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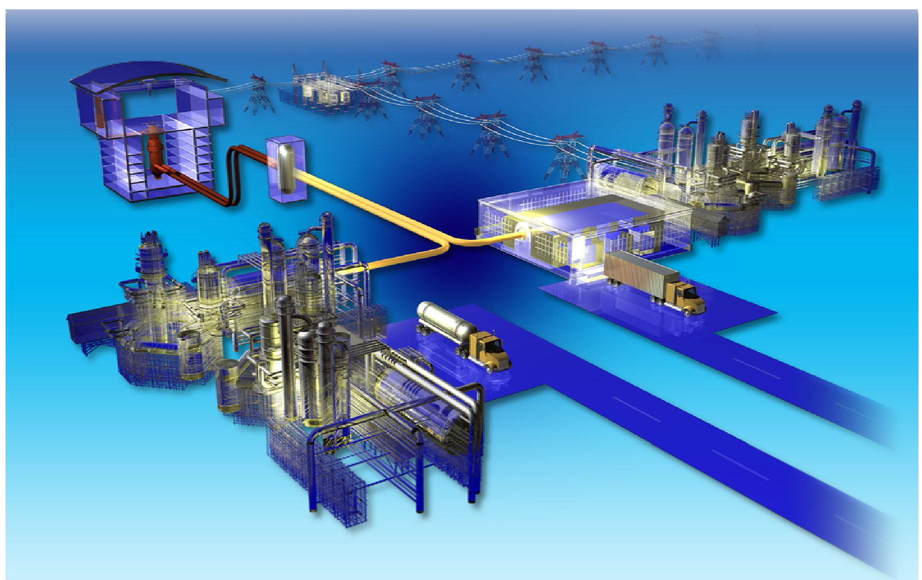
Preliminary
Project Execution Plan

Project No. 23843

Next Generation Nuclear Plant



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Next Generation Nuclear Plant Project

Preliminary Project Execution Plan

PLN-2825

Project File No. 23843

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REVISION LOG

Rev.	Date	Affected Pages	Revision Description
0	09/30/08	All	New Issue
1	09/30/09	4, 5, 6, 9, 34, 35, 36, 37, 40, 50, 57, 58, 59	Deleted 1st para. of Sec 2.1; all of Sec 2.2; 3rd para. of Sec 3.1; and parts of 3rd para. and all subsections of Sec 9.7. Cleaned up tables (format) esp. Table 6; removed the Dennis Miotla reference; updated the Project Authorization Form in App C; and deleted Table F-1 and Figures F-2 and F-3.

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EXECUTIVE SUMMARY

The Next Generation Nuclear Plant (NGNP) represents an integration of high-temperature reactor technology with advanced hydrogen, electricity, and process heat production capabilities, thereby meeting the mission need identified by the U.S. Department of Energy (DOE). The strategic goal of the NGNP Project is to broaden the environmental and economic benefits of nuclear energy technology to the U.S. economy by demonstrating its applicability to market sectors not served by light water reactors and drawing their energy needs from fossil fuels.

The NGNP Project will be a Nuclear Regulatory Commission (NRC)-licensed plant that will provide the basis for commercialization of a new generation of advanced energy plants that utilize High Temperature Gas-Cooled Reactor (HTGR) technology. The general scope of the project is to design, construct, and operate a full-scale prototype HTGR plant and associated technologies thus establishing the technological basis for expanded commercial applications and infrastructure for the commercialization of this new generation of advanced nuclear plants. NGNP is scheduled to be operational by 2021, as required by the *Environmental Policy Act of 2005*.

The purpose of this *Draft Preliminary Project Execution Plan* (PEP) is to provide the framework for the Preliminary PEP to be developed in the FY 2009 – FY 2010 timeframe. Ultimately, a fully developed PEP will be submitted and will incorporate the DOE's Final Acquisition Strategy and Engineering Design. This draft plan is very preliminary in nature and is based on the current maturity level of knowledge and strategy development for the design, schedule, and acquisition of the NGNP Project. However, it does provide descriptions and illustrations of the methods currently in place to execute the project as defined.

Nuclear systems suppliers and end-user communities have been extensively engaged through subcontracts, workshops, or industry meetings to identify and validate a set of requirements (functional, operational, and performance) for the NGNP demonstration plant. These requirements will continue to be refined and, as a result, the design and required technology development activities will reduce uncertainty and risk. These activities are being integrated with the licensing process to support a 2021 startup. The development of an integrated, non-resource loaded project schedule with logic ties is underway and will identify critical activities, which will provide guidance in establishing future funding priorities.

Due to the level of maturity, the NGNP Project is currently operating on an annual scope and budget basis instead of using a life-cycle project baseline, which will be established at the end of Conceptual Design. As such, earned value is calculated and reported against a fiscal year approved budget using Earned Value Management principles. Change control is also exercised with approved processes using thresholds agreed upon with NGNP management and DOE. The Work Breakdown Structure currently adopted by the project is consistent with industry standards and capable of expansion and transfer to other organizational structures without making extensive modifications.

The Quality Assurance Project Plan developed by NGNP is consistent with NQA-1 and is being applied to all work currently undertaken by NGNP. Environmental, Health and Safety (industrial and radiological) guidelines and procedures at INL govern the work being performed there.

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ACRONYMS

AGR	Advanced Gas-cooled Reactor
ANL	Argonne National Laboratory
ASME	American Society of Mechanical Engineers
ATR	Advanced Test Reactor
AVR	Arbeitsgemeinschaft Versuchsreaktor – Germany
B&R	Budget and Reporting
CAM	Control Account Manager
CD	Critical Decision
CFR	Code of Federal Regulations
COL	Combined License
COLA	Combined License Application
CTF	Component Test Facility
DC	Design Certification
DCA	Design Certification Application
DD&D	Decommissioning, Decontamination, and Dismantlement
DOE	Department of Energy
-ID	Idaho Operations Office
-NE	Office of Nuclear Energy
EAC	Estimate at Completion
EDMS	Electronic Document Management System
EES&T	Energy and Environment Science and Technology Directorate
EIS	Environmental Impact Statement
EOI	Expression of Interest
EPAct	Energy Policy Act of 2005
ES&H	Environment, Safety and Health
ESP	Early Site Permit
ETC	Estimate to Complete
EVM	Earned Value Management
EVMS	Earned Value Management System
F&OR	Functional and Operational Requirement
Gen IV	Generation IV

HFEF	Hot Fuel Examination Facility
HTGR	High Temperature Gas-cooled Reactor
HTR	High Temperature Reactor – China
HTS	Heat Transfer/Transport System
HTSE	High Temperature Steam Electrolysis
HTTR	High Temperature Test Reactor – Japan
IHX	Intermediate Heat Exchanger
INL	Idaho National Laboratory
ITAAC	Inspections, Tests, Analyses, and Acceptance Criteria
IWO	Interagency Work Order
LOE	Level of Effort
LWA	Limited Work Authorization
LWR	Light Water Reactor
MFC	Materials and Fuel Complex
MOU	Memorandum of Understanding
MPO	Memorandum Purchase Order
NASA	National Aeronautical and Space Administration
NEPA	National Environmental Policy Act
NERAC	Nuclear Energy Research Advisory Committee
NGNP	Next Generation Nuclear Plant
NHI	Nuclear Hydrogen Initiative
NIRMA	Nuclear Information and Records Management Association
NQA	Nuclear Quality Assurance
NRC	Nuclear Regulatory Commission
NS&T	Nuclear Science and Technology Directorate
ORNL	Oak Ridge National Laboratory
OUO	Official Use Only
P&IDs	Piping and Instrumentation Diagrams
PICS	Program Information Collection System
PIRT	Phenomena Identification and Ranking Table
PCS	Power Conversion System
PEP	Project Execution Plan

PFD	Process Flow Diagram
PRA	Probabilistic Risk Assessment
PSAR	Preliminary Safety Analysis Report
QA	Quality Assurance
QAP	Quality Assurance Program
QAPP	Quality Assurance Program Plan
R&D	Research and Development
R2A2	Roles, Responsibilities, Authorities, and Accountabilities
RPV	Reactor Pressure Vessel
SSC	structures, systems, and components
SNL	Sandia National Laboratory
T&FR	Technical and Functional Requirement
TBA	Task Baseline Agreement
TDO	Technology Development Office
THTR	Thorium Hochtemperatur Reaktor – Germany
TRISO	tristructural-isotropic (fuel)
TRL	Technology Readiness Level
V&V	Verification and Validation
VHTR	Very High Temperature Reactor
WBS	Work Breakdown Structure
WPM	Work Package Manager

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Preliminary—Project Execution Plan

1. OVERVIEW

1.1 Introduction

In response to a national strategic need identified in the National Energy Policy to promote reliance on safe, clean, economic nuclear energy and to establish a greenhouse-gas-free technology for the production of hydrogen, the Department of Energy (DOE) has defined a mission need to develop new, advanced reactor and hydrogen generation technology. The Next Generation Nuclear Plant (NGNP) represents an integration of high-temperature reactor technology with advanced hydrogen, electricity, and process heat production capabilities thereby meeting the mission need identified by DOE. The strategic goal of the NGNP Project is to broaden the environmental and economic benefits of nuclear energy technology to the U.S. economy by demonstrating its applicability to market sectors not served by light water reactors (LWR).

The purpose of this *Preliminary Project Execution Plan* (PEP) is to provide the framework for the Preliminary PEP to be developed in the FY 2009 – FY 2010 timeframe. Ultimately, a fully developed PEP will be submitted and will incorporate the DOE's Final Acquisition Strategy and Design Approach. This draft plan is preliminary in nature and is based on the current maturity level of the project, in terms of strategy development for the design, schedule, and acquisition of the NGNP. However, it does provide descriptions and illustrations of the methods currently in place to execute the project as defined.

1.2 Background and History

In July of 2005, Congress passed the *Energy Policy Act of 2005* (EPAct; H.R. 6), which was signed into law by President George W. Bush in August of 2005. Under Section 641, the Act 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:

a. "Is based on research and development activities supported by the Generation IV Nuclear Energy systems Initiative….

b. "Shall be used

- To generate electricity
- To produce hydrogen
- Or both to generate electricity and to produce hydrogen."

The EPAct established the expectations for NGNP program execution, including industry participation and cost sharing, international collaboration, U.S. Nuclear Regulatory Commission (NRC) licensing, and review by the Nuclear Energy Research Advisory Committee (NERAC).

The U.S. DOE selected the Idaho National Laboratory (INL) as the lead national laboratory for nuclear energy research. Per the terms of EPAct, Title VI, Subtitle C, Section 662, 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.

1.3 Mission Need

The mission need statement developed for NGNP was approved by DOE Deputy Secretary on October 18, 2004, officially completing CD-0.

High-level NGNP project objectives that support the mission need are:

- Develop and implement the technologies important to achieving the functional performance and design requirements determined through close collaboration with commercial industry end-users
- Demonstrate the basis for commercialization of the nuclear system, a heat transfer/ transport system (HTS), a hydrogen production process, and a power conversion concept. An essential part of the prototype operations will be demonstrating that the requisite reliability and capacity factor can be achieved over an extended period of operation.
- Establish the basis for licensing the commercial version of NGNP by the NRC. This will be achieved in major part through licensing of the prototype by the NRC and initiating the process for certification of the nuclear system design.
- Foster rebuilding of the U.S. nuclear industrial infrastructure and contributing to making the U.S. industry self-sufficient for our nuclear energy production needs.

1.4 Project Description

The nuclear energy industry has traditionally used Light Water Reactor (LWR) technology for the generation of electricity. This technology is limited to approximately 300°C reactor outlet temperature. Alternatively, High Temperature Gas-Cooled Reactor (HTGR) technology can provide not only electricity but also high-temperature process heat needed for industrial processes and hydrogen production at reactor outlet temperatures ranging from 750 to 800°C. HTGR technology can significantly reduce the use of premium fuels for the production of process heat and the release of greenhouse gases, thus providing a significant competitive advantage for the U.S. industrial markets. This technology is inherently safe and proliferation resistant.

The NGNP Project will result in an NRC-licensed plant that will provide the basis for commercialization of a new generation of advanced nuclear plants that utilize HTGR technology. The general scope of the project is to design, construct, and obtain a license to operate a full-scale prototype HTGR plant and associated technologies to establish the basis for the commercialization of this new generation of advanced nuclear plants and expanded commercial applications and infrastructure. The major activities that need to be completed for NGNP to be operational in year 2021, as required by the EPAct, are:

- Secure sufficient support from government and commercial entities to ensure the viability of the NGNP Project
- Execute and complete all project deliverables, including conceptual design, preliminary and final design, construction, and startup and acceptance testing for the NGNP facility
- Identify, integrate, and complete technology development and system confirmatory and verification tasks needed for design, licensing, construction, and testing at power
- Obtain NRC licensing as required for a commercial demonstration reactor prototype

- Complete all state and federal permitting required for construction and operation, including support for DOE *National Environmental Policy Act* (NEPA) activities.
- Provide project management and integration that will coordinate and combine the efforts of the project partners, subcontractors, and stakeholders.

This Preliminary Draft of the NGNP PEP provides an initial roadmap for continued development and execution of the project in accordance with the DOE mission and objectives and those of its partners.

2. PROJECT ACQUISITION STRATEGY

The DOE is responsible for preparing the overall Project Acquisition Strategy. However, EPAct Sections 641 through 645 established expectations for research, development, design, construction, and operation of a prototype nuclear plant that will provide electricity and/or hydrogen. Central to those expectations is the creation of a Public-Private Partnership with commercial industry, both domestic and international, for sharing the cost and risks associated with the commercialization of this technology. EPAct Section 988 provides the overall formulation and considerations for cost-sharing.

The provisions of the EPAct also establish two distinct phases for the project. In Phase I, to be completed by 2011, DOE, with its industrial partners, is directed to select a hydrogen production technology and develop initial reactor design parameters for use in Phase II. Phase I is the research and planning portion of the initiative and the current phase of the project. As contemplated in Phase II, DOE and its industrial partners would complete the design and construction of a prototype plant at the INL by 2021. The EPAct also establishes expectations for NGNP program execution, including industry participation and cost-share, international collaboration, NRC licensing, and review by the NEAC.

2.1 Alternatives Development and Strategy

During Phase I, conceptual and preliminary designs for both nuclear system designs currently under consideration will be initiated with the objective of completing the designs sufficiently to support application for an NRC Combined License (COL) using either of the design concepts. As noted above, it is anticipated that one of the designs will then be selected for NGNP and will be used to apply for a COL and subsequently certified for future deployment of commercial units. Long-lead procurement for selected components will also be initiated.

Phase II consists of completing conceptual and preliminary designs and preparing the Combined License Application (COLA) for the selected HTGR nuclear system while long-lead procurements continue. NRC licensing is an important part of Phase II, and the proposed licensing strategy requires that the final design for all safety systems be completed when the COLA is submitted to the NRC in FY 2013.

Initial plant operation is scheduled for the end of FY 2021. The initial operating period includes two years to achieve full power and temperature operation. Open items raised during the NRC review period that require plant operation to be resolved will be addressed during this period. It is assumed that these will be included in the provisions of the operating license in the form of confirmatory actions. In the third year, the plant will be shut down for major inspections and modifications identified during the operating period. Commercial operation of the plant will resume the fourth year after initial startup.

2.2 Connection to other Energy Programs

2.2.1 HTGR Development – Component Test Facility

The purpose of the Component Test Facility (CTF) is to support development of high-temperature gas-thermal hydraulic technologies (e.g., helium, helium-nitrogen, carbon dioxide) as applied in heat transfer and transport applications in HTGRs. Such applications include but are not limited to primary coolant; secondary coolant; direct-cycle power conversion; intermediate, secondary, and tertiary heat transfer; and demonstration of industrial processes requiring high temperatures (e.g., hydrogen production). Current efforts to develop the technologies supporting design, construction, operation, and maintenance of these large-scale test loops are limited to existing laboratory and pilot-scale testing. There are few facilities available or planned that have the capacity to develop and test equipment/components at a scalable engineering level or at full scale.

The development of CTF is necessary to ensure the timely demonstration of component reliability and acquisition of confirmatory data in support of NGNP licensing activities. The CTF startup is scheduled for 2014 to support the 2021 NGNP reactor startup date.

This facility will support NGNP licensing and also be available for use by the full range of suppliers, end-users, government laboratories, and others in the domestic and international community supporting the development and application of HTGR technology. The facility will provide for full-scale testing and qualification of high-temperature fluid flow systems, materials, components, and equipment; control and instrumentation development; verification and validation (V&V) of methods/codes to support licensing and future commercial applications; operations procedure development and qualification training; operational problem/troubleshooting; high-temperature gas applications mockup engineering-scale testing and qualifications (e.g., hydrogen production, coal to liquids, steam generators for Alberta Oil Sands application, etc.); maintenance and repair program and process development; and component replacement program and process development.

2.3 Key Factors that will Impact the Development of NGNP

2.3.1 Siting

This information will be provided in a later revision of this Preliminary PEP.

2.3.2 Laws Affecting Location

This information will be provided in a later revision of this Preliminary PEP.

2.3.3 Infrastructure Development Needs for Disseminating Process Heat

This information will be provided in a later revision of this Preliminary PEP.

2.3.4 Infrastructure Development Needs for Commercial Electric Grid Tie-In

This information will be provided in a later revision of this Preliminary PEP.

2.3.5 Infrastructure Development Needs for Hydrogen Production

This information will be provided in a later revision of this Preliminary PEP.

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). DOE O 413.3 outlines the requirements for the acquisition of capital assets within the Federal Acquisition System. 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 management and execution of the project.

The DOE Federal Project Director receives the mission, goals, and objectives from DOE-NE and provides those elements to the NGNP Project Director, who executes the project via implementation of the INL Project Management System Document (PLN-7305, Rev. 1). Although the NGNP Project is multi-year and has developed a preliminary cost and schedule, DOE provides funding on a fiscal year basis. An annual budget is initially set up and, later in the year, is appropriated by Congress, at which point NGNP's annual budget is revised and officially baselined. As work is performed during the fiscal year, the DOE Federal Project Director receives reports and feedback from the NGNP Project Director and other responsible team members on progress, issues, accomplishments, and overall status of the project. The NGNP Project will be comprised of many different team members, and it will be very important to maintain the concept of a single point of control focused through the NGNP Project Director and project team. Figure 1 provides the overall NGNP Project organization structure; project interfaces are shown in Table 1.

The INL's Technology Development Office (TDO), described in Section 3.2, is responsible to plan and execute the Research and Development (R&D) work scope required to design and ultimately license the NGNP (in response to design data needs [DDNs] and in accordance with Functional and Operating Requirements [F&ORs]), identify and meet R&D milestones and deliverables, report on monthly status, develop schedules, and provide Earned Value Management (EVM) on the budget assigned to the TDO for NGNP.

3.1.1 Roles, Responsibilities, Authorities, and Accountabilities

The following sub-sections provide the high-level functional responsibilities for senior management positions of the NGNP Project as shown on the organizational diagram (see Figure 1). The senior management level is indicated by the first horizontal line directly reporting to the Project Director. Specific roles, responsibilities, authorities, and accountabilities (R2A2s) for these individuals, along with all other NGNP staff not explicitly covered under this section, are documented in INL Position Descriptions and are subject to company implementing procedures, NGNP specific requirements, and specific assignment requirements made by NGNP management. Senior management is responsible for establishing overall expectations specific to their organization that will lead to the successful completion of the project and for establishing expectations for the effective implementation of the NGNP Quality Assurance (QA) program. More specific information pertaining to the responsibilities and authorities for establishing and implementing the QA program is addressed in the Quality Assurance Program Plan for the NGNP (NGNP QAPP), PLN-2021.

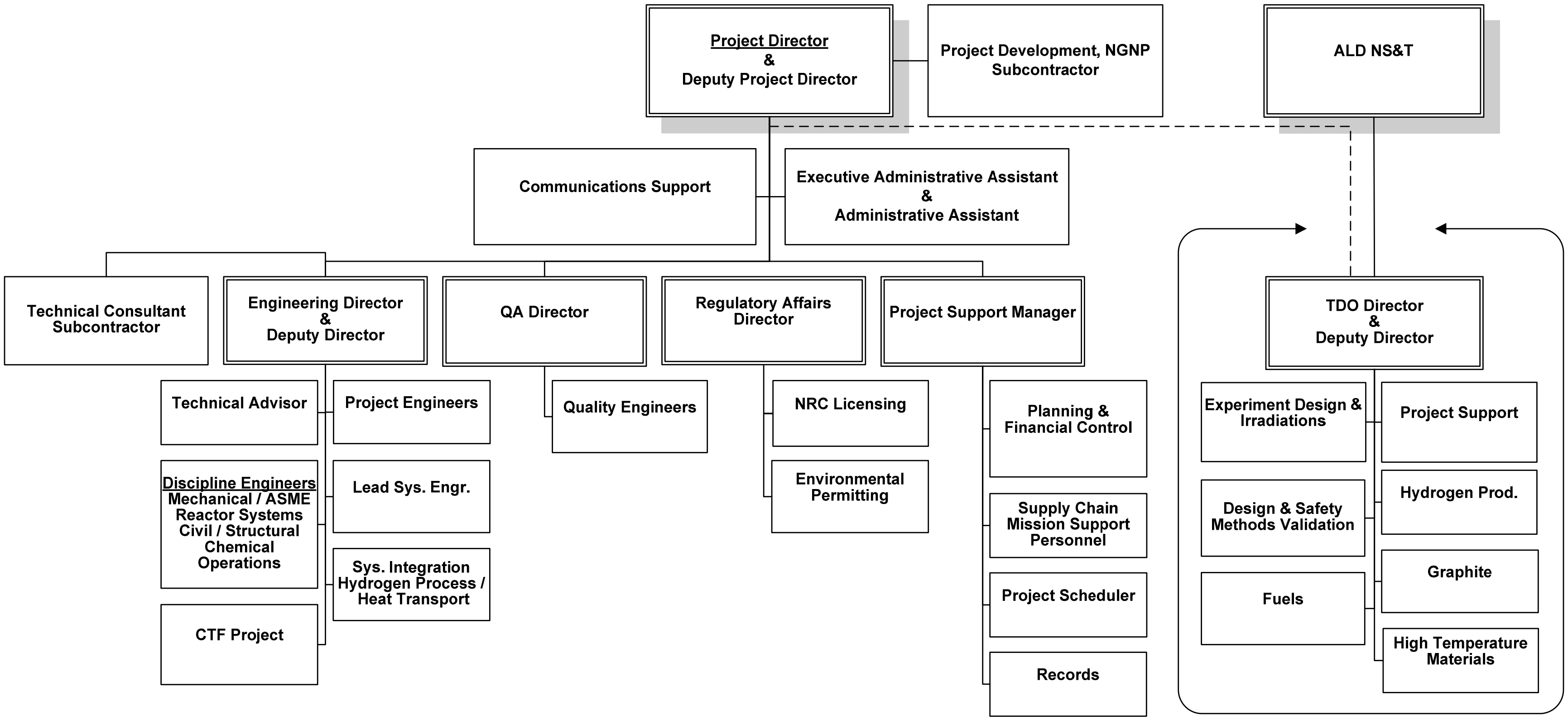

Figure 1. INL NGNP Project organization.

Table 1. Project interfaces and documentation matrix.

Project Interface	Responsibility Description	Project Interface
DOE-HQ	Provide Programmatic Direction, mission, high level objectives	NGNP Project Director
DOE-ID Budget Counterpart	Provide Project Budget Authorization upon direction form DOE-HQ's Guidance Letters	NGNP Lead Project Financial Controls
DOE-ID Technical Counterparts	Evaluates Battelle Energy Alliance's (BEA) performance in its execution of NGNP work scope and serves as liaison with DOE-HQ	NGNP Project Director and direct reports
DOE-ID QA	Provide DOE oversight on QA issues	NGNP QA Director
Other DOE National Laboratories	Participate in work scope development and execution in response to project needs.	TDO Director or Technical Area Leads via Memorandum Purchase Order
Universities	Contribute with work effort with INL	TDO Director or Technical Area Leads via Contract
Design Subcontractors	Perform Design work commensurate with project development stage	Engineering Director or designee
Consultants	Provide unique technical skills and interface with specific industrial sectors	Project Director or designee
INL Organizations (typical): • Advanced Test Reactor • Hot Fuel Examination Facility • Test Train Assembly Facility Neutron Radiography Reactor • FCF Mockup Area • Analytical Laboratories • Training Department • QA • Safety • Engineering • Crafts	Provide critical project facilities and capabilities (e.g., Advanced Test Reactor [ATR],Materials and Fuels Complex [MFC]), as well as infrastructure support on areas of general interest and applicability (Environmental, Safety and Health [ES&H], Human Resources [HR], Financial Controls, etc.)	NGNP Project personnel as designated via Task Baseline Agreement or personnel matrix assignments

3.1.1.1 Project Director

The Project Director provides overall management for the execution of the NGNP Project. The Project Director is also the leader of the cross-functional group of project team members assembled to successfully execute the project objectives established jointly with the customer and INL senior management. The Project Director is responsible for establishing overall expectations for effective implementation of the QA program and is responsible for obtaining the desired end result. The project Director is responsible for ensuring that project milestones are met within the defined time frame and must ensure that the project objectives safely meet the NGNP program and project requirements and are fulfilled within cost and schedule. These responsibilities span the life cycle of the project and encompass all aspects of R&D applicable to the NGNP design; licensing; construction; operations; and decommissioning, decontamination, and dismantlement (DD&D).

3.1.1.2 Deputy Project Director

The Deputy Project Director assumes the R2A2s of the NGNP Project Director in the absence of the Director. This assumption of the Project Director's R2A2s has been formally established by project policy to ensure clear lines of accountability and communication of expectations within the project organization and the project team.

3.1.1.3 Project Support Manager

The Project Support Manager facilitates the day-to-day operations of all supporting functions for successful execution of the NGNP Project. Supporting functions in many cases are matrixed functions from other support organizations and include, but are not limited to, financial, scheduling, records and document management, and procurement.

3.1.1.4 Engineering Director

The Engineering Director leads the development and maintenance of the NGNP Project system technical requirements in coordination with the NGNP Project Management, NGNP Project R&D, and Licensing organizations. The Engineering Director is responsible for the planning and implementation of engineering technical work, safety analysis, risk management, and directs project engineering work, ensuring technical integration of other efforts, such a licensing and R&D, as needed.

3.1.1.5 Quality Assurance Director

The QA director ensures that an appropriate QA program has been established and verifies activities affecting quality. The QA Director is responsible for assisting the NGNP Project Director in developing and maintaining the written description of the NGNP QA program.

3.1.1.6 Regulatory Affairs Director

The Regulatory Affairs Director develops and implements the overall strategy for NRC licensing the NGNP prototype and for fulfilling DOE requirements for the safe management of nuclear facilities. The Regulatory Affairs Director also coordinates all technical and licensing interfaces with DOE, NRC and environmental regulatory agencies.

3.2 Project Communications

The communications plan under development envisions that NGNP Project management will perform outreach to develop cooperation and sustain project support by communicating project information to the following seven broad groups or audiences:

- DOE (NE and ID)
- Policymakers
- Public-private partnerships
- Media outlets
- INL and NGNP employees
- University and National Laboratory partners
- Local audience

- National audiences.

3.2.1 Communications Objectives

The objectives of NGNP communications for each of the seven audiences include, but are not limited to, the following:

- *DOE (NE and ID)* – Jointly plan and coordinate all NGNP work scope with DOE at Headquarters and Field Offices to ensure DOE's objectives are met.
- *Policymakers* – Encourage the continued financial and political support for NGNP to develop the technology and infrastructure necessary for project completion.
- *Public-private partnerships* – Promote substantial technical and financial support for NGNP.
- *Media outlets* – Cast NGNP in a positive light as the application of advanced nuclear energy systems giving consumers the products they need without carbon emissions. NGNP should be shown as a critical means of addressing growing energy demand, the high and volatile price of fossil fuels, and contributing to achieving national energy independence.
- *INL and NGNP employees* – Inform employees regarding successes and progress in technical and infrastructure development, and engage employees as ambassadors for the project on a grass-roots level.
- *University and national laboratory partners* – Engage and promote cooperative efforts in collaboration with university and national laboratory partners in developing the technology and providing subsequent funding for the NGNP Project.
- *Local audience* – Educate local and regional residents about HTGR technology to bolster support for NGNP deployment in industrial complexes as a primary fuel source for industrial processing and to increase support for HTGRs as a viable solution to some national energy concerns. Communications should address concerns about the following:
  - Safety of nuclear energy processes
  - Tristructural-isotropic (TRISO) fuel performance
  - Waste concerns and future refining possibilities
  - Siting of the plant within the boundaries of commercial facilities and initial siting at INL
  - Function and operation of the Public-Private Partnership
  - Expectation that other areas of interest will emerge to be addressed by the project as relevant.
- *National audience* – Provide information to reach a wider geographical audience interested in the NGNP Project and increase and sustain support for HTGRs as a viable solution to some national energy concerns. Communications should address the same concerns identified above for local audiences.

4. NGNP DESIGN

One of the first phases of NGNP's Design effort is to identify and validate functional, operational, and technical requirements based on intended use and within regulatory constraints. The end-user community has been engaged to identify such requirements and to help in bounding the operating parameters to facilitate the development of design alternatives leading to a technology down-select consistent with an initial startup of 2021.

The NGNP is currently in the early conceptual design phase. During this phase, NGNP Engineering will continue to engage nuclear systems vendor community participation through the assignment and oversight of specific design tasks with the selected commercial gas reactor contractor teams. These design tasks are identified via recommended work presented during the close of pre-conceptual design; tasks to support technology down-selections; tasks to advance the development of key Structures, Systems, and Components (SSC); and tasks that address emerging identified concerns, such as the NRC's Phenomena Identification and Ranking Tables (PIRT) and subsequent meetings and workshops.

During this early conceptual design phase, NGNP Engineering will also develop and validate documentation of design and technology maturation levels and, subsequently, develop and implement the process to perform and track risk reduction strategies and activities for key SSCs. This technology risk reduction, as described in Section 7 of this document, is crucial to the sound advancement of the NGNP.

During the conceptual design phase, the design of the NGNP will be developed so as to provide the project technical and functional requirements (T&FRs), including safety requirements; requirements analysis; alternatives evaluation; hazards analysis; project risk evaluation; information needed for a focused R&D effort; and a defined basis for a cost range, schedule, and performance requirements for the project. The information developed during the conceptual design phase will be integrated with information gained during the pre-conceptual design phase to allow technology and alternatives selections to be made and actual design work for systems and subsystems to commence.

At the end of conceptual design, Piping and Instrumentation Diagrams (P&IDs), General Arrangements (Gas) and Process Flow Diagrams (PFDs) for all major system elements and subsystems will be provided and integrated with site and facility area plans. The project baseline (i.e., cost estimates, schedule, design documents, long-lead item procurements, etc.) will be developed at a conceptual design level with contingencies in the 20% to 30% range. Independent assessments and reviews are performed throughout the design effort.

The conceptual design work and results will be utilized to support Probabilistic Risk Assessments (PRA), Combined License Application (COLA), and all pre-application licensing submittals to the NRC.

5. R&D SCOPE IN SUPPORT OF NGNP

The VHTR TDO has been established at the INL with the responsibility to provide/coordinate the R&D activities required to license and design the first NGNP reactor as well as perform other R&D in support of the DOE Generation IV (Gen IV) VHTR technology. The R&D work needed by NGNP will be performed by a number of national laboratories, including INL, Oak Ridge National Laboratory (ORNL), Argonne National Laboratory (ANL), and Sandia National Laboratories (SNL). Additionally, R&D support activities may be performed by universities in concert with the national laboratories. The TDO has the responsibility to:

1. Plan and execute the R&D work scope identified by the project and required to support design and licensing of NGNP
2. Establish deliverables
3. Establish and meet Quality Assurance (QA) requirements commensurate with the intended use of data generated
4. Measure and report performance on scope, schedule, and budget using EVM principles
5. Ensure the necessary memorandum purchase orders (MPOs), interagency work orders (IWOs), and other contracting mechanisms are in place with the performing organizations for selected R&D activities to document work requirements and concurrence with work schedules and deliverables
6. Provide funds to each performing organization in accordance with contract terms.

For work performed inside the INL, multiple organizations are involved, including the Advanced Test Reactor (ATR), Hot Fuel Examination Facility (HFEF) hot cells, and general laboratories inside the Nuclear Science and Technology (NS&T) Directorate and the Energy and Environment Science and Technology (EES&T) Directorate. To communicate with those organizations (largely through the NGNP TDO R&D Execution Leads) and hold them accountable for the work they will perform, TDO uses task baseline agreements (TBAs), which are instruments to jointly develop scope execution schedules, cost estimates and staffing requirements in advance of the performance period. Management from the performing organization signs the TBAs to formalize the resource commitment.

The TDO will integrate three specific areas of research, called major project elements, to support the NGNP Project. These project elements are as follows:

- *Fuels* – Nuclear fuel development, characterization, and qualification
- *Materials* – Materials selection, development, testing, and qualification
- *Methods* – Reactor and BOP design, engineering, safety analysis, V&V.

A technical program plan is used for each of the three R&D elements currently within the VHTR TDO and will be updated as necessary to serve as guidance for establishing and completing the schedules for R&D activities identified by the project to support the design and licensing of the NGNP. The execution of the R&D work performed by the VHTR TDO will be governed by its Project Execution Plan, PLN-2494.

6. REGULATORY AFFAIRS SCOPE IN SUPPORT OF NGNP

Although gas-cooled reactor technology dates back to the 1960s, the NGNP is a new and unproven reactor design, different form previously licensed reactors. Therefore, the NRC will need to adapt its licensing requirements and processes, which have historically evolved around Light Water Reactor (LWR) designs, for licensing the NGNP nuclear reactor. Thus, EPAct Section 644 recognized the need for an alternative licensing strategy. The jointly-developed *Next Generation Nuclear Plant Licensing Strategy, A Report to Congress*, dated August 2008, addresses the following four elements of the licensing strategy set forth in EPAct Section 644(b):

1. A description of the ways in which current NRC LWR licensing requirements need to be adapted for the types of reactors considered for the project

2. A description of the analytical tools that the NRC will need to independently verify the NGNP design and its safety performance

3. A description of other R&D activities that the NRC will need to review in support of an NGNP license application

4. A budget estimate associated with the licensing strategy.

After extensive review of industry recommendations, it was decided that a Combined License application (COLA) submitted and granted in accordance with 10 CFR 52 should be the foundation of the NGNP licensing strategy. This approach is consistent with the Congressional Report's recommended licensing process discussed above. It is the most expedient means of obtaining regulatory approval based on gas reactor technology as applied to the specific site for the NGNP Project. The ESP and Limited Work Authorization (LWA) licensing options (see Figure 2) will be considered in this licensing strategy to enable further management of licensing schedule risk. As site selection, site data, and construction schedule detail become available, additional assessments will be made to determine whether the envisioned schedule benefits of an application based on coupled ESP and LWA will be realized.

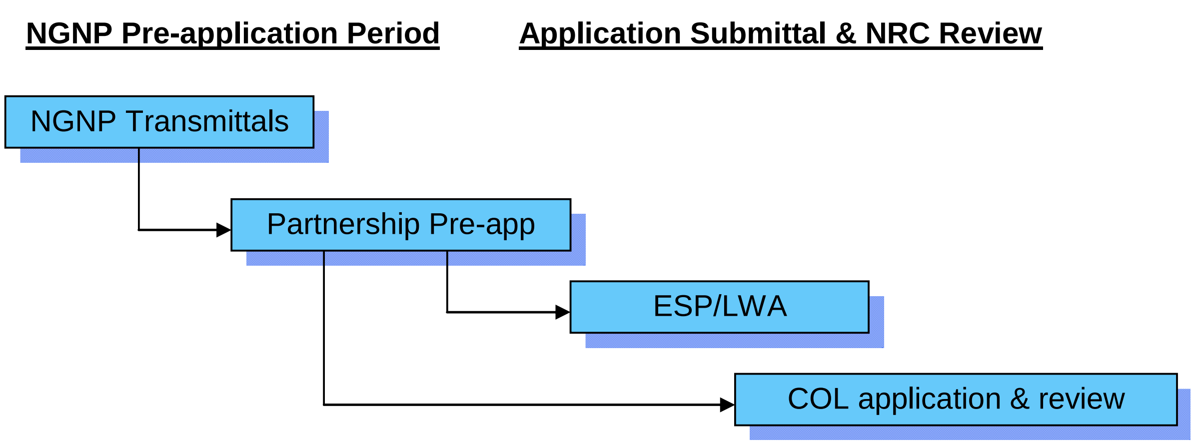

Figure 2. Summary of anticipated NGNP licensing process.

The Regulatory Affairs support scope for the NGNP project organization is to coordinate activities and serve as interface between DOE and NRC as the licensing approach is further refined and implemented. The Regulatory Affairs organization will coordinate DOE, NGNP (and its subcontractors), and NRC activities to ensure 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 described in Section 4, and will draw significant inputs from the project Procurement Strategy and the R&D scope.

The primary Regulatory Affairs functions are: (1) coordination with DOE and NRC in establishing a project licensing approach and schedule, and (2) implementation of the selected licensing approach. As the project licensing approach and schedule are finalized, Regulatory Affairs activities will include:

- Transmitting information (e.g., reports, data, descriptions of design features, etc.) to DOE and NRC in a format consistent with the applicable interagency agreement(s) and MOUs to support their review of the design

- Coordinating with NGNP staff and DOE responses to incoming NRC requests for additional information

- Arranging NRC meetings, as required to advance the licensing process and coordinated with DOE

- Communicating project schedule information and status 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.

7. RISK MANAGEMENT

INL Project Risk Management provides a reproducible and reliable process for conducting risk management planning, identification, analysis, response, monitoring, and control on a project. Implementation of an effective risk management process enhances the probability of project success by addressing each identified risk with an assigned risk mitigation strategy and associated actions. The implementation of this process improves project performance and decreases the likelihood of unanticipated cost overruns, schedule delays, or compromises in quality and safety.

NGNP has identified several technical risk areas as well as procurement risks affecting long-lead items. Early decisions will be needed to accommodate the heavy industry market availability constraints or, conversely, flexibility in the design could facilitate late orders for key components. Section 7.2 provides additional detail.

7.1 Project Risk Management Process

The project risk management process ensures that project risks and uncertainties are identified, analyzed, managed, or determined to have been mitigated or eliminated. The process also provides a structured, formal, and disciplined approach to determine and control risk events and general uncertainties at an acceptable level through the lifecycle of the project. Under this approach, risks are first identified and used to populate the project Risk Register. These risks are analyzed and categorized as Very Low, Low, Moderate, High, and Very High based on probability of occurrence and consequence. A Risk Mitigation Strategy is then developed for each risk and becomes part of the Risk Response Plan for those High and Very High risks. The Risk Response Plan includes the actions required to accept, monitor, mitigate, reduce, or avoid the risk. The NGNP will document the plan for managing risk during the lifecycle of the project in a standalone Risk Management Plan, currently scheduled for publication in late FY 2009.

NGNP risks are technical and programmatic, and both types have the ability to manifest themselves in cost and schedule impacts. NGNP pre-conceptual design work has highlighted several known technical risks that must be resolved to ensure successful completion of the NGNP Project. The steps and other design work to resolve these risks will require the NGNP Project to make decisions on alternatives for the NGNP (e.g., operating power level, gas temperatures, heat transport configuration, etc.). Additionally, throughout the design process other risks will be identified. To ensure that decisions are made and risks (both known and unknown) are addressed on a consistent and objective basis, the NGNP Project has tailored a systematic approach to managing technology-related risk and uncertainty. This approach combines similar technology maturity measurement methodologies as those used by NASA and the Department of Defense in their programs with unique approaches and tools developed at the INL for using uncertainty measurement to both make decisions and manage project execution. This systematic approach correlates technical risk areas identified through DDNs to the maturity of any one technology using Technology Readiness Levels (TRLs), as depicted in Figure 3. This roadmapping process is used to improve confidence in project success (i.e., meeting cost and schedule objectives) during each design development phase.

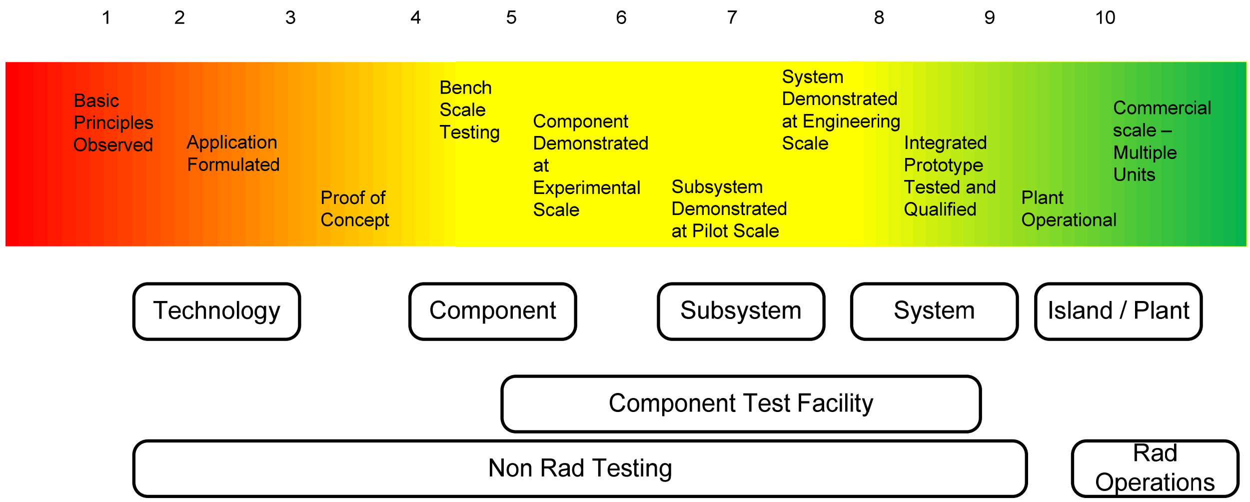

Figure 3. Technology Readiness Levels.

7.2 Long-Lead Procurement Items and their Procurement Strategy

The plan for long-lead procurement is to select the most promising technologies and mature the selected technologies through R&D as identified in area-specific technology development roadmaps. These technology development roadmaps identify the required engineering studies; laboratory, experimental, pilot, and engineering-scale tests; and prototype tests needed to support design, determine licensing requirements, and procure long-lead items. Long-lead procurement items will be identified as early as possible, and procurement will be scheduled consistent with the overall project schedule. Some items anticipated to be long-lead procurement include fuel, graphite, high-temperature material, the Intermediate Heat Exchanger (IHX), the Reactor Pressure Vessel (RPV), and the Power Conversion System (PCS). Procurement details for each of these items are addressed below.

7.2.1 Fuel

Supplying the NGNP first core fuel and subsequent reload fuel on a schedule to support plant startup in the 2021 timeframe is possible but heavily schedule-constrained. The major challenges from a schedule perspective are ensuring that the quality and performance capability of the fuel will meet the NGNP requirements and providing performance data necessary to support the licensing of the NGNP. Meeting the proposed schedule will require a degree of risk in the specification and production of fuel to be tested, and in the production of fuel for the first core. The Fuel Development and Qualification Program will qualify TRISO-coated particle fuel for use in the NGNP. Feasible acquisition strategies for fabrication of first core and qualification of the associated production-scale fuel fabrication facility for both design concepts have been established and will be executed once the reactor design decision is made.

7.2.2 Graphite

The current world market share for nuclear graphite is extremely small. While graphite manufacturers are willing to produce nuclear grade graphite, the petroleum industry, which produces the raw starting material, specialty coke, is much less interested. The material specifications for specialty coke are much more exacting than what is needed for electrode production, the majority market share for graphite. Since this material's market share is so small, the coke suppliers have very little financial interest in changing their production process to enable manufacture of these small batches of specialty coke necessary for nuclear graphite production.

As a consequence, there may not be enough specialty coke material available for initial or sustained production of nuclear graphite for HTGR applications. This can significantly affect the graphite R&D schedule if multiple lots of graphite are required for testing and qualification. This potential shortage of coke sources has been addressed in much more detail within the *NGNP Graphite Selection Strategy Report* (ORNL/TM-2007/153).

7.2.3 High Temperature Material

The goal of the NGNP High Temperature Materials Program is to establish the relevant thermo-mechanical performance data to support the development of IHXs and other high temperature components for an outlet temperature up to 800°C. Prototype testing of key components is envisioned in a high-temperature flow test loop within the CTF to characterize overall behavior under prototypic flowing HTGR conditions and to validate in-service inspection techniques. Final design and procurement would follow. Components would include piping, circulators, valves, heat exchangers, and equipment that would be exposed to process heat.

7.2.4 Intermediate Heat Exchanger

The IHX will be operated in flowing, impure helium on the primary and secondary side at temperatures up to 800°C. However, there are major high-temperature design, materials availability, and fabrication issues that need further evaluation.

The proposed designs for the IHX include a plate machined heat exchanger, plate fin heat exchanger, and the plate stamped heat exchanger, which are compact heat exchanger designs. The tubular IHX is a standard industrial design.

The important attributes of the proposed IHX designs are summarized in Table 5-1 of INL-EXT-08-14054, *NGNP Heat Exchanger Acquisition Strategy*. It is clear from this summary that successful design and reasonable service life for the heat exchanger remain problematical. Tubular designs represent the configuration with minimum technical and schedule risk. These designs have a large base of service experience and are fabricated using well known fusion welding processes. Additional designs discussed in this report include the foam, capillary, and ceramic IHX designs, which are less mature technologies.

Compact designs are attractive to minimize the capital investment in materials; however, they represent a significant technical risk at this stage of their development. Qualification of diffusion bonding methods and development of in-service inspection methods represent significant schedule risk.

The prospective materials for the IHX are Alloys 617, 230, 800H, and XR. In the pre-conceptual design studies all of the vendor teams have identified Alloy 617 as the preferred metallic material for the high temperature heat exchanger fabrication and use at 800°C. While this alloy has greater technical maturity compared to Alloy 230, it will still require successful completion of a code case for acceptance in the nuclear section of the American Society of Mechanical Engineers (ASME) Code for this heat exchanger application. The delivery schedule for these materials does not pose a problem for a 2021 start up as the vendors can quote reasonable delivery times at the moment. However, the product forms and amount needed must be finalized as soon as possible.

The availability of product forms for Alloys 617 seems to be reasonable at present. To further ensure that the metallic alloy materials, such as Alloy 617 for the IHX and HTS, are available in the proper product form in a timely manner, intermediate product forms, such as slab, are planned to be purchased in the near future. This will take the alloy fabrication process through the initial melting and secondary refining steps where the product availability would not have to depend on the melt shop schedule. This intermediate product form will be stored at the supplier's facility and will be made into the final products on an as-requested basis by the component fabricators.

An issue for the fabrication of the IHX pressure and tubular design heat exchanger is the identification of vessel fabrication vendors with the appropriate ASME certifications to perform nuclear work. The number of these firms has declined over the last 20 years, and the NGNP will be competing for these services with resurgent orders for LWRs and chemical process facility components in a world market.

It would be prudent to complete the IHX design(s) so as to get the required material on order and complete the fabrication procurement. The NGNP staff will plan and execute a program of fabrication vendor interaction so as to identify qualified suppliers for development of scheduling information and final procurement. This may involve plant visits by the NGNP staff and/or a NGNP sponsored meeting where vendors could discuss the design, fabrication, and schedule for manufacturing these components.

7.2.5 Reactor Pressure Vessel

There is currently a world-wide shortage of fabrication capability for nuclear qualified components. Potential vendors for components of sufficient size for the NGNP RPV have considerable experience with A 508/533 steel. However, there is no experience with forging Grade 91 steel in heavy sections for nuclear applications and no plans appear to be in place to develop capability to forge large Grade 91 components. The maximum forging size that can be obtained is closely related to the maximum ingot that can be cast by the forge shop. Ingots up to 450 T are possible for A 508, while issues associated with segregation during solidification limit Grade 91 ingots to about 120 T.

The combination of technical maturity, availability, and fabricability strongly suggest that an A 508/533 RPV presents the minimum technical and schedule risk for the NGNP Project. While this steel may not have been the preferred candidate of all of the vendors, the NGNP *Reactor Pressure Vessel Acquisition Strategy* report, INL/EXT-08-13951, and subsequent work have indicated that this is an acceptable choice of materials.

Given the shortage of capacity to fabricate heavy sections for nuclear components and the anticipated demand for LWR vessels, the current delivery time is estimated to be ten years. It is imperative that the NGNP design be finalized and an order placed for the vessel in the next several years to support startup by 2021. It is also recommended that the NGNP Project continue to work with potential vendors that are considering adding capacity to fabricate large nuclear components to ensure that large components are available.

The following recommendations are made to further define the RPV and IHX vessel acquisition strategy and define the risk for obtaining the properly designed and fabricated RPV and IHX pressure vessels to meet the 2021 NGNP startup date:

1. Complete the overall NGNP reactor system design
2. Choose the appropriate RPV and IHX vessel materials
3. Complete the detailed design of the RPV and IHX pressure vessels

4. Work with material suppliers and vessel fabricators to ascertain the delivery schedule for the heavy section materials and the completed components to the INL site

5. Work with the construction contractor and/or vessel fabricator to ensure correct assembly of these vessels as regarding welding and heat treatment procedures.

More detailed information can be found in the report *NGNP Reactor Pressure Vessel Acquisition Strategy*, INL/EXT-08-13951.

7.2.6 Power Conversion System

The PCS would include turbines and other components that would be exposed to process heat. Existing technology may be used depending on final process requirements. Once the reactor type, operating conditions, and performance requirements are defined, PCS equipment will be specified and procured as required to meet the project schedule.

8. ENVIRONMENT, SAFETY, HEALTH AND QUALITY ASSURANCE

The NGNP Project will continue to use the current INL environment, safety and health (ES&H) processes until such time as the framework for the management of the Public-Private Partnership is more fully established. The project is currently adhering to the INL's Integrated Safety Management System and associated work control procedures. It is anticipated that all future work performed via interface with INL facilities will follow the same INL ES&H processes and procedures.

ASME Nuclear Quality Assurance (NQA)-1 is the baseline standard for the NGNP QA program (QAP). Currently, the NGNP Project is relying on the INL's QAP, which implements the requirements of NQA-1-2000. The INL QAP meets the requirements of 10 CFR 830 Subpart A and DOE Order 414.1C. An NGNP Project-specific Quality Assurance Program Plan (QAPP) was developed to identify deviations from the INL QAP and to addresses NGNP Project-specific implementation approaches. Personnel performing quality-affecting activities are required to abide by the NGNP QAPP.

The NGNP reactor is sponsored by DOE-NE and is subject to the licensing and related regulatory authority of the NRC as stated in the EPAct. NRC requirements in 10 CFR 50, Appendix B, will be applicable to the fabrication, construction, and testing of the SSCs of the reactor. The NGNP QA program will be updated to meet these NRC requirements on a schedule consistent with the NGNP regulatory strategy and agreements reached during pre-application discussions with the NRC. It is anticipated that the NRC will accept a QA program based on NQA-1-2008.

9. PROJECT CONTROLS

Project Controls describe the project work authorization, project controls processes, and performance measurement commensurate with the framework of the current level of maturity of the project. The non resource-loaded project schedule will be aligned with the WBS showing the integration of individual schedules from each functional area.

The project will continue to use the current INL financial control reporting processes until such time as the framework for the management of the Public-Private Partnership and a project performance baseline are more fully established. The project is using the INL's earned value management system (EVMS) as the mechanism for reporting project earned value status.

9.1 Work Breakdown Structure

The NGNP Work Breakdown Structure (WBS) is designed as a hierarchy of two-digit, numeric codes separated by decimal points on each of several levels. These codes integrate with key aspects of INL's financial and scheduling systems and follow industry standard WBS conventions.

The first two levels, which are predefined by INL as "C.Q" ("C.C" for the VHTR TDO); "C" represents the INL level and "Q" represents major projects. The third level, 10, identifies the NGNP Project. Subsequent breakdown levels are used to distinguish between different functions, Control Accounts and Work Packages. Costs are planned and tracked by assigning charge numbers within each work package, corresponding to specific activities. Appendix B provides the WBS currently used by NGNP and the VHTR TDO.

9.2 Project Work Authorization

The work authorization process (see Figure 4) involves management approval of the expenditure of project resources by a responsible organization to accomplish a specified scope of work within agreed to budget, schedule, and technical objectives. Formal work authorization provides a means for effective internal coordination, communication, and a process to obtain the required management approvals prior to initiating work.

The project work authorization process has been formalized and commences after the customer work/funds authorization is received. The objective of the project work authorization process is to ensure that all defined project work is authorized by the Project Manager.

The DOE Federal Project Director is responsible for granting authority to perform project work scope. Documentation for review by DOE representatives is prepared prior to each Critical Decision to support the work authorization process. Upon successful completion of this review, the DOE Acquisition Executive will issue a Critical Decision approval and a written authorization for INL to perform work consistent with the approved baseline plan. Once the work authorization is received and funding allocations have been made, project work will be performed consistent with the project schedule and budget baselines. An example of the FY 2008 Work Authorization Document is attached in Appendix C.

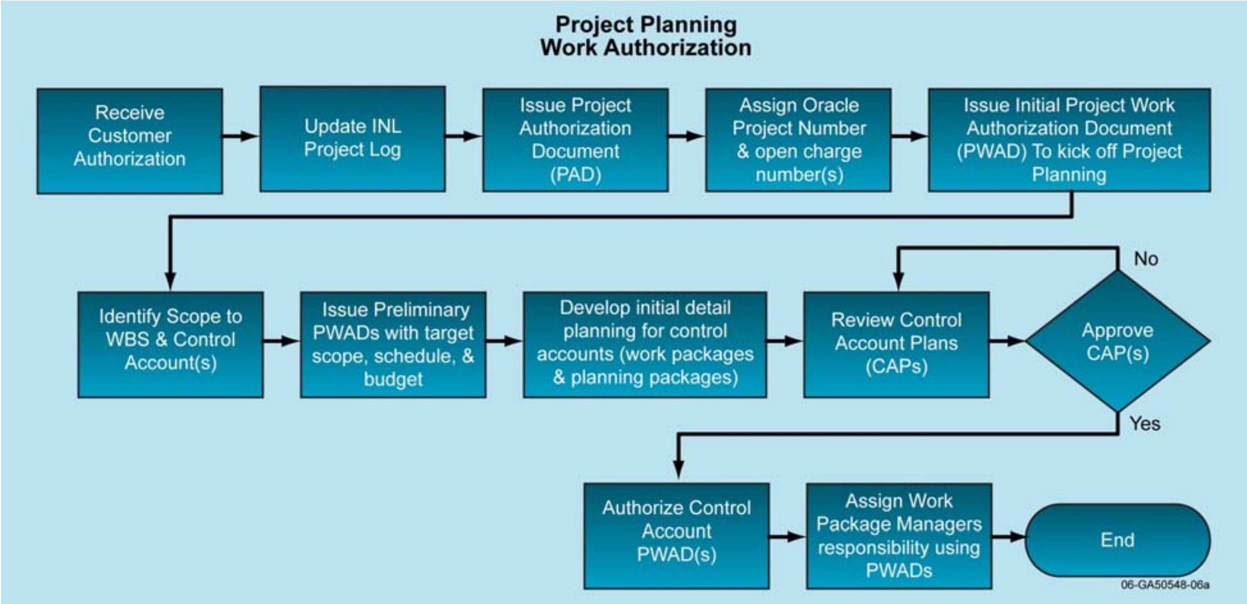

Figure 4. INL Work Authorization Process

9.3 Budget Development and Management

Under the existing funding system, DOE funding authorization is received annually via the DOE Approved Funding Program. DOE-ID issues a "Work Authorization Form" to Battelle Energy Alliance to authorize the work. The INL Project Director then issues Project Work Authorization Documents to the Control Account Managers (CAMS).

Consistent with the agreed upon fiscal year budget and associated scope, DOE-NE issues a program execution guidance letter to DOE-ID authorizing the scope and funding to be issued to the project by budget and reporting (B&R) code. Work planning then becomes an iterative process until the fiscal year baseline contained in a control account is formally approved by DOE-NE. An example of the FY 2008 Budget is attached in Appendix D.

9.4 Performance Measurement

NGNP uses EVM to measure performance against an approved (annual) project baseline (see Section 3.1). Until an approved project life-cycle baseline is officially developed and approved, monitoring project performance addresses work performed against work planned for the fiscal year, major accomplishments, status of key milestones, significant issues and their corrective actions, and cost and schedule performance data on a level that is commensurate with the maturity level of the project.

The annual program baselines establish core elements and activities required to measure performance and control the program. Performance measurement will be conducted in accordance with current procedures on Baseline Development and Management (LWP-7330).

Earned value methods to measure accomplishment of work are established for each work package during the planning phase. Each work package must have consistent earned value techniques applied to similar activities within the work package. Many earned value methods are available for measurement of progress, but the two most common methods used by the NGNP are Percent Complete, and Level of Effort (LOE).

9.4.1 EVM Percent Complete

The Percent Complete method is used for activities with durations of three months or more and for which no interim milestones can be identified. An example of this type of activity is a multi-year irradiation test at the ATR, where the goal is to reach a certain dose over a period of time, typically measured in days. This earned value method allows Work Package Managers (WPMs) to use a consistent method to determine the cumulative percent completion status at the end of each accounting period.

9.4.2 EVM Level of Effort

The LOE method is used for those scheduled activities that do not have technical deliverables. This method is generally applied only to management and project support efforts. Budgets for LOE scheduled activities must still have a documented basis of estimate and be time-phased to properly reflect when project work will be accomplished. The earned value method for LOE activities equals the time-phased budget; therefore, no schedule variance will occur.

Work Package Managers (WPMs) status each individually scheduled activity on a monthly basis to identify the percentage of completion. This information is forwarded to the project controls representative where it is entered into the project management system. The project management system is used to produce weekly and monthly financial reports that are distributed by the project controls representative. During each monthly reporting period, each WPM and Control Account Manager (CAM) is responsible for evaluating cost and schedule status reports for in-process work (for non LOE activities) in terms of percentage complete against the baseline. Each time a work package experiences a cumulative schedule or cost variance exceeding plus or minus 10% during any given month, the WPB will prepare a variance analysis report that addresses the cause, corrective action and schedule, and impact of the variance. This information is summarized by the Project Manager and reported monthly in the Program Information Collection System (PICS) at the control account level, and to the NGNP Project Director.

The WPMs, along with the CAM, must identify, develop, and implement corrective actions quickly to keep the program within the budget and schedule limits. Methods for calculating cost and schedule variances are shown in Tables 2 and 3, respectively:

Table 2. Cost variance formula.

$$\text{Cost Variance} = \text{BCWP} - \text{ACWP}$$

$$\text{Cost Variance \%} = \frac{CV}{BCWP} \times 100$$

$$\text{Cost Performance Index (CPI)} = \frac{BCWP}{ACWP}$$

Table 3. Schedule variance formula.

Schedule Variance (SV) = BCWP – BCWS

Schedule Variance % = $\frac{SV}{BCWS} \times 100$

Schedule Performance Index (SPI) = $\frac{BCWP}{BCWS}$

Note: BCWS: Budgeted Cost of Work Scheduled; BCWP: Budgeted Cost of Work Performed; ACWP: Actual Cost of Work Performed.

9.4.3 Estimate at Completion

Work Package Managers (WPMs) perform a detailed monthly Estimate at Completion (EAC) analysis. The purpose of this analysis is to evaluate the remaining scope for each task by establishing an Estimate to Complete (ETC). The EAC is the sum of cumulative actual costs plus the ETC. For each task, the EAC is compared to the budget, and adjustments or corrective actions are implemented accordingly.

Input into the performance measurement system by the CAMs is used to produce weekly and monthly reports (see Appendix E) that are distributed to the project and its customers. Each work package that exceeds pre-established threshold limits for the cumulative schedule or cost variance will prepare a variance analysis report that addresses the cause, corrective action, schedule, and impact of the variance. This information is summarized by the Project Manager and reported monthly to management. The threshold level of reporting will be defined in the final PEP. An example of Earned Value Report for August 2008 is attached in Appendix E.

9.4.4 Reporting

NGNP reports on project status at various levels for different audiences. Table 4 includes some of these reports.

Table 4. NGNP recurring reports.

Report Title	Recipient	Frequency
Weekly Report (informal status on salient activities)	DOE, NGNP staff	Weekly
Monthly Technical Report (formal, no financial information – just technical)	Wide distribution including DOE, other laboratories, selected subcontractors and NGNP staff	Monthly
Project Review (formal) – includes technical status and performance indicators	INL Manager of Projects - format is 2-hr discussion and presentation to senior management. DOE is frequently in attendance	No more than monthly and no less than quarterly
Annual Program Review (formal)	DOE	Annually
PICS Reports (comprehensive)	DOE	Monthly

9.5 Change Control Processes

The NGNP Project uses trends as a way to identify potential changes to scope, schedule, or cost stemming from unplanned events. The intent of the NGNP trends process, as shown in Figure 5, is to describe the means by which NGNP personnel will formally identify and track events that could have an impact on the project scope, schedule, or cost baselines. Documentation of these trends allows project management to mitigate the impact of negative events and to maximize the benefit of positive events to the project. The Trends Program is one of a number of project management tools that precede and supplement the Baseline Change Control Process, also described below.

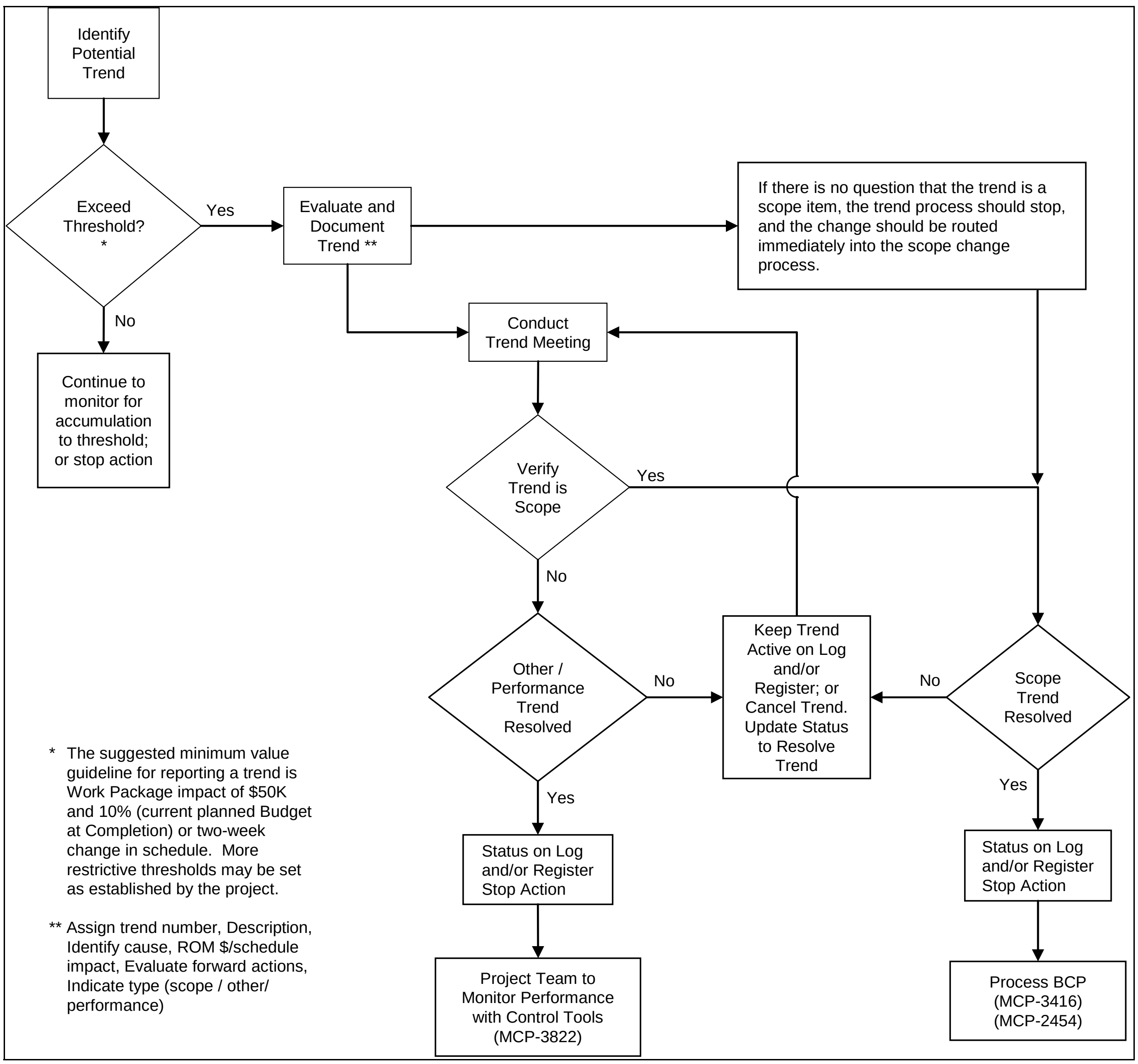

Figure 5. NGNP trend process flow.

The INL Baseline Change Control Process (see Figure 6) provides a formalized approach to developing, reviewing, approving, implementing, communicating, and tracking changes to the annual baseline.

Baseline change control will be managed in accordance with process guidelines developed for the NGNP Project. A baseline change will be completed when any one of the following conditions exists:

1. New work resulting from direction by a customer, new regulatory requirements, or a change to scope or schedule contained in the initial SOW
2. Budget reductions by the government or customer
3. Contractor inability to meet commitments due to funding limitations from such things as continuing resolution
4. Acceleration and slippage of project milestones as directed by the customer (particularly, milestones related to strategic initiatives or contract deliverables)
5. When management reserve is used to mitigate project risk.

Baseline change proposals (BCPs) are classified as internal or external based on the extent of the change and the requirements for approval. Change control thresholds are listed in Table 5, and authorization levels are listed in Table 6. All new scope and changes made to the approved Extended Year Plan (scope, schedule, and budget) fall under the change control process. Until such time when the NGNP Project has an approved life-cycle baseline, the time context in which the BCPs will apply shall be annual.

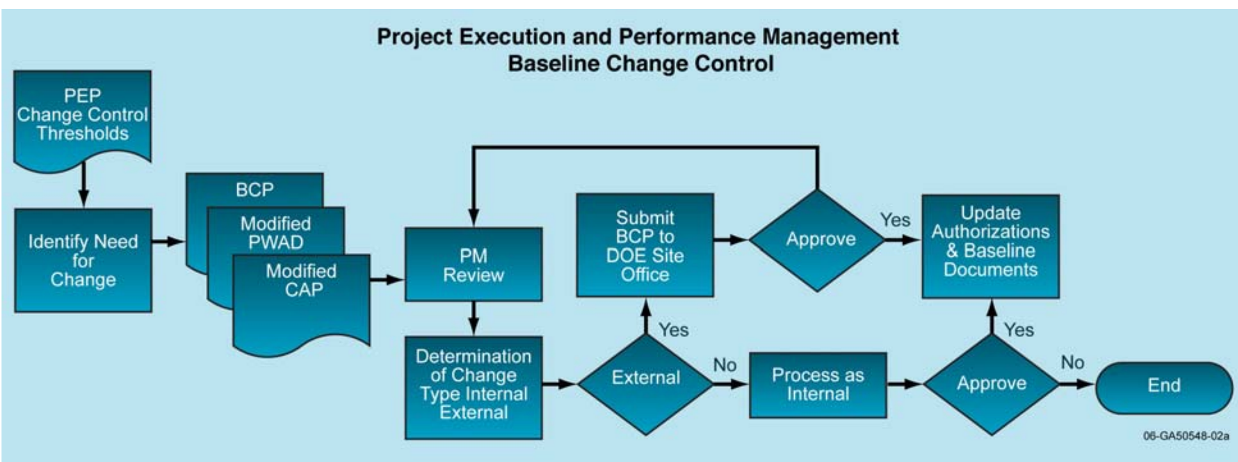

Figure 6. INL baseline change control process.

Table 5. Change control thresholds.

Change Type	Change Control Threshold		
	Level 1	Level 2	Level 3
Technical Baseline	Any single scope change greater than $3M or external milestone definitions or completion criteria.	Any single scope change less than $3M and that does not affect external milestone definitions or completion criteria, but does affect project baselines.	Any single scope change that does not affect external milestone definitions, completion criteria, or other project baselines.
Schedule Baseline	Any single schedule change that impacts an external milestone or regulatory mandate.	Any single schedule change that does not affect an external milestone or regulatory mandate but does affect project baselines.	Any single schedule change that does not affect an external milestone, regulatory mandate or project baseline.
Budget Baseline	Any single budget change greater than $3M or that increases the NGNP Project's total allocated budget (current fiscal year or life cycle), and requests additional funding from the DOE.	Any single budget change less than $3M that does increase the NGNP Project's total allocated budget (current fiscal year or life cycle) but does not request additional funding from the DOE.	Any single budget change that does not increase the NGNP Project's total allocated budget.

Table 6. NGNP change authorization.

Change Authorization	Change Control Threshold		
	Level 1	Level 2	Level 3
Project Sponsor (currently DOE)	A	—	—
NGNP Project Director	A	A	C
Control Account Manager	A	A	A

A = approve
C = concur
Copies of Level 2 and 3 baseline change proposals are available for DOE by request.

9.6 Non Resource-Loaded Schedule

The NGNP Project is currently developing an integrated planning schedule, which will account for major activities from the various technology development plans within R&D, the recently identified licensing path forward, and the engineering and design work performed during FY 2007 and FY 2008. Each of these areas had generated a schedule to meet their individual goals using technical requirements and acquisition strategies, current at the time of their respective development.

The resulting integrated planning schedule is not resource loaded, but logically ties technical and programmatic activities to inform the project of key milestones and predecessor activities and the required priority to reduce project risk. The work to date has already identified conflicts and interdependencies not previously recognized and promoted more frequent interaction between the responsible NGNP technical staff to resolve these issues.

The current integrated planning schedule contains different levels of granularity, depending on the maturity of each technical area. Fuels Development and Qualification is the most mature area and has a great deal of detail in terms of scope and sequence. High Temperature Materials, however, is still identifying performance requirements – highly dependent on reactor type and configuration – to define the necessary activities to support a startup date of 2021. As the technologies mature and a partnership is established, the schedule will change. This integrated planning schedule is part of the INL PLN-2924, "NGNP Integrated Schedule Development Plan," submitted under separate cover. A graphical representation of the summary level NGNP schedule is shown in Appendix F, Figure F-1.

9.7 High-Level Cost Estimate of Life-cycle Project Cost

The high-level cost estimate for the NGNP is composed of two major elements, design and construction, with a combined life-cycle cost of approximately $6.9 billion[a]. The cost is based on 2007 dollars escalated at a constant rate of 3.3% per year. The government's share of the cost will be focused on supporting development of areas of broad applicability to the Project, while the private sector share will include specific development of nuclear system design and the principal support of construction, start up testing, and initial operation of NGNP. The costs for completing the Project are consistent with projections of required funding needed to support any of the various project scenarios and schedules that have been proposed but not yet determined

Several tasks were initiated in the early part of FY 2008 that supported refinement of the pre-conceptual design cost and schedule estimates. These included:

- Developing the high-level schedule containing estimated project cost distribution by year and sponsor, according to the sharing assumptions made for an initial operating date of 2021
- Refining the program plans, schedules, and funding profile for R&D
- Adapting funding profiles from the Pre-Conceptual design work to the 2021 schedule
- Addressing the strategy, cost and schedule for licensing. This work is ongoing at the date of this report and will include:
  - Continuing development of the Licensing Strategy for the NGNP
  - Developing the content and schedule of the NGNP pre-application program,
  - Defining the development of additional NGNP-specific white papers for NGNP pre-application.
  - Conducting a workshop discussion with all contractor teams of the NGNP licensing strategy and schedule
  - Evaluating the content and schedule for engineering and organizational prerequisites necessary for effective NGNP pre-application engagement with NRC;
- Preparing functional and operational requirements, concept designs and cost and schedule estimates for the CTF
- Developing more detailed cost and schedule estimates for development of the high temperature steam electrolysis (HTSE) hydrogen production process including testing in the CTF, and completion of the design, construction, commissioning and operation of the process in the NGNP.

This additional work was used to update the original cost estimates and schedules from the pre-conceptual design work in FY 2007. Costs will be revised periodically based on need and the availability of information.

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a. This figure represents the "most likely" cost within a range, previously established during the pre-conceptual design studies, which included participation from WEC, GA and Areva, and their respective team members.

10. RECORDS MANAGEMENT AND CONFIGURATION CONTROL

10.1 Records Management

The Records Management Plan for the Next Generation Nuclear Plant (NGNP) Project, currently an INL document, PLN-1485, Rev. 7, describes the activities, responsibilities, authorities, and interfaces required to ensure the consistent care of information in all media forms throughout the NGNP life cycle (i.e., creation/receipt, use, maintenance, storage, and disposition).

The NGNP uses the commercially available Electronic Document Management System (EDMS) for management and storage of electronic records of all types. When electronic media are used to manage QA records, guidelines published by the Nuclear Information and Records Management Association (NIRMA)b will be implemented to satisfy the requirements of 10 CFR Part 50, Appendix B, and also 10 CFR Parts 60, 71, 72, and 76. The DOE Idaho Operations Office QA organization documented in their latest QA audit that EDMS effectively implements the NIRMA guideline requirements and accepted EDMS as a storage medium for NRC-licensed facility records (Ref: letter CCN 51988, UFC 0352, ISFSI-QA-04-017).

10.2 Data Management and Configuration Control

A method for managing NGNP Project-related data (such a drawings, reports, and commercial vendor data, etc.) that logically ties the configuration numbering system to the WBS is being developed. Currently, an NGNP Project number (23843) is used to identify NGNP Project-related data within EDMS. As the WBS is finalized, it may be included as an “index” or attribute of the electronic file for ease of reference and retrieval.

To satisfy the need for controlling the distribution of project-controlled information – mostly time-sensitive – yet not meeting the criteria for standard classification (Official Use Only [OUO], Controlled Unclassified Information, etc), a restricted folder has been created in EDMS to temporarily hold such information while controlling its configuration. Information in this folder can only be accessed by permission from the NGNP Project Director and is administered by the NGNP Records Management Coordinator.

b. NIRMA is a standards-based organization under the American National Standards Institute. Their guidelines can be found at <http://www.nirma.org>.

11. CONSTRUCTION

The project is not at the level of maturity or phase necessary to formulate plant construction information. As such, any information relative to these areas that is currently known and available, including a discussion of current expectations, will be provided in future revision of this Preliminary PEP.

12. REFERENCES

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

LST-216, "INL Drawing Type Index Code List," Rev. 1, Idaho National Laboratory, August 31, 2006.

LWP-7350, "Project Risk Management," Rev. 0, Idaho National Laboratory, December 13, 2006.

LWP-7380, "Project Work Authorization," Rev. 0, Idaho National Laboratory, December 18, 2006.

LWP-7400, "Baseline Change Control," Rev. 0, Idaho National Laboratory, December 18, 2006.

LWP-7410, "Reporting," Rev. 0, Idaho National Laboratory, December 18, 2006.

LWP-7430, "Variance Analysis," Rev. 0, Idaho National Laboratory, December 18, 2006.

Mizia, R. E., *Next Generation Nuclear Plant Heat Exchanger Acquisition Strategy*, INL-EXT-08-14054, Idaho National Laboratory, April 2008.

Mizia, R. E., *Next Generation Nuclear Plant Reactor Pressure Vessel Acquisition Strategy*, INL/EXT-08-13951, Idaho National Laboratory, April 2008.

Patterson, Michael W., and Charles V. Park, *Maintaining a Technology-Neutral Approach to Hydrogen Production Process Development Through Conceptual Design of the Next Generation Nuclear Plant,* INL/EXT-08-14193, Idaho National Laboratory, May 2008.

PLN-1485, "Records Management Plan for Next Generation Nuclear Plant (NGNP) Project," Rev. 7, Idaho National Laboratory, May 29, 2008.

PLN-2021, "Quality Assurance Program Plan (QAPP) for the Next Generation Nuclear Plant Project (NGNP)," Rev. 4, Idaho National Laboratory, May 29, 2008.

PLN-2489, "Next Generation Nuclear Plant Project (NGNP) Preliminary Project Management Plan," Rev. 2, Idaho National Laboratory, June 2008.

PLN-2690, "VHTR Technology Development Office Quality Assurance Program Plan," Rev. 1, Idaho National Laboratory, June 3, 2008.

PLN-7305, "Program Management System Document," Rev. 1, Idaho National Laboratory, January 23, 2007.

PLN 2924, "NGNP Integrated Schedule Development Plan", Idaho National Laboratory, September 30, 2008.

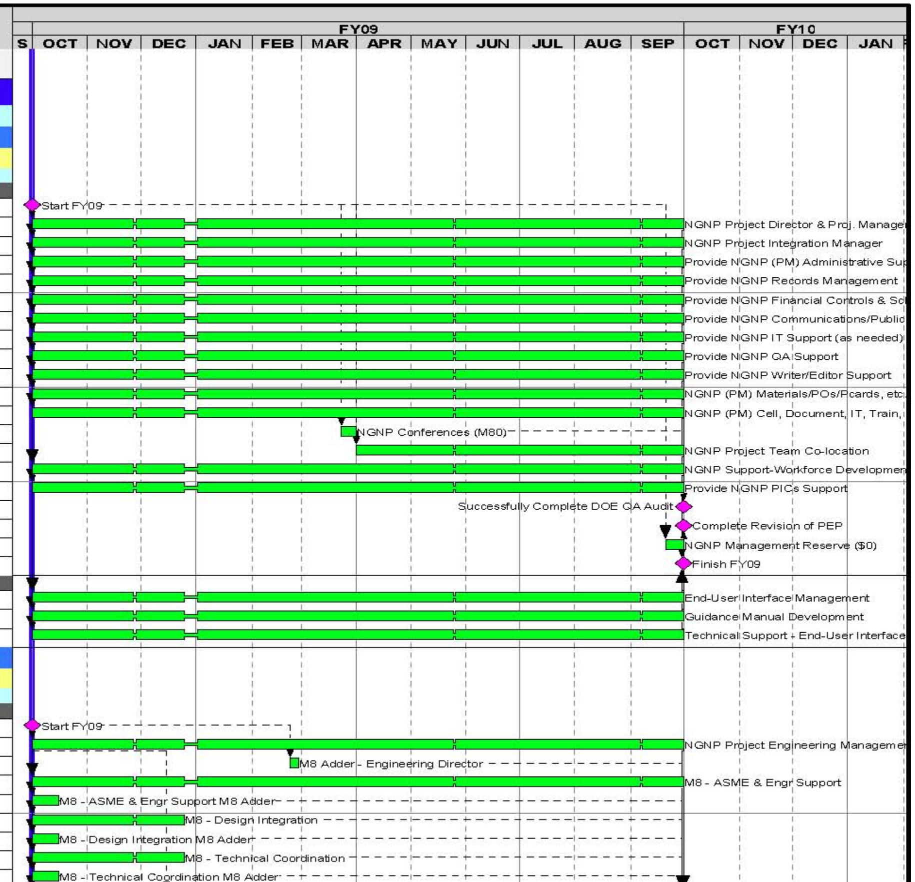
PLN-2494. "VHTR Technology Development Office Project Execution Plan", Rev. 1, June 2008.

Appendix A

Sample NGNP Work Breakdown Structures and Activity Planning

Appendix A
Sample NGNP Work Breakdown Structures and Activity Planning

Activity ID	Activity Description	Early Start	Early Finish
C Idaho National Laboratory			
C.Q Projects			
C.Q.10 Next Generation Nuclear Plant			
C.Q.10.01 NGNP Project Management			
C.Q.10.01.01 NGNP Project Management			
C.Q.10.01.01.03 Project Management			
C.Q.10.01.01.03.01 Project Management			
A90BEG09	Start FY09	01OCT08	
A91000	NGNP Project Director & Proj. Manager (&travel)	01OCT08	30SEP09
A91010	NGNP Project Integration Manager	01OCT08	30SEP09
A91020	Provide NGNP (PM) Administrative Support	01OCT08	30SEP09
A91030	Provide NGNP Records Management	01OCT08	30SEP09
A91040	Provide NGNP Financial Controls & Scheduling Spt	01OCT08	30SEP09
A91050	Provide NGNP Communications/Public Affairs	01OCT08	30SEP09
A91060	Provide NGNP IT Support (as needed)	01OCT08	30SEP09
A91070	Provide NGNP QA Support	01OCT08	30SEP09
A91080	Provide NGNP Writer/Editor Support	01OCT08	30SEP09
A91090	NGNP (PM) Materials/POs/Pcards, etc.	01OCT08	30SEP09
A91100	NGNP (PM) Cell, Document, IT, Train, Misc. Serv.	01OCT08	30SEP09
A91110	NGNP Conferences (M80)	23MAR09*	31MAR09
A91120	NGNP Project Team Co-location	01APR09*	30SEP09
A91130	NGNP Support-Workforce Development	01OCT08	30SEP09
A91140	Provide NGNP PICs Support	01OCT08	30SEP09
A91500	Successfully Complete DOE QA Audit		30SEP09
A91510	Complete Revision of PEP		30SEP09
A91990	NGNP Management Reserve ($0)	21SEP09*	30SEP09
A9END09	Finish FY09		30SEP09
C.Q.10.01.01.03.03 NGNP Public/Private Partnership			
A92000	End-User Interface Management	01OCT08	30SEP09
A92010	Guidance Manual Development	01OCT08	30SEP09
A92020	Technical Support - End-User Interface	01OCT08	30SEP09
C.Q.10.02 Engineering			
C.Q.10.02.00 Engineering			
C.Q.10.02.00.01 Engineering			
C.Q.10.02.00.01.01 Engineering Management			
B90BEG09	Start FY09	01OCT08	
B91000	NGNP Project Engineering Management	01OCT08	30SEP09
B91010	M8 Adder - Engineering Director	23FEB09*	26FEB09
B91020	M8 - ASME & Engr Support	01OCT08	30SEP09
B91030	M8 - ASME & Engr Support M8 Adder	01OCT08	15OCT08
B91040	M8 - Design Integration	01OCT08	24DEC08
B91050	M8 - Design Integration M8 Adder	01OCT08	15OCT08
B91060	M8 - Technical Coordination	01OCT08	24DEC08
B91070	M8 - Technical Coordination M8 Adder	01OCT08	15OCT08



Start Date 01OCT08 Finish Date 23OCT09 Data Date 01OCT08 Run Date 15SEP08 09:13	Early Bar Progress Bar Critical Activity	AT0A INL FY09 CQ10 NGNP RevA Base 9-09-08	Sheet 1 of 4

Idaho National Laboratory

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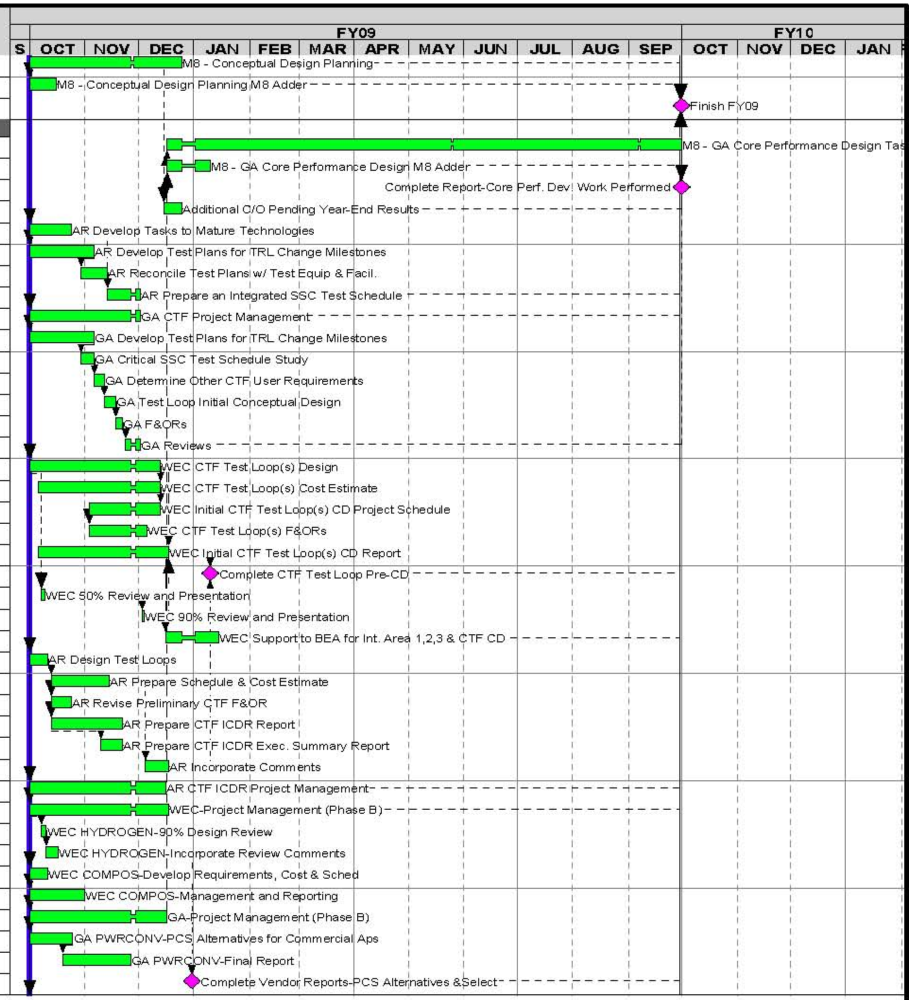
Activity ID	Activity Description	Early Start	Early Finish
B91080	M8 - Conceptual Design Planning	01OCT08	24DEC08
B91090	M8 - Conceptual Design Planning M8 Adder	01OCT08	15OCT08
B99END09	Finish FY09		30SEP09
C.Q.10.02.00.01.02 NGNP Engineering Design Development			
B92040	M8 - GA Core Performance Design Tasks	17DEC08	30SEP09
B92050	M8 - GA Core Performance Design M8 Adder	17DEC08	09JAN09
B92060	Complete Report-Core Perf. Dev. Work Performed		30SEP09
B92070	Additional C/O Pending Year-End Results	15DEC08*	24DEC08
B9210140	AR Develop Tasks to Mature Technologies	01OCT08	23OCT08
B9210150	AR Develop Test Plans for TRL Change Milestones	01OCT08	05NOV08
B9210170	AR Reconcile Test Plans w/ Test Equip & Facil.	30OCT08	13NOV08
B9210180	AR Prepare an Integrated SSC Test Schedule	14NOV08	01DEC08
B9210195	GA CTF Project Management	01OCT08	01DEC08
B9210250	GA Develop Test Plans for TRL Change Milestones	01OCT08	05NOV08
B9210270	GA Critical SSC Test Schedule Study	30OCT08	05NOV08
B9210280	GA Determine Other CTF User Requirements	06NOV08	11NOV08
B9210290	GA Test Loop Initial Conceptual Design	12NOV08	17NOV08
B9210295	GA F&ORs	18NOV08	21NOV08
B9210297	GA Reviews	24NOV08	01DEC08
B921B100	WEC CTF Test Loop(s) Design	01OCT08	12DEC08
B921B110	WEC CTF Test Loop(s) Cost Estimate	06OCT08	12DEC08
B921B120	WEC Initial CTF Test Loop(s) CD Project Schedule	03NOV08	12DEC08
B921B130	WEC CTF Test Loop(s) F&ORs	03NOV08	05DEC08
B921B140	WEC Initial CTF Test Loop(s) CD Report	06OCT08	17DEC08
B921B150	Complete CTF Test Loop Pre-CD		09JAN09*
B921B160	WEC 50% Review and Presentation	08OCT08*	08OCT08
B921B170	WEC 90% Review and Presentation	03DEC08*	03DEC08
B921B190	WEC Support to BEA for Int. Area 1,2,3 & CTF CD	16DEC08	14JAN09
B921B500	AR Design Test Loops	01OCT08	10OCT08
B921B510	AR Prepare Schedule & Cost Estimate	13OCT08	14NOV08
B921B530	AR Revise Preliminary CTF F&OR	13OCT08	23OCT08
B921B540	AR Prepare CTF ICDR Report	13OCT08	21NOV08
B921B550	AR Prepare CTF ICDR Exec. Summary Report	10NOV08*	21NOV08
B921B570	AR Incorporate Comments	05DEC08*	17DEC08
B921B590	AR CTF ICDR Project Management	01OCT08	15DEC08
B9220000	WEC-Project Management (Phase B)	01OCT08	17DEC08
B9221190	WEC HYDROGEN-90% Design Review	08OCT08*	09OCT08
B9221200	WEC HYDROGEN-Incorporate Review Comments	10OCT08	16OCT08
B9221250	WEC COMPOS-Develop Requirements, Cost &	01OCT08	10OCT08
B9221260	WEC COMPOS-Management and Reporting	01OCT08	31OCT08
B9223000	GA-Project Management (Phase B)	01OCT08	16DEC08
B9223090	GA PWRCONV-PCS Alternatives for Commercial	01OCT08	24OCT08
B9223100	GA PWRCONV-Final Report	20OCT08	26NOV08
B9223111	Complete Vendor Reports-PCS Alternatives &Select		30DEC08*



Start Date	01OCT08
Finish Date	23OCT09
Data Date	01OCT08
Run Date	15SEP08 09:14

Early Bar
Progress Bar
Critical Activity

AT0A

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FY09 CQ10 NGNP RevA Base 9-09-08

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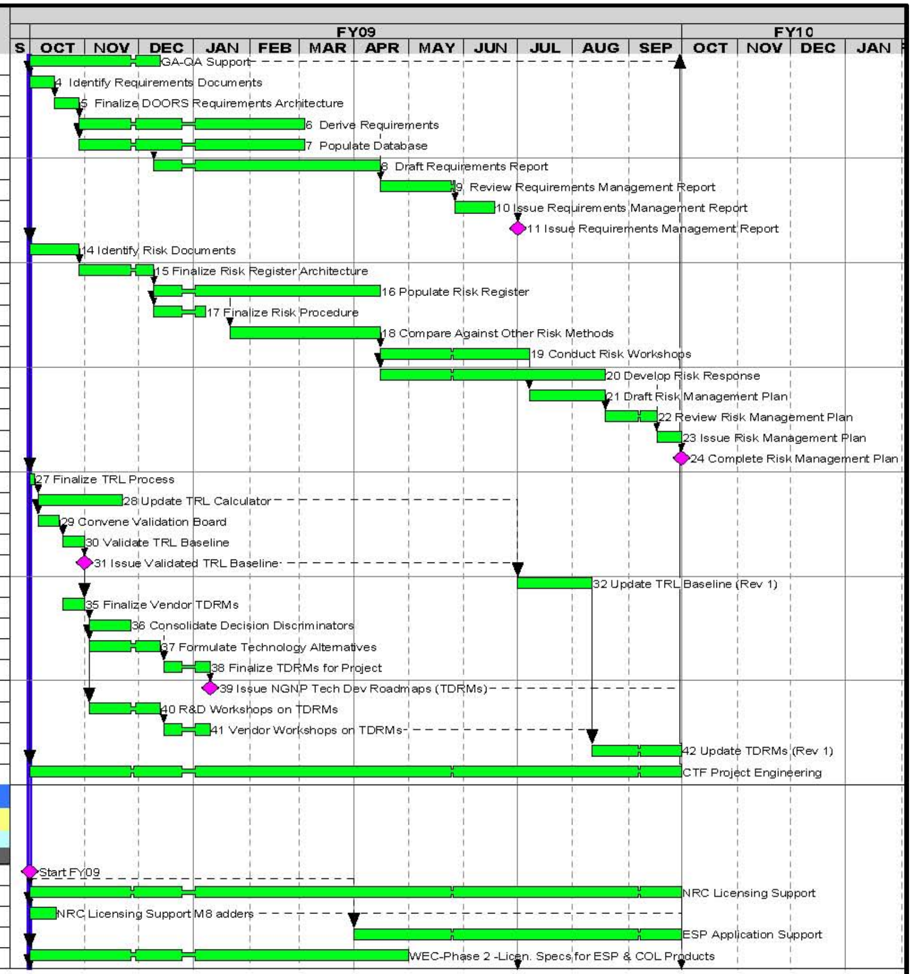
Activity ID	Activity Description	Early Start	Early Finish
B9223170	GA-QA Support	01OCT08	12DEC08
B92400	4 Identify Requirements Documents	01OCT08	14OCT08
B92410	5 Finalize DOORS Requirements Architecture	15OCT08	28OCT08
B92420	6 Derive Requirements	29OCT08	03MAR09
B92430	7 Populate Database	29OCT08	03MAR09
B92440	8 Draft Requirements Report	10DEC08	14APR09
B92450	9 Review Requirements Management Report	15APR09	26MAY09
B92460	10 Issue Requirements Management Report	27MAY09	17JUN09
B92470	11 Issue Requirements Management Report		30JUN09
B92500	14 Identify Risk Documents	01OCT08	28OCT08
B92510	15 Finalize Risk Register Architecture	29OCT08	09DEC08
B92520	16 Populate Risk Register	10DEC08	14APR09
B92530	17 Finalize Risk Procedure	10DEC08	06JAN09
B92540	18 Compare Against Other Risk Methods	21JAN09	14APR09
B92550	19 Conduct Risk Workshops	15APR09	07JUL09
B92560	20 Develop Risk Response	15APR09	18AUG09
B92570	21 Draft Risk Management Plan	08JUL09	18AUG09
B92580	22 Review Risk Management Plan	19AUG09	16SEP09
B92590	23 Issue Risk Management Plan	17SEP09	30SEP09
B92595	24 Complete Risk Management Plan		30SEP09
B92600	27 Finalize TRL Process	01OCT08	03OCT08
B92610	28 Update TRL Calculator	06OCT08	21NOV08
B92620	29 Convene Validation Board	06OCT08	17OCT08
B92630	30 Validate TRL Baseline	20OCT08	31OCT08
B92640	31 Issue Validated TRL Baseline		31OCT08
B92650	32 Update TRL Baseline (Rev 1)	01JUL09*	11AUG09
B92700	35 Finalize Vendor TDRMs	20OCT08	31OCT08
B92710	36 Consolidate Decision Discriminators	03NOV08	26NOV08
B92720	37 Formulate Technology Alternatives	03NOV08	12DEC08
B92730	38 Finalize TDRMs for Project	15DEC08	09JAN09
B92740	39 Issue NGNP Tech Dev Roadmaps (TDRMs)		09JAN09
B92750	40 R&D Workshops on TDRMs	03NOV08	12DEC08
B92760	41 Vendor Workshops on TDRMs	15DEC08	09JAN09
B92770	42 Update TDRMs (Rev 1)	12AUG09	30SEP09
B93000	CTF Project Engineering	01OCT08	30SEP09
C.Q.10.04 Regulatory			
C.Q.10.04.01 NRC Licensing			
C.Q.10.04.01.01 NRC Licensing			
C.Q.10.04.01.01.01 NRC Licensing			
D90BEG09	Start FY09	01OCT08	
D94000	NRC Licensing Support	01OCT08	30SEP09
D940005	NRC Licensing Support M8 adders	01OCT08	15OCT08
D94010	ESP Application Support	01APR09*	30SEP09
D9401160	WEC-Phase 2 -Licen. Specs for ESP & COL	01OCT08	30APR09



Start Date 01OCT08 Finish Date 23OCT09 Data Date 01OCT08 Run Date 15SEP08 09:14	Early Bar Progress Bar Critical Activity	AT0A INL FY09 CQ10 NGNP RevA Base 9-09-08	Sheet 3 of 4

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Appendix B

NGNP and VHTR TDO Work Breakdown Structures

Appendix B
NGNP and VHTR TDO Work Breakdown Structures

Table B-1. NGNP Work Breakdown Structure.

C							Idaho National Laboratory
C	Q						Projects
C	**Q**	**10**					**Next Generation Nuclear Plant**
C	**Q**	**10**	**01**				**NGNP Project Management**
C	Q	10	01	01			NGNP Project Management
C	Q	10	01	01	03		Project Management
C	Q	10	01	01	03	01	Project Management
C	Q	10	01	01	03	03	NGNP Public/Private Partnership
C	Q	10	01	01	04		Public Outreach
C	Q	10	01	01	04	01	Public Outreach
C	**Q**	**10**	**02**				**Engineering**
C	Q	10	02	00			Engineering
C	Q	10	02	00	01		Engineering
C	Q	10	02	00	01	01	Engineering Management
C	Q	10	02	00	01	02	NGNP Engineering Design Development
C	Q	10	02	00	01	03	Hydrogen Process/Heat Transport
C	Q	10	02	00	01	04	Component Test Facility (CTF)
C	**Q**	**10**	**04**				**Regulatory**
C	Q	10	04	01			NRC Licensing
C	Q	10	04	01	01		NRC Licensing
C	Q	10	04	01	01	01	NRC Licensing
C	Q	10	04	01	01	02	Site Selection

Table B-2. VHTR TDO Work Breakdown Structure.

C	**C**	**70**					**VHTR Technology Development Office**
C	C	70	01				VHTR Technology Development Office
C	**C**	**70**	**01**	**01**			**VHTR Technical Development Office**
C	C	70	01	01	01		Technology Development Office Program Management
C	C	70	01	01	01	01	Technology Development Office Project Management
C	**C**	**70**	**01**	**03**			**Fuels**
C	C	70	01	03	01		Fuel Development
C	C	70	01	03	01	01	Fuels Project Management
C	C	70	01	03	01	02	Fuel Fabrication
C	C	70	01	03	01	03	Fuel Safety Testing and PIE
C	C	70	01	03	01	04	Fuel Performance Modeling
C	C	70	01	03	01	05	Fuels Fission Product Transport and Source Term
C	**C**	**70**	**01**	**04**			**High Temperature Materials**
C	C	70	01	04	01		High Temperature Materials
C	C	70	01	04	01	02	High Temperature Materials – Scoping Studies
C	**C**	**70**	**01**	**05**			**Graphite**
C	C	70	01	05	01		Graphite
C	C	70	01	05	01	01	Graphite Project Management
C	C	70	01	05	01	05	AGC Experiment Design
C	C	70	01	05	01	08	Graphite Material Properties
C	**C**	**70**	**01**	**06**			**Design Methods and Validation**
C	C	70	01	06	01		Design Methods and Validation
C	C	70	01	06	01	03	Design Methods and Validation

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Appendix C

Sample Work Authorization Document

Appendix C
Sample Work Authorization Document

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07/10/2009
Rev. 0

INL Work Authorization Document
LWBS Level 4 (Program/Large Project)

Execution of this work is dependent on receipt of customer's formal funds and work authorization per LWP-3420/3310. Page 1

- (●) LWBS Level 4 (Program/Large Project)
- ( ) LWBS Level 5 (Subprogram/Project)
- ( ) LWBS Level 6 (Control Account)
- ( ) LWBS Level 7 (Work Package)

- (●) Preliminary Planning
- ( ) Baseline Plan

LWBS Level 3 Number				
LWBS Level 3 Title				
LWBS Level 4 Number				
LWBS Level 4 Title				
Period of Performance	Start Date:		Finish Date:	
LWBS Level 3 Manager	*(approve)*			*(signature/date)* *(typed name)*
LWBS Level 4 Manager	*(accept)*			*(signature/date)* *(typed name)*
Planning & Financial Control Specialist				*(typed name)*
DOE-ID Technical POC				*(typed name)*
DOE-ID Budget Rep				*(typed name)*
Oracle Funds Source Number(s)				

Preliminary Planning Targets ($)	
Target Budget	Comments

Appendix D

Sample FY 2008 NGNP Budget

Appendix D
Sample FY 2008 NGNP Budget

Program: CQ10-09
Run Date: 9/16/2008 6:37

Description: **FY09 NGNP 9-05-08**
Status Date: 9/30/2008

Approval: Program Manager
Functional Manager
Cost Account Manager

WBS[6]	WBS[7]		Oct-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Cumulative
	NGNP														
C.Q.10.01.01.03 Project Management															
	C.Q.10.01.01.03.01 Project Management	BCWS	226,445	191,357	306,388	244,374	271,268	272,571	352,746	311,914	363,820	374,919	303,043	418,735	3,637,580
	C.Q.10.01.01.03.03 NGNP Public/Private Partnership	BCWS	103,068	87,097	139,454	108,995	120,026	120,602	118,215	119,038	138,796	142,994	115,581	159,706	1,473,572
WBS[6] Totals:		BCWS	329,512	278,454	445,842	353,369	391,294	393,173	470,961	430,953	502,616	517,913	418,624	578,441	5,111,152
C.Q.10.02.00.01 Engineering															
	C.Q.10.02.00.01.01 Engineering Management	BCWS	290,145	233,626	374,066	223,725	240,822	249,596	237,188	238,840	278,481	286,905	231,902	320,435	3,205,731
	C.Q.10.02.00.01.02 NGNP Engineering Design Development	BCWS	1,208,318	1,007,285	1,022,898	595,290	448,828	391,864	360,671	381,772	429,935	528,037	466,590	598,422	7,439,911
WBS[6] Totals:		BCWS	1,498,463	1,240,910	1,396,964	819,015	689,650	641,460	597,859	620,612	708,417	814,942	698,492	918,858	10,645,642
C.Q.10.04.01.01 NRC Licensing															
	C.Q.10.04.01.01.01 NRC Licensing	BCWS	241,991	187,114	299,594	235,854	260,471	261,722	273,553	206,524	182,672	188,198	152,118	210,192	2,700,000
WBS[6] Totals:		BCWS	241,991	187,114	299,594	235,854	260,471	261,722	273,553	206,524	182,672	188,198	152,118	210,192	2,700,000
	WBS(4) Totals:	BCWS	2,069,967	1,706,477	2,142,400	1,408,237	1,341,415	1,296,355	1,342,373	1,258,088	1,393,704	1,521,053	1,269,234	1,707,490	18,456,793
	VHTR TDO														
C.C.70.01.01.01 TDO Program Management															
	C.C.70.01.01.01.01 TDO Project Management	BCWS	224,993	187,427	300,095	239,935	247,549	0	0	0	0	0	0	0	1,200,000
WBS[6] Totals:		BCWS	224,993	187,427	300,095	239,935	247,549	0	0	0	0	0	0	0	1,200,000
C.C.70.01.03.01 Fuel Development															
	C.C.70.01.03.01.01 Fuels Project Management	BCWS	127,993	106,229	170,087	136,428	151,311	152,038	149,028	150,066	174,973	180,266	145,707	201,333	1,845,159
	C.C.70.01.03.01.02 Fuel Fabrication	BCWS	579,098	476,994	736,759	549,781	840,537	865,188	780,526	457,462	454,496	344,928	278,802	350,958	6,715,530
	C.C.70.01.03.01.03 Fuel & Material Irradiation	BCWS	283,252	239,362	383,250	453,816	615,630	450,597	408,584	401,976	431,228	456,871	414,540	598,047	5,137,152
	C.C.70.01.03.01.04 Fuel Safety Testing and PIE	BCWS	524,533	453,637	790,079	521,954	433,126	465,840	461,279	418,908	436,280	564,983	480,785	824,524	6,375,927
	C.C.70.01.03.01.05 Fuel Performance Modeling	BCWS	62,048	65,329	114,925	92,236	73,578	62,254	60,286	60,355	70,373	72,502	58,602	80,975	873,463
	C.C.70.01.03.01.06 Fuels Fission Product Transport & Source Term	BCWS	38,120	33,810	48,935	32,100	69,349	72,220	79,389	78,667	116,047	56,528	39,424	39,179	703,768
	C.C.70.01.03.01.07 Dry Transfer Facility GPP	BCWS	151,031	119,389	191,158	150,953	166,913	167,714	52,841	0	0	0	0	0	1,000,000
WBS[6] Totals:		BCWS	1,766,075	1,494,750	2,435,193	1,936,970	2,350,444	2,235,851	1,991,933	1,567,435	1,683,397	1,676,077	1,417,860	2,095,015	22,651,000
C.C.70.01.04.01 High Temperature Materials															
	C.C.70.01.04.01.02 High Temperature Materials - Scoping Studies	BCWS	152,167	139,928	266,358	474,893	274,969	229,421	214,712	200,896	220,897	284,358	181,356	240,045	2,880,000
WBS[6] Totals:		BCWS	152,167	139,928	266,358	474,893	274,969	229,421	214,712	200,896	220,897	284,358	181,356	240,045	2,880,000
C.C.70.01.05.01 Graphite															
	C.C.70.01.05.01.01 Graphite Project Management	BCWS	22,840	19,301	30,903	24,807	27,605	27,738	27,189	27,378	31,922	32,888	26,583	36,731	335,885
	C.C.70.01.05.01.05 AGC Experiment Design	BCWS	303,884	328,874	584,276	355,767	380,213	243,266	170,780	139,692	183,877	114,696	67,394	93,123	2,965,842
	C.C.70.01.05.01.08 Graphite Material Properties	BCWS	214,579	178,755	535,371	273,754	358,929	382,872	377,081	519,389	296,216	263,004	212,583	293,740	3,906,273
WBS[6] Totals:		BCWS	541,303	526,930	1,150,550	654,328	766,748	653,875	575,050	686,459	512,015	410,588	306,560	423,595	7,208,000
C.C.70.01.06.01 Design Methods & Validation															
	C.C.70.01.06.01.03 Design Methods & Validation	BCWS	381,911	312,878	500,960	399,447	432,234	289,015	283,294	285,267	332,614	342,675	276,981	382,723	4,220,000
WBS[6] Totals:		BCWS	381,911	312,878	500,960	399,447	432,234	289,015	283,294	285,267	332,614	342,675	276,981	382,723	4,220,000
	WBS(4) Totals:	BCWS	3,066,449	2,661,913	4,653,156	3,705,574	4,071,944	3,408,162	3,064,988	2,740,057	2,748,924	2,713,699	2,182,757	3,141,378	38,159,000
	GRAND TOTALS:		5,136,416	4,368,390	6,795,556	5,113,811	5,413,359	4,704,517	4,407,361	3,998,145	4,142,628	4,234,752	3,451,991	4,848,868	56,615,793

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Appendix E

Sample Earned Value Report for August 2008

Cost Performance Report - August Final

WBS[6] WBS[7] CHRGNUM[4] Item	Current Period: Budgeted Cost: Work Scheduled	Current Period: Budgeted Cost: Work Performed	Current Period: Actual Cost Work Performed	Current Period: Variance: Schedule	Current Period: Variance: SV%	Current Period: Variance: Cost	Current Period: Variance: CV%	Cumulative to Date: Budgeted Cost: Work Scheduled	Cumulative to Date: Budgeted Cost: Work Performed	Cumulative to Date: Actual Cost Work Performed	Cumulative to Date: Variance: Schedule	Cumulative to Date: Variance: SV%	Cumulative to Date: Variance: Cost	Cumulative to Date: Variance: CV%	At Completion FY08-09: Budgeted	At Completion FY08-09: Latest Revised Estimate	At Completion FY08-09: Variance
(1)	(2)	(3)	(4)	(5)		(6)		(7)	(8)	(9)	(10)		(11)		(12)	(13)	(14)
C.Q.10.01.01.03 Project Management																	
C.Q.10.01.01.03.01 Project Management																	
WBS[7]Totals:	687,217	593,142	462,136	-94,075	-13.69%	131,006	22.09%	3,395,272	3,097,669	2,863,154	-297,603	-8.77%	234,515	7.57%	4,027,574	3,793,059	234,515
WBS[7]Project Management Totals:	687,217	593,142	462,136	-94,075	-13.69%	131,006	22.09%	3,395,272	3,097,669	2,863,154	-297,603	-8.77%	234,515	7.57%	4,027,574	3,793,059	234,515
C.Q.10.01.01.03.03 Commercial Alliance																	
WBS[7] Commercial Alliance Totals:	128,594	165,181	117,913	36,587	28.45%	47,268	28.62%	769,717	696,747	580,997	-72,970	-9.48%	115,750	16.61%	906,756	791,006	115,750
WBS[6]Project Management Totals:	815,811	758,323	580,049	-57,488	-7.05%	178,274	23.51%	4,164,989	3,794,416	3,444,151	-370,573	-8.90%	350,265	9.23%	4,934,330	4,584,065	350,265
C.C.70.01.01.01.01 VHTR TDO Project Management																	
C.Q.10.05.04.01.01 R&D Project Management																	
WBS[7]R&D Project Management Totals:	0	0	0	0		0		335,529	335,529	315,372	0	0.00%	20,157	6.01%	335,529	315,372	20,157
C.C.70.01.01.01.01 VHTR TDO Project Management																	
WBS[7]VHTR TDO Totals:	224,120	224,538	347,626	418	0.19%	-123,088	-54.82%	1,427,022	1,426,464	1,599,615	-557	-0.04%	-173,151	-12.14%	1,665,861	1,839,013	-173,151
WBS[6]VHTR TDO Proj Management Totals:	224,120	224,538	347,626	418	0.19%	-123,088	-54.82%	1,762,551	1,761,993	1,914,987	-557	-0.03%	-152,994	-8.68%	2,001,391	2,154,384	-152,994
WBS[5] Project Management Totals:	**1,039,931**	**982,861**	**927,675**	**-57,070**	**-5.49%**	**55,186**	**5.61%**	**5,927,540**	**5,556,409**	**5,359,138**	**-371,131**	**-6.26%**	**197,271**	**3.55%**	**6,935,721**	**6,738,450**	**197,271**
C.Q.10.02.00.01 Engineering																	
C.Q.10.02.00.01.01 Engineering Management																	
WBS[7] Engineering Management Totals:	596,259	594,131	589,053	-2,128	-0.36%	5,077	0.85%	4,921,606	4,920,994	4,689,575	-612	-0.01%	231,419	4.70%	5,557,025	5,325,607	231,419
C.Q.10.02.00.01.02 Engineering Design Development																	
WBS[7] Engr Design Development Totals:	1,945,019	2,696,703	2,837,879	751,684	38.65%	-141,176	-5.24%	12,263,076	11,052,244	11,250,874	-1,210,832	-9.87%	-198,630	-1.80%	16,998,740	17,197,370	-198,630
C.Q.10.02.00.01.03 Hydrogen Process/Heat Transport																	
WBS[7] HydrogenProcess/Heat Transport:	471,911	408,825	344,050	-63,087	-13.37%	64,775	15.84%	2,608,738	2,577,227	2,698,104	-31,511	-1.21%	-120,877	-4.69%	3,188,568	3,309,445	-120,877
C.Q.10.02.00.01.ZZ Engineering Suspense																	
C.Q.10.02.00.01.ZZ Engineering Suspense	0	0	0	0		0		0	0	-30,403	0		30,403		0	-30,403	30,403
WBS[6] Engineering Totals:	**3,013,189**	**3,699,659**	**3,770,982**	**686,469**	**22.78%**	**-71,324**	**-1.93%**	**19,793,420**	**18,550,465**	**18,608,150**	**-1,242,955**	**-6.28%**	**-57,685**	**-0.31%**	**25,744,333**	**25,802,018**	**-57,685**
C.Q.10.04.01.01 NRC Licensing																	
C.Q.10.04.01.01.01 NRC Licensing																	
WBS[7] Licensing Totals:	269,726	254,886	222,817	-14,840	-5.50%	32,069	12.58%	750,426	736,702	714,272	-13,724	-1.83%	22,430	3.04%	1,937,867	1,915,437	22,430
C.Q.10.04.01.01.02 Site Selection																	
WBS[7]Site Characterization Totals:	158,212	98,365	80,134	-59,847	-37.83%	18,231	18.53%	776,470	631,983	628,907	-144,487	-18.61%	3,076	0.49%	885,479	873,321	12,158
WBS[6] Licensing Totals:	**427,938**	**353,251**	**302,952**	**-74,687**	**-17.45%**	**50,299**	**14.24%**	**1,526,896**	**1,368,685**	**1,343,179**	**-158,211**	**-10.36%**	**25,506**	**1.86%**	**2,823,346**	**2,788,757**	**34,589**
C.C.70.01.03.01 AGR Fuel Development																	
C.C.70.01.03.01.01 Fuels Project Management																	
WBS[7] Fuels Project Management Totals:	242,693	244,220	174,742	1,527	0.63%	69,479	28.45%	1,334,634	1,335,274	1,138,570	640	0.05%	196,703	14.73%	1,588,961	1,392,258	196,703
C.C.70.01.03.01.02 Fuel Fabrication																	
WBS[7] Fuel Development & Fab Totals:	50,393	582,405	840,371	532,012	1055.72%	-257,966	-44.29%	6,006,826	5,751,729	5,804,422	-255,097	-4.25%	-52,693	-0.92%	7,004,000	7,056,693	-52,693
C.C.70.01.03.01.03 Fuel & Material Irradiation																	
WBS[7] Fuel Material & Irradiation Totals:	248,705	461,609	177,348	212,904	85.60%	284,261	61.58%	2,932,479	2,858,532	2,068,674	-73,947	-2.52%	789,858	27.63%	3,502,031	2,712,173	789,858
C.C.70.01.03.01.04 Fuel Safety Testing and PIE																	
WBS[7] Safety Testing & PIE Totals:	-414,838	345,881	649,283	760,719	-183.38%	-303,402	-87.72%	3,304,091	3,736,277	3,886,876	432,186	13.08%	-150,598	-4.03%	4,337,433	4,462,986	-125,552
C.C.70.01.03.01.05 Fuel Performance Modeling																	
WBS[7]Fuel Performance Modeling Totals:	15,792	187,084	113,124	171,292	1084.65%	73,960	39.53%	609,645	610,183	575,711	538	0.09%	34,472	5.65%	725,000	690,528	34,472
C.C.70.01.03.01.06 Fuels Fission Product Transport & Source Term																0	0
WBS[7]Fission Product Transprot Totals:	30,587	18,024	65,078	-12,564	-41.08%	-47,055	-261.07%	334,173	178,924	285,176	-155,249	-46.46%	-106,252	-59.38%	353,001	459,252	-106,252
C.C.70.01.03.01.07 Dry Transfer Facility GPP																	
WBS[7]Dry Transfer Facility	198,422	14,587	27,630	-183,835	-92.65%	-13,043	-89.41%	511,554	104,764	68,112	-406,790	-79.52%	36,652	34.99%	723,008	686,356	36,652
C.Q.10.05.01.01.ZZ																	
WBS[7]Project Suspense	0	0	0	0		0		0	0	2,157	0		-2,157		0	2,157	-2,157
WBS[6] Fuels Totals:	**371,756**	**1,853,809**	**2,047,575**	**1,482,053**	**398.66%**	**-193,765**	**-10.45%**	**15,033,403**	**14,575,683**	**13,829,698**	**-457,720**	**-3.04%**	**745,985**	**5.12%**	**18,233,435**	**17,462,404**	**771,031**
C.C.70.01.04.02 High Temp Materials																	
C.C.70.01.04.01.02 High Temperature Materials - Scoping Studies																	
WBS[6]High Temp Materials Totals:	173,765	356,914	301,513	183,149	105.40%	55,400	15.52%	2,517,860	2,475,787	2,320,227	-42,074	-1.67%	155,560	6.28%	2,830,007	2,674,447	155,560
C.C.70.01.05.01 Graphite																	
C.C.70.01.05.01.01 Graphite Project Management																	
WBS[7]Graphite Project Management Totals:	64,512	64,157	72,463	-355	-0.55%	-8,306	-12.95%	490,251	490,091	339,634	-160	-0.03%	150,457	30.70%	559,000	408,543	150,457
C.C.70.01.05.01.05 AGC Experiment Design																	
WBS[7] Experiment Design Totals:	205,289	246,415	497,299	41,126	20.03%	-250,885	-101.81%	2,626,314	2,489,818	2,163,159	-136,496	-5.20%	326,659	13.12%	3,166,998	2,840,339	326,659
C.C.70.01.05.01.08 Graphite Material Properties																	
WBS[7] Graphite Material Properties Totals:	612,742	250,595	660,721	-362,147	-59.10%	-410,127	-163.66%	3,320,750	3,318,125	3,572,816	-2,624	-0.08%	-254,690	-7.68%	3,534,998	3,789,689	-254,690
C.Q.10.05.02.01.ZZ Materials Suspense																	
WBS[7]Totals:	0	0	0			0		0	0	-6,445	0		6,445		0	-6,445	6,445
WBS[6]Graphite Totals:	818,031	497,010	1,158,021	-321,021	-39.24%	-661,011	-133.00%	5,947,064	5,807,943	5,729,529	-139,121	-2.34%	78,414	1.35%	6,701,997	6,623,583	78,414
WBS[5] Materials Totals:	**991,795**	**853,923**	**1,459,534**	**-137,872**	**-13.90%**	**-605,611**	**-70.92%**	**8,464,924**	**8,283,730**	**8,049,756**	**-181,194**	**-2.14%**	**233,974**	**2.82%**	**9,532,003**	**9,298,030**	**233,974**
C.C.70.01.06.03 Methods																	
C.C.70.01.06.01.03 Design Methods & Validation																	
WBS[7]Methods Thermal Fluids Totals:	490,010	455,004	688,562	-35,005	-7.14%	-233,558	-51.33%	4,036,866	3,753,670	3,780,562	-283,196	-7.02%	-26,892	-0.72%	4,818,959	4,845,852	-26,892
C.Q.10.05.03.01.ZZ Methods Suspense																	
WBS[7]Totals:	0	0	0	0		0		0	0	7,560	0		-7,560		0	7,560	-7,560
WBS[6] Methods Totals:	**490,010**	**455,004**	**688,562**	**-35,005**	**-7.14%**	**-233,558**	**-51.33%**	**4,036,866**	**3,753,670**	**3,788,122**	**-283,196**	**-7.02%**	**-34,452**	**-0.92%**	**4,818,959**	**4,853,411**	**-34,452**
WBS[4] Research & Development Totals:	**1,853,561**	**3,162,737**	**4,195,671**	**1,309,176**	**70.63%**	**-1,032,935**	**-32.66%**	**27,535,193**	**26,613,083**	**25,667,576**	**-922,110**	**-3.35%**	**945,507**	**3.55%**	**34,585,788**	**31,613,845**	**2,971,944**
NGNP Totals:	**6,334,619**	**8,198,507**	**9,197,280**	**1,863,888**	**29.42%**	**-998,773**	**-12.18%**	**54,783,050**	**52,088,642**	**50,978,043**	**-2,694,407**	**-4.92%**	**1,110,600**	**2.13%**	**68,087,798**	**66,943,070**	**1,144,728**

Appendix F

NGNP High Level Schedule and Costs Estimates

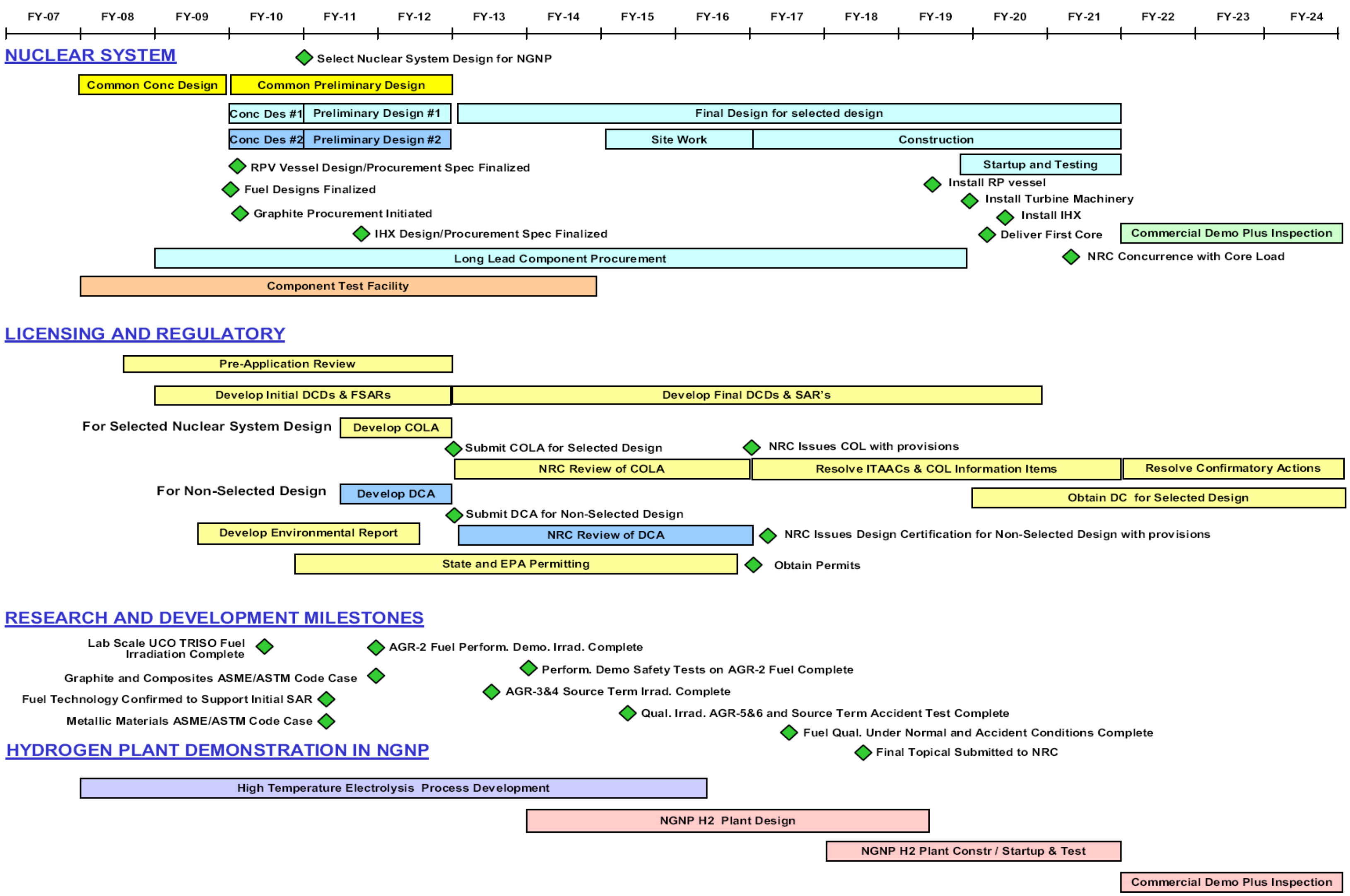

Figure F-1. Summary level NGNP schedule (two nuclear system designs for certification; one design selected for NGNP).