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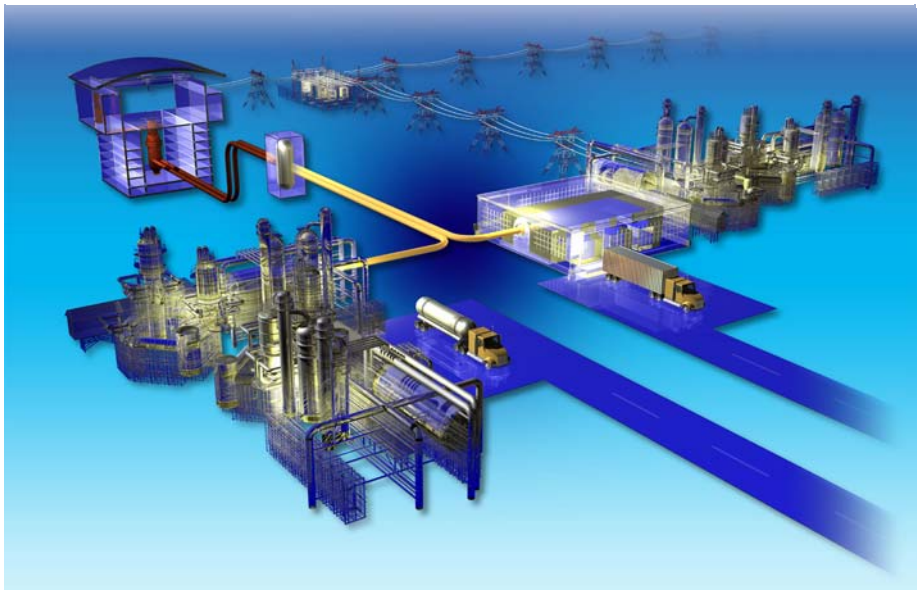
Plan

Project No. 29980

NGNP Licensing Plan



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NGNP Project	Plan	eCR Number: 570776

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REVISION LOG

Rev.	Date	Affected Pages	Revision Description
0	6/26/09	All	New Document

CONTENTS

ACRONYMS

CFR	Code of Federal Regulations
COL	Combined License
DBA	design-basis accident
DOE	Department of Energy
EPAct	*Energy Policy Act of 2005*
ESP	Early Site Permit
FSAR	Final Safety Analysis Report
HTGR	high temperature gas-cooled reactor
INL	Idaho National Laboratory
ISG	Interim Staff Guidance
LBE	licensing basis event
LWA	limited work authorization
LWR	light water reactor
MHTGR	Modular High Temperature Gas-Cooled Reactor
MOU	Memorandum of Understanding
NGNP	Next Generation Nuclear Plant
NRC	Nuclear Regulatory Commission
PBMR	Pebble Bed Modular Reactor
PEP	Project Execution Plan
PIRTs	Phenomena Identification and Ranking Tables
PRA	probabilistic risk assessment
RAI	request for additional information
RG	Regulatory Guide
SRM	staff requirements memorandum
SRP	Standard Review Plan
SSC	structures, systems, and components
V&V	verification and validation
VHTR	very high temperature reactor

1. OVERVIEW

The nuclear energy industry has been traditionally using light water reactor (LWR) technology for the generation of electricity. This technology limits process steam temperature to approximately 300°C. Alternatively, high temperature gas-cooled reactor (HTGR) technology can provide both electricity and the high temperature heat needed for industrial processes. In fact, HTGR technology is expected to supply process heat as an alternative to existing carbon-based sources in commercial applications. These potential applications include co-generation of electricity and steam supply or high temperature gas supply to petrochemical and refining plants, electricity and steam supply for oil sands oil recovery, and high temperature steam or gas and electricity for hydrogen production. Applied in this way, HTGR technology can significantly reduce the use of premium fossil fuels for the production of process heat and reduce greenhouse gas releases, thus providing a significant competitive advantage for U.S. industrial markets.

The Next Generation Nuclear Plant (NGNP) will be a licensed commercial HTGR plant capable of producing the electricity and high temperature process heat for the industrial markets discussed above. The NGNP Project will design, construct, and operate the HTGR plant and associated technologies to establish the technological basis for commercialization of this new generation of advanced nuclear plants.

The Nuclear Regulatory Commission (NRC) will license the NGNP for operation, which is consistent with the Energy Reorganization Act of 1974 that assigns the responsibility for licensing new Department of Energy (DOE) reactors to the NRC if they are used to generate power for an electric utility system or operated in any manner to demonstrate the suitability for subsequent use by the commercial power industry. NRC licensing of the NGNP will demonstrate the efficacy of licensing future gas-cooled reactors for commercial industrial applications.

1.1 Purpose

This document describes the NGNP Project's licensing plan, including expected near-term activities for implementing a strategy that will support licensing of the NGNP and benefit future commercial applicants. This plan focuses on the most significant policy issues for resolution during this near-term phase of interactions with the NRC and outlines a licensing path for the NGNP that will lead to approval of a Combined License (COL) application by the NRC. In the near-term, the plan focuses on critical licensing activities that will proceed in parallel with the DOE's establishment of the public-private partnership, which is ultimately responsible for the facility license.

The approach described in this plan establishes a regulatory framework and project licensing structure that will result in the successful licensing, construction, and operation of the NGNP Project facility. This structure is also intended to directly support future replication and deployment of multiple HTGRs.

1.2 Background and History

1.2.1 Energy Policy Act of 2005

Under Section 641of the *Energy Policy Act of 2005* (EPAct),[1] which was signed into law by the President in August of 2005, it states, *"The Secretary shall establish a project to be known as the 'Next Generation Nuclear Plant Project'."* It continues, *"The Project shall consist of the research, development, design, construction, and operation of a prototype plant, including a nuclear reactor that:*

(1) is based on research and development activities supported by the Generation IV Nuclear Energy Systems Initiative under section 942(d); and

(2) shall be used

(a) to generate electricity;

(b) to produce hydrogen; or

(c) both to generate electricity and to produce hydrogen."

The EPAct also established the expectations for NGNP program execution, including industry participation and cost sharing, international collaboration, NRC licensing, and review by the Nuclear Energy Research Advisory Committee.

The provisions of Section 644 of the EPAct required the Secretary of Energy and the Chairman of the NRC to jointly submit to Congress, within 3 years of enactment, a licensing strategy for the prototype NGNP. The NGNP licensing strategy report was directed to include the following elements:

- A description of the ways in which the NRC needs to adapt its current light-water reactor licensing requirements to accommodate the types of reactors considered for the project
- A description of the analytical tools that the NRC will need to develop to independently verify the NGNP design and its safety performance
- A description of other research or development activities that the NRC will need to conduct a review of an NGNP license application
- A budget estimate associated with the licensing strategy.

As a result of the Section 644 provisions, DOE and NRC developed the *Next Generation Nuclear Plant Licensing Strategy—A Report to Congress*,[2] (dated August 2008) that addressed the four elements listed above. See Section 2.1.2 for more details.

The DOE selected Idaho National Laboratory (INL) as the lead national laboratory for nuclear energy research. Per the terms of Section 662 of the EPAct, INL will lead the development of the NGNP by integrating, conducting, and coordinating all necessary research and development (R&D) activities and by organizing project participants.

1.2.2 NGNP Project Execution Plan

In September 2008, the NGNP Project issued PLN-2825, "Project Execution Plan—Next Generation Nuclear Plant."[3] This document provides the high-level description of the project's organization and interfaces, facility design requirements, R&D scope, regulatory affairs scope, risk management strategy, quality management, project controls, and records management.

In PLN-2825, Section 6, "Regulatory Affairs Scope in Support of NGNP," the purpose and functions of the Regulatory Affairs team are described as follows.

> *The Regulatory Affairs support scope for the NGNP project organization is to provide the primary point of contact and interface between NGNP and the NRC as the licensing approach is further refined and implemented. The Regulatory Affairs organization will coordinate NGNP and NRC activities to assure that a comprehensive program is established and implemented that will ultimately support timely licensing of the selected plant design, while complying with all applicable regulatory requirements. These coordination activities will be aligned with the project phase structure… and will draw significant inputs from the project Procurement Strategy and the R&D scope.*

The functions of the Regulatory Affairs team are discussed in more detail in Section 3 of this plan.

2. PROJECT LICENSING STRATEGY

NGNP has developed a strategic implementation plan to establish the regulatory licensing basis and COL application for an HTGR to result in review/approval by the NRC. This plan focuses on three key elements of plant development and licensing:

1. The development and understanding of the radiological source term (based primarily on fuel design, qualification testing results, and analytical methods development)
2. The prevention/mitigation of the release of this source term to the environment (including definition of licensing basis events and design/implementation of multiple release barriers, consistent with defense in depth strategies and requirements)
3. The development of an updated emergency planning structure that considers potential radiological releases from the HTGR, coupled with various industrial application configurations, in order to assure the protection of the health and safety of the public in the unlikely event of a release

This plan contains the following key components and attributes in addressing these three elements of plant licensing:

- Identifies and implements activities that will support the issuance of a COL in accordance with applicable 10 CFR 52[4] requirements (see Section 2.1).
- Implements a risk-informed and performance-based licensing approach that is consistent with the licensing process-related recommendations included in the *Report to Congress* (Ref. 2) (see Section 2.2).
- Builds on previous licensing efforts and NRC interactions associated with gas-cooled reactor technology (see Section 2.2).
- Identifies the earliest and highest priority preapplication issues to be addressed in the preapplication period, independent of the technology selected, the site where this technology will be located, and whether or not an Early Site Permit (ESP) is submitted. Current work could support multiple applications and sites, pending results of the DOE's Financial Offer of Assistance process (see Section 2.3).
- Establishes the regulatory basis and proposed COL application content for licensing the NGNP by the NRC (see Section 2.4 and Section 2.5).

The remainder of Section 2 of this plan provides the details for the actions needed to implement the licensing strategy components listed above.

2.1 Licensing Regulatory Approach

2.1.1 Background

New nuclear power plants can be licensed under either of two existing regulatory approaches. The first approach is the traditional "two-step" process described in Title 10, Part 50, "Domestic Licensing of Production and Utilization Facilities,"[5] which requires both a construction permit and a separate operating license. The second approach is the "one-step" licensing process described in 10 CFR 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," (Ref 4) which incorporates a COL. Both of these processes allow either a deterministic, or a risk-informed and performance-based approach to technical requirements.

2.1.2 Report to Congress

In response to the direction provided in Section 644 of the EPAct, an NRC and DOE working group was formed to develop the licensing strategy Report to Congress. Since the NGNP is a new reactor design, the NRC will need to adapt its licensing requirements and process, which have historically evolved from LWR experience. Thus, Section 644 of the EPAct recognized the need for an alternative licensing strategy. The working group conducted an in-depth analysis of the current U.S. commercial LWR licensing process and technical requirements options.

The following conclusions are found in the Executive Summary of the *Report to Congress* (Ref 2).

"Based on the detailed analysis of these alternatives and balancing schedule considerations with licensing risk and other pertinent factors, the Secretary of Energy and the Commission concluded that the following NGNP licensing strategy provides the best opportunity for meeting the 2021 date for initial operation of a prototype NGNP:

(1) The best alternative for licensing the NGNP prototype will be for the applicant to submit a combined license (COL) application under Subpart C, "Combined Licenses," of Title 10, Part 52 "Licenses, Certifications, and Approvals for Nuclear Power Plants," of the Code of Federal Regulations (10 CFR Part 52).

(2) The best approach to establish the licensing and safety basis for the NGNP will be to develop a risk-informed and performance-based technical approach that adapts existing NRC LWR technical licensing requirements in establishing NGNP design-specific technical licensing requirements. This approach uses deterministic engineering judgment and analysis, complemented by probabilistic risk assessment (PRA) information and insights, to establish the NGNP licensing basis and requirements. As discussed in this report, the selected approach provides significant advantages in meeting the schedule for licensing an NGNP while providing consistency with Commission policy guidance on the use of probabilistic risk information and insights."

The DOE and NRC staffs believe that the recommended licensing process will greatly reduce both licensing schedule risk and attendant financial risk compared to other licensing options considered. This licensing approach will provide for the most effective and efficient use of NRC and applicant resources while minimizing licensing risk and taking no longer than other alternatives to complete. The licensing

plan described in this document includes the steps that will be taken to address the DOE-related aspects of the strategy recommendations noted above.

2.1.3 NGNP Approach

The NGNP Project has adopted the 10 CFR 52 COL application process, as recommended in the *Report to Congress* (Ref 2), as the foundation for the NGNP licensing strategy. This approach is consistent with the recommended licensing process discussed above and is judged to be the most expedient means of obtaining regulatory approval based on HTGR technology as applied to the NGNP Project.

The ESP process is an optional method of packaging the site safety and environmental information required of the 10 CFR 52 licensing approach that can be submitted prior to the COL application, and will be considered to enable further management of licensing schedule risk. Pursuit of a Limited Work Authorization (LWA) is also an option being considered because it can provide authorization to start limited construction of structures, systems, and components (SSC) that are highly important to the safe operation and security of the facility before NRC issues the construction authorization for the complete plant (see Section 2.4 of this document for more details).

2.2 Method for Adapting LWR Regulations

2.2.1 Background

Historically, a range of approaches have been taken to adapt LWR licensing technical requirements for advanced reactor designs. These approaches have mostly used deterministic methods. Fort St. Vrain (an HTGR located in Colorado) was licensed in the early 1970s using a traditional deterministic approach to adapting (then) existing LWR requirements. At Commission direction, since the early 1990s, greater use of probabilistic methods has been employed, resulting in a continuing effort to risk-inform the traditional deterministic requirements. Existing LWR licensees as well as new LWR COL applicants have availed themselves of the expanding use of risk-informed and performance-based methods. However, the approaches have varied in the extent to which probabilistic information was used for establishing the licensing basis.

2.2.2 Early Guidance Regarding a Risk-Informed Licensing Approach

The NRC's guidance on application of probabilistic information dates back to July 23, 1993, and a Commission staff requirements memorandum (SRM) that approved an approach proposed by the staff (documented in SECY-93-092, *Issues Pertaining to the Advanced Reactor (PRISM, MHTGR, and PIUS) and CANDU 3 Designs and Their Relationship to Current Regulatory Requirements*,[6] and draft safety evaluation report for the Modular High Temperature Gas-Cooled Reactor [MHTGR]). The approved approach would allow adaptation of LWR requirements by applying traditional deterministic engineering judgment, complemented by PRA information and insights. Specifically, in SECY-93-092, the staff proposed an approach that had the following eight characteristics:

1. Events and sequences would be selected deterministically and would be complemented with insights from PRAs of the specific designs.
2. Categories of events would be established according to expected frequency of occurrence. One category of events that would be examined was accident sequences of a lower likelihood than traditional LWR design-basis accidents (DBAs). These accident sequences would be analyzed

without applying the conservatisms used for DBAs. Events within a category equivalent to the current DBA category would require conservative analyses, as is presently done for LWRs.

3. Consequence acceptance limits for core damage and onsite or offsite releases would be established for each category to be consistent with Commission guidance.
4. Methodologies and evaluation assumptions would be developed for analyzing each category of events consistent with existing LWR practices.
5. Source terms would be determined as approved by the Commission.
6. A set of events would be selected deterministically to assess the safety margins of the proposed designs, to determine scenarios to mechanistically determine a source term, and to identify a containment challenge scenario.
7. External events would be chosen deterministically on a basis consistent with that used for LWRs.
8. Evaluations of multi-module reactor designs would be considered as to whether specific events apply to some or all reactors on site for the given scenario for all operations permitted by proposed operating practices.

2.2.3 Recent Applications Associated with Risk-Informed Approach

During preapplication reviews of the Pebble Bed Modular Reactor (PBMR) in 2001 and 2002, Exelon proposed a licensing approach for the PBMR that made greater use of probabilistic risk information to establish the licensing basis for the PBMR. This approach included the application of probabilistic risk information for the selection of the events to be included in the licensing basis and for determining the special treatment requirements for SSCs.

The SECY-93-092 SRM guidance[7] was subsequently updated June 26, 2003, by a Commission SRM related to the review of licensing of non-LWR designs.[8] This SRM allowed the staff to modify the Commission's guidance described in the July 23, 1993 SRM to permit greater emphasis on the use of probabilistic risk information for reactor licensing. The approval allowed:

1. Use of a probabilistic approach to select LBEs for the design, provided there is sufficient understanding of plant and fuel performance and if deterministic engineering judgment is used to bound uncertainties
2. Use of a probabilistic approach for the safety classification of SSCs
3. Replacement of the traditional single-failure criterion with a probabilistic criterion in developing event sequences

This updated guidance was subsequently used by PBMR (Pty) Ltd in the preapplication review of the PBMR Design Certification application that was initiated in 2005. The approach included using the PRA to select events to include in the Final Safety Analysis Report (FSAR) Chapter 15 licensing basis analysis and to provide probabilistic information that could be used to classify SSCs and the appropriate level of special treatment that would be necessary to assure functional performance. This approach would be complemented with deterministic analysis and engineering judgment to provide an appropriate level of defense-in-depth.

In 2007, the NRC staff published a report on the history of risk-informed licensing efforts and proposed the development of a proposed new reactor licensing framework that relies more heavily on risk-informed performance-based concepts. This framework is documented in NUREG-1860, "Feasibility Study for a Risk-Informed and Performance-Based Regulatory Structure for Future Plant Licensing."[9]

The report includes a proposed set of new regulations as an example of what new regulations might look like. The NRC staff currently plans to further develop those draft requirements by gaining experience from licensing an advanced design under 10 CFR 50 (Ref 5) or 10 CFR 52 (Ref 4), applying the framework to the same design to create parallel licensing products, and comparing them to the original products used to license the plant. This path forward was recommended to the Commission in SECY-07-0101, dated June 14, 2007,[10] and was subsequently approved in the Commission SRM.[11]

2.2.4 Report to Congress Recommendation

The *Report to Congress* (Ref 2) included a recommended approach for how to adapt the current LWR technical requirements to apply to a very-high-temperature gas reactor (VHTR) as follows:

> *Within this regulatory framework, there are several technical options for establishing the NGNP licensing basis, each placing progressively greater emphasis on the use of probabilistic risk assessment (PRA) techniques and risk insights. With the exception of the last option (option 4), all other options adapt existing LWR requirements for licensing an NGNP. The last option entails rulemaking to develop a new body of risk-informed and performance-based regulations. These options are described below.*
>
> *(1)* ***Option 1: Deterministic Approach.*** *This option uses deterministic engineering judgment and analysis to establish the licensing basis (including selection of events) and licensing technical requirements. This approach has been used for licensing operating LWRs and involves no use of PRA information and insights.*
>
> *(2)* ***Option 2: Risk-Informed and Performance-Based Approach.*** *This option uses deterministic engineering judgment and analysis, complemented by NGNP design-specific PRA information, to establish the licensing basis (including selecting licensing basis events) and licensing technical requirements. The use of the PRA would be commensurate with the quality and completeness of the PRA presented with the application.*
>
> *(3)* ***Option 3: Risk-Informed and Performance-Based Approach (with greater emphasis on PRA).*** *This option places greater emphasis on the use of the NGNP design-specific PRA in complementing deterministic engineering judgment and analysis, to establish the licensing basis (including selecting licensing basis events) and licensing technical requirements. As in Option 2, the use of the PRA would be commensurate with the quality and completeness of the PRA presented with the application.*
>
> *(4)* ***Option 4: New Body of Risk-Informed and Performance-Based Regulations.*** *This option would use a new body of regulations to establish the licensing basis (including selecting licensing basis events) and licensing technical requirements. The new body of regulations would make extensive use of the risk-informed and performance-based regulatory structure, and would require rulemaking to be implemented.*

The *Report to Congress* (Ref 2) recommended that the best option for licensing the NGNP prototype would be to start with a risk-informed and performance-based technical approach, Option 2 (as described above), and then adapt the existing LWR technical requirements and establish any NGNP-unique requirements that are needed.

It also noted:

Given the current state of Very-High-Temperature Gas Reactor (VHTR) technology design, development and experience, and the quality and completeness of the associated NGNP design-specific PRA, Option 2 is the preferred option for licensing the NGNP prototype, which makes primary use of deterministic judgment and analysis, complemented by NGNP-specific PRA to establish the licensing basis and requirements. The use of the PRA would be commensurate with the quality and completeness of the PRA presented with the application. Once the NGNP technology is demonstrated through successful operation and testing of the NGNP prototype, and a quality PRA including data becomes available, greater emphasis on design-specific PRA to establish the licensing basis and requirements will be a more viable option for licensing a commercial version of the NGNP reactor.

2.2.5 NGNP Approach for Adapting LWR Regulations

Given the limited regulatory experience with gas reactor technology as well as its deployment in nontraditional process heat applications, there is not an existing and complete body of regulations directly suited to the NGNP design. Consequently, for a license application to be successfully prepared, reviewed, and approved, updated regulatory guidance (or an agreed framework) derived from the existing LWR regulations will have to be proposed and agreed upon to guide the approval of the NGNP COL application (see Section 2.4 of this document for more details). Subsequently, it would be expected that such updated guidance would guide future applicants and the NRC staff in preparing and reviewing HTGR license applications. The introduction to Appendix A of 10 CFR 50 (Ref 5) recognizes the need to adapt LWR regulations for non-LWR applications when it states:

> *These General Design Criteria establish minimum requirements for the principal design criteria for water-cooled nuclear power plants similar in design and location to plants for which construction permits have been issued by the Commission.* ***The General Design Criteria are also considered to be generally applicable to other types of nuclear power units and are intended to provide guidance in establishing the principal design criteria for such other units [emphasis added].***

It is therefore clear that the current set of regulations and guidance should be reviewed for applicability to a high-temperature gas reactor design like the NGNP. Engagement with the NRC is needed to reach agreement on the scope and development of new regulatory policies or to change existing regulatory policies that support the high-temperature gas reactor design so that the NGNP licensing process is successful.

2.2.5.1 Deterministic Elements of Adapting LWR Regulations

The NGNP safety approach is rooted in deterministic engineering principles. However, as noted above, the licensing approach for determining licensing basis events (LBEs) is risk-informed, and thus is based on both deterministic and probabilistic elements. Other areas where a combination of deterministic and probabilistic analysis will play a role include the definition of NGNP safety functions and success criteria, the prediction of plant response to initiating events, and the development of mechanistic source terms. Traditional regulatory objectives that are not generally amenable to probabilistic treatment include issues such as occupational exposure minimization, environmental impacts other than radiological, and security and safeguards, which will thus be addressed in a deterministic manner.

2.2.5.2 Risk Assessment Elements of Adapting LWR Regulations

Consistent with the *Report to Congress* (Ref 2) recommendation, the NGNP Project is developing a risk-informed and performance-based technical approach that adapts existing NRC LWR technical licensing requirements in establishing NGNP design-specific technical licensing requirements. The rationale for use of these risk-assessment techniques includes:

- Using a PRA to aid in the development of events that are included in the licensing basis maximizes the probability of establishing a comprehensive safety basis. By its nature, PRA development is a rigorous process that considers the comprehensive performance of the facility design and safety margins.
- The PRA development process includes evaluations and analyses that are deterministic in nature (e.g., failure modes and effects analysis and reactor system performance analyses).
- Probabilistic methods for event selection, SSC classification, special treatment identification, as well as integration and evaluation of defense-in-depth strategies will take advantage of the safety characteristics provided by gas-cooled reactor designs.
- Integrating PRA insights into the design provides a more structured means for both assessing single point vulnerabilities as required by the single failure criterion used in current LWRs and providing more robust capability for considering functional vulnerabilities and diversity for all portions of the event frequency spectrum. This is of considerable value, particularly for designs that are new or contain novel features.
- Using a PRA provides a rational method for selecting design features and resolving safety issues; hence avoiding conflicting requirements that can arise from a purely deterministic design and safety analysis approach.
- The PRA provides a rational approach for identifying, understanding, and addressing uncertainties.

2.2.5.3 LWR Regulation Reconciliation Development

The project has commenced work to initiate a detailed analysis that includes a reconciliation of existing LWR regulatory requirements with the characteristics of a typical HTGR. The list of regulatory requirements includes 10 CFR 50, 10 CFR 50 Appendix A (General Design Criteria), 10 CFR 51, 10 CFR 52, 10 CFR 100, and applicable Regulatory Guides, Standard Review Plans (SRPs), NUREGs, and NRC generic guidance.

It was decided that it would be most productive to perform a detailed review of Standard Review Plan (NUREG-0800[12]) criteria, since they have a more direct impact on the preparation of the COL application. Using this process, it was recognized that some of the current design-related regulations are fully applicable to any design, some are not applicable to gas reactors, and many may be partially applicable. There may also be some features of the NGNP design that cannot be addressed by any current regulatory criterion, thus requiring new guidance criteria to be developed or other agreements reached between the NGNP Project and NRC during the licensing process.

2.2.5.4 Regulatory Gap Analysis

The initial reconciliation of SRP acceptance criteria with NGNP features was performed, but additional design detail and more discussion with the designers is needed to finalize the applicability

assessment. The assessment will also depend on the specific NGNP design being evaluated. However, the initial reconciliation demonstrated that the SRP can provide a strong foundation for future preparation and review of Part 2 (FSAR) of a NGNP COL application.

An additional review of all regulations (addressing administrative as well as design-related regulations) and subtier guidance provided or referenced in the SRP such as Branch Technical Positions, Interim Staff Guidance (ISG), various NRC "NUREG" reports, Unresolved and Generic Safety Issues, and NRC Bulletins and Generic Letters is still needed in the near future. When completed, the results of the gap analysis, especially those regulations judged to be not applicable, will form a part of the population of regulatory issues that will need to be resolved with the NRC staff. The gap analysis methodology and results should be discussed with NRC staff during the COL preapplication program. An approach for conducting the future gap analysis is provided in Figure 1.

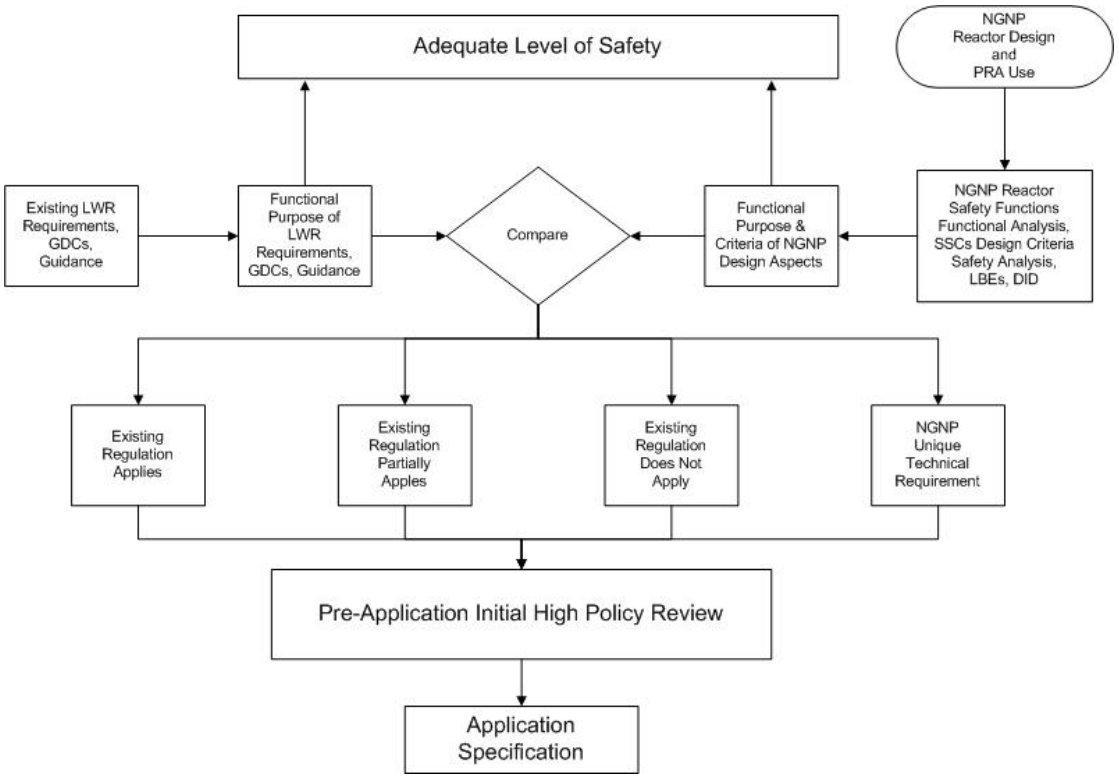

Figure 1. Gap analysis process.

As a starting point (as shown in the upper right oval), the screening of existing LWR regulations for applicability to the NGNP design requires additional NGNP design information and the NGNP PRA. The NGNP design and PRA are used to establish the LBEs and associated technical requirements. The LBEs determine the specific design functions and design functional capabilities that will be required for prevention and mitigation of each LBE. As shown by the diamond-shaped box, these design functions and capabilities will then be compared against the regulatory requirements and criteria of the existing LWR regulations.

A similar approach for adapting existing LWR regulations was proposed by Exelon (letter to NRC dated August 31, 2001[13]) in support of preapplication review activities for the PBMR design. In response, the NRC issued a report (*NRC Staff's Preliminary Findings Regarding Exelon Generation's [Exelon's]*

Proposed Licensing Approach for the Pebble Bed Modular Reactor [PBMR], dated March 26, 2002[14]) that included the following statement:

> *The staff finds that Exelon's proposed classification scheme (which purports to classify existing NRC regulations as completely applicable, partially applicable, or not applicable and identify necessary PBMR-specific requirements) is sufficiently comprehensive to permit an effective screening of regulations. The process also permits the development of considerations that may serve as a basis for appropriate exemption requests.*

2.3 Preapplication Review Activities

2.3.1 Background

An effective preapplication program is a critical part of the NGNP licensing strategy and overall project plan because the early establishment of the approach to resolution of issues can significantly impact the preparation of acceptable COL applications, subsequent application review schedule, and ultimate deployment of the demonstration plant.

Frequent, focused, and coordinated interactions with the NRC Staff will be critical to the success of the preapplication period. This licensing plan contains a summary listing of licensing issues that are considered to be of highest priority, and will therefore be a focus of the NGNP Project team in the near term in order to support commencement of the preapplication process with the NRC Staff in FY 2010. As described in the *Report to Congress* (Ref 2), it is expected that the NRC will participate in the project preapplication review by gathering information; identifying and developing proposals for resolution of key design, safety, and licensing issues; and preparing papers identifying programmatic, regulatory, and key technical issues with recommendations for consideration and approval by the Commission.

Industry collaboration on resolution of issues will also be important during both the preapplication and application review phases of the NGNP Licensing Program. This collaboration is expected to include the designers (e.g., pebble bed and prismatic designs), the Nuclear Energy Institute in regards to owner/operator support and LWR lessons learned that are applicable to HTGRs, and industry standards groups.

It is also recognized that resolving many of the preapplication items discussed in this section will require more detail regarding the plant design and configuration that may not be available until the initial license application is being developd. These additional design details are expected to be developed as the project progresses and the associated public-private partnership(s) are formed. Therefore, this plan focuses first on priority topics that can be developed and addressed with limited design detail, and then lays the groundwork for addressing the more design-driven preapplication topics as designs are further developed during the preapplication period.

2.3.2 Highest Priority NRC Preapplication Items

The issues proposed for preapplication discussions with NRC were selected from a number of sources, including MHTGR precedent, the Exelon PBMR licensing program, the PBMR (Pty) Ltd. U.S. Design Certification program, and NGNP program studies. These sources are summarized in Table 1. The issues identified from these sources were combined as necessary to eliminate overlap and were then prioritized, considering their potential overall impact on the plant design, related project activities, licensing, and project completion. The results of this effort are presented in Appendix A of this report,

which includes a tabulated summary description for each of the issues identified by this initial selection process.

Table 1. Sources for high priority preapplication issues.

Category	Document
MHTGR Precedent	• Preliminary Safety Information Document (DOE-HTGR-86-024) • Regulatory Technology Development Plan (DOE-HTGR-86-064) • NRC Safety Evaluation (NUREG-1338, 1989)
Exelon Licensing Approach	• Exelon letter to NRC, dated May 10, 2001 (PBMR regulatory issues) • Exelon letter to NRC, dated May 25, 2001 (Part 52 applications and licensing plan) • Exelon letter to NRC, dated July 9, 2001 (PBMR preapplication meeting) • Exelon letter to NRC, dated August 31, 2001 (PBMR proposed licensing approach) • NRC letter to Exelon, dated March 26, 2002 (NRC preliminary findings on licensing approach) • Exelon letter to NRC, dated July 22, 2001 (Preapplication activities summary)
PBMR. U.S. Design Certification Preapplication White Papers	• PRA Approach • Licensing Basis Event and Design Basis Accident Selection • Safety Classification of SSCs • Defense-in-Depth • Fuel Design and Qualification • Analytical Code Verification and Validation • High Temperature Materials—Metallics • High Temperature Materials—Ceramics (pending)
NGNP Program	• Special Study 20.6—January 2007 • Preconceptual Design Report—May 2007 • Licensing Risk Reduction Study—April 2008 • NGNP Team letter to NRC (dated March 11, 2008) • NGNP PIRT Gap Report (ORNL, #ORNL/TM-2007/228)
NRC Documents	• SECY Reports (e.g., SECY-90-016, SECY-93-087, SECY-03-047) • R&D Plan (draft, dated April 2007)

The major technical issues planned for early discussion with NRC are:

- Implementation of risk-informed, performance-based methods; these methods are expected to contain the following primary inputs:
  - Use of PRA
  - Selection of licensing basis events

- Defense-in-depth
- Classification of SSCs

- Emergency planning zone reduction and establishment of associated emergency action levels
- Regulatory guidance and related restrictions associated with co-location of HTGRs at industrial sites
- Mechanistic source term, fission product transport and containment function performance requirements
- Fuel qualification
- Analytical code verification & validation (V&V)
- High temperature materials—metallics
- High temperature materials—ceramics
- Applicable codes and standards
- Air ingress
- Water ingress

2.3.3 Interactions with the NRC

The NGNP Project is developing a series of white papers that address each of the preapplication issues as a means of focusing NRC review and establishing requirements for acceptable COL application contents. The basic project approach will generally follow the white paper process implemented for the PBMR U.S, Design Certification project.[15] In this process, white papers will be prepared, including specific NRC review objectives, for each preapplication issue and then submitted, reviewed and revised according to the following process:

- White paper submittal, including specific issues, proposed approaches to resolution, and expected outcomes from the NRC review
- NRC Staff review of paper
- 1st Workshop (discussion and feedback on issues and proposed resolutions)
- NRC issues requests for additional information (RAIs) as needed
- Responses to RAIs are prepared and submitted
- NRC reviews responses
- 2nd Workshop (discussion of responses, if necessary)
- Revised white paper submittal (incorporating all RAI responses)
- NRC provides final feedback and documentation in a format that can be used as a firm basis for preparing the license application(s)

As discussed earlier, the priority preapplication items were selected primarily due to their potentially significant impact on the design configuration of the plant, related project activities, licensing, and project completion. It is therefore critical that NRC feedback regarding the white papers be developed and

documented with as much regulatory certainty as possible (consistent with the maturity of the proposed design and its associated licensing strategy, and the position for the selected topic). This regulatory certainty is critical to the efficient progress of the project.

The form of the NRC feedback is still being developed via project dialogue with the NRC Staff, but is generally expected to take one of four forms, depending on the format and content of the preapplication submittal:

- NRC status review letter, providing Staff inputs and insights related to the position(s) being proposed, including the staff's acceptance of portions of the position, and recommendations/requests for further work on particular topics (similar in format/content to the status letters provided as a part of the Exelon licensing process).
- Based on NRC Staff review of a particular topic (when such positions do not require submission to the Commission for decisions), ISG will later be incorporated into appropriate guidance documents (as required) for additional or future deployments.
- NRC Staff Safety Evaluations for material that is presented in a Topical Report format that is intended to be directly referenced and credited in future license application(s).
- Commission SRM for those matters that are submitted by the NRC staff to the Commission seeking resolution of a policy question.

The duration of the above process depends on the content of the paper and its significance to the NRC safety review. It is expected that specific schedules will be established in concert with the NRC prior to or during the early stages of the preapplication program. The results of these preapplication activities will be utilized when revising or developing the format and/or content of the COL or ESP applications, so that early and ongoing alignment with the NRC is developed. This minimizes the potential for significant mismatches in content expectations when the applications undergo acceptance reviews. The conduct of the preapplication program as outlined above will significantly reduce the schedule risk in the preparation and review of the COL application.

2.3.4 Follow-on Preapplication Activities

2.3.4.1 Regulatory Technology Development Plan

A significant preapplication topic is the establishment of a research program that is both coordinated and integrated between the NGNP project team and the NRC Staff. A clearly defined connection between the project's Regulatory Technology Development Plan and the NRC Staff's Advanced Reactor Research Plan is crucial to assuring that the research necessary to complete the design and provide adequate bases for future NRC safety conclusions is completed. This is especially true for items that significantly impact the basic plant design, or that have long lead times due to the required development and confirmatory testing. It is expected that the results of the consolidated research activities described in the Regulatory Technology Development Plan will be made available to related DOE organizations, the NRC, and license applicants in accordance with project document control requirements. The research and development phase of the NGNP Project is anticipated to continue well into the final design.

2.3.4.2 Phenomena Identification and Ranking Table Process

The Phenomena Identification and Ranking Tables (PIRTs)[16,17] process provides expert assessment of a broad range of safety relevant phenomena and identifies research and development needs. A nine step process was conducted by expert panels in the following topical areas:

- Coated particle fuel
- Accident and thermal fluids
- Fission-product transport and dose
- High-temperature materials
- Graphite
- Process heat and hydrogen co-generation production

Phenomena important to safety systems and components were identified and figures of merit were established. The NGNP panel members rated (as high, medium, or low) the importance and the associated knowledge level of the phenomena that apply to NGNP.

As the NGNP design is developed and the resolution of PIRT issues continues, the PIRTs will need to be updated and resolutions of related design and safety issues will require interaction with NRC. Many of the issues resolution will be documented in topical reports and submitted for NRC review and approval. It is anticipated that these topical reports will be submitted during the preapplication and application review phases of the licensing process.

2.3.4.3 Regulatory Gap Analysis

The preapplication topics (Section 2.3.2) were developed based on an initial review of existing requirements, references, and project material that were expected to identify many of the most critical regulatory issues for commencement of the preapplication program. In order to arrive at a more comprehensive listing of issues to be addressed as a part of the preapplication and application processes, a more detailed regulatory gap analysis will be required. The NGNP approach for implementing this process is described in Section 2.2.5, and is consistent with the recommended implementation strategy described in the *Report to Congress* (Ref 2).

2.4 COL Application Content Development

The centerpiece of the licensing approach is a COL application submitted to NRC pursuant to 10 CFR 52 of the NRC regulations (Ref 4). Successfully and efficiently implementing this approach requires that the NGNP Project and NRC agree on a set of COL application development requirements and guidance documents (hereafter referred to as a "COL application specification" document) suitable for the NGNP. This is critical because the existing LWR regulatory framework only applies in part to the NGNP HTGR design and its use in process heat and electricity co-generation applications. Thus, the early development of a new syllabus of application content requirements that parallel existing LWR requirements is needed to properly and completely present the unique features of the NGNP, guide engineering and design, and promote regulatory stability and efficiency.

Pursuit of an ESP is optional for the NGNP and is retained in the licensing approach because it can provide a vehicle for resolving site related issues early in the schedule. Pursuing an LWA is also optional because it can provide authorization to start limited construction (including driving of piles, subsurface

preparation, placement of backfill, concrete, or permanent retaining walls within an excavation which are for SSCs important to safe operation and security) up to approximately 10–12 months before NRC issues the construction authorization for the complete plant (the COL). ESP and LWA development requirements and guidance documents may be necessary to provide a complete set of application content requirements.

The NGNP COL application is expected to be comprised of up to 11 parts, supplemented by various topical reports. Topical reports can be used as a supplemental mechanism to document technical nuclear plant safety topics that are submitted to the NRC for review and approval either in advance of the COL application or in parallel with the application. These reports document information not suitable for inclusion in the application itself (e.g., proprietary, safeguards information) and/or establish standard, approved references that can be used for multiple applications.

The overall structure of the NGNP COL application will be based on the structure used by recent LWR COL applications and is expected to include the following parts:

- Part 1: General and Administrative Information
- Part 2: Final Safety Analysis Report (FSAR), including the following chapters:
    (1) Introduction/Description
    (2) Site Characteristics
    (3) Design of Structures, Systems and Components
    (4) Reactor
    (5) Reactor Coolant and Connecting Systems
    (6) Engineered Safety Features
    (7) Instrumentation and Controls
    (8) Electrical Power
    (9) Auxiliary Systems
    (10) Steam and Power Conversion Systems
    (11) Radioactive Waste Management
    (12) Radiation Protection
    (13) Conduct of Operations
    (14) Verification Programs
    (15) Transient and Accident Analysis
    (16) Technical Specifications
    (17) QA and Reliability Assurance
    (18) Human Factors Engineering
    (19) Probabilistic Risk Analysis (PRA)
- Part 3: Environmental Report
- Part 4: Technical Specifications
- Part 5: Emergency Plan
- Part 6: LWA/Site Redress Plan (if applicable)

- Part 7: Departures/Variances/Exemptions Report (variances if an ESP is used; departures if design certifications are pursued)
- Part 8: Security Plan
- Part 9: Withheld Information (Proprietary and Sensitive) (if necessary)
- Part 10: Inspection, Test, Analysis Acceptance Criteria
- Part 11: Enclosures (e.g., documents incorporated by reference)

The COL application specification defines the content requirements for the COL application and addresses the following areas:

- An overview of the 11 major parts of an application
- Generation of a writers' guide for each of the 19 chapters of an FSAR (Part 2 of the application) consolidated into a single document
- A cross reference between NRC Regulatory Guide (RG) 1.206, "Combined License Applications For Nuclear Power Plants (LWR Edition),"[18] section titles and those in the writers' guide
- Generation of a writers' guide for the Environmental Report
- A cross reference to NRC RG 4.2, "Preparation of Environmental Reports for Nuclear Power Stations"[19]
- Listing of significant insights and lessons from the writers' guide efforts
- A generic listing of the topical reports normally expected to support an FSAR, sorted by chapter
- An assessment of the design maturity required at the time of application submittal

As discussed above, the main effort in developing a COL application specification document is the development of COL application writers' guides. A writers' guide provides format and content guidance, comments for the benefit of the COL application author, insights and lessons learned, initial applicability assessment for regulatory acceptance criteria in the NRC LWR SRP, and define engineering work products needed to support writing of the COL application. Since NRC guidance is focused on LWRs and has no specific NGNP variant, the writers' guide will prove useful in prescribing those requirements to the individuals responsible for producing an FSAR and an Environmental Report for the NGNP Project.

The format and content of the FSAR for LWRs is described from the viewpoint of the COL applicant in NRC RG 1.206, and is also described from the viewpoint of the reviewer in SRP (NUREG-0800) (Ref 12). Similar NRC guidance is provided for the Environmental Report in RG 4.2 (Ref 19) and NUREG-1555, "Environmental Standard Review Plan."[20] The development of the writers' guide is also intended to be a common working reference for both the NRC and NGNP during preapplication and provide a means for consistently capturing the NGNP specific application content requirements agreements derived from the individual preapplication topic discussions. Development of NGNP writers' guides would not result in revisions to RG 1.206 or RG 4.2, which would remain in place for LWRs. Rather, the writers' guides would serve as equivalent, standalone guidance documents for use during the licensing of HTGR facilities.

Each chapter of the COL writers' guide will provide standalone content guidance and include the following elements:

- Section-by-section text following the format of RG 1.206 for the FSAR and RG 4.2 for the Environmental Report, in which content requirements are described utilizing the NGNP design and analyses knowledge where specific plant design issues are important, including:
  - Areas where there may be preapplication issues to discuss with NRC
  - Areas where technology development and/or topical reports are likely to be needed to support the section
- An SRP (NUREG-0800 for FSAR and NUREG-1555 for the Environmental Report) Applicability Review table showing SRP acceptance criteria, applicability (yes/no/partial); regulations and RGs; and links to other chapters and/or SRPs. For areas where new or updated SRP guidance is needed, this material will be included in the writer's guide as the guidance is established.
- Required engineering and data items table, including a brief description of the work category (drawing, analysis, reports, design descriptions, specifications, etc.) and the related design or engineering decisions needed. This list of engineering and data items helps integrate the engineering support work and the licensing schedule.

The COL application writers' guide will be periodically updated to reflect new information, including:

- New or revised design features selected as the NGNP design is developed
- Results from technology development programs
- Revised descriptions needed for NGNP design or site features that differ from the generic descriptions
- Progress in the topical report program, especially results from the V&V of safety analysis evaluation model computer programs
- Commitments and insights resulting from preapplication program interactions with NRC staff, including their review of white papers

Each COL applicant will need to decide whether or not to pursue an ESP and/or an LWA, depending on specific site and construction schedule considerations. If either of these options is pursued, specifications for an ESP application and/or LWA could be similarly developed, consistent with experiences reflected in ESP and LWA applications reviewed by the NRC as well as specific guidance and lessons learned from the NRC, Nuclear Energy Institute, and DOE such as COL/ESP ISG-4, *Interim Staff Guidance on the Definition of Construction and on Limited Work Authorizations*.[21]

It is recognized that the required level of design maturity required for submittal of the COL application varies depending on the relationship of the issue to the review to be conducted by the regulator. Generally, a higher level of maturity is needed for those SSCs and their related analyses that have a higher importance in the NRC safety evaluation. Insight to the maturity of the design and analysis required to support the application should be provided in the writers' guide. A COL application must contain sufficient technical information in scope and depth for the NRC staff to begin its detailed technical review and complete it within a predictable time frame, otherwise the COL application risks being rejected by the staff. Refer to NRC Office Instruction NRO-REG-100, "Acceptance Review Process for Design Certification and Combined License Applications."[22] It is also recognized that the design and analysis will continue to mature after the COL application is submitted and, to the extent necessary to resolve NRC review issues, the COL application will be updated accordingly.

2.4.1 COL Application Topical Reports

Topical reports are submitted individually to the NRC for formal review and approval, and form a portion of the overall COL application. These reports are typically incorporated into the application by reference. Each topical report will undergo the NRC acceptance and review process in accordance with NRC Office Instruction LIC-500, "Processing Requests for Reviews of Topical Reports."[23] A topical report should contain complete and detailed information on the specific subject presented. Once approved by the NRC, the topical report is republished by the applicant (in an "-A" version) that appends the staff's final safety evaluation, all RAIs, and the responses to the RAIs. Topical reports are useful to:

- Protect intellectual property
- Establish standard, approved references that can be used in multiple applications
- Take advantage of the opportunity to submit reports as soon as they are available, rather than waiting for an entire FSAR to be submitted, thus mitigating risks of long review periods
- Better manage resources of the applicant and NRC by compartmentalizing information that needs to be reviewed, particularly in highly specialized areas

A listing of topical reports anticipated for technical support of the FSAR/COL application and overall licensing effort will be developed. This list will be based on experience with licensing of commercial nuclear power plants and on expectations for NGNP licensing. Topical report activity is expected to be particularly heavy in support of FSAR Chapters 3, 4 and 7, where the efforts to establish equipment design characteristics and design verification will dominate, and in support of FSAR Chapter 15, where accident analysis code requirements will be extensive.

Topics that lend themselves to being addressed in topical reports include:

- System and plant assessment reports—usually prepared in preliminary and final versions, e.g., early on when sufficient design information is available and later when plant programmatic information becomes available. Examples include:
  - Security assessment
  - Fire protection assessment
  - Aircraft impact assessment
- Safety analysis code reports needed for complete description of the evaluation models used in the safety analyses. For each unique safety analysis code, a series of reports may be submitted that address:
  - Evaluation model description
  - Individual safety analysis code description
  - Code V&V process description
  - Test data
  - Scaling analyses
  - Analysis of code applicability to specific design application
- Analyses or documentation of select design aspects. As with the plant assessments, these topical reports may be prepared in preliminary and final versions, especially in those areas that require early submittal to the NRC of a descriptive process and (later) submittal of an as-built reconciliation report. Examples include:

- Materials code selection
- Component integrity analyses such as:
  - Piping analyses
  - Structural analyses
- Specialized design requirements such as:
  - Control room Human Reliability Analyses (HRA)
- Equipment qualification methods such as:
  - Seismic
  - Environmental
- Digital I&C Software Management and Development Plans.

- Vendor data reports (proprietary)

In regards to the timing of topical report submittals, the earliest topical reports—submitted prior to the application—are those that have not been previously evaluated by NRC and which are intended to address long lead items. These can embrace the application's use of unique or new safety analysis codes, confirmation of the adequacy of test data collection needed to support code V&V, or the need for additional test programs not currently planned. These early topical reports have their greatest benefit when they are available in advance of the license application and when their review and approval is completed in a time frame that helps support preparation of the application.

2.4.2 Interactions with the NRC

During development of the COL application specification documents (e.g., writers' guides and topical report list) there will be significant interaction between the NGNP team and NRC staff to ensure staff agreement and endorsement of the guidance documents ultimately used as guidance to develop the COL application.

Additional interactions will occur between the applicant and the NRC staff following COL application submittal through public meetings, written requests for additional information by the NRC staff, NRC audits, and public workshops.

In addition to NRC staff interactions, the 10 CFR 52 (Ref 4) COL process requires a hearing before the Atomic Safety and Licensing Board (or alternatively before the Commission) and meetings before the Advisory Committee on Reactor Safeguards before a COL is issued.

2.5 Schedule Overview

The licensing plan is focused on the following four key portions of the licensing timeline.

1. Ongoing licensing support associated with establishing regulatory-driven research and development activities for the NGNP Project
2. Licensing activities associated with preapplication phase of the project
3. Licensing activities associated with an ESP—although an ESP is optional for the NGNP, it is discussed here since it can provide a vehicle for establishing owner-operator consortia, resolving site related issues early in the process and, if the ESP approach is not selected, the discussion is directly applicable to corresponding sections in the COL application

4. Licensing activities associated with the COL application phase of the project.

Each of these key areas involves review and approval of select activities by the NRC as summarized in the rest of this section.

2.5.1 Research and Development

The research and development phase of the NGNP Project is currently in progress and is anticipated to continue well into the COL application phases, and may continue into the final design phase of the project.

2.5.2 Preapplication

The preapplication phase of the project involves development of series of white papers that require early NRC review and approval of the regulatory approach for resolution of key programmatic, regulatory, and technical issues. The approach for resolution may require development of new regulatory policies, development of new regulatory guidance documents (e.g., RGs, SRP, ISG, or NUREGs) and/or new rulemaking to support the NGNP Project.

It is anticipated that key programmatic, regulatory, and technical issues identified during the preapplication review will be defined prior to submittal of the COL application. To achieve this, preliminary (conceptual) design descriptions of safety significant systems should be available at the beginning of the preapplication review. The NGNP licensing strategy for implementing the preapplication process is provided in Section 2.3.

2.5.3 Early Site Permit

Pursuit of an ESP is optional for the NGNP and is retained in the licensing approach because it can provide a vehicle for resolving site-related issues early in the licensing process. The licensing process for obtaining NRC approval of the ESP involves: performing site characterization study and analysis of data for the chosen site location, completing a site safety analysis based on the selected design or a plant parameter envelop, preparing an ESP report (license application) , and submitting the ESP report. The ESP report is then reviewed by the NRC which may take 24 months. Prior to final approval of the ESP report, public hearing(s) is conducted. The overall process may take as long as approximately 5 years from start of the process.

2.5.4 COL Application

Development of the COL application will follow the NRC 10 CFR 52 process (Ref 4). The COL application is then reviewed by the NRC in a process that may take 28-32 months. Prior to final approval of the COL application, a public hearing(s) is conducted. The overall process may take as long as 6 years from start of the process. The NGNP licensing strategy for implementing the preapplication process is provided in Section 2.4.

A timeline reflecting the overall NGNP Licensing Process is presented in Figure 2. It includes the most significant activities and key milestones associated with processing the ESP and COL applications for the NGNP Project.

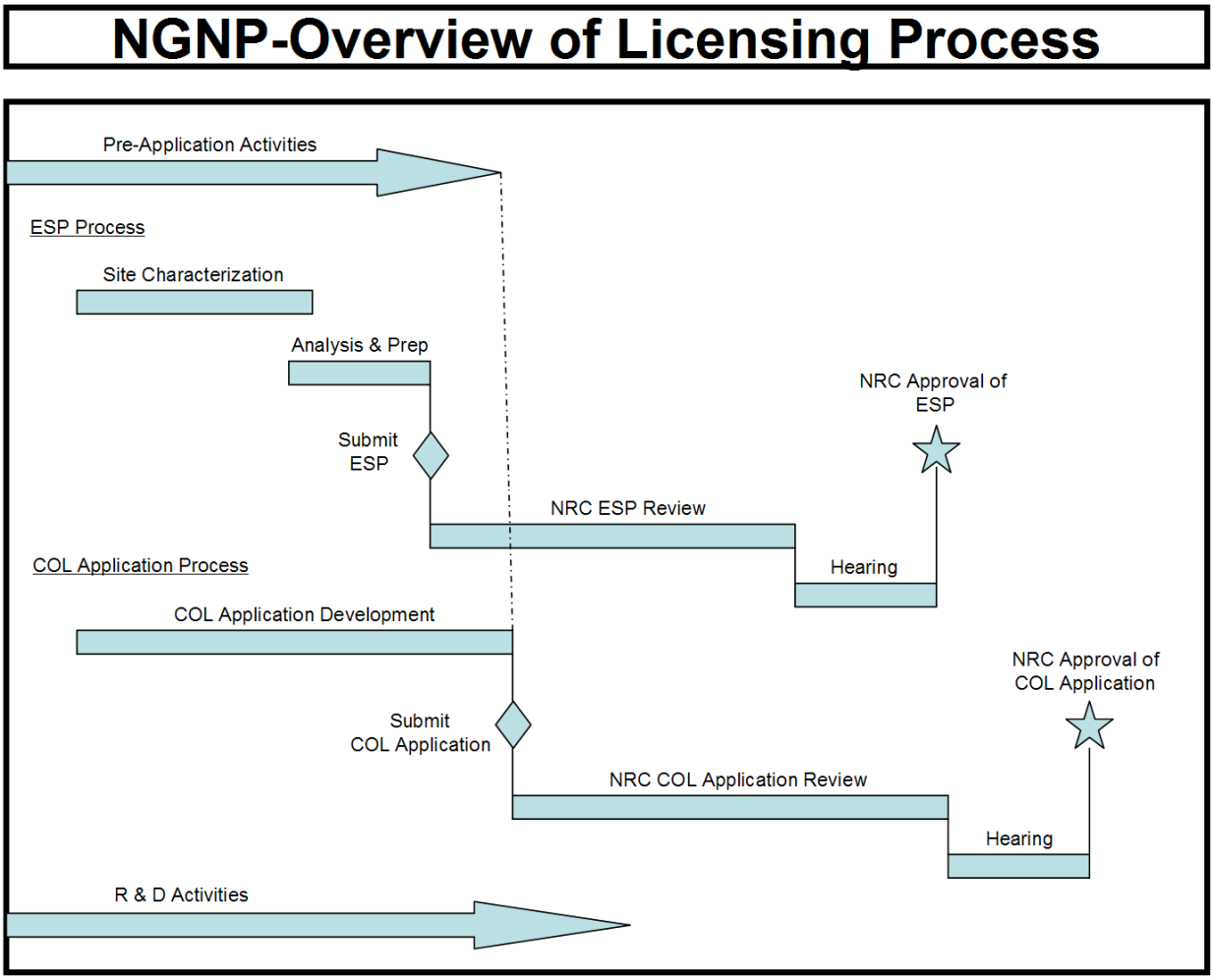

Figure 2. NGNP licensing timeline.

3. PROJECT ORGANIZATION AND INTERFACES

3.1 Project Organizational Framework and Relationships

The NGNP Project is sponsored by DOE-NE and is managed under the Office of Gas Reactor Deployment (NE-33). The DOE Federal Project Director provides the overall project direction, and the NGNP Project Director provides the single point of communications and control with support from the project team to carry out day-to-day management of the project. The NGNP Project Execution Plan (PEP)[24] provides a description of the structure of these day-to-day activities.

Going forward, the NGNP Project is expected to be structured as a Public-Private Partnership under a common NGNP management structure. Industry partners will provide current and practical project input to ensure that the prototype nuclear plant will be licensable and representative of future marketable reactor system designs and fulfill the process requirements of commercial end-user of process heat for the production of hydrogen and other commodities. These industry partners will also support design, permitting, licensing, construction, startup, and operational activities. As the DOE project strategy is developed and implemented, the specific approach for development and the formation of the partnership will be determined.

3.1.1 Regulatory Affairs Functions

The primary functions of the NGNP Regulatory Affairs team are described in the PEP (Ref 24) and summarized as follows:

1. Coordination With NRC in Establishing a Project Licensing Approach and Schedule

Regulatory Affairs will work closely with other NGNP team members and with NRC to establish and mutually agreed upon regulatory and policy issues that need to be addressed in support of plant licensing and authorization to load fuel. These interactions and communications between NGNP and the NRC will be conducted in accordance with applicable Memorandums of Understanding (MOUs) and DOE/NRC interagency agreements. As described in the recently issued NGNP Licensing Strategy Report to Congress and in support of this Licensing Plan, these activities are summarized in Appendix A of this report and primarily focus on:

- Requirements and criteria for functional performance of the multibarrier NGNP configuration as a radiological barrier
- Allowable dose consequences for the licensing-basis event categories
- Approach for using the PRA to inform the selection of licensing-basis events, including establishment of special treatment requirements and defense-in-depth requirements
- Acceptable basis for event-specific mechanistic source term calculation, including the siting source term.

Based on inputs from the project team, Regulatory Affairs is responsible for developing a strategy that draws from the Congressional Report and establishing regulatory positions that take advantage of the unique attributes of the HTGR, while maintaining a viable path for the timely and efficient licensing of the

selected design. This licensing approach forms the basis for activities that will be conducted prior to the submittal of a COL application for NRC review and approval.

2. Implementation of the Selected Licensing Approach

As the project licensing approach and timeline are finalized, Regulatory Affairs activities will include:

- The transmittal of information (reports, data, descriptions of design features, etc.) to the NRC in a format consistent with the applicable interagency agreement(s) and MOUs, in support of their review of the design
- Coordinating responses to incoming NRC requests for additional information
- Arranging NRC public and drop-in meetings as required to advance the licensing process
- Communicating project status information so that NRC review resources can be most efficiently planned
- Coordinating NRC audits and inspections of project activities
- Establishing and maintaining a process for regularly communicating regulatory interface activities with project team members and stakeholders.

3.1.2 Project Inputs Supporting Plant Licensing

The activities and NRC interfaces described above rely on the ongoing development of plant design information along with the underlying research necessary to validate the design and its support of the proposed plants licensing bases. These critical, integrated activities are described in more detail in the PEP (Ref 24).

4. REFERENCES

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Appendix A

NGNP Preapplication Issues

Table A-1. NGNP preapplication issues.

Issue No.	Description
1	Implementation of Risk-Informed, Performance-Based Methods: Implementation of rigorous risk-informed, performance-based methods for NGNP is the primary means for controlling licensing risks related to design compliance with regulatory criteria. Use of risk-informed, performance-based methods provides a comprehensive, logical and consistent approach to the design and licensing processes and, thereby, provides a sound approach. This approach directly responds to the NRC policy for the use of modern risk methods to both simplify plants and to better focus on issues that materially impact safety.
2	Emergency Planning Zone Reduction: High temperature gas reactors present an accident source term considerably less than that of the current generation of LWRs. Consequently, the reduction of the EPZ to approximately the size of the EAB has been a major goal of the corresponding development programs.
3	Mechanistic Source Term, Fission Product Transport and Confinement: NGNP is designed to ensure that unacceptable heat-up of the fuel and supporting core structures and significant radiological releases from the plant do not occur for the full spectrum of design basis and beyond design basis events. An approach to the use of a mechanistic source term (i.e., a source term based on analysis of fuel and reactor behavior during specific accidents) and the related fission product transport mechanisms (from the fuel, through the reactor building, to the release to the environment) needs to be developed for the NGNP in order to demonstrate this capability and to defend the safety case, This development takes advantage of experience developed during the MHTGR program of the 1990s and the white paper to be submitted to NRC on radionuclide releases from the fuel. The analytical approach will be consistent for both the design basis and beyond design basis event analyses, using the NGNP risk-informed, performance-based approach.
4	Tritium Migration: The design of the NGNP must ensure that the migration of tritium beyond the nuclear heat system is limited such that the maximum amount of tritium released from the integrated NGNP facilities or found in drinking water does not exceed established standards.
5	Fuel Qualification: The use of HTGR designed and manufactured fuel for initial plant startup is critical to the aggressive NGNP startup schedule, however, the corresponding fuel qualification program needs to be established and agreed upon.
6	Analytical Code V&V: Verification & Validation (V&V) of the analytical methods used in the safety analysis is a critical part of the NGNP COL application. These analytical models will require the modeling of gas reactor phenomena (e.g., as identified in the MHTGR, PBMR and NGNP PIRTs) as well as the validation of those models. The overall approach to V&V taken by NGNP is expected to follow current NRC regulatory guidance (Regulatory Guide 1.203). The NGNP V&V program should be coordinated with similar efforts being conducted by DOE/BEA to ensure that related research is conducted in an efficient and coordinated manner (allowing for the necessary independence of a regulatory review.
7	Nuclear-Industrial Island Boundary: In regards to licensing and regulatory oversight, the NGNP Project presents the issue of defining an interface (i.e., “boundary”) between the Nuclear Island and the remainder of the plant. This issue is important not only for the NGNP, but also for the follow-on commercial plants for which NGNP is the demonstration project. While the NRC necessarily has the regulatory lead over the NHSS, other parts of the plant that impact NHSS safety and the safety of the plant workers and public during normal operation and emergencies, it will be necessary to determine which parts or functions of the remainder of the plant impact NHSS nuclear safety (the “nuclear island” and hence are under regulatory oversight by the NRC) and which parts or functions should be subject to regulatory oversight by other governmental agencies (the “industrial island”). During the preapplication review, discussions should address the process for identifying and developing the interface requirements between the nuclear and industrial islands (per 10 CFR 52.47(a) (24–26).

Issue No.	Description
8	Regulatory Guidance for Co-location of HTGR at Existing Industry Sites: NGNP will evaluate applicable regulatory guidance and restrictions related to co-locating HTGRs at existing industrial sites. This item will then be addressed as a pre-application issue if it is determined that changes or updates to the regulatory guidance are needed.
9	High Temperature Materials—Metallics: The range of operating temperatures for the NGNP Project may challenge the temperature limits of critical metal components.
10	Regulatory Technology Development Plan: For an efficient and comprehensive review of the NGNP Project, the NGNP team and the NRC staff need to ensure that the NGNP technology development program provides the data needed for safety evaluations. In addition, the NRC staff may determine that it needs to conduct its own selected R&D that will independently confirm the NGNP project results or they may propose collaborative research programs.
11	Topical Report & Reference List: NGNP scope and schedule for submitting engineering references and topical reports for the COL application, including those in support of analytical code V&V needs to be agreed with NRC staff.
12	Regulatory Gap Analysis: Current NRC regulations are based significantly on LWR. Based on early reviews, much of the existing regulation base and guidance is applicable to HTGR designs, however, the current set of regulations and guidance needs to be reviewed for applicability. NRC feedback on the screening process used for NGNP is needed during preapplication meetings. Engagement with the NRC is then needed to scope the process and the extent of necessary revisions to or exemptions from regulatory requirements (and guidance) deemed critical to NGNP licensing success. This activity will utilize the NGNP project assessment of (1) compliance with NRC guidance (Reg. Guides, SRP, NUREGs, etc.), (2) new regulatory guides needed for HTGRs subsequent to NGNP, (3) new rulemakings needed subsequent to NGNP, and (4) new policies.
13	Applicable Codes and Standards: It is the intent of the NGNP Project to use existing applicable codes and standards to the extent practical, but some industry standards either do not exist or need confirmation. The NRC staff and the NGNP Project need to concur on the approach to identifying the codes and standards that need revisions or development.
14	Core Design and Heat Removal: The NGNP Project needs NRC concurrence on the specific issues that need to be addressed (e.g., to address air ingress) and on related sub-issues, such as the role during accidents of the helium pressure boundary and the helium flow through the core.
15	Air Ingress: The NGNP Project needs NRC concurrence on the design and safety analysis methods used to demonstrate that air ingress into the reactor vessel during accidents does not pose a significant threat to the health and safety of the public during both design basis and beyond design basis accidents.
16	Water Ingress: The NGNP Project needs NRC concurrence on the design and safety analysis methods used to demonstrate that water ingress into the reactor vessel during accidents does not pose a significant threat to the health and safety of the public. This issue is especially applicable to designs involving a subsystem or component that could become significantly more pressurized than the nuclear heat system during an accident. Therefore,
17	Human Factors Guidance: The NGNP Project needs NRC concurrence on the specific issues to be addressed and on the development of human factors engineering methods and guidance (e.g., for the control room).

Issue No.	Description
18	Structural Analysis Methods: Based on the NRC draft R&D report (April 2007), Section III.5.3.1, a discussion during preapplication is needed to identify specific NRC concerns.
19	Site Evaluation: Construction of a nuclear plant at an existing industrial site will likely raise issues related to the adequacy of that site (e.g., seismic qualification, emergency planning, and radiological safety) that should be addressed during preapplication to avoid unnecessary delays during review of the license application.
20	COL Application Specification: Application content should be discussed and agreed with NRC during the preapplication period to ensure a timely and efficient review for NGNP—this is especially important considering the overall project schedule set by the Congress and DOE.
21	Site Security in Design: The NGNP program for site security, including a “design for security” effort early in the plant design process should be described in order to determine whether there are any issues that need special attention. A preliminary design security assessment is considered essential to assist in ensuring integration of security and safety considerations into the NGNP design.
22	Fuel Cycle Waste and Fuel Transportation: Coated particle fuel waste characteristics are different than those for LWR spent fuel. NRC regulations 10 CFR 51.51, Table S-3, "Uranium Fuel Cycle Environmental Data” and 10 CFR 5 1.52, Table S-4, "Environmental Effects of Transportation of Fuel and Waste” address LWRs but not HTGRs. Additionally, confirmation is needed that 10 CFR 51.23 “Temporary storage of spent fuel after cessation of reactor operation—generic determination of no significant environmental impact," applies to NGNP.
23	High Temperature Materials—Ceramics: The NRC and the NGNP Project should review and agree on the applicability of the previous gas-cooled reactor licensing activities to the NGNP Project. Of prime interest is the qualification of graphite to be used for core internal structures.
24	Waste Confidence Rule: NRC confidence in that the government (DOE) will be able to manage nuclear waste in the future when it may be necessary to remove spent fuel from operating reactor sites is expressed in 10 CFR 51.23. While that rule was promulgated based largely on knowledge of LWR fuel, it appears that NGNP fuel would fall within the scope of the current regulation. However, the NGNP Project should discuss this matter with NRC and DOE to confirm this expectation.
25	Price Anderson Act Applicability: The NGNP Project needs to determine how the Price-Anderson Act applies to non-electrical generation plants and gain NRC feedback. See also the "liability ceiling limit" issue discussed in the NRC Supplemental Letter dated August 19, 2008 [supplements the August 2008 NGNP Report to Congress].
26	License Application Review Fees: 10 CFR Part 170 addresses NRC review fees for license application reviews. Agreement is needed with the NRC on the extent of fees for review of the NGNP applications, considering the possibility of an exemption for work that supports NRC long-range development of their HTGR experience and R&D.

Issue No.	Description
27	Decommissioning Cost and Funding Method: Confirmation is needed from the NRC that positions stated in SECY-02-0180 will be applicable to the NGNP Project. Alternatives should be discussed. Non-electric-utility applicants are not allowed to use the sinking fund option exclusively (uniform series of payments). The staff recommends in SECY-02-0180 that the NRC require non-electric-utility applicants to use the other options provided in 10 CFR §50.75 to fund decommissioning costs. The staff does not recommend that the regulations be modified to allow additional alternatives for decommissioning funding. 10 CFR §50.75 identifies decommissioning cost estimates for PWRs and BWRs, but not for HTGRs. The NRC has recently revisited the topic of decommissioning funding surety agreements (SECYs 2006-0065 and 2007-0197).
28	ISI, IST & RIM for HTGRs: In order to most efficiently plan the NGNP design and subsequent maintenance and operations, early NRC feedback is requested on issues such as In-service Inspection & Testing and Reliability Integrity Management.
29	Fuel Surcharge: The NGNP Project will need to know whether the spent fuel surcharge will be a function of the electrical output of the plant or whether it will be based on thermal output.
30	Modular HTGR Design Certification: While the NGNP includes only a single reactor module, one of the project goals is that this first plant be a demonstration project for follow-on commercial plants some of which may include more than one reactor module. Therefore, it may be advantageous to begin discussions with NRC staff so that any related design matters such as sharing of the control room and support systems can be factored into both the NGNP design and that for Design Certification of the follow-on commercial plants.
31	Modular HTGR Operator Staffing: The NGNP Project needs a determination as to whether a modular facility should be allowed to control more than two reactors from one control room and operate with a control room staffing complement that is less than would be required for individual reactors.
32	Modular HTGR Integrated Risk: In evaluating risk assessments for compliance with the Commission's Safety Goals, the staff's practice for large reactors has been to assess risk on an individual reactor basis. However, for smaller modular reactors where approximately 8 modules would be required to produce the power of one large reactor, the matter of treating each reactor separately needs to be re-evaluated. NRC input on the resolution of this issue is needed.
33	Modular HTGR Operation and Construction: Concurrent construction and operations at a multi-module plant would need to be addressed in regards to design, safety, and plant security. NRC input on the resolution of this issue is needed.
34	Modular HTGR Annual Fees: The NRC staff needs to confirm its position that, as a result of the Omnibus Budget Reconciliation Act of 1990, no further change is needed to the 10 CFR 171 fee rule to address the assessment of "fair and equitable" annual fees for modular facilities.
35	Modular HTGR Licensing: The NRC and the NGNP Project need to determine whether a multi-modular plant can be licensed with a single review and set of hearings. If so, it also needs to be determined whether the duration of the license will be a function of the start of construction for each particular module (or simply a fixed duration from start of the first module).