

**Work Plan**  
**Pre-Conceptual Engineering**  
**Services for the NGNP with**  
**Hydrogen Production**

BEA Contract No. 000 60209  
December 13, 2006

WORK PLAN APPROVAL



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## **1.0     *Work Plan***

# **Pre-conceptual Engineering Services for the NGNP with Hydrogen Production**

## **1.1 Introduction**

The AREVA work plan is formulated to provide engineering services for the pre-conceptual design activities for NGNP with high efficiency electricity production and process heat applications including a hydrogen production facility. This work begins with definition of mission level requirements and a series of special design studies to establish sound technical bases and high-level plant requirements. The work then shifts into engineering and design activities for the NGNP pre-conceptual design and preliminary planning for permitting and licensing. The conduct of these activities includes careful technology road-mapping to assure that R&D needs are identified, evaluated, and sequenced. This work will be documented in a pre-conceptual design studies report.

AREVA has the overall project responsibility. Other key technical competencies needed for full execution of this and follow-on phases of the NGNP including final design, construction and operations work have been assembled within the AREVA NGNP Team that include Burns & Roe, Washington Group International, BWXT, Dominion Engineering, Air Products, PW Rocketdyne and Mitsubishi Heavy Industries (MHI).

The AREVA NGNP design work plan as detailed in this document embraces the fundamental elements of system engineering and recognizes that the development and realization of NGNP with hydrogen production will require a series of R&D that will be identified. A priority list of NGNP R&D needs will be defined that will focus for near term design objectives. In addition, a secondary list of R&D needs will be developed that will focus on longer term design enhancements and extensions.

AREVA NGNP Team members were selected to bring key technical competencies for the successful execution and completion of the pre-conceptual and follow-on phases of this project. AREVA NGNP team members bring relevant experience and/or on-going R&D work needed to perform the pre-conceptual design being proposed. This work plan capitalizes on the team members existing and ongoing R&D work to produce a high value pre-conceptual design for the NGNP prototype facility. This will be executed within the constraints of strict and aggressive project schedule and project management principles.

## **1.2 Key Activities and Work Breakdown Structure**

The proposed work plan consists of four key activities:

- Finalization of the draft work plan;
- Execution of four (4) special studies;
- Performance of the pre-conceptual engineering and design; and
- Preparation of the pre-conceptual design studies report

The work plan also includes the overall project management, administration, reporting, and schedule. (Copies of our WBS and Primavera (P3) schedule are located

in Appendix B and C. For convenience, a copy of our summary-level schedule is provided in Figure 1 below.)

Upon contract award, the work begins with finalizing this draft work plan followed by performing the proposed special design and trade studies to define and establish sound technical bases and high-level plant requirements. The special studies will be conducted in parallel; however, because certain design parameters and options are highly interrelated, close integration and communication are planned. A list of proposed design studies and the schedule of their performance and completion is provided in Table 1. Although AREVA has the overall design responsibility, the team member that is most competent in the subject will lead each study. It is recognized that the overall integration among the studies is vital to the success of the project. The design integration team in concert with AREVA NGNP technical and project management team will perform this function.

The work then shifts into pre-conceptual design, engineering and licensing activities for the NGNP with hydrogen production and electricity generation prototype plant. A limited scope hydrogen production study will be performed based on direction from INL. A hydrogen plant pre-conceptual study will not be performed. The overall effort will be conducted at the pre-conceptual design level and will include systems design and integration, nuclear island facilities including nuclear fuel production and supply, electricity generation and associated support systems. The output of the pre-conceptual design and engineering activities include: systems requirements manual, prototype plant layout (except for hydrogen production, heat transfer loop, balance of plant and site) and risk identification and assessment, and an economics and cost

analysis of the systems studied. This work will be documented in a pre-conceptual design studies report.

**Table 1 – Special Studies**

<b>Special Studies</b>	<b>Completion Date</b>
1. Reactor Type Comparison	Feb – 2007
2. Prototype Power Level	Jan -2007
3. Power Conversion System Trade Study	Feb– 2007
4. Primary and Secondary Cycle Concept	Jan - 2007

### 1.3 Project Schedule

The AREVA NP team NNGNP project schedule is based on the WBS as described in this draft work plan. Following the approval of the draft work plan this schedule will be base-lined and the work will tracked accordingly. Each major WBS item is linked to a PCDSR section. The work assignments for each WBS item are made to an appropriate team member company. The schedule is then resource loaded from the lead company or other team members as required and the scheduled progress and deliverables completions are monitored. Schedule updates are made periodically and each deliverable progress is tracked in accordance with the activity worksheet. Earned values (EV) are then calculated and reported.

The four key schedule milestones are listed below. These key milestones may not be changed without prior client approval.

#### Key Milestones

1. Kickoff Meeting 5 December 2006
2. 50% Design Review 21&22 February 2007

3. 90% Design Review 13 & 14 June 2007

4. Completion of the Final Deliverable 26 June 2007

AREVA NP will manage the remaining schedule items to be completed within the framework of the key milestones. Schedule adjustments to any milestones – other than the four key milestones - can be made up to 30 days (plus or minus) without client approval.

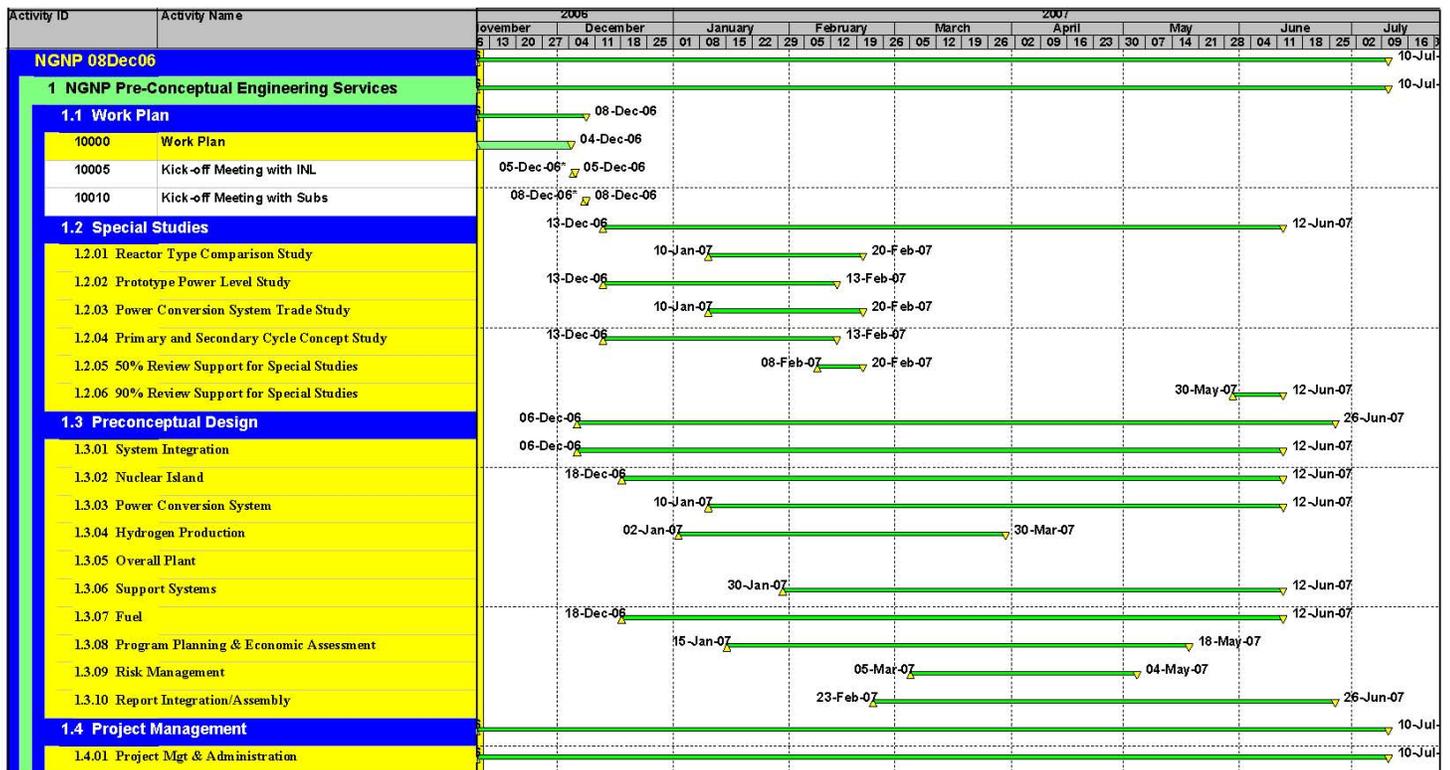


Figure 1 Summary-level P3 Schedule

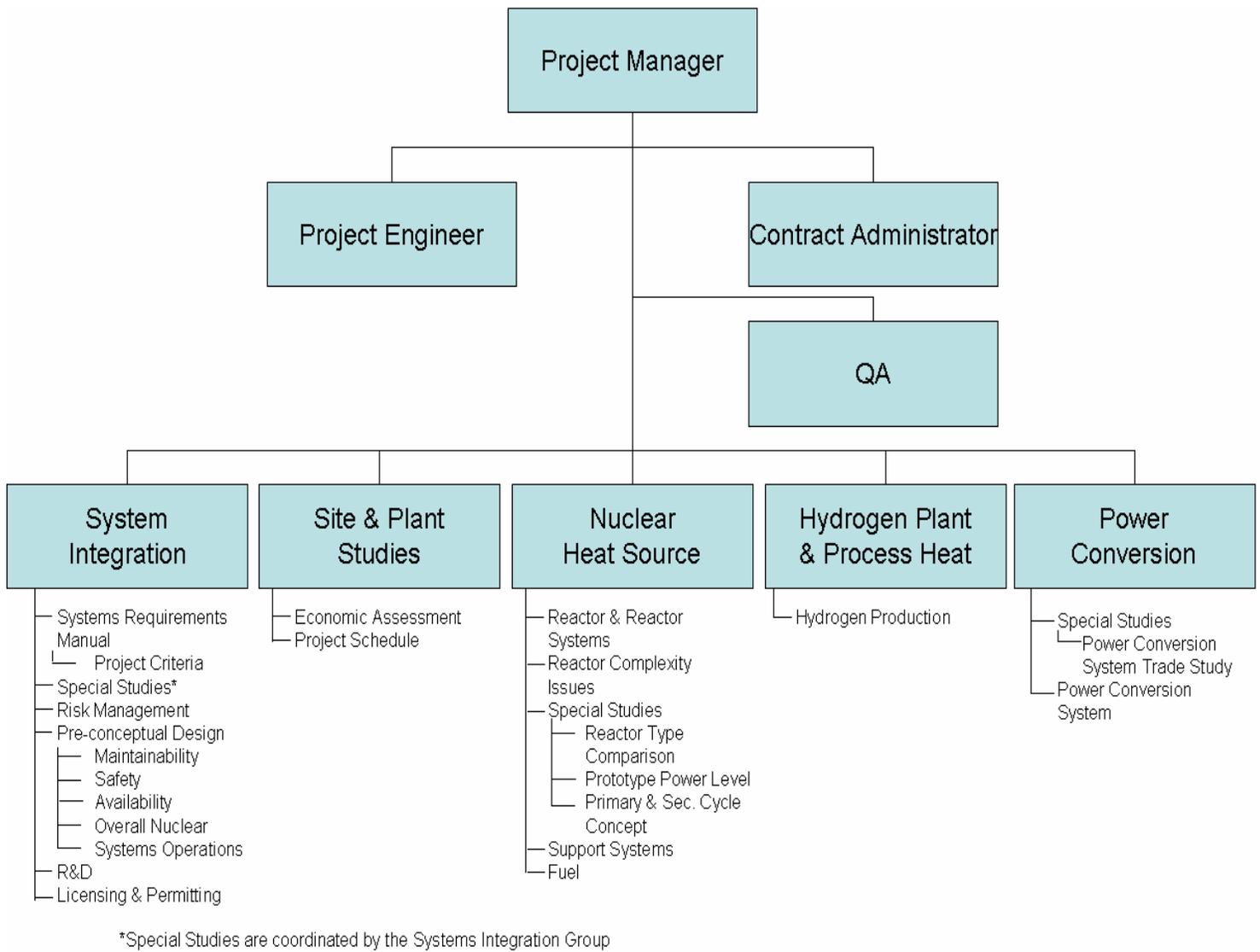
#### 1.4 AREVA NGNP Team Organization

AREVA, as the lead BEA NGNP contractor for this work scope, has the overall project responsibility. In support of the NGNP pre-conceptual design work, AREVA has assembled a team of sub-contractor companies with the key technical competencies needed for full execution of this and follow-on phases of the NGNP project including final design, construction, and operations. The AREVA NGNP Team includes Burns & Roe, Washington Group International, BWXT, Dominion Engineering, Air Products, PW Rocketdyne, and Mitsubishi Heavy Industries (MHI). The Responsibility Assignment Matrix for this project is shown below:

**Table 2 Responsibility Assignment Matrix**

<b>Responsibility</b>	<b>Lead Organization</b>	<b>Support Organizations</b>
Work Plan	Finis Southworth, AREVA NP	
Special Studies	Lewis Lommers, AREVA NP	Gregory Johnson, PW Rocketdyne Tomomi Otani, MHI
System Integration	Farshid Shahrokhi, AREVA NP	
Nuclear Island	Bernard Riou, AREVA NP	
Power Conversion System	Gregory Johnson, PW Rocketdyne Tomomi Otani, MHI	Robert Varrin, Dominion Engineering
Hydrogen Production	Shankar Nataraj, Air Products	William Summers, WGI, Tomomi Otani, MHI
Support Systems	Bernard Riou, AREVA NP	Robert Lenyk, Burns & Roe

Fuel	Jeff Halfinger, BWXT	Lewis Lommers, AREVA NP
Program Planning and Schedule	Robert Lenyk, Burns & Roe	Lewis Lommers, AREVA NP
Risk Management	Farshid Shahrokhi, AREVA NP	
Report Integration and Assembly	Lewis Lommers, AREVA NP	
Project Management	Finis Southworth, AREVA NP	



**Figure 2 AREVA NGNP Functional Organization Chart**

#### **1.4.1 Subcontractor Team Structure**

AREVA as the prime BEA contractor is supported by team members from a variety of industries with the necessary collective expertise to fully support the NGNP project. AREVA is the prime contractor for the AREVA NGNP team, and the other team members are subcontractors to AREVA.

Within AREVA, AREVA NP Inc. is supported by AREVA's global engineering and development organization. Support from technical experts in both France (AREVA NP SAS) and Germany (AREVA NP GmbH.) is anticipated. This support will also be provided via subcontract from AREVA NP Inc.

#### **1.4.2 Organizational Responsibilities**

As the prime BEA contractor AREVA has overall responsibility for execution of project. This includes management oversight, cost, schedule, etc., and technical oversight and coordination. Both the Project Manager and the Project Engineer are taken from AREVA.

With responsibility for the nuclear heat source and related work scope, AREVA will also perform a large fraction of the technical work in the project. AREVA will be assisted in its technical workscope by AREVA NP SAS and AREVA NP GmbH. These components of AREVA have key expertise and resources that will be of clear value to the project.

Other AREVA NGNP team members have responsibility for specific work scope within their areas of expertise. The table below lists the main responsibilities for each organization within the AREVA NGNP team.

**Table 3 AREVA NP Team Member Responsibilities**

<b>Company</b>	<b>Relevant Expertise</b>
Air Products	Hydrogen Plant
Burns & Roe	Economic Studies and Support Systems
BWXT	Reactor Fuel (TRISO), Heavy Components
Dominion Engineering	Heat Transfer
Pratt & Whitney Rocketdyne	Power Conversion, Reactor Technology
WGI	Hydrogen Plant
MHI	Power Conversion, Hydrogen Plant
AREVA	Nuclear Island Reactor Technology, IHX, Main Circulator

**1.4.3 Key Individual Responsibilities**

Project Manager (AREVA NP Inc.) – Finis Southworth – Oversight of Project Management (Cost, Schedule, etc.), Programmatic Customer Interface

Project Engineer – (AREVA NP Inc.) – Lewis Lommers - Technical coordination and direction of project.

**1.4.4 Other Lead Individuals**

Project QA – (AREVA NP Inc.) – Jerome Ebner - Facilitate compliance with program Quality Assurance requirements, including interfacing with team member QA programs.

Technical Staff Leads – Oversee specific technical work scope within designated technical areas in compliance with budget and schedule requirements.

- System Integration – Farshid Shahrokhi, AREVA NP

- Nuclear Heat Source – Bernard Riou, AREVA NP
- Power Conversion – Gregory Johnson, PW Rocketdyne
- Hydrogen Plant and Process Heat Applications – William Summers, WGI

## **1.5 Work Approach**

The approach to perform the pre-conceptual design of the NGNP with hydrogen generation as the lead prototype plant for next generation of nuclear power plants is to systematically perform key design studies for selection of the lead design, top level plant requirements, and to identify the necessary focused R&D to for design, build, license, and operate the prototype plant.

The design of the NGNP as the energy source for electricity production and the potential driver for a demonstration hydrogen production facility requires assembly and integration of a variety of disciplines and development of system requirements through conduct of special trade studies and top level plant requirements management. It is envisioned that these requirements will be captured before the pre-conceptual design work is commenced in a system requirements manual (SRM). The SRM will then drive the lower level system requirements in the pre-conceptual design activities. Furthermore, based on experience in current design work done by AREVA and others for this reactor and hydrogen generation technology, certain materials and equipment must be developed and designed; this effort needs specific research and development requirements. The pre-conceptual design draft work plan is designed to identify the required special R&D and it is tailored to focus on the type of R&D results needed.

AREVA work approach as discussed here brings together the overall competencies necessary to design the plant and its components, construct and obtain an operating license, and operate and maintain the plant. Lessons learned, equipment designed and construction techniques used in the course of this project will be used in the commercialization of this class of reactors and demonstration of the ability to produce hydrogen fuel on a commercial scale with a sustainable nuclear power cycle to drive the future economy of the United States. It is the goal of each member of the AREVA NGNP Team that, upon completion of the NGNP design, construction and operation of the plant, there would be adequate technology development underway that can support commercialization of such reactor type. The reactor could be used to generate electricity, or to provide process heat to a hydrogen plant or other industrial application of process heat.

Commercialization of any new technology must be driven by economics of the processes. The NGNP pre-conceptual design economics and market evaluation will provide valuable insights into the design such that the end product, i.e. hydrogen, process heat and electricity is produced with economic and market viability.

### ***1.5.1 Systems Engineering Philosophy***

AREVA plans to use system engineering top-down requirements driven approach for the NGNP design activities. The system engineering philosophy has proven to be the key element of success in a complex design project with multiple participants and competing requirements. The process provides a structured framework for orderly requirements development and assessment based on functional analysis performed.

The use of system engineering approach from the inception of this design and R&D identification project provides the important logic and documentation for design decisions made and therefore, establishes the required design bases of systems, structures and components, which must be maintained throughout the entire life cycle of the nuclear power plant.

In the conceptual design phase of this project a more structured and rigorous approach to system engineering would be necessary. This will be a top-down approach to system design development and AREVA will use a standard computer software tool such as CORE from Vitech Corporation. System engineering processes and procedures will be uniquely configured and implemented at the start of conceptual design. During pre-conceptual design, because of short time constraint and limited budget, it is not practical to use such a rigorous tool, i.e. CORE or equivalent software. Instead the work plan will identify and track the development of key top-level requirements in the system requirements manual (SRM) based on the experience, insights, and knowledge possessed by the team members.

- The key top-level requirements will be defined and listed in the system requirements manual within categories including commercial, customer needs, design constraints, safety constraints, and existing and evolving regulatory/licensing requirements. At the pre-conceptual design level this limited set of key requirements can be adequately managed without specialized computer software but the subsequent design phases require increasingly more sophisticated approach.
- Work Execution

The pre-conceptual design studies conducted at the beginning of this project will define the NGNP with hydrogen production facility design in sufficient detail such that the project risks and R&D needs are identified for follow-on design and R&D planning. All future R&D will be defined in a manner that will progressively minimize the risks to project completion.

AREVA NGNP design team was established to bring in all core competencies necessary for NGNP design development from nuclear reactor and fuel design competencies to hydrogen production knowledge and expertise. Each major work plan activity is led by a team member organization with highest level of competency in that area with support and interface from all other team members as necessary. System engineering principles will be utilized from the beginning of the project and progressively will become sophisticated as the project progresses to support development of the design and coordination between various plant systems and components.

A design integration team will coordinate the special studies at the project inception. These special studies will help support and define top-level plant requirements and design decisions based on sound technical, commercial, regulatory and economic bases. It is natural that certain compromises and trade-offs must take place in meeting various top level requirements; however, it is paramount to document reasons and bases for those decisions such that transparency and decision trail is well documented and traceable. Design integration team is responsible for this task.

Once the special studies are completed, key top-level requirements, and a reactor design concept is selected, the pre-conceptual design activities will begin.

During the course of pre-conceptual design work a structured system captures and documents the required R&D as defined in the subsequent section.

Regularly scheduled calls and meetings will be held with INL to discuss the progress of the work Appendix D of this Work Plan contains the Schedule for Status and Progress meetings. Appendix E of this Work Plan contains the Assumptions that govern this work scope.

### ***1.5.2 Change Control***

AREVA NP has the responsibility to manage the project within the overall dollar limit. The budget can be transferred between individual activity data sheets up to \$50,000 without client approval. The client will be notified when such transfers take place. These transfers will not create a project overrun. Any scope expansion beyond the original contract will have prior authorization by the client before work is started.

### ***1.5.3 Technology Development Philosophy***

During this prototype design project certain R&D activities are required. During the course of this project three types of R&D needs will be identified and coordinated with the overall project completion schedule. The R&D needs will be categorized as a) developmental R&D, b) conformation or characterization R&D, and c) qualification R&D.

The design process utilizing system-engineering tools complemented with a mechanism for capturing, categorizing, and prioritizing R&D needs. The prioritization process coordinates the R&D needs with the project phases. In addition, alternative success paths will be developed in case of high-risk R&D activities.

The timing for the R&D results is an important factor for the overall success of the project. Therefore, each R&D need will be coordinated with the overall completion schedule. Multiple levels of R&D needs and design options will be identified to minimize project risk and plant cost.

#### ***1.5.4 Use of Existing Internal Information***

AREVA and the team members of the AREVA NGNP design team possess key knowledge and competency required for successful execution of the project. Each member has significant amount of prior technical information or on-going R&D in various areas directly related to reactor and fuel design, hydrogen production, power generation, and related systems and components.

Each team member's prior technical knowledge (legacy information) can and will be used as appropriate in the preparation of the required design studies and pre-conceptual design work. A list of unique products and technologies developed by the AREVA NGNP team members that are directly usable for NGNP application includes:

- Advanced Modular High Temperature Gas-cooled Reactor design work
- Design and evaluation of a variety of compact intermediate heat exchangers (IHX) concepts
- Fuel design and production (TRISO)
- Materials testing and qualification (9 Cr steel)
- HTR specific Neutronics and Thermo Hydraulic design code development and code qualification
- Heavy component design and manufacturing capability and capacity

- Thermo-Chemical hydrogen process development
- Large helium isolation valves
- Power conversion systems (PCS)

Existing documentation and historical data owned by each team member will not be directly transferred to the NGNP pre-conceptual design project. All pre-conceptual special studies and design work will be developed specifically for NGNP project. However, portions of the existing work that is judged technically applicable to the NGNP pre-conceptual design may be recast for NGNP use.

It is the intention of each AREVA NGNP team member to retain the intellectual property (IP) rights of prior inventions or developmental work. Transfer of existing IPs to the BEA NGNP project, if required, will be identified and addressed on a case-by-case basis outside of the pre-conceptual design project. No intellectual property rights are expected to be transferred during the pre-conceptual phase of the NGNP project.

#### ***1.5.5 QA and Configuration Management***

The pre-conceptual design quality assurance approach is tailored to the needs and anticipated schedule and budget constraints of this phase of the project. A project QA manual will be developed to specify the QA requirements for the AREVA NGNP project.

As the Prime Contractor for the NGNP Project, AREVA will require all subcontractor companies to perform their work in accordance with the AREVA Quality Assurance (QA) Program. AREVA procurement documents issued to those

subcontractors will flow down the technical, quality, and special requirements of this project.

A Project Plan and a Project QA Plan (PQAP) will be used to manage and control the technical, quality, and special requirements of this project. The Project Plan will describe contract objectives, including technical and schedule requirements. The PQAP will specify the methods, controls, and procedures that are to be used to complete the scope of work by describing workscope details; deliverables; technical, quality, and special requirements; procedures to be used; software to be used; and external and internal interfaces.

AREVA design control process procedures, prescribed by the PQAP, will govern the preparation, review, approval, and issuance of all project pre-conceptual designs, reports, and other deliverables.

Internal products are issued by each team member from their own configuration management system that will be in conformance with the project QA. Documents from other team members are imported into individual team member's configuration management system when necessary as external documents.

Formal project deliverables are issued from the guidance of the formal AREVA configuration management system.

#### **1.5.6 Project Staffing and Resources**

The capability to provide the required project staffing and acquire the necessary resources for development and completion of initial design studies and preparation of

pre-conceptual design report was a key factor in the formation of the AREVA NGNP Team. AREVA has confirmed that each team member has the necessary experience and organizational depth to execute their assigned scope.

As outlined above regarding discussion of organizational responsibilities, each member of the AREVA NGNP team will be directly responsible for identification of specific experience and capability needed to accomplish the work scope assignment.

Resource assignments will be based on required skills. Staff will not be relocated to a central facility due to the short project time frame and the need for maximum work production within the limited budget.

AREVA is experienced in managing projects with a dispersed workforce located in multiple locations. The most pertinent example is AREVA's commercial HTR design project, which is managed in this way. Efficient regular communication is facilitated by telephone, email, and telephone/video conferencing, reinforced by periodic face-to-face meetings.

For AREVA's portion of the workscope, key staff will be made available from AREVA's commercial HTR program. This includes staff from each of AREVA's primary operating regions (US, France, Germany). To facilitate effective communication with INL and BEA and to maximize work efficiency, the majority of the work will be performed in the US region.

Considering the limited schedule and budget of this pre-conceptual design study period, it is important to maximize the efficiency and minimize the impact of different time zones and long distance travel. However, in those areas where expertise from other regions is required it will be actively engaged. A proposed schedule for any

necessary international travel will be provided at the Project Kickoff meeting. Similarly, existing staff at the worksites of other members of the AREVA NGNP team will support the project from their home offices.

In summary, AREVA has a strong base of experience managing projects with a widely dispersed workforce with the focus on supplying the best available expertise for each task in an efficient and cost effective manner.

### **1.5.7 Milestones**

### **1.5.8 Project Deliverables**

Project deliverables will consist of the following items as required by the Statement of Work:

Design progress communication and correspondence.

Draft Pre-conceptual Design Studies Report

Twenty (20 hardcopies)

Final Pre-conceptual Design Studies Report.

Forty (40) hard copies

Ten (10) compact discs (CDs) Electronic format on CDs will be Adobe Acrobat pdf files, including drawings.

One (1) copy on CD in MS Word format, with drawings in AutoCAD format.

### **1.5.9 Key Internal Project Milestones**

Major project milestones are identified in the summary activity worksheets. Detailed activity worksheets correspond to WBS items and the schedule and resources allowed. The pre-conceptual design studies report sections are linked to individual

worksheet deliverable as a WBS item. Project tracking through the WBS and project schedule progress is used for earned value calculations.

Only high level milestones will be shown

Draft and final System Requirements Manual

Final report from each special study

50% review presentation package

PCDSR input for each applicable WBS element from activity lead

90% review presentation package

#### **1.5.10 Project Reporting and Customer Interface**

All communication with INL will be documented with copies sent to both the INL Project Engineer and the AREVA NP Project Manager. The following reports, customer interfaces/meetings/interactions and other items as listed will be provided during the period of work execution as required by the Statement of Work:

Final Work Plan: Provide final work plan within 10 working days after Kickoff meeting based on receipt of BEA comments on draft work plan within 5 working days after Kickoff Meeting.

Kickoff Meeting: Attend kickoff meeting on December 5, 2006

Status Review: In accordance with the schedule submitted with the proposal, attend quarterly status meetings with BEA, monthly status meeting video conference calls and weekly teleconference calls. Teleconference calls are utilized to review status. Items covered in monthly status meetings are: progress to date vs. plan,

recovery plan for activities behind schedule, status of staffing and job hour expenditures, highlight of activities in the upcoming month, support required from BEA, schedule concerns and issues, to-date costs vs. budget, cost trends and earned value. Status (percent complete) of the tasks identified on the Work Task Summary Sheets will be presented at the monthly status meetings. Work-in-progress will be presented at the status meetings for interim review by BEA.

Meeting Minutes and Telephone Records: Prepare meeting minutes and records of telephone conversations between BEA and subcontractor personnel, regardless of who initiates the call. Send copies of meeting minutes and phone call records to BEA within two working days of the meeting or call.

Action Item List: Maintain an individually numbered action item list showing responsibilities and completion dates. The list will be updated, identified with the current date and distributed within two working days after action items are added.

Key Assumptions List: Prepare and maintain a Key Assumptions List. The list will be updated, highlighted to denote changes, dated with the current date and distributed within two working days after adding items to the list.

Equipment Lists: Prepare equipment lists for facility and process equipment for use in cost estimate preparation. Identify long lead procurement items and recommended equipment quality levels.

Drawings: Prepare drawings as part of the final Pre-conceptual Design Report.

Design Reviews: Make a presentation on the draft Pre-conceptual Design Report to BEA reviewers at approximately the 50% and 90% of completion points. Resolve and incorporate all comments received during the interim reviews prior to

submitting the final report. Document the comments and resolutions for inclusion in the project files.

Performance Requirements: Prior to submittal of the Pre-conceptual Design Studies Report for review, cite and reference all key information and decisional statements or data used in preparing the report. Also, document the quality assurance reviews and validation.

Future Studies List: Prepare a list of items not included in the Scope of Work, but which should be covered in future design studies or in the conceptual design phase.

**Appendix A**  
**Activity Worksheet**

**Activity Datasheet**

Title: Work Plan		WBS No.: 1.1	
Responsible: AREVA NP		Rev. 0	
<p>Scope: Prepare AREVA NGNP Work Plan for INL approval. Work Plan shall include updated work plan document from proposal based on agreed upon work scope. Main elements of the plan include the summary level WBS, Preconceptual Design Study Project Schedule, and Activity Data Sheets. As indicated, these elements are to be defined in the work plan at the summary level, typically WBS level 3.</p>			
<p>Assumptions: Agreed work scope includes 4 studies (Reactor Type, Power Level, PCS, and Primary/Secondary Concept), and Nuclear Island and PCS preconceptual design description. The NI and PCS design will be adapted from the AREVA commercial HTR design, including use of prismatic core and indirect cycle CCGT power generating system. Cost, Economic Assessment, NGNP Project Schedule and R&amp;D needs will be provided for Nuclear Island and PCS.</p>			
Start Date: 9-Nov-06		End Date: 19-Dec-06	
	Title	% Value	Due Date
Milestones:			
Deliverables:			
1	Draft Preconceptual Design Study Work Plan	90%	5-Dec-06
	Approved Work Plan	10%	19-Dec-06
Cost: \$24,811			



**Activity Datasheet**

Title: Project Management and Administration		WBS No.: 1.4	
Responsible: AREVA		Rev. 0	
Scope: Prepare and attend Kickoff Meeting Hold monthly status meetings (face to face or videoconference meetings) and weekly phone calls with BEA Prepare meeting minutes and telephone records Maintain an Action Item List Maintain a Key Assumptions List Coordinate 50% and 90% Design Reviews Cost Tracking and Reporting Schedule tracking and reporting			
Assumptions:			
Start Date: 9-Nov-06		End Date: 15-Aug-07	
	Title	% Value	Due Date
Milestones:			
1	Kickoff meeting		5-Dec-06
2	50% Design Review		21-Feb-07
3	90% Design review		13-Jun-07
Deliverables:			
Cost: \$345,623			



**Activity Datasheet**

Title: Prototype Power Level Study		WBS No.: 1.2.2	
Responsible: AREVA		Rev. 0	
Scope:	This study selects the NGNP prototype reactor power level answering to the following questions: - What power plant size is required to demonstrate commercial scalability for the electric plant? - What H2 plant size is required to demonstrate commercial scalability for the H2 plant? (may have different answers for different H2 processes) - What is the recommended size for the NGNP Reactor and H2 plant?		
Assumptions:	The reactor type shall be a prismatic type modular gas cooled reactor similar to AREVA ANTARES design concept.		
Start Date:	13-Dec-06	End Date:	1-Mar-07
	Title	% Value	Due Date
Milestones:			
1	Define Special Study Question(s), Scope, Assumption(s), and Decision Criteria	15	18-Dec-06
2	Conduct Study and Evaluate Options Considering Decision Criteria	30	12-Jan-07
3	Prioritization and Ranking of Options	10	15-Jan-07
4	Synthesize Special Study Results for Optimum Solution - Recommendation	15	18-Jan-07
5	Expert Review and Validation of Decision and Bases for Recommendation	10	19-Jan-07
6	Prepare PCDSR Input	10	13-Feb-07
7	50% Review Support	10	21-Feb-07
Deliverables:			
Cost:	\$95,696		



**Activity Datasheet**

Title: Power Conversion System Study		WBS No.: 1.2.3	
Responsible: PW Rocketdyne		Rev. 0	
Scope: The power conversion system (PCS) concept will be recommended based on a trade study that will evaluate the available options and provide recommendation for the NGNP PCS answering to the following questions: - What is the recommended NGNP Power Conversion System concept? (i.e. Direct vs Indirect Cycle, Brayton vs CCGT vs Steam Cycle) - What is the working fluid if indirect cycle? - What is the working fluid for H2 plant heat transfer?			
Assumptions:			
Start Date:	10-Jan-07	End Date:	1-Mar-07
	Title	% Value	Due Date
Milestones:			
1	Define Special Study Question(s), Scope, Assumption(s), and Decision Criteria	15	15-Jan-07
2	Conduct Study and Evaluate Options Considering Decision Criteria	30	26-Jan-07
3	Prioritization and Ranking of Options	15	30-Jan-07
4	Synthesize Special Study Results for Optimum Solution - Recommendation	15	6-Feb-07
5	Expert Review and Validation of Decision and Bases for Recommendation	10	8-Feb-07
6	Prepare PCDSR Input	15	20-Feb-07
Deliverables:			
Cost: \$125,505			







**Activity Datasheet**

Title: Power Conversion System		WBS No.: 1.3.3	
Responsible: MHI		Rev. 0	
Scope: Adapt PCS design to NGNP conditions. Evaluate performance of system. Describe PCS for Preconceptual Design Studies Report (including PCS building). Identify critical components and issues. Provide PCS cost input. Provide PCS input to NGNP schedule. Provide PCS risk input.			
Assumptions: ANTARES indirect cycle CCGT design adapted to NGNP requirements.			
Start Date:	10-Jan-07	End Date:	22-May-07
	Title	% Value	Due Date
Milestones:			
1	PCS Cost Input	10%	1-Mar-07
2	NGNP Schedule Input for PCS	5%	12-Mar-07
3	PCS Risk Input	5%	19-Mar-07
4	PCS Description for PCDSR	70%	23-Apr-07
5	50% Design Review Input	5%	20-Feb-07
6	90% Design Review Input	5%	12-Jun-07
Deliverables:			
Cost:	\$97,500		



**Activity Datasheet**

Title: Hydrogen Production		WBS No.: 1.3.4	
Responsible: Air Products		Rev. 0	
Scope: Specific work scope to be determined. Anticipate evaluation of hydrogen production strategies and interfaces with the nuclear plant			
Assumptions:			
Start Date:		End Date:	
	Title	% Value	Due Date
Milestones:			
1			
Deliverables:			
Cost:	\$37,403		



**Activity Datasheet**

Title: Support Systems		WBS No.: 1.3.6	
Responsible: AREVA		Rev. 0	
Scope: This task provides a description of the key systems necessary to ensure safe operation. A particular emphasis will be put on the following systems: <ul style="list-style-type: none"> <li>. Shutdown Cooling System (SCS)</li> <li>. Reactor Cavity Cooling System (RCCS)</li> <li>. Fuel Handling System</li> <li>. Helium Services System</li> <li>. Plant control, protection and monitoring systems</li> </ul> This action also covers the design of the reactor building and the description of the other buildings of the Nuclear Island.			
Assumptions: Trade Studies define basic design parameters System Requirements Manual provides requirements to be satisfied			
Start Date:	30-Jan-07	End Date:	12-Jun-07
	Title	% Value	Due Date
Milestones:			
1	Support systems	30	7-May-07
2	NI Building	65	15-May-07
3	50% Design Review support	2	20-Feb-07
4	90% Design Review support	3	12-Jun-07
Deliverables:			
Cost:	\$186,405		

**Activity Datasheet**

Title: Fuel		WBS No.: 1.3.7	
Responsible: AREVA		Rev. 0	
Scope: This task is aimed at providing the fuel fabrication strategy and the fuel qualification plan. The fuel qualification plan will address not only manufacturing issues but also the testing which is required to qualify the fuel under normal and off-normal conditions. This task will also provide necessary input information related to fuel R&D needs, cost, schedule and risk.			
Assumptions: Trade Studies define basic design parameters System Requirements Manual provides requirements to be satisfied			
Start Date: 18-Dec-06		End Date: 12-Jun-07	
	Title	% Value	Due Date
Milestones:			
1	Fuel design concept description	7	19-Feb-07
2	Fuel fabrication strategy	32	12-Feb-07
3	Fuel qualification plan	32	30-Mar-07
4	R&D, cost, schedule and risk Input	17	3-Apr-07
5	50% Design Review support	7	20-Feb-07
6	90% Design Review support	5	12-Jun-07
Deliverables:			
Cost: \$98,179			





**Activity Datasheet**

Title: Risk Management		WBS No.: 1.3.9	
Responsible: AREVA		Rev. 0	
Scope: This activity performs the project risk management function by defining the risk identification process and interfacing with safety, design and R&D definition activities to collect and compile project risks for reporting in the PCDSR.			
Assumptions: Risks are identified in the design adaptation, R&D and fuel activities.			
Start Date:	15-Feb-07	End Date:	1-Jul-07
	Title	% Value	Due Date
Milestones:			
1	Define Risk Management Process	10	9-Mar-07
2	Project Risk Management	50	30-Apr-07
3	PCDSR Input	30	4-May-07
4	Design Review Support	10	12-Jun-07
Deliverables:			
Cost:	\$45,949		



**Activity Datasheet**

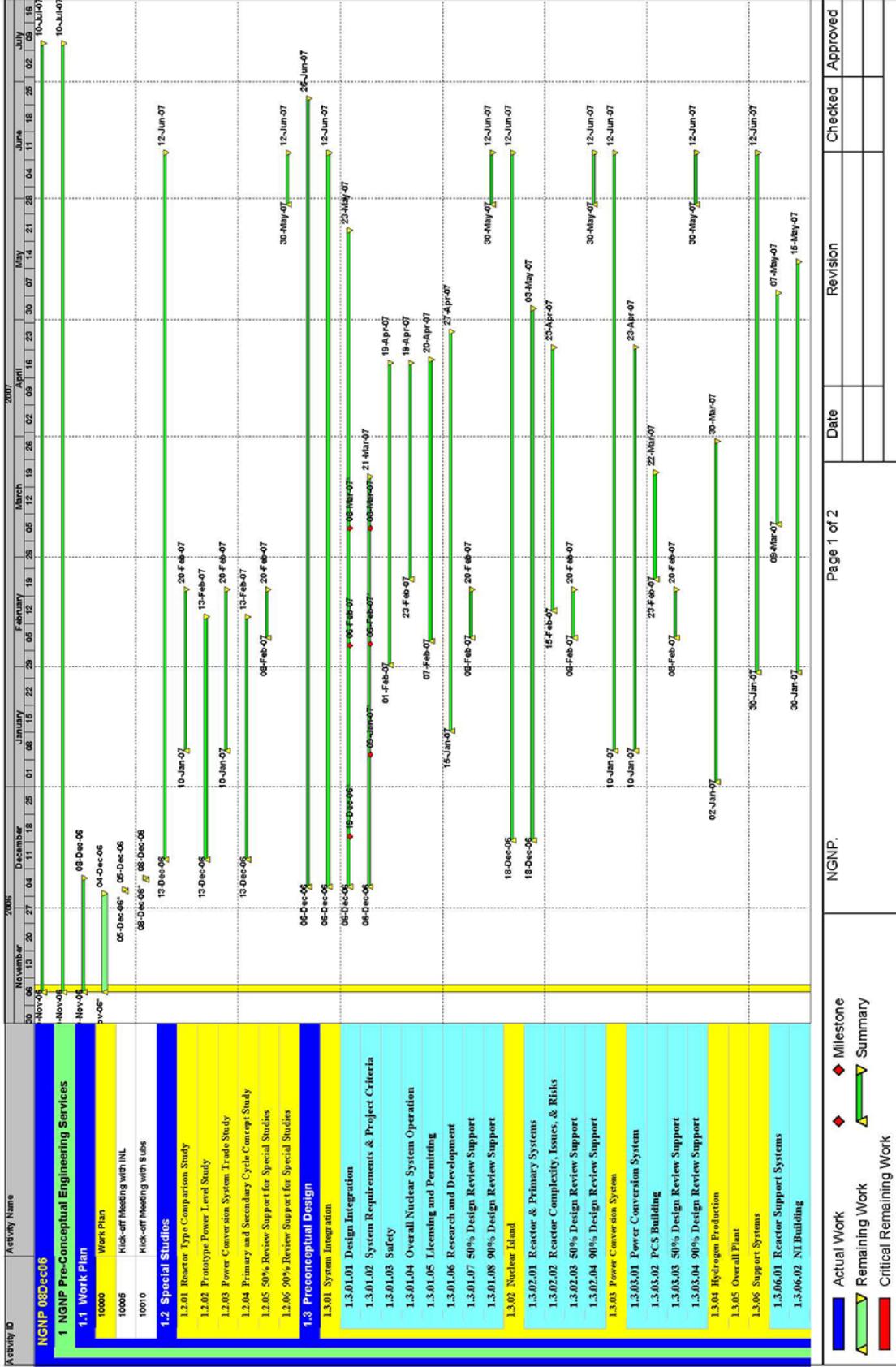
Title: Report Integration and Assembly		WBS No.: 1.3.10	
Responsible: AREVA		Rev. 0	
Scope: Assemble Pre-Conceptual Design Studies Report. The report includes a summary section, the body of the report in accordance with the proposed PCDSR outline.			
Assumptions:			
Start Date:	23-Feb-07	End Date:	26-Jun-07
	Title	% Value	Due Date
Milestones:			
1	Summary	27	19-Apr-07
2	Introduction	18	13-Apr-07
3	Future Studies	36	19-Apr-07
Deliverables:			
1	PCDSR Report (Draft)	13	8-Jun-07
	PCDSR Report (Final)	6	26-Jun-07
Cost:	\$68,230		

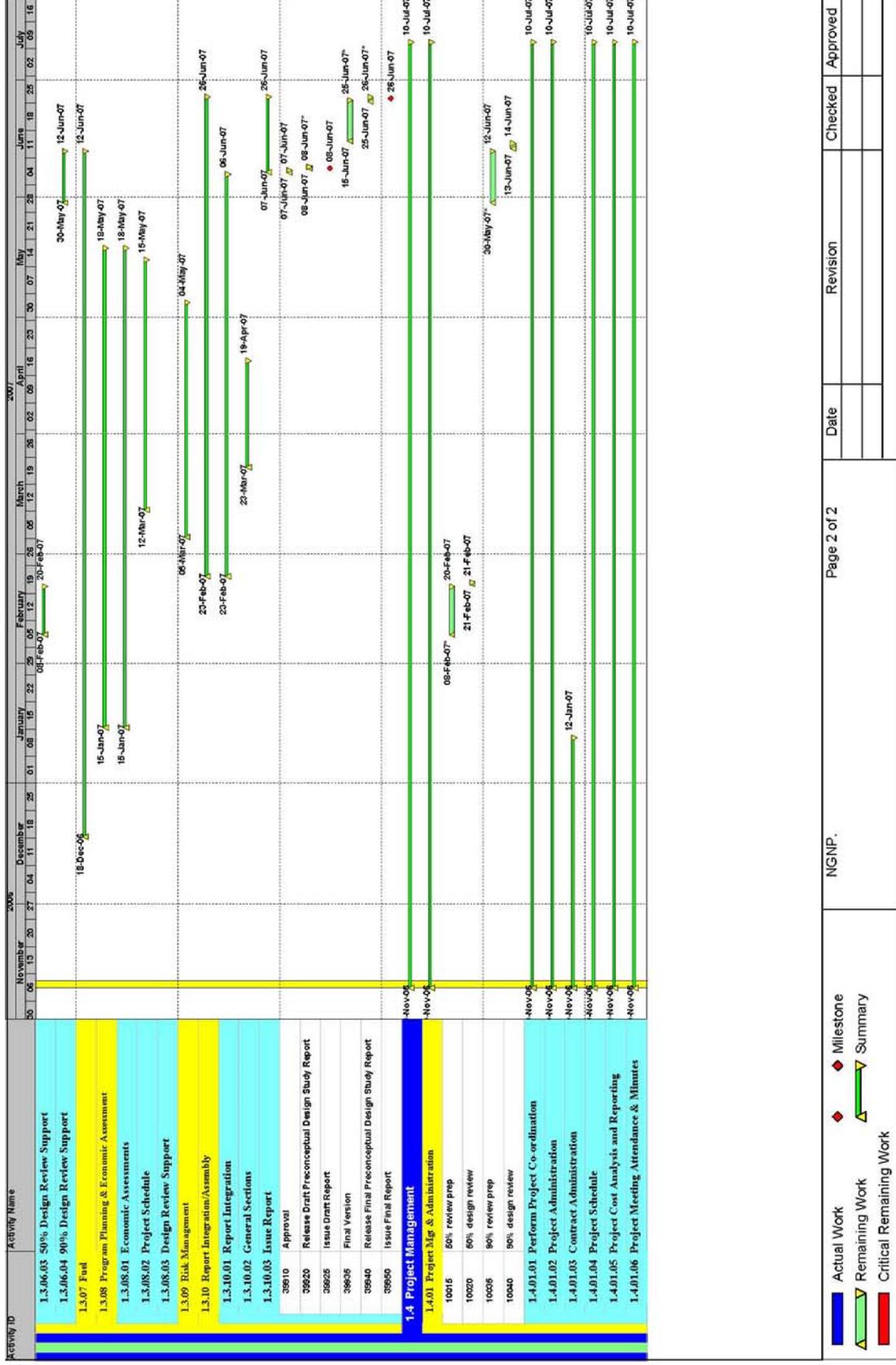
**Appendix B**  
**WBS**

WBS	Item Description	Lead Company	Support Company
<b>1</b>	<b>NGNP Pre-Conceptual Engineering Services Project</b>		
<b>1.1</b>	<b>Work Plan</b>	AREVA	
<b>1.2</b>	<b>Special Studies</b>		
1.2.1	REACTOR TYPE COMPARISON STUDY	AREVA	B&R
1.2.2	PROTOTYPE POWER LEVEL STUDY	AREVA	WGI, DEI
1.2.3	POWER CONVERSION SYSTEM TRADE STUDY	PW Rocketdyne	B&R, DEI, MHI
1.2.4	PRIMARY AND SECONDARY CYCLE CONCEPT STUDY	AREVA	
1.2.5	50% Review Support	AREVA	
1.2.6	90% Review Support	AREVA	
<b>1.3</b>	<b>Preconceptual Design</b>		
<b>1.3.1</b>	<b>SYSTEM INTEGRATION</b>		
1.3.1.1	Design Integration	AREVA	
1.3.1.2	Develop System Requirements and Project Criteria	AREVA	B&R, DEI
1.3.1.3	Safety	AREVA	DEI
1.3.1.4	Overall Nuclear System Operation	AREVA	
1.3.1.5	Licensing and Permitting	AREVA	B&R, WGI, DEI
1.3.1.6	Research and Development	PW Rocketdyne	AREVA, MHI
1.3.1.7	50% Review Support	AREVA	
1.3.1.8	90% Review Support	AREVA	
<b>1.3.2</b>	<b>NUCLEAR ISLAND</b>		
1.3.2.1	Reactor and Primary Systems	AREVA	BWXT
1.3.2.2	Reactor Complexity, Issues and Risks	AREVA	
1.3.2.3	50% design review support	AREVA	
1.3.2.4	90% design review support	AREVA	
<b>1.3.3</b>	<b>POWER CONVERSION SYSTEM</b>		
1.3.3.1	Power Conversion System	MHI	
1.3.3.2	PCS Building	B&R	
1.3.3.3	50% design review support	AREVA	MHI, B&R
1.3.3.4	90% design review support	AREVA	MHI, B&R
<b>1.3.4</b>	<b>HYDROGEN PRODUCTION</b>	AP	
<b>1.3.5</b>	<b>OVERALL PLANT</b>		
<b>1.3.6</b>	<b>SUPPORT SYSTEMS</b>		
1.3.6.1	Reactor Support Systems	AREVA	
1.3.6.2	NI Building	B&R	
1.3.6.3	50% design review support	AREVA	B&R
1.3.6.4	90% design review support	AREVA	B&R
<b>1.3.7</b>	<b>FUEL</b>	AREVA	BWXT
1.3.7.1	Fuel		
1.3.7.2	50% design review support	AREVA	BWXT
1.3.7.3	90% design review support	AREVA	BWXT
<b>1.3.8</b>	<b>PROGRAM PLANNING AND ECONOMIC ASSESSMENT</b>		
1.3.8.1	Economic Assessments	B&R	AREVA
1.3.8.2	Project Schedule	B&R	AREVA
1.3.8.3	Design review support	AREVA	B&R
<b>1.3.9</b>	<b>RISK MANAGEMENT</b>	AREVA	B&R
<b>1.3.10</b>	<b>REPORT INTEGRATION / ASSEMBLY</b>	AREVA	
1.3.10.1	Coordinate report integration		
1.3.10.2	Prepare general sections		
1.3.10.3	Issue report		
1.3.10.4	90% design review support		

WBS	Item Description	Lead Company	Support Company
1.4	Project Management	AREVA	
1.4.1	PROJECT MANAGEMENT & ADMINISTRATION		
1.4.1.1	Project coordination		
1.4.1.2	Project administration		
1.4.1.3	Contract administration		
1.4.1.4	Project schedule		
1.4.1.5	Project Cost analysis and reporting		
1.4.1.6	Project meeting attendance and minutes		
1.4.1.7	Travel and Temporary Lodging		
1.4.1.8	Other non-labor costs		

**Appendix C**  
**Schedule**





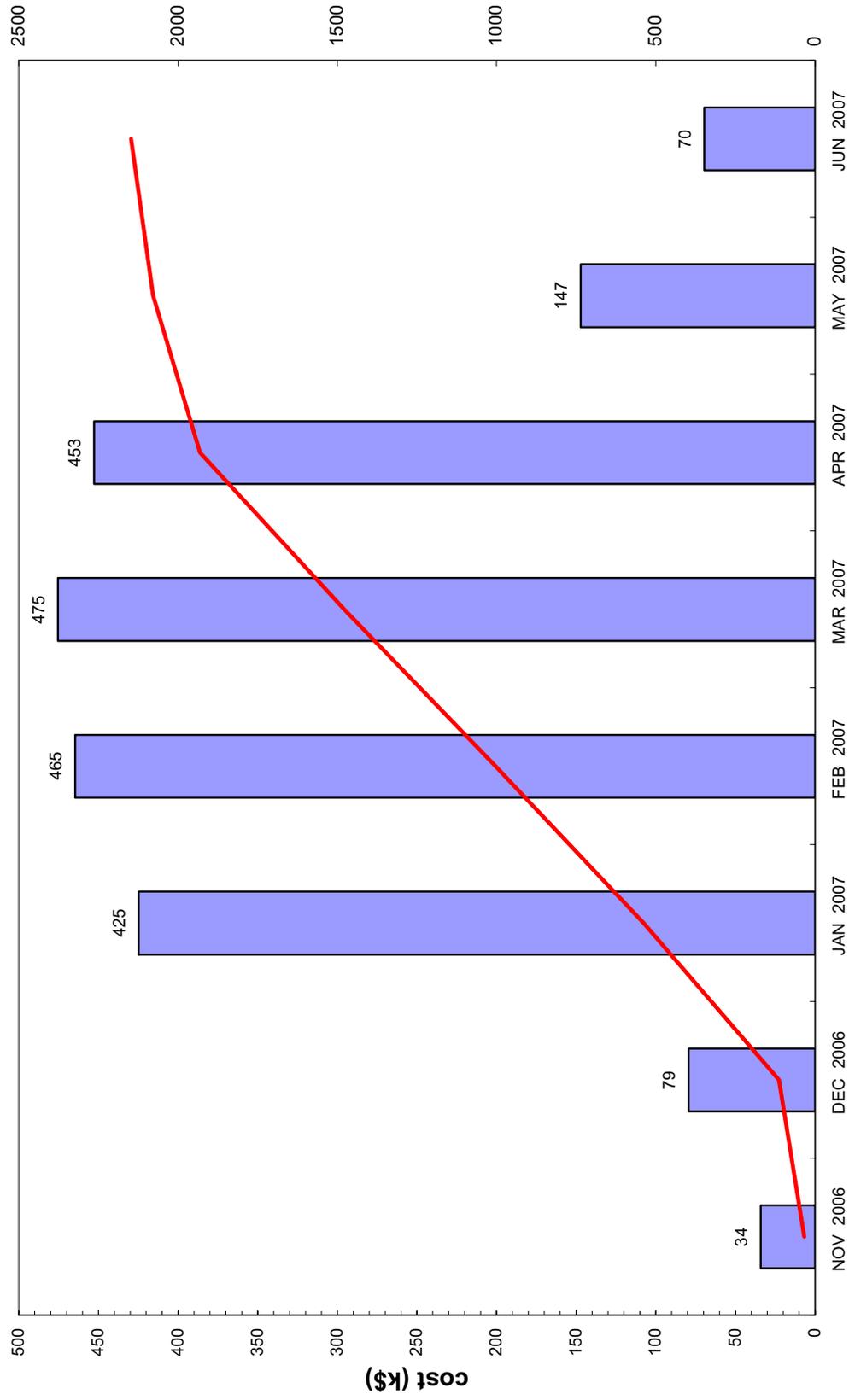
Activity Name	Date	Revision	Checked	Approved
1.3.06.03 50% Design Review Support				
1.3.06.04 90% Design Review Support				
1.3.07 Fuel				
1.3.08 Program Planning & Economic Assessment				
1.3.08.01 Economic Assessments				
1.3.08.02 Project Schedule				
1.3.08.03 Design Review Support				
1.3.09 Risk Management				
1.3.10 Report Integration/Assembly				
1.3.10.01 Report Integration				
1.3.10.02 General Sections				
1.3.10.03 Issue Report				
38910 Approval				
38920 Release Draft Preconceptual Design Study Report				
38925 Issue Draft Report				
38935 Final Version				
38940 Release Final Preconceptual Design Study Report				
38950 Issue Final Report				
1.4 Project Management				
1.4.01 Project Mgt. & Administration				
10015 50% review prep				
10020 60% design review				
10035 90% review prep				
10040 90% design review				
1.4.01.01 Perform Project Co-ordination				
1.4.01.02 Project Administration				
1.4.01.03 Contract Administration				
1.4.01.04 Project Schedule				
1.4.01.05 Project Cost Analysis and Reporting				
1.4.01.06 Project Meeting Attendance & Minutes				

Legend:

- Actual Work (Blue bar)
- Remaining Work (Green bar)
- Critical Remaining Work (Red bar)
- Milestone (Red diamond)
- Summary (Green triangle)

Page 2 of 2  
NGNP.

### NGNP spending profile



## **Appendix D**

### **Schedule of Status and Progress Meetings**

1. Weekly status update teleconference AREVA and key team members
  - Each Wednesday 10:00 a.m. Eastern
  
2. Status Meetings
  - December 5                      Lynchburg (Kickoff Meeting)
  - January 23                      Lynchburg Status and Special Studies Discussion
  - February 21&22                Lynchburg (50% Design Review & Status)
  - March 22                         INL
  - April 19                         Video Conference
  - May 17                         Video Conference
  - June 13&14                      INL (90% Design Review & Status)
  - July 10                         Video Conference
  
- 3.

## **Appendix E**

### **Assumptions List**

Following the issuance of RFP 56889 Addendum 3 and several phone conversations with INL NGNP technical personnel, AREVA NP has prepared the proposed scope of work which is partially responsive to RFP-56889 Addendum 3.

The purpose of this "Assumption List" is to clarify which portions of the modified scope of work outlined in Addendum 3 the AREVA NGNP Team proposes to perform.

The AREVA NGNP Team modified workscope deviates from the scope listed in RFP Addendum 3 as described below:

1. The proposed heat balance and emissions scope of work proposed are included only for the adaptation of the existing design electrical power conversion system (PCS) and that necessary for the NGNP adaptation of existing nuclear heat source.
2. The definition and design of the heat transfer and transport systems and concepts to carry process heat from the nuclear island (NI) to the hydrogen plant are not included. (The IHX which transfers heat from the primary circuit to the intermediate heat transport system will be included in the NI description.)
3. The definition, evaluation and development of hydrogen plant system description and characteristics are not included.
4. The scope of the System Requirements Manual will not be comprehensive. At the top level, the SRM will provide the organization of the whole NGNP plant. However, the details developed at lower levels will only emphasize the requirements associated with the nuclear island (NI) and PCS. Emphasis will be placed on those functions and requirements that shape the NGNP concept. Generic requirements will not be emphasized.
5. Only the major NI and PCS systems and components will be described. "Critical" equipment for which significant feasibility or development issues exist will be identified.
6. Only NI and PCS specific R&D needs will be identified.
7. AREVA Team modified scope of work does not include Systems Descriptions and data on relative sizing of components and structures (e.g. heat exchangers, pumps, compressors, piping, structural, etc.). (Heat balances will provide boundary conditions and key flows for major equipment.)
8. The Pre-conceptual Design Studies Report will address the safety approach and the safety characteristics of the proposed NI design. However, a detailed safety evaluation of the proposed concept will not be performed in the pre-conceptual design phase.
9. Balance of plant support facilities are not included in the modified scope of work.
10. General site layout and plant interfaces are not included in the modified scope of work.

11. A site study for the INL site will not be performed.
12. Cost estimates proposed in the modified scope of work are limited to NI and PCS in the base proposal.
13. The Economic Assessment to be performed under the base proposal, including Life Cycles cost analyses are limited to electricity production of the nth-of-a-kind plant.
14. The hydrogen plant design is not included in the proposed scope. INL has also not accepted the proposed optional scope of work to perform a cost evaluation and economic assessment for a hydrogen plant based on existing design concept information.
15. However, it was decided to maintain a place for Air Products within the scope to provide hydrogen production plant design and operation insights. It was agreed that the details of this work scope would be defined in the detailed work plan.
16. The project schedule will be developed for the NI and PCS. While key interaction with the hydrogen plant schedule will be identified, a detailed schedule for the hydrogen plant portion of the project will not be provided.
17. The licensing and permitting special study will not be performed. The Pre-conceptual Design Studies Report will describe the AREVA NGNP Team's recommended licensing strategy, but the decision process and evaluation of alternatives will not be described.
18. Licensing and permitting strategies is limited to the Nuclear Island with the Electricity production plant issues (key interfaces with the hydrogen plant will be noted).
19. The NGNP By-Products study will not be performed.

The pre-conceptual design concept described by the AREVA NGNP Team will be an adaptation of existing designs to satisfy NGNP conditions. However, no proprietary information including existing intellectual property, trade secrets, or business sensitive information will be provided to BEA/INL.

The AREVA NGNP Team will provide to BEA/INL a single formal deliverable entitled "NGNP and Hydrogen Production Pre-conceptual Design Studies Report." This report will include the System Requirements Manual and those special studies performed as a part of the proposed scope.

AREVA Team travel will be limited where practical. Monthly status meetings with BEA/INL will be conducted by video conference or in conjunction with other project meetings to reduce travel. Project kick-off meeting and 50% design review will be conducted at AREVA Team location.