Ministry of Economic Affairs and Climate Policy of the Netherlands

assystem

WORKSTREAM 1 – TECHNOLOGY & LICENSING

Appendix to TFS Scope of Work & Deliverables

Contents

1. Purpose

This document is an appendix to the Technical Feasibility Study - Scope of Work & Deliverables. It describes the deliverables expected from the Vendor with regards to Technology and Licensing:

- Issuance of Concept Safety Document (Pre-PSAR) / compliance to Dutch regulation (ANVS)
- Presentation of Proposed Plant (Reference Plant + changes)

For the sake of clarity, conventional (non-nuclear) permitting such as the EIA are covered under Workstream 2 Site Specifics.

2. References

[1] ANVS Memo - Scope and content for a Conceptual Safety Document
[2] ANVS Guidelines for the Safe Design and Operation of Nuclear Reactors
[3] European Requirements for Generators and the translation into the Dutch Netcode Electricity/ Requirements for Generators (RFG): EUR-Lex - 32016R0631 - EN - EUR-Lex (europa.eu)
[4] Tennet : Netcode Electricity: https://wetten.overheid.nl/BWBR0037940/2022-12-18

3. Terms and definition

AC	Alternating current (frequency)
AOO	Anticipated Operational occurrences
ALARA	As low as reasonably achievable
ANVS	Autoriteit Nucleaire Veiligheid en Stralingsbescherming
BOP	Balance of plant
BOC	Beginning of Cycle
CSD	Conceptual Safety Document
CDF	Core damage frequency
DBT	Design basis threat
DiD	Defense in depth
DBA	Design basis accident
DSA	Deterministic safety analysis
FP	Full Power
EOC	End of Cycle
EPZ	Emergency planning zone
IAEA	International Atomic Energy Agency
I&C	Instrumentation and control
Keff	Effective multiplication factor
LRF	Large Release Frequency
MOX	Mixed oxide
NPP	Nuclear power plant
NSSS	Nuclear steam supply system
O&M	Operation and maintenance
OPEX	Operational experience

PSA	Probabilistic safety assessment
PWR	Pressurized water-cooled reactor
QA	Quality assurance
SNM	Special nuclear materials
SSC	Systems, structures, and components
V&V	Verification and validation
VOBK	Veilig Ontwerp en het veilig Bedrijven van Kernreactoren

4. Scope

The following Work Packages are identified under the "Technology & Licensing" Workstream 1:

- WP 01: Licensing,
- WP 02: presentation of proposed technology.

The Vendor shall avoid duplicating the information provided under WP 01 in 02.
In each WP, the data relevant for the economic model in the Workstream 3 shall be clearly identified.

5. Licensing / Conceptual Safety Document (WP 01)

ANVS issued on April 7th 2023 a memo presenting the scope and content of a Conceptual Safety Document (CSD). This document is construed as a preliminary PSAR to ensure both that the Vendor has properly understood the Dutch regulations and that ANVS can pre-assess (without prejudice) the licensability of the Vendors design.

Transcription of the memo "Scope and content for a Conceptual Safety Document" from ANVS to EZK dated April 7, 2023:

An important part of the licensing for new nuclear reactors is a document called the preliminary safety analysis report (PSAR). This is an elaborate document giving the full design of the reactor systems and associated safety aspects, which can be used to assess the safety demonstration and to decide on the approval for building the reactor (the construction license).

Prior to the PSAR, it is useful to have some form of document which can be used to give insight and reach agreement on specific design considerations at an early stage. Hence it is considered a good practice to have some form of an early safety demonstration document. In this note, the term 'Conceptual Safety Document' (CSD) is used.

The goal of this CSD is twofold. First, it allows the ANVS to familiarize themselves with the design in an early stage. Secondly it allows the designer of a reactor to explain their design in light of requirements from Dutch regulation and highlight topics for discussion. For example, because an alternative to the Dutch guidelines for safe design and operation of nuclear reactors1 is proposed by the designer.

This note gives the ANVS perspective on what would be useful in terms of scope and content for such a document. The structure compares to the expected structure of the PSAR (SSG-61: Format and Content of the Safety Analysis Report for Nuclear Power Plants) as follows:

- The sections 'Introduction and general considerations', 'Safety objectives and design rules for structures, systems, and components' and 'Safety analysis' form the basis for the CSD.
- For the technical design chapters, the systems (reactor, cooling, electrical systems etc.) themselves are briefly described in section 1) and their general requirements in section 2).
- The operational sections have been left out, as their content would not impact the design in general and as such the information from those sections is less useful in the early stage.
- The site related characteristics have been left out as they aren't delivered by the vendor at this stage. Hazard tolerance limits are included under design objectives to allow for comparison with site characteristics.

The expected scope and content of the conceptual safety document is as follows:

a) General description

- *Introduction and general description of the power plant design, including a short description of main systems significant for safety: fuel (including proposed fuel cycle), core layout, primary and secondary cooling systems, reactivity control, power supply, containment, engineered safety features.*
- *Introduction to the vendor organization including existing licensing and safety assessment experience, as well as any important safety related lessons from earlier projects which are incorporated in the design.*
- *General compliance to the technical guidelines of the ANVS (VOBK).*

b) Design requirements

- *Implementation of Defense in Depth in the design, as described in the EU EURATOM directive 2014/87, art. 17, and the proposed methodology for safety classification of SSC's.*
- *General requirements for redundancy, diversity, and physical separation for the SSC's mentioned in the general description, based on Defense in Depth/ Safety Classes derived from the methodology described above.*
- *General protection concept and tolerance limits for internal and external hazards and events (i.e., what kind of seismicity, levels of flooding etc. are considered) and the approach to mitigate core melt incidents.*

c) Safety analysis

- *Proposed scope and methodology for the various assessments, including DSA, PSA, failure and/or (radiological) hazards analysis and acceptance criteria with respect to core melt frequency, population risks (individual and societal risks), (operational) radiation exposure and/or other quantitative acceptance criteria.*
- *Information on security measures: any information on resiliency against human induced events such as air plane crash (including assumed event accounted for in the design).*
- *Vendor proposal on how to prove that a large or unauthorized release of radioactive material is extremely unlikely (i.e., practical exclusion of large early releases) as described in EU EURATOM directive 2014/87, article 20.*

It is important to state that it is not necessary to adhere strictly to this structure. The writer is explicitly encouraged to make use of any existing documentation. As long as the presentation of the content is adequate for the aforementioned goals, any structure of the CSD is acceptable. In terms of level of detail, it is expected that the mentioned topics are treated comprehensively yet concise, allowing the reader to grasp the safety impact without spending too much time and effort.

Signed ANVS.

Regarding the General description (§a), last bullet point), the Vendor is requested to assess his compliance to the “Guidelines for the Safe Design and Operation of Nuclear Reactors” (Veilig Ontwerp en het veilig Bedrijven van Kernreactoren or “VOBK”). Those guidelines are subject to a “comply or explain” principle.

The Vendor shall review them in detail and demonstrate compliance or explain deviations as per attached compliance matrix:

a) State if the proposed design is compliant with ANVS requirement.
b) Explain the compliance of the proposal, in particular if compliance constitutes a change to the Reference Design.
c) Explain any non-compliance (rationale, benefits, safety guarantees).
d) Detail the changes to the Reference Design to meet ANVS requirements. The Vendor is encouraged to identify also changes to non-nuclear Dutch regulation. The cost and schedule impact shall be reported in Workstream 3 – NPP Delivery Model Economics (Appendix to the TFS specification)

The justification for each criteria can be provided in a separate document or justification notes. In case of compliance, high level presentation is sufficient. In case of non compliance, the level of detail shall be adapted to ensure adequate explanation.

Compliance matrix to VOBK requirements

TECHNOLOGY & LICENSING COMPLIANCE TEST

GUIDELINES FOR THE SAFE DESIGN AND OPERATION OF NUCLEAR REACTORS (ANVS)

	TOPICS OF THE ANVS GUIDELINES	Compliance of proposal to ANVS (y/n)	Explanation of compliance	Explanation of non compliance (rationale, benefits, safety guarantees)	Design change required (y/n-description
1	OBJECTIVES				
2	TECHNICAL SAFETY CONCEPT				
	1 Defence in depth concept				
	2 Concept of multi-level confinement				
	3 Concept of the fundamental safety functions				
	4 Evaluation of the site characteristics				
	5 Concept of protection against internal and external hazards				
	6 Radiological safety obligations				
3	TECHNICAL REQUIREMENTS				
	1 Overall requirement				
	2 Design of the reactor core and the shutdown systems				
	3 Systems for fuel cooling				
	4 Reactor coolant pressure boundary and the "external systems"				
	5 Buildings				
	6 Containment system				
	7 Instrumentation and Control system				
	8 Control rooms and emergency response facilities				
	9 Electrical power supply				
	10 Handling and storage fo the fuel assemblies				
	11 Radiation protection				
	12 Waste management				
4	POSTULATED OPERATING CONDITIONS AND EVENTS				
	1 Operating conditions, anticipates occurrences and accidents (level 1 to 3a of DiD)				
	2 Events involving multiple failures of safety systems (level 3b of DiD)				
	3 Accident with core melt (level 4 of DiD)				
	4 Internal and external hazards				
5	REQUIREMENTS FOR THE SAFETY DEMONSTRATION				
6	REQUIREMENTS FOR THE OPERATING RULES				
7	REQUIREMENTS FOR THE DOCUMENTATION				
An1	POSTULATED EVENTS				
1	OBJECTIVES AND SCOPE				
2	GENERAL REQUIREMENTS FOR SAFETY DEMONSTRATION				
3	ACCEPTANCE TARGETS AND CRITERIA				
4	GENERIC review the list				
An2	REQUIREMENTS FOR THE PROVISIONS AND PROTECTION AGAINST HAZARDS				
1	PROTECTION CONCEPTS FOR PLANT INTERNAL AND EXTERNAL HAZARDS				
2	PREVENTIVE MEASURES				
3	INTERNAL HAZARDS				
	1 Basic requirements				
	2 Hazards specific requirements				
4	EXTERNAL HAZARDS				
	1 Basic requirements				
	2 Event specific requirements				
	Natural Hazard				
	Human Induced Hazard				
An3	SINGLE FAILURE CRITERION AND MAINTENANCE				
1	Single failure concept-basic principles of the application of the single failure criterion				
2	Application of the single failure concept				
	1 General Requirements				
	2 Redundancy requirements for items important to safety for operating phases A and B				
	3 Redundancy requirements for items important to safety for operating phases C to F				
	4 System and component specific requirements for the application of the single failure criterion				
3	Maintenance and modification				
	1 General requirement for maintenance				
	2 Maintenance procedure for achieving the specified nomal condition				
	3 Preventive maintenance of items important to safety				
4	Ensuring the functional standby of items important to safety				
An4	SAFETY DEMONSTRATION AND DOCUMENTATION				
1	Objective and scope				
2	System assessment				
3	Deterministic analysis of events and conditions				
	1 Validation of analysis methods				
	2 Specifications regardign initial and boundary conditions as well as the scope of safety demonstration				
	3 Quantification of uncertainties of results				
	4 Conservative safety demonstration				
4	Safety demonstration by measurements				
5	Engineering judgement				
6	Probabilistic safety analyses				

6. Presentation of the proposed technology

The Vendor shall present its proposed nuclear technology to:

- Identify the performances and risks relevant for the economic model,
- Identify the change to the Reference Design to comply to Dutch regulations and the designated construction site.
- Enable the Owner to prepare a BIS after the TFS.

Preferably, this presentation shall be structured as per the IAEA NG-T-3-9 “Invitation and evaluation of Bid for Nuclear Power Plants” and shall focus on:

<u>3.7 “General Technical Requirements”</u>

1- General design characteristics
2- Safety and licensing
3- Operation and maintenance
4- Waste handling and decommissioning
5- Safeguards
6- Security and physical protection
7- Emergency preparedness

<u>3.8 “Structure Systems and components”</u>

1- Nuclear Island

<u>3.9 “Scope of supply and services”</u>

8- Nuclear fuel cycle supplies and services

The Vendor shall use the comprehensive questionnaire in annex as guideline and checklist in the presentation of its technology and Proposed Plant. This questionnaire is based on Assystem’s experience in designing and assessing reactor technologies, and on relevant IAEA documentations such as IAEA SSR-2/1 (Rev. 1) “Safety of Nuclear Power Plant: Design” and IAEA NG-T-3.9 “Invitation and evaluation of Bid for Nuclear Power Plants”. The Vendor can provide existing and/or reference documentation provided that all questions are addressed. Hence, a line-by-line answer is not requested.

Regarding non-nuclear Structures Systems and Components such as the Conventional Island and the Heat Sink, the Vendor shall provided typical documentation to explain the Operation & Maintenance costs under WS3.

If a subject has already been detailed in the previous paragraphs (compliance to regulation, Pre-PSAR), the Vendor can repeat the information or reference the previous description.

For decommissioning, security and physical protection and nuclear fuel cycle typical information from past experience is sufficient.

Annex 1 – Questionnaire about proposed technology

NG-T-3- 9	Topic	Question
3.7 GENERAL TECHNICAL REQUIREMENTS		
1-GENERAL DESIGN CHARACTERISTICS	Main design characteristics	What is the core thermal power (MWth) at 100% FP?
	Main design characteristics	What is the value of the net electrical (MWe) at 100% Full Power (FP)?
	Main design characteristics	What is the design lifetime of the Proposed Plant?
	Main design characteristics	What is the reactor fuel enrichment level for the proposed fuel cycle length?
	Main design characteristics	What are the principal design criteria that are incorporated in the design of the Proposed Plant?
	Main design characteristics	What are the values of the reactivity coefficients (e.g., fuel temperature coefficient, power coefficient of reactivity) both at the beginning and the end of the first cycle for different conditions?
	Main design characteristics	Vendor to provide the reactivity coefficients including the fuel temperature and power coefficient of reactivity for normal, hot shutdown and cold shutdown conditions at the Beginning of Cycle (BOC) and End of Cycle (EOC)
	Main design characteristics	Value of the prompt neutron lifetime (Λ)?
	Main design characteristics	Value of the delayed neutron fraction (β)?
	Main design characteristics	What is the limit on the calculated k-effective value established to ensure that conditions calculated to be subcritical will actually be subcritical (i.e., upper Subcritical Limit)
	Main design characteristics	What is the value of the k-eff of the core during refueling? Also, which neutron poison (e.g.; Gadolinium, Boron) is used to maintain the reactor subcritical during the core refueling?
	Technology&Design	What is your design shutdown margin, including uncertainties, for normal operation (hot and cold shutdown). Also, explain how your shutdown margin is calculated

	Technology&Design	Does the design allow for flexibility with different fuels, such as MOX, thorium, and higher enriched fuel?
	Technology&Design	What are the average and maximum fuel burnup values?
	Technology&Design	What are the design and licensing features that limit fuel burnup?
	Technology&Design	What part of MOX can be used in the reactor (e.g., 30%, 40%)?
	Technology&Design	How many spent fuel assemblies can be stored in the spent fuel pool?
	Technology&Design	For how many years of operation does the plant have a storage capacity of spent fuel assemblies?
	Technology&Design	Is it possible to increase the storage capacity of a spent fuel pool in the future?
	Technology&Design	For how long can the spent fuel assemblies be stored in the selected spent fuel storage system?
	Technology&Design	Which type of inspection of the spent fuel storage system is needed and at what frequency is the inspection planned/required?
	Technology&Design	Typically, what are the necessary examinations of a long term spent fuel storage?
	Technology&Design	Typically, when is it possible to have dry storage for spent fuel?
	Technology&Design	What is your overall approach for incorporating the Defense in depth (DiD) concept in the reactor design?
	Technology&Design	What is your safety design philosophy to implement redundancy, separation and diversity between different DiD levels?
	Technology&Design	What are the general safety design criteria with regard to emergency core cooling system capacity, single failure/redundancy, diversity, separation and independence as it relates to reactor trip and emergency cooling?
	Technology&Design	What conditions should be satisfied in the design to avoid core damage and/or fuel pool failure following sustained loss of the Ultimate Heat Sink?
	Technology&Design	Is the spent fuel pool stored above ground or in ground?
	Technology&Design	What are the design features and procedures defined in your design to assure equipment qualification will be maintained during the plant life?
	Technology&Design	What specific features are included in the design to facilitate desired continuous monitoring of reactor power levels and other important operating parameters needed to verify fuel loading burnup?

	Technology&Design	What specific features are included in the design to facilitate detection and monitoring of significant reactor operations that could affect special nuclear materials (SNM) accounting and control?
	Technology&Design	What are the separation, redundancy and diversity features that are applied to the plant Instrumentation and control systems?
	Technology&Design	Under which International Commission on Radiological Protection standards was the NPP designed?
	Technology&Design	What are your design and operational considerations for maintaining occupational radiation exposure ALARA?
	Technology&Design	What are the sources of radiation that form the basis for shielding design calculation?
	Technology&Design	Which external events are considered in the design of the main BOP buildings and what are the associated design criteria and margins?
	Technology&Design	How have severe external events or multiple external/internal events been considered in the design and operating procedures?
	Technology&Design	What provisions are taken to protect the switchyard and its supplies from external events?
	Technology&Design	What provisions are taken to avoid turbine damage, which could generate a turbine missile?
	Technology&Design	What is the maximum fuel cladding temperature during normal operating condition and anticipated Operational occurrences (AOOs)
	Technology&Design	Does nucleate boiling occur during normal operation and anticipated operational occurrences? Please elaborate.
	Technology&Design	What is the number of fuel assemblies in the reactor?
	Technology&Design	What are the transport and handling operations due to fuel reloading?
	Technology&Design	Is it possible to detect damaged assemblies during the outage?
	Technology&Design	Is it possible to examine all the fuel assemblies during the outage?
	Technology&Design	What is the expected fuel cycle outage duration?
	Technology&Design	Is the melting point of the UO2 reached during anticipated operational occurrences?
	Technology&Design	Are there any conditions under which the reactor is unable to preclude the possibility of power level oscillation? Elaborate

	Technology&Design	What experience do you have with different fuel cycles (18-24 months) used in this reactor or in similar reactors?
	Technology&Design	What is the capacity factor during operation of the Proposed Plant?
	Technology&Design	What is the Nuclear Power Plant (NPP) net thermal efficiency in normal full power and load following operations?
	Technology&Design	What is the rationale that the proposed turbine system is optimal to the proposed reactor in terms of the net thermal efficiency?
	Technology&Design	What are the considerations in design to maximize the net thermal efficiency to adjust short term environmental temperature change (summer versus winter) and long-term environmental temperature change (global warming effect)?
	Technology&Design	What average NPP availability and capacity factors that are expected to be achieved for the local conditions in the Netherland?
	Technology&Design	What changes have been made to address past limitations to improve NPP availability and capacity factors?
	Technology&Design	What is the demonstrated in-plant operational experience for major nuclear steam supply system (NSSS) systems and components? How many years of operation?
	Technology&Design	What are the major contributors to planned and unplanned capacity loss?
	Technology&Design	Is it possible to insert a steam extraction at the steam turbine (200MWthermal) for high temperature electrolysis (HTSE)?
2-Safety & Licensing	Safety	What is the seismic design of the Proposed Plant?
	Safety	Specify if the design takes into account the potential impact of a large commercial aircraft. Is the integrity of the fuel pool maintained during an aircraft impact (large commercial aircraft)?
	Safety	What are the provisions made to ensure that the concentration of hydrogen from reaching the lower flammability limit of 4% by volume in air or steam-air mixtures in the containment in the event of a sever accident?
	Safety	What is the core damage frequency (CDF) associated with internal and external events?

	Safety	What is the Large Release Frequency (LRF) associated with internal and external events?
	Safety	What is your safety design philosophy to minimize human errors (from conceptual to operation)?
	Safety	Are there any conditions under which the fuel coolability cannot be maintained?
	Safety	Is the NPP designed to maintain safe shutdown (cold shutdown) conditions in the event of a postulated design basis accident? Elaborate
	Safety	What is the approach to incorporate redundancy, train separation and diversity of sensors or other components for initiating safety functions (e.g., reactor trip, emergency cooling) into the plant design?
	Safety	What are the heat sinks that are diverse from emergency core cooling and what is the ultimate heat sink where available? Explain separation, redundancy, diversity from sensors to cooling source to final elements for the additional heat sinks among each other and the Emergency core cooling
	Safety	Which internal and external events are considered in the design of the nuclear island and what are the associated design criteria and margins?
	Safety	Have you considered multi-unit effects due to hazards in the design and PSA calculation?
	Safety	Does the plant PSA include contributions from internal and external hazards?
	Safety	Following loss of offsite power, how long can the station operate on local power and water resources? Provide an explanation of the actions taken following loss of off-site power to account for this operation duration.
	Safety	What are the systems in place to maintain core cooling in the event of loss of AC power? Specify the capability, source of power and operating time and the diversity of these systems from each other.
	Safety	How long can the plant operate before start of core damage on total loss of AC and DC power?
	Safety	What is the operator action time to put in place off-site power following total loss of AC power and on-site emergency diesel generators?
	Safety	Does your system design include an offsite power source to make it available to the station following station blackout (total loss of on-site AC and emergency diesel generators)? What is its qualifications and time to bring it into operation?

	Safety	Which levels are covered by the PSA?
	Safety	What are the safety performance features of the primary reactor coolant system loop (conventional or integrated) adopted in the NPP design?
	Safety	Are there any conditions under which the plant could have a positive coefficient of reactivity (e.g. moderator temperature)? If so, what is the justification and control of this condition?
	Safety	What are the margins to dose limits for the NPP design?
	Safety	What are the barriers to fission product release in the NPP design?
	Safety	Demonstrate that means of shutdown are adequate to prevent any foreseeable increase in reactivity leading to unintentional criticality during the shutdown, or during refueling operations or other routine or non-routine operations in the shutdown state
	Safety	How did you validate the following physical phenomenon: Coolant-void-Change Induced Reactivity and Fuel-Isotopic-Composition-Change Induced Reactivity?
	Safety	What is the maximum temperature and pressure inside the containment during the most limiting design basis accident (e.g., Main Steam Line break accident)?
	Safety	Will the integrity of the containment be impacted under any postulated accident scenario?
	Safety	What are the severe accident mitigation systems and how are they redundant to and diverse from other safety and operating systems?
	Safety	What systems are included in the design specifically to minimize the consequence of potential severe accidents?
	Safety	What specific post core damage management is implemented (e.g., in-vessel melt retention, ex-vessel core cooling with core catcher)?
	Safety	What specific combustible gas management is implemented in containment (e.g., ignitors, mixing, venting, passive autocatalytic recombiners)?
	Safety	In the event of severe core damage, what measures are available to prevent containment failure?
	Safety	Describe expectations for severe accidents on-site and off-site response. What systems and equipment are needed for severe accident on-site and off-site response?

	Safety	Describe the capability of safety systems in terms of the grace period for operator action and available off-site power during a station blackout (loss of all AC power and emergency diesel generators) and for other major events
	Safety	Does the NPP design include connection points to allow use of portable supplies of cooling water and electrical power?
	Safety	Is there alternate cooling in the spent fuel pool in the case of a loss of integrity?
	Safety	Is a neutron absorber required to ensure subcriticality in the spent fuel pool? If yes, what type of neutron absorber and what is the concentration (in ppm) of this neutron absorber.
	Safety	Is hydrogen generation possible in the event of a loss of coolant or loss of cooling and how is it mitigated?
	Safety	What is the design margin to extend major components such as reactor vessel beyond the plant design life? List similar components and specify their design margin and potential replacement costs.
	Safety	What are the actions taken as a result of significant events such as Fukushima?
	Safety	What nuclear safety and operational reliability improvements have been made to the design as a result of the accident at the Fukushima Daiichi nuclear power plant and other accidents?
	Safety	What is the fuel tolerance to accidents?
	Safety	What OPEX program do you have in place for your technology?
	Safety	What programme do you have in place to address material science and ageing in power plant components?
	Safety	Are the computer codes used for design and safety analysis validated? If yes then:
	Safety	A) Have you developed a validation manual?
	Safety	B) Which method are you using to establish uncertainties and biases in you validation manual?
	Safety	What is the range of applicability and qualification of your main computer codes used in the design?
	Licensing	Which regulatory agencies have approved/are approving (and/or certified) this design? What are the

		ongoing or recent major licensing issues being addressed?
	Licensing	Does the design make exceptions to any IAEA safety standards?
	Licensing	What is the licensing history of the design in the country of origin or other countries?
	Licensing	What licensing has been completed for site, construction and operation in other countries?
	Licensing	What are the Design Licensing Design Basis of the Proposed Plant?
	Licensing	To what extent has standardization of equipment and components of the nuclear power plant been addressed in the licensing process?
	Licensing	Which international or national regulations/guidance (including the IAEA safety standards) has the design been assessed against?
	Licensing	Has the design been certified/reviewed by other national or international organizations?
	Licensing	What regulatory or peer reviews have been conducted on the PSA methodology, analyses and results?
	Licensing	Describe how the exclusion zone boundary is established including the regulatory requirements (primarily the radiation protection regulations) that have been considered?
	Licensing	Confirm that the exclusion zone will be sustainable for the full lifecycle of the facility?
	Licensing	Is the shutdown system capable of maintaining the reactor subcritical by adequate margin and with high reliability?
	Licensing	Demonstrate that the fuel elements and fuel assemblies and their supporting structures for the nuclear power plant are designed so that, in operational states and in accident conditions other than severe accidents, a geometry that allows for adequate cooling is maintained and the insertion of control rods is not impeded
	Licensing	How long the site can operate without external supply of water or diesel fuel under loss of off-site power?
	Licensing	Specify the capabilities of a steam driven safety system (if any), emergency power supplies (including DC power) and diverse or redundant safety systems (including electric and non-electric cooling systems) in the event of loss of AC power?

	Licensing	Do the codes and standards used in the design and test of the waste management systems aligned with applicable codes and standards in the Netherland? If no, specify how you will address any discrepancy.
	Licensing	Are the Waste Management Systems designed to keep occupational exposures as low as reasonably achievable (ALARA).
	Licensing	Has the plant digital control, safety and display system and architecture been licensed in the country of origin?
	Licensing	What are the licensing criteria and approaches that have been taken for this design? Prescriptive, deterministic arguments, probabilistic arguments?
	Codes & Standards	Provide the list of applicable guidelines, codes and standard used for design and nuclear safety (e.g., IAEA Safety Standards Series No. SSR-2/1, SSR-2/2, other specific codes & standard)?
	Codes & Standards	Under which International Commission on Radiological Protection standards was the NPP designed?
	Codes & Standards	What are the national and international standards that are called for in the management system?
	Codes & Standards	Does the plant Instrumentation and control system meet the requirements of IEC 61513 and other IEC applicable standards?
	Codes & Standards	Which quality assurance codes (e.g., ASME-NQA-1, ISO, others) were used in the design of the Proposed Plant?
	Design Changes	The Vendor shall provide the list of design changes necessary to adapt the Reference Design to the site conditions and/or to meet technical and Dutch regulatory requirements (categorized as safety related and non-safety related).
	Design Changes	What is/are the driver(s) for each design change?
	Design Changes	Do the proposed design changes meet their relevant objectives and regulatory acceptance criteria? Elaborate
	Design Changes	The Vendor shall provide any design changes to critical safety systems, structures, and components (SSCs) and identify the impact of these changes on several aspects (e.g., design change may affect the size of the reactor building or cause the redesign of portions of SSCs).
	Design Changes	The Vendor shall identify the safety implications that may arise from identified design changes

	Design Changes	Vendor shall provide cost adjustments that will need to be made to the Reference Design model to account for design changes and obsolescence.
	Design Changes	What is the impact of design changes on the project schedule and cost?
	Design Changes	Vendors to describe the approval process of the design changes
	Design Changes	Vendor to explain how the configuration management of relevant documentation (e.g., design, specifications) are maintained
	Design Changes	Vendor to describe how the approved design changes are controlled
	Design Changes	Are there any fuel design changes that are being proposed for this reactor design that have not been demonstrated through industry experience?
	Design Changes	Do you have design changes to extend the fuel cycle length and what is the present fuel cycle length?
	Design Changes	What other improvements have been made to the design as a result of regulatory or internal/external design reviews in the past five years?
	Design Changes	What changes have been made to address past limitations to improve NPP availability, capacity factors and net output?
	Design Changes	What are the anticipated design changes required to simplify plant maintenance and/enhance operation, safety and control?
	Design Changes	What is the obsolescence strategy adopted for the plant control, display and protection system?
	Design Changes	Under what conditions does the Vendor involve external reviewers (not part of the vendor staff) to take part in peer reviews of the plant systems and their design changes?
3-Operation and Maintaince	Operability, Maintainability	How many people are needed to operate the NPP?
	Operability, Maintainability	How many people are needed to maintain the NPP?
	Operability, Maintainability	What is the average number of annual days required for maintenance?
	Operability, Maintainability	What is the number of maintenance days outside planned outages?
	Operability, Maintainability	What are the maintenance activities and their frequencies that require an outage outside of the normal refueling outages?
	Operability, Maintainability	What are the key components that affect overall plant availability and what are their mean time between failure and mean time between maintenance?

	Operability, Maintainability	Typically, what part of maintenance is done by the operator?
	Operability, Maintainability	Typically, what part of maintenance is done by specialized companies?
	Operability, Maintainability	How have adequate space and access requirements for efficient maintenance been assured in this design?
	Operability, Maintainability	What is your on-line and offline maintenance program and its experience base?
	Operability, Maintainability	What is the average duration of the refueling outages?
	Operability, Maintainability	What support is available after plant commissioning, including plant operation and maintenance?
	Operability, Maintainability	Which other maintenance operations require an outage? What is the periodicity? For how long? Can they be done during the refueling outage? Could you provide a maintenance / major overhaul schedule?
	Operability, Maintainability	What are the impacts on cost and maintenance for a reactor practicing load following?
	O&M	What are the assumptions regarding the availability of replacement components, materials, equipment and parts? What assurance is provided regarding the availability of suppliers or commonality of replacement supply?
	O&M	What is the extent of standardization used for the supply of equipment, materials and components?
	O&M	Does the plant Instrumentation and control architecture allow the use of alternate hardware/software platforms without changes to the architecture?
	O&M	What is the digital Instrumentation and Control expected life from reactor 100% full power operation and number of years of available spare parts?
	O&M	What are the features included in the plant instrumentation and control system to identify component failures and how fast can they be discovered?
	O&M	What constraints are provided during the maintenance and repair of control components and to what extent maintenance can be done without affecting normal operation?
	O&M	What is the extent of the integration of the actual plant digital I&C with the plant simulator and will it be available for operator training?
	O&M	Will the plant owner have the ability to modify the plant control design and perform required V&V independent for the digital I&C supplier?

	Grid / Flexibility	What are the grid interface requirements and expectations?
	Grid / Flexibility	What is the load following capability (range of %FP, %FP ramp up/mn, effect on fuel, constraints etc.) of the plant?
	Grid / Flexibility	How much additional capacity is needed for the backup power source in the grid system to accommodate the additional generating capacity for the planned NPP site?
	Grid / Flexibility	What are the actions taken by the plant in response to grid frequency fluctuations, and to short term grid power interruptions?
	Grid / Flexibility	What is the operational state of the plant following total loss of offsite Power?
	Grid / Flexibility	What is the load rejection of plant without going to shutdown?
	Grid / Flexibility	Are there any requirements for the emergency power systems on the grid?
	Grid / Flexibility	What design changes are anticipated to your standard plant design to comply with the Dutch grid frequency and allowable variations in voltage and frequency?
	Grid / Flexibility	What is the capability of the plant for grid faults?
	Grid / Flexibility	Does the plant have required capability of frequency sensitive mode?
	Grid / Flexibility	What is the capability of the plant for island mode on loss of grid?
	Grid / Flexibility	What are the safety features that are designed specifically for the operation in load following mode?
	Grid / Flexibility	What is your experience with the load following operation?
	Grid / Flexibility	What are the operational margins of the NPP design during normal full power and load follow operation?
	Grid / Flexibility	Does operation in load following increase the waste generated? Specify the additional waste and percentage changes?
	Grid / Flexibility	Are there any concerns on fuel mechanical conditioning and capability during load following (e.g., pellet–cladding interaction, stress corrosion cracking)
	Grid / Flexibility	In how many minutes can the reactor reduce its production by 50% or 80%?
	Grid / Flexibility	What are the cost impacts (fuel, maintenance, waste etc.) resulting from load following operation (assumption: one daily cycle from 100 to 50% load, [2 hours down from 100% to 50%, followed by 2hours stable at 50% and 2 hours back from 50% to 100%])?

4-Waste handling and decommissioning	Waste Management	What other materials, beside fuel, require special consideration in terms of waste issues or supply?
	Waste Management	What is the expected annual waste volume of solid, liquid and gaseous waste?
	Waste Management	Have you made any design changes to minimize the typical quantity of radioactive waste generated by the NPP?
	Waste Management	Which codes and standards are used to design and test the waste management systems?
	Waste Management	What are the design bases of waste management systems?
	Waste Management	What are the provisions made in the design to reduce personnel exposure to radiation?
	Waste Management	Confirm that the Solid Waste Management System is designed with sufficient storage and capacity to accommodate the maximum anticipated volume?
	Waste Management	What is the expected source term (i.e., annual releases from the plant to the environment on an average basis)? Also, how this source term is established?
	Waste Management	Demonstrate that the waste management systems are designed with sufficient storage and capacity to accommodate the maximum anticipated volume?
	Waste Management	After how many years is it possible to transfer fuel to a deep geological repository?
	Waste Management	Do you consider any fuel failure in your waste management calculation (e.g., reactor coolant fission product source term)? Elaborate.
	Waste Management	Are there any radionuclides which enter the secondary system from the primary system via potential steam generator tube leakage? If yes, provide the name and concentration of these radionuclides.
	Waste Management	What is the maximum activity of tritium produced per cycle from activation in the reactor coolant?
	Decommissioning	Do you have experience in costing decommissioning projects? If yes, please provide:
	Decommissioning	a) Estimated cost for the decommissioning of NPP
	Decommissioning	b) your estimating methodology
	Decommissioning	Provide the expected duration of decommissioning stages (e.g., facility shutdown) of the NPP
	Decommissioning	What is the quantity and category (e.g., Low level waste) of waste resulting from decommissioning?
	Decommissioning	What lessons learnt in costing and best practices can be gained from completed decommissioning project?

	Decommissioning	Provide the estimated schedule for the decommissioning of the NPP?
	Decommissioning	What would be the preferred and cost-effective decommissioning and dismantling Strategy? Elaborate
5-Security and Physical Protection	Security Physical Protection	What are the levels of diversity and redundancy used of physical Security of the NPP?
	Security Physical Protection	What are the facilities provided for physical security and protection of the NPP?
	Security Physical Protection	What programmes and facilities for site security are provided?
	Security Physical Protection	What are the Design Basis Threats (DBT) specified for physical protection of the NPP?
	Security Physical Protection	What physical protection are provided for plant systems
	Security Physical Protection	How is an attempted malicious act managed by an integrated system of detection, delay and response?
	Security Physical Protection	What design features are provided to mitigate the consequences of malicious acts?
	Security Physical Protection	What features are provided to minimize the impact of insider physical threats?
	Security Physical Protection	What are the specifications of the secure communication system required to interface with external support services in case of emergency?
	Security Physical Protection	How is cybersecurity addressed across the different safety levels (safety, control, display, maintenance and development tools) of the plant digital I&C?
	Security Physical Protection	What is the cybersecurity standard applied to the integration of the plant I&C with other information and data management systems and the wider internet?
	Security Physical Protection	What are cybersecurity measures taken for the support functions of the plant?
	Security Physical Protection	How do you assess the vulnerability of the plant security and safety related systems against cybersecurity threats including Design Basis Threats?
	Security Physical Protection	What features are provided in your plant systems (including security and safety critical system) to prevent or minimize insider cyber threats?
6-Safeguards	Safeguards	Do construction plans include specific, agreed phases for IAEA safeguards design verifications?
	Safeguards	What are the features provided in the plant design to allow for the implementation of the IAEA Safeguards requirements (e.g., space, secure access, maintenance envelope, constructability, local and remote operation

		(where applicable) power supply, secure communications etc.)?
	Safeguards	What specific features are included in the design to facilitate installation of cameras, counting systems and radiation detectors, and their access for maintenance?
	Safeguards	Does the design include adequate physical space, stable uninterruptible power and secure data transmission for IAEA safeguards equipment?
	Safeguards	At what stages of the plant design process do you consult with the IAEA Safeguards department to ensure their requirements are addressed?
7-Emergency Prepardness	Emergency Prepardness	What is the emergency planning zone (EPZ) of the Proposed Plant?
	Emergency Prepardness	How do you assure the main control habitability during accident conditions and other design basis threats and what design features are in place to allow operators to evacuate and assume operation from the alternate/emergency control room facility?
3.8 STRUCTURES SYSTEMS AND COMPONENTS (SSCs)		
1-Nuclear Island	Nuclear Island	What are the values of the Containment Design Pressure and the Containment Elastic Limit?
	Nuclear Island	What is the containment's Liner type (e.g., Carbon Steel, Epoxy)?
	Nuclear Island	Does the design include a single or a double containment?
	Nuclear Island	What is the value of the design Leakage rate limit of the containment?
3.9 SCOPE OF SUPPLIES AND SERVICES		
8-Nuclear fuel cycle supplies and services	Nuclear fuel cycle supplies and services	What is the state of your relationship with fuel supplier(s) in the past and for the future?
	Nuclear fuel cycle supplies and services	How many reactor-years has the fuel operated successfully?
	Nuclear fuel cycle supplies and services	For what kind of fuel types have you established agreements with your fuel suppliers?

	Nuclear fuel cycle supplies and services	Do your suppliers have alternate fuels and materials for your reactor technology?
	Nuclear fuel cycle supplies and services	Will the fuel supply chain be ready when the designs are ready to come to market?
	Nuclear fuel cycle supplies and services	Does the contract include several mines or plants for the supply of materials and components?
	Nuclear fuel cycle supplies and services	How can security of supply be obtained or achieved? Quantity of stocks? Price of stocks? Number of suppliers for these materials in the world?
	Nuclear fuel cycle supplies and services	What is the stock level for the fuel product?
	Nuclear fuel cycle supplies and services	Who are the fuel suppliers for your reactor?
	Nuclear fuel cycle supplies and services	How many fuel plants are available by each fuel supplier?
	Nuclear fuel cycle supplies and services	What is the experience of other NPPs with the use of the fuel type you specify for your reactor?
	Nuclear fuel cycle supplies and services	Can you supply analysis software and methods to help optimize fuel loading plan and safety evaluation?
	Nuclear fuel cycle supplies and services	What are the assumptions regarding the availability of replacement components, materials, equipment, and parts? What assurance is provided regarding the availability of suppliers or commonality of replacement supply?
	Nuclear fuel cycle supplies and services	Can you propose reprocessing of used fuel?

Annex 2 – ANVS Guidelines for the Safe Design and Operation of Nuclear Reactors 2023