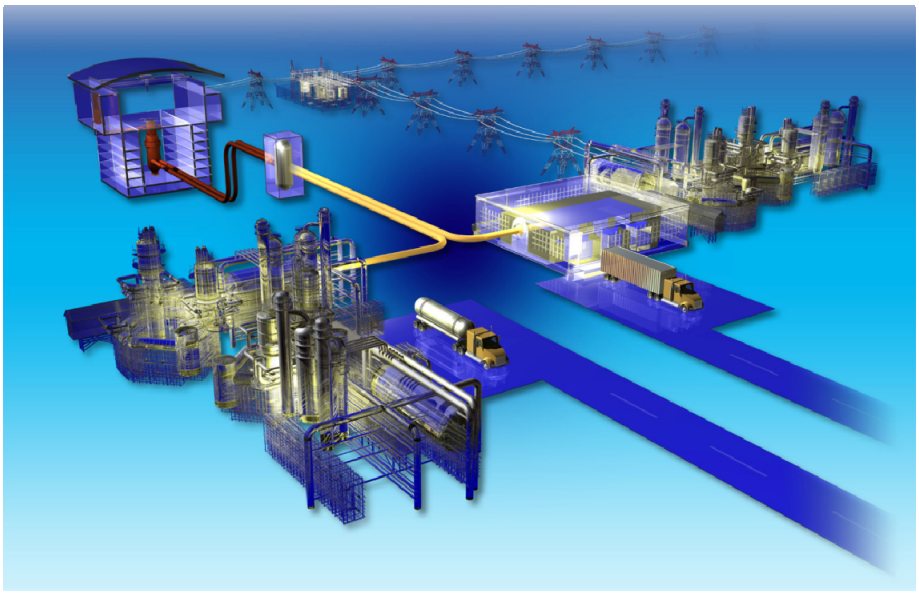
INL/MIS-10-19013
Revision 0

Licensing Status

August 2010



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Tab 5

INL/MIS-10-19013
Revision 0

Licensing Status

August 2010

Idaho National Laboratory
Next Generation Nuclear Plant Project
Idaho Falls, Idaho 83415

Prepared for the
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Next Generation Nuclear Plant Project

Licensing Status

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August 2010

Approved by:

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8-10-10
Date

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8-10-10
Date

SUMMARY

The *Energy Policy Act of 2005* (Public Law 109-58) mandated creation of a licensing strategy for the Next Generation Nuclear Plant (NGNP). This report outlines the approach, progress, current status, and future path of the NGNP Project in addressing the required licensing strategy. The centerpiece of the NGNP licensing approach is the development of a combined license application (COLA) pursuant to 10 CFR 52. To do this, the NGNP Project and Nuclear Regulatory Commission (NRC) must agree on COLA content requirements and the guidance documents suitable for the NGNP. Furthermore, the NGNP design must be developed to the point where sufficient information is available to complete the COLA and assure NRC acceptance for review.

The *NGNP Licensing Plan* (PLN-3202, June 26, 2009) describes a strategy that will support NGNP licensing and future commercial applicants. The plan focuses on the most significant policy issues for resolution during initial NRC interactions and outlines a licensing path that will lead to approval of a COLA by the NRC. The plan currently emphasizes performance of critical preapplication licensing activities that will proceed in parallel with the DOE's establishment of a public-private partnership for NGNP deployment. The effort has identified 35 high-priority technical and policy issues essential to enabling project execution. Among these issues are: the implementation of risk-informed, performance-based methods; the selection of licensing basis events; defense-in-depth; the safety classification of structures, systems, and components; emergency planning zone reduction; the co-location of HTGRs at industrial sites; mechanistic source terms; fission product transport; containment functional performance; fuel qualification; and analytical code verification and validation. After the partnership is defined, the facility owner/operator within that partnership will become responsible for acquiring the facility license.

The plan also identifies activities that support issuance of a COLA in accordance with 10 CFR 52 requirements. It calls for implementing a risk-informed and performance-based licensing approach and builds on previous licensing efforts and NRC interactions associated with gas-cooled reactor technology. It also 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 is submitted. The plan establishes, in two distinct phases, the regulatory basis and proposed COLA content for licensing of the NGNP by the NRC.

The NGNP Project will lead in the development of a COLA Content Guide, which prescribes the requirements for a high temperature gas-cooled reactor (HTGR) final safety analysis report (FSAR). The new COLA Content Guide will provide format and content guidance, insights and lessons learned, and an initial applicability assessment for regulatory acceptance criteria of a HTGR within the current NRC Light Water Reactor (LWR) Standard Review Plan structure. This guide will serve to define engineering and other technical work products needed to support writing of the COLA.

There are two key sources of input for the COLA Content Guide. The first will come from the positions and strategies developed in NGNP licensing white papers that are submitted to the NRC staff early in the prelicense application period. The highest priority items were identified based on the potential for significant impact on the plant design and/or planned research and development activities, and the likelihood that NRC action will be required to address the issue. The white papers that the NGNP Project has or is in the process of submitting to the NRC include Defense-in-Depth, High Temperature Materials, Mechanistic Source Terms, Fuel Qualification, Licensing Basis Events, and SSC Classification. The second source of input for the COLA Content Guide is development of a regulatory gap analysis, which defines the specific gaps between NRC's existing LWR regulations and guidance, and those that are needed for the evaluation and licensing of HTGR's. This input is considered critical because the existing LWR regulatory framework can only be partially applied to the NGNP HTGR design. Performance of the gap analysis, using a procedure already written for this purpose, is planned to commence in the fourth quarter of FY 2010 and finish in mid-FY 2011.

The COLA must contain a FSAR that describes the facility, presents the design bases and limits on operation, and presents a safety analysis of the facility as a whole. The FSAR must include information at a level sufficient to enable the NRC to reach a final conclusion on all safety matters before a COLA will be issued. The NGNP COLA is expected to be comprised of up to 11 parts, supplemented by various topical reports. A topical report is an administrative tool used to establish a technical basis in a particular safety topic area to support a pending licensing action. Topical reports are submitted individually to the NRC and form the basis for a portion of the overall COLA. Preliminary evaluations of the HTGR COLA suggest that 100 to 150 topical reports will likely be included as a part of the first HTGR application. Since topical reports are intended to bring regulatory finality to a specific subject, they have their greatest benefit when they are made available to the NRC early in the licensing process. Issues that lend themselves to topical reports include the High Temperature Test Reactor tritium study, composites study, contamination control study, air and water ingress analysis, multiple module integrated risks, containment functionality, fuel qualification, graphite and material qualification, qualification of radionuclide transport barrier decontamination factors, and the probabilistic risk assessment basis.

Many preapplication items identified in the *NGNP Licensing Plan* will require significantly more details than can be supported by a conceptual plant design. Certain plant configurations may not be available until the initial license application is finally developed by the facility owner/operator. These specific design details will continue to be developed as the overall project progresses and associated public-private partnership(s) are formed. Therefore, NGNP licensing efforts will continue to focus on priority topics that can be developed and addressed with the available design detail and lay the groundwork for addressing the more design-driven preapplication topics. Essential elements of current plant development and licensing efforts include establishing Top Level Radiological Requirements for the plant, (e.g., setting dose limits at the exclusion area boundary) that reduce emergency planning requirements and support close co-location of the HTGR with an industrial facility. It also includes development and understanding of the radiological source term based primarily on fuel design, qualification testing results, and analytical method development, as well as prevention and mitigation of source term releases to the environment that includes defining licensing basis events and establishing multiple release barriers consistent with a defense-in-depth strategy. Also important is the development of an updated emergency planning structure that considers potential radiological releases coupled with various industrial application configurations to ensure the protection of public health and safety in the unlikely event of a radiological release.

Proceeding through the licensing sequence summarized in this report will result in a more predictable and well-understood licensing path forward for the project, with significantly reduced regulatory uncertainty for HTGR licensing. Key to this process is the regular and continued interaction with the NRC Staff as HTGR policy and technical issues are addressed and resolved. These resolutions must then be reflected in the jointly developed HTGR COLA Content Guide. NGNP Project licensing activities intend to continue on this path to the point where licensing activities can be transitioned to the COLA applicant.

CONTENTS

FIGURES

ACRONYMS

COL	combined license
COLA	Combined License Application
DOE	Department of Energy
EPAct	Energy Policy Act of 2005
ESP	Early Site Permit
FSAR	Final Safety Analysis Report
FY	fiscal year
HTGR	high temperature gas-cooled reactor
LWR	light water reactor
MHTGR	modular high temperature gas-cooled reactor
NGNP	Next Generation Nuclear Plant
NHSS	National Health Security Strategy
NRC	Nuclear Regulatory Commission
PIRT	Phenomena Identification and Ranking Table
PPE	plant parameter envelope
PRA	probabilistic risk assessment
R&D	research and development
SSC	structures, systems, and components
SRP	Standard Review Plan

Licensing

1. OBJECTIVE

In August of 2008, in response to the *Energy Policy Act of 2005* (EPAct; Public Law 109-58), Title VI, Subtitle C, Section 644, the Secretary of the U.S. Department of Energy (DOE) and the Chairman of the Nuclear Regulatory Commission (NRC) jointly submitted a licensing strategy to Congress for the Next Generation Nuclear Plant (NGNP), hereafter referred to as the *Report to Congress*. This report addresses the approach, progress, current status, and future path of the NGNP program in addressing the four elements of the licensing strategy as set forth in Section 644(b) of the EPAct.

2. HISTORY

The four elements set forth in the *Report to Congress* are summarized as:

1. A description of the ways in which current NRC light water reactor (LWR) licensing requirements need to be adapted for the types of reactors considered for the project.
2. A description of the analytical tools that NRC will need to independently verify the NGNP design and its safety performance.
3. A description of other research or development activities that NRC will need to review an NGNP license application.
4. A budget estimate associated with the licensing strategy.

The licensing strategy in the *Report to Congress,* developed by a working group made up of DOE and NRC experienced senior staff, was based on an in-depth analysis of LWR licensing process and technical requirements options. The methodology used in formulating the NGNP licensing strategy alternatives also included development of a Phenomena Identification and Ranking Table (PIRT) for a prototypical NGNP by subject matter experts in the nuclear field (NUREG/CR-6844 and NUREG/CR-6944). The PIRT results assisted in the identification of key research and development (R&D) needs. 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 NRC concluded that the following NGNP licensing strategy attributes provided the best opportunity for meeting the 2021 date for initial operation of a NGNP:

- The best alternative for licensing the NGNP reactor will be for the applicant to submit a Combined License Application (COLA) 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).
- 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. The selected approach provides significant advantages in meeting the schedule for licensing an NGNP while providing consistency with NRC policy guidance on the use of probabilistic risk information and insights.
- Analytical tools, models, and associated data in major technical areas of the NGNP design will be required to address very high temperature reactor safety-relevant phenomena and perform confirmatory analysis. Analytical tools for LWR accident analysis, including thermal-fluid analysis and fission products transport, can be modified for analyzing the NGNP by incorporating appropriate

NGNP models and data. Ongoing R&D activities funded by DOE, as well as international cooperative R&D programs, are addressing many of these areas. The NRC will coordinate with DOE on these activities and, to the extent feasible and appropriate, participate in the R&D programs and use the information to develop its independent confirmatory analysis capability. Furthermore, the NRC will make extensive use of experimental data generated by an applicant and provided as part of the license submittal, as well as data available in the open literature.

- Areas expected to require regulatory infrastructure development include regulatory guides, standard review plans, codes and standards, reactor oversight process development, and inspection programs. These guidance documents will need to address NGNP-specific issues involving security and safeguards, spent fuel, environmental matters, and inspection and startup testing. For a first-of-a-kind NGNP plant, interim guidance based on LWR experience may be sufficient in many of these areas. Regulatory guides, standards, and similar documents for the commercial NGNP design can be developed subsequently based on the experience gained from the review of the design.
- Other issues associated with the NGNP design and application may be identified in the future, and NRC will need to engage the NGNP applicant during the preapplication phase to address them. Most issues are expected to be in the technical areas related to NGNP licensing.
- The NRC estimates that it will take 5 years to develop necessary analytical tools, data, and other regulatory infrastructure (e.g., regulatory guides, standard review plan, etc.) for confirmatory safety analysis and license review. The NRC also estimates that it will take 4 to 5 years to conduct the licensing review. In order to meet the statutory requirement to complete construction and operation of the NGNP by FY 2021, the NRC staff and the NGNP applicant will have to engage in a 3-year preapplication review starting in FY 2010, followed by a very aggressive 4-year license application review period starting in FY 2013.

The NGNP Project has adopted the 10 CFR 52 COLA process, as recommended in the *Report to Congress*, as the foundation for the NGNP licensing strategy. In June 2009, the NGNP Project developed the *NGNP Licensing Plan* to describe a more detailed and specific plan for implementing this process, including a discussion of the key activities and interactions that must occur within and between DOE's NGNP project team and the NRC in order to accomplish the timely and efficient licensing and deployment of the high temperature gas-cooled reactor (HTGR) demonstration plant. The activities and activity sequences described in this licensing plan are consistent with the *Report to Congress*.

3. APPROACH

As described in both the *Report to Congress* and the *NGNP Licensing Plan*, the centerpiece of the NGNP licensing approach is the development of a COLA submitted to the NRC for their review and approval pursuant to 10 CFR 52 of the NRC regulations. Development and submittal of a COLA will require that:

- The NGNP Project and NRC come to a common agreement regarding the COLA development and content requirements, and guidance documents suitable for the NGNP
- The NGNP design is developed to the point where sufficient information is available to complete the COLA and assure NRC acceptance of the COLA for review, and to assure timely review by the NRC Staff once the application is accepted.

The *NGNP Licensing Plan* describes expected activities for implementing a strategy that will support licensing of the NGNP and benefit future commercial applicants. The plan focuses on the most significant policy issues for resolution during this initial phase of interactions with the NRC and outlines a licensing path for the NGNP that will lead to approval of a COLA by the NRC. In the near-term, the plan emphasizes performance of critical preapplication licensing activities that will proceed in parallel with the

DOE's establishment of the public-private partnership. After the partnership is defined, the facility owner/operator within that partnership will become ultimately responsible for acquiring the facility license. The approach described in the 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 HTGR modules.

Important issues proposed for early preapplication discussion with NRC were derived from a number of industry sources and prioritized on the basis of their expected impact to plant design, licensing, and overall project completion. The effort identified 35 high-priority technical and policy issues essential to enabling project execution. These issues include:

- Implementation of risk-informed, performance-based methods that utilized inputs from probabilistic risk assessments, selection of licensing basis events, defense-in-depth, and the safety classification of structures, systems, and components (SSCs).
- Emergency planning zone reduction and associated emergency action levels.
- Regulatory concerns related to the co-location of HTGRs at industrial sites.
- Mechanistic source terms, fission product transport, and containment functional performance.
- Fuel qualification
- Analytical code verification and validation
- High temperature materials performance
- Applicable codes and standards
- Air and water ingress

A complete listing of the 35 priority items can be found in Appendix A.

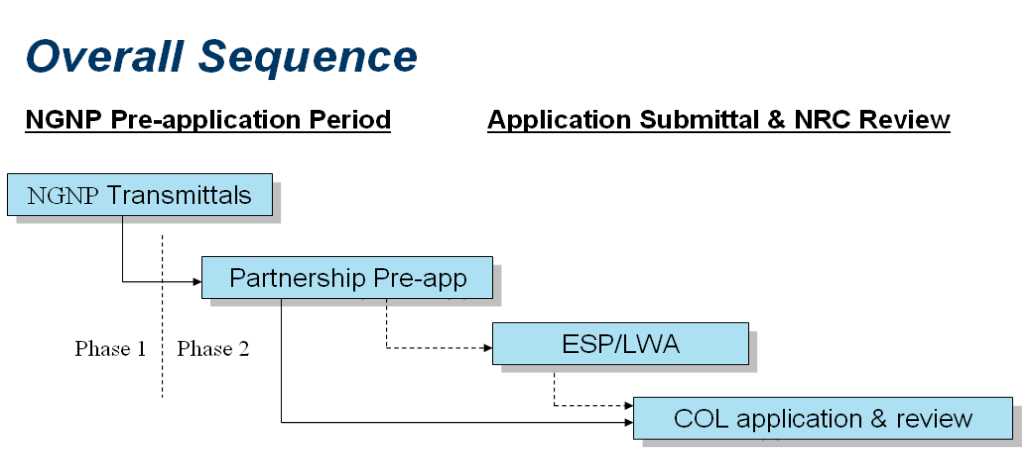
The plan also contains the following key components and attributes in addressing important elements of plant licensing:

- Identifies and implements activities that will support the issuance of a combined license (COL) in accordance with applicable 10 CFR 52 requirements.
- Implements a risk-informed and performance-based licensing approach that is consistent with the licensing process-related recommendations included in the *Report to Congress*.
- Builds on previous licensing efforts and NRC interactions associated with gas-cooled reactor technology.
- 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.
- Establishes the regulatory basis and proposed COLA content for licensing of the NGNP by the NRC.

4. PHASES

The NGNP project is planned out in two phases:

- **Phase 1** covers: selecting and validating the appropriate technologies; carrying out enabling research, development, and demonstration activities; preliminary evaluation of potential applications for plant heat end-use; and carrying out initial design activities. Phase 1 of the NGNP project is currently in progress. For project licensing activities being performed during Phase 1, it is noted that a license applicant has not yet been selected. Therefore, the NGNP project team is performing the necessary priority licensing activities to support timely plant deployment, as described in the NGNP Licensing Plan, and consistent with assumptions from the DOE-NRC Licensing Strategy "*NRC staff and the NGNP applicant will have to engage in a 3-year preapplication review starting in FY 2010"*
- **Phase 2** covers: development of a final design for the nuclear reactor and plant through a competitive process; development, submittal, and approval of a COLA; and construction and start-up operations for the plant. DOE is not going to be the COLA. The development and submittal of the COLA will be an activity undertaken by a commercial entity, to be designated in the future, which will serve as the COLA working with the NGNP Project team and DOE in a public-private partnership. A decision to pursue an ESP will be made within this framework. The partnership will be established at the outset of Phase 2 of the project. An overview of the project sequence, as it relates to licensing activities, is shown in Figure 4.1.



Note:

a) "Partnership" refers to the future NGNP Project public-private partnership

b) The potential benefits of an ESP application will be evaluated by the future partnership; an ESP is not included in current DOE project plans.

Figure 4-1. Project sequence.

During this overall project sequence, there are two primary components to the overall licensing process supporting ultimate deployment and operation of the HTGR plant. The first component, which is described in more detail in Section 4.1 below, involves the evaluation and adaptation of existing LWR requirements and regulatory guidance into an updated structure to be followed when developing the COLA for the HTGR. Development of this guidance is expected to require regular and frequent interaction with the NRC, ultimately resulting in the establishment of a mutually agreed upon HTGR COLA Content Guide. The second component, described in Section 4.1.1 below, involves the actual development of the COLA, based on the Content Guide, with follow-on submittal of the application to the NRC for review/approval.

4.1 COLA Content Requirements

Current NRC guidance in the area of COLA content is prescribed in 10 CFR Part 2 and is focused on LWRs; there is no specific variant to the guidance that enables acquisition of a NRC license for HTGR plants. The NGNP Project will assist in the development of a COLA Content Guide (aka writers' guide), which prescribes requirements to the individuals responsible for producing and reviewing a HTGR final safety analysis report (FSAR). The new COLA Content Guide will provide format and content guidance, insights, and lessons learned and an initial applicability assessment for regulatory acceptance criteria of a HTGR within the current NRC LWR Standard Review Plan (SRP) structure. This guide will also define engineering and other technical work products needed to support writing of the COLA. However, it is expected that for a first-of-a-kind HTGR plant like the NGNP facility, the guide will likely contain a certain number of unresolved policy and technical issues at the time of application. These areas will be identified early in the preapplication process, with a resolution path that is defined and mutually agreed upon with NRC. This approach will provide for NRC acceptance of the COLA for docketing, while assuring that remaining open issues are addressed and resolved with NRC prior to their final approval of the license application. Adaptability must be maintained in the writers guide to properly accommodate the resolution of these remaining open items.

NRC developed Regulatory Guide 1.206, *Combined License Applications for Nuclear Power Plants (LWR Edition)*, for LWRs, which is the content guide for LWR COLAs. The development and issuance of a draft Regulatory Guide (DG-1145) preceded the issuance Regulatory Guide 1.206, and served as a mechanism for NRC staff and industry to exchange ideas regarding COL content guidance. The NGNP project team intends to pursue a similar path with the development of an HTGR COLA Content Guide. It also considers the joint NRC development and understanding of these content requirements and expectations to be the key to an efficient HTGR licensing process.

Although final and complete agreement with the NRC staff regarding COLA content may not be achieved at the time the COLA is submitted, substantial progress is expected to be made through submittal of NGNP licensing white papers, and disposition of regulatory gap analysis results to provide a framework for developing an initial COLA. This framework, described in greater detail below, will be captured in an HTGR COLA Content Guide that is expected to be very similar in structure to NRC Regulatory Guide 1.206. Given this expectation, the development of sufficient NGNP design information will most likely present the critical path activity for COLA submittal, since technical completeness is necessary for resolving many of the identified preapplication licensing issues, and is also required for application acceptance. The NGNP *Report to Congress* states that the COLA will include the preliminary design. In keeping with this expectation, COLA development is currently scheduled to begin during Phase 2 of the project, when the preliminary design is approximately 50% complete.

4.1.1 Development of COLA Content Guide

There are two key sources of input for the COLA Content Guide. The first will come from the positions and strategies developed in NGNP licensing white papers. These white papers are being developed and submitted to the NRC staff for their review and disposition early in the prelicense application period. NRC disposition may take the form of endorsement through regulatory guides, issuance of NRC papers (SECY papers and staff requirements memoranda), or other forms of disposition, depending on the topic. A key to this disposition process is assuring that all parties arrive at a clear understanding of the application requirements associated with the topic in question. As discussed in Section 3 above, the NGNP Licensing Plan contains a summary listing of licensing issues that are considered to be of highest priority, and are therefore the focus of the NGNP Project team. The highest priority items were identified based on two primary criteria, namely:

- Potential for significant impact on the plant design and/or planned R&D activities

- Likelihood that NRC action will be required to address and resolve issues.

Development and submittal of priority NGNP licensing white papers is currently underway. It is expected to continue in the sequence summarized in Figure 4-2.

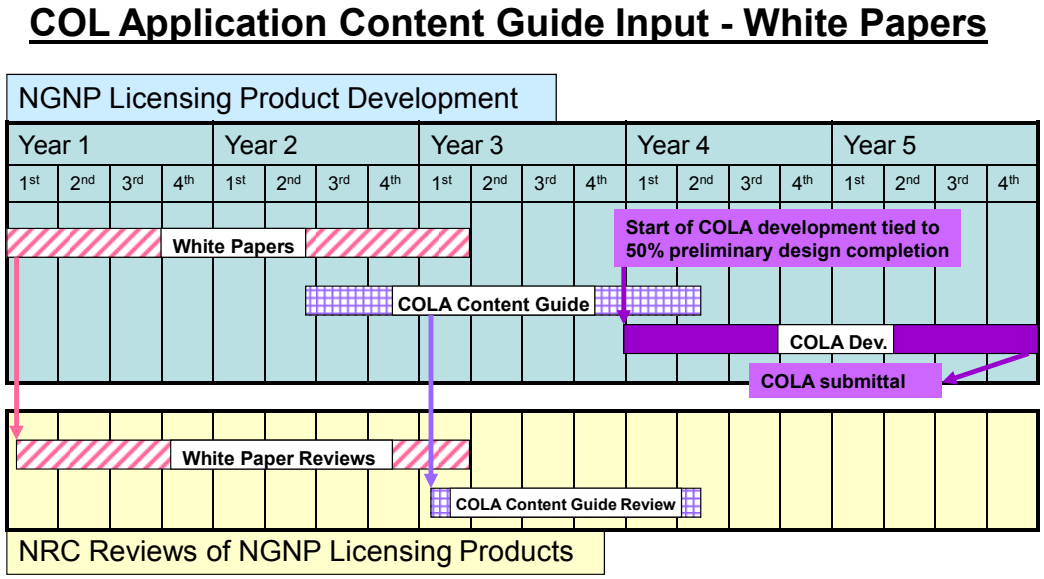


Figure 4-2. Licensing white paper sequence.

4.1.2 Status and Accomplishments—White Papers

Notable activities in the development of white papers include:

- Priority white paper licensing topics were identified and validated within the NGNP Project team, and were documented in the NGNP Licensing Plan—Appendix A (June 2009).
- NRC validated this series of priority topics both through NGNP project interactions, and via their issuance of SECY 10-0034 "Potential Policy, Licensing, and Technical Issues for Small Modular Nuclear Reactor Designs" (March, 2010), which summarizes advanced reactor licensing topics requiring priority NRC Staff focus.
- NRC established and staffed an HTGR project team within its Advanced Reactor Programs branch dedicated to the NGNP reviews.
- The NGNP Project has developed and submitted white papers to the NRC that address a number of the highest priority licensing topics, as summarized below:
  - Defense-in-depth (submitted December 2009)
  - High Temperature Materials (submitted June 2010)
  - Mechanistic source term (submitted July 2010)
  - Fuel qualification (submitted July 2010)
  - License Structure for Multi-Module Facilities (submitted August 2010)
  - Licensing basis event selection (expected submittal September 2010)
  - SSC classification (expected submittal September 2010).
- The NGNP Project has begun a series of public meetings with the NRC to discuss and disposition the licensing issues described in the NGNP Licensing Plan and associated white papers.

The second source of input for the COLA Content Guide will be the development of a regulatory gap analysis, which will establish the specific gaps between NRC's existing LWR regulations and guidance, and those that are needed for the evaluation and licensing of HTGR's. This input 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. Given the limited regulatory experience with gas-cooled reactor technology, as well as HTGR future commercial deployment in process heat applications, a complete body of regulations directly suited to the NGNP design does not exist. 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 COLA. Thus, the early development of a new framework 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. When completed, the results of the gap analysis, especially related to those regulations judged to be not directly applicable to HTGR's, will form a part of the population of regulatory issues that will need to be resolved with the NRC staff. It is expected that interaction with the NRC staff regarding the results of the gap analysis will occur in parallel with the joint development of the COLA Content Guide. The expected timing of the regulatory gap analysis work and the NRC review is shown in Figure 4-3.

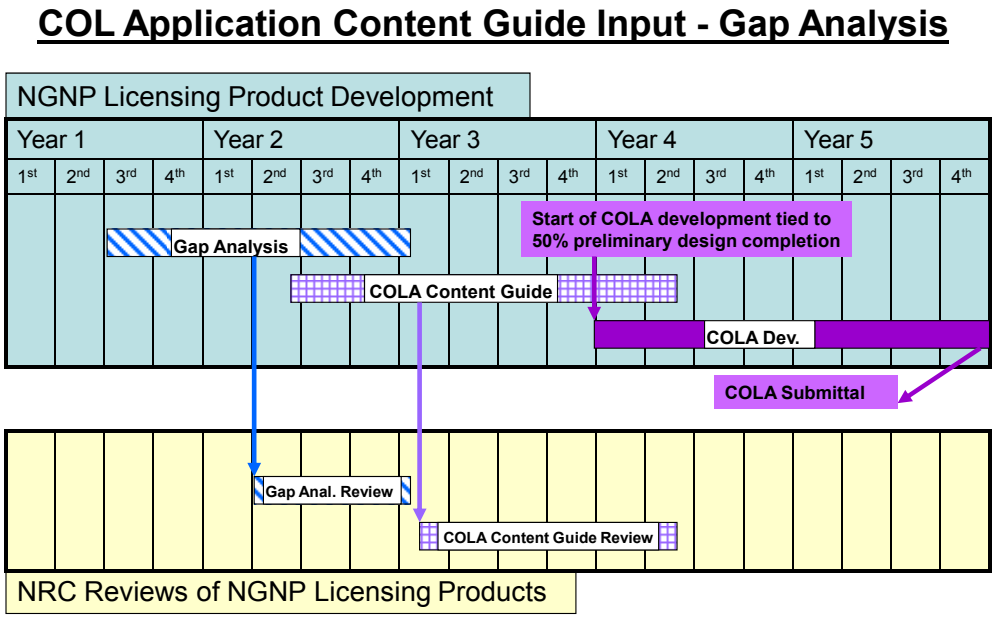


Figure 4-3. Regulatory gap analysis sequence.

4.1.3 Status and Accomplishments—Regulatory Gap Analysis

Notable achievements in the development of a regulatory gap analysis include:

- A preliminary assessment of LWR regulations was performed utilizing a review of the NRC Standard Review Plan for LWR's (NUREG-0800). Completed results were compiled in a final report issued June 2008.
- The NGNP Project has developed and issued a procedure for completing the more detailed regulatory gap analysis.

Performance of the detailed gap analysis, using the above procedure, is planned to commence in the fourth quarter of FY 2010 and finish in mid-FY 2011. The results of this effort will provide a detailed accounting of regulatory requirements to be complied with or modified for HTGRs. Results of the gap analysis will be provided to NRC for evaluation. Resolution to some of these informational gaps may affect key components necessary for the completion of the COLA Content Guide

4.2 Development of COLA

The COLA must contain a final safety analysis report that describes the facility, presents the design bases and the limits on its operation, and presents a safety analysis of the SSCs of the facility as a whole. The final safety analysis report shall include information at a level sufficient to enable the NRC to reach a final conclusion on all safety matters that must be resolved by the NRC before issuance of a combined license. The NGNP COLA is expected to be comprised of up to 11 parts, supplemented by various topical reports.

The overall structure of the NGNP COLA will be based on the structure used by recent LWR COLAs, as modified by the jointly developed HTGR COLA Content Guide described above, and is expected to include the following parts:

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

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 Early Site Permit 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)

4.2.1 Development of Licensing Topical Reports

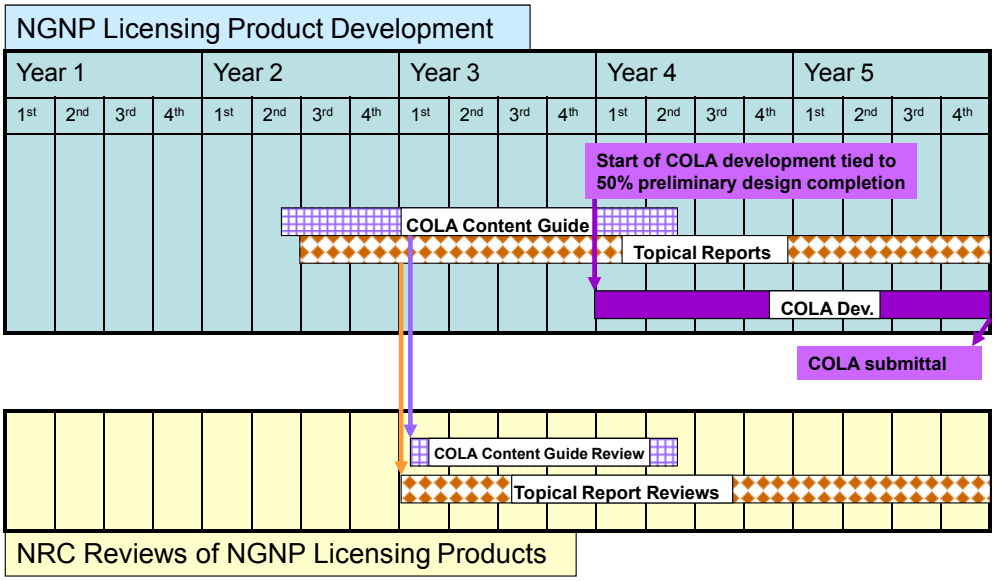
A topical report is an administrative tool used to establish a technical basis in a particular safety topic area to support a pending licensing action. Topical reports are submitted individually to the NRC for formal review and approval and form the basis for a portion of the overall COLA. A typical design certification application for an advanced LWR that is currently under review by the NRC may refer to over 100 topical reports as a part of the application. Preliminary evaluations of the content of the HTGR COLA suggest that 100 to 150 topical reports will likely be included as a part of the HTGR application. Since topical reports are intended to bring regulatory finality to a specific subject, they have their greatest benefit when they are made available to the NRC for review early in the licensing process.

By submitting topical reports, the NGNP Project's license applicant can take advantage of the opportunity to submit reports as soon as appropriate information becomes available rather than waiting for an entire FSAR to be submitted, thus mitigating the risk of long review periods. This will allow better management of NGNP and NRC resources by compartmentalizing information that needs to be reviewed, particularly in highly specialized areas. However, it must be remembered that many topical reports will be quite specific to a particular reactor design and, since designs continue to evolve at this time, the exact nature of some vital reports have yet to be authoritatively established. An initial listing of expected HTGR topical reports is provided in Appendix B.

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. Additional gas-cooled reactor topics that will likely lend themselves to be addressed in topical reports include:

- High Temperature Test Reactor tritium study
- Composites
- Contamination control
- Air and water ingress analysis
- Multiple module integrated risks
- Containment Functionality
- Fuel Qualification
- Graphite and Material Qualification
- Qualification of Radionuclide Transport Barrier Decontamination Factors
- PRA Basis Report.

The approximate timeframes for beginning work on topical reports and submitting these documents to the NRC are shown in Figure 4-4.



Note:

a Topical reports will provide input to plant design and the COLA.

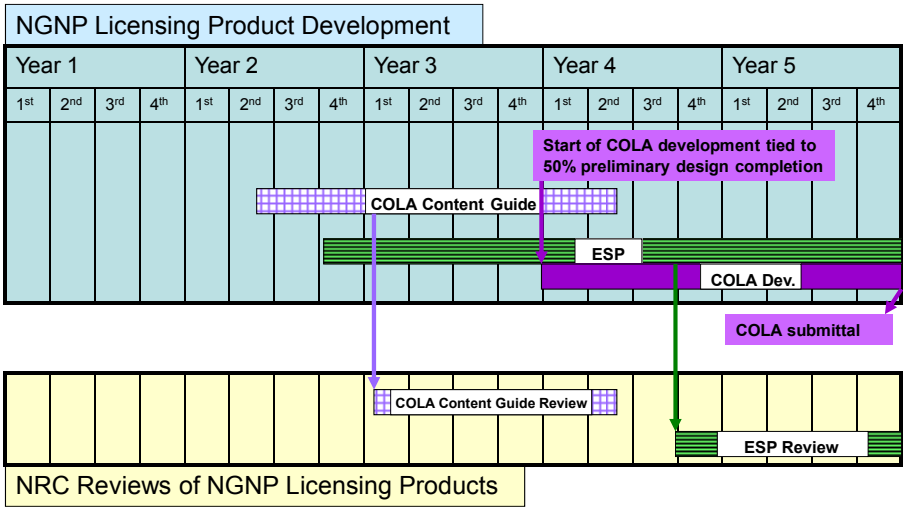
b Topical report submittals are expected to continue up to (and perhaps beyond) the COLA submittal date.

Figure 4-4. Topical report sequence.

4.2.2 Identification and Development of Candidate Site ESP

The ESP process is an optional method of packaging the selected deployment site's safety and environmental information required of the 10 CFR 52 licensing approach that can be submitted prior to the COLA. The ESP is another tool that can enable further management of licensing schedule risk, particularly if the HTGR design is not developed sufficiently to submit the entire COLA once the site is selected. The use of an ESP, which is valid up to 20 years, offers two main advantages: first, an ESP resolves issues involving site safety and environmental characteristics and emergency preparedness, which are independent of a specific nuclear reactor design. These reviews could be critical activities, especially given the possible introduction of unreviewed concepts associated with the NGNP such as co-location of the site with an industrial facility and potentially revised emergency management requirements. The second advantage of the ESP is that, as a substitute for plant specific design information, the ESP can utilize a plant parameter envelope approach, which can serve as a surrogate for actual facility information to support required safety and environmental reviews. Hence, NRC review of environmental and siting issues can begin even though the plant design has not matured to the level necessary to support COL development. The final decision regarding whether to submit an ESP will lie with the COLA.

Having obtained an ESP, an applicant for a COL for a nuclear power plant or plants can then reference it in the COLA. In accordance with 10 CFR 52.39, site-related issues resolved at the ESP stage will be treated as resolved at the COL stage unless a contention is admitted that a reactor does not fit within one or more of the site parameters established in the ESP. An ESP can provide a vehicle for resolving site-related issues early in the schedule in advance of a COLA submittal. Approximate timeframes for beginning ESP work and submittal the ESP for review are provided in Figure 4-5.



Note:

a 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 COLA.

b ESP development expected to take 2 years.

Figure 4-5. ESP sequence.

5. PROJECT RELEVANCE AND PATH FORWARD

It is recognized that final resolution of many preapplication items identified in the NGNP Licensing Plan will require significantly more details than can be supported by a conceptual plant design. Indeed, certain plant configuration descriptions may not be available until the initial license application is finally developed by the facility owner/operator. These specific design details will continue to be developed as the overall project progresses and associated public-private partnership(s) are formed. Therefore, NGNP licensing efforts will continue to focus on priority topics that can be developed and addressed with the available design detail and lay the groundwork for addressing the more design-driven preapplication topics as designs are further developed during the licensing preapplication period. Essential elements of current plant development and licensing efforts are:

1. Establishing Top Level Radiological Requirements for the plant (e.g., setting dose limits at the exclusion area boundary) that reduce emergency planning requirements and support close co-location of the HTGR with the industrial facility.
2. Development and understanding of the radiological source term based primarily on fuel design, qualification testing results, and analytical method development.
3. Prevention and mitigation of source term releases to the environment that includes defining licensing basis events and establishment of multiple release barriers consistent with a defense-in-depth strategy.
4. Development of an updated emergency planning structure that considers potential radiological releases coupled with various industrial applications configurations to assure protection of public health and safety in the unlikely event of radiological release.

Proceeding through the licensing sequence summarized above, and described in more detail in the NGNP Licensing Plan, is resulting in a more predictable and well-understood licensing path forward for the project, with significantly reduced regulatory uncertainty for HTGR licensing. Key to this process is the regular and continued interaction with the NRC Staff as HTGR policy and technical issues are addressed and resolved, and those resolutions are reflected in the jointly developed HTGR COLA Content Guide.

NGNP Project licensing activities intend to continue on this path to the point where licensing activities can be transitioned to the COL applicant during Phase 2 of the project. It must be remembered, however, that resolution to certain HTGR licensing questions may be predicated upon the timely resolution of other related technical issues. For instance, the definition of plant siting and emergency planning requirements are directly related to preceding determinations made during review of HTGR licensing basis event selections, mechanistic source terms, and fuel qualification. It is therefore essential that the NGNP white paper submittals in these areas be dispositioned by the NRC in the May, 2011 timeframe, to enable timely resolution of follow-on issues.

The overall relationships and approximate timeframes for each of the various licensing activities are shown together in Figure 4.6.

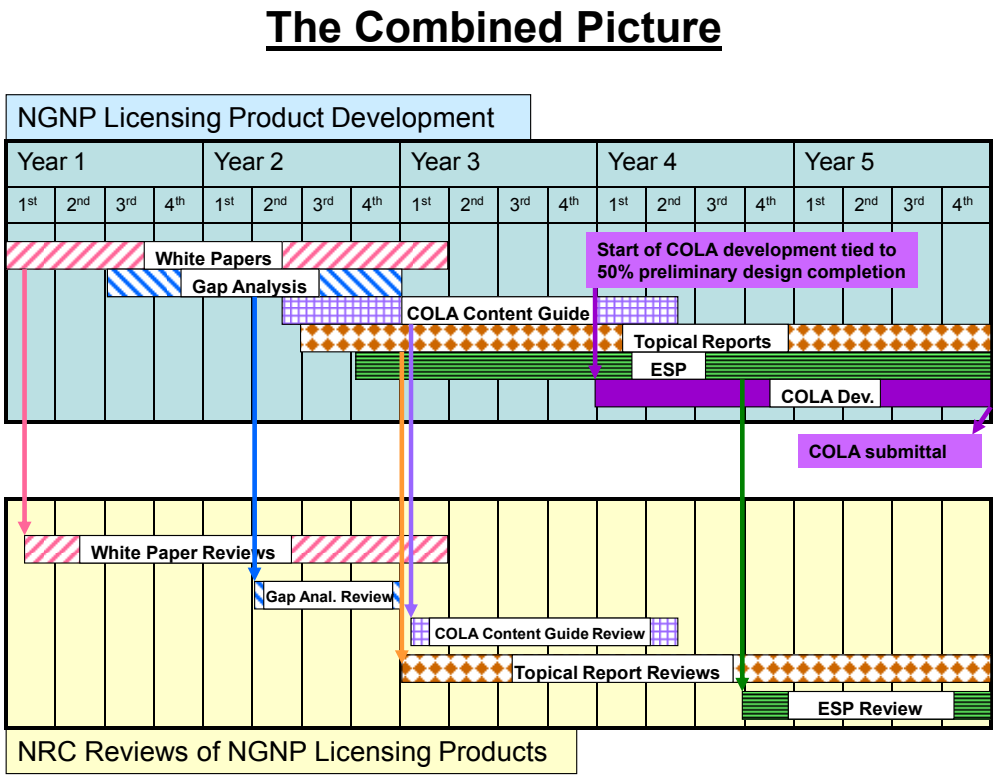


Figure 4-6. Overall licensing activity sequence.

6. REFERENCES

DOE-NRC Licensing Strategy—*Report to Congress* (August 2008)

NGNP Licensing Plan, PLN-3202 (June 26, 2009)

NRC Regulatory Guide 1.206, *Combined License Applications for Nuclear Power Plants* (LWR Edition)

NUREG-0800, *Standard Review Plan*

NUREG/CR-6844, *TRISO-Coated Particle Fuel Phenomena Identification and Ranking Tables (PIRTs) for Fission Product Transport Due to Manufacturing, Operations, and Accidents.* Vol. 1-3. (July 2004)

NUREG/CR-6944, *Next Generation Nuclear Plant Phenomena Identification and Ranking Tables (PIRTs)*, Vol. 1-6. (March 2008)

SECY-10-0034, *Potential Policy, Licensing, and Technical Issues for Small Modular Nuclear Reactor Designs*. (March 28, 2010)

Appendix A:
NGNP Preapplication Issues

Issue No.	Description
1	Implementation of Risk-Informed, Performance-Based Methods: Implementation of rigorous risk-informed, performance-based methods for Next Generation Nuclear Plant (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 Nuclear Regulatory Commission (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 light water reactors (LWRs). Consequently, the reduction of the emergency planning zone to approximately the size of the exclusion area boundary 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 (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 modular high temperature gas-cooled reactor (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 high temperature gas-cooled reactor (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 Verification and Validation (V&V): V&V of the analytical methods used in the safety analysis is a critical part of the NGNP Combined License Application (COLA). These analytical models will require the modeling of gas reactor phenomena such as identified in the MHTGR, pebble bed modular reactor (PBMR), and NGNP Phenomena Identification and Ranking Tables (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 Department of Energy (DOE)/Battelle Energy Alliance (BEA) to ensure that related research is conducted in an efficient and coordinated manner (allowing for the necessary independence of a regulatory review.

Issue No.	Description
7	Nuclear-Industrial Island Boundary: In regards to licensing and regulatory oversight, the NGNP Project presents the issue of defining an interface ("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 National Health Security Strategy (NHSS), other parts of the plant that impact NHSS safety and the safety of the plant workers and public during normal operation and postulated events, 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).
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 preapplication 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 research and development (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 COLA, 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 technology. 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 (Regulatory Guides, Standard Review Plans, NUREGs, etc.), (2) new regulatory guidance 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.

Issue No.	Description
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.
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).
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	COLA 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 or decommissioned 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].

Issue No.	Description
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.
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. Nonelectric-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 pressurized water reactor and boiling water reactors, 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 and 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).

Appendix B:
Expected HTGR Topical Reports

NGNP Test Programs Description Report
Compliance with Standard Review Plan (SRP) Criteria
Conformance with Regulatory Guides
Test Programs Description Report
Compliance with TMI Requirements
Proposed Resolutions of Unresolved Safety Issues (USI) and Medium/High Priority Generic Safety Issues (GSI)
Operational Experience Assessment Report
Development Methodology for Seismic Design Input
Plant Parameters Envelope Technical Report
Codes and Standards Selection Report
Safety Classification of SSCs/Regulatory Treatment of Non-Safety SSCs
Risk Informed Evaluation of Defense-in-Depth
Methodology for Calculation of Turbine Missile Probabilities
Aircraft Impact Assessment Report
Helium Pressure Boundary (HPB) Leaks and Breaks Identification Report
Leak-Before-Break (LBB) Assessment Report
Piping Analysis and Support Design Report
Documentation of Selected Seismic and Structural Analysis Computer Models
Computer Code (Seismic) Description and Verification and Validation (V&V) Report(s)
Reactor Pressure Vessel (RPV) Internals Dynamic Response Analysis Report
Reactor Pressure Vessel (RPV) Internals Flow-Induced Vibration Test Report
Control Rod Drive System Mechanical Design Report
Control Rod Operability Assurance Report
Reliability Integrity Management (RIM) Report
Seismic Qualification Report for Mechanical and Electrical Equipment
Environmental Qualification Program Description
Fuel System Design Description Report
Fuel Test and Inspection Plan
Fuel Performance Envelope Report (Nuclear Design)
Ex-core Monitoring Description and Analysis Report
Core Monitoring Approach
Fuel Performance Model(s) Description Report(s)
Load Follow Strategy Report
Control Rod Design Report
Nuclear Design Analysis Methods (Code) Description and V&V Report(s)
Core Thermal Characteristics and Hydraulics Report
Core Power Peaking and Heat Removal Correlations Report
Core Thermal Methods (Code) and Verification and Validation (V&V) Report(s)
Core Barrel Code Case Justification Report
Graphite Code Case Justification Report
Ferritic Material Selection and Qualification Report
Reactor Pressure Vessel (RPV) Code Case Justification Report
Reliability Integrity Management (RIM) Report
Basis for Heatup and Cooldown Limit Curves
Digital Instrumentation and Control (I&C) Software Management Plan
Digital Instrumentation and Control (I&C) Software Development Plan

Digital I&C Software Quality Assurance Plan
Digital I&C Integration Plan
Digital I&C Installation Plan
Digital I&C Maintenance Plan
Digital I&C Training Plan
Digital I&C Operations Plan
Digital I&C Software Safety Plan
Digital I&C Software Verification & Validation (V&V) Plan
Digital I&C Software Configuration Management Plan
Digital I&C Software V&V Requirements Analysis Report
Digital I&C Software V&V Design Analysis Report
Digital I&C Software V&V Implementation Analysis & Test Report
Digital I&C Software V&V Integration Analysis & Test Report
Digital I&C Software V&V Validation Analysis & Test Report
Digital I&C Software V&V Installation Analysis & Test Report
Digital I&C Defense-in-Depth and Diversity Report
Cyber Security Assessment Report
Fire Protection Assessment Report
Process and Effluents Monitoring and Sampling Program
Standard Radiological Effluents Controls (SREC)
Offsite Dose Calculation Manual (ODCM)
Process Control Program (PCP)
Radiological Effluents Control Program (RECP)
Operator Training Program Description
Physical Security Plan
Safeguards Contingency Plan
Security Assessment Report
Security Personnel Training and Qualification Plan
Fitness for Duty Program Description
Maintenance Program Description
Evaluation Model Development and Assessment Process (EMDAP)
Codes and Methods Applicability Report
Licensing Basis Event (LBE) Selection Report
Safety Evaluation Model Description Report
Safety Evaluation Model V&V Report
Safety Evaluation Model Scaling Report
Safety Test Data Report(s)
Safety Evaluation Model Applicability Report(s)
Overpressure Protection Report
Basis for Heatup and Cooldown Limit Curves
Setpoints Methodology for Protection Systems
QA Program Description
Human System Interface Description and Human Factors Engineering Process
Human System Interface Verification and Validation
Probabilistic Risk Assessment Methods Report
Treatment of Passive and Inherent Safety Features in Probabilistic Risk Assessment (PRA)
Probabilistic Risk Assessment Summary Report