INL/EXT-07-12999
Rev. 3

Next Generation Nuclear Plant System Requirements Manual

September 2009

The INL is a U.S. Department of Energy National Laboratory
operated by Battelle Energy Alliance

Idaho National Laboratory

INL/EXT-07-12999
Rev. 3
Project No. 23843

Next Generation Nuclear Plant System Requirements Manual

September 2009

Idaho National Laboratory
Idaho Falls, Idaho 83415

http://www.inl.gov

Prepared for the
U.S. Department of Energy
Office of Nuclear Energy
Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517

Approved by:

John W. Collins 9/10/2009
Lead Systems Engineer Date

Vincent F. Tonc 9/10/2009
Acting Engineering Director Date

This page intentionally left blank.

REVISION LOG

Rev.	Date	Affected Pages	Revision Description
3	9/10/09	Various	Incorporated INL/EXT-16548, NGNP Requirements Verification Traceability Report

This page intentionally left blank.

SUMMARY

This revision of the Next Generation Nuclear Plant (NGNP) System Requirements Manual (SRM) contains requirements derived or taken from key source documents, which include the *Energy Policy Act of 2005* (EPAct), reports from the Nuclear Energy Research Advisory Council (NERAC) and the National Research Council of the National Academics, and previous versions of the NGNP SRM. The latter document consolidated requirements from prior reactor supplier reports and the preconceptual design report. These requirements were then categorized as high-level programmatic requirements and functional, operational, and technical requirements for the NGNP Project. This report contains the categorized programmatic and technical requirements associated with the NGNP, as well as the derived project requirements, and describes the requirements hierarchy. Project requirements are traceable to initial project baseline documents and are being designed to follow the good practices suggested in the *Systems Engineering and Interface Management* document, which states that project requirements are:

- Identified, defined, and approved as early as possible
- Documented and placed under change control
- Available to all project participants
- Refined and developed as the project progresses.

This report also provides definition of the design entity's and design authority's responsibilities for future design documents. This document presents in detail the attributes of a fully relational database (i.e., DOORS®), which contains the requirements.

As the project matures, a verification method will be selected for each requirement to ensure full implementation. Programmatic requirements are derived from the legislative directives, including the EPAct, and other regulatory requirements through the Nuclear Regulatory Commission (NRC) licensing process. The technical requirements are assigned to the applicable Plant, Areas, Systems, Subsystems, and Components (PASSCs) and include assumptions that are made during the design process. These assumptions are tagged as verified and unverified assumptions. For unverified assumptions, the project either knowingly accepts the risk of proceeding with the unverified assumption or completes the necessary tasks to validate the assumption. Changes to the requirements will be controlled in the database and formally adopted by the project via revision control.

By developing, deriving, and documenting the requirements and assumptions associated with NGNP, requirements are tracked with full accounting of each requirement to ensure customer and stakeholder needs are met. Fully implemented requirements are necessary to verify that the project has successfully met customer and stakeholder needs.

This page intentionally left blank.

CONTENTS

REVISION LOG iii

SUMMARY v

ACRONYMS ix

DEFINITIONS x

1. INTRODUCTION 1
   - 1.1 Areas, Systems, Subsystems, and Components 1
   - 1.2 Requirements Hierarchy 2

2. REQUIREMENTS DATABASE 3
   - 2.1 Database Modules 3
   - 2.2 Database Attributes 4
     - 2.2.1 Reference and Alternative Designs 6
     - 2.2.2 Verification Methods 6
   - 2.3 Allocation and Traceability 7
   - 2.4 Configuration Control 8

3. NGNP REQUIREMENTS 9

4. REFERENCES 11

Appendix A NGNP Programmatic Requirements 13
- A-1. Regulatory Requirements 14
- A-2. Legislative Requirements 23
- A-3. End User Requirements 35
- A-4. Stakeholder Requirements 36

Appendix B NGNP Functional, Operational, and Technical Requirements 65
- B-1. Nuclear Heat Supply Requirements 66
- B-2. Heat Transport System Requirements 80
- B-3. Hydrogen Production System Requirements 85
- B-4. Power Conversion System Requirements 91
- B-5. Balance of Plant Requirements 94

FIGURES

Figure 1. NGNP plant architecture. 1

Figure 2. Sample DOORS® screen 3

Figure 3. INL-controlled DOORS® modules. 4

Figure 4. Sample DOORS® Attributes screen 6

Figure 5. DOORS® Graphics Mode screen 8

Figure 6. Requirements processing. 9

TABLES

Table 1. Critical PASSCs for Different Reference Designs. 2

Table 2. Cited source documents for NGNP requirements. 10

ACRONYMS

CFR	Code of Federal Regulations
CM	Configuration Management
COLA	Combined Operating License Application
CORE®	Unknown. Automated requirements management/systems engineering tool, produced by ViTech Corporation
DOE	U.S. Department of Energy
DOORS®	Dynamic Object Orientated Requirements System (produced by IBM Rational / Telelogic)
EPAct	Energy Policy Act of 2005
FOAK	first of a kind
HTE	High-Temperature Electrolysis
HyS	Hybrid Sulfur
ICD	Interface Control Document
INCOSE	International Council on Systems Engineering
INL	Idaho National Laboratory
ITAAC	Integrated Test Analysis and Acceptance Criteria
NGNP	Next Generation Nuclear Plant
NOAK	nth of a kind
RC	Nuclear Regulatory Commission
OECM	Office of Engineering and Construction Management
PASSC	Plant, Areas, Systems, Subsystems, and Components
RAI	Request for Additional Information
RAM	Requirements Allocation Matrix
RMIP	Requirements Management Implementation Plan
SAG	Senior Advisory Group
SE	Systems Engineering
SRM	System Requirements Manual
TDRM	Technology Development Roadmap
TRL	Technology Readiness Level

DEFINITIONS

Design Entity	Organization responsible for supplying the plant design specifications for the design authority's approval. Currently, this role is fulfilled by the reactor suppliers.
Design Authority	Organization responsible for establishing and maintaining the high-level requirements and acceptance criteria and ensuring the design documents accurately reflect the design basis. Currently, this role is fulfilled by the Idaho National Laboratory under the direction of the U.S. Department of Energy.

1. INTRODUCTION

This document constitutes the 3rd revision of the Next Generation Nuclear Plant (NGNP) System Requirements Manual (SRM) for the programmatic requirements and the Plant, Areas, Systems, Subsystems, and Components (PASSC) level requirements. The SRM defines and contains the initial requirements for the current maturity of the NGNP Project. These initial requirements are design-neutral; in other words, they remain in force regardless of the specific design decisions made in the future. Similar to a requirements allocation matrix (RAM), this SRM was prepared at the early stages of conceptual design and allocates, traces, and ensures requirements are properly met via verification methods (i.e., analysis, test, inspection, or demonstration).

As the project matures, particularly after the nuclear system design, plant operating conditions, and plant configuration are finalized, detailed design requirements for the five NGNP areas will be generated, documented, and maintained by the design entity with design authority approval. The SRM is the means of documenting programmatic and technical requirements and tracking those requirements to full implementation. The requirements are assigned to the applicable PASSCs and will include assumptions that are made during the design process. The requirements in this report represent only those requirements identified at the current state of plant design and additional requirements or modifications identified via early conceptual design work. As the requirements identification and documentation process evolves, the scope of these requirements may change. Detailed requirements will be documented in this SRM for all PASSCs as the NGNP matures.

It is the intent of the NGNP Project to meet *Energy Policy Act of 2005* (EPAct). As such, EPAct language is adopted as requirements for the project. This SRM was developed under the assumption that funding levels necessary to meet the requirements contained herein will be available, as projected by the NGNP Project.

1.1 Areas, Systems, Subsystems, and Components

The NGNP is comprised of five areas: Nuclear Heat Supply, Heat Transport, Hydrogen Production, Power Conversion, and Balance of Plant. Each area is broken down further into systems, which are comprised of subsystems, which are further comprised of components, as shown in Figure 1.

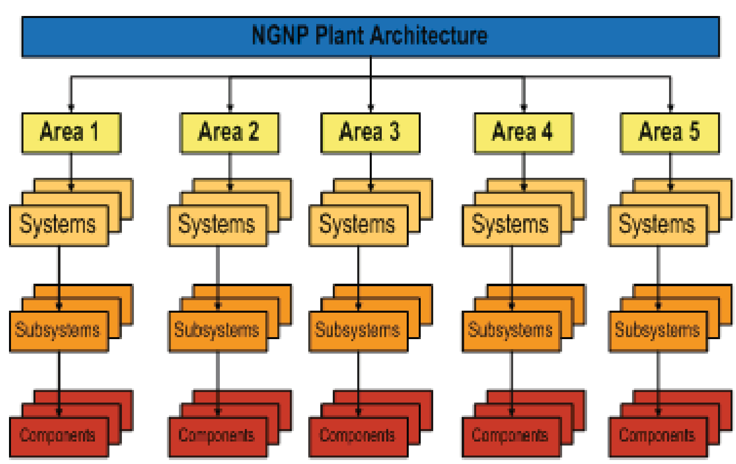


Figure 1. NGNP plant architecture.

The requirements captured in this SRM are the high-level functional requirements as well as the operational requirements assigned to the appropriate PASSC requirements. The technical processes contained in the Requirements Management Implementation Plan (RMIP) apply to both the existing requirements contained in this SRM and the future requirements to be developed through various design phases of the project. Table 1 shows the critical PASSCs for a 750°C – 800°C reactor outlet temperature ROT; (see

INL/EXT-09-16598)[1] and for a 950°C ROT (see INL/EXT-08-15148)[2]. These critical PASSCs may change as the NGNP is further developed. The reactor suppliers have developed updates to the PASSCs to incorporate changes in reactor outlet temperatures (750°C – 800°C) and in configurations (prismatic design utilizing a steam generator in the primary loop).

Table 1. Critical PASSCs for Different Reference Designs.

NGNP Areas	750 – 800°C ROT INL-Consolidated Critical PASSCs	950°C ROT INL-Consolidated Critical PASSCs
Nuclear Heat Supply	Reactor Pressure Vessel Reactor Vessel Internals Reactor Core & Core Structure Fuel Elements Reserve Shutdown System Reactivity Control System Core Conditioning System (Shutdown Cooling) Reactor Cavity Cooling System	Reactor Pressure Vessel Reactor Vessel Internals Reactor Core & Core Structure Fuel Elements Reserve Shutdown System Reactivity Control System Core Conditioning System (Shutdown Cooling) Reactor Cavity Cooling System
Heat Transport	Intermediate Heat Exchangers Circulators Hot Duct – Cross Vessel High Temperature Valves (Isolation, Flapper, & Relief)	Intermediate Heat Exchangers Circulators Hot Duct – Cross Vessel High Temperature Valves (Isolation, Flapper, & Relief) Mixing Chamber
Hydrogen Production	HTE, S-I, and HyS (currently identifying all three technologies until one is selected for NGNP)	HTE, S-I, and HyS (currently identifying all three technologies until one is selected for NGNP)
Power Conversion	Steam Generator	Steam Generator Power Conversion System
Balance of Plant	Fuel Handling System Instrumentation and Control	Fuel Handling System Instrumentation and Control

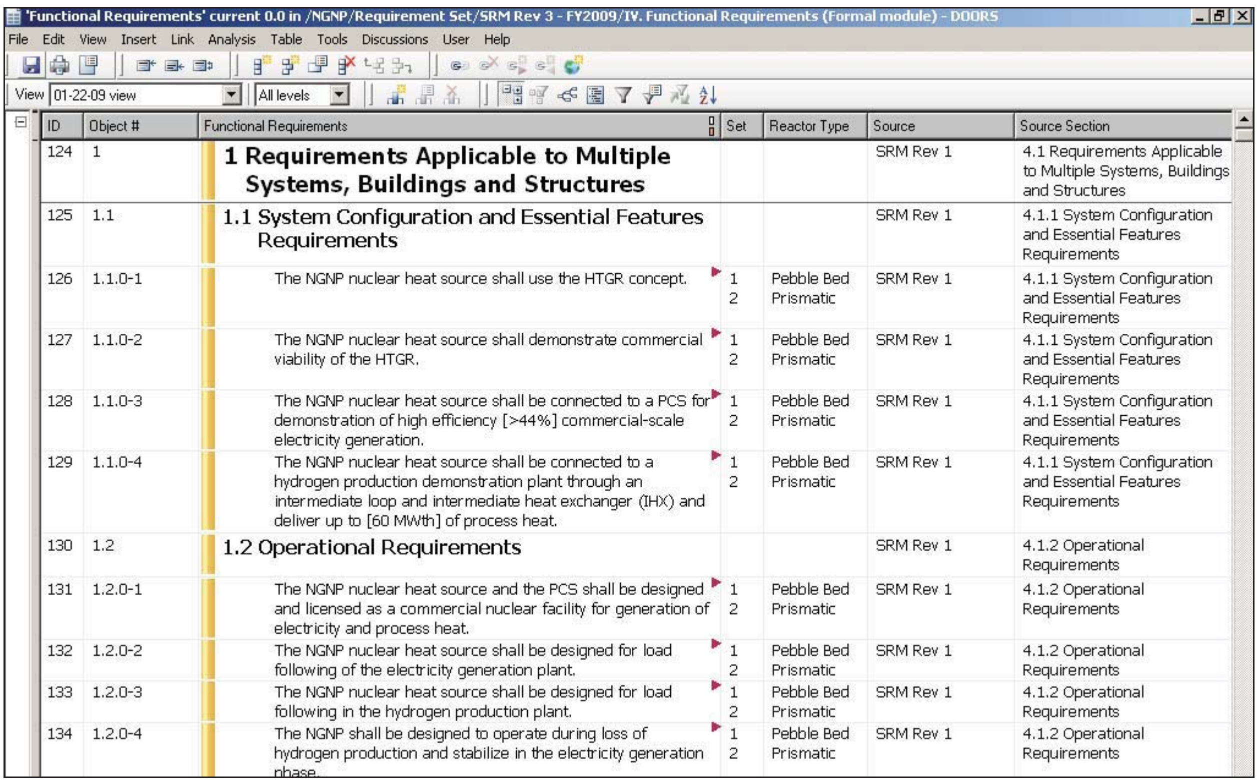
1.2 Requirements Hierarchy

The requirements hierarchy is based on the physical structure of the plant, and its associated areas, systems, subsystems, and components for both hydrogen production and electricity production. The lowest levels of requirements are at the plant design level. The requirements hierarchy is structured in a way that allows for further enhancement and the derivation of additional requirements without changing the original structure as the project is further defined. This SRM currently contains the NGNP's legislative and regulatory, end-user, and functional and operational requirements for the PASSC levels. Assumptions made during the design process are also captured, as verified or unverified assumptions. For unverified assumptions, the project either knowingly accepts the risk of proceeding with the unverified assumption or completes the necessary tasks to validate the assumption.

2. REQUIREMENTS DATABASE

The NGNP requirements are managed in an internationally recognized, structured database tool that aids in the development and management of requirements throughout the life cycle of any given project. The Dynamic Object Orientated Requirements System (DOORS®), produced by IBM Rational/Telelogic, was specifically designed with the ability to link and track the flow-down of requirements through a complex series of requirements modules. DOORS® has been used on large projects of similar size and complexity to the NGNP project and, as such, was selected to manage NGNP requirements. The design entities may initially implement design specification requirements in other software packages. This is acceptable provided the design requirements are received in a format approved by the design authority.

DOORS® enables its users to store data in formal modules, organize requirements in a template, relate different levels of requirements through linked modules, restrict access to the data, enter data directly into the modules, run reports, search requirements, and trace requirements through the various stages of development. Figure 2 is a sample screen of the DOORS® tool.



ID	Object #	Functional Requirements	Set	Reactor Type	Source	Source Section
124	1	1 Requirements Applicable to Multiple Systems, Buildings and Structures			SRM Rev 1	4.1 Requirements Applicable to Multiple Systems, Buildings and Structures
125	1.1	1.1 System Configuration and Essential Features Requirements			SRM Rev 1	4.1.1 System Configuration and Essential Features Requirements
126	1.1.0-1	The NGNP nuclear heat source shall use the HTGR concept.	1 2	Pebble Bed Prismatic	SRM Rev 1	4.1.1 System Configuration and Essential Features Requirements
127	1.1.0-2	The NGNP nuclear heat source shall demonstrate commercial viability of the HTGR.	1 2	Pebble Bed Prismatic	SRM Rev 1	4.1.1 System Configuration and Essential Features Requirements
128	1.1.0-3	The NGNP nuclear heat source shall be connected to a PCS for demonstration of high efficiency [>44%] commercial-scale electricity generation.	1 2	Pebble Bed Prismatic	SRM Rev 1	4.1.1 System Configuration and Essential Features Requirements
129	1.1.0-4	The NGNP nuclear heat source shall be connected to a hydrogen production demonstration plant through an intermediate loop and intermediate heat exchanger (IHX) and deliver up to [60 MWth] of process heat.	1 2	Pebble Bed Prismatic	SRM Rev 1	4.1.1 System Configuration and Essential Features Requirements
130	1.2	1.2 Operational Requirements			SRM Rev 1	4.1.2 Operational Requirements
131	1.2.0-1	The NGNP nuclear heat source and the PCS shall be designed and licensed as a commercial nuclear facility for generation of electricity and process heat.	1 2	Pebble Bed Prismatic	SRM Rev 1	4.1.2 Operational Requirements
132	1.2.0-2	The NGNP nuclear heat source shall be designed for load following of the electricity generation plant.	1 2	Pebble Bed Prismatic	SRM Rev 1	4.1.2 Operational Requirements
133	1.2.0-3	The NGNP nuclear heat source shall be designed for load following in the hydrogen production plant.	1 2	Pebble Bed Prismatic	SRM Rev 1	4.1.2 Operational Requirements
134	1.2.0-4	The NGNP shall be designed to operate during loss of hydrogen production and stabilize in the electricity generation phase.	1 2	Pebble Bed Prismatic	SRM Rev 1	4.1.2 Operational Requirements

Figure 2. Sample DOORS® screen

2.1 Database Modules

The current requirements sets that apply to various aspects of the NGNP are contained in the Idaho National Laboratory (INL) DOORS® database, and future, more encompassing requirements will continue to be tracked and stored in the database as the NGNP project matures. The NGNP requirements stored in the DOORS© database are presented in Appendices A and B of this SRM. Figure 3 lists the modules that contain the NGNP requirements.

DOORS® Modules

Programmatic Requirements
- Regulatory
  - Top Level Design Criteria
  - Top Level Safety Criteria
  - ITAAC Validation Requirements
  - Request for Additional Information Requirements
- Legislative
- End-User Requirements
- Stakeholder Requirements

Functional, Operational, and Technical Requirements
- Nuclear Heat Supply Requirements
  - Reactor Pressure Vessel
  - Reactor Vessel Internals
  - Reactor Core and Core Structures
  - Nuclear Instrumentation
  - Fuel Elements
  - Reserve Shutdown Systems
  - Reactivity Control Systems
  - Core Conditioning System (Shutdown Cooling)
  - Reactor Cavity Cooling system
- Heat Transport System Requirements
  - Circulators
  - Intermediate Heat Exchangers
  - Cross Vessel Piping
  - Mixing Changer
  - High Temperature Valves
- Hydrogen Production System Requirements
  - Hydrogen Production System
- Power Conversion System Requirements
  - Steam Generator
  - Power Conversion System Equipment for Direct Combined Cycle
- Balance of Plant Requirements
  - Fuel Handling System
  - Instrumentation and Control

Figure 3. INL-controlled DOORS® modules.

2.2 Database Attributes

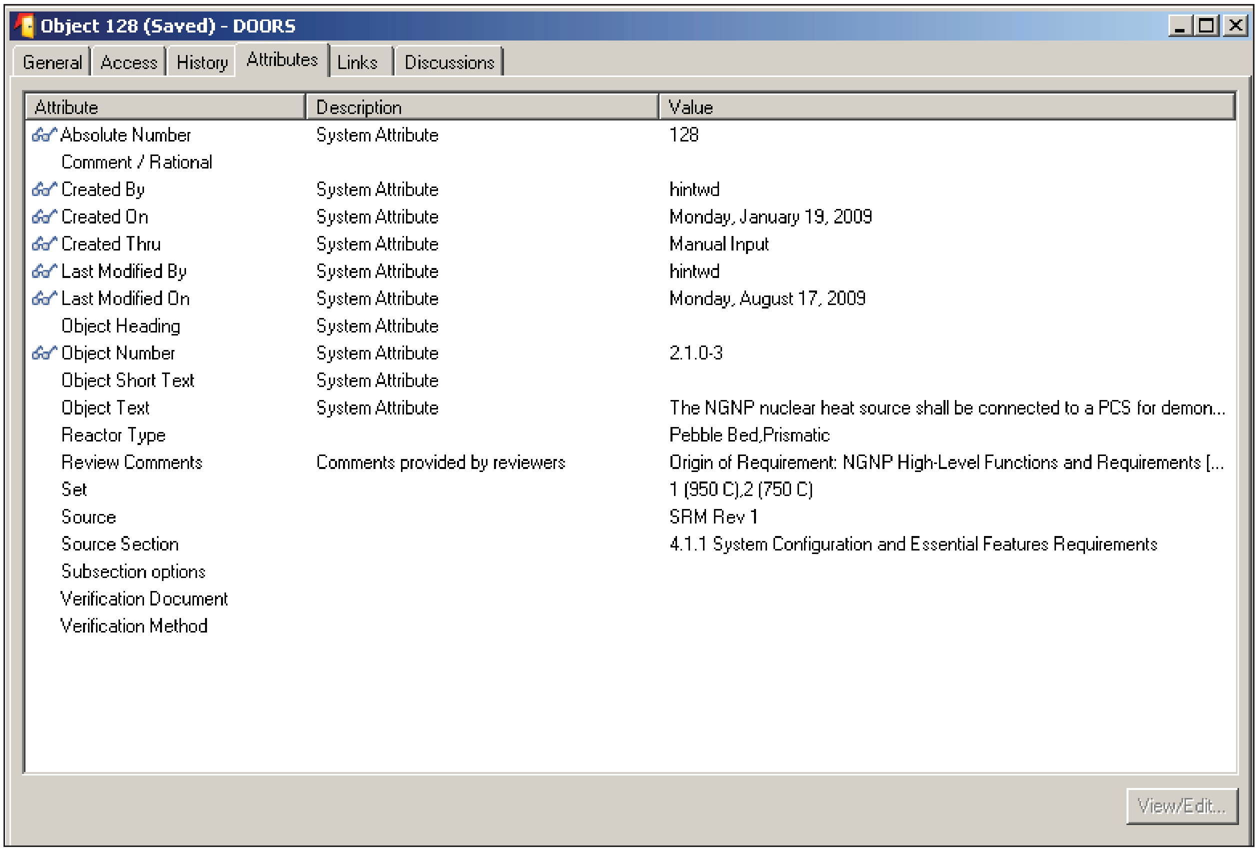
The DOORS® tool allows the user to filter requirements based on user selected attributes. From these filtered requirements, a report can be generated for a specific design. For example, one may filter a module of requirements for a prismatic reactor type with an outlet temperature of 750°C, and the tool will output a listing of the requirements applicable to this scenario. The attributes currently contained in each of the DOORS® modules for each requirement include the following:

- ID (Created by DOORS – unique for each requirement)
- Object # (Level hierarchy of requirements)
- Requirement Text
- 950°C or 750°C
- Reactor Type (Pebble Bed or Prismatic)
- Source of Requirement.

Future attributes may include the following:

- Additional Sets for various outlet temperatures
- Subsection or type of requirement may include the following selections:
  - Performance Requirement
  - Structural or Construction Requirement
  - Environmental Requirement
  - Instrumentation and Control Requirement
  - Startup or Shutdown Requirement
  - Monitoring or Surveillance Requirement
  - In-Service Requirement
  - Availability, Maintainability, Reliability or Testability Requirement
  - Safety Requirement Codes and Standards Requirement
  - Quality Assurance Requirement
  - Decommission Requirement
  - Interface Requirement
  - Other Requirement
- Verification Method
- Verification Document
- Comment / Basis.

A sample screen of the attributes for each requirement currently in a DOORS® module is provided in Figure 4.



Attribute	Description	Value
Absolute Number	System Attribute	128
Comment / Rational		
Created By	System Attribute	hintwd
Created On	System Attribute	Monday, January 19, 2009
Created Thru	System Attribute	Manual Input
Last Modified By	System Attribute	hintwd
Last Modified On	System Attribute	Monday, August 17, 2009
Object Heading	System Attribute	
Object Number	System Attribute	2.1.0-3
Object Short Text	System Attribute	
Object Text	System Attribute	The NGNP nuclear heat source shall be connected to a PCS for demon...
Reactor Type		Pebble Bed,Prismatic
Review Comments	Comments provided by reviewers	Origin of Requirement: NGNP High-Level Functions and Requirements [...
Set		1 (950 C),2 (750 C)
Source		SRM Rev 1
Source Section		4.1.1 System Configuration and Essential Features Requirements
Subsection options		
Verification Document		
Verification Method		

Figure 4. Sample DOORS® Attributes screen

2.2.1 Reference and Alternative Designs

Due to the current development stage of the project, requirements for both the initial design and the anticipated updates are included. The initial requirements are for maximum operating temperatures of 950°C and the steam generator in the primary loop. The updated requirements reflect a plant with maximum operating temperatures between 750°C and 800°C and a steam generator in the primary loop. Each set of requirements are designated by their respective headings of 950°C or 750°C in the appropriate attribute field. In some instances, requirements apply to both scenarios and will be clearly indicated. As the project continues to mature, more alternative designs and their related requirements may be developed while other designs are retired.

2.2.2 Verification Methods

Each requirement will have a verification method documented in the DOORS® database. The verification method options include those listed in the International Council on Systems Engineering (INCOSE) *Systems Engineering Handbook*, v3.1[3], as follows:

- <u>*Inspection*</u> – an examination of the item against applicable documentation to confirm compliance with requirements. Inspection is used to verify properties best determined by examination and observation (e.g., - paint color, weight, etc.).

- *Analysis* – use of analytical data or simulations under defined conditions to show theoretical compliance. Used where testing to realistic conditions cannot be achieved or is not cost-effective. Analysis (including simulation) may be used when such means establish that the appropriate requirement, specification, or derived requirement is met by the proposed solution.

- *Demonstration* – a qualitative exhibition of functional performance, usually accomplished with no or minimal instrumentation. Demonstration (a set of test activities with system stimuli selected by the system developer) may be used to show that system or subsystem response to stimuli is suitable.

- *Test* – an action by which the operability, supportability, or performance capability of an item is verified when subjected to controlled conditions that are real or simulated. These verifications often use special test equipment or instrumentation to obtain very accurate quantitative data for analysis.

2.3 Allocation and Traceability

The NGNP requirements are organized in a way to show traceability to the source documents. The DOORS® tool has the capability to link requirements and visibly show the traceability flow of requirements through the graphics mode view provided by DOORS®. Many requirements currently contained in DOORS® are linked and their flows can be viewed as shown in Figure 5.

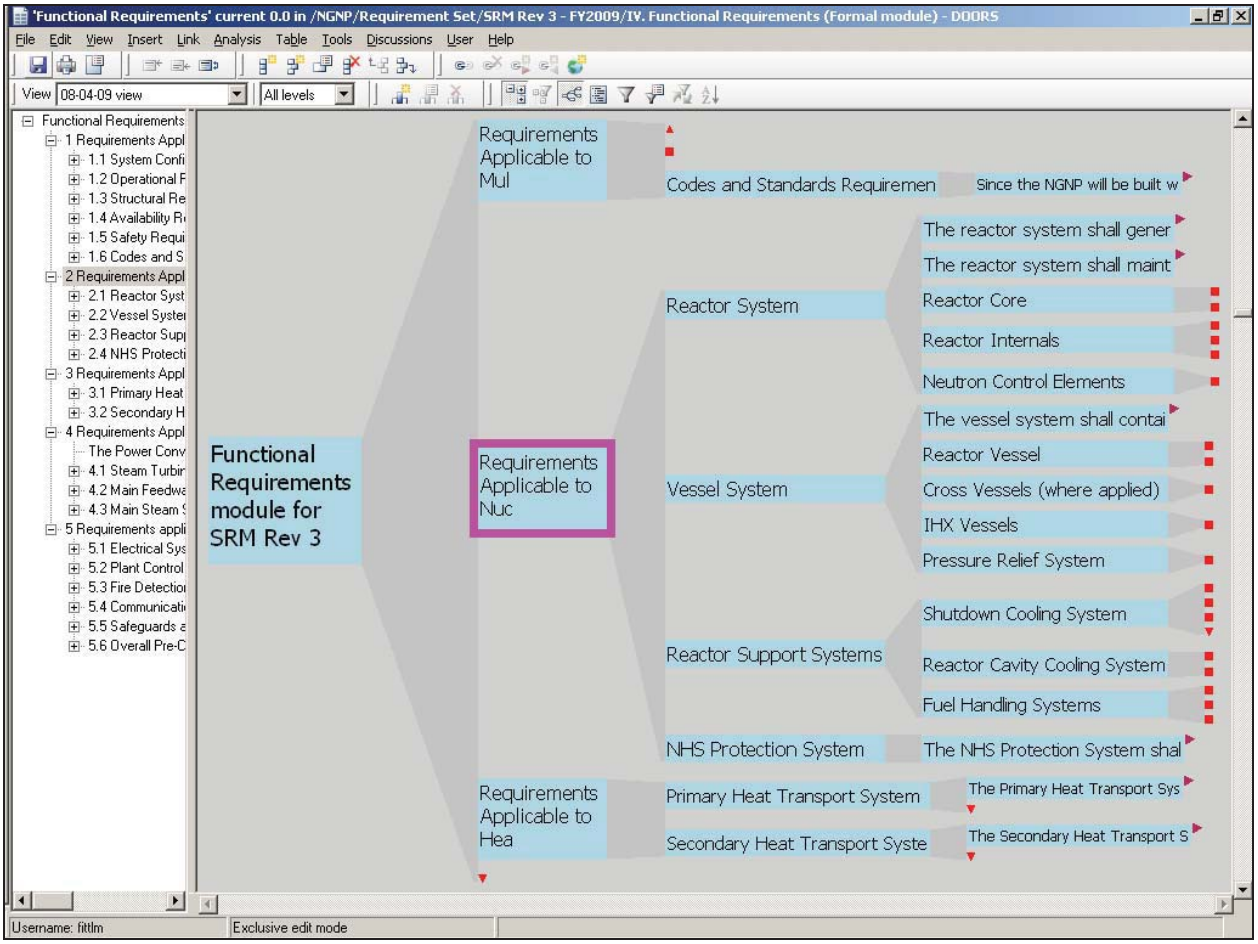


Figure 5. DOORS® Graphics Mode screen

2.4 Configuration Control

The design authority will maintain configuration control over the programmatic and functional, operational, and technical requirements, as shown Figure 6. The design authority is the single organization responsible for establishing and maintaining the design requirements and for ensuring that design output documents accurately reflect the design basis (DOE-STD-107-2003)[4]. The design entities will capture and maintain configuration control over the plant level design requirements.

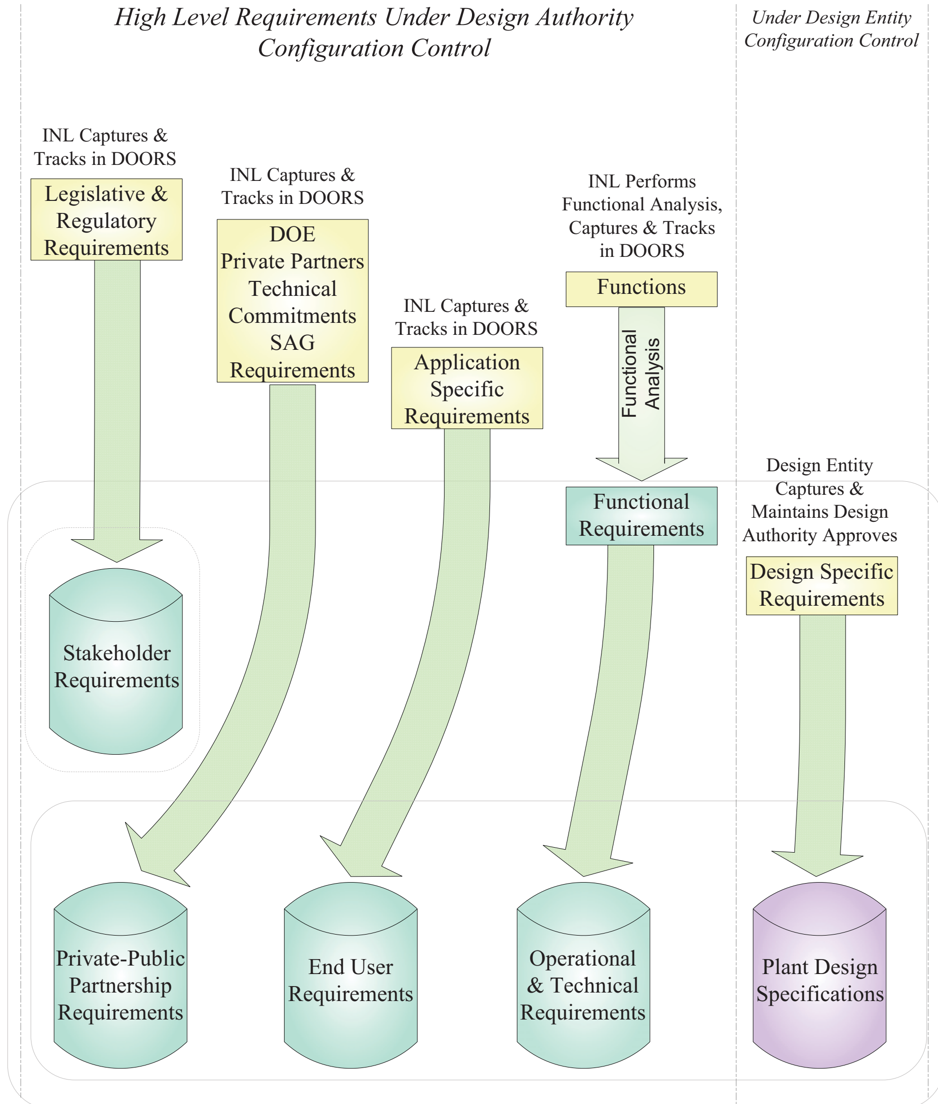


Figure 6. Requirements processing.

3. NGNP REQUIREMENTS

Programmatic requirements (see Appendix A) and Functional, Operational, and Technical Requirements (see Appendix B) are traceable to initial project baseline documents and follow the good practices suggested in *Systems Engineering and Interface Management*[5], which states that project requirements are:

- Identified, defined, and approved as early as possible
- Documented and placed under change control
- Available to all project participants
- Refined and developed as the project progresses.

Programmatic requirements comprise regulatory (including the *Environmental Policy Act of 2005* [EPAct 2005][6]) and licensing (i.e., NRC) requirements pertinent to NGNP PASSCs, including high-level functional and location requirement. The Top Level Design Criteria, Top Level Safety Criteria, and requirements resulting from Integrated Test Analysis and Acceptance Criteria (ITAAC) Validation are also included as regulatory requirements. The ITAAC is developed and submitted with the design and the Combined Operating License Application (COLA). These requirements reflect the verification tests and analyses performed to provide evidence that the system was built as designed and performs the function intended.

Additionally, following the licensing submittals, it is anticipated that the NRC will issue Requests for Additional Information (RAIs). The RAI and any derived requirements from the responses will be tracked as requirements to ensure that each commitment is fully implemented in the design developed and systems built.

End-user requirements are specific to the intended application of NGNP. For example, an NGNP that provides process heat for an oil refinery will have different end-user requirements than an NGNP that provides electricity and hydrogen. Specific site requirements and technical direction or commitments are also included in the end-user requirements.

Per *EPAct*, the NGNP documentation and project definition were reviewed by the independent Nuclear Energy Research Advisory Committee (NERAC), resulting in the *A Review of the NGNP Project* report, which provides additional high-level requirements. Other reports and publications by internal and external entities to the NGNP Project provided feedback into this requirements document. The publications include nationally recognized entities, such as the National Research Council of the National Academies.

Table 2 lists the cited source documents for the requirements contained herein.

Table 2. Cited source documents for NGNP requirements.

Source Document	Requirement Source Key
Energy Policy Act of 2005	EPAct2005
Summary of Bounding Conditions for Development of the NGNP Project, INL/EXT-08-14370, June 2008	Bounding Conditions
A Review of the NGNP Project	NERAC
Next Generation Nuclear Plant System Requirements Manual, INL/EXT-07-12999 Rev. 1, June 2008	SRM Rev 1
Next Generation Nuclear Plant System Requirements Manual, INL/EXT-07-12999 Rev. 2, March 2009	SRM Rev 2
Review of DOE's Nuclear Energy Research and Development Program by The National Research Council of the National Academies, 2008	NAS
SAG Meeting Minutes (as of October 22, 2008)	SAG

4. REFERENCES

1. Collins, John, *Next Generation Nuclear Plant Project Technology Development Roadmaps: The Technical Path Forward for 750 – 800°C Reactor Outlet Temperature*, INL/EXT-08-16598, Idaho National Laboratory, August 2009.

2 Collins, John, *Next Generation Nuclear Plant Project Technology Development Roadmaps: The Technical Path Forward*, INL/EXT-08-15148, Idaho National Laboratory, January 12, 2009.

3 INCOSE, *Systems Engineering Handbook: A Guide for System Life Cycle Processes and Activities*, International Council on Systems Engineering, version 3.1, International Council on Systems Engineering, August 2007.

4. DOE-STD-1073-2003, *Configuration Management*, U.S. Department of Energy, October 2003.

5. OECM, 2003, *Systems Engineering and Interface Management*, Office of Engineering and Construction Management, Rev. E, June 2003.

6. Public Law 109-58, *Energy Policy Act (EPAct) of 2005*, Department of Energy, Office of Energy Efficiency and Renewable Energy, August 2005.

Cited Requirements Source Documents

INL, 2008, *Next Generation Nuclear Plant System Requirements Manual*, INL/EXT-07-12999, Rev. 1, June 2008.

INL, 2008, *Summary of Bounding Conditions for Development of the NGNP Project*, INL/EXT-08-14370, June 2008.

INL, 2009, *Next Generation Nuclear Plant System Requirements Manual*, INL/EXT-07-12999, Rev. 2, March 2009.

Review of DOE’s Nuclear Energy Research and Development Program, The National Research Council of the National Academics, 2008.

Review of the NGNP Project, Nuclear Energy Research Advisory Committee.

Additional Requirements Documents

29 CFR 1910.103, “Occupational Safety and Health Standards,” Subpart H, “Hazardous Materials-Hydrogen,” *Code of Federal Regulations*, Office of Federal Register, January 2009.

29 CFR 1910.104, “Occupational Safety and Health Standards,” Subpart H, “Hazardous Materials-Oxygen,” *Code of Federal Regulations*, Office of Federal Register, January 2009.

29 CFR 1910.119, “Occupational Safety and Health Standards,” Subpart H, “Hazardous Materials-Process Safety Management of Highly Hazardous Chemicals,” *Code of Federal Regulations*, Office of Federal Register, January 2009.

DOE G 413.3-1, *Managing Design and Construction Using Systems Engineering for Use with DOE O 413.3A*, U.S. Department of Energy, September 2008.

FR Doc E8-24268, "Policy Statement on the Regulation of Advanced Reactors," *Federal Register*, October 14, 2008 (NRC Document ID NRC-2008-0237-0010, effective date November 13, 2008).

INEEL 2003, *Next Generation Nuclear Plant – High Level Functions and Requirements*, INEEL/EXT-03-01163, Idaho National Laboratory, September 2003.

INEEL, 2004, *Independent Technology Review Group, Design Features and Technology Uncertainties for the Next Generation Nuclear Plant*, INEEL/EXT-04-01816, Idaho National Laboratory, June 30, 2004.

PLN-2489 (INL/MIS-08-14339), "Next Generation Nuclear Plant Project (NGNP) Preliminary Project Management Plan," Rev. 2, NGNP, Idaho National Laboratory, June 2008 (NOTE: suspended by Rev. 3, October 2008).

PLN-2825, "NGNP Preliminary Project Execution Plan," Rev. 0, NGNP, September 30, 2008.

Appendix A

NGNP Programmatic Requirements

Appendix A
NGNP Programmatic Requirements

NOTE: Items appearing in brackets ([ ]) represent approximations and/or undefined values.

A-1. Regulatory Requirements

Object #	Requirement ID	Requirements Statements	Set	Reactor Type	Source	Source Section
2		**Regulatory Documents**			SRM Rev 1	3.3 Regulatory Documents
2.1		**NRC/EPA Regulatory Documents**			SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents
	2.1-1	The following documents shall, as a minimum, become complied with for the NGNP Project	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents
	2.1-2	51 CFR 28044 - Policy Statement on Safety Goals for the Operation of Nuclear Power Plants	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents
	2.1-3	10 CFR 20 - Standards for Protection Against Radiation, (Permissible dose levels and activity concentrations in restricted and unrestricted areas).	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents
	2.1-4	10 CFR 50 - Domestic Licensing of Production and Utilization Facilities (applicable portions as needed)	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents
	2.1-5	10 CFR 51 - Environmental Protection Regulation for Domestic Licensing and Related Regulatory Functions	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents
	2.1-7	10 CFR 52 - Licenses, Certifications, and Approvals for Nuclear Power Plants	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents
	2.1-9	10 CFR 50, Appendix I - Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "as Low as is Reasonably Achievable."	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents

Object #	Requirement ID	Requirements Statements	Set	Reactor Type	Source	Source Section
	2.1-10	10 CFR 73 - Physical Protection of Plants and Materials	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents
	2.1-11	10 CFR 74 - Material Control and Accounting of Special Nuclear Material	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents
	2.1-12	10 CFR 75 - Safeguards on Nuclear Material - Implementation of US/IAEA (International Atomic Energy Agency) Agreement	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents
	2.1-14	10 CFR 95, Facility Security Clearance and Safeguarding of National Security Information and Restricted Data	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents
	2.1-15	10 CFR 100 - Reactor Site Criteria, (Numerical dose guidelines for determining the exclusion area boundary, low population zone, and population center distances)	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents
	2.1-16	10 CFR 835 - Occupational Radiation Protection	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents
	2.1-17	29 CFR 1910 - Occupational Safety and Health Standards, Subpart H, Hazardous Materials	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents
	2.1-18	40 CFR 50-99 - Clean Air Act	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents
	2.1-19	40 CFR 100-149 - Clean Water Act	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents
	2.1-20	40 CFR 190 - Environmental Radiation Protection Standards for Nuclear Power Operations	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents
	2.1-21	40 CFR 1502 - Environmental Impact Statement	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents

Object #	Requirement ID	Requirements Statements	Set	Reactor Type	Source	Source Section
	2.1-22	EPA - 520/1-75-001 - Protective Action Guide Doses for Protective Actions for Nuclear Incidents	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents
	2.1-23	47 CFR 47073 - Accident Radioactive Contamination of Human Food and Animal Feed; Recommendations for State and Local Agencies	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents
	2.1-25	Nuclear Regulatory Commission, NUREG-1860, Vols. 1 and 2, Feasibility Study for a Risk-Informed and Performance-Based Regulatory Structure for Future Plant Licensing, December 2007. (NGNP plant licensing shall be consistent with the NRC new regulatory framework developed as a guide for future plant licensing for advanced [non-light water] reactors).	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents
	2.1-26	Nuclear Regulatory Commission, 10 CFR Part 50 [NRC-2008-0237], Policy Statement on the Regulation of Advanced Reactors, Final policy statement (FR Doc E8-24268), effective November 13, 2008.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents
	2.1-27	Nuclear Regulatory Commission, Regulatory Guide 1.206, Combined License Applications for Nuclear Power Plants (LWR Edition), June 2007	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents
	2.1-28	Nuclear Regulatory Commission, NUREG-0800, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, March 2007	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.1 NRC/EPA Regulatory Documents
2.2		**DOE Documents**			SRM Rev 2	3.3.2 DOE Documents
	2.2-1	The acquisition strategy for the NGNP project may include a combination of requirements from both the federal and commercial sectors. Until a better definition of the commercial participant(s) is obtained, the DOE Acquisition Management system will be used, including the documents listed below.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.2 DOE Documents
	2.2-2	DOE O 413.3A - Program and Project Management for the Acquisition of Capital Assets	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.2 DOE Documents
	2.2-3	DOE O 420.1B - Facility Safety	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.2 DOE Documents
	2.2-4	DOE O 435.1 - Radioactive Waste Management	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.2 DOE Documents

Object #	Requirement ID	Requirements Statements	Set	Reactor Type	Source	Source Section
	2.2-5	DOE Policy 450.4 - Safety Management System Policy	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.2 DOE Documents
	2.2-6	DOE O 450.1A - Environmental Protection Program	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.2 DOE Documents
	2.2-7	10 CFR 851 - Worker Safety and Health Program.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.2 DOE Documents
	2.2-8	DOE M 470.4-2 Chg.1, Physical Protection.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.2 DOE Documents
2.3		**FERC Regulations**			SRM Rev 2	3.3.3 FERC Regulations
	2.3-1	Since the NGNP is expected to produce electricity for commercial use, it shall follow applicable FERC requirements.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.3 FERC Regulations
2.4		**State of Idaho Regulations**			SRM Rev 2	3.3.4 State of Idaho Regulations
	2.4-2a	If the NGNP is sited at the INL, as indicated in the 2005 EPAct, the NGNP shall meet applicable state requirements and observe treaties with sovereign nations such as the Shoshone -Bannock.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.4 State of Idaho Regulations
	2.4-2b	If the NGNP is sited at the INL, as indicated in the 2005 EPAct, the NGNP shall observe treaties with sovereign nations such as the Shoshone -Bannock.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.4 State of Idaho Regulations
2.5		**Indian Reservation Rights**			SRM Rev 2	3.3.5 Indian Reservation Rights
	2.5-1	DOE has committed to additional interaction and exchange of information with the Shoshone-Bannock Tribes at the Fort Hall Reservation.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.3.5 Indian Reservation Rights
3		**Requirements Applicable to Multiple Systems, Buildings and Structures**			SRM Rev 2	4.1 Requirements Applicable to Multiple Systems, Buildings and Structures
3.1		**Environmental Requirements**			SRM Rev 2	4.1.4 Environmental Requirements

Object #	Requirement ID	Requirements Statements	Set	Reactor Type	Source	Source Section
	3.1-2	The NGNP plant shall be capable of controlling the transport of radionuclides to the end products at levels below the concentration or exposure requirements for the product (e.g., tritium in steam, gas, hydrogen). (Initial acceptable tritium levels will be set at a fraction of the U.S. Environmental Protection Agency [EPA] limits for drinking water and air.)	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.2.2 HTGR Fundamental Requirements
	3.1-3	The NGNP and hydrogen production facilities (if applicable) shall comply with applicable requirements of the Clean Air Act/Air Programs.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.4 Environmental Requirements
	3.1-4a	The NGNP shall identify all waste streams generated in NGNP by type and estimated quantity.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.4 Environmental Requirements
	3.1-4b	The NGNP shall provide a disposition pathway within the applicable regulatory framework.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.4 Environmental Requirements
	3.1-5a	The NGNP Project shall minimize the generation of all waste, including radioactive, nonradioactive, and mixed waste.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.4 Environmental Requirements
	3.1-5b	The NGNP Project shall comply with applicable DOE orders, NRC regulations, and EPA regulations in the treatment of these wastes.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.4 Environmental Requirements
3.2		**Codes and Standards Requirements**			SRM Rev 2	4.1.10 Codes and Standards Requirements
	3.2-1a	The design of the NGNP shall comply with all applicable federal, state, and local codes and standards.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.10 Codes and Standards Requirements
	3.2-1b	Codes and standards pertinent to the nuclear industry shall only be utilized in the design, fabrication, and installation of the structures, systems, and equipment where such codes and standards are applicable.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.10 Codes and Standards Requirements
	3.2-1c	The plant designer shall list all applicable codes and standards, and the applicable revision of each document.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.10 Codes and Standards Requirements

Object #	Requirement ID	Requirements Statements	Set	Reactor Type	Source	Source Section
	3.2-2	NUREG/CR-5973 shall be used as a starting point for the identification of codes and standards to be followed during conceptual design.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.10 Codes and Standards Requirements
3.3		**Quality Assurance Requirements**			SRM Rev 2	4.1.11 Quality Assurance Requirements
	3.3-1	The NGNP project shall use the U.S. national consensus standard ASME Nuclear Quality Assurance (NQA)-1-2000, “Quality Assurance Program Requirements for Nuclear Facilities Applications.”	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.11 Quality Assurance Requirements
3.4		**Physical Protection, Material Control and Safeguards - IAEA**				
	3.4-1	The NGNP shall comply with the following statement. “Designs that include considerations for safety and security requirements together in the design process such that security issues (e.g., newly identified threats of terrorist attacks) can be effectively resolved through facility design and engineered security features, and formulation of mitigation measures, with reduced reliance on human actions.”	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.11 Physical Protection, Material Control and Safeguards - IAEA
	3.4-2	The NGNP shall comply with the following statement “Designs with features to eliminate or reduce the potential theft of nuclear materials.”	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.11 Physical Protection, Material Control and Safeguards - IAEA
	3.4-3	The NGNP shall comply with the following statement. “Designs that emphasize passive barriers to potential theft of nuclear materials.”	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.11 Physical Protection, Material Control and Safeguards - IAEA
	3.4-4	The NGNP shall comply with the following statement. “Finally, the NRC also believes that it will be in the interest of the public as well as the design Suppliers and the prospective license applicants to address security issues early in the design stage to achieve a more robust and effective security posture for future nuclear power reactors.”	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.11 Physical Protection, Material Control and Safeguards - IAEA

Object #	Requirement ID	Requirements Statements	Set	Reactor Type	Source	Source Section
	3.4-7	The design of the NGNP shall comply with 10 CFR 73.55, Requirements for physical protection of licensed activities in nuclear power reactors against radiological sabotage.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.11.1 Physical Protection of Plants and Materials
	3.4-8	The design of the NGNP shall comply with 10 CFR 73.67, Licensee fixed site and in-transit requirements for the physical protection of special nuclear material of moderate and low strategic significance.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.11.1 Physical Protection of Plants and Materials
	3.4-9a	The design of the NGNP shall include preparation and update of a Security Assessment, “High Assurance Evaluation and Mitigative Measures Evaluation” per NUREG-800 Sections 13.6.4.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.11.1 Physical Protection of Plants and Materials
	3.4-9b	The design of the NGNP shall include the development of Physical Security Hardware Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) per NUREG-0800 Section 14.3.12.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.11.1 Physical Protection of Plants and Materials
	3.4-9c	The results of and insight from the above evaluations and the ITAAC shall be used to integrate safeguards by design into the NGNP.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.11.1 Physical Protection of Plants and Materials
	3.4-11	The NGNP design shall comply with NRC requirements for the control and accounting of special nuclear material including 10 CFR 74.19, Recordkeeping.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.11.2 Material Control and Accounting of Special Nuclear Material
	3.4-12	The design of the NGNP shall comply with 10 CFR 75, Safeguards on Nuclear Material-Implementation of US/IAEA Agreement.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.11.3 Safeguards on Nuclear Material - Implementation of US/IAEA Agreement

Object #	Requirement ID	Requirements Statements	Set	Reactor Type	Source	Source Section
	3.4-13	The design of the NGNP shall incorporate design features to facilitate the application of international safeguards under INFCIRC/57, The Text of the Agreement for the Application of Agency Safeguards to United States Reactor Facilities, and INFCIRC/540, Model Protocol Additional to the Agreements(s) Between State(s) and the International Atomic Energy Agency for the Application of Safeguards.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.11.3 Safeguards on Nuclear Material - Implementation of US/IAEA Agreement
4		**Public and Worker Exposure Limits**			Bounding Condition	4.5 Public and Worker Exposure Limits
4.1		**Protection Criteria for the Worker and the Public**				
	4.1-1	Upper bound offsite doses during design basis events shall meet 10 CFR 50.34 with margin.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.9 Safety Requirements
	4.1-2a	There shall be a technical basis for eliminating or minimizing the need for offsite emergency planning. .	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.9 Safety Requirements
	4.1-2b	This technical basis (for eliminating or minimizing the need for offsite emergency planning) shall consider a risk-informed, realistic assessment of design basis and beyond design basis accidents and shall demonstrate high confidence that the EPA Protection Action Guidelines are met.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.9 Safety Requirements
	4.1-2c	The NGNP design shall effectively demonstrate that off-site emergency plan requirements may be minimized (e.g., eliminate requirements for emergency drills, sirens, etc.).	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.9 Safety Requirements
	4.1-3	Exposure to the Worker and the Public under normal operation shall meet 10 CFR 20 and ALARA (as low as reasonably achievable) as quantified in Appendix I of 10 CFR 50.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.9 Safety Requirements
4.2		**Bounding Condition - 005**			Bounding Condition	4.5.1 Bounding Condition - 005
	4.2-1	Fuel specifications, operating conditions, and plant shielding shall be sufficient to meet NRC and Environmental Protection Agency (EPA) exposure limits for the public and workers under normal operation and calculated accident conditions. These limits are as follows:	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.5.1 Bounding Condition - 005

Object #	Requirement ID	Requirements Statements	Set	Reactor Type	Source	Source Section
	4.2-2	Under accident conditions, the release rates shall be limited to meet the EPA Protective Action Guidelines limits and 10% of the 10 CFR 100 limit at the exclusion area boundary (EAB; 400+ meters).	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.5.1 Bounding Condition - 005
	4.2-3	Exposure to the public under normal plant operation shall not exceed 0.1 rem in a year, exclusive of the dose contributions from background radiation.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.5.1 Bounding Condition - 005
	4.2-4	The occupational dose to individual adults shall be limited on an annual basis to 10% of the 10 CFR 20 limits.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.5.1 Bounding Condition - 005
	4.2-5	Tritium concentration control shall be sufficient to meet activity limits in the products of the plant.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.5.1 Bounding Condition - 005
	4.2-6a	Tritium concentrations in products shall not exceed 100 Bq/liter (~10% of the EPA limit for drinking water, 740 Bq/liter).	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.5.1 Bounding Condition - 005
	4.2-6b	Tritium concentrations in liquid effluents shall not exceed 100 Bq/liter (~10% of the EPA limit for drinking water, 740 Bq/liter).	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.5.1 Bounding Condition - 005
	4.2-7	Tritium concentrations in gaseous effluents and products shall not exceed 3.7 Bq/liter (the NRC limit for air).	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.5.1 Bounding Condition - 005
4.3		**Bounding Condition - 006**			Bounding Condition	4.5.2 Bounding Condition - 006
	4.3-1	Methods shall be developed and implemented to control the concentrations of tritium sufficient to meet or exceed the activity concentration limits for the products using the HTGR technology and the NRC and EPA limits on plant gaseous and liquid effluents.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.5.2 Bounding Condition - 006
4.4		**Bounding Condition - 007**			Bounding Condition	4.5.3 Bounding Condition - 007
	4.4-1a	Characterization of dust circulation in the primary system shall be required to ensure acceptable levels of dust-borne activity in the system.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.5.3 Bounding Condition - 007
	4.4-1b	Control of dust circulation in the primary system shall be required to ensure acceptable levels of dust-borne activity in the system.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.5.3 Bounding Condition - 007

Object #	Requirement ID	Requirements Statements	Set	Reactor Type	Source	Source Section
	4.4-1c	Characterization of dust circulation in the primary system shall be required to minimize the impact on operability of primary system components (e.g., the control rods and circulators) and abrasion of primary system components.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.5.3 Bounding Condition - 007
	4.4-1d	Control of dust circulation in the primary system shall be required to minimize the impact on operability of primary system components (e.g., the control rods and circulators) and abrasion of primary system components.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.5.3 Bounding Condition - 007

A-2. Legislative Requirements

Object #	Requirements ID	Legislative Requirements	Set	Reactor Type	Source	Source Section
3		**TITLE VI -- NUCLEAR MATTERS**			EPAct2005	
3.1		**Subtitle C--Next Generation Nuclear Plant Project**			EPAct2005	
3.1.1		**SEC. 641. PROJECT ESTABLISHMENT.**			EPAct2005	
	3.1.1-1	(a) Establishment- The Secretary shall establish a project to be known as the Next Generation Nuclear Plant Project' (referred to in this subtitle as the Project').	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.1-2	(b) Content- The Project shall consist of the research, development, design, construction, and operation of a prototype plant, including a nuclear reactor that--	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.1-2-1	(1) is based on research and development activities supported by the Generation IV Nuclear Energy Systems Initiative under section 942(d); and	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.1-2-2	(2) shall be used--	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.1-2-2-1	(A) to generate electricity;	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.1-2-2-2	(B) to produce hydrogen; or	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.1-2-2-3	(C) both to generate electricity and to produce hydrogen.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
3.1.2		**SEC. 642. PROJECT MANAGEMENT.**			EPAct2005	

Object #	Requirements ID	Legislative Requirements	Set	Reactor Type	Source	Source Section
	3.1.2-1-1	(1) IN GENERAL- The Project shall be managed in the Department by the Office of Nuclear Energy, Science, and Technology.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.2-1-2	(2) GENERATION IV NUCLEAR ENERGY SYSTEMS PROGRAM- The Secretary may combine the Project with the Generation IV Nuclear Energy Systems Initiative.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.2-1-3	(3) EXISTING DOE PROJECT MANAGEMENT EXPERTISE- The Secretary may utilize capabilities for review of construction projects for advanced scientific facilities within the Office of Science to track the progress of the Project.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.2-2-1	(1) LEAD LABORATORY- The Idaho National Laboratory shall be the lead National Laboratory for the Project and shall collaborate with other National Laboratories, institutions of higher education, other research institutes, industrial researchers, and international researchers to carry out the Project.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.2-2-2	(2) INDUSTRIAL PARTNERSHIPS-	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.2-2-2-1	(A) IN GENERAL- The Idaho National Laboratory shall organize a consortium of appropriate industrial partners that will carry out cost-shared research, development, design, and construction activities, and operate research facilities, on behalf of the Project.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.2-2-2-2	(B) COST-SHARING- Activities of industrial partners funded by the Project shall be cost-shared in accordance with section 988.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.2-2-2-3	(C) PREFERENCE- Preference in determining the final structure of the consortium or any partnerships under this subtitle shall be given to a structure (including designating as a lead industrial partner an entity incorporated in the United States) that retains United States technological leadership in the Project while maximizing cost sharing opportunities and minimizing Federal funding responsibilities.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.2-2-3	(3) PROTOTYPE PLANT SITING- The prototype nuclear reactor and associated plant shall be sited at the Idaho National Laboratory in Idaho.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	

Object #	Requirements ID	Legislative Requirements	Set	Reactor Type	Source	Source Section
	3.1.2-2-4	(4) REACTOR TEST CAPABILITIES- The Project shall use, if appropriate, reactor test capabilities at the Idaho National Laboratory.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.2-2-5	(5) OTHER LABORATORY CAPABILITIES- The Project may use, if appropriate, facilities at other National Laboratories.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
3.1.3		**SEC. 643. PROJECT ORGANIZATION.**			EPAct2005	
	3.1.3-1	(a) Major Project Elements- The Project shall consist of the following major program elements:	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-1-1	(1) High-temperature hydrogen production technology development and validation.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-1-2	(2) Energy conversion technology development and validation.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-1-3	(3) Nuclear fuel development, characterization, and qualification.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-1-4	(4) Materials selection, development, testing, and qualification.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-1-5	(5) Reactor and balance-of-plant design, engineering, safety analysis, and qualification.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-2	(b) Project Phases- The Project shall be conducted in the following phases:	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-2-1	(1) FIRST PROJECT PHASE- A first project phase shall be conducted to--	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-2-1-1	(A) select and validate the appropriate technology under subsection (a)(1);	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-2-1-2	(B) carry out enabling research, development, and demonstration activities on technologies and components under paragraphs (2) through (4) of subsection (a);	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-2-1-3	(C) determine whether it is appropriate to combine electricity generation and hydrogen production in a single prototype nuclear reactor and plant; and	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-2-1-4	(D) carry out initial design activities for a prototype nuclear reactor and plant, including development of design methods and safety analytical methods and studies under subsection (a)(5).	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-2-2	(2) SECOND PROJECT PHASE- A second project phase shall be conducted to--	950 C 750 C	Pebble Bed Prismatic	EPAct2005	

Object #	Requirements ID	Legislative Requirements	Set	Reactor Type	Source	Source Section
	3.1.3-2-2-1	(A) continue appropriate activities under paragraphs (1) through (5) of subsection (a);	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-2-2-2	(B) develop, through a competitive process, a final design for the prototype nuclear reactor and plant;	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-2-2-3	(C) apply for licenses to construct and operate the prototype nuclear reactor from the Nuclear Regulatory Commission; and	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-2-2-4	(D) construct and start up operations of the prototype nuclear reactor and its associated hydrogen or electricity production facilities.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-3	(c) Project Requirements-	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-3-1	(1) IN GENERAL- The Secretary shall ensure that the Project is structured so as to maximize the technical interchange and transfer of technologies and ideas into the Project from other sources of relevant expertise, including--	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-3-1-1	(A) the nuclear power industry, including nuclear power plant construction firms, particularly with respect to issues associated with plant design, construction, and operational and safety issues;	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-3-1-2	(B) the chemical processing industry, particularly with respect to issues relating to--	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-3-1-2-1	(i) the use of process energy for production of hydrogen; and	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-3-1-2-2	(ii) the integration of technologies developed by the Project into chemical processing environments; and	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-3-1-3	(C) international efforts in areas related to the Project, particularly with respect to hydrogen production technologies.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-3-2	(2) INTERNATIONAL COLLABORATION-	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-3-2-1	(A) IN GENERAL- The Secretary shall seek international cooperation, participation, and financial contributions for the Project.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	

Object #	Requirements ID	Legislative Requirements	Set	Reactor Type	Source	Source Section
	3.1.3-3-2-2	(B) ASSISTANCE FROM INTERNATIONAL PARTNERS- The Secretary, through the Idaho National Laboratory, may contract for assistance from specialists or facilities from member countries of the Generation IV International Forum, the Russian Federation, or other international partners if the specialists or facilities provide access to cost-effective and relevant skills or test capabilities.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-3-2-3	(C) PARTNER NATIONS- The Project may involve demonstration of selected project objectives in a partner country.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-3-2-4	(D) GENERATION IV INTERNATIONAL FORUM- The Secretary shall ensure that international activities of the Project are coordinated with the Generation IV International Forum.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-3-3	(3) REVIEW BY NUCLEAR ENERGY RESEARCH ADVISORY COMMITTEE-	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-3-3-1	(A) IN GENERAL- The Nuclear Energy Research Advisory Committee of the Department (referred to in this paragraph as the NERAC') shall--	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-3-3-1-1	(i) review all program plans for the Project and all progress under the Project on an ongoing basis; and	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-3-3-1-2	(ii) ensure that important scientific, technical, safety, and program management issues receive attention in the Project and by the Secretary.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-3-3-2	(B) ADDITIONAL EXPERTISE- The NERAC shall supplement the expertise of the NERAC or appoint subpanels to incorporate into the review by the NERAC the relevant sources of expertise described under paragraph (1).	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-3-3-3	(C) INITIAL REVIEW- Not later than 180 days after the date of enactment of this Act, the NERAC shall--	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-3-3-3-1	(i) review existing program plans for the Project in light of the recommendations of the document entitled Design Features and Technology Uncertainties for the Next Generation Nuclear Plant,' dated June 30, 2004; and	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-3-3-3-2	(ii) address any recommendations of the document not incorporated in program plans for the Project.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	

Object #	Requirements ID	Legislative Requirements	Set	Reactor Type	Source	Source Section
	3.1.3-3-3-4	(D) FIRST PROJECT PHASE REVIEW- On a determination by the Secretary that the appropriate activities under the first project phase under subsection (b)(1) are nearly complete, the Secretary shall request the NERAC to conduct a comprehensive review of the Project and to report to the Secretary the recommendation of the NERAC concerning whether the Project is ready to proceed to the second project phase under subsection (b)(2).	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.3-3-3-5	(E) TRANSMITTAL OF REPORTS TO CONGRESS- Not later than 60 days after receiving any report from the NERAC related to the Project, the Secretary shall submit to the appropriate committees of the Senate and the House of Representatives a copy of the report, along with any additional views of the Secretary that the Secretary may consider appropriate.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
3.1.4		**SEC. 644. NUCLEAR REGULATORY COMMISSION.**			EPAct2005	
	3.1.4-1	(a) In accordance with section 202 of the Energy Reorganization Act of 1974 (42 U.S.C. 5842), the Nuclear Regulatory Commission shall have licensing and regulatory authority for any reactor authorized under this subtitle.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.4-2	(b) Licensing Strategy- Not later than 3 years after the date of enactment of this Act, the Secretary and the Chairman of the Nuclear Regulatory Commission shall jointly submit to the appropriate committees of the Senate and the House of Representatives a licensing strategy for the prototype nuclear reactor, including--	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.4-2-1	(1) a description of ways in which current licensing requirements relating to light-water reactors need to be adapted for the types of prototype nuclear reactor being considered by the Project;	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.4-2-2	(2) a description of analytical tools that the Nuclear Regulatory Commission will have to develop to independently verify designs and performance characteristics of components, equipment, systems, or structures associated with the prototype nuclear reactor;	950 C 750 C	Pebble Bed Prismatic	EPAct2005	

Object #	Requirements ID	Legislative Requirements	Set	Reactor Type	Source	Source Section
	3.1.4-2-3	(3) other research or development activities that may be required on the part of the Nuclear Regulatory Commission in order to review a license application for the prototype nuclear reactor; and	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.4-2-4	(4) an estimate of the budgetary requirements associated with the licensing strategy.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.4-3	(c) Ongoing Interaction- The Secretary shall seek the active participation of the Nuclear Regulatory Commission throughout the duration of the Project to--	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.4-3-1	(1) avoid design decisions that will compromise adequate safety margins in the design of the reactor or impair the accessibility of nuclear safety-related components of the prototype reactor for inspection and maintenance;	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.4-3-2	(2) develop tools to facilitate inspection and maintenance needed for safety purposes; and	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.4-3-3	(3) develop risk-based criteria for any future commercial development of similar reactor architectures.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
3.1.5		**SEC. 645. PROJECT TIMELINES AND AUTHORIZATION OF APPROPRIATIONS.**			EPAct2005	
	3.1.5-1	(a) Target Date to Complete the First Project Phase- Not later than September 30, 2011, the Secretary shall--	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.5-1-1	(1) select the technology to be used by the Project for high-temperature hydrogen production and the initial design parameters for the prototype nuclear plant; or	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.5-1-2	(2) submit to Congress a report establishing an alternative date for making the selection.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.5-2	(b) Design Competition for Second Project Phase-	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.5-2-1	The Secretary, acting through the Idaho National Laboratory, shall fund not more than 4 teams for not more than 2 years to develop detailed proposals for competitive evaluation and selection of a single proposal for a final design of the prototype nuclear reactor.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	

Object #	Requirements ID	Legislative Requirements	Set	Reactor Type	Source	Source Section
	3.1.5-2-2	(2) SYSTEMS INTEGRATION- The Secretary may structure Project activities in the second project phase to use the lead industrial partner of the competitively selected design under paragraph (1) in a systems integration role for final design and construction of the Project.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.5-3	(c) Target Date to Complete Project Construction- Not later than September 30, 2021, the Secretary shall--	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.5-3-1	(1) complete construction and begin operations of the prototype nuclear reactor and associated energy or hydrogen facilities; or	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.5-3-2	(2) submit to Congress a report establishing an alternative date for completion.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.5-4	(d) Authorization of Appropriations- There is authorized to be appropriated to the Secretary for research and construction activities under this subtitle (including for transfer to the Nuclear Regulatory Commission for activities under section 644 as appropriate)--	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.5-4-1	(1) $1,250,000,000 for the period of fiscal years 2006 through 2015; and	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	3.1.5-4-2	(2) such sums as are necessary for each of fiscal years 2016 through 2021.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
4		**TITLE VIII--HYDROGEN**			EPAct2005	
4.1		**SEC. 801. HYDROGEN AND FUEL CELL PROGRAM.**			EPAct2005	
5.2		**Subtitle E--Nuclear Energy**			EPAct2005	
5.2.1		**SEC. 952. NUCLEAR ENERGY RESEARCH PROGRAMS.**			EPAct2005	
	5.2.1-1	(a) Nuclear Energy Research Initiative- The Secretary shall carry out a Nuclear Energy Research Initiative for research and development related to nuclear energy.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.2.1-2	(b) Nuclear Energy Systems Support Program- The Secretary shall carry out a Nuclear Energy Systems Support Program to support research and development activities addressing reliability, availability, productivity, component aging, safety, and security of existing nuclear power plants.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.2.1-3	(c) Nuclear Power 2010 Program-	950 C 750 C	Pebble Bed Prismatic	EPAct2005	

Object #	Requirements ID	Legislative Requirements	Set	Reactor Type	Source	Source Section
	5.2.1-3-1	(1) IN GENERAL- The Secretary shall carry out a Nuclear Power 2010 Program, consistent with recommendations of the Nuclear Energy Research Advisory Committee of the Department in the report entitled A Roadmap to Deploy New Nuclear Power Plants in the United States by 2010' and dated October 2001.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.2.1-3-2	(2) ADMINISTRATION- The Program shall include--	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.2.1-3-2-1	(A) use of the expertise and capabilities of industry, institutions of higher education, and National Laboratories in evaluation of advanced nuclear fuel cycles and fuels testing;	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.2.1-3-2-2	(B) consideration of a variety of reactor designs suitable for both developed and developing nations;	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.2.1-3-2-3	(C) participation of international collaborators in research, development, and design efforts, as appropriate; and	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.2.1-3-2-4	(D) encouragement for participation by institutions of higher education and industry.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.2.1-4	(d) Generation IV Nuclear Energy Systems Initiative-	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.2.1-4-1	(1) IN GENERAL- The Secretary shall carry out a Generation IV Nuclear Energy Systems Initiative to develop an overall technology plan for and to support research and development necessary to make an informed technical decision about the most promising candidates for eventual commercial application.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.2.1-4-2	(2) ADMINISTRATION- In conducting the Initiative, the Secretary shall examine advanced proliferation-resistant and passively safe reactor designs, including designs that--	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.2.1-4-2-1	(A) are economically competitive with other electric power generation plants;	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.2.1-4-2-2	(B) have higher efficiency, lower cost, and improved safety compared to reactors in operation on the date of enactment of this Act;	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.2.1-4-2-3	(C) use fuels that are proliferation resistant and have substantially reduced production of high-level waste per unit of output; and	950 C 750 C	Pebble Bed Prismatic	EPAct2005	

Object #	Requirements ID	Legislative Requirements	Set	Reactor Type	Source	Source Section
	5.2.1-4-2-4	(D) use improved instrumentation.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.2.1-5	(e) Reactor Production of Hydrogen- The Secretary shall carry out research to examine designs for high-temperature reactors capable of producing large-scale quantities of hydrogen.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
5.3		**Subtitle I--Research Administration and Operations**			EPAct2005	
5.3.1		**SEC. 988. COST SHARING.**			EPAct2005	
	5.3.1-1	(a) Applicability- Notwithstanding any other provision of law, in carrying out a research, development, demonstration, or commercial application program or activity that is initiated after the date of enactment of this section, the Secretary shall require cost-sharing in accordance with this section.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.3.1-2	(b) Research and Development-	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.3.1-2-1	(1) IN GENERAL- Except as provided in paragraphs (2) and (3) and subsection (f), the Secretary shall require not less than 20 percent of the cost of a research or development activity described in subsection (a) to be provided by a non-Federal source.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.3.1-2-2	(2) EXCLUSION- Paragraph (1) shall not apply to a research or development activity described in subsection (a) that is of a basic or fundamental nature, as determined by the appropriate officer of the Department.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.3.1-2-3	(3) REDUCTION- The Secretary may reduce or eliminate the requirement of paragraph (1) for a research and development activity of an applied nature if the Secretary determines that the reduction is necessary and appropriate.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.3.1-3	(c) Demonstration and Commercial Application-	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.3.1-3-1	(1) IN GENERAL- Except as provided in paragraph (2) and subsection (f), the Secretary shall require that not less than 50 percent of the cost of a demonstration or commercial application activity described in subsection (a) to be provided by a non-Federal source.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	

Object #	Requirements ID	Legislative Requirements	Set	Reactor Type	Source	Source Section
	5.3.1-3-2	(2) REDUCTION OF NON-FEDERAL SHARE- The Secretary may reduce the non-Federal share required under paragraph (1) if the Secretary determines the reduction to be necessary and appropriate, taking into consideration any technological risk relating to the activity.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.3.1-4	(d) Calculation of Amount- In calculating the amount of a non-Federal contribution under this section, the Secretary--	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.3.1-4-1	(1) may include allowable costs in accordance with the applicable cost principles, including--	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.3.1-4-1-1	(A) cash;	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.3.1-4-1-2	(B) personnel costs;	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.3.1-4-1-3	(C) the value of a service, other resource, or third party in-kind contribution determined in accordance with the applicable circular of the Office of Management and Budget;	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.3.1-4-1-4	(D) indirect costs or facilities and administrative costs; or	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.3.1-4-1-5	(E) any funds received under the power program of the Tennessee Valley Authority (except to the extent that such funds are made available under an annual appropriation Act); and	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.3.1-4-2	(2) shall not include--	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.3.1-4-2-1	(A) revenues or royalties from the prospective operation of an activity beyond the time considered in the award;	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.3.1-4-2-2	(B) proceeds from the prospective sale of an asset of an activity; or	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.3.1-4-2-3	(C) other appropriated Federal funds.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.3.1-5	(e) Repayment of Federal Share- The Secretary shall not require repayment of the Federal share of a cost-shared activity under this section as a condition of making an award.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.3.1-6	(f) Exclusions- This section shall not apply to--	950 C 750 C	Pebble Bed Prismatic	EPAct2005	

Object #	Requirements ID	Legislative Requirements	Set	Reactor Type	Source	Source Section
	5.3.1-6-1	(1) a cooperative research and development agreement under the Stevenson-Wydler Technology Innovation Act of 1980 (15 U.S.C. 3701 et seq.);	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.3.1-6-2	(2) a fee charged for the use of a Department facility; or	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.3.1-6-3	(3) an award under--	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.3.1-6-3-1	(A) the small business innovation research program under section 9 of the Small Business Act (15 U.S.C. 638); or	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
	5.3.1-6-3-2	(B) the small business technology transfer program under that section.	950 C 750 C	Pebble Bed Prismatic	EPAct2005	
6		**"A Review of the NGNP Project"**			NERAC	
6.1		**APPENDIX A: EPACT CHARGE to NERAC for NGNP REVIEW**			NERAC	APPENDIX A: EPACT CHARGE to NERAC for NGNP REVIEW
6.1-1		**(3) REVIEW BY NUCLEAR ENERGY RESEARCH ADVISORY COMMITTEE-**			NERAC	APPENDIX A: EPACT CHARGE to NERAC for NGNP REVIEW
	6.1-1-1	(A) IN GENERAL- The Nuclear Energy Research Advisory Committee of the Department (referred to in this paragraph as the 'NERAC') shall -	950 C 750 C	Pebble Bed Prismatic	NERAC	APPENDIX A: EPACT CHARGE to NERAC for NGNP REVIEW
	6.1-1-1-1	(i) review a11 program plans for the Project and a11 progress under the Project on an ongoing basis; and	950 C 750 C	Pebble Bed Prismatic	NERAC	APPENDIX A: EPACT CHARGE to NERAC for NGNP REVIEW
	6.1-1-1-2	(ii) ensure that important scientific, technical, safety, and program management issues receive attention in the Project and by the Secretary.	950 C 750 C	Pebble Bed Prismatic	NERAC	APPENDIX A: EPACT CHARGE to NERAC for NGNP REVIEW

Object #	Requirements ID	Legislative Requirements	Set	Reactor Type	Source	Source Section
	6.1-1-2	(B) ADDITIONAL EXPERTISE- The NERAC shall supplement the expertise of the NERAC or appoint subpanels to incorporate into the review by the NERAC the relevant sources of expertise described under paragraph (I).	950 C 750 C	Pebble Bed Prismatic	NERAC	APPENDIX A: EPACT CHARGE to NERAC for NGNP REVIEW
	6.1-1-3	(C) INITIAL REVIEW- Not later than 180 days after the date of enactment of this Act, the NERAC shall -	950 C 750 C	Pebble Bed Prismatic	NERAC	APPENDIX A: EPACT CHARGE to NERAC for NGNP REVIEW
	6.1-1-3-1	(i) review existing program plans for the Project in light of the recommendations of the document entitled 'Design Features and Technology Uncertainties for the Next Generation Nuclear Plant,' dated June 30, 2004; and	950 C 750 C	Pebble Bed Prismatic	NERAC	APPENDIX A: EPACT CHARGE to NERAC for NGNP REVIEW
	6.1-1-3-2	(ii) address any recommendations of the document not incorporated in program plans for the Project.	950 C 750 C	Pebble Bed Prismatic	NERAC	APPENDIX A: EPACT CHARGE to NERAC for NGNP REVIEW
	6.1-1-4	(D) FIRST PROJECT PHASE REVIEW- On a determination by the Secretary that the appropriate activities under the first project phase under subsection (b)(l) are nearly complete, the Secretary shall request the NERAC to conduct a comprehensive review of the Project and to report to the Secretary the recommendation of the NERAC concerning whether the Project is ready to proceed to the second project phase under subsection (b)(2).	950 C 750 C	Pebble Bed Prismatic	NERAC	APPENDIX A: EPACT CHARGE to NERAC for NGNP REVIEW
	6.1-1-5	(E)TRANSMITTAL OF REPORTS TO CONGRESS- Not later than 60 days after receiving any report from the NERAC related to the Project, the Secretary shall submit to the appropriate committees of' the Senate and the House of Representatives a copy of the report, along with any additional views of the Secretary that the Secretary may consider appropriate.	950 C 750 C	Pebble Bed Prismatic	NERAC	APPENDIX A: EPACT CHARGE to NERAC for NGNP REVIEW

A-3. End User Requirements

No requirements currently exist.

A-4. Stakeholder Requirements

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
2		**NGNP TOP-LEVEL REQUIREMENTS**				3. NGNP TOP-LEVEL REQUIREMENTS
2.1		**NGNP Program Requirements**				3.2 NGNP Program Requirements
2.1.1		**Overall Objectives**				3.2.1 Overall Objectives
	2.1.1-2	The plant shall be capable of completing design, licensing, construction, and startup testing for initial operation by 2021.	950 C 750 C	Pebble Bed Prismatic	SAG	Meeting Agreements October 22, 2008
	2.1.1-3	The NGNP Project mission is the development of a full-scale commercial plant demonstration that provides (a) high-efficiency electricity generation and (b) CO2-free hydrogen production based on high temperature, modular gas-cooled, graphite moderated reactor technology as the heat source. The mission need statement developed for NGNP was approved by the DOE Deputy Secretary on October 18, 2004, officially completing CD-0.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.1 NGNP Mission Need
	2.1.1-5	Establish the basis for licensing the commercial version of the NGNP by the Nuclear Regulatory Commission (NRC). This will be achieved in major part through licensing of the prototype by the NRC and initiating the process for certification of the nuclear system design.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.1 NGNP Mission Need
	2.1.1-6	Foster rebuilding of the U.S. nuclear industrial infrastructure and contributing to making the U.S. industry self-sufficient for our nuclear energy production needs.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.1 NGNP Mission Need
2.1.2		**NGNP Project Requirements**				3.2.2 NGNP Project Requirements
	2.1.2-10	Costs for anticipated “Nth”-of-a-kind (NOAK), based on design certification, construction, and operation of first-of-a-kind (FOAK) design, shall support a viable economic business model (competitive with natural gas price at $8/MMBtu)	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.2.2 HTGR Fundamental Requirements

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
	2.1.2-12a	Because the NGNP will be built within a DOE facility and will interface with other existing facilities, the plant designer shall evaluate DOE orders to ensure that the NGNP can interface with the DOE site.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.10 Codes and Standards Requirements
	2.1.2-12b	Because the NGNP will be built within a DOE facility and will interface with other existing facilities, the plant designer shall evaluate DOE orders to ensure that it is acceptable to DOE.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.10 Codes and Standards Requirements
3		**NGNP Project Scope**				1.2 NGNP Project Scope
	3-1-4a	The NGNP project shall identify, technology development and system confirmatory and verification tasks needed for design.				1.4 Project Description
	3-1-4b	The NGNP project shall identify, technology development and system confirmatory and verification tasks needed for licensing.				1.4 Project Description
	3-1-4c	The NGNP project shall identify, technology development and system confirmatory and verification tasks needed for, construction,.				1.4 Project Description
	3-1-4d	The NGNP project shall identify, technology development and system confirmatory and verification tasks needed for design, licensing, construction, and testing at power				1.4 Project Description
	3-1-4e	The NGNP project shall integrate technology development and system confirmatory and verification tasks needed for design.				1.4 Project Description
	3-1-4f	The NGNP project shall integrate technology development and system confirmatory and verification tasks needed for licensing,.				1.4 Project Description
	3-1-4g	The NGNP project shall integrate technology development and system confirmatory and verification tasks needed for construction.				1.4 Project Description
	3-1-4h	The NGNP project shall integrate technology development and system confirmatory and verification tasks needed for design, licensing, construction, and testing at power				1.4 Project Description
	3-1-4i	The NGNP project shall complete technology development and system confirmatory and verification tasks needed for testing at power.				1.4 Project Description
	3-1-6	The NGNP project shall complete all federal permitting required for operation, including support for DOE National Environmental Policy Act (NEPA) activities.				1.4 Project Description

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
	3-1-6	The NGNP project shall complete all state permitting required for construction, including support for DOE National Environmental Policy Act (NEPA) activities.				1.4 Project Description
	3-1-6	The NGNP project shall complete all federal permitting required for operation, including support for DOE National Environmental Policy Act (NEPA) activities.				1.4 Project Description
	3-1-6	The NGNP project shall complete all state permitting required for construction, including support for DOE National Environmental Policy Act (NEPA) activities.				1.4 Project Description
5		**Pre-Conceptual Design Scope, Planning, and Execution**				2.1 Pre-Conceptual Design Scope, Planning, and Execution
5-1.1		**Pre-Conceptual Design Project Requirements**				3.2.1 NGNP Project Requirements at Pre-Conceptual Design
	5-1.1-1	NGNP shall be designed, constructed, licensed, and operating by 2021.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.2.1 NGNP Project Requirements at Pre-Conceptual Design
	5-1.1-2	NGNP design configuration shall consider cost and risk profiles to ensure that NGNP establishes a sound foundation for future commercial deployment.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.2.1 NGNP Project Requirements at Pre-Conceptual Design
	5-1.1-3	NGNP shall be licensed by the NRC as a commercial cogeneration facility producing electricity and hydrogen.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.2.1 NGNP Project Requirements at Pre-Conceptual Design

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
	5-1.1-4	The project shall include identification of necessary and sufficient research and development technical scope and priorities.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.2.1 NGNP Project Requirements at Pre-Conceptual Design
	5-1.1-5	NGNP licensing shall support potential future NRC technology neutral rule-making activities (i.e., Risk-Informed, Performance-Based Alternative to 10 CFR Part 50).	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.2.1 NGNP Project Requirements at Pre-Conceptual Design
7		**"A Review of the NGNP Project"**			NERAC	
7.1		**The subcommittee recommends a series of actions to make the NGNP program as effective as possible.**			NERAC	Executive Summary
	7.1-1a	The current mission for the NGNP is to design and build a reactor that generates electricity and produces hydrogen. The subcommittee recommends that this dual mission shall be reconsidered and not be accepted without further analysis.	950 C 750 C	Pebble Bed Prismatic	NERAC	Executive Summary
	7.1-1b	The subcommittee further recommends that this analysis be done as outlined in the following discussion.	950 C 750 C	Pebble Bed Prismatic	NERAC	Executive Summary
	7.1-2	The DOE-NE staff shall conduct, with the assistance of key industry representatives, economic and engineering trade studies that consider:	950 C 750 C	Pebble Bed Prismatic	NERAC	Executive Summary
	7.1-3	The targets for hydrogen production for various scenarios over the next few decades;	950 C 750 C	Pebble Bed Prismatic	NERAC	Executive Summary
	7.1-4	The DOE target for hydrogen production via nuclear power in this overall context;	950 C 750 C	Pebble Bed Prismatic	NERAC	Executive Summary
	7.1-5	The likely hydrogen production and electricity production alternatives and how those alternatives would be factored into determining the proper mission for the NGNP.	950 C 750 C	Pebble Bed Prismatic	NERAC	Executive Summary
	7.1-6	The selection of the ultimate NGNP mission can drive the reactor design in different directions. The subcommittee recommends that these trade studies be funded, initiated immediately and completed as soon as possible.	950 C 750 C	Pebble Bed Prismatic	NERAC	Executive Summary

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
	7.1-7	DOE shall develop the NGNP as a reactor facility that can be upgraded as the technology advances. Conceptually, the facility would be built using a smaller reactor, carefully choosing the scale to be the smallest reactor that could be reasonably extrapolated to support full size commercial applications, as a 'technology demonstrator'.	950 C 750 C	Pebble Bed Prismatic	NERAC	Executive Summary
	7.1-8	The DOE-NE staff shall update its R&D plans and develop options that can support a reactor deployment much before the 2017-2021 timeframe. EPACT requires the overall cost of the NGNP project be shared with U.S. industry as well as members of the international community. The subcommittee believes that the chances of substantial industrial contributions and international collaborations to NGNP are greatly decreased with a completion target date of 2021.	950 C 750 C	Pebble Bed Prismatic	NERAC	Executive Summary
	7.1-8	These plans should enhance the ITRG perspective that to achieve a successful project even in the later time period, less aggressive project objectives must be adopted; e.g., for reactor outlet temperatures, fuel selection and performance.	950 C 750 C	Pebble Bed Prismatic	NERAC	Executive Summary
7.2		**IV. NERAC Committee Review Approach**			NERAC	IV. NERAC Committee Review Approach
7.3		**V. NGNP Technology Mission**			NERAC	V. NGNP Technology Mission
	7.3-1	The subcommittee recommends that the NGNP dual mission shall be reconsidered and not be accepted without further analysis. There are several reasons for this conclusion:	950 C 750 C	Pebble Bed Prismatic	NERAC	V. NGNP Technology Mission
7.5		**VII. ITRG NGNP Recommendations**			NERAC	VII. ITRG NGNP Recommendations
7.6		**VIII. NGNP Research and Development Program Plan**			NERAC	VIII. NGNP Research and Development Program Plan

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
	7.6-3-1	An integrated schedule shall be developed of all planned activities, similar to the computer-based scheduling program currently used by DOE staff for the Nuclear Hydrogen program. This integrated schedule and associated work breakdown structure can be used to identify a baseline R&D plan for highest priority R&D activities (and assess the impact of alternative/additional R&D tasks). Such a schedule should facilitate the adjustments that will be needed to the NGNP R&D program after its mission is selected.	950 C 750 C	Pebble Bed Prismatic	NERAC	VIII. NGNP Research and Development Program Plan
	7.6-3-2	A series of structured workshops with industry, regulatory, laboratory, and international representatives shall be conducted to discuss the following:	950 C 750 C	Pebble Bed Prismatic	NERAC	VIII. NGNP Research and Development Program Plan
	7.6-3-2-1	Trade study results to select the NGNP's mission	950 C 750 C	Pebble Bed Prismatic	NERAC	VIII. NGNP Research and Development Program Plan
	7.6-3-2-2	Design optimization studies to meet the selected NGNP mission (e.g., plant power level, fuel configuration, fuel material, operating temperatures, structural materials)	950 C 750 C	Pebble Bed Prismatic	NERAC	VIII. NGNP Research and Development Program Plan
	7.6-3-2-3	R&D program elements (analysis codes and associated data needs, materials research, fuels development and certification). As noted below, steering committees may be required to ensure that appropriate parties provide continued input in some of these areas.	950 C 750 C	Pebble Bed Prismatic	NERAC	VIII. NGNP Research and Development Program Plan
	7.6-3-2-4	Appropriate cost sharing by NGNP stakeholders (industry, international, regulatory agencies, DOE)	950 C 750 C	Pebble Bed Prismatic	NERAC	VIII. NGNP Research and Development Program Plan

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
	7.6-3-3	Materials R&D: The subcommittee is aware that there is also research being conducted in this area in the nuclear hydrogen program and recommends that the work for NGNP be better coordinated with that work to avoid overlap and assure the work is complementary. After trade studies are completed and an NGNP mission selected, the following items should be considered:	950 C 750 C	Pebble Bed Prismatic	NERAC	VIII. NGNP Research and Development Program Plan
	7.6-3-3-1	Focus on key material research needs. For example, if hydrogen production were selected as the key mission and an Intermediate Heat Exchanger (IHX) concept were included in the optimized design for that mission, the use of developmental materials should be limited to the IHX (and a systematic evaluation should be conducted to identify an appropriate material for the IHX operating conditions and develop a "code case" for the identified material). To the extent possible, the remainder of the plant should rely on conventional, proven materials.	950 C 750 C	Pebble Bed Prismatic	NERAC	VIII. NGNP Research and Development Program Plan
	7.6-3-3-2	Graphite certification activities, which are required irrespective of the NGNP mission and reactor design, shall be reviewed and accelerated so that an appropriate material is certified within the required timeframe for deployment.	950 C 750 C	Pebble Bed Prismatic	NERAC	VIII. NGNP Research and Development Program Plan
7.6-3-4		**Design Methods**	950 C 750 C	Pebble Bed Prismatic	NERAC	VIII. NGNP Research and Development Program Plan
	7.6-3-4-1	Using results from Item 2 workshops, identify analysis tools of interest and areas where data are needed for developing, verifying and validating these codes.	950 C 750 C	Pebble Bed Prismatic	NERAC	VIII. NGNP Research and Development Program Plan
	7.6-3-4-2	Develop a joint USNRC/industry/regulatory NGNP steering group to define required tests, needed facilities, and data to be collected (including parameter definition, accuracy, etc.). Determine data quality level and need for sequestering some data for use with "blind" predictions.	950 C 750 C	Pebble Bed Prismatic	NERAC	VIII. NGNP Research and Development Program Plan

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
	7.6-3-4-3	Define appropriate cost sharing required by industry, regulatory, DOE, and international organizations to complete such tests.	950 C 750 C	Pebble Bed Prismatic	NERAC	VIII. NGNP Research and Development Program Plan
	7.6-3-5	Plant Operations - The need to potentially couple two diverse processes (electric power generation and hydrogen production) complicates the dual mission and the differing dynamic responses of the reactor plant and the hydrogen production process or the electricity production process must be carefully assessed for the single mission project. Design and analytical studies need to be performed to investigate possible configurations and control schemes. The results of these studies will provide insights as to the reactor design conditions, provision of direct versus indirect process heat cycles, etc. (The subcommittee is aware that the there is also research in this area being performed under the nuclear hydrogen program, which is also managed by DOE-NE; the work for NGNP should be coordinated with that work to avoid overlap and assure the work is complementary.)	950 C 750 C	Pebble Bed Prismatic	NERAC	VIII. NGNP Research and Development Program Plan
	7.6-3-6	Safety and Licensing - A conversation should be begun with the NRC regarding the key aspects of safety and licensing that need to be addressed if the NGNP were deployed prior to the 2017-2021 timeframe. The subcommittee notes that the NRC staff has already begun a concerted effort for a "technology-neutral" licensing framework that the NGNP project can utilize as initial guidance (SECY-05-0130). However, this staff document has not yet been adopted by the NRC commission, but is under on-going discussion and review by the NRC staff and ACRS.	950 C 750 C	Pebble Bed Prismatic	NERAC	VIII. NGNP Research and Development Program Plan

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
	7.6-3-7	Fuels Development - The Subcommittee notes this is a complex subject area. The ITRG recommended that the NGNP fuel R&D program focus on UO2, which has the largest experience base worldwide, instead of its current focus on UCO fuel, which is also TRISO fuel but with kernels that have a mixture of UO2 and UC fuel particles. U.S. and international experts concur that UCO fuel has the potential to exhibit superior performance over the UO2 kernel fuel. If UCO can be successfully developed and demonstrated, including developing and proving the needed manufacturing methods and parameters, it should allow higher burn-ups, operate at higher power densities, and release less fission products at higher accident temperatures. The use of UCO fuel is particularly important to the eventual economic success of reactors with prismatic fuel, as compared to the pebble bed fuel, since the prismatic reactor pushes the fuel harder to avoid the undesirable complexity of the pebble bed reactor's refueling scheme. Nevertheless, UCO fuel would confer performance advantages on both reactors and if it worked would likely be adopted for both.	950 C 750 C	Pebble Bed Prismatic	NERAC	VIII. NGNP Research and Development Program Plan

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
	7.6-3-7-1	However, UCO fuel performance is not proven and requires fundamental research and development to establish that its properties are superior to UO2. In addition, R&D is required to demonstrate that it is possible to manufacture fuel of the requisite quality, get it accepted by the regulator and then produce the large quantity of fuel needed to load the reactor. UO2 fuel is much further along in this process. The international community, (France, South Africa, China, Japan) have focused on first demonstrating their ability to fabricate UO2 and demonstrating that it meets the required performance. Once this is accomplished, they will consider going forward with UCO. In the near term, it appears they would be willing to cooperate with the US on work on UO2, but are less enthused about UCO cooperation because obtaining a successful and proven capability in UO2 for TRISO fuel is such a large undertaking (of the same order as the cost and of longer duration than building the capability to manufacture the reactor plant). Once UO2 can be manufactured successfully and is proven to the regulators, the international community plans to adapt their approach to UCO, which can then be loaded into existing and future reactors as desired. That is, the international community de-couples the reactor design, construction, and operation processes from the need to successfully develop UCO.	950 C 750 C	Pebble Bed Prismatic	NERAC	VIII. NGNP Research and Development Program Plan
9		**NGNP PEP**			PEP	
10		**NAS Review**			NAS	
10.1		**Summary**			NAS	Summary
	10.1-1	Deployment and Infrastructure Issues	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
	10.1-1-1	NE shall immediately initiate a cooperative project with industry to identify problems that have arisen in the construction and start-up of new plants and define best practices for use by the industry.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
	10.1-1-2	DOE shall fund a taskforce to work with industry groups on construction technology and planning to ensure that consortia construction time goals of 4 years or less will be met.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
10.1-2		**Next-Generation Nuclear Plant**			NAS	Summary
	10.1-2-3	The main risk associated with NGNP is that the current business plan calls for the private sector to match the government (DOE) funding. So far, however, not a single program has been articulated that coordinates all the elements required to successfully commission the NGNP. The current disconnect between the base NGNP program plan and the complementary public/private partnership initiative must be resolved. DOE shall decide whether to pursue a different demonstration with a smaller contribution from industry or, alternatively, a more basic technology approach for the VHTR.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
	10.1-2-4	In assessing NGNP conceptual designs, NE shall favor design approaches that can achieve a variety of objectives at an acceptable technical risk.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
	10.1-2-5	NE shall size the NGNP reactor system to facilitate technology demonstration for future commercial units, including safety.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
	10.1-2-6	Because of the very high temperatures and severe material performance requirements for thermo chemical water splitting, NE shall maintain the flexibility to first operate the NGNP using high-temperature steam electrolysis.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
	10.1-2-7a	DOE shall focus on developing advanced materials for in-reactor operation at temperatures above 900ºC and fuel particles that can withstand high burn-up and adverse transients.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
	10.1-2-7b	NE shall ensure that sufficient funds are available to advance these technologies whether or not industry matching funds are available.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
	10.1-2-8	To ensure the good performance of hydrogen produced in an NGNP, NE shall put more emphasis on the following:	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
	10.1-2-9	• Conceptual integrated process development and optimizing plan flow sheets, before moving to engineering designs.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
	10.1-2-10	• Selecting the interface between the reactor and the hydrogen plant.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
	10.1-2-11	• Developing system performance tools to address unsteady conditions, such as plant start-up, plant trip, and maintenance needs.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
	10.1-2-12	• Assessment of total system economics.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
10.1-3		**Nuclear Hydrogen Initiative**			NAS	Summary
	10.1-3-2	DOE shall expand NHI program interactions with industrial and international research organizations experienced in chemical processes and operating temperatures similar to those in thermo chemical water splitting. NE should also broaden the hydrogen production system performance metrics beyond economics-for example, it could use the Generation IV performance metric of economics, safety, and sustainability.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
10.1-4		**Other Generation IV Nuclear Energy System Programs**			NAS	Summary
	10.1-4-1	Within the Generation IV program, NE shall modestly and reasonably support long-term base technology options other than the VHTR and the SFR, particularly for actinide management, using thermal and fast reactors and appropriate fuels.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
	10.1-4-2	Though NE currently focuses on the VHTR for process heat and the SFR for advanced fuel cycles, it should assess the cost-benefit of a single reactor system to meet both needs.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
10.1-5		**IDAHO NATIONAL LABORATORY**			NAS	Summary
	10.1-5-2	NE shall set up and document a process for evaluating alternative approaches for accomplishing NE-sponsored activities, assigning these tasks appropriately, and avoiding duplication.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
	10.1-5-3	NE shall set up a formal, high-level working group jointly with the Idaho Operation Office (ID) and INL (Battelle Energy Alliance [BEA]). Consideration should be given to also having one or more knowledgeable outsiders participate on an ongoing basis to provide a wider perspective.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
	10.1-5-4	For INL to accomplish its expected mission, a number of large, sophisticated and unique facilities will be needed. These could include large hot cells and associated laboratories for post-irradiation examination of materials and test reactors such as the Advanced Test Reactor (ATR). The intent is for INL to have magnet facilities attracting researchers and industrial users. For these facilities to attract users, the full costs cannot be charged, and the user would pay only the justified incremental costs associated with use. This arrangement is typical of user facilities in the Office of Science laboratories.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
	10.1-5-5	The NE/INL budgeting system and the budget documents themselves are opaque and hard to understand. It is difficult to trace budget amounts to particular projects and programs or to specific activities within the INL sub budget. The committee concludes that a much more transparent, structured planning and budgeting process is needed.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
	10.1-5-6	NE, ID, and INL (BEA) shall agree on a multiyear, resource-loaded, high-level schedule and plan for the INL facilities, such as the Primavera Project Planner (P3).	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
	10.1-5-7	NE, ID, and INL (BEA) shall improve the form and content of the INL facilities budget documentation. They should support a much more transparent, structured planning and budget process. Budget items should be readily traceable to specific items in the overall plan and schedule.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
	10.1-5-8a	NE shall meet with DOE and National Nuclear Security Administration organizations that are PSOs for other laboratories to review and discuss their practices and processes.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
	10.1-5-8b	Based on the lessons they learned, it should develop and document its own internal processes and procedures for discharging its responsibilities as the lead PSO for INL.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
10.1-6		**PROGRAM PRIORITIES, BALANCE, AND OVERSIGHT**			NAS	Summary
10.1-6-1		**Program Balance**			NAS	Summary

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
	10.1-6-1-1	• University infrastructure support. A sizeable buildup in nuclear energy production, research, and development necessitates strengthening university capabilities to educate a growing number of young professionals and scientists in the relevant areas. DOE should include this program in its budget at the levels authorized by the Energy Policy Act of 2005.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
	10.1-6-1-2	• INL. It is essential to provide reasonable and predictable funding to support the PSO responsibility for site condition and capacity building. DOE should create a strategic plan based on concepts laid out in Chapter 6 (see Table 6-2) to establish the target funding level for the Idaho Facilities Management account.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
	10.1-6-2	Program Oversight	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
	10.1-6-2-1	Recommendation. As a counterbalance to the short-term nature of the federal budget process, NE should adopt an oversight process for evaluating the adequacy of program plans, evaluating progress against these plans and adjusting resource allocations as planned decision points are reached.	950 C 750 C	Pebble Bed Prismatic	NAS	Summary
10.2		**The Generation IV and Nuclear Hydrogen Initiative Programs**			NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
10.2-1		**NEXT-GENERATION NUCLEAR PLANT**			NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
10.2-1-1		**Program Description**			NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
	10.2-1-1-1	The NGNP program is authorized under EPAct05 at total funding of $1.25 billion for Phase I, which extends to 2011. During this phase, fundamental R&D would be carried out for the associated technologies and components. This includes the reactor and its fuel, the energy conversion system, materials, and hydrogen generation technologies. In addition, certain fundamental decisions are to be made, including selection of the mission of the NGNP (efficient electricity production, process heat, hydrogen generation, or a combination of these) and the specific hydrogen generation technology. EPAct05 also discusses Phase II, which extends from 2012 to 2021 and wherein a detailed design should be competitively developed, a license should be obtained from the U.S. Nuclear Regulatory Commission (USNRC), and the plant should be constructed and commissioned.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
	10.2-1-1-2	According to EPAct05, the program will be based on the R&D activities of the Generation IV program, the Idaho National Laboratory (INL) will be the lead national laboratory, and the NGNP demonstration will be sited at INL. INL is charged to organize a consortium of industrial partners to cost-share the project. The NGNP project is to maximize technical exchange and transfer from other relevant sources, including other industries and international Generation IV partners.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
10.2-1-2		**HTR/NGNP Technology Challenges and Development Needs**			NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
10.2-1-2-1-2		**Fuels Development and Requirements**			NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
10.2-1-2-1-4		**Plant Operations**			NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
10.2-1-2-1-5		**Safety and Licensing**			NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
	10.2-1-2-1-5-1	There shall be a discussion with the USNRC on the key aspects of safety and licensing that should be addressed if the NGNP is deployed in the 2017 to 2021 time frame. It is known that USNRC staff has already begun to develop a technology-neutral licensing framework that the NGNP project can use as initial guidance (SECY-05-0130). However, this staff document has not yet been adopted by the USNRC but is still being reviewed by the staff and the Advisory Committee on Reactor Safeguards. EPAct05 requires that DOE and USNRC develop a joint approach to licensing NGNP by August 2008. This activity is currently under way with inputs from the Phase 1 NGNP program. The DOE-USNRC discussions related to NGNP licensing are focused on defining the approach that will be used. It is possible the technology-neutral approach will be used, but it is not clear if that approach would be ready in time for the engineering phase of the NGNP. In addition, the PBMR is currently in pre-application review for design certification by the USNRC. The issues being addressed are generic to HTR licensing, and this effort will provide a tangible forum in which to make progress on a licensing strategy for NGNP.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
10.2-1-2-1-6		**Fuel Cycle and Waste Technology**			NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
10.2-1-3		**NGNP Evaluation**			NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
	10.2-1-3-1-1	The program is designed to develop an advanced new reactor that can provide process heat and/or electricity. The cogeneration function appears to be a complication since electricity might be generated more economically by advanced LWRs. However, no other nuclear technology can generate the high temperatures needed for the broad range of process heat applications discussed. It has been recommended by NERAC that this dual mission be reconsidered and not be accepted without further analysis. It was felt that the dual mission would drive the design, increase the cost of the program, and extend the schedule. It is important to maintain flexibility in the sizing of the NGNP reactor to facilitate obtaining the needed international collaboration or co-funding by end users. Furthermore, while a dual-purpose mission would not be necessary for future commercial plants, it could serve as an engineering-scale heat exchanger for the NGNP plant to demonstrate the viability of coupling of a nuclear plant with a hydrogen production plant.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
	10.2-1-3-4-1	The budget for NGNP currently requested by DOE is not adequate to meet the preferred schedule: To remedy this state of affairs, a significant ramp-up of roughly $100 million per year would be required within 1 or 2 years. The budget for FY 2008 should be at least $60 million if the program is to be launched on a trajectory that will meet the 2017 operations date. DOE’s notional budget projection for the next 6 years is only about 20 percent of what is required to meet the stated schedule. The budgets for NHI are also probably not adequate if this preferred schedule is to be maintained. Finally, it is imperative that private sector funding be brought into the program to supplement the required research, development, and demonstration. The technology partners must be selected and end users must be convinced to join the public/private partnership at significant levels.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
	10.2-1-3-5-1	Since the long-term performance goals are not fully established-for example, the final temperature design for the VHTR is not defined-it is not possible to judge the NGNP's program on this criterion yet. The actual NGNP program remains in an early formative stage. This criterion should be held in abeyance until more progress is made on the program.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
10.2-2		**NUCLEAR HYDROGEN INITIATIVE**			NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
10.2-2-1		**Nuclear Hydrogen Production**			NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
10.2-2-3		**Nuclear Hydrogen Initiative Evaluation**			NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
	10.2-2-3-1-1	Much of the current NHI R&D is university based, which is appropriate for many aspects of the current laboratory-scale R&D. However, as integrated experiments are started, an increasing fraction of the program support will need to be directed to the national laboratories and industrial participants in the program. More attention to industrial-scale implications of the technology is needed, starting with studying the implications of operating conditions for cost, reliability, and safety.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
	10.2-2-3-3	The NHI program is evaluated using the Generation IV program performance measures. For the NHI program, the economics and the safety and reliability criteria are the most important. However, specific metrics for evaluating performance have not been established. The committee recommends that the NHI program select specific economic metrics that can be linked to the cost of hydrogen produced by competing technologies, such as natural gas steam reforming. It is reasonable that until materials and fabrication methods have been identified for all of the major system components, a great deal of uncertainty will surround these evaluations. The design information will become available once decisions have been made before entering the pilot-scale demonstration phase in 2011. These decisions should be based on the potential to meet specific economic criteria.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
10.2-3		**OTHER GENERATION IV REACTOR NUCLEAR ENERGY SYSTEMS**			NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
10.2-3-1		**Other Generation IV System Program Descriptions**			NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
	10.2-3-1-1	Crosscutting R&D can benefit more than one reactor concept. Important fundamental information is needed in the following crosscutting areas:	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
	10.2-3-1-1-1	• Data to validate the models for the effects of irradiation on materials characteristics since the expected service time for nuclear power plants has effectively become at least 60 years and could soon be as much as 80 years.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
	10.2-3-1-1-2	• Data on the behavior of UO2 and nonfertile (neutronically inert) actinide-bearing fuels operating at high temperatures for long times. For example, ceria, magnesia, and zirconia could be used in the Generation IV reactors to host the actinide fuel.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
	10.2-3-1-1-3	• Information on advanced energy conversion systems, including equipment that interfaces between the coolant and the turbine working fluids in advanced cycles, such as the supercritical CO2 power cycle.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
	10.2-3-1-1-4	• Information on the application of technology-neutral approaches to reactor licensing and advances in the regulatory system to include performance-based criteria for monitoring.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
10.2-4		**FINDINGS AND RECOMMENDATIONS**			NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
10.2-4-1		**Next-Generation Nuclear Plant**			NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
	10.2-4-1-4	A schedule that coordinates the required elements for public-private partnership, design evolution, defined regulatory approach, and R&D results should be articulated to enhance the potential for program success.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
	10.2-4-1-5	DOE should decide whether to pursue a different demonstration plant (perhaps a smaller one with less total energy output or a plant with fewer hydrogen production options or a more basic technology approach for the VHTR) with a smaller contribution from industry.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
	10.2-4-1-6	In assessing NGNP conceptual designs, NE should favor design approaches that can achieve a variety of objectives at an acceptable technical risk-for example, hydrogen production, other high-temperature process heat products, enabling deep-burn actinide management, and improving economics.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
	10.2-4-1-7	NE should size the NGNP reactor system to facilitate technology demonstration for future commercial units, including safety. Consistent with resources available, NE should adopt an appropriate power level to demonstrate components and functionality of practical significance to commercial size.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
	10.2-4-1-8	Because of the very high temperatures and severe material performance requirements for thermo chemical water splitting, NE should maintain the flexibility to first operate the NGNP using high-temperature steam electrolysis.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
	10.2-4-1-9	DOE should focus on the following NGNP technologies that require significant development and ensure that sufficient funds are available to advance these technologies whether or not industry matching funds are available:	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
	10.2-4-1-10	• Advanced materials for in-reactor operation at temperatures above 900ºC.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
	10.2-4-1-11	• Fuel particles that can withstand high burn-up and adverse transients.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
	10.2-4-1-12	• The heat transport system for process heat applications, specifically to improve its efficiency and reliability.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
	10.2-4-1-13	• Waste management technologies related to commercial deployment.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
	10.2-4-2	Nuclear Hydrogen Initiative			NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
	10.2-4-2-1	NHI is well formulated to identify and develop workable technologies, but the schedules and budgets need to be adjusted to assure appropriate coupling to the larger NGNP program.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
	10.2-4-2-3	DOE should expand NHI program interactions with industrial and international research organizations experienced in chemical processes and operating temperatures similar to those in thermo chemical water splitting. NE should also broaden the hydrogen production system performance metrics beyond economics-for example, it could use the Generation IV performance metrics of economics, safety, and sustainability.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
	10.2-4-3	Other Generation IV Nuclear Energy System Programs			NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
	10.2-4-3-1	Within the Generation IV program, NE should modestly and reasonably support long-term base technology options other than the VHTR and the SFR, particularly for actinide management, using thermal and fast reactors and appropriate fuels.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
	10.2-4-3-2	Though NE currently focuses on the VHTR for process heat and the SFR for advanced fuel cycles, it should assess the cost-benefit of a single reactor system design to meet both needs.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
	10.2-4-3-3	Funding for NGNP and NHI should be increased if the schedule is to be accelerated to attract more industrial support.	950 C 750 C	Pebble Bed Prismatic	NAS	3. The Generation IV and Nuclear Hydrogen Initiative Programs
2		**Requirements Applicable to Multiple Systems, Buildings and Structures**			SRM Rev 2	4.1 Requirements Applicable to Multiple Systems, Buildings and Structures
2.1		**Operational Requirements**			SRM Rev 2	4.1.2 Operational Requirements
	2.1-3	The NGNP shall demonstrate a minimum 18-month refueling interval capability (if applicable).	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.2 Operational Requirements

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
	2.1-4	The NGNP shall implement the technologies important to achieving the functional performance and design requirements determined through close collaboration with commercial industry end-users.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.1 NGNP Mission Need
	2.1-5	The NGNP shall demonstrate the basis for commercialization of the nuclear system, a heat transfer/transport system, a hydrogen production process, and a power conversion concept. An essential part of the hydrogen operations will be demonstrating that the requisite reliability and capacity factor can be achieved over an extended period of operation.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.1 NGNP Mission Need
	2.1-6a	NGNP nuclear heat source shall be based on the HTGR concept	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.2.1 NGNP Project Requirements at Pre-Conceptual Design
	2.1-6b	The NGNP nuclear heat source shall utilize passive safety features to cool the core from full power to safe shutdown conditions.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.2.1 NGNP Project Requirements at Pre-Conceptual Design
	2.1-7a	The NGNP shall produce high-efficiency electricity and generate hydrogen on a scale that sets a foundation for future commercial deployment.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.2.1 NGNP Project Requirements at Pre-Conceptual Design
	2.1-7b	NGNP shall generate hydrogen on a scale that sets a foundation for future commercial deployment.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.2.1 NGNP Project Requirements at Pre-Conceptual Design
	2.1-8	NGNP shall include provisions for future testing.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.2.1 NGNP Project Requirements at Pre-Conceptual Design

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
	2.1-9a	The NGNP shall enable demonstration of energy products utilizing its nuclear heat source.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.2.1 NGNP Project Requirements at Pre-Conceptual Design
	2.1-9b	The NGNP shall enable demonstration of energy processes utilizing its nuclear heat source.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.2.1 NGNP Project Requirements at Pre-Conceptual Design
	2.1-10	The NGNP shall limit normal maintenance exposure of no more than 50 person-REM/year per module in a refueling year.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2 SAG	3.2.2 HTGR Fundamental Requirements Meeting Agreements October 22, 2008 Meeting Minutes
	2.1-11	The NGNP shall have an availability factor of greater than or equal to 90%.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.2.2 HTGR Fundamental Requirements
	2.1-12	The NGNP shall have a plant design lifetime of 60 years (calendar).	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.2.2 HTGR Fundamental Requirements
	2.1-14	The NGNP reactor gas outlet temperature shall be in the range of 750°C to 800°C	950 C 750 C	Pebble Bed Prismatic	SAG	Meeting Agreements October 22, 2008 Meeting Minutes
3		**Requirements Applicable to Nuclear Heat Source**			SRM Rev 2	4.3 Requirements Applicable to Nuclear Heat Source
3.1		**Reactor System**			SRM Rev 2	4.3.1 Reactor System
	3.1-2	The NGNP core shall use forced circulation helium as the heat transport fluid.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.1 Reactor System

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
	3.1-3a	The NGNP non-replaceable structural materials in contact with helium shall resist erosion during plant cycle life.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.1 Reactor System
	3.1-3b	The NGNP non-replaceable structural materials in contact with helium shall resist erosion during plant cycle life.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.1 Reactor System
4		**Requirements Applicable to Heat Transport System**			SRM Rev 2	4.4 Requirements Applicable to Heat Transport System
4.1		**Primary Heat Transport System**			SRM Rev 2	4.4.1 Primary Heat Transport System
5		**Reactor Type**			Bounding Condition	4.1 Reactor Type
5.1		**Bounding Condition - 001**			Bounding Condition	4.1.1 Bounding Condition - 001
6		**Reactor Design Power Level**			Bounding Condition	4.2 Reactor Design Power Level
6.1		**Bounding Condition - 002**			Bounding Condition	4.2.1 Bounding Condition - 002
	6.1-1	The NGNP shall be capable of operation at power levels up to 600 Mwt, depending on the core design, and core power densities that will demonstrate the technical and economic feasibility of commercial HTGRs with a passive safety basis such that maximum fuel temperatures under normal and abnormal conditions are acceptable.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.2.1 Bounding Condition - 002
	6.1-3-1	The peak time averaged fuel temperature does not exceed 1250°C under normal operating conditions.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.2.1 Bounding Condition - 002
	6.1-3-2	The peak fuel temperature shall not exceed 1600°C under accident conditions.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.2.1 Bounding Condition - 002
	6.1-4	In addition, the core design shall result in a self-consistent set of operating parameters (e.g., power density, core delta T) and material choices (e.g., fuel, graphite, core barrel, reactor vessel) that demonstrate adequate safety margin when uncertainties in operating parameters and in the associated calculation methods (typically at 95% confidence) are explicitly accounted.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.2.1 Bounding Condition - 002

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
	6.1-5	Final design work is required to verify that the calculated fuel temperatures meet the specified ranges under all conditions after appropriately accounting for uncertainties in the calculations.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.2.1 Bounding Condition - 002, Summary of Bases
	6.1-6	The design of the nuclear island for the nuclear system selected for NGNP needs to be completed along with the research and development (R&D) supporting the qualification of fuel, graphite, materials, and methods required to support the licensing basis of the plant.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.2.1 Bounding Condition - 002, Summary of Bases
	6.1-7	Additional work is required to develop the characteristics of the nuclear system with a lower power rating (e.g., one half the maximum power design) in conjunction with an evaluation of design and any additional R&D that would be required to include or evolve certification of this lower-power design under that for the higher-power design.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.2.1 Bounding Condition - 002, Summary of Bases
	6.1-9	Clearly identify the lower-power design requirements in further evaluations with the private sector and through evaluation of other factors (e.g., availability of components, transportation of large vessels and components, potential for mass production, licensing)	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.2.1 Bounding Condition - 002, Summary of Bases
	6.1-10	The lower-power designs by the vendors shall be developed through scaling, where possible, of the current designs to meet the private sector needs	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.2.1 Bounding Condition - 002, Summary of Bases
7		**Reactor Gas Outlet Temperature**			Bounding Condition	4.3 Reactor Gas Outlet Temperature
7.1		**Bounding Condition - 003**			Bounding Condition	4.3.1 Bounding Condition - 003
	7.1-1	The reactor island shall be designed for operation at the highest temperature achievable for the reactor core design (i.e., pebble bed, the prismatic cores) and the maximum power level (see specific fuel temperature requirements above).	950 C	Pebble Bed Prismatic	Bounding Condition	4.3.1 Bounding Condition - 003
	7.1-2	NGNP shall be capable of operating at lower power and temperature to accommodate a period of plant operation below design conditions.	950 C	Pebble Bed Prismatic	Bounding Condition	4.3.1 Bounding Condition - 003
8		**Reactor Gas Inlet Temperature**			Bounding Condition	4.4 Reactor Gas Inlet Temperature

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
8.1		**Bounding Condition - 004**			Bounding Condition	4.4.1 Bounding Condition - 004
	8.1-1	The reactor gas inlet temperature shall be compatible with the maximum reactor power, gas outlet temperature, and required gas flow rate to achieve acceptable fuel operating temperatures (see design limits above) and material choices, particularly the RPV.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.4.1 Bounding Condition - 004
9		**Containment**			Bounding Condition	4.11 Containment
9.1		**Bounding Condition - 015**			Bounding Condition	4.11.1 Bounding Condition - 015
	9.1-1	NGNP shall include reactor and reactor building containment features that, in combination with the other mechanisms for radionuclide containment (e.g., fission product retention capabilities of the fuel) and transport, (e.g., entrainment, plate out), result in calculated dose rates at the EAB that meet the criteria established above (see Public and Worker Exposure Limits) for normal operation, abnormal conditions, and accident conditions.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.11.1 Bounding Condition - 015
10		**Licensing**			Bounding Condition	4.12 Licensing
10.1		**Bounding Condition - 016**			Bounding Condition	4.12.1 Bounding Condition - 016
11		**Risk Management**			Bounding Condition	4.13 Risk Management
11.1		**Bounding Condition - 017**			Bounding Condition	4.13.1 Bounding Condition - 017
12		**Component Test Facility**			Bounding Condition	4.14 Component Test Facility
12.1		**Bounding Condition - 018**			Bounding Condition	4.14.1 Bounding Condition - 018
	12.1-1	A CTF shall be provided as part of the infrastructure supporting HTGR technologies.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.14.1 Bounding Condition - 018

Object #	Requirement ID	Stakeholder Requirements	Set	Reactor Type	Source	Source Section
	12.1-2	The facility shall be capable of completing proof-of-performance testing of major HTGR and NGNP components at engineering or full scale.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.14.1 Bounding Condition - 018

Appendix B

NGNP Functional, Operational, and Technical Requirements

Appendix B
NGNP Functional, Operational, and Technical Requirements

B-1. Nuclear Heat Supply Requirements

B-1.1 Reactor Pressure Vessel

Object #	Requirement ID	Requirements for Reactor Pressure Vessel	Set	Reactor Type	Source	Source Section
2		**Requirements Applicable to Multiple Systems, Buildings and Structures**			SRM Rev 2	4.1 Requirements Applicable to Multiple Systems, Buildings and Structures
2.1		**Surveillance and In-Service Inspection requirements**			SRM Rev 2	4.1.6 Surveillance and In-Service Inspection requirements
	2.1-1	The NGNP design shall provide access to the primary and secondary loop pressure boundary to permit In-Service Inspection as required by appropriate sections of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code.	950 C	Pebble Bed Prismatic	SRM Rev 2	4.1.6 Surveillance and In-Service Inspection requirements
2.2		**Vessel System Function and Design**			SRM Rev 2	
	2.2-2	The duration of maintenance shall be minimized.	950 C	Pebble Bed Prismatic	SRM Rev 2	4.3.2 Vessel System
	2.2-2	The duration of, In-Service shall be minimized.	950 C	Pebble Bed Prismatic	SRM Rev 2	4.3.2 Vessel System
	2.2-2	The duration of repair/replacement operations of the vessel system shall be minimized.	950 C	Pebble Bed Prismatic	SRM Rev 2	4.3.2 Vessel System
	2.2-3	All parts of the vessel system shall be designed for an operating duration of 60 years.	950 C	Pebble Bed Prismatic	SRM Rev 2	4.3.2 Vessel System
	2.2-4	Lifetime of isolation valves, piping and cross-vessels (where applicable) of the vessel system shall be optimized according to the investment cost and replacement duration.	950 C	Pebble Bed Prismatic	SRM Rev 2	4.3.2 Vessel System

Object #	Requirement ID	Requirements for Reactor Pressure Vessel	Set	Reactor Type	Source	Source Section
	2.2-5	The vessel system shall be designed for design basis duty-cycle events.	950 C	Pebble Bed Prismatic	SRM Rev 2	4.3.2 Vessel System
3		**Requirements Applicable to Nuclear Heat Source**			SRM Rev 2	4.3 Requirements Applicable to Nuclear Heat Source
3.1		**Vessel System**			SRM Rev 2	4.3.2 Vessel System
3.1.1		**Reactor Vessel**			SRM Rev 2	4.3.2.1 Reactor Vessel
	3.1.1-3	During normal operation, the reactor vessel shall maintain its operating temperature through a thermal balance between the core heat flux, core inlet helium flow, and the reactor cavity cooling system.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.2.1 Reactor Vessel
	3.1.1-4	The reactor vessel shall maintain the primary pressure boundary integrity.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.2.1 Reactor Vessel
	3.1.1-5	The operating conditions shall be considered according to the following statements:	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.2.1 Reactor Vessel
	3.1.1-5-1	In normal operation, creep effects on the reactor vessel shall be avoided (negligible creep).	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.2.1 Reactor Vessel
	3.1.1-5-2	No leakage shall result from Anticipated Operating Occurrences (AOO).	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.2.1 Reactor Vessel
	3.1.1-5-3	For AOOs and DBAs, the reactor vessel shall not prevent restarting of the plant.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.2.1 Reactor Vessel
3.1.1.1		**Vessel System**			SRM Rev 1	4.3.2 Vessel System
	3.1.1.1-1	The vessel system shall contain and support the components of the reactor core, reactor internal supports and structures, and the nuclear heat transport components.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.3.2 Vessel System
3.1.2		**Cross Vessels (where applied)**			SRM Rev 2	
	3.1.2-2	The cross vessels shall maintain the primary pressure boundary integrity.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.2.2 Cross Vessels (where applied)

Object #	Requirement ID	Requirements for Reactor Pressure Vessel	Set	Reactor Type	Source	Source Section
	3.1.2-3	The cross vessels shall provide the primary heat transport path to/from the reactor vessel and IHX vessels, or steam generator vessels, as applicable.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.2.2 Cross Vessels (where applied)
3.1.3		**IHX Vessels (where applied)**			SRM Rev 2	
	3.1.3-1	The function of the IHX vessel shall be to support the IHX modules.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.2.3 IHX Vessels (where applied)
	3.1.3-2	The IHX vessels shall maintain the primary pressure boundary integrity.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.2.3 IHX Vessels (where applied)
3.1.4		**Vessel Supports**			SRM Rev 2	
	3.1.4-1	The IHX vessel supports shall support the vertical load.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.2.4 Vessel Supports
	3.1.4-2	The IHX vessel supports shall include keying for lateral support.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.2.4 Vessel Supports
	3.1.4-3	The IHX vessel supports shall accommodate thermal expansion.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.2.4 Vessel Supports
	3.1.4-4	The IHX vessel supports shall accommodate duty-cycle events.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.2.4 Vessel Supports
	3.1.4-5	The IHX vessel supports shall withstand coupled vibration from the circulator.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.2.4 Vessel Supports
	3.1.4-6	The reactor vessel shall provide core support and maintain its relative position to the control rods.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.3.2.1 Reactor Vessel
	3.1.4-7	The reactor vessel shall provide decay heat and residual heat removal by radial conduction during loss-of-forced circulation events.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.3.2.1 Reactor Vessel
3.1.5		**Pressure Relief System**			SRM Rev 2	
	3.1.5-2	In case of primary overpressure, the safety valves shall open to eliminate the overpressure and reclose once the overpressure condition terminates.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.2.5 Pressure Relief System
	3.1.5-3	The pressure relief system shall provide the primary coolant loop's overpressure protection as required by ASME pressure relief code.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.3.2.5 Pressure Relief System
4		**Primary System Pressure Vessels**			Bounding Condition	4.6 Primary System Pressure Vessels

Object #	Requirement ID	Requirements for Reactor Pressure Vessel	Set	Reactor Type	Source	Source Section
4.1		**Bounding Condition - 008**			Bounding Condition	4.6.1 Bounding Condition - 008
	4.1-1	The nuclear heat supply system, which includes the heat transfer/transport system, shall be designed to minimize schedule risk for the primary pressure vessels at full design power level and inlet and outlet temperatures.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.6.1 Bounding Condition - 008
	4.1-2	In this regard, the design of the primary pressure vessels, including the RPV, shall incorporate standard LWR RPV material (e.g., SA 508/533).	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.6.1 Bounding Condition - 008
	4.1-3	A parallel effort shall be continued by the NGNP Project in collaboration with the appropriate reactor vendors to develop the modified 9Cr (Grade 91) material as a viable alternative to the SA 508/533 material.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.6.1 Bounding Condition - 008
	4.1-4	If required, use of active cooling or other measures shall be identified and the design developed as necessary to meet this requirement.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.6.1 Bounding Condition - 008
	4.1-5	The reactor system shall be designed to provide passive residual heat removal under conditions of loss of forced cooling and loss of coolant.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.1 Reactor System
	4.1-6	The reactor system shall be designed such that the reactor core is maintained in a coolable geometry under all normal operating, abnormal operating, and postulated design basis and beyond design basis accident conditions.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.1 Reactor System
	4.1-7	The reactor system shall be designed for an operational lifetime of 60 years (calendar). Excluding those portions of the system that can be replaced.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.1 Reactor System
	4.1-8	The core shall use forced circulation helium as the heat transport fluid.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.1 Reactor System
	4.1-9	Non-replaceable structural materials in contact with helium shall resist corrosion and erosion during plant life as to avoid failure and or need for replacement.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.1 Reactor System

B-1.2 Reactor Vessel Internals

Object #	Requirement ID	Requirements for Reactor Vessel Internals	Set	Reactor Type	Source	Source Section
2		**Requirements Applicable to Nuclear Heat Source**			SRM Rev 2	4.3 Requirements Applicable to Nuclear Heat Source
2.1		**Reactor System**			SRM Rev 2	4.3.1 Reactor System
2.1.1		**Reactor Internals**			SRM Rev 2	4.3.1.2 Reactor Internals
	2.1.1-1	The reactor internals shall be designed to properly control bypass flows.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.1.2 Reactor Internals
	2.1.1-2	The reactor internals shall be designed to transport residual decay heat from the reactor core to the reactor vessel.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.1.2 Reactor Internals
	2.1.1-3	The reactor internals shall be designed to channel primary coolant to and from the reactor core for transfer of heat to the Primary Heat Transport System (PHTS).	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.1.2 Reactor Internals
	2.1.1-4	The reactor internals shall be designed to provide radiological shielding to limit neutron fluence to the reactor vessel.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.1.2 Reactor Internals
	2.1.1-5	The reactor internals shall be designed to limit gamma radiation exposure to the plant personnel and equipment.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.1.2 Reactor Internals
	2.1.1-6	The reactor internals shall be designed to limit damage to plant components during conduction cooldown events.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.1.2 Reactor Internals
	2.1.1-7	The reactor internals shall maintain reactor core geometry.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.3.1.2 Reactor Internals
	2.1.1-8	The reactor internals shall provide heat transfer during conduction cooldown.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.3.1.2 Reactor Internals
	2.1.1-9	The reactor internals shall conserve neutrons in the reactor core and provide shielding.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.3.1.2 Reactor Internals

B-1.3 Reactor Core and Core Structures

Object #	Requirement ID	Requirements for Core and Core Structures	Set	Reactor Type	Source	Source Section
1		**Note: Items appearing in brackets ([ ]) represent approximations and/or undefined values.**				
2		**Requirements Applicable to Nuclear Heat Source**			SRM Rev 2	4.3 Requirements Applicable to Nuclear Heat Source
2.1		**Reactor System**			SRM Rev 2	4.3.1 Reactor System
2.1.1		**Reactor Core**	950 C 750 C		SRM Rev 2	4.3.1.1 Reactor Core
	2.1.1-1	The decay heat removal shall be possible by passive heat transfer means (conduction and radiation) from the fuel to the reactor internals without reaching unacceptable fuel temperatures during all DBA conditions.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.1.1 Reactor Core
	2.1.1-2	The core shall utilize thermal spectrum neutrons for fission reaction.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.1.1 Reactor Core
	2.1.1-3	The core shall be moderated with graphite.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.1.1 Reactor Core
	2.1.1-4	The active core height shall ensure the axial stability of the neutron flux and preclude the risk of xenon oscillations.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.1.1 Reactor Core
	2.1.1-5	Reference fuel shall be LEU-based (UCO or UO2) with an enrichment limited to <20.0% (in mass) and with a peak burn-up limited to 20% fissions per initial metal ion (FIMA).	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.1.1 Reactor Core
	2.1.1-7	The core bypass flow shall be maintained within an acceptable range [TBD], to ensure fuel temperatures in normal and accidental conditions are maintained within [TBD] limits (existence of a minimum amount of bypass in lateral reflector).	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.1.1 Reactor Core
	2.1.1-8	The reactivity temperature coefficient shall be sufficiently negative to shutdown the nuclear chain reaction before an unacceptable fuel temperature is reached, and maintain the core in a safe state for a time offering the certainty to reliably introduce absorber elements.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.1.1 Reactor Core
	2.1.1-9	The following is a required function of the reactor core: Generate heat.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.1.1 Reactor Core

Object #	Requirement ID	Requirements for Core and Core Structures	Set	Reactor Type	Source	Source Section
	2.1.1-10	The reactor core shall generate heat.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.3.1.1 Reactor Core
	2.1.1-11	The reactor core shall transfer heat to coolant and/or reactor internals.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.3.1.1 Reactor Core

B-1.4 Nuclear Instrumentation

Currently, no requirements exist.

B-1.5 Fuel Elements

Object #	Requirements ID	**Requirements for Fuel Elements** Note: Items appearing in brackets ([ ]) represent approximations and/or undefined values.	Set	Reactor Type	Source	Source Section
2		**Requirements Applicable to Multiple Systems, Buildings and Structures**			SRM Rev 2	4.1 Requirements Applicable to Multiple Systems, Buildings and Structures
2.1		**Operational Requirements**			SRM Rev 2	4.1.2 Operational Requirements
	2.1-1	The NGNP shall be designed to use low enriched uranium (LEU) TRISO-coated particle fuel.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.2 Operational Requirements
3		**Requirements Applicable to Fuel**				
	3-3	The fuel performance shall allow for a source term calculation capable of obtaining an NRC license with an exclusion zone of no more than 400 meters (approximately) for the design power level.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.2 Requirements Applicable to Fuel
	3-4	The fuel shall meet following requirement: As-manufactured Quality Requirements, at a 95% confidence level: Heavy metal contamination: ≤2 × 10 -5 (Prismatic Block); ≤6.0 × 10 -5 (Pebble Bed)	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.2 Requirements Applicable to Fuel
	3-5	The fuel shall meet the following requirement: As-manufactured Quality Requirements, at a 95% confidence level: SiC Defect Fraction: ≤1 × 10 -4 (Prismatic Block); ≤6.0 × 10 -5 (Pebble Bed)	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.2 Requirements Applicable to Fuel

Object #	Requirements ID	Requirements for Fuel Elements Note: Items appearing in brackets ([ ]) represent approximations and/or undefined values.	Set	Reactor Type	Source	Source Section
	3-6	The fuel shall meet the following requirement: In-service Fuel Performances Requirements, at a 95% confidence level: Fuel failure during normal operations: $\leq 2 \times 10^{-4}$ (Prismatic Block); $\leq 4.6 \times 10^{-5}$ (Pebble Bed)	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.2 Requirements Applicable to Fuel
	3-7	The fuel shall meet the following requirement: In-service Fuel Performances Requirements, at a 95% confidence level: Incremental fuel failures during accident conditions: $\leq 6.0 \times 10^{-4}$ (Prismatic Block); $\leq 5.0 \times 10^{-4}$ (Pebble Bed)	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.2 Requirements Applicable to Fuel

B-1.6 Reserve Shutdown System

No requirements currently.

B-1.7 Reactivity Control System

Object #	Requirement ID	Requirements for Reactivity Control System	Set	Reactor Type	Source	Source Section
2		**Requirements Applicable to Nuclear Heat Source**			SRM Rev 2	4.3 Requirements Applicable to Nuclear Heat Source
2.1		**Reactor System**			SRM Rev 2	4.3.1 Reactor System
	2.1-1	The reactor system shall generate heat and transfer it to the primary coolant.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.3.1 Reactor System
	2.1-2	The reactor system shall maintain reactor shutdown.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.3.1 Reactor System
2.1.1		**Neutron Control Elements**			SRM Rev 2	4.3.1.3 Neutron Control Elements
	2.1.1-1	The neutron control elements shall be designed to provide sufficient negative reactivity to shut down the reactor and maintain it in subcritical condition for any state while compensating for the worst positive reactivity insertion.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.1.3 Neutron Control Elements

	2.1.1-2	The neutron control elements shall control the nuclear chain reaction in the reactor core by absorbing neutrons in any operational mode.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.3.1.3 Neutron Control Elements
2.2		**NHS Protection System**			SRM Rev 2	4.3.4 NHS Protection System
	2.2-1	The protection system shall implement the relevant monitoring, analysis, and actuation functions necessary to reach the controlled state in case of abnormal events.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.4 NHS Protection System
2.3		**NHS Control Room and Operator Interface System**			SRM Rev 2	4.3.6 NHS Control Room and Operator Interface System
	2.3-1	The NGNP facility design shall permit the operators to take control of the reactor and support processes from within a single integrated control room using the manual mode at any time.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.6 NHS Control Room and Operator Interface System

B-1.8 Core Conditioning System (Shutdown Cooling)

Object #	Requirement ID	Requirements for Core Conditioning System	Set	Reactor Type	Source	Source Section
2		**Requirements Applicable to Nuclear Heat Source**			SRM Rev 2	4.3 Requirements Applicable to Nuclear Heat Source
2.1		**Reactor Support Systems**			SRM Rev 2	4.3.3 Reactor Support Systems
2.1.1		**Shutdown Cooling System**			SRM Rev 2	4.3.3.1 Shutdown Cooling System
	2.1.1-9	The Shutdown Cooling System (SCS) shall limit the ingress of potential contaminants into the primary helium circuit from components of the SCS external to the primary HPB.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.1 Shutdown Cooling System
	2.1.1-10	The Shutdown Cooling System (SCS) shall retain helium and radionuclides within the parts of the SCS comprising the primary Helium Pressure Boundary (HPB).	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.1 Shutdown Cooling System

Object #	Requirement ID	Requirements for Core Conditioning System	Set	Reactor Type	Source	Source Section
	2.1.1-11	The Shutdown Cooling System shall transport core residual and decay heat from the reactor system to the environment when the reactor system is shutdown and the PHTS is not operational. The helium primary coolant may be pressurized or depressurized.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.3.3.1 Shutdown Cooling System
	2.1.1-12	The Shutdown Cooling System shall transport core residual and decay heat from the reactor system to the environment when the helium primary coolant is depressurized during reactor core refueling operations.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.3.3.1 Shutdown Cooling System
	2.1.1-13	The Shutdown Cooling System shall transport core residual and decay heat from the reactor system to the environment when the helium primary coolant is depressurized during scheduled maintenance of core, vessel, and internal components.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.3.3.1 Shutdown Cooling System
	2.1.1-14	The Shutdown Cooling System shall transport core residual and decay heat from the reactor system to the environment when the helium primary coolant is depressurized during certain potential unscheduled maintenance or repair activities.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.3.3.1 Shutdown Cooling System
	2.1.1-15	The Shutdown Cooling System shall support cooling of the IHX, as needed, and potentially for other components when the PHTS is not operating.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.3.3.1 Shutdown Cooling System
	2.1.1-16	The Shutdown Cooling System shall limit core bypass flow through its components during PHTS operation.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.3.3.1 Shutdown Cooling System

B-1.9 Reactor Cavity Cooling System

Object #	Requirement ID	Requirements for Reactor Cavity Cooling System	Set	Reactor Type	Source	Source Section
2		**Requirements Applicable to Nuclear Heat Source**			SRM Rev 2	4.3 Requirements Applicable to Nuclear Heat Source
2.1		**Reactor System**			SRM Rev 2	4.3.1 Reactor System
	2.1-1	The reactor system shall be designed to provide passive residual heat removal under conditions of loss of cooling.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.1 Reactor System

Object #	Requirement ID	Requirements for Reactor Cavity Cooling System	Set	Reactor Type	Source	Source Section
2.2		**Reactor Support Systems**			SRM Rev 2	4.3.3 Reactor Support System
2.2.1		**Reactor Cavity Cooling System**			SRM Rev 2	4.3.3.2 Reactor Cavity Cooling System
	2.2.1-3	The Reactor Cavity Cooling System (RCCS) shall operate continuously and maintain reactor cavity concrete temperatures to less than [90ºC] during normal operations and less than [150ºC] for off-normal events (short term).	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.2 Reactor Cavity Cooling System
	2.2.1-4	The RCCS shall be designed to operate through the utility/user duty-cycle events for the number of cycles specified [TBD] plus those events and event combinations determined to be required by plant transient analysis.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.2 Reactor Cavity Cooling System
	2.2.1-5	Inaccessible parts of the RCCS shall be designed for an operating life of 60 years.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.2 Reactor Cavity Cooling System
	2.2.1-6	The need for access to individual components during normal plant operation and under accident conditions shall be considered in developing building and component arrangements.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.2 Reactor Cavity Cooling System
	2.2.1-8	The RCCS shall accommodate continuous operation at any power level up to 100% of rated power.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.2 Reactor Cavity Cooling System
	2.2.1-9	The RCCS shall incorporate features required to implement on-line surveillance and performance monitoring.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.2 Reactor Cavity Cooling System
	2.2.1-10	The RCCS shall incorporate those features required to accomplish ISI activities within the time and scheduling constraints imposed by the allotted design planned outage time.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.2 Reactor Cavity Cooling System
	2.2.1-11	The RCCS shall be required to operate continuously in all plant states, including shutdown following loss of forced reactor cooling by the PHTS and SCS with simultaneous loss of pumped circulation of RCCS cooling water and an SSE.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.2 Reactor Cavity Cooling System

Object #	Requirement ID	Requirements for Reactor Cavity Cooling System	Set	Reactor Type	Source	Source Section
	2.2.1-12	The RCCS shall operate continuously in all plant states, including shutdown following loss of forced reactor cooling by the PHTS and SCS with simultaneous loss of pumped circulation of RCCS cooling water, where applicable.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.2 Reactor Cavity Cooling System
	2.2.1-13	All components and piping of the RCCS shall meet seismic loads requirements.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.2 Reactor Cavity Cooling System
	2.2.1-14	All components and piping inside the reactor building, including the connections for emergency water supply (fire brigade), shall be designed against external events (e.g., aircraft crash or pressure waves).	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.2 Reactor Cavity Cooling System
	2.2.1-15	The Reactor Cavity Cooling System shall protect the reactor cavity concrete structure, including the support structures of the reactor pressure vessel, from overheating during all modes of operation.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.3.3.2 Reactor Cavity Cooling System
	2.2.1-16	The Reactor Cavity Cooling System shall provide an alternate means of reactor core heat removal from the reactor system to the environment when neither the PHTS nor the SCS is available.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.3.3.2 Reactor Cavity Cooling System
2.2.2		**Nuclear Island Cooling System**			SRM Rev 2	4.3.3.5 Nuclear Island Cooling System
	2.2.2-3	The nuclear island cooling system shall serve the needs of the reactor and its associated components at all times under full-power operating conditions.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.5 Nuclear Island Cooling System
	2.2.2-4	System makeup shall be provided from the plant Water Supply Treatment System.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.5 Nuclear Island Cooling System
	2.2.2-5a	Redundant components shall be provided for the nuclear island cooling system, as needed, to support continuous operation of the reactor..	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.5 Nuclear Island Cooling System
	2.2.2-5b	Redundant components shall be provided for the nuclear island cooling system, as needed, to provide for on-line maintenance of the cooling system components.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.5 Nuclear Island Cooling System

B-1.10 General

Object #	Requirement ID	General Requirements	Set	Reactor Type	Source	Source Section
2		**Nuclear Heat Supply System - General Requirements**				
2.1		**Requirements Applicable to Nuclear Heat Supply**				
	2.1-1	The Nuclear Heat Supply System shall be design certified for a broad range of applications and sites. Note that the Nuclear Heat Supply System includes the nuclear island (e.g., the reactor, primary coolant system, and supporting systems) and the heat transfer/transport system.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.2.2 HTGR Fundamental Requirements
	2.1-2	The NHSS shall be licensed independent of the application. In this regard the licensing boundary and interface requirements shall be defined for the reference configurations (e.g., transients, feed and gas return chemistry.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.2.2 HTGR Fundamental Requirements
	2.1-5	Applicable to broad range of cogeneration applications supplying, singly or in combination, electricity, steam, and hot gas.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.2.2 HTGR Fundamental Requirements
	2.1-6	Reactor gas outlet temperature in the range of 750 to 800°C.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.2.2 HTGR Fundamental Requirements
	2.1-7	Capable of completing design, licensing, construction, and startup testing for initial operation by 2021.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.2.2 HTGR Fundamental Requirements
	2.1-8	Capable of following process load variations.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.2.2 HTGR Fundamental Requirements
	2.1-9	The NGNP design will be applicable to a broad range of cogeneration applications supplying, singly or in combination, electricity, steam, and hot gas.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.1 System Configuration and Essential Features Requirements
	2.1-10	For the NGNP (FOAK), the designed reactor gas outlet temperature shall be in the range of 750 to 800°C.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.1 System Configuration and Essential Features Requirements
	2.1-11	The NHSS shall be capable of controlling the transport of radionuclides to the end products at levels below the concentration or exposure requirements for the product (e.g.,	950 C 750 C	Pebble Bed Prismatic	SAG	Meeting Agreements October 22, 2008

Object #	Requirement ID	General Requirements	Set	Reactor Type	Source	Source Section
		tritium in steam, gas, hydrogen) [Initial acceptable tritium levels will be set at a TBD fraction of the EPA limits for drinking water and air]				
	2.1-12	The Nuclear Heat Supply System (NHSS) shall be design certified for a broad range of applications and sites.	950 C 750 C	Pebble Bed Prismatic	SAG	Meeting Agreements October 22, 2008
	2.1-13	The NHSS shall be licensed independent of the application. In this regard the licensing boundary and interface requirements shall be defined for the reference configurations, (e.g., transients, feed and gas return chemistry).	950 C 750 C	Pebble Bed Prismatic	SAG	Meeting Agreements October 22, 2008
	2.1-14	The NHSS designs shall be applicable, on economic, availability and reliability bases, to a broad range of co-generation applications supplying, singly or in combination, electricity, steam, and hot gas (helium).	950 C 750 C	Pebble Bed Prismatic	SAG	Meeting Agreements October 22, 2008
2.2		**System Configuration and Essentials Features Requirements**				
		The NGNP nuclear heat source (NHS) shall use the HTGR concept.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.1 System Configuration and Essential Features Requirements
	2.2-1	The NGNP NHS shall demonstrate commercial viability of the HTGR.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.1 System Configuration and Essential Features Requirements
	2.2-2	The NGNP NHS shall be designed such that it can be design certified for a broad range of applications and sites.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.1 System Configuration and Essential Features Requirements
2.3	2.2-3	**Operational Requirements**				
	2.3-1	The NGNP NHS shall have an operational lifetime of 60 years (calendar).	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.2 Operational Requirements
	2.3-4	The NGNP shall be designed to operate during loss of hydrogen production and stabilize in the electricity generation phase.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.1.2 Operational Requirements
	2.3-5	The NGNP plant shall be capable of following process load variations.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.2 Operational Requirements

Object #	Requirement ID	General Requirements	Set	Reactor Type	Source	Source Section
	2.3-7	The NGNP shall demonstrate a minimum 18-month refueling interval capability (if applicable).	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.2 Operational Requirements
	2.3-8	The NGNP shall be designed to operate following loss of a secondary heat process, such as hydrogen production, and stabilize in the electricity generation phase.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.2 Operational Requirements
2.4		**Surveillance and In-Service Inspection Requirements**				
	2.4-1	The NGNP design shall provide access to the primary and secondary, if applicable, loop pressure boundary to permit ISI as required by appropriate sections of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, minimizing the need for requests for Code relief due to accessibility constraints.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.6 Surveillance and In-Service Inspection Requirements

B-2. Heat Transport System Requirements

B-2.1 Circulators

Object #	Requirement ID	Requirements for Circulators	Set	Reactor Type	Source	Source Section
2		**Requirements Applicable to Heat Transport System**			SRM Rev 2	4.4 Requirements Applicable to Heat Transport System
2.1		**Primary Heat Transport System**			SRM Rev 2	4.4.1 Primary Heat Transport System
	2.1-1	The Primary Heat Transport System shall transfer heat from the reactor core to the secondary circuit.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.4.1 Primary Heat Transport System
2.1.1		**Main Helium Circulator (MHC)**			SRM Rev 2	4.4.1.1 Main Helium Circulator
	2.1.1-2	The MHC shall be driven by electrical motors capable of rated and variable speeds.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.4.1.1 Main Helium Circulator
	2.1.1-4	Bearing design shall preclude contaminant (e.g., lubricating product) ingress in the primary circuit.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.4.1.1 Main Helium Circulator

Object #	Requirement ID	Requirements for Circulators	Set	Reactor Type	Source	Source Section
	2.1.1-5	Thermal insulation shall be required to protect the internal components by reducing heat migration due to primary system temperatures.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.4.1.1 Main Helium Circulator
	2.1.1-6	The MHC shall be designed with a minimum lifetime of 10 years.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.4.1.1 Main Helium Circulator
	2.1.1-7	The MHC shall be designed with hydraulic characteristics as stable as possible over the required speed range without distinctive reversal points and without pronounced peaks.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.4.1.1 Main Helium Circulator
	2.1.1-8	The MHC shall maintain primary pressure boundary integrity.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.4.1.1 Main Helium Circulator
	2.1.1-9	The Main Helium Circulator shall control the flow of helium to match the heat generation of the reactor core with the heat removal of the PHTS.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.4.1.1 Main Helium Circulator
3		**Helium Circulators**			Bounding Condition	4.8 Helium Circulators
3.1		**Bounding Condition - 012**			Bounding Condition	4.8.1 Bounding Condition - 012
	3.1-1	The ability to operate multiple circulators in parallel shall be evaluated and tested as an alternative to installation of a single high-power design that requires significant development.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.8.1 Bounding Condition - 012
	3.1-2	Development of high-power designs that are required for application in the secondary loop shall be continued.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.8.1 Bounding Condition - 012

B-2.2 Intermediate Heat Exchangers

Object #	Requirement ID	Requirements for Intermediate Heat Exchangers	Set	Reactor Type	Source	Source Section
4		**Requirements Applicable to Heat Transport System**			SRM Rev 2	4.4 Requirements Applicable to Heat Transport System
4.1		**Primary Heat Transport System**			SRM Rev 2	4.4.1 Primary Heat Transport System
4.1.1		**Intermediate Heat Exchanger (IHX)**			SRM Rev 2	4.4.1.3 Intermediate Heat Exchanger (IHX)

Object #	Requirement ID	Requirements for Intermediate Heat Exchangers	Set	Reactor Type	Source	Source Section
5		**Intermediate Heat Exchanger Design**			Bounding Condition	4.7 Intermediate Heat Exchanger Design
5.1		**General**			Bounding Condition	4.7.1 General
5.2		**Bounding Condition - 009**			Bounding Condition	4.7.2 Bounding Condition - 009

B-2.3 Cross Vessel Piping

Object #	Requirement ID	Requirements for Cross Vessel Piping	Set	Reactor Type	Source	Source Section
2		**Requirements Applicable to Heat Transport System**			SRM Rev 2	4.4 Requirements Applicable to Heat Transport System
2.1		**Primary Heat Transport System**			SRM Rev 2	4.4.1 Primary Heat Transport System
2.1.1		**Hot Duct Assembly (HDA) (where applied)**			SRM Rev 2	4.4.1.2 Hot Duct Assembly (where applied)
	2.1.1-2	Radial keys shall provide a radial support during operating and seismic conditions.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.4.1.2 Hot Duct Assembly (where applied)
	2.1.1-3	The HDA shall provide helium leak tightness at each end (with Core support structure and IHX).	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.4.1.2 Hot Duct Assembly (where applied)
	2.1.1-4	The Hot Duct Assembly (where applied) shall channel high-temperature helium from the reactor core outlet plenum to the IHX inlet.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.4.1.2 Hot Duct Assembly (where applied)
3.1.1		**Cross Vessels (where applied)**				4.3.2.2 Cross Vessels (where applied)
	3.1.1-1	The cross vessels shall maintain the primary pressure boundary integrity.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.2.2 Cross Vessels (where applied)

Object #	Requirement ID	Requirements for Cross Vessel Piping	Set	Reactor Type	Source	Source Section
	3.1.1-2	The cross vessels shall provide the primary heat transport path to/from the reactor vessel and IHX vessels.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.2.2 Cross Vessels (where applied)
4		**Intermediate Heat Exchanger Design**			Bounding Condition	4.7 Intermediate Heat Exchanger Design
	4-1	The Intermediate Heat Exchanger (IHX) shall transfer heat from the primary loop to the secondary loop during specified normal operating conditions and certain abnormal and accident conditions.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.4.1.3 Intermediate Heat Exchanger (IHX)
	4-2	The Intermediate Heat Exchanger (IHX) shall separate the primary loop from the secondary loop during all normal and abnormal conditions and during accident conditions for a specified time.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.4.1.3 Intermediate Heat Exchanger (IHX)
4.1		**Bounding Condition - 010**			Bounding Condition	4.7.3 Bounding Condition - 010
	4.1-1	Materials being evaluated for the NGNP heat transfer/transport system shall be capable of sustained operation (i.e., 10 effective full-power years of operation or longer) at the upper bounds of the reactor gas outlet and inlet temperatures.	950 C	Pebble Bed Prismatic	Bounding Condition	4.7.3 Bounding Condition - 010
	4.1-2	R&D shall be conducted to support development and codification of these materials for use in NGNP and future HTGR commercial applications.	950 C	Pebble Bed Prismatic	Bounding Condition	4.7.3 Bounding Condition - 010
4.2		**Bounding Condition - 011**			Bounding Condition	4.7.4 Bounding Condition - 011
	4.2-1	At least two primary loops shall be provided: a full power loop(s) for the PCS and a smaller loop (e.g., up to 60 Mwt) for the hydrogen plant.	950 C	Pebble Bed Prismatic	Bounding Condition	4.7.4 Bounding Condition - 011

B-2.4 Mixing Chamber

No requirements currently.

B-2.5 High Temperature Valves

Object #	Requirement ID	Requirements for High Temperature Valves	Set	Reactor Type	Source	Source Section
2		**Requirements Applicable to Heat Transport System**			SRM Rev 2	4.4 Requirements Applicable to Heat Transport System
2.1		**Primary Heat Transport System**			SRM Rev 2	4.4.1 Primary Heat Transport System
2.1.1		**Secondary Gas Isolation Valves**			SRM Rev 2	4.4.1.4 Secondary Gas Isolation Valves
	2.1.1-2	The secondary gas isolation valves shall accommodate a pressure differential of [5-9 MPa].	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.4.1.4 Secondary Gas Isolation Valves
	2.1.1-3	The secondary gas isolation valves shall maintain primary pressure boundary integrity.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.4.1.4 Secondary Gas Isolation Valves
	2.1.1-4	The secondary gas isolation valves shall have a maximum leakage rate when shut of [TBD].	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.4.1.4 Secondary Gas Isolation Valves (where applied)
2.2		**Secondary Heat Transport System**			SRM Rev 1	4.4.2 Secondary Heat Transport System
	2.2-1	The Secondary Heat Transport System shall provide hot helium to the hydrogen production plant and receives the circulating helium at a lower temperature from the hydrogen production plant.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.4.2 Secondary Heat Transport System
	2.2-2	The Secondary Heat Transport System shall provide hot helium to the PCS and received the circulating helium at a lower temperature from the PCS.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.4.2 Secondary Heat Transport System

B-2.6 General

Object #	Requirement ID	General Requirements for Heat Transport System	Set	Reactor Type	Source	Source Section
2		**Requirements Applicable to Heat Transport System**			SRM Rev 2	4.4 Requirements Applicable to Heat Transport System
2.1		**Primary Heat Transport System**			SRM Rev 2	4.4.1 Primary Heat Transport System

B-3. Hydrogen Production System Requirements

B-3.1 Hydrogen Production System

Object #	Requirement ID	Requirements for Hydrogen Production System	Set	Reactor Type	Source	Source Section
2		**Requirements Applicable to Hydrogen Production Plant**			SRM Rev 2	4.6 Requirements Applicable to Hydrogen Production Plant
2.1		**Hydrogen Production Plant Parameters and Performance**			SRM Rev 2	4.6.1 Hydrogen Production Plant Parameters and Performance
	2.1-1	The hydrogen production plant shall receive process helium at temperatures up to [900°C] and utilize heat at a rate of up to [60 MWth] in the production of hydrogen.	950 C	Pebble Bed Prismatic	SRM Rev 1	4.6.1 Hydrogen Production Plant Parameters and Performance
	2.1-2	The hydrogen production plant shall receive process helium at temperatures up to 800°C and utilize heat at a rate of up to [TBD MWth] in the production of hydrogen.	750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.1 Hydrogen Production Plant Parameters and Performance
	2.1-3	The hydrogen production plant process efficiency shall be no less than [40% higher heating value].	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.1 Hydrogen Production Plant Parameters and Performance

Object #	Requirement ID	Requirements for Hydrogen Production System	Set	Reactor Type	Source	Source Section
2.2		**Hydrogen Production Plant Configuration**			SRM Rev 2	4.6.2 Hydrogen Production Plant Configuration
	2.2-2	The hydrogen production plant shall be physically separated from the remainder of the NGNP consistent with commercial plant economic and risk tradeoffs.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.2 Hydrogen Production Plant Configuration
	2.2-3	The interfaces between the hydrogen production plant and the remainder of the NGNP shall be designed to ensure that failures or upset conditions in the hydrogen production plant do not result in failures or adverse impacts to the remainder of the NGNP facility.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.2 Hydrogen Production Plant Configuration
	2.2-4	The interfaces between the hydrogen production plant and the remainder of the NGNP shall be designed to ensure that failures or upset conditions in the NGNP facility do not result in failures or adverse impacts to the hydrogen production plant.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.2 Hydrogen Production Plant Configuration
	2.2-5	The hydrogen production plant shall provide for storage of feedstock (e.g., water and makeup chemicals), as required.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.2 Hydrogen Production Plant Configuration
	2.2-6	The hydrogen production plant shall include all necessary pretreatment or conditioning of readily available raw materials needed for the specific hydrogen process (e.g., water treatment).	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.2 Hydrogen Production Plant Configuration
	2.2-7	Hydrogen produced in the hydrogen production plant shall be made available for distribution.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.2 Hydrogen Production Plant Configuration
	2.2-9a	No central storage shall be included at the hydrogen production plant other than buffer storage, as required for efficient operations.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.2 Hydrogen Production Plant Configuration
	2.2-9b	Storage of hydrogen shall provide for pressure relief, venting, valving, instrumentation, and maximum allowable quantities to limit postulated conflagration.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.2 Hydrogen Production Plant Configuration
	2.2-10	The oxygen by-product gas shall have purity levels consistent with current industry standards for bulk oxygen applications.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.2 Hydrogen Production Plant Configuration

Object #	Requirement ID	Requirements for Hydrogen Production System	Set	Reactor Type	Source	Source Section
	2.2-11	The hydrogen delivery pressure shall be [TBD MPa].	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.2 Hydrogen Production Plant Configuration
	2.2-12	The hydrogen product gas shall have purity levels consistent with current industry standards for bulk hydrogen applications.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.2 Hydrogen Production Plant Configuration
	2.2-13	The interface system between the hydrogen production plant and the remainder of the NGNP shall be designed to ensure that tritium migration into the hydrogen production plant will be limited, such that the maximum amount of tritium released to the hydrogen production plant does not exceed [TBD] standards.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.2 Hydrogen Production Plant Configuration
	2.2-15	The total concentration of radioactive contaminants in the hydrogen product gas and associated hydrogen production systems shall be minimized to ensure that public dose limits do not exceed NRC regulatory limits.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.2 Hydrogen Production Plant Configuration
	2.2-15	The total concentration of radioactive contaminants in the hydrogen product gas and associated hydrogen production systems shall be minimized to ensure that worker dose limits do not exceed NRC regulatory limits.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.2 Hydrogen Production Plant Configuration
2.3		**Hydrogen Production Plant Waste**			SRM Rev 2	4.6.3 Hydrogen Production Plant Waste
	2.3-2	The hydrogen production plant design shall be such that there is a disposal path for all waste. Hazardous waste streams identified in 40 CFR 261.3 shall be disposed of accordingly.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.3 Hydrogen Production Plant Waste
	2.3-3	A means of disposing (such as flaring) of out-of-specification hydrogen product during upsets or startup/shutdown shall be included.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.3 Hydrogen Production Plant Waste
2.4		**Hydrogen Production Plant Safety and Licensing**			SRM Rev 2	4.6.4 Hydrogen Production Plant Safety and Licensing

Object #	Requirement ID	Requirements for Hydrogen Production System	Set	Reactor Type	Source	Source Section
	2.4-1	The hydrogen production facilities, including the conversion, storage, and distribution systems, shall comply with the requirements of 29 CFR 1910.103, Occupational Safety and Health Standards, Subpart H - Hazardous Materials, Hydrogen.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.4 Hydrogen Production Plant Safety and Licensing
	2.4-2	In the event that the hydrogen production plant also produces and stores significant quantities of oxygen, the requirements of 29 CFR 1910.104, "Oxygen," shall apply.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.4 Hydrogen Production Plant Safety and Licensing
	2.4-3a	The operation, of the hydrogen production plant shall comply with 29 CFR 1910.119, "Process Safety Management of Highly Hazardous Chemicals."	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.4 Hydrogen Production Plant Safety and Licensing
	2.4-3b	The maintenance of the hydrogen production plant shall comply with 29 CFR 1910.119, "Process Safety Management of Highly Hazardous Chemicals."	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.4 Hydrogen Production Plant Safety and Licensing
	2.4-4	Standby power to the hydrogen production facility ventilation, treatment systems, temperature controls, alarms, detection systems, and other electronically operated systems shall be provided in accordance with National Fire Protection Association (NFPA) requirements.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.4 Hydrogen Production Plant Safety
	2.4-5	Heat exchangers and/or steam generators shall meet the applicable pressure vessel requirements in the ASME B&PV Code.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.4 Hydrogen Production Plant Safety
	2.4-6a	HPS Piping systems shall prevent electrostatic discharge from acoustically induced fatigue.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.4 Hydrogen Production Plant Safety
	2.4-6b	HPS storage systems shall prevent electrostatic discharge from acoustically induced fatigue.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.4 Hydrogen Production Plant Safety
	2.4-6c	HPS Piping systems shall prevent equipment failures from hydrogen embrittlement.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.4 Hydrogen Production Plant Safety

Object #	Requirement ID	Requirements for Hydrogen Production System	Set	Reactor Type	Source	Source Section
	2.4-6d	HPS storage systems shall prevent equipment failures from hydrogen embrittlement.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.4 Hydrogen Production Plant Safety
2.5		**Hydrogen Production Plant Reliability and Availability**			SRM Rev 2	4.6.5 Hydrogen Production Plant Reliability and Availability
2.5.1		**Capacity Factor**			SRM Rev 2	4.6.5.1 Capacity Factor
	2.5.1-1	Excluding NGNP mission-specific outages for inspection and testing, the hydrogen production plant design capacity factor for hydrogen production averaged over the plant lifetime shall be at least [TBD %] when modeled with equipment mean time to failure and mean time to repair data for the same or similar systems and/or components.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.5.1 Capacity Factor
2.5.2		**Planned Outages**			SRM Rev 2	4.6.5.2 Planned Outages
	2.5.2-1	Excluding NGNP mission-specific outages for inspection and testing, the capacity factor loss due to hydrogen production plant planned outages averaged over the plant lifetime shall be no greater than [TBD %], including all planned inspection and maintenance activities that must be accomplished with the hydrogen production plant shutdown.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.5.2 Planned Outages
2.5.3		**Hydrogen Production Plant Investment Protection**			SRM Rev 2	4.6.5.3 Hydrogen Production Plant Investment Protection
	2.5.3-1	Excluding NGNP mission-specific outages for inspection and testing, the calculated capacity factor loss due to unplanned hydrogen production plant outages averaged over the lifetime of the plant shall not exceed [TBD. %].	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.5.3 Hydrogen Production Plant Investment Protection

Object #	Requirement ID	Requirements for Hydrogen Production System	Set	Reactor Type	Source	Source Section
2.6		**Hydrogen Production Plant Maintenance and In-Service Inspection**			SRM Rev 2	4.6.6 Hydrogen Production Plant Maintenance and In-Service Inspection
2.6.1		**Hydrogen Production Plant Maintenance Requirements**			SRM Rev 2	4.6.6.1 Hydrogen Production Plant Maintenance Requirements
	2.6.1-1	The hydrogen production plant shall be designed to allow all components to be removed, replaced (if necessary), and reinstalled.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.6.1 Hydrogen Production Plant Maintenance Requirements
	2.6.1-2	The hydrogen production plant design shall include provisions for monitoring equipment status, configuration, and performance and for detecting and diagnosing malfunctions as a basis for predictive maintenance plans and decision making.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.6.1 Hydrogen Production Plant Maintenance Requirements
	2.6.1-3	The hydrogen production plant design shall provide storage facilities for an adequate amount of spare parts as determined by a preventive maintenance and facility availability plan.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.6.1 Hydrogen Production Plant Maintenance Requirements
	2.6.1-4	Hydrogen detectors, relief valves, alarms, and isolation valves required for safety will be designed for periodic testing and calibration.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.6.1 Hydrogen Production Plant Maintenance Requirements
2.6.2		**Hydrogen Production Plant In-Service Inspection**			SRM Rev 2	4.6.6.2 Hydrogen Production Plant In-Service Inspection
	2.6.2-2	The hydrogen production plant design shall provide access to the pressure boundary to permit operational inspection as required by appropriate sections of the ASME B&PV Code.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.6.6.2 Hydrogen Production Plant Operational Inspection
3		**Hydrogen Plant**			Bounding Condition	4.10 Hydrogen Plant

Object #	Requirement ID	Requirements for Hydrogen Production System	Set	Reactor Type	Source	Source Section
3.1		**Bounding Condition - 014**			Bounding Condition	4.10.1 Bounding Condition - 014
	3.1-1	The interface for the hydrogen plant shall be via a separate parallel primary loop with an IHX designed to accommodate the process with the highest production module energy requirement (expected to be in the 60 Mwt range).	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.10.1 Bounding Condition - 014
	3.1-2	This loop shall be designed to operate at temperatures up to 950°C at power levels from 5 Mwt to 60 MWt.	950 C	Pebble Bed Prismatic	Bounding Condition	4.10.1 Bounding Condition - 014
	3.1-3	The heat transfer/ transport system supplying these processes must be capable of a turndown ratio of 10:1 to accommodate these variations.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.10.1 Bounding Condition - 014, Summary of Bases
	3.1-4	The interface between NGNP and the hydrogen process must be designed to accommodate the thermo-chemical processes as they become available for demonstration at the production module level.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.10.1 Bounding Condition - 014, Summary of Bases

B-4. Power Conversion System Requirements

B-4.1 Steam Generator

Object #	Requirement ID	Requirements for Steam Generator	Set	Reactor Type	Source	Source Section
2		**Requirements Applicable to Power Conversion System**			SRM Rev 2	4.5 Requirements Applicable to Power Conversion System
	2-1	The Power Conversion System shall convert energy from the PHTS or steam generator, as applicable, into electricity for distribution on the commercial gird.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.5 Requirements Applicable to Power Conversion System
2.1		**Steam Turbine and Generator**			SRM Rev 2	4.5.1 Steam Turbine and Generator

Object #	Requirement ID	Requirements for Steam Generator	Set	Reactor Type	Source	Source Section
	2.1-2	The steam turbine and generator shall be designed for superheated steam at a pressure of [TBD] and temperature of [TBD] at the turbine throttle.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.5.1 Steam Turbine and Generator
	2.1-3	The steam turbine and generator shall be designed with a single shaft.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.5.1 Steam Turbine and Generator
	2.1-4	The turbine shall be designed for main steam temperature variations of up to [TBD].	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.5.1 Steam Turbine and Generator
	2.1-5	The steam turbine generator rating shall be [TBD].	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.5.1 Steam Turbine and Generator
	2.1-6	The Steam Turbine and Generator shall produce electricity using steam.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.5.1 Steam Turbine and Generator

B-4.2 Power Conversion System Equipment for Direct Combined Cycle

Object #	Requirement ID	Requirements for PCS Equipment for Direct Combined Cycle	Set	Reactor Type	Source	Source Section
3		**Power Conversion System**			Bounding Condition	4.9 Power Conversion System
3.1		**Bounding Condition - 013**			Bounding Condition	4.9.1 Bounding Condition - 013
	3.1-1	The NGNP PCS shall be an indirect sub-critical Rankine cycle (i.e., the steam generator shall be installed in the secondary loop supplying a standard steam turbine generator) with a rating equivalent to the nuclear system power rating.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.9.1 Bounding Condition - 013
	3.1-2	The steam conditions and configuration of the cycle shall be selected to result in a net generation efficiency of at least 42%; balancing cost with efficiency and reliability.	950 C 750 C	Pebble Bed Prismatic	Bounding Condition	4.9.1 Bounding Condition - 013

B-4.3 General

Object #	Requirement ID	General Requirements for Power Conversion System	Set	Reactor Type	Source	Source Section
1		**Note: Items appearing in brackets ([ ]) represent approximations and/or undefined values.**				
2		**Power Conversion System - General Requirements**				
2.1		**Requirements Applicable to Power Conversion System**				
	2.1-2	The NGNP PCS shall be connected to a local public transmission line for external distribution and sale of up to [250-300] MWe.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.5 Requirements Applicable to Power Conversion System
	2.1-3	The NGNP PCS shall produce electricity at nominal 60 Hz.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.5 Requirements Applicable to Power Conversion System
	2.1-4	The NGNP PCS shall be sized to produce electricity at commercial scale using 100% of the NGNP thermal energy from the reactor.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.5 Requirements Applicable to Power Conversion System
	2.1-5	The NGNP electrical output shall be delivered to the operating utility at the low-voltage bushings of the main power transformer.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.5 Requirements Applicable to Power Conversion System
2.2		**Main Feed-Water System**				
	2.2-1	The Main Feedwater System shall deliver feedwater to the steam generator at the specified temperature, pressure, flow rate, and water chemistry.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.5.3 Main Feedwater System
	2.2-2	The Main Feedwater System shall provide storage to accommodate process fluid surge and volume fluctuations.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.5.3 Main Feedwater System
	2.2-3	The Main Feedwater System shall provide isolation of the feedwater to prevent water inflow to a failed steam generator.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.5.3 Main Feedwater System
2.3		**Main Steam System**				
	2.3-1	The Main Steam System shall convey steam from the steam generator outlet nozzles to the inlet nozzles of the high-pressure turbines.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.5.4 Main Steam System
2.4		**Main Condensate System**				

Object #	Requirement ID	General Requirements for Power Conversion System	Set	Reactor Type	Source	Source Section
	2.4-1	TBD	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.5.5 Main Condensate System
2.5		**PCS Control and Instrumentation System**				
	2.5-1	TBD	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.5.6 PCS Control and Instrumentation System

B-5. Balance of Plant Requirements

B-5.1 Fuel Handling System

Object #	Requirements ID	Requirements for Fuel Handling System	Set	Reactor Type	Source	Source Section
2		**Requirements Applicable to Multiple Systems, Buildings and Structures**			SRM Rev 2	4.1 Requirements Applicable to Multiple Systems, Buildings and Structures
2.1		**Decommissioning Requirements**	950 C 750 C		SRM Rev 2	4.1.13 Decommissioning Requirements
	2.1-1a	Upon completion of its useful life, the NGNP nuclear heat source shall be put into a condition of safe storage for 10 years.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.14 Decommissioning Requirements
	2.1-1b	After the safe storage period of 10 years, the NGNP shall be decommissioned and dismantled to allow continued use of the land as a power plant or industrial site.				
	2.1.1	The design of the NGNP shall incorporate features consistent with decommissioning and decontamination best practices.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.4 Environmental Requirements
3		**Requirements Applicable to Nuclear Heat Source**			SRM Rev 2	4.3 Requirements Applicable to Nuclear Heat Source

Object #	Requirements ID	Requirements for Fuel Handling System	Set	Reactor Type	Source	Source Section
3.1		**Reactor Support Systems**			SRM Rev 2	4.3.3 Reactor Support Systems
3.1.1		**Fuel Handling Systems**			SRM Rev 2	4.3.3.3 Fuel Handling Systems
	3.1.1-8	For the prismatic reactor design during reactor shutdown, the Fuel Handling System (FHS) shall receive new and irradiated fuel, reflector blocks, and other core elements from the spent fuel storage system (SFSS) and place them in the reactor vessel, physically replacing and restacking the core.	950 C 750 C	Prismatic	SRM Rev 2	4.3.3.3 Fuel Handling Systems
	3.1.1-9	For the pebble bed reactor design, the FHS shall be developed such that the fuel pebbles are circulated through the core to affect on-line plant refueling.	950 C 750 C	Pebble Bed	SRM Rev 2	4.3.3.3 Fuel Handling Systems
	3.1.1-10	The FHS shall provide shielding to protect workers from radiation during certain fuel handling operations, as applicable.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.3 Fuel Handling Systems
	3.1.1-11	The FHS shall limit the ingress of potential contaminants into the primary helium circuit from components of the FHS external to the primary HPB.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.3 Fuel Handling Systems
	3.1.1-12	For the prismatic reactor design, the FHS shall be designed to accomplish plant refueling within a time interval specified in planned outage allocations.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.3 Fuel Handling Systems
	3.1.1-13	The Fuel Handling System shall remove and replace fuel from the reactor core.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.3.3.3 Fuel Handling Systems
	3.1.1-14	The Fuel Handling System shall prepare new fuel for use in the reactor core.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.3.3.3 Fuel Handling Systems
	3.1.1-15	The Fuel Handling System shall store spent fuel.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.3.3.3 Fuel Handling Systems
3.1.2		**Spent Fuel Cooling System**			SRM Rev 2	
	3.1.2-2	The spent fuel cooling system shall continuously remove [TBD MWt] of heat absorbed by the cooling water at ambient atmospheric conditions.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.4 Spent Fuel Cooling System
	3.1.2-3	The spent fuel cooling system shall be designed to operate continuously whenever spent fuel is located in storage.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.4 Spent Fuel Cooling System
	3.1.2-4	Water quality requirements shall be maintained at all times.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.4 Spent Fuel Cooling System

B-5.2 Instrumentation and Control

Object #	Requirement ID	Requirements for Instrumentation and Control	Set	Reactor Type	Source	Source Section
2		**Requirements Applicable to Multiple Systems, Buildings and Structures**			SRM Rev 2	4.1 Requirements Applicable to Multiple Systems, Buildings and Structures
2.1		**Instrumentation and Control Requirements**			SRM Rev 2	4.1.5 Instrumentation and Control Requirements
	2.1-2	The NGNP shall be capable of being controlled from a single control room.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.5 Instrumentation and Control Requirements
	2.1-3	The main control room shall include controls for the PCS and high-temperature heat transport system.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.5 Instrumentation and Control Requirements
	2.1-4	The NGNP design shall optimize the human-machine interface based on human factors engineering principles and operating experience to the extent possible without compromising plant safety.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.5 Instrumentation and Control Requirements
2.2		**Maintenance Requirements**			SRM Rev 2	4.1.8 Maintenance Requirements
	2.2-1	The NGNP design shall include provisions for monitoring equipment status, configuration, and performance and for detecting and diagnosing malfunctions as a basis for predictive maintenance plans and decision making.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.8 Maintenance Requirements

B-5.3 General

Object #	Requirements ID	General Requirements for Balance of Plant	Set	Reactor Type	Source	Source Section
2		**Requirements Applicable to Balance of Plant**			SRM Rev 2	
2.1		**Cooling Water Systems**				
	2.1-1	TBD	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.7.1 Cooling Water Systems
2.2		**Liquid and Gas Supplies**				
	2.2-1	TBD	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.7.2 Liquid and Gas Supplies
2.3		**Piping Systems**				
	2.3-1	TBD	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.7.3 Piping Systems
2.4		**Electrical Systems**				
	2.4-1	The Electrical Systems shall deliver power generated by the plant to the offsite transmission network.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.7.4 Electrical Systems
	2.4-2	The Electrical Systems shall take power from the off-site transmission network for various plant operations, including startup.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.7.4 Electrical Systems
	2.4-3	The Electrical Systems shall provide backup power to select auxiliaries when the plant power units and off-site power are not available.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.7.4 Electrical Systems
2.4-5.1		**High Voltage Power System**				
	2.4-5.1-1	TBD	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.7.4.1 High Voltage Power System
2.4-5.2		**Medium Voltage Power System**				
	2.4-5.2-1	TBD	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.7.4.2 Medium Voltage Power System
2.4-5.3		**Low Voltage Power System**				
	2.4-5.3-1	TBD	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.7.4.3 Low Voltage Power System
2.4-5.4		**Backup Power System**				

Object #	Requirements ID	General Requirements for Balance of Plant	Set	Reactor Type	Source	Source Section
		TBD	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.7.4.4 Backup Power System
2.4-5.5		**Direct Current/Uninterruptible Power Supply System**				
	2.4-5.4-1	The Direct Current (DC)/Uninterruptible Power Supply (UPS) System shall provide a stored energy source for the all plant DC loads.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.7.4.5 DC/UPS System
2.4-5.6		**Grounding System**				
	2.4-5.6-1	The Grounding System shall protect personnel and equipment from system faults and lightning strikes.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.7.4.6 Grounding System
	2.4-5.6-2	The Grounding System shall minimize electrical noise in signal cables.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.7.4.6 Grounding System
2.4-5.7		**Communication and Lighting**				
	2.4-5.7-1	Communication and Lighting shall provide intra-plant communications.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.7.4.7 Communication and Lighting
	2.4-5.7-2	Communication and Lighting shall provide internal and external lighting.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.7.4.7 Communication and Lighting
2.5		**Plant Control Room System**				
	2.5-1	The NGNP facility design shall permit the operators to take control of the reactor and support processes from within a single integrated control room using the manual mode at any time.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.6 NHS Control Room and Operator Interface System
	2.5-2	The control room shall remain operable and capable of occupation during credible external events.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.6 NHS Control Room and Operator Interface System
	2.5-3	TBD for additional control room and operator interface requirements, such as human factors, protection in DBAs, etc.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.6 NHS Control Room and Operator Interface System
	2.5-4	The Plant Control Room System shall provide an interface between plant operators and each of the necessary systems within the plant.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.7.5 Plant Control Room System
2.6		**Plant Mechanical Services System**				

Object #	Requirements ID	General Requirements for Balance of Plant	Set	Reactor Type	Source	Source Section
	2.6-1	TBD	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.7.6 Plant Mechanical Services System
2.7		**Fire Detection and Suppression System**				
	2.7-1	The Fire Detection and Suppression System shall rapidly detect and annunciate the presence and location of combustion by-products or the presence of fire within the plant.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.7.7 Fire Detection and Suppression System
	2.7-2	The Fire Detection and Suppression System shall control and extinguish fires that do occur.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.7.7 Fire Detection and Suppression System
	2.7-3	The Fire Detection and Suppression System shall provide protection for PASSCs such that the performance of safety functions are not prevented.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.7.7 Fire Detection and Suppression System
2.8		**Communications System**				
	2.8-1	The Communications System shall provide plant to off-site communications.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.7.8 Communications System
2.9		**Safeguards and Security System**				
	2.9-1	The Safeguards and Security System shall provide physical protection of the plant.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.7.9 Safeguards and Security System
2.10		**Plant I&C and Protection**				
	2.10-1	TBD	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.7.10 Plant I&C and Protection
2.11		**NGNP Supervisory and Control System**				
	2.11-1	TBD	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.7.11 NGNP Supervisory and Control System
2.12		**Site and Civil Works**				
	2.12-1	TBD	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.7.12 Site and Civil Works
2.13		**Structural Requirements**			SRM Rev 2	4.1.3 Structural

Object #	Requirements ID	General Requirements for Balance of Plant	Set	Reactor Type	Source	Source Section
						Requirements
	2.13-5	Can be collocated with the process; Protective Action Guidelines limits at site boundary of approximately 400 meters.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	3.2.2 HTGR Fundamental Requirements
	2.13-6	The NGNP design will be such that the HTGR can be collocated with the process; PAG limits met at the site boundary of approximately 400 meters.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.1 System Configuration and Essential Features Requirements
	2.13-7	NGNP PASSCs shall be designed and constructed using and demonstrating modular plant construction.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.3 Structural Requirements
	2.13-8	The NGNP shall be designed for a reference safe shutdown earthquake (SSE) horizontal peak ground acceleration (PGA) of [0.3g].	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.3 Structural Requirements
	2.13-9	The NGNP shall be designed such that the minimum level at which a shutdown is required to evaluate the condition of the plant following an earthquake shall be [0.1g] PGA.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.3 Structural Requirements
	2.13-10	A seismic margin assessment shall be performed to demonstrate that there is seismic margin in the NGNP beyond the design level SSE. The seismic margin earthquake used in the seismic margin assessment process shall be the NUREG/CR-0098 median shape curve anchored to a [0.5g] PGA.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.3 Structural Requirements
	2.13-11	NGNP plant external structures, important to safety, shall be designed and constructed with consideration of aircraft impacts, as required by NRC final rule RIN 3150-AI19.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.3 Structural Requirements
2.14		**Construction Requirements**			SRM Rev 2	4.1.12 Construction Requirements
	2.14-1	Advanced techniques, such as the use of factory or field-fabricated and assembled modules containing portions of systems and/or structures, shall be utilized (as appropriate) to reduce erection costs and schedule risks and to enhance quality control.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.12 Construction Requirements
	2.14-2	The design of buildings and equipment shall facilitate plant construction and the installation, repair, and replacement of equipment.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.12 Construction Requirements
2.15		**Safety Requirements**				

Object #	Requirements ID	General Requirements for Balance of Plant	Set	Reactor Type	Source	Source Section
	2.15-1	The nuclear system safety basis shall not depend on active cooling systems during design basis accident (DBA) conditions.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.9 Safety Requirements
2.16		**Physical Protection of Plants and Materials Requirements**				
	2.16-1	The design of NGNP shall possess features to eliminate or reduce the potential theft of nuclear materials.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.11.1 Physical Protection of Plants and Materials
	2.16-2	The design of NGNP shall emphasize passive barriers to potential theft of nuclear materials.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.11.1 Physical Protection of Plants and Materials
	2.16-3	The design of the NGNP shall incorporate design features intended to provide physical protection against acts of sabotage that could create a radiological hazard to the personnel or a potential radioactive release to the public and the environment.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.11.1 Physical Protection of Plants and Materials
	2.16-4	Measures that have been designed into the NGNP for safety purposes shall be taken into account, to the extent practicable; these safety features should be designed and located within the NGNP in a manner that facilitates sabotage and theft protection, including consideration of damage control/recovery actions from sabotage attempts.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.11.1 Physical Protection of Plants and Materials
	2.16-5	There shall be concurrent consideration of safety and security, which will commence at the beginning of the design process.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.11.1 Physical Protection of Plants and Materials
	2.16-6	The NGNP shall incorporate design features facilitating implementation of material control and accounting procedures that are sufficient to enable the NGNP operating organization to account for the special nuclear material in its possession.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.11.2 Material Control and Accounting of Special Nuclear Material
2.17		**Maintenance Requirements**				
	2.17-1	The NGNP design shall include provisions for monitoring equipment status, configuration, and performance and for detecting and diagnosing malfunctions as a basis for predictive maintenance plans and decision making.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.1.8 Maintenance Requirements
2.18		**NHS Protection System**				
	2.18-1	The NHS Protection System shall maintain plant parameters within acceptable limits established for DBAs.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.3.4 NHS Protection System

Object #	Requirements ID	General Requirements for Balance of Plant	Set	Reactor Type	Source	Source Section
	2.18-2	The protection system shall implement the relevant monitoring, analysis, and actuation functions necessary to reach the controlled state in case of abnormal events.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.4 NHS Protection System
	2.18-3	The protection system shall provide redundant, fail-safe protective functions.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.4 NHS Protection System
	2.18-4	The protection system shall remain operable or fail-safe during credible external events.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.4 NHS Protection System
3		**Requirements Applicable to Nuclear Heat Source**			SRM Rev 2	4.3 Requirements Applicable to Nuclear Heat Source
3.1		**Reactor Support Systems**			SRM Rev 2	4.3.3 Reactor Support Systems
3.1.1		**Helium Service System**			SRM Rev 2	4.3.3.6 Helium Service System
	3.1.1-1	The following is a required function of the helium service system: Remove chemical and particulate contaminants from the primary coolant to maintain specified values.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.6 Helium Service System
	3.1.1-2	The following is a required function of the helium service system: Supply purified helium to systems filled with helium.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.6 Helium Service System
	3.1.1-3	The following is a required function of the helium service system: Remove helium from the primary system and the helium-filled supporting systems and store in a gas store for purified helium.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.6 Helium Service System
	3.1.1-4	The following is a required function of the helium service system: Accept helium from helium-filled auxiliary and supporting systems during depressurization activities and, possibly, store radioactively contaminated helium.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.6 Helium Service System
	3.1.1-5	The following is a required function of the helium service system: Evacuate primary systems and helium supporting systems.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.6 Helium Service System
	3.1.1-6	The following is a required function of the helium service system: Maintain chemical contaminants within required concentration bands.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.6 Helium Service System

Object #	Requirements ID	General Requirements for Balance of Plant	Set	Reactor Type	Source	Source Section
	3.1.1-7	The Secondary Helium Purification System shall process a small side-stream of helium from the Secondary Heat Transport System to remove chemical and radioactive impurities.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.4.2.1 Secondary Helium Purification System
	3.1.1-8	The Secondary Helium Purification System shall provide for tritium removal as required to meet tritium transport limits to plant effluents and products.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 1	4.4.2.1 Secondary Helium Purification System
3.1.2		**Radioactive Waste and Decontamination System**			SRM Rev 2	4.3.3.7 Radioactive Waste and Decontamination System
	3.1.2-1	The Radioactive Waste and Decontamination System shall provide for collecting radioactive (or potentially radioactive) liquid and gaseous wastes, including various forms of solid waste generated within the plant.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.7 Radioactive Waste and Decontamination System
	3.1.2-1	The Radioactive Waste and Decontamination System shall provide for storing radioactive (or potentially radioactive) liquid and gaseous wastes, including various forms of solid waste generated within the plant.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.7 Radioactive Waste and Decontamination System
	3.1.2-1	The Radioactive Waste and Decontamination System shall provide for processing, radioactive (or potentially radioactive) liquid and gaseous wastes, including various forms of solid waste generated within the plant.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.7 Radioactive Waste and Decontamination System
	3.1.2-1	The Radioactive Waste and Decontamination System shall provide for monitoring radioactive (or potentially radioactive) liquid and gaseous wastes, including various forms of solid waste generated within the plant.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.7 Radioactive Waste and Decontamination System
	3.1.2-2	The Radioactive Waste and Decontamination System shall provide equipment to remove radioactive surface contamination from components, as necessary, to facilitate control and minimize migration of radioactive contamination and to limit personnel exposure to radionuclides.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.7 Radioactive Waste and Decontamination System

Object #	Requirements ID	General Requirements for Balance of Plant	Set	Reactor Type	Source	Source Section
	3.1.2-3	The radioactive and potentially radioactive floor and equipment liquid runoff. waste streams shall be routed to the liquid radioactive waste subsystem.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	
	3.1.2-4	Provisions shall be included to reduce activity levels contained in liquid effluent.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.7 Radioactive Waste and Decontamination System
	3.1.2-5	Radioactive liquid waste system components shall be redundant to provide for both system reliability and on-line maintenance.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.7 Radioactive Waste and Decontamination System
	3.1.2-6	The gas waste portion of the radioactive waste system shall have sufficient storage capacity to allow for radioactive decay prior to release.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.7 Radioactive Waste and Decontamination System
	3.1.2-7	Decontamination equipment shall be skid mounted. Each decontamination skid shall provide steam, wash water (including detergent and/or additives), rinse water, drying air, and vacuuming service.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.7 Radioactive Waste and Decontamination System
	3.1.2-8	Decontamination system wastes shall be collected locally and routed to the appropriate radioactive waste systems.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.7 Radioactive Waste and Decontamination System
	3.1.2-9	All radioactive wastes generated within the facility shall be collected, monitored, treated, and processed onsite prior to shipment offsite.	950 C 750 C	Pebble Bed Prismatic	SRM Rev 2	4.3.3.7 Radioactive Waste and Decontamination System