gaps identified by the Stress Test and preliminary proposals to overcome them (upgrades, procedures, interface with external organisations as applicable)
  + Provision of the workshop venue and translation/interpretation services during workshop
* Jointly with the Contractor, review and – if necessary – consider the comments received during the workshop in view of updating the Self-Assessment Stress Test report.
* Review and endorse the task deliverables.

Expected deliverables

* Summary report on the workshop, including the comments on the Self-Assessment Stress Test and the discussions held
* Task report containing the description of the activities performed and results obtained (including working documents, minutes of meetings and proceedings of workshops, presentations and training material).

### Task 4: Support in the development of the final Self-Assessment Stress Test report

Objective of the task

The objective of this task is to support NPPD in the development of the final Self-Assessment Stress Test report.

Activities of the task

The task shall include the following activities:

*a) Contractor*

The Contractor shall:

* Support NPPD in the detailed resolution of the comments received as a result of INRA's regulatory review. Jointly with NPPD experts, resolve INRA's comments and prepare the final Self-Assessment Stress Test report. This final report shall follow the INRA format, and an additional chapter with the main conclusions and an action plan with the list of identified (decided or possible) improvement measures following the outcome of the stress test (hardware and software modifications, further studies, decisions regarding operation of plants, indication of their implementation timescale).

The satisfactory resolution of all INRA comments may take a few iterations. Support NPPD in an effective and efficient organisation of the corresponding interactions and meetings with INRA, as adequate.

*b) End User*

In order to fulfill this project task, the End User shall:

* Cooperate with the Contractor in the detailed resolution of the comments received as a result of INRA's regulatory review. Jointly with the Contractor, resolve INRA's comments and prepare the final Self-Assessment Stress Test report. The satisfactory resolution of all INRA comments may take a few iterations.
* Consider making the final Self-Assessment Stress Test report available to the public in accordance with national legislation and international obligations, provided that this does not jeopardize other interests such as, inter alia, security, recognized in national legislation or international obligations.
* Review and endorse the task deliverables.

Expected deliverables

* Final Self-Assessment Stress Test report
* Task report containing the description of the activities performed and results obtained (including working documents, minutes of meetings and proceedings of workshops, presentations and training material).

### Task 5: Support in designing safety improvement measures resulting from the stress test (i.e. mobile equipment)

Objective of the task

The objective of this task is to support NPPD in the design of (already decided) safety improvement measures resulting from the stress test, and in particular of the mobile equipment to be installed at BNPP-1 in support of accident management.

However, this task is of second priority and shall be submitted to an overriding priority to the tasks related to the stress test self-assessment (tasks 1 to 4), in terms of project resources as well as project schedule.

Moreover, task 5 shall be performed in consideration of – and in line with – the emerging results of tasks 1 to 4.

Background information

Following its 2012 'stress test report' for BNPP-1, the vendor country recommended NPPD ordering a specific set of mobile equipment for BNPP-1. This equipment mainly includes:

* 4 mobile diesel-driven pumps for the injection of water into the primary circuit into the steam generator(s), into the spent fuel pool, and for the make-up of specific water reservoir(s) whose characteristics are as follows
  + Pump for the injection of water into the primary circuit:
  + Engine Driven Pump EDP (Q=150 m3/h, H=120 m)

(heat removal from the core through the primary circuit)

* + Pump for the injection into the steam generator(s):
  + Portable Pump Unit PPU (Q=150 m3/h, H=900 m)
* Pump for the make-up of specific water reservoir(s):
  + EDP (Q=500 m3/h, H=50 m)

(Water supply for tanks of emergency water supply system of steam generator)

* + Pump for the injection into the spent fuel pool:
  + EDP (Q=40 m3/h, H=50 m)
* 2 mobile diesel generators with the power of 2 MW and 0.2 MW for the electrical back-up of various safety systems.
  + DG Diesel Generator 2MW /10 KV

Power supply for safety systems during the accident

* + DG 0.2 MW /400 V

Power supply for I&C systems

Meanwhile in BNPP, there are four channels of the emergency power supply system as follows:

* Each channel is equipped with two diesel-generators. Diesel-generators are connected in parallel and connected with the emergency power supply section via one circuit breaker.
* Basic characteristics of the diesel-generator:
* Capacity, kW 3100
* (total capacity) 3100×2=6200)
* Voltage of the diesel-generator, kV 10.5
* Frequency, Hz 50
* Time of unserviced operation at full load

(without maintenance and repair), hours 250

* Mean time before failure, hours 1600
* Prescribed service life to overhaul, hours 16000

Normal operation reliable power supply system consists of two mutually redundant channels, which allows to provide power supply to process loads, required for ensuring reliable power supply in case of a loss of normal power supply. Both channels are provided with one diesel-generator (with power 3100 kW) of which the characteristics are similar to emergency diesel-generator.

The diesel generators will be supplied to BNPP-1 relatively soon. NPPD has started a design project for the corresponding implementation measures of this mobile equipment. The design is being performed by a local contractor (TAVANA) of NPPD.

The status of the design is as follows:

* Conceptual Design is currently being finalised
* Basic Design and Detailed Design: a list and a schedule of activities to be performed by the contractor of NPPD have been drawn up. The design is estimated to be finalised by the end of 2017 (tentative date).

Activities of the task

The task shall include the following activities:

*a) Contractor*

The Contractor shall:

* Review the approach to the design process, the design requirements and the results of the different stages of the design, formulate comments and recommendations, considering inter alia: envisaged safety functions (accurate definition, completeness); operability of batteries, I&C systems and actuators that are necessary to perform the safety functions; accessibility; implantation; connections; testing; reliability; storage; supplies; procedures; etc.
* Take full advantage of previous experiences and lessons learned from conducting the EU stress tests.
* Take explicitly into account the emerging results of the stress test (tasks 1 to 4), e.g. by assessing
  + the adequacy of the equipment and its safety functions being designed
  + the completeness of these decided improvement measures for BNPP-1

and formulate recommendations as appropriate.

* Facilitate and provide opportunity for the local contractor (which is responsible for the design of implementation of mobile equipment) with scientific/benchmarking visits to nuclear power plants in which modernizations related to implementation of mobile equipment has been successfully accomplished.

*b) End User*

In order to fulfill this project task, the End User shall:

* Provide the Contractor with all relevant information regarding the design process in place.
* Cooperate with the Contractor in his review, and consider his comments and recommendations. Consider involving the Contractor in meetings, walk-downs and tests, as appropriate.
* Review and endorse the task deliverables.

Expected deliverables

* Task report containing the description of the activities performed and results obtained (including working documents, minutes of meetings and proceedings of workshops, presentations and training material).

## Meanwhile, for all the above-mentioned tasks, the End User reviews and approves the task reports and the results obtained from the activities performed by the Contractor. The start of the executive activities of the next task is dependent on the successful fulfilment of the Contractor’s obligations related to the previous task and the End User’s approval of report and the required technical documents of that taskProject management

### Responsible bodies

* Contracting Authority – European Commission
* Partner Country – The Islamic Republic of Iran
* Beneficiary – Atomic Energy Organization of Iran (AEOI)
* End User – Iranian operating organisation of the Bushehr Nuclear Power Plant (NPPD)/The unite operator of the Bushehr Nuclear Power Plant (BNPP) , and its technical support organisation Tavana
* The Contractor
* EC Monitors

### Management structure

#### EU stakeholders

During the implementation of the project, the Contractor and the other project participants must interact with the European Commission (EC) through the following bodies involved in the implementation of the INSC programme:

* The unit B5 “Instrument for Stability, Nuclear Safety” of the Directorate General for International Cooperation and Development: this unit formulates the annual programme (on the basis of the multi-annual plan), identifies the projects, and is responsible for the project descriptions as well as for all tendering. The EC Project Manager responsible for the management of the work to be performed under this contract is based in unit B5.
* The unit B6 “Financial and Contract Management” of Directorate General for International Cooperation and Development: this unit is responsible for the financial management of the contract and invoice settlement.
* The EC Monitors: these are external experts mandated by the EU to check and monitor implementation of INSC projects in the Partner Country. They report to the EU.
* The future EU Delegation in Iran will be the local representative body of the EU.
* The Joint Research Centre (JRC) of the EU: JRC provides technical support to the EU services and is involved in ToR preparation, tender evaluation, project technical follow-up, review of reports, etc.

During the course of the implementation of the project, the Contractor and the other project participants should apply modern management practices in order to have a close follow-up of the project's progresses and regularly report to the European Commission (EC). The Contractor will use modern computer software tools for the management of the project.

After the signature of the contract, the Contractor will initiate with the Partner Country negotiation to have a **Communication Procedure** - describing the exchange of the documents between the partners - ideally signed before or at the latest at the Inception Meeting.

#### End User

# The End User is Iranian operating organisation of the Bushehr Nuclear Power Plant (NPPD)/The unite operator of the Bushehr Nuclear Power Plant (BNPP) , and its technical support organisation Tavana

The End User should provide during the inception phase full information of other past, ongoing and planned future cooperation projects. During implementation, it should, together with the Contractor, co-ordinate the work to avoid overlapping and ensure complementarities, as appropriate.

During the implementation of the contract, the End User shall:

* Approve the Inception Report as well as any further updates of the work plan and the schedule, and the project related procedures established by the Contractor.
* Prepare all formal documents that may be required for implementation of project tasks at the End User’s facilities by Partner Country’s national or industry standards, rules and regulations.
* Provide the Contractor with all necessary technical information, design documentation, specific local regulations, input data, etc., as required by these ToR or deemed necessary by the Contractor for performance of technical tasks and preparation of technical reports.
* Analyse the results of the project phases.
* Receive and comment on the project results, the final report and the specific deliverables.
* Provide, as necessary, information for the project-related actions taking place in or out of Iran.
* Endorse all technical deliverables of the project (reports or other products), before they enter the approval procedure as defined in Section 7.2 of these ToR.
* Support the Contractor in working at the End User’s facilities during project implementation. The End User shall arrange all necessary permits for the Contractor experts to access the specified End Users’ facilities and assist them in the work with the facility equipment to the extent necessary and permitted to the Contractor.
* Provide necessary interpretation from and to the Partner Country language for project-related activities, like workshops, training activities, visits to technical facilities, etc., taking place inside the Partner Country.
* Appoint a senior member of its staff to liaise with the Contractor and ensure that staff of an appropriate level is made available to work alongside the staff of the Contractor. Staff of the End User shall not be paid from project funds.
* Provide all reasonable assistance to solve unforeseen problems that the Contractor may face locally in Iran. The possible failure to solve some of the Contractor's problems encountered locally will not free the Contractor from meeting its contractual obligation vis-à-vis the Contracting Authority.

#### The Contractor

The Contractor is the legal person with whom the European Commission has concluded the contract. The Contractor is responsible for all the achievements of the project and for the assistance and transfer of know-how to the Partner Country organisations. He/she shall directly perform part of the work within the scope and limits that are described in these ToR.

The Contractor, inter alia, shall:

* Assure the interface with the European Commission (DEVCO B5). In particular, the Contractor's Project Leader will regularly brief and de-brief the European Commission project manager on meetings and achievements.
* Assure the co-ordination between all participating organisations and definition of procedures for exchange of information.
* Establish the planning and schedule of the activities as well as the inception report.
* Perform the project according to the scope, as described in these Terms of Reference, and the agreed time schedule.
* Survey other related activities and establish inter-relationships with other parties involved in the work of this project.
* Prepare the administrative reports and technical task reports as described in Section 7 and have them circulated for approval according to the procedure set out in Section 7.2.
* Organise regular project progress meetings and prepare minutes of the meetings; the minutes will be produced in English.
* Be responsible for translating selected technical reports and related written deliverables (User‘s manuals, training/workshop materials, etc.) into Iranian language, if justified. The selection will be proposed and justified by NPPD and agreed by the project partners.
* Provide necessary interpretation from and to the Partner Country language for project-related activities, like workshops, training activities, visits to technical facilities, etc., taking place outside the Partner Country. Note that in principle interpretation may be required only for those events, where participants are mainly from other Iranian stakeholders and not only from NPPD.
* Assure a sound financial project management.
* Organise the final project meeting and participate in the final project presentation for the dissemination of results.
* Assure coordination with other cooperation or support projects (e.g. IAEA) in order to avoid overlaps.
* Take care, in accordance with applicable procedures of the European Commission, of:
  + Travel, accommodation, local travel, subsistence and medical insurance for the experts of the counterpart organisations who will be travelling to/within/from the European Union (EU) at the request of the Contractor.
  + The necessary interpretation in case of visits and joint work in the EU countries.
  + Local transport and accommodation arrangements for the above mentioned experts when they travel with or at the request of the Contractor outside their normal place of work.
  + Translation of documents when necessary

Meetings between the Contractor and EuropeAid Project Manager and other appropriate EU Commission services will be organised by the respective parties as appropriate. Meetings between representative of the End User, the Contractor, the EuropeAid Project Manager, Commission Delegation may be called as appropriate.

### Project language

The official language of the project is English. The working language for the documentation within the project is English and/or Farsi, as appropriate.

All input and working documents (normative, technical, training, etc.) will be submitted to the Contractor in Farsi language; the English versions shall be provided, if available. Almost all documents are however available in English.

The technical reports and deliverables prepared by the Contractor are prepared in English as specified in Section 7.2.

# LOGISTICS AND TIMING

## Location

Iran, Tehran and Bushehr Nuclear Power Plant, and possibly other locations linked to the work of the Action, e.g. research reactors, fuel cycle facilities or other locations where nuclear and radiation activities are carried out in Iran.

The operational base for the project shall be Tehran and the Bushehr Nuclear Power Plant (Iran).

The normal places of posting of the Contractor are Tehran and the Bushehr Nuclear Power Plant (Iran) and the premises of the Contractor.

## Start date and period of implementation

The intended start date is the Contract signature and the period of implementation of the contract will be **36 months** from this date. Please refer to Articles 19.1 and 19.2 of the Special Conditions for the actual start date and period of implementation.

An explicit work plan and schedule must be provided in the Contractor's "Organisation and Methodology" document. At the project start, a detailed schedule identifying the various interfaces of the project, input/output information, deliverables, etc. will be laid down by the Contractor with the agreement of the End User in the "Inception Report".

# REQUIREMENTS

## Staff

Note that civil servants and other staff of the public administration, of the Partner Country or of international/regional organisations based in the country, shall only be approved to work as experts if well justified. The justification should be submitted with the tender and shall include information on the added value the expert will bring as well as proof that the expert is seconded or on personal leave.

A team of nuclear safety experts from different EU Member States shall be set up to cooperate with and support the Partner organisation. Their experience in partner relations with the Iranian nuclear operator and its support organizations, as well as familiarity with nuclear technology present in Iran and with current nuclear regulatory requirements of Iran would be an asset.

Clearly structured information shall be provided in the Contractor’s "Organisation and Methodology" for the following items:

* A diagram covering the responsibilities for each of the tasks of the project, involving the Contractor, the End User and other stakeholders. This diagram shall indicate the names of the key persons carrying responsibility for the management of the work.
* A table regarding the breakdown of planned manpower, providing the expected number of man-days, per task (also indicating the part spent in the EU and in Iran), and in total.
* A log frame matrix, clearly indicating objectives, targets, inputs, outputs, milestones, progress and performance indicators, monitoring, etc. Examples given in Appendixes I A and I B should be adapted and developed in the offer.

### Key experts

Key experts have a crucial role in implementing the contract.

These terms of reference contain the required key experts’ profiles. The tenderer shall submit CVs and Statements of Exclusivity and Availability for the following key experts.

The profiles of the key experts for this contract are as follows:

Key expert 1: Project Leader

Qualifications and skills:

General professional experience:

Specific professional experience:

This Key expert is also expected to carry out large parts of xxx.

Key expert 2: Senior expert Nuclear Safety Assessment

Qualifications and skills:

General professional experience:

Specific professional experience:

This Key expert is also expected to carry out large parts of xxx.

Key expert 3: Senior expert Nuclear Safety Assessment

Qualifications and skills:

General professional experience:

Specific professional experience:

This Key expert is also expected to carry out large parts of xxx.

All experts must be independent and free from conflicts of interest in the responsibilities they take on.

### Non-key experts

CVs for non-key experts should not be submitted in the tender but the tenderers will have to demonstrate in their offer that they have access to experts with the required profiles.

The Contractor must select and hire other experts as required according to the profiles identified in the Organisation & Methodology or these Terms of Reference. They must indicate clearly which profile they have so it is clear which fee rate in the budget breakdown will apply. All experts must be independent and free from conflicts of interest in the responsibilities they take on.

Two types of experts can be distinguished:

* Senior experts: they should have at least 10 years professional experience in the area defined for the tasks they will be committed to;
* Junior experts: they should have at least 5 years professional experience in the area defined for the tasks they will be committed to.

The selection procedures used by the Contractor to select these non-key experts shall be transparent, and shall be based on pre-defined criteria, including professional qualifications, language skills and work experience. The findings of the selection panel shall be recorded.

The selected experts shall be subject to approval by the Contracting Authority before the start of their implementation of tasks.

### Support staff & backstopping

The Contractor will provide support facilities to their team of experts (back-stopping) during the implementation of the contract.

The support staff shall include personnel in charge of administrative and financial management of the project.

Backstopping and support staff costs must be included in the fee rates of the experts.

## Office accommodation

Office accommodation of a reasonable standard and of approximately 10 square metres for each expert working on the contract is to be provided by the Partner Country/End User.

The workplaces shall be equipped with desks, chairs, telephone and Internet connection. The costs for the telephone line and Internet connection are to be covered by the fees.

## Facilities to be provided by the Contractor

The Contractor shall ensure that experts are adequately supported and equipped. In particular it shall ensure that there is sufficient administrative, secretarial and interpreting provision to enable experts to concentrate on their primary responsibilities. It must also transfer funds as necessary to support its activities under the contract and to ensure that its employees are paid regularly and in a timely fashion.

## Equipment

## No equipment (hardware or software) is to be purchased on behalf of the Contracting Authority / Partner Country as part of this service contract or transferred to the Contracting Authority / Partner Country at the end of this contract. Incidental expenditure

The Provision for incidental expenditure covers the ancillary and exceptional eligible expenditure incurred under this contract. It cannot be used for costs which should be covered by the Contractor as part of its fee rates, as defined above. Its use is governed by the provisions in the General Conditions and the notes in Annex V of the contract. It covers:

* Travel costs and subsistence allowances for missions, outside the normal place of posting, undertaken as part of this contract:
  + trips within EU for key and non-key experts for meetings and missions approved in the framework of the project;
  + trips of Iranian experts (NPPD and/or its support organisations) for study tours, workshops and training in the EU;
  + Visa costs for the beneficiary and end-user's experts.
* Other incidental costs:
  + Study tour, training, tutoring, workshops
  + Translations and interpretations costs. However, almost all documentation is available in English, and no translations into Farsi are foreseen. Interpretation is probably also not necessary (and if necessary, interpretation will be provided by the Beneficiary/End User).

It is reminded that the travels to/from the base of operations and per diems of international experts are included in their fee rates.

The provision for incidental expenditures is **€ 100.000.** This amount must be included unchanged in the Budget Breakdown.

Daily subsistence costs may be reimbursed for missions foreseen in these terms of reference or approved by the Contracting Authority, and carried out by the contractor’s authorised experts, entailing overnight stays outside the expert’s normal place of posting.

The per diem is a flat-rate maximum sum covering daily subsistence costs. These include accommodation, meals, tips and local travel, including travel to and from the airport. Taxi fares are therefore covered by the per diem. Per diem are payable on the basis of the number of hours spent on the mission by the contractor's authorised experts for missions carried out outside the expert's normal place of posting. The per diem is payable if the duration of the mission is 12 hours or more. The per diem may be paid in half or in full, with 12 hours = 50% of the per diem rate and 24 hours = 100% of the per diem rate. Any subsistence allowances to be paid for missions undertaken as part of this contract must not exceed the per diem rates published on the website - <http://ec.europa.eu/europeaid/work/procedures/implementation/per_diems/index_en.htm>

- at the start of each such mission.

The Contracting Authority reserves the right to reject payment of per diems for time spent travelling, if the most direct route and the most economical fare criteria have not been applied.

Prior approval by the Contracting Authority for the use of the incidental expenditure is not needed [with the exception of training for NPPD experts in the EU.

## Lump sums

No lump sums are foreseen in this contract.

## Expenditure verification

The Provision for expenditure verification covers the fees of the auditor who has been charged with the expenditure verification of this contract in order to proceed with the payment of any pre-financing instalments and/or interim payments.

The Provision for expenditure verification for this contract **is € 30.000**. This amount must be included unchanged in the Budget breakdown.

This provision cannot be decreased but can be increased during the execution of the contract.

# Reports

## Reporting requirements

Please see Article 26 of the General Conditions. Interim reports must be prepared every six months during the period of implementation of the tasks. They must be provided along with the corresponding invoice, the financial report and an expenditure verification report defined in Article 28 of the General Conditions. There must be a final report, a final invoice and the financial report accompanied by an expenditure verification report at the end of the period of implementation of the tasks. The draft final report must be submitted at least one month before the end of the period of implementation of the tasks. Note that these interim and final reports are additional to any required in Section 4.2 of these Terms of Reference.

Each report must consist of a narrative section and a financial section. The financial section must contain details of the time inputs of the experts, incidental expenditure and expenditure verification.

To summarise, in addition to any documents, reports and output specified under the duties and responsibilities of each key expert above, the Contractor shall provide the following reports:

|  |  |  |
| --- | --- | --- |
| **Name of report** | **Content** | **Time of submission** |
| Inception Report | Analysis of existing situation and work plan for the project | No later than 1 month after the start of implementation |
| 6-month Progress Report | Short description of progress (technical and financial) including problems encountered; planned work for the next 6 months accompanied by an invoice and the expenditure verification report. | No later than 1 month after the end of each 6-month implementation period. |
| Draft Final Report | Short description of achievements including problems encountered and recommendations. | No later than 1 month before the end of the implementation period. |
| Final Report | Short description of achievements including problems encountered and recommendations; a final invoice and the financial report accompanied by the expenditure verification report. | Within 1 month of receiving comments on the draft final report from the Project Manager identified in the contract. |

For the sake of dissemination of project results and possible re-use for similar projects in other countries, the Contractor shall provide the European Commission with electronic copies of all deliverables and any training material prepared under this project.

A final press release, summarizing the achievements of the project, shall be pro¬duced by the Contractor and has to be approved by the EC before publication;

A final presentation meeting for the dissemination of the project results organized by the Contractor. The proposal for such meeting needs approval from the End User and from the Commission in order to ensure the dissemination of the results under an audience as wide as possible. Organization and costs (except the travel expenses of EC representatives) shall be borne by the Contractor (part of incidental expenditure). There¬fore the Contractor shall include a proposal for the organization and attendance of such meeting in his offer as well as a provision for its cost in his financial proposal.

## Submission and approval of reports

Three copies of the reports referred to above must be submitted to the Project Manager identified in the contract. The reports must be written in English. The Project Manager is responsible for approving the reports. The End User shall be involved in commenting on and approving the reports.

# MONITORING AND EVALUATION

The project will be monitored according to standard procedures as the "EU Result Oriented Monitoring Programme for the European Neighbourhood and Partnership Countries and for the Instrument for Nuclear Safety Cooperation (INSC)". Project monitoring and evaluation will be based on periodic assessment of progress on delivery of specified project results and towards achievement of project objectives.

## Definition of indicators

Suitable, objectively quantifiable, Key Performance Indicators related to the project itself and the impact of the project on nuclear safety have been defined by the Contracting Authority, supported as necessary by the Monitoring Consultant, and are presented in the Indicative Framework Matrix (Appendix 1).

## Special requirements

None

# LIST OF ACRONYMS

AAP Annual Action Programme

AEOI Atomic Energy Organization of Iran

AD Action Document

AM Ageing Management

BDBA Beyond Design Basis Accident

BNPP Bushehr Nuclear Power Plant, subsidiary of NPPD

CFD Computational Fluid Dynamics

DBA Design Basis Accident

DEVCO EuropeAid Co-operation Office (EC)

DSA Deterministic Safety Assessment

E3/EU+3 China, Russia, USA / EU + France, Germany, United Kingdom

EC European Commission

EEAS European External Action Service (EU)

ENSREG European Nuclear Safety Regulators Group

EOP Emergency Operating Procedure

EPR Emergency Preparedness and Response (also: EP&R)

ESARDA European Safeguards Research and Development Association

EU European Union

Euratom European Atomic Energy Community

EuropeAid EuropeAid Co-operation Office (EC)

IAEA International Atomic Energy Agency

INRA Iranian Nuclear Regulatory Authority, part of AEOI

INSC Instrument for Nuclear Safety Cooperation (EC)

ISO International Organization for Standardization

JCPoA Joint Comprehensive Plan of Action, agreed between E3/EU+3 and Iran

JRC Joint Research Centre (EC)

JWG Joint Working Group

KPI Key Performance Indicator

KWU Kraftwerk Union

LOCA Loss of Coolant Accident

LOOP Loss of Off-site Power

LTO Long Term Operation

MCCI Molten Core-Concrete Interaction

NAcP National Action Plan (from the Regulatory Authority) (Stress Test)

NIAEP-ASE Nizhny-Novgorad Atomenergoproekt – Atomstroyexport

NNSD National Nuclear Safety Directorate (INRA)

NNSG National Nuclear Safeguards Directorate (INRA)

NPP Nuclear Power Plant

NPPD Nuclear Power Production & Development Company of Iran, subsidiary of AEOI

NRA Nuclear Regulatory Authority

NRPD National Radiation Protection Directorate (INRA)

NSC Nuclear Safety Centre

OJT On-the-job Training

PHARE Poland and Hungary: Assistance for Restructuring their Economies (EC)

PSA Probabilistic Safety Assessment

PWR Pressurised Water Reactor

RA Regulatory Authority

RP Radiation Protection

RR Research Reactor

QA Quality Assurance

SA Severe Accident

SAM Severe Accident Management

SAMG Severe Accident Management Guidelines

SAR Safety Analysis Report

SAST report Self-Assessment Stress Test report (from the Licensee)

SBO Station Blackout

SSC Systems, Structures and Components

ST Stress Test

T&T Training and Tutoring

TACIS Technical Assistance to the Commonwealth of Independent States (EC)

TC Technical Cooperation (IAEA)

ToR Terms of Reference

TSO Technical Support Organisation (to a Regulatory Authority)

UHS Ultimate Heat Sink

VVER Vodo-Vodianoï Energuetitcheski Reaktor (Water-Water Energy Reactor)

WENRA Western European Nuclear Regulators Association

# Appendix 1: Indicative framework matrix

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Intervention Logic** | **Objectively Verifiable Indicators** | **Sources of Verification** | **Assumptions and risks** |
| **Overall Objective** |  |  |  |  |
| **Project Purpose** |  |  |  |  |
| **Activities** |  |  |  |  |
|  |  |  |  |  |

# Appendix 2: INRA stress test specification

# Appendix 3: INRA Contents and Format of the Final Stress Test Report

Post-Fukushima “stress tests” of european nuclear power plants – CONTENTS AND FORMAT OF National Reports

This document is intended to provide guidance for the European Nuclear Regulators and for the European Nuclear Licensees on application of ENSREG document ***Annex I, EU “Stress test” specifications***. It is obvious that each Licensee will in addition take into account the specifications given by his National Nuclear Regulator.

The guidance is given by way of indication. It is liable to be adjusted during the writing and integration of the report (e.g. to summarize aspects to improve comprehensibility of licensee’s explanations). It should be used by the European Nuclear Licensees so that the reports are as homogeneous as possible.

The National Reports shall be written in English and be aimed for full release to the public. They should be detailed enough to give adequate understanding of the robustness of the design but avoid revealing security relevant details. This implies that presenting information on details of systems design and on location and physical protection of equipment should be avoided.

The Licensee Reports are preferably also written in English. These reports should be available as reference material for the peer reviews. They shall provide accurate information as explained in this guidance, including systems details, the plant lay-out, and equipment location. This information could partly be released to the public as identified by the authors, but some parts are evidently sensitive from security point of view. No details must be released that could be used for planning terrorist acts to the plants.

For giving a good overview of the robustness of the design, a comprehensive and detailed description should be presented at the beginning of the report on all systems that could be used for providing or supporting main safety functions. Guidance on this information is given under Section 1.3. This information can then be referred to in later text, without a need to repeat it in detail.

# General data about site/plant

## Brief description of the site characteristics

* location (sea, river)
* number of units;
* license holder

## Main characteristics of the units

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

## Systems for providing or supporting main safety function

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

### Reactivity control

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

### Heat transfer from reactor to the ultimate heat sink

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

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

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

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

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

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

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

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

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

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

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

### AC power supply

#### Off-site power supply

* + - * 1. Information on reliability of off-site power supply: historical data at least from power cuts and their durations during the plant lifetime.
        2. Connections of the plant with external power grids: transmission line and potential earth cable routings with their connection points, physical protection, and design against internal and external hazards.

#### Power distribution inside the plant

* + - * 1. Main cable routings and power distribution switchboards.
        2. Lay-out, location, and physical protection against internal and external hazards.

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

* + - * 1. On-site sources that serve as first back-up if offsite power is lost.
        2. Redundancy, separation of redundant sources by structures or distance, and their physical protection against internal and external hazards.
        3. Time constraints for availability of these sources and external measures to extend the time of use (e.g., fuel tank capacity).

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

* + - * 1. All diverse sources that can be used for the same tasks as the main back-up sources, or for more limited dedicated purposes (e.g., for decay heat removal from reactor when the primary system is intact, for operation of systems that protect containment integrity after core meltdown).
        2. Respective information on location, physical protection and time constraints as explained under 1.3.5.3.

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

* + - * 1. Potential dedicated connections to neighbouring units or to nearby other power plants.
        2. Possibilities to hook-up transportable power sources to supply certain safety systems.
        3. Information on each power source: power capacity, voltage level and other relevant constraints.
        4. Preparedness to take the source in use: need for special personnel, procedures and training, connection time, contract arrangements if not in ownership of the Licensee, vulnerability of source and its connection to external hazards and weather conditions, as well as arrangements for accessing these, including where they are stored (both in relation to the site and protection from potential hazards), and whether they are shared between units or sites.

### Batteries for DC power supply

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

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

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

#### Alternative possibilities for recharging each battery bank.

## Significant differences between units

This section is relevant only for sites with multiple NPP units of similar type.

In case some site has units of completely different design (e.g., PWR’s and BWR’s or plants of different generation), design information of each unit is presented separately.

## Scope and main results of Probabilistic Safety Assessments

Scope of the PSA is explained both for level 1 addressing core meltdown frequency and for level 2 addressing frequency of large radioactive release as consequence of containment failure.

At each level, and depending on the scope of the existing PSA, the results and respective risk contributions are presented for different initiating events such as random internal equipment failures, fires, internal and external floods, extreme weather conditions, seismic hazards.

Information is presented also on PSA’s conducted for different initiating conditions: full power, small power, or shutdown.

# Earthquakes

Both the reactor and spent fuel pools, as well as spent fuel storages at site, are to be considered.

## Design basis

### Earthquake against which the plant is designed

#### Characteristics of the design basis earthquake (DBE)

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

#### Methodology used to evaluate the design basis earthquake

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

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

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

### Provisions to protect the plant against the design basis earthquake

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

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

#### Protection against indirect effects of the earthquake

* + - * 1. Assessment of potential failures of heavy structures, pressure retaining devices, rotating equipment, or systems containing large amount of liquid that are not designed to withstand DBE and that might threaten heat transfer to ultimate heat sink by mechanical interaction or through internal flood.
        2. Loss of external power supply that could impair the impact of seismically induced internal damage at the plant.
        3. Situation outside the plant, including preventing or delaying access of personnel and equipment to the site.
        4. Other indirect effects (e.g. fire or explosion).

### Compliance of the plant with its current licensing basis

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

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

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

## Evaluation of safety margins

### Range of earthquake leading to severe fuel damage

Weak points and cliff edge effects: estimation of PGA above which loss of fundamental safety functions or severe damage to the fuel (in vessel or in fuel storage) becomes unavoidable.

### Range of earthquake leading to loss of containment integrity

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

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

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

### Measures which can be envisaged to increase robustness of the plant against earthquakes

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

# Flooding

Both the reactor and spent fuel pools, as well as spent fuel storages at site, are to be considered.

## Design basis

### Flooding against which the plant is designed

#### Characteristics of the design basis flood (DBF)

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

#### Methodology used to evaluate the design basis flood.

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

#### Conclusion on the adequacy of protection against external flooding

### Provisions to protect the plant against the design basis flood

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

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

#### Main operating provisions to prevent flood impact to the plant.

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

### Plant compliance with its current licensing basis

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

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

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

## Evaluation of safety margins

### Estimation of safety margin against flooding

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

### Measures which can be envisaged to increase robustness of the plant against flooding.

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

# Extreme weather conditions

## Design basis

### Reassessment of weather conditions used as design basis

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

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

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

#### Consideration of potential combination of weather conditions.

#### Conclusion on the adequacy of protection against extreme weather conditions

## Evaluation of safety margins

### Estimation of safety margin against extreme weather conditions

Analysis of potential impact of different extreme weather conditions to the reliable operation of the safety systems, which are essential for heat transfer from the reactor and the spent fuel to ultimate heat sink.

Estimation of difference between the design basis conditions and the cliff edge type limits, i.e. limits that would seriously challenge the reliability of heat transfer.

### Measures which can be envisaged to increase robustness of the plant against extreme weather conditions

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

# Loss of electrical power and loss of ultimate heat sink

For writing Chapter 5, it is suggested that detailed systems information given in Section 1.3 is used as reference and the emphasis is in consecutive measures that could be attempted to provide necessary power supply and decay heat removal from the reactor and from the spent fuel.

Chapter 5 should focus on prevention of severe damage of the reactor and of the spent fuel, including all last resort means and evaluation of time available to prevent severe damage in various circumstances. As opposite, the Chapter 6 should focus on mitigation, i.e. the actions to be taken after severe reactor or spent fuel damage as needed to prevent large radioactive releases. Main focus in Chapter 6 should thus be in protection of containment integrity.

## Nuclear power reactors

### Loss of electrical power

All offsite electric power supply to the site is lost. The offsite power should be assumed to be lost for several days. The site is isolated from delivery of heavy material for 72 hours by road, rail or waterways. Portable light equipment can arrive to the site from other locations after the first 24 hours.

#### Loss of off-site power

* + - * 1. Design provisions taking into account this situation: back-up power sources provided, capacity and preparedness to take them in operation.
        2. Autonomy of the on-site power sources and provisions taken to prolong the time of on-site AC power supply

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

* + - * 1. Design provisions taking into account this situation: diverse permanently installed AC power sources and/or means to timely provide other diverse AC power sources, capacity and preparedness to take them in operation
        2. Battery capacity, duration and possibilities to recharge batteries

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

* + - * 1. Battery capacity, duration and possibilities to recharge batteries in this situation
        2. Actions foreseen to arrange exceptional AC power supply from transportable or dedicated off-site source
        3. Competence of shift staff to make necessary electrical connections and time needed for those actions. Time needed by experts to make the necessary connections.
        4. Time available to provide AC power and to restore core cooling before fuel damage: consideration of various examples of time delay from reactor shutdown and loss of normal reactor core cooling condition (e.g., start of water loss from the primary circuit).

#### Conclusion on the adequacy of protection against loss of electrical power

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

### Loss of the ultimate heat sink

The connection with the primary ultimate heat sink for all safety and non safety functions is lost. The site is isolated from delivery of heavy material for 72 hours by road, rail or waterways. Portable light equipment can arrive to the site from other locations after the first 24 hours.

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

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

* + - * 1. Availability of an alternate heat sink
        2. Possible time constraints for availability of alternate heat sink and possibilities to increase the available time.

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

* + - * 1. External actions foreseen to prevent fuel degradation.
        2. Time available to recover one of the lost heat sinks or to initiate external actions and to restore core cooling before fuel damage: consideration of various examples of time delay from reactor shutdown to loss of normal reactor core cooling condition (e.g., start of water loss from the primary circuit).

#### Conclusion on the adequacy of protection against loss of ultimate heat sink

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

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

#### Time of autonomy of the site before loss of normal reactor core cooling condition (e.g., start of water loss from the primary circuit).

#### External actions foreseen to prevent fuel degradation.

#### Measures, which can be envisaged to increase robustness of the plant in case of loss of primary ultimate heat sink, combined with station black out

## Spent fuel storage pools

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

### Loss of electrical power

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

### Loss of the ultimate heat sink

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

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

#### Measures, which can be envisaged to increase robustness of the plant in case of loss of primary ultimate heat sink, combined with station black out

# Severe accident management

## Organisation and arrangements of the licensee to manage accidents

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

### Organisation of the licensee to manage the accident

#### Staffing and shift management in normal operation

#### Plans for strengthening the site organisation for accident management

#### Measures taken to enable optimum intervention by personnel

#### Use of off-site technical support for accident management

#### Procedures, training and exercises.

### Possibility to use existing equipment

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

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

#### Management of radioactive releases, provisions to limit them

#### Communication and information systems (internal and external).

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

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

#### Loss of communication facilities / systems

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

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

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

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

#### Unavailability of power supply

#### Potential failure of instrumentation

#### Potential effects from the other neighbouring installations at site, including considerations of restricted availability of trained staff to deal with multi-unit, extended accidents.

### Conclusion on the adequacy of organisational issues for accident management

### Measures which can be envisaged to enhance accident management capabilities

## Accident management measures in place at the various stages of a scenario of loss of the core cooling function

### Before occurrence of fuel damage in the reactor pressure vessel/a number of pressure tubes (including last resorts to prevent fuel damage)

### After occurrence of fuel damage in the reactor pressure vessel/a number of pressure tubes

### After failure of the reactor pressure vessel/a number of pressure tubes

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

### Elimination of fuel damage / meltdown in high pressure

#### Design provisions

#### Operational provisions

### Management of hydrogen risks inside the containment

#### Design provisions, including consideration of adequacy in view of hydrogen production rate and amount

#### Operational provisions

### Prevention of overpressure of the containment

#### Design provisions, including means to restrict radioactive releases if prevention of overpressure requires steam / gas relief from containment

#### Operational and organisational provisions

### Prevention of re-criticality

#### Design provisions

#### Operational provisions

### Prevention of basemat melt through

#### Potential design arrangements for retention of the corium in the pressure vessel

#### Potential arrangements to cool the corium inside the containment after reactor pressure vessel rupture

#### Cliff edge effects related to time delay between reactor shutdown and core meltdown

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

#### Design provisions

#### Operational provisions

### Measuring and control instrumentation needed for protecting containment integrity

### Capability for severe accident management in case of simultaneous core melt/fuel damage accidents at different units on the same site

### Conclusion on the adequacy of severe accident management systems for protection of containment integrity

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

## Accident management measures to restrict the radioactive releases

### Radioactive releases after loss of containment integrity

#### Design provisions

#### Operational provisions

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

#### Hydrogen management

#### Providing adequate shielding against radiation

#### Restricting releases after severe damage of spent fuel in the fuel storage pools

#### Instrumentation needed to monitor the spent fuel state and to manage the accident

#### Availability and habitability of the control room

### Conclusion on the adequacy of measures to restrict the radioactive releases

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

1. *Vodo-Vodianoï Energuetitcheski Reaktor or* *Water Water Energy Reactor* [↑](#footnote-ref-1)