

NGNP ACTIVITY SHEET for WEC

Activity No. 1 Title: Summary

Task No. None

Lead Responsibility: Westinghouse Electric Company LLC

Description:

A summary of the Westinghouse team effort expended in this study will be provided in the Preconceptual Design Report. This summary will include the topics identified in the Preconceptual Design Report outline, as identified in the Work Plan and accompanying schedule. Recognizing that the summary will serve to:

- Assist in focusing the technical scope and priorities of research & development activities for the NGNP,
- and, Provide a basis for subsequent development of the technical and functional specifications for the prototype facilities for NGNP,

The Summary will define the initial design parameter selections by the Westinghouse team for the NGNP, select the principal hydrogen production technology and recommend supporting research and development.

The Westinghouse team will provide a complete synopsis of all findings and conclusions. The summary will be stand-alone to be used as appropriate by BEA.

Reporting Requirements:

This will be the Summary in the Preconceptual Design Report.

Resource Forecast:

- Manhours
 - WEC: 240manhours
 - Shaw: 16manhours
 - PBMR: 16manhours
 - TI: 16manhours
 - Kadak: 16manhours
 - M-Tech: 8manhours

- Travel Required:

Travel required to meet the BEA meeting requirements by WEC is included here for WEC management of their scope, Activity 1 and Activity 2

- 4 trips; WEC to INL; 1 person; 3 days, 2 nights
- Materials and Services: \$2000 (for WEC overall Federal Express and miscellaneous)
- Other Direct Costs **None**

Schedule Forecast:

- Duration: 6 weeks
- Milestone(s): Input to Preliminary and Final drafts (Minor)
Completed Preconceptual Design Report (Major)

Support Requirements:

- Related Activity/Tasks to be completed first: All inputs to other chapters
- Support Team Responsibilities: Review of and input to the Summary
- Next Activity/Tasks requiring this effort: **None**

NGNP ACTIVITY SHEET for WEC

Activity No. 2 Title: Introduction

Task No. 2.1 Title: PBMR DPP Status, PHP Initiative, etc.

Task No. 2.2 Title: Concept Overview of PBMR Based NGNP and Rationale

Lead Responsibility: Westinghouse Electric Company LLC

Description:

An Introduction to the Westinghouse team Preconceptual Design Report will be provided. This Introduction will describe the preconceptual design work which will include evaluation of a range of design parameters and alternatives and, based on the justification for the parameters and alternatives developed, will recommend a preconceptual design for the NGNP prototype facilities.

An important purpose of the evaluation of parameters and alternatives in this study will be to determine what is appropriate for the prototype to support subsequent commercialization of NGNP technologies (e.g., scaling and licensing considerations). Research and development needs and priority changes deemed necessary to select such parameters among the alternatives will be identified.

Information from the concept design will provide a foundation to define the next level of technical and functional requirements, provide NGNP management with important decisional information in preparation for the NGNP Conceptual Design phase and provide NGNP program management with critical data.

Reporting Requirements:

This will be the Introduction in the Preconceptual Design Report.

Resource Forecast:

The labor for this Activity/Task:

- WEC: 100manhours
- Shaw: 8manhours
- PBMR: 8 manhours
- TI: 8manhours
- Kadak: 8manhours

- Travel Required:

Required Travel for this activity is included under Activity 1

- Materials and Services: **None**
- Other Direct Costs **None**

Schedule Forecast:

- Duration: 6 weeks
- Milestone(s): Input to Preliminary and Final drafts (Minor)
Completed Preconceptual Design Report (Major)

Support Requirements:

- Related Activity/Tasks to be completed first: All except Activity 1, Summary
- Support Team Responsibilities: Review the drafts
- Next Activity/Tasks requiring this effort: Activity 1, Summary

NGNP TASK SHEET

Task No. 2.1 Title: PBMR DPP Status, PHP Initiative

Lead Responsibility: Westinghouse Electric Company LLC

Description:

The WEC team will provide a status of the major activities being conducted by the PBMR design teams for the Demonstration Power Plant (DPP) in South Africa, and the Process Heat Plant (PHP) initiatives which are being explored for their application to utilization of process heat from a high temperature reactor.

In addition, other PBMR activities which could provide benefit, experience or lessons learned to the NNGP objectives will be described.

Reporting Requirements:

As for Activity 2

Resource Forecast:

The labor for this Activity/Task:

- Manhours
 - WEC: 40manhours
 - PBMR: 4manhours
 - Shaw: 4manhours
 - TI: 4manhours
 - Kadak: 4manhours

- Travel Required:

Included in Activity 1

- Materials and Services: **None**

- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 6 weeks
- Milestone(s): As for Activity 2

Support Requirements:

- Related Activity/Tasks to be completed first: As for Activity 2
- Support Team Responsibilities: As for Activity 2
- Next Activity/Tasks requiring this effort: As for Activity 2

NGNP TASK SHEET

Task No. 2.2 Title: Concept Overview of PBMR Based NGNP and Rationale

Lead Responsibility: Westinghouse Electric Company LLC

Description:

The Westinghouse team will outline its concept and rationale for an NGNP prototype, which will be derived from the South African experience, the guidance provided in Ref. 5.3 (“Design Features and Technology Uncertainties for the Next Generation Nuclear Plant”) of the SOW and the special studies completed during the execution of the early Phase I SOW.

This overview will serve to assist BEA in focusing the technical scope and priorities of research & development activities for the NGNP, and provide a basis for subsequent development of the technical and functional specifications for the prototype facilities for the NGNP.

Reporting Requirements:

As for Activity 2

Resource Forecast:

The labor for this Activity/Task:

- Manhours
 - WEC: 60manhours
 - PBMR: 4manhours
 - Shaw: 4manhours
 - TI: 4manhours
 - Kadak: 4manhours
- Travel Required:
Included under Activity 1
- Materials and Services: **None**
-
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 6 weeks

- Milestone(s): As for Activity 2

Support Requirements:

- Related Activity/Tasks to be completed first: As for Activity 2
- Support Team Responsibilities: As for Activity 2
- Next Activity/Tasks requiring this effort: As for Activity 2

NGNP TASK SHEET

Task No. Project Management Title: Technical Integration

Lead Responsibility: Westinghouse Electric Company LLC

Description:

Technical integration of the WEC team activities, tasks and reports will be conducted.

Reporting Requirements:

As for Project Management

Resource Forecast:

The labor for this Activity/Task:

- WEC: 360manhours
- Travel Required:
10 trips; WEC to INL; 1 person; 3 days, 2 nights
- Materials and Services: **None**
-
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 12 Months
- Milestone(s): Reports as identified in each Activity

Support Requirements:

- Related Activity/Tasks to be completed first: Per Schedule
- Support Team Responsibilities: As for Project Management
- Next Activity/Tasks requiring this effort: Project Management

NGNP ACTIVITY SHEET for WEC

Activity No. N/A **Title:** Quality Assurance

Lead Responsibility: Westinghouse Electric Company LLC

Description:

Conduct Quality Assurance (QA) as required for the conduct of the BEA contract.

Reporting Requirements:

None

Resource Forecast:

The labor for this Activity/Task:

- WEC: 100manhours
- Travel Required: **None**
- Materials and Services: **None**
- Other Direct Costs **None**

Schedule Forecast:

- Duration: 12 Months
- Milestone(s): None

Support Requirements:

- Related Activity/Tasks to be completed first: N/A
- Support Team Responsibilities: N/A
- Next Activity/Tasks requiring this effort: N/A

NGNP TASK SHEET

Task No. 6.8 Title: Nuclear System Control Data and Instrumentation System

- Subtask No. 6.8.1 Title: Nuclear System Control Data and Instrumentation System (NIS) Scope**
- Subtask No. 6.8.2 Title: Nuclear System Control Data and Instrumentation System Subsystem Definition**
- Subtask No. 6.8.3 Title: Nuclear System Control Data and Instrumentation System Conceptual Architecture**

Lead Responsibility: Westinghouse Electric Company LLC

Description:

The purpose of this Task is to identify the scope of the Nuclear Instrumentation System (NIS) along with the typical required subsystems. A lifecycle documentation list and required design input documentation shall be identified. As needed evaluations, licensing basis, system interfaces and technology shall be identified. The major subsystems of the NIS will be identified along with the scope and purpose of each subsystem. An overall conceptual architecture shall be designed to support the scope of the NIS.

Reporting Requirements:

The product of the task will be an NIS Scope Definition Report.

Resource Forecast:

- The Labor for this Task/Activity:
 - WEC: 120 hours
- Travel required:
 - 2 3-day meetings at INL (Idaho)
WEC: 2 persons (Pittsburgh to Idaho); 3 days, 2 nights
 - 2 2-day meetings with WEC Team at Windsor
WEC: 1 person (Pittsburgh to Windsor); 2 days, 1 night
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 16 weeks
- Milestone(s): Minor – draft report for DOE/INL assessment after 10 weeks
Major – final report after 15 weeks

Support Requirements:

- Related Activity/Tasks to be completed first: **None**
- Support Team Responsibilities:
 - SHAW: provide overall coordination and overall I&C Architecture
 - PBMR: Provide high level system requirements and function description.
- Next Activity/Tasks requiring this effort: **None**

NGNP TASK SHEET

Task No. 6.9 Title: Reactor Protection System

- | | |
|--------------------------|---|
| Subtask No. 6.9.1 | Title: Reactor Protection System (RPS) Scope |
| Subtask No. 6.9.2 | Title: Reactor Protection System Subsystem Definition |
| Subtask No. 6.9.3 | Title: Reactor Protection System Conceptual Architecture |

Lead Responsibility: Westinghouse Electric Company LLC

Description:

The purpose of this Task is to identify the scope of the RPS system along with the typical required subsystems. A lifecycle documentation list and required design input documentation shall be identified. As needed evaluations, licensing basis, system interfaces and technology shall be identified. The major subsystems of the RPS will be identified along with the scope and purpose of each subsystem. An overall conceptual architecture shall be designed to support the scope of the RPS.

Reporting Requirements:

The product of the task will be an RPS Scope Definition Report.

Resource Forecast:

- The Labor for this Task/Activity:
 - WEC: 80 hours
- Travel required:
Included in Task 6.8
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 16 weeks
- Milestone(s): Minor – draft report for DOE/INL assessment after 10 weeks
Major – final report after 15 weeks

Support Requirements:

- Related Activity/Tasks to be completed first: **None**
- Support Team Responsibilities:
 - SHAW: provide overall coordination and overall I&C Architecture
 - PBMR: Provide high level system requirements and safety function description.
- Next Activity/Tasks requiring this effort: **None**

NGNP TASK SHEET

Task No. 6.10 Title: Investment Protection System

Subtask No. 6.10.1 Title: Investment Protection System (IPS) Scope

Subtask No. 6.10.2 Title: Investment Protection System Subsystem Definition

Subtask No. 6.10.3 Title: Investment Protection System Conceptual Architecture

Lead Responsibility: Westinghouse Electric Company LLC

Description:

The purpose of this Task is to identify the scope of the system along with the typical required subsystems. A lifecycle documentation list and required design input documentation shall be identified. As needed evaluations, system interfaces and technology shall be identified. The major subsystems of the IPS will be identified along with the scope and purpose of each subsystem. An overall conceptual architecture shall be designed to support the scope of the IPS.

Reporting Requirements:

The product of the task will be an IPS Scope Definition Report.

Resource Forecast:

- The Labor for this Task/Activity:
 - WEC: 120 manhours
- Travel required:
Included in Task 6.8
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 16 weeks
- Milestone(s): Minor – draft report for DOE/INL assessment after 10 weeks
Major – final report after 15 weeks

Support Requirements:

- Related Activity/Tasks to be completed first: **None**
- Support Team Responsibilities:
 - SHAW: provide overall coordination and overall I&C Architecture
 - PBMR: Provide high level system requirements and system function description.
- Next Activity/Tasks requiring this effort: **None**

NGNP TASK SHEET

Task No. 6.11 Title: Nuclear System Monitoring and Control System

- Subtask No. 6.11.1 Title: Nuclear System Monitoring and Control System (OCS) Scope**
- Subtask No. 6.11.2 Title: Nuclear System Monitoring and Control System Subsystem Definition**
- Subtask No. 6.11.3 Title: Nuclear System Monitoring and Control System Conceptual Architecture**

Lead Responsibility: Westinghouse Electric Company LLC

Description:

The purpose of this Task is to identify the scope of the Control System (OCS) system along with the typical required subsystems. A lifecycle documentation list and required design input documentation shall be identified. As needed evaluations, licensing basis, system interfaces and technology shall be identified. The major subsystems of the OCS will be identified along with the scope and purpose of each subsystem. An overall conceptual architecture shall be designed to support the scope of the OCS.

Reporting Requirements:

The product of the activity will be an OCS Scope Definition Report.

Resource Forecast:

- The Labor for this Task/Activity:
 - WEC: 160 hours
- Travel required:
Included in Task 6.8
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 16 weeks
- Milestone(s): Minor – draft report for DOE/INL assessment after 10 weeks
Major – final report after 15 weeks

Support Requirements:

- Related Activity/Tasks to be completed first: **None**
- Support Team Responsibilities:
 - SHAW: provide overall coordination and overall I&C Architecture
 - PBMR: Provide high level system requirements and function description.
- Next Activity/Tasks requiring this effort: **None**

NGNP ACTIVITY SHEET for WEC

Activity No. 15 Title: Licensing and Permitting

Task No. 1	Title: Licensing under Part 50 vs. Part 52
Task No. 2	Title: Feasibility of Mixed Licensing Approach (Part 52 ESP and Part 50 CP/OL)
Task No. 3	Title: Feasibility of Using New Advanced Reactor Licensing Framework (to become Part 53)
Task No. 4	Title: Practicality of “License By Test” Licensing Method
Task No. 5	Title: Licensing of an Integrated Nuclear Power/Hydrogen Plant
Task No. 6	Title: Method for Integration of PRA Techniques During Design Phase
Task No. 7	Title: EPA/State Permits for Integrated Nuclear Power/Hydrogen Plant

Lead Responsibility: Westinghouse Electric Company LLC

Description:

Work specific to this activity consists of generating an Executive Summary providing 1) an overview of the seven tasks that comprise this Activity and 2) the general conclusions and recommendations of the Activity. Then the Activity will compile the Executive Summary, seven task reports and related presentations into a single report and set of presentations. This effort will utilize the results of Special Study 20.6.

Reporting Requirements:

The product of this Activity will be slide presentations for each of the tasks, an Executive Summary and reports summarizing results and conclusions for each of the tasks in a format compatible with the NGNP Preconceptual Design Report.

Resource Forecast:

The following resource forecast table consists of 1) 40 manhours (WEC) required to generate the Executive Summary and compile the report and 20 manhours (PBMR) for Team Member review/comment (i.e., Activity level), and 2) a summary of the resource forecasts for each of the seven individual tasks. Per Note 1, the proposed effort for Attorney Steven Frantz, Morgan, Lewis & Bockius LLP, is included in the table; however, this effort is not included in the total manhours or costing of this activity.

Note 1: WEC is proposing to engage the services of Attorney Steven P. Frantz, Morgan, Lewis & Bockius LLP, a specialist in this subject. These services are not costed here, but the proposed levels of effort are shown. WEC will discuss

this with BEA prior to contract award, during the finalization of the contract SOW.

Summary Resource Forecast for Activity 15						
Task	Total Manhours	WEC	PBMR	TI	Shaw	Morgan Lewis*
1	80	80	40			40
2	120	80	40			20
3	160	80	40	40		20
4	180	100	60			20
5	200	80		40	20	40
6	150	80	30	40		20
7	80				60	10
Totals:	910	500	210	120	80	170

* manhours not included in totals (See Note 1)

- Travel required- The following list summarizes the travel for this Activity by individual Task:
- Task 15.1
 - One 1-day review meeting in Washington, DC.
 - WEC: one person, BDL to DCA, one night, one day
 - One 1-day meeting with DOE/INL at INL
 - WEC: two persons, BDL to IDA, one night, two days
- Task 15.3
 - One 2-day review meeting in Washington, DC.
 - WEC: one person, BDL to DCA, one night, two days
 - One 1-day meeting with DOE/INL at INL
 - WEC: one person, BDL to IDA, one night, two days
- Task 15.4
 - One 1-day meeting with DOE/INL at INL
 - WEC: one person, BDL to IDA, one night, two days
- Task 15.5
 - One 2-day review meeting in Washington, DC.
 - WEC: two persons, BDL to DCA, one night, two days
 - One 1-day meeting with DOE/INL at INL
 - WEC: two persons, BDL to IDA, one night, two days
- Task 15.6
 - One 1-day meeting with DOE/INL at INL
 - WEC: one person, BDL to IDA, one night, two days

Schedule Forecast:

- Duration: 22 weeks (duration spans all Activity 15 Tasks)
- Milestone(s): Minor: Draft Executive Summary after 18 weeks.
Major: Final presentation and report after 20 weeks.

Support Requirements:

- Related Activity/Tasks to be completed first: Special Study 20.6 and Tasks 15.1-15.7
- Support Team Responsibilities:
 - Westinghouse: Draft write-up
 - Members: Input, comments and review
- Next Activity/Tasks requiring this effort: **None**

NGNP TASK SHEET

Task No. 15.1 Title: Licensing Under Part 50 vs. Part 52

Lead Responsibility: Westinghouse Electric Company LLC

Description:

The pros and cons of licensing under Part 50 vs. Part 52 will be summarized and the risks identified. This task will include: 1) review of the developing PBMR licensing documentation for its applicability to either Part 50 or Part 52 and 2) evaluating any feedback from the USNRC during the ongoing PBMR pre-application activities on the acceptability of a Part 50 application vs. a Part 52 application.

Reporting Requirements:

The product of this Task will be a slide presentation and a report summarizing results and conclusions in a format compatible with the NNGP Preconceptual Design Report.

Resource Forecast:

- The labor for this Activity/Task:
 - WEC: 80 manhours
 - PBMR: 40 manhours
 - Morgan Lewis: 40 manhours (See Note 1 for Activity 15)
- Travel required: (see Activity 15 totals)
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 10 weeks
- Milestone(s): Minor: Draft presentation and report outline after 4 weeks.
Major: Final presentation and report after 9 weeks.

Support Requirements:

- Related Activity/Tasks to be completed first: Special Study 20.6
- Support Team Responsibilities:
 - Westinghouse: Draft write-up
 - PBMR: Task kickoff input and draft report review
 - Members: Input, comments and review
- Next Activity/Tasks requiring this effort: Tasks 15.2, Activity 15

- **NGNP TASK SHEET**

Task No. 15.2 Title: Feasibility of Mixed Licensing Approach (Part 52 ESP and Part 50 CP/OL)

Lead Responsibility: Westinghouse Electric Company LLC

Description:

The feasibility of a mixed use of Parts 50 and 52 will be established – for example, use of Part 52 for an Early Site Permit and Part 50 for the Construction Permit and Operating License. This task will include: 1) review of the developing PBMR licensing documentation for its applicability to a mixed Part 50/52 application and 2) evaluating any feedback from the USNRC during the ongoing PBMR pre-application activities on the acceptability of a mixed application.

Reporting Requirements:

The product of this Task will be a slide presentation and a report summarizing results and conclusions in a format compatible with the NGNP Preconceptual Design Report.

Resource Forecast:

The labor for this Activity/Task:

- WEC: 80 manhours
- PBMR: 40 manhours
- Morgan Lewis: 20 manhours (See Note 1 for Activity 15)

- Travel required: **None**

- Materials and Services: **None**

- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 6 weeks
- Milestone(s): Minor: Draft presentation and report outline after 3 weeks.
Major: Final presentation and report after 6 weeks.

Support Requirements:

- Related Activity/Tasks to be completed first: Special Study 20.6, Task 15.1
- Support Team Responsibilities:
 - Westinghouse: Draft write-up
 - PBMR: Task kickoff input and draft report review
 - Members: Input, comments and review
- Next Activity/Tasks requiring this effort: Activity

NGNP TASK SHEET

Task No. 15.3 Title: Feasibility of Using New Advanced Reactor Licensing Framework (to become Part 53)

Lead Responsibility: Westinghouse Electric Company LLC

Description:

The feasibility of using the proposed Technology Neutral Licensing Framework (new Part 53) will be evaluated. The evaluation will include: 1) reviewing the developing PBMR licensing documentation and other relevant PBMR documentation (e.g., NRC pre-application white papers, PRA documentation, etc.) against the requirements of the recent NRC ANPR on "Approaches to Risk-Informed and Performance-Based Requirements for Nuclear Power Reactors," and 2) feedback from Westinghouse's ongoing participation in the NEI Technology Neutral Licensing Framework Task Force and related USNRC workshops.

Reporting Requirements:

The product of this Task will be a slide presentation and a report summarizing results and conclusions in a format compatible with the NGNP Preconceptual Design Report.

Resource Forecast:

- The labor for this Activity/Task:
 - WEC: 80 manhours
 - TI: 40 manhours
 - PBMR: 40 manhours
 - Morgan Lewis: 20 manhours (See Note 1 for Activity 15)
- Travel required: (see Activity 15 totals)
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 10 weeks
- Milestone(s): Minor: Draft presentation and report outline after 4 weeks.
Major: Final presentation and report after 9 weeks.

Support Requirements:

- Related Activity/Tasks to be completed first: Special Study 20.6
- Support Team Responsibilities:
 - Westinghouse: Draft write-up
 - PBMR: Task kickoff input and draft report review
 - TI: Draft write-up PRA impact
 - Members: Input, comments and review
- Next Activity/Tasks requiring this effort: Activity 15

NGNP TASK SHEET

Task No. 15.4 Title: Practicality of “License By Test” Licensing Method

Lead Responsibility: Westinghouse Electric Company LLC

Description:

The pros and cons of applying a “license by test” approach for the NGNP demonstration facility shall be evaluated and summarized. The evaluation will include: 1) the feasibility of utilizing information from operation of the PBMR demonstration power plant in South Africa and 2) potential plant operating restrictions/additional instrumentation required to perform the licensing tests on a plant to be built in the US.

Reporting Requirements:

The product of this Task will be a slide presentation and a report summarizing results and conclusions in a format compatible with the NGNP Preconceptual Design Report.

Resource Forecast:

- The labor for this Task:
 - WEC: 80 manhours
 - PBMR: 60 manhours
 - Morgan Lewis: 20 manhours (See Note 1 for Activity 15)
- Travel required: (see Activity 15 totals)
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 10 weeks
- Milestone(s): Minor: Draft presentation and report outline after 4 weeks.
Major: Final presentation and report after 9 weeks.

Support Requirements:

- Related Activity/Tasks to be completed first: Special Study 20.6
- Support Team Responsibilities:
 - Westinghouse: Draft write-up
 - PBMR: Task kickoff input and draft report review
 - Shaw: Input on construction impact
 - Members: Input, comments and review
- Next Activity/Tasks requiring this effort: Activity 15

- **NGNP TASK SHEET**

Task No. 15.5 **Title: Licensing of an Integrated Nuclear Power/Hydrogen Plant**

Lead Responsibility: Westinghouse Electric Company LLC

Description:

An approach (general plan) for licensing an integrated nuclear power-/hydrogen production plant will be outlined. The proposed licensing approach will address the impact of current USNRC/FEMA licensing requirements, as well as potential new licensing regulations required to allow operation of a hydrogen production facility in close proximity to a nuclear power plant.

Reporting Requirements:

The product of this Task will be a slide presentation and a report summarizing results and conclusions in a format compatible with the NGNP Preconceptual Design Report.

Resource Forecast:

- The labor for this Task:
 - WEC: 100 manhours
 - TI: 40 manhours
 - Shaw: 20 hours
 - Morgan Lewis: 40 manhours (See Note 1 for Activity 15)
- Travel required: (see Activity 15 totals)
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 10 weeks
- Milestone(s): Minor: Draft presentation and report outline after 4 weeks.
Major: Final presentation and report after 9 weeks.

Support Requirements:

- Related Activity/Tasks to be completed first: Special Study 20.6
- Support Team Responsibilities:
 - Westinghouse: Draft write-up
 - PBMR: Task kickoff input and draft report review
 - Shaw: Draft write-up on integration with hydrogen plant
 - Members: Input, comments and review
- Next Activity/Tasks requiring this effort: Activity 15

NGNP TASK SHEET

Task No. 15.6 Title: Method for Integration of PRA Techniques During Design Phase

Lead Responsibility: Westinghouse Electric Company LLC

Description:

A method for use of a PRA in the design phase and integration of its results into the design and licensing process shall be summarized. The method will be based on ongoing Westinghouse and PBMR activities to utilize the results of PRA evaluations in the design process for advanced plants.

Reporting Requirements:

The product of this Task will be a slide presentation and a report summarizing results and conclusions in a format compatible with the NGNP Preconceptual Design Report.

Resource Forecast:

- The labor for this Task:
 - WEC: 80 manhours
 - PBMR: 30 manhours
 - TI: 40 manhours
 - Morgan Lewis: 20 manhours (See Note 1 for Activity 15)
- Travel required: (see Activity 15 totals)
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 8 weeks
- Milestone(s): Minor: Draft presentation and report outline after 3 weeks.
Major: Final presentation and report after 7 weeks.

Support Requirements:

- Related Activity/Tasks to be completed first: Special Study 20.6
- Support Team Responsibilities:
 - Westinghouse: Draft write-up
 - PBMR: Task kickoff input and draft report review
 - TI: Input on integration of PRA
 - Members: Input, comments and review
- Next Activity/Tasks requiring this effort: Activity 1

NGNP ACTIVITY SHEET for WEC

Activity No. 18 Title: Safeguards and Security

Task No. 18.1 Title: Safeguards and Security Integration

Task No. 18.2 Title: Security Design Integration

Lead Responsibility: Westinghouse Electric Company LLC

Description:

The purpose of this Activity is to integrate the various aspects of safeguards and security related to the NGNP and to integrate the design requirements and features for security into the preconceptual design of the plant. It will be based upon the lessons learned while developing the Combined License Application for AP1000. Many aspects of security are now included in various rules of Title 10 of the Code of Federal Regulations. Other details and expectations are embedded in documentation that is classified as Safeguards and Confidential. The efforts planned for this phase of NGNP will not be classified as Safeguards. The results of these efforts will be guidance and recommendations for layout to enhance the design's potential to pass a rigorous security assessment.

Reporting Requirements:

Task No. 18.1, Safeguards and Security Integration, will be a level of effort task to review progress and integration of Subtasks 18.1, 18.2 and 18.3 to ensure that the overall security approach for NGNP is seamless, robust and achievable.

Task No. 18.2, Security Design Integration, will be a level of effort task to review and comment on plant layout and operating philosophy to better position the design to pass a rigorous security assessment. The review will be based upon lessons learned in establishing proper security design features in operating plants and in AP1000.

See Subtasks 18.1.1, 18.1.2 and 18.1.3 for plans and reports.

Resource Forecast:

The labor for this Activity/Task:

- WEC: 200manhours
 - 140manhours for Task 18.1 (see following Subtask Sheets)
 - 60manhours for Task 18.2

- Travel Required:

One 2-day meeting with DOE/INL at INL; one person; PIT to IDA; 2 nights, 3 days

One 2-day meeting in Boston; one person; PIT to BOS; 1 night, 2 days

- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 9 months
- Milestone(s): These activities will be coincident with the review and issue of layout drawings and information.

Support Requirements:

- Related Activity/Tasks to be completed first: Initial plant layout design
- Support Team Responsibilities: Include security in the generation of plant layout and operating philosophy reviews
- Next Activity/Tasks requiring this effort: Next plant layout design

NGNP TASK SHEET

Subtask No. 18.1.1 Title: Fuel Security

Lead Responsibility: Westinghouse Electric Company LLC

Description:

The purpose of this Subtask is to develop a preconceptual fuel security plan for the NGNP type fuel based upon current practice for LWR fuel in the United States. It will be based upon Westinghouse Columbia practice and cover the fuel from its factory to its receipt at NGNP.

Reporting Requirements:

This activity will result in a non-Safeguards preconceptual security plan for fuel between its factory and receipt at NGNP.

Resource Forecast:

The labor for this Activity/Tasks:

- WEC: 40manhours
- Travel Required: Included in Activity 18
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 6 months
- Milestone(s): Issue preconceptual Fuel Security Plan

Support Requirements:

- Related Activity/Tasks to be completed first: Fuel delivery strategy
- Support Team Responsibilities: Review
- Next Activity/Tasks requiring this effort: Overall NGNP preconceptual security plan

NGNP TASK SHEET

Subtask No. 18.1.2 Title: Terrorism

Lead Responsibility: Westinghouse Electric Company LLC

Description:

This subtask is to develop preconceptual Beyond Design Basis Threats and scenarios for NGNP. These would be on the order of b.5.B threats and scenarios used for operating plants and for AP1000. They would include consideration of the unique reactor, hydrogen and other related features of NGNP that are different from LWRs. These threats and scenarios would be developed and described as non-Safeguards.

Reporting Requirements:

The result of this activity will be a short report of potential preconceptual Beyond Design Basis Threats and scenarios.

Resource Forecast:

The labor required for this Activity/Task:

- WEC: 40manhours
- Travel Required: Included in Activity 18
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 6 months
- Milestone(s): Issue of report of potential preconceptual Beyond Design Basis Threats and scenarios.

Support Requirements:

- Related Activity/Tasks to be completed first: Preconceptual NGNP layout and operating philosophy
- Support Team Responsibilities: Review
- Next Activity/Tasks requiring this effort: Overall NGNP preconceptual security plan

NGNP TASK SHEET

Subtask No. 18.1.3 Title: Facility Security

Lead Responsibility: Westinghouse Electric Company LLC

Description:

This Subtask is to develop a preconceptual overall NGNP security plan. This plan will be short and non-Safeguards and will describe general features of NGNP that make it resistant to the NRC and rule defined Design Basis Threat (DBT). Although the DBT is safeguards, general good practice design features can be described. The security review process for AP1000 and operating plants will provide the background for determining general good practice. The report will also include, by reference, the results of the Beyond Design Basis Threat report described in Subtask No. 18.1.2 above. This will ensure that there is no conflict between the two.

Reporting Requirements:

The result of this activity is a short report of general features and good practice of NGNP that make it resistant to the NRC and rule defined Design Basis Threat (DBT).

Resource Forecast:

The labor for this Activity/Task:

- WEC: 60manhours
- Travel Required: Included in Activity 18
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 9 months
- Milestone(s): Issue of preconceptual Overall NGNP Security Plan

Support Requirements:

- Related Activity/Tasks to be completed first: Potential preconceptual Beyond Design Basis Threats and Scenarios Report, preconceptual Fuel Security Plan, and preconceptual NGNP layout and operating philosophy
- Support Team Responsibilities: Review
- Next Activity/Tasks requiring this effort: None

NGNP ACTIVITY SHEET (Updated November 2006)

Special Study No. 20.6	Title: Licensing and Permitting Study
Task No. 20.6.1	Title: Licensing under Part 50 vs. Part 52
Task No. 20.6.2	Title: Feasibility of Mixed Licensing Approach (Part 52 ESP and Part 50 CP/OL)
Task No. 20.6.3	Title: Feasibility of Using New Advanced Reactor Licensing Framework (to become Part 53)
Task No. 20.6.4	Title: Practicality of “License by Test” Licensing Method
Task No. 20.6.5	Title: Licensing of an Integrated Nuclear Power/Hydrogen Plant
Task No. 20.6.6	Title: Method for Integration of PRA Techniques During Design Phase
Task No. 20.6.7	Title: EPA/State Permits for Integrated Nuclear Power/Hydrogen Plant
Task No. 20.6.8	Title: Detailed Work Plan
Task No. 20.6.9	Title: Summary Overview and Recommendations

Lead Responsibility: Westinghouse Electric Company LLC

Description:

The purpose of this Activity is to prepare a study to address the tasks listed above and to provide other comments on issues related to the licensing of the NGNP prototype. The pros and cons of licensing under Part 50 vs. Part 52 will be summarized and the risks identified. The feasibility of a mixed use of Parts 50 and 52 will be established – for example, use of Part 52 for an Early Site Permit and Part 50 for the Construction Permit and Operating License. This task will also address the potential for using Part 50 for the licensing of the NGNP prototype and Part 52 for NGNP commercial plants. Also, the feasibility of using the proposed Technology Neutral Licensing Framework (new Part 53) will be evaluated. The pros and cons of developing and applying a “license by test” approach for the NGNP demonstration facility will be evaluated and summarized. Issues related to the licensing of an integrated nuclear power/hydrogen production plant will be reviewed and summarized.

A method for use of a PRA in the design phase and integration of its results into the design and licensing process will be summarized, based on the currently ongoing Design Certification pre-application effort being conducted by the PBMR US Team.

Finally, an assessment of the required EPA and State permitting process will be made, including an identification of potential risks. This task will reference the existing site report (“Site Selection Report for the NPR at INEL,” dated July 1989).

The work for this special study activity will address basic features and issues of the above tasks and general applicability to NGNP. Detailed investigation, review, and comments specific to the NGNP design and schedule will be performed as part of Activity 15, Licensing and Permitting.

The need for regulatory consultation from the law firm Morgan, Lewis, & Brockius will be identified, if needed, and discussed during the course of this special study.

Licensing schedule and costing general considerations will be provided to Activity 16 (Economic Assessments) and Activity 17 (Construction Scheduling).

Stanley Ritterbusch, Westinghouse Licensing Manager, is assigned to coordinate and develop this study as well as the specific applications of this study to the focused tasks for the pre-conceptual assessment in Activity 15, Licensing and Permitting.

Reporting Requirements:

The product of this Activity will be a slide presentation and a report summarizing results and conclusions in a format compatible with the NGNP Pre-conceptual Design Report.

Resource Forecast:

The labor for this Special Study:

- WEC: 760 manhours
- PBMR: 80 manhours
- TI: 40 manhours
- Shaw: 80 manhours
- Morgan, Lewis & Brockius: 16 manhours proposed, subject to BEA discussion and needs as Special Study 20.6 proceeds (also, see Note 1 for Activity 15).
- Travel Required:
 - One 5-day review meeting with WEC Team and BEA in San Diego, CA.
WEC: two persons, BDL to San Diego, four nights, five days
 - Two 3-day meetings with WEC Team and BEA in Boston, MA.
WEC: two persons, two nights, three days.
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 15 weeks
- Milestone(s): Minor: Draft presentation and report outline end of November.
Major: Final presentation and report mid-January 2007.

Support Requirements:

- Related Activity/Tasks to be completed first: None
- Support Team Responsibilities:
 - PBMR: Write-up for PRA integrations task
 - TI: Review of PRA Integration task write-up
 - Shaw: Write-up for EPA and State Permitting task.
- Next Activity/Tasks requiring this effort: Tasks 15, 16 and 17

Task Descriptions:

Task No. 20.6.1 Title: Licensing under Part 50 vs. Part 52

This task will summarize and compare the two regulations in regards to the NRC's technical review of the NGNP prototype design. General comments will be made in regards to related technical issues, level of detailed design information available and the relation of this information to the NGNP prototype schedule and economics. Other issues which will be reviewed are (1) the licensing of an R&D reactor vs. a utilization facility, (2) the handling of exceptions for non-LWRs, and (3) environmental licensing regulations.

Issues to be investigated in more detail as part of Activity 15 will be identified.

Task No. 20.6.2 Title: Feasibility of Mixed Licensing Approach (Part 52 ESP and Part 50 CP/OL)

An overview of the three basic parts of Part 52 (Early Site Permit, Design Certification, and Combined Operating License) will be provided and general comments on using various combinations of the three parts of Part 52 and Part 50 for the NGNP prototype will be provided. The impact of these choices on the NGNP prototype project schedule (timeline) will be assessed.

Issues to be investigated in more detail as part of Activity 15 will be identified.

Task No. 20.6.3 Title: Feasibility of Using New Advanced Reactor Licensing Framework (to become Part 53)

The new advanced reactor “technology neutral” framework will be summarized, including the status of its development (most current NUREG). The feasibility of using this new regulation for licensing of the NGNP prototype will be summarized, including an overview of the potential problems and corresponding risks and benefits.

Issues to be investigated in more detail as part of Activity 15 will be identified.

Task No. 20.6.4 Title: Practicality of “License by Test” Licensing Method

The concept of “license by test” is well established; however, there is no firm definition or regulatory guidance for licensing a reactor based on startup test results. While license by test may have been implemented to some extent for Fort St. Vrain and for the reactors constructed and operated at the Idaho National Engineering Laboratory, there is no obligation on NRC’s part to do the same for the NGNP prototype. The degree of implementation and the success of the license by test concept will depend on the extent of (1) design completion, (2) safety analysis completed, the NGNP prototype schedule, and (4) the selection of the licensing approach (Part 50, Part 52, Part 53 or a combination).

Issues, if any, which should be investigated in more detail as part of Activity 15 will be identified.

Task No. 20.6.5 Title: Licensing of an Integrated Nuclear Power/Hydrogen Plant

Potential issues related to licensing of a plant which uses reactor-generated energy for a process other than generation of electricity will be identified. This review will address the NGNP prototype concept of a combined hydrogen-electricity generation plant and will identify, as appropriate, similar issues for a full-size commercial NGNP hydrogen generation plant. Any advantage of a particular licensing approach (Part 50, Part 52, or Part 53) in regards to the NGNP prototype will be identified.

Issues to be investigated in more detail as part of Activity 15 will be identified.

Task No. 20.6.6 Title: Method for Integration of PRA Techniques During Design Phase

The US Design Certification team for the PBMR has explored the development and use of a PRA for the PBMR project. This effort is almost completely and directly applicable to the NGNP prototype project. Therefore, the “white papers” written for the PBMR effort will be perused and summarized as they apply to the NGNP prototype. The

relevant issues are the PRA development plan, licensing basis event selection, SSC classification, interactions with the deterministic safety analyses, and defense-in-depth assessments

Issues to be investigated in more detail as part of Activity 15 will be identified.

Task No. 20.6.7 Title: EPA/State Permits for Integrated Nuclear Power/Hydrogen Plant

The required EPA permits will be identified and the state permits required at the INL will be investigated. Site definition, characterization, and the use of existing INL data will be investigated. Any significant issues to either the economics or schedule of the NGNP prototype will be identified.

Work to be performed in more detail as part of Activity 15 will be identified.

Task No. 20.6.8 Title: Detailed Work Plan

A Microsoft Project work plan network was developed to summarize the tasks for this Activity, including the estimated durations and budgets for subtasks.

Task No. 20.6.9 Title: Summary Overview and Recommendations

The summary overview and recommendations for this task will be based on inputs from each of the tasks for this Activity. The subtasks include (1) drafting a report for WEC Team review and preparing the corresponding Powerpoint presentation slides, (2) revision of the report, and (3) preparation and attendance at the January 2007 “50% review meeting” with BEA.

The outline of the report is currently being established. The following sections are being considered for inclusion:

- Executive Summary
- Introduction
- Selected Licensing Tasks
 - Licensing under Part 50 vs. Part 52
 - Types of licenses
 - Part 50
 - Part 52
 - Comparison
 - Feasibility of Mixed Licensing Approach (Part 52 ESP and Part 50 CP/OL)
 - Feasibility of Using New Advanced Reactor Licensing Framework (to become Part 53)

- Practicality of “License by Test” Licensing Method
 - Licensing of an Integrated Nuclear Power/Hydrogen Plant
 - Method for Integration of PRA Techniques During Design Phase
 - EPA/State Permits for Integrated Nuclear Power/Hydrogen Plant
- Other Licensing Issues
 - Pros and Cons for the development of a Licensing Review Basis document (i.e., an early “MOU” with the NRC)
 - ?
- Major Issues Requiring Resolution for NGNP
- Recommendations
 - Early recommendations for licensing of the NGNP prototype
 - Summary of more focused investigations to be carried into Activity 15 (Licensing and Permitting)

NGNP ACTIVITY SHEET for SHAW

Activity No. N/A Title: Project Management

Task A Title: Project Manager

Task B Title: Cost, Schedule and Reporting Management

Lead Responsibility: Shaw Environmental & Infrastructure, Inc.

Description:

This purpose of this overall task is to provide the overall project management, cost, schedule and reporting management and project administration.

Task A: This task is the overall function of the Project Manager. The Project Manager will be the primary interface with BEA and has overall responsibility for quality, cost and schedule of the preconceptual design. The Project Manager also will be responsible to integrate the work activities of the team. The Project Manager will conduct weekly status conference calls and monthly status meetings with BEA. The Project Manager will issue a monthly progress, cost and schedule report to BEA. This task includes the following work items:

- Preparation of top level project plans and procedures
- Arranging the 50% and 90% design reviews, and issuing the results of the reviews
- Preparation and/or collection of communications in the form of letters, notes of teleconference calls, minutes of meetings and other forms of communication
- Dissemination of Task A project management documents to the records retention system

Task B: This task includes the cost, schedule and reporting management. The task includes the following work items:

- Revising the Work Plan upon comment from BEA
- Collecting status information on the progress of the work
- Updating the preconceptual design schedule
- Collecting costs at the activity level, and reporting against the cost plan for that activity
- Maintaining a project Action Item List and Key Assumptions List
- Managing the accounting and billing for the project.

Reporting Requirements:

Project management will produce the following work products:

- Revision to the Work Plan incorporating BEA comments
- Monthly project reports
- Responses to the 50% and 90% design reviews

Resource Forecast:

- The labor for this Activity/Task:

Shaw Project Manager: 1200manhours

Shaw Cost & Scheduling Manager: 600manhours

- Travel Required

Task A

10 trips to INL from Boston /2 days 2 nights

15 trips to Windsor from Boston / 3 days/2 nights

Task B

3 trips to Windsor from Boston 3 days/2 nights

- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: Level of effort
- Milestone(s): None

Support Requirements:

- Support team responsibilities include the following:
 - Monthly cost and schedule update information
 - Monthly billing information
 - Participate in weekly teleconferences

Participate in monthly meetings as appropriate

NGNP ACTIVITY SHEET for SHAW

Activity No. 3 Title: Overall NGNP Plant Site Description

Task No. 3.1 NGNP Plant Site Development

Task No. 3.2 Nuclear Heat Source Arrangement (TI lead)

Task No. 3.3 Balance of Plant

Lead Responsibility: Shaw Environmental & Infrastructure, Inc.

Description:

The purpose of this Activity is to execute the tasks as indicated above. Separate task descriptions are provided in the following task summary sheets.

Reporting Requirements:

Final report Section 3 –Overall NGNP Plant Site Description”and associated project criteria, supporting calculations and drawings will be the principal work products.

Resource Forecast:

- The labor for the Task/Activity:
 - Shaw: 300 manhours
 - TI: 180 manhours
 - PBMR: 40 manhours
 - WEC: 40 manhours
- Travel Required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 13 weeks total after inputs are available from other tasks

Support Requirements:

Please refer to the support requirements identified on the individual task summary sheets.

- Milestone(s): Minor – Completion of Activity Subtask 3.1
Minor – MS46: Completion of NGNP Site Development Portion of Design Report at end of week 13
Major – MS58: Issue Pre Conceptual Design Study

Support Requirements:

- Related Activity/Tasks to be completed first: 22.1, 22.2
 - Support Team Responsibilities: WEC, PBMR, TI, APC: Provide Site Utilities interface requirements for the NGNP Plant equipment / systems.
 - Information to be requested from BEA on available site Roads and utilities.
- Next Activity/Tasks requiring this effort: **None**

NGNP TASK SHEET

Task No. 3.3 **Title: Balance of Plant**

- Subtask No. 3.3.1** **Title: Support Facilities (Medical, Fire Station, Laboratories, Offices, Warehouses, Simulator/Training Facilities, Hot & Cold Maintenance Shops, Security Systems, Etc.)**
- Subtask No. 3.3.2** **Title: Power Generation Facility**
- Subtask No. 3.3.3** **Title: Hydrogen Production Plant**

Lead Responsibility: Shaw Environmental & Infrastructure, Inc.

Description:

The purpose of this task is to provide descriptions for the NGNP Balance of Plant facility. This task will describe the Support Facilities (Medical, Laboratories, Offices, Warehouse(s) Simulator Training facilities, Hot & Cold Maintenance Shops, Security Building, etc.) the Power Generation Facility, and the Hydrogen Production Plant.

Reporting Requirements:

The products associated with this task shall include a section in the activity report identifying design considerations associated with the Balance of Plant and Support Facilities. Descriptions of design requirements and design codes will be developed for inclusion in the Pre Conceptual Design Study activity. Figures will be provided as required.

Resource Forecast:

The labor for this Activity/Task:

- Shaw: 100manhours
- Travel Required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 13 weeks
- Milestone(s): Minor – Completion of Activity Subtask 3.3
Minor – MS46: Completion of NGNP Site Development Portion of Design Report at end of week 13

Major – MS58: Issue Pre Conceptual Design Study

Support Requirements:

- Related Activity/Tasks to be completed first: 5.1, 5.2, 20.4, 22.1, 22.2
- Support Team Responsibilities: WEC, PBMR, APC: Provide design information on the Support Facility, Simulator Training facility, Power Generation facility, and Hydrogen Production Plant for the NGNP Plant equipment / systems.
- Information to be requested from BEA on available site Roads and utilities.

Next Activity/Tasks requiring this effort: **None**

NGNP ACTIVITY SHEET for SHAW

Activity No. 6 Title: Reactor Support Systems and Balance of Plant

Task 6.1	Core Conditioning System
Task 6.2	Reactor Cavity Cooling System
Task 6.3	Spent Fuel Cooling System
Task 6.4	Nuclear Island Cooling System
Task 6.5	Helium Services System
Task 6.6	Radioactive Waste and Decontamination System
Task 6.8	Nuclear System Control Data and Instrumentation System
Task 6.9	Reactor Protection System
Task 6.10	Investment Protection System
Task 6.11	Nuclear System Monitoring and Control Systems
Task 6.12	Nuclear System Electrical System
Task 6.14	Building and Structures
Task 6.15	Nuclear Island HVAC & Contamination Control
Task 6.16	Balance of Plant HVAC Systems
Task 6.17	Life Safety Systems

Lead Responsibility: Shaw Environmental & Infrastructure, Inc.

Description:

The purpose of this Activity is to execute the following tasks.

Activity No. 6 is divided into 15 tasks as indicated above. It should be noted that Tasks 6.7 and 6.13 are deemed not applicable to the proposed reactor designs. Separate task descriptions are provided in the following task summary sheets.

Reporting Requirements:

Final report “Section 6 – Reactor Support Systems and Balance of Plant” and associated project criteria, supporting calculations and drawings will be the principal work products.

Resource Forecast:

Total resources for this Activity are enumerated on the individual task summary sheets included with the proposed Work Plan.

Schedule Forecast:

Please refer to the schedule forecasts on the individual task summaries.

Support Requirements:

Please refer to the support requirements identified on the individual task summary sheets.

NGNP TASK SHEET

Task No. 6.14 Title: Buildings and Structures

- Subtask No. 6.14.1 Title: Reactor Building**
- Subtask No. 6.14.2 Title: Reactor Service Building**
- Subtask No. 6.14.3 Title: Operations Center**
- Subtask No. 6.14.4 Title: Other Buildings**

Lead Responsibility: Shaw Environmental & Infrastructure, Inc.

Description:

The purpose of this task is to determine the structural requirements for the various buildings and structures required for the NGDP systems and develop conceptual building designs and layouts for the respective structures. Coordination with the Reactor and Reactor Systems, Power Conversion System and Reactor Support System and Balance of Plant activity tasks will be required for foundation, erection, support and spatial requirements for system and subsystem components. Appropriate design codes will be identified and reviewed

Reporting Requirements:

The products associated with this task shall include a section in the activity report identifying design considerations associated with specific reactor system of subsystem components. Descriptions of design requirements and design codes will be developed for inclusion with the Design Criteria activity. Pre-conceptual building design layout drawings will be developed with estimated number of sheets as follows, subject to adjustment based on data provided in special studies.

- Reactor Building (6 sheets)
- Reactor Service Building (4 Sheets)
- Operations Center (1 sheet)
- Other Buildings (12 sheets)

Resource Forecast:

The labor for this Activity/Task:

- Shaw: 520manhours
- Travel Required: **None**
- Materials and Services: **None**

- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 12 weeks
- Milestone(s): Minor – completion of Activity Subtask 4.2.2;
 - completion of Activity Subtask 4.2.1.2;
 - completion of Activity Task 5.2;
 - completion of Activity Subtasks 6.1 to 6.7;Major – Complete design drawings at end of week 12.

Support Requirements:

- Related Activity/Tasks to be completed first: 4.2.4,4.2.5, 4.3, 5.2, 6.1 through 6.7, 22.2
- Support Team Responsibilities: PBMR: Provide Reactor, Reactor Ancillary and Reactor Support Equipment design requirements and power generation requirements. TI provide plant level requirements, heat transport system requirements, Shaw to provide Hydrogen plant requirements.
-

Next Activity/Tasks requiring this effort: 3.3, 22.1

NGNP ACTIVITY SHEET for SHAW

Task No. 6.15 Title: Nuclear Island HVAC & Contamination Control

Lead Responsibility: Shaw Environmental & Infrastructure, Inc.

Description:

The purpose of this task is to determine the HVAC requirements associated with the Nuclear Island building(s) spaces and develop a conceptual design description for the appropriate systems required. Pertinent design codes shall be identified and their applicability to building spaces and processes evaluated. Consideration for control of contamination by the use of confinement zones with appropriate pressure differential shall be included based on review of advanced light water reactor and other nuclear program requirements. Coordination with the Reactor, Reactor Ancillary, and Reactor Support Systems activity tasks will be required to identify heating and cooling requirements.

Reporting Requirements:

The products associated with this task shall include a section in the activity report identifying design considerations associated with specific systems and conceptual equipment sizing. Descriptions of design requirements and design codes, figures, and confinement zone tables will be developed for inclusion with the Project Criteria activity.

Resource Forecast:

The labor for this Activity/Task:

- Shaw: 150manhours

- Travel Required: **None**

- Materials and Services: **None**

- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 13 weeks
- Milestone(s): Minor – Completion of Activity Subtask 6.15
Minor – MS46: Completion of HVAC Portion of Design Report at end of week 13
Major – MS58: Issue Pre Conceptual Design Study

Support Requirements:

- Related Activity/Tasks to be completed first: 3.2, 4.1, 4.2, 4.3, 5.2, 6.1 through 6.4, 6.14.1, 22.1, 22.2
- Support Team Responsibilities: PBMR: Provide reactor, vessel and ancillary equipment design requirements.

Next Activity/Tasks requiring this effort: **None**

Support Requirements:

- Related Activity/Tasks to be completed first: 3.3, 5.2, 6.5 through 6.7, 6.14.2 through 6.14.4, 13.1, 22.1, 22.2
- Support Team Responsibilities: PBMR, TI: Provide ancillary Power Conversion System, Helium Services, Rad Waste, and Hydrogen Plant equipment design requirements.

Next Activity/Tasks requiring this effort: 3.3, 22.1.

Support Requirements:

- Related Activity/Tasks to be completed first: 3.2, 3.3, 22.1, 22.2
- Support Team Responsibilities: WEC, PBMR, TI: Provide hazards information associated with equipment / systems.

Next Activity/Tasks requiring this effort: **None**

NGNP ACTIVITY SHEET for APC

Activity No. 13 Title: Hydrogen Plant

Task No. 13.1	Title: Hydrogen Plant Requirements
Task No. 13.2	Title: Production Technology Options/Issues {See separate Task Sheets and Plan}
Task No. 13.3	Title: Intermediate Heat Transfer Loop {Replaced by Activity B}
Task No. 13.4	Title: Balance of Hydrogen Plant
Task No. 13.5	Title: Schedule for Development
Task No. 13.6	Title: Production Unit Cost of Hydrogen

The **focus** of this study is a **future commercial hydrogen plant based on water-splitting and NGNP technology** rather than the NGNP prototype hydrogen plant to be built at the INL site in Idaho.

The **purpose** of this activity (subsequent to subtask 13.2) is

1. to develop a pre-conceptual plant design for the reference water-splitting technology, including purification, storage, utilities and other off-sites;
2. to develop a realistic schedule for technology and project development;and
3. to develop a cost of production for hydrogen based upon this pre-conceptual plant design.

Lead Responsibility: Air Products and Chemicals, Inc.

Description:

Reporting Requirements: A section of the pre-conceptual design report including the items described in the task sheets following

Resource Forecast (not including 13.2):

- Manhours (total, including all support, planning, and supervision) : **2230 manhours**

Subtasks

APCI	: 1310
Shaw	: 76
WEC	: 140
TI	: 24

- Travel Required (**Yes / No**) (excluding regular meetings with BEA)
 - Allentown, PA to Boston 2 persons 4 nights
 - Pittsburgh to Boston 1 person 2 nights
- Materials and Services **None Required**
- Other Direct Costs **None Required**

Schedule Forecast:

- Duration: 9Weeks
- Milestone(s): Completion of Prerequisite tasks (13.2)
Completion of subtask 13.1.1
Completion of subtask 13.1.4
Completion of subtask 13.1.5
Completion of subtask 13.1.6

Support Requirements:

- Related Activity/Tasks to be completed first: Task 20.7, 13.2 & Activity B
 - **Support Team Responsibilities:**
 - Shaw: Lead on 13.1, 13.5& 13.6, Support on 13.4
 - TI: Support on 13.5& 13.6
 - WEC: Support on 13.1, 13.5& 13.6
 - APCI: Lead on 13.4, Support on 13.1, 13.5& 13.6
- Next Activity/Tasks requiring this effort: Activity 16 & SubTask 13.4

NGNP TASK SHEET

Task No. 13.1 Title: Hydrogen Plant Pre-conceptual Design

SubTask No. 13.1.1	Title: Plant Requirements
SubTask No. 13.1.1.1	Operational requirements
SubTask No. 13.1.1.2	Purity requirements
SubTask No. 13.1.1.3	Safety requirements
13.1.1.3.1	Off-set distance to NHS
SubTask No. 13.1.2	Title: Pre-conceptual design
13.1.2.1	Heat and material balance
13.1.2.2	Process flow diagram
13.1.2.3	Process description
13.1.2.4	Sized equipment list
13.1.2.5	Special equipment descriptions
13.1.2.6	Engineering notes
13.1.2.7	Plot Plan

Lead Responsibility: Shaw E&I

Description: The **focus** of this study is the pre-conceptual design of a **commercial hydrogen plant based on NGNP technology**, not the NGNP prototype to be built at the INL site in Idaho.

The purpose of this task is first to define the overall requirements of the hydrogen plant and then, in the light of the results of Tasks 13.2 to generate a preconceptual design of a commercial-scale hydrogen unit, including the process-coupling heat exchanger and secondary heat transfer loop.

Reporting Requirements:

1. A pre-conceptual hydrogen plant functional specification including capacity, availability, product composition, site, utilities, and safety and environmental requirements.
2. A pre-conceptual design of the hydrogen plant for the preferred technology including a process block flow diagram (prepared in Microsoft Office Visio 2003), process description, mass and energy balance, sized equipment list and plot plan.

Resource Forecast:

APCI	:	340
Shaw	:	444
WEC	:	100
Subtask total :	:	884

- **Travel Required (Yes /No)**
 - Allentown, PA to Boston 2 persons 4 nights
 - Boston to Allentown, PA 2 persons 2 nights

-
- Materials and Services: **None Required**
- Other Direct Costs: **None Required**

Schedule Forecast:

See attached schedule

- Milestone(s):
 - Completion of prerequisite activities
 - Completion of Deliverable #
 - Completion of Deliverable #

Support Requirements:

- Related Activity/Tasks to be completed first: 20.7 & 13.2
- Support Team Responsibilities:
 - WEC: assistance in the process flow diagram, process description and mass and energy balance.
 - APCI:
 - Support plant specification:
 - Complete the pre-conceptual design, assemble the deliverables:
- Next Activity/Tasks requiring this effort: 13.4;13.6;16

NGNP TASK SHEET

**Task No. 13.3 Title: Intermediate Heat Transfer Loop
{Replaced by Activity B}**

NGNP TASK SHEET

Task No. 13.4 Title: Balance of Hydrogen Plant

- SubTask No. 13.4.1 Title: Downstream product purification**
- SubTask No. 13.4.2 Title: Product gases storage and handling**
- SubTask No. 13.4.3 Title: Utilities needs and usage**
- SubTask No. 13.4.4 Title: Catalyst and chemicals needs, usage, handling and storage**
- SubTask No. 13.4.5 Title: Environmental protection facilities**
- SubTask No. 13.4.6 Title: Distribution needs and facilities**
- SubTask No. 13.4.7 Title: Off-sites sized equipment list**
- SubTask No. 13.4.8 Title: Off-sites plot plan**

Lead Responsibility: Air Products and Chemicals, Inc.

Description: The purpose of this task is to define at a pre-conceptual level all the product purification facilities, utilities, catalyst and chemicals handling facilities, storage and distribution facilities, and environmental protection facilities required to properly and safely complete the tasks of producing hydrogen and delivering it to the customer in the proper form.

Reporting Requirements:

1. Description of functional requirements for product purification, storage, handling, utilities, catalyst and chemicals, environmental protection, and product distribution.
2. Conceptual sized equipment list and plot plan for feed water storage and treating, product gas storage and handling, catalyst and chemicals handling and storage, environmental protection facilities.
3. Distribution and delivery plan and description of required facilities at the customer's location.

Resource Forecast:

APCI	:	76
Shaw	:	144
Subtask total :	:	89

- Travel Required (Yes / No)
 - Boston to Allentown, PA 2 persons 2 nights
- Materials and Services **None Required**
- Other Direct Costs **None Required**

Schedule Forecast:

- Duration: 9 Weeks
- Milestone(s): Definition of needs for BOP

Completion of sized equipment list and plot plan
Completion of task documentation

Support Requirements:

- Related Activity/Tasks to be completed first: 13.1.1
- Support Team Responsibilities:
 - Shaw: support for SubTask No. 13.4.1;13.4.3;13.4.4;13.4.5
13.4.7;13.4.8
- Next Activity/Tasks requiring this effort: 13.6

NGNP TASK SHEET

Task No. 13.5 Title: Schedule for Development

Lead Responsibility: Shaw E&I

Description: The purpose of this task is to list the development needs for the preferred hydrogen production technology as well as the process-coupling heat exchanger and intermediate heat transfer loop and to develop a schedule for research and development including precedence of tasks and estimated duration and effort required for each task.

Reporting Requirements: A schedule and report prepared in Microsoft Office Project 2003 as well as a brief description of each of the research and development tasks.

Resource Forecast:

APCI	:	80
Shaw	:	84
TI	:	12
WEC	:	20
Subtask total :	:	10

- Travel Required (~~Yes~~ / No)
- Materials and Services: None Required
- Other Direct Costs: None Required

Schedule Forecast:

- Duration: 2 Weeks
- Milestone(s): Completion of prerequisite activities
 Completion of draft schedule
 Review
 Completion of final schedule

Support Requirements:

- Related Activity/Tasks to be completed first: 13.2 & 13.3
- Support Team Responsibilities: Reviews by
 - WEC:
 - APCI:
 - TI:
- Next Activity/Tasks requiring this effort: 13.4

NGNP TASK SHEET

- Task No. 13.6 Title: Production Unit Cost of Hydrogen**
- SubTask No. 13.6.1 Title: Capital cost for the hydrogen unit**
 - SubTask No. 13.6.2 Title: Capital cost for the hydrogen off-sites**
 - SubTask No. 13.6.3 Title: Operating cost for the hydrogen unit**
 - SubTask No. 13.6.4 Title: Operating cost for the hydrogen off-sites**
 - SubTask No. 13.6.5 Title: Cost of production of hydrogen**

Lead Responsibility: Shaw E&I

Description: The purpose of this task is to develop a cost of production for hydrogen produced by the NGNP using the preferred hydrogen production technology. The task consists of developing a capital cost estimate and operating costs based upon the sized equipment lists and operating requirements developed in Tasks 13.1 and 13.4. Cost of the thermal energy received from the HGR and the financial parameters will be estimated in Task 16. From these estimates a cost of production of hydrogen will be estimated.

Reporting Requirements:

1. A rough-order-of-magnitude capital cost estimate based upon the sized equipment lists of the hydrogen plant including off-sites.
2. A rough order-of-magnitude operating cost estimate based upon the operating requirements of the equipment shown in the equipment lists.
3. A spreadsheet prepared in Microsoft Office Excel 2003 breaking down the cost of production of hydrogen from a commercial unit based on NGNP technology as well as a set of notes describing each of the cost elements.

Resource Forecast:

APCI	:	140
Shaw	:	84
TI	:	12
WEC	:	20
Subtask total :	:	26

- Travel Required (Yes / No) **(Included in Task 13.4, above)**
- Materials and Services: **None Required**
- Other Direct Costs : **None Required**

Schedule Forecast:

- Duration: 3 Weeks
- Milestone(s): Completion of Tasks 13.1 & 13.4
Completion of capital cost estimate
Completion of operating cost estimate

Completion of final spreadsheet

Support Requirements:

- Related Activity/Tasks to be completed first: 13.1 & 13.4
- Support Team Responsibilities:
 - Significant contribution to off-sites cost estimating
 - APCI:
- Review by:
 - TI:
 - WEC:
- Next Activity/Tasks requiring this effort: Activity 16

NGNP TASK SHEET

Task No. 15.7 Title: EPA/State Permits for Integrated Nuclear Power/Hydrogen Plant

Lead Responsibility: Shaw Environmental & Infrastructure, Inc.

Description:

The purpose of this task is to identify the issues and recommend an approach for licensing an integrated nuclear facility/hydrogen production plant. Identify applicable Environmental Protection Agency (EPA) and State permit requirements associated with construction and operation of this facility. Identify potential risks.

Reporting Requirements:

The products associated with this task shall include a section in the activity report identifying permit requirements and input to the Licensing and Permitting Study for the development of the licensing approach for the NGNP with a Hydrogen Production facility.

Resource Forecast:

The labor for this Activity/Task:

- Shaw: 60manhours
- Travel Required: **No**
- Materials and Services: **None**
-
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 8 weeks
- Milestone(s): Minor – Completion of Activity Task 157
Major – MS39 Complete SS# Licensing and Permitting Study
Major – MS46: Complete of Life Safety Systems Portion of Design Report at end of week 13
Major – MS8: Issue Preconceptual Design Study

Support Requirements:

- Related Activity/Tasks to be completed first: MS29
- Support Team Responsibilities: WEC: Integration of the Licensing & Permitting Study
- Next Activity/Tasks requiring this effort: None

NGNP ACTIVITY SHEET for SHAW

Activity No. 16 Title: Economic Assessments

Lead Responsibility: Shaw Stone & Webster Management Consultants

Description:

The purposes of this Activity are to:

1. [Task 16.1] Compile a Nuclear System Capital Cost Estimate
2. [Task 16.2] Evaluate risks for each alternative reactor design
3. [Task 16.3] Establish operating costs for the proposed reactor design
4. [Task 16.4] Establish Life Cycle Costs over the design life of the reactor
5. [Task 16.5] Evaluate the commercial economic viability of the NNGNP project

Activity 16 is divided into tasks as indicated above. Separate task descriptions are provided in the following sections.

Reporting Requirements:

Final report “Section 16 – Economic Assessments” and supporting spreadsheet calculations will be the principal work products.

Resource Forecast:

- The Labor for this Activity/Task:
 - Shaw: 1000 manhours
 - PBMR: 320 manhours
 - TI: 320 manhours
 - WEC: 80 manhours

Schedule Forecast:

- Duration: 8 weeks total after inputs are available from other tasks

Support Requirements:

- Design descriptions and cost inputs (capital and operating) for heat integration and hydrogen production

Activity No. 16 Title: ECONOMIC ASSESSMENTS

Task No. 16.1 Title: Nuclear System Capital Cost Estimate

Lead Responsibility: Shaw Stone & Webster Management Consultants

Description:

The purpose of this Activity is to:

1. Define the site, interfaces and scope of supply for the proposed NGNP project
2. Establish methodology, basis and assumptions
3. Prepare an order of magnitude cost estimate for the project

Approach:

The approach will be to first develop a Plant Description which documents the site assumptions, project schedule, facility interfaces and scope of supply. Project specific schedule parameters needed for the estimate will be obtained from Task 17 results, including construction duration and approximate construction midpoint (for determining escalation and interest during construction). Allowances for prerequisite R&D and technology development will be included. Owners costs, including project development, engineering, permitting/licensing and construction schedule. Key construction cost estimating assumptions will also be assembled including representative labor rates and productivity assumptions, escalation rates, construction interest costs and contingencies will be documented..

Based on the Plant Description and project cost assumptions, an order-of-magnitude cost estimate will be prepared including

- Prerequisite R&D costs
- Project development costs
 - Cost of obtaining permits and licenses
 - Costs to prepare and execute major project agreements
 - Costs of obtaining private financing for a portion of the capital cost
- Supply costs for major vendor packages
- Material costs outside of vendor packages
- Construction costs including site labor, supervision, construction equipment and tools
- Site construction management costs
- Project engineering and procurement costs
- Commissioning and startup costs
- Training

The basis for the capital cost estimate will be derived from a budget estimate to be provided by PBMR for the nuclear power and steam production portions of the plant, and preliminary costs available for water splitting technologies.

Sensitivity of the capital cost estimate to key assumptions and uncertainties will be reviewed and documented..

Information from Other Tasks:

NGNP proposed plant design basis (set at San Diego Project Meetings in January, 2007)
Project schedule from Task 17

Reporting Requirements:

The Project Description and capital cost estimate will be documented in a section of the Final report “Section 16 – Economic Assessments” as the principal work product.

Resource Forecast:

- Resources by company and activity are shown on the attached Activity 16 Schedule
- The Labor for this Activity/Task:
 - Shaw: 360 manhours
 - PBMR: 304 manhours
 - TI: 200 manhours
 - WEC: 80 manhours
- Travel– One trip for two persons to INL from Boston/3 days/3 nights

Schedule Forecast:

See attached Activity 16 schedule

Activity No. 16 Title: ECONOMIC ASSESSMENTS

Task No. 16.2 Title: Risks for Each Reactor Design

Lead Responsibility: Shaw Stone & Webster Management Consultants

Description:

The purpose of this Activity is to summarize the risks associated with each aspect of implementing the proposed and alternative NGNP projects.

Risks will be reviewed and summarized in each of the following areas;

- Remaining R&D Requirements
- Commercialization Requirements
- Licensing Requirements
- Codification
- Design
- Construction
- Operations
- Fuel cycle
- Availability
- Maintenance
- Decommissioning
- Costs

Approach

This review will consider two representative reactor designs – the pebble bed reactor design currently defined by PBMR and a generalized block reactor design representative of work currently in progress by Areva and General Atomics. A comparison matrix will be developed characterizing each of the two technologies against each risk criterion.

Shaw will prepare a draft matrix, which will be circulated for inputs from TI and other project participants for completion and review.

Reporting Requirements:

The results of this review of implementation risks will be documented in a section of the Final report “Section 16 – Economic Assessments” as the principal work product.

Resource Forecast:

- Resources by company and activity are shown on the attached Activity 16 Schedule
- The Labor for this Activity/Task:
 - Shaw: 80 manhours
 - TI: 120 manhours
- No travel is required for this subtask

Schedule Forecast:

See attached Activity 16 schedule

Activity No. 16 Title: ECONOMIC ASSESSMENTS

Task No. 16.3 Title: Operating Cost for the Reactor Design

Lead Responsibility: Shaw Stone & Webster Management Consultants

Description:

The purpose of this Activity is to establish estimates for the annual costs for the proposed NGNP plant design, along with underlying assumptions and methodology.

Approach:

Based on the Project Description prepared in Task 16.1 and additional inputs from other participants, the following cost elements will be prepared

- Economic assumptions and methodology
- Additional capital requirements during operation
- Operating and maintenance costs
- Fuel cycle costs
- Decommissioning cost estimate and annual contribution to decommissioning fund

A written description of economic assumptions and methodology will be drafted and circulated to other participants by Shaw for comment and completion.

Supporting calculations to estimate each element of annual costs, divided into fixed and variable components, will be prepared in a self-documenting spreadsheet format for inclusion in the life cycle cost model in Task 16.4.

PBMR inputs will be required to define the basis for O&M costs associated with reactor and related systems operations, maintenance and projected repairs and overhauls, as well as for the nuclear fuel cycle and decommissioning requirements.

Reporting Requirements:

The results of this review of implementation risks will be documented in a section of the Final report "Section 16 – Economic Assessments" as the principal work product.

Resource Forecast:

- Resources by company and activity are shown on the attached Activity 16 Schedule
- The Labor for this Activity/Task:
 - Shaw: 120 manhours
 - PBMR: 16 manhours
- No travel is required for this task

Schedule Forecast:

See attached Activity 16 schedule

Activity No. 16 Title: ECONOMIC ASSESSMENTS

Task No. 16.4 Title: Life Cycle Costs Over the Design Life of the Reactor

Lead Responsibility: Shaw Stone & Webster Management Consultants

Description:

The purpose of this Activity is to determine the life cycle cost of the proposed NGNP project over the design life of the reactor.

Approach:

Based on the Project Description and other information from the Activity 16 tasks, the following life cycle cost elements will be developed and represented in a cash flow model for the project.

- R&D, licensing and other project prerequisites
- Project development
- Engineering, procurement and construction
- Startup and testing
- Operations and maintenance (including outages and repairs)
- Fuel cycle costs
- Plant availability and dispatch
- Decommissioning

The cash flow model will be prepared using spreadsheet software to provide a self-documenting build-up of cost elements, plant operations and maintenance scheduling and dispatch, and projected income streams. The model will illustrate project cash flow requirements considering variable assumptions regarding the potential sale of power, steam and hydrogen based on the design capabilities of the NGNP project design.

Reporting Requirements:

The results of this review of implementation risks will be documented in a section of the Final report “Section 16 – Economic Assessments” as the principal work product.

Resource Forecast:

- Resources by company and activity are shown on the attached Activity 16 Schedule
- The Labor for this Activity/Task:
 - Shaw: 180 manhours
- No travel is required for this task

Schedule Forecast:

See attached Activity 16 schedule

Activity No. 16 Title: ECONOMIC ASSESSMENTS

Task No. 16.5 Title: Commercial Economic Viability Analysis

Lead Responsibility: Shaw Stone & Webster Management Consultants

Description:

The purpose of this Activity is to:

1. Establish potential revenue projections for the NGNP plant and determine the potential for private financing of a portion of the capital cost based on contracts to secure this revenue,
2. Adapt the cash flow model for the proposed NGNP project for projected representative commercial designs likely to be implemented for power generation, hydrogen production and steam production based on a projected commercialization schedule.
3. Identify projected economics for commercial applications of the NGNP plant including the following cases:
 - a. Electricity production
 - b. Steam only production for oil sands applications
 - c. Cogeneration of steam and power
 - d. Coproduction of power, steam and hydrogen
4. Identify order of magnitude economics for possible competing technologies for comparison
 - a. Projected range of power production costs from conventional technologies
 - b. Projected range of hydrogen production costs from conventional technologies (SMR and low temperature electrolysis)
 - c. Projected range of energy costs for steam production from conventional fuels

Approach:

The approach will be to first develop a set of economic assumptions and financial modeling method that reflects an expected commercial basis for NGNP and representative commercial projects. Key elements will include:

- Commercialization schedule
- Financing structure (equity and loan content for raising capital)
- Inflation and escalation assumptions
- Tax treatment
- Expected required return on equity for private financed projects
- Market value of products and byproducts (power, steam, hydrogen and oxygen)

Representative assumptions regarding financing structures and economic parameters will be recommended by Shaw Stone & Webster Management Consultants based on experience with similar studies and actual market conditions. Capital and operating costs, plant performance

estimates and availability projections will be drawn from the other tasks in Activity 16 and available information from other project participants as appropriate.

These assumptions and proposed detailed approach for this task will be reviewed by the study team, formalized into a letter report, submitted to BEA for review and finalized prior to their application in the development of specific models.

The economic evaluation model prepared for Task 16.4 will be adapted by Shaw for each of the commercial NGNP plant configurations, which will include combinations of power, steam and hydrogen production that are representative of commercial opportunities in the 2018+ time frame.

Reporting Requirements:

The economic evaluation models will utilize Microsoft Excel spreadsheet software and will be self-documenting to clearly show assumptions, calculation structures, results and the history of revisions to each model application. The modeling results will be included in the Final Report “Section 16 – Economic Assessments”, which will be the principal work product. Copies of the spreadsheet models will be provided to BEA for review and as part of the final work product (not to be distributed to other organizations).

Resource Forecast:

- Resources by company and activity are shown on the attached Activity 16 Schedule
- The Labor for this Activity/Task:
 - Shaw: 260 manhours
- One trip for one person to INL from Boston/3 days/3 nights; One trip for one person to INL from San Diego 3 days/3 nights

Schedule Forecast:

See attached Activity 16 schedule

Support Requirements:

Related Activity/Tasks to be completed first:

Project Schedule (Activity 17)
Hydrogen Plant (Activity 13)
Capital Cost estimates (Tasks 16.1)
Operating Costs (Task 16.3)
Cash Flow Model (Task 16.4)

NGNP ACTIVITY SHEET for SHAW

Activity No. 17 Title: Project Schedule

- Task No. 17 Title: R&D**
- Task No. 12 Title: Conceptual Design**
- Task No. 13 Title: Design**
- Task No. 13 Title: Licensing
(construction permit/operating permit)**
- Task No. 17 Title: Long Lead Systems Procurement**
- Task No. 14 Title: Construction**
- Task No. 15 Title: Startup and Testing**
- Task No. 16 Title: Operation Demonstration**
- Task No. 17 Title: Commercialization**
- Task No. 18 Title: Key Milestones**
- Task No. 19 Title: Critical Path Analysis**

Lead Responsibility: Shaw

Description:

The purpose of this activity is to develop a pre-conceptual project schedule for each of the project phases: R&D, conceptual design, design (Title I and Title II) licensing (construction permit and operating license) long lead systems procurement, construction, start-up and testing, operation/demonstration, commercialization. An overall integrated schedule for all of the project phases will be developed. Activities with logic ties will be planned at the major system, component, and discipline level. Key milestones will be shown on the overall integrated schedule. A critical path analysis will be performed and the critical path will be shown on the integrated schedule. The pre-conceptual project schedule will include the Critical Decision points in accordance with DOE Order 413.3 as well as relationship to the budget cycle. The schedule will show all major systems, buildings, and discipline efforts.

The schedule will be resource loaded based on the pre-conceptual order of magnitude cost estimate. A yearly funding profile will be developed based on the resource loaded schedule

Reporting Requirements:

A pre-conceptual resource loaded Primavera project schedule will be provided showing the critical path for the overall schedule.

A summary description of key assumptions that the schedule is based on will be provided

A summary description of the long lead items will be provided

A summary description of the critical path activities will be provided

A summary list of key project milestones will be provided

Resource Forecast:

The labor for this Activity/Task:

- Shaw: 600manhours
- PBMR: 40manhours
- WEC: 40manhours
- TI: 30manhours

- Travel Required: **None**

- Materials and Services: **None**

- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 8 weeks total (task will commence upon completion of initial issue of the preconceptual design)
- Week 1: Letter with proposed schedule assumptions
- Week 1 : Request for input from team members
- Week 6: Draft summary reports and schedule
- Week 7: Comments on draft summary reports and schedule
- Week 8: Final report sections and summary schedule

Support Requirements:

- Related Activity/Tasks to be completed first: Capital Cost Estimate in time to develop resource lading of the schedule. The project description for the capital cost estimate will also be used for the project schedule

Support Team Responsibilities: Input to the schedule and review of the final product

NGNP ACTIVITY SHEET for SHAW

Special Study No. 20.7 Title: NGNP By-Products Study

SubTask No.20.7.1 Title: Identify potential product markets

SubTask No.20.7.2 Title: Identify product purity, production rate, and delivery form per market

SubTask No.20.7.3 Title: Literature search on water splitting

SubTask No.20.7.4 Title: Prepare preconceptual energy and mass balances per technology

Subtask No. 20.7.5 Title: Identify product purification needs per technology

Subtask No. 20.7.6 Title: Identify NGNP by-products and waste streams per technology

Subtask No. 20.7.7 Title: Identify appropriate destinations for products, by-products and waste streams

Subtask No. 20.7.8 Title: Identify limits to NGNP sizing based on by-products and waste streams

Subtask No. 20.7.9 Title: Identify critical equipment by technology

Subtask No. 20.7.10 Title: Identify appropriate demo size per technology based on scaling

Subtask No. 20.7.11 Title: Prepare presentation

Subtask No. 20.7.12 Title: Presentation

Subtask No. 20.7.13 Title: Write trade study report

Subtask No. 20.7.14 Title: Incorporate comments

The **focus** of this study is the NGNP **prototype hydrogen plant** to be built at the INL site in Idaho rather than a future commercial plant.

The **purpose** of this study is two-fold:

1) Identify products, co-products, by-products, waste materials, and emissions of the NGNP prototype plant as well as appropriate destinations for these as well as any limits these may place on the size of the NGNP.

2) Recommend an appropriate size for the NGNP prototype hydrogen plant based upon these considerations as well as integration with the heat transfer system of the NGNP.

Description: This activity will characterize and quantify the products, by-products and waste streams from the NGNP and identify potential destinations or markets for them. In addition the potential impacts of the product, by-product and waste stream characteristics on the size and design of the hydrogen plant, IHX, and on the NGNP as a whole will be identified and evaluated at a pre-conceptual level. Furthermore, an appropriate size for the NGNP prototype hydrogen plant will be recommended and justified for each of the three water-splitting technologies.

Lead Responsibility: Shaw

Reporting Requirements: The products of this work are pre-conceptual heat and material balances for each of the hydrogen generation options prepared in a spreadsheet as well as a report describing the results of the study including potential sizing, design and economic impacts.

Resource Forecast:

- Manhours (total, including all support and planning) : **370 manhours**
 - Subtasks
 - Shaw : 260
 - WEC : 30
 - PBMR : 10
 - TI : 30
 - APCI : 40

- Travel Required (~~Yes~~ / No)
- Materials and Services: **None Required**
- Other Direct Costs: **None Required**

Schedule Forecast and Support Requirements:

- See attached Microsoft Project File

NGNP TASK SHEET

SubTask No.20.7.1 Title: Identify potential product markets

Lead Responsibility: Shaw

Description:

Reasonably feasible current and future (2018) markets for the four main co-products of the NGNP will be identified. Initially, a broad range of markets will be identified for each co-product. An initial estimate of the capacity of the NGNP hydrogen plant will be made. The initial set of markets will be screened based on capacity and site considerations of the NGNP. Some of these markets are expected to be eliminated in this screening. These markets will be eliminated from further consideration in the study and reasons for elimination will be given.

Reporting Requirements: Section of the report identifying and screening potential markets for NGNP products: hydrogen, oxygen and power.

Resource Forecast:

Shaw	:	20
APCI	:	8
Total	:	28 manhours

Support Requirements:

Output: Supply Preliminary hydrogen plant capacity (power level) to Activities 20.2 and 22 by 11/20

Input: None Required

NGNP TASK SHEET

SubTask No.20.7.2 Title: Identify product purity, production rate, and delivery form per market

for:

Electricity

Hydrogen

Oxygen

High temperature process heat

For guidance in the preparation of the pre-conceptual commercial design (Activity 13), purity and production rate requirements for all markets identified in subtask 20.7.1 will be investigated and recorded. Some additional markets for products from the NGNP prototype may be eliminated from further consideration in this subtask due to the difficulty in reaching the required product purity and/or production rate.

Reporting Requirements: Purity, form and capacity requirements for the markets to be included in the section for Subtask 20.7.1.

Resource Forecast:

Shaw	:	12
APCI	:	10
TI	:	6
Total	:	28 manhours

Support Requirements:

Output: None

Input: None Required

NGNP TASK SHEET

SubTask No.20.7.3 Title: Literature search on water splitting

Material generally recognized as both reliable and up-to-date on the development of the three leading technologies will be gathered, cataloged, and used as source material for this trade study.

Reporting Requirements: Reference list for the work of this Activity

Resource Forecast:

Shaw	:	34
Total	:	34 manhours

Support Requirements:

Output: None

Input: None Required

NGNP TASK SHEET

SubTask No.20.7.4 Title: Prepare pre-conceptual energy and mass balances per technology

Scalable energy and material balances for each of the leading water-splitting technologies will be prepared in sufficient detail to identify and to quantify the major co-products and the energy requirements for their production. These balances should also provide an order-of-magnitude estimate of by-product and waste streams as well. All three balances will be prepared on a common basis. Each technology has been assigned to a different organization:

HyS:	WEC
SI:	TI/ APCI
HTE:	Shaw
Process heat:	Shaw

Technology Insights will prepare an energy and material balance as appropriate using the extractive distillation flowsheet for the SI process. APCI will comment on the initial draft of this balance. Shaw and APCI will jointly decide upon the basis for these balances.

Reporting Requirements: Scalable preconceptual energy and material balances for the three leading water-splitting technologies (hybrid sulfur, high temperature electrolysis, and sulfur, iodine thermochemical) based on current literature.

Resource Forecast:

Shaw	:	24
APCI	:	4
TI	:	8
WEC	:	14
Total	:	50 manhours

Support Requirements:

Output: None

Input: None Required

NGNP TASK SHEET

Subtask No. 20.7.5 Title: Identify product purification needs per technology

From the flowsheets and energy and material balances, possible impurities will be identified and concentrations estimated. Comparing the impurity levels in the raw products with the market requirements identified in subtask 20.7.2 will indicate what purification steps are required. Appropriate purification unit operations will be suggested for each technology.

Reporting Requirements: Included in the section describing subtask 20.7.10

Resource Forecast:

Shaw	:	16
APCI	:	6
TI	:	4
WEC	:	4
Total	:	30 manhours

Support Requirements: TI to assist in identifying tritium leakage protection and expected emissions, helium purification, etc.

Output: None

Input: None Required

NGNP TASK SHEET

Subtask No. 20.7.6 Title: Identify NNGP by-products and waste streams per technology

From the flowsheets and energy and material balances as well as any streams from the purification operations, by-products and waste streams will be identified.

Reporting Requirements: Included in the section describing Subtask 20.7.7

Resource Forecast:

Shaw	:	16
APCI	:	4
TI	:	6
WEC	:	4
PBMR	:	10

Total : 40 manhours

Support Requirements: TI and PBMR to quantify expected nuclear waste streams from the NNGP

Output: None

Input: None Required

NGNP TASK SHEET

Subtask No. 20.7.7 Title: Identify appropriate destinations for products, by-products and waste streams

Appropriate markets, disposal means, and waste treatment operations will be identified for the products, by-products and waste streams identified in subtask 20.7.1 and 20.7.6.

Reporting Requirements: Section in the report describing the destinations described above

Resource Forecast:

Shaw	:	16
APCI	:	4
Total	:	20 manhours

Support Requirements:

Output: None

Input: None Required

NGNP TASK SHEET

Subtask No. 20.7.8 Title: Identify limits to NGNP sizing based on by-products and waste streams

Any limits imposed on NGNP sizing due to the difficulty in disposing of by-products or waste materials will be identified at a pre-conceptual level.

Reporting Requirements: Included in the section describing 20.7.10

Resource Forecast:

Shaw : 16

Total : 16 manhours

Support Requirements:

Output: None

Input: None Required

NGNP TASK SHEET

Subtask No. 20.7.9 Title: Identify critical equipment by technology

For each technology flowsheet that piece of equipment that limits the capacity of the largest single stream will be identified.

Reporting Requirements: A section of the report identifying the critical equipment for each technology and why this particular component was selected.

Resource Forecast:

Shaw	:	24
WEC	:	8
Total	:	32 manhours

Support Requirements:

Output: None

Input: None Required

NGNP TASK SHEET

Subtask No. 20.7.10 Title: Identify appropriate demo size per technology based on scaling and markets

For the critical piece of equipment in each of the three technology flowsheets, an appropriate module will be sized such that it will demonstrate the technical feasibility of the commercial scale unit and the capacity (power level) of the demonstration unit will be based upon that size. An early preliminary decision on this size will be made to facilitate work on other tasks this is part of subtask 20.7.1.

Reporting Requirements: Section of the report identifying the appropriate demonstration unit size for the hydrogen plant including the reasons for selection of the chosen size.

Resource Forecast:

Shaw	:	24
APCI	:	4
TI	:	6
Total	:	34 manhours

Support Requirements:

Output: None

Input: None Required

NGNP TASK SHEET

Reporting subtasks:

Subtask No. 20.7.11 Title: Prepare presentation

The presentation will be prepared in time for the December 2006 monthly meeting on December 6, 2006.

Subtask No. 20.7.12 Title: Presentation

To be made during the monthly meeting held on December 6-7, 2006.

Subtask No. 20.7.13 Title: Write the trade study report

The trade study report will be written prior to the January monthly meeting

Subtask No. 20.7.14 Title: Incorporate comments

Comments received as a result of both the presentation at the December and January monthly meetings will be incorporated. This will be a chapter in the Preconceptual Design Report.

Reporting Requirements: None

Resource Forecast:

Shaw : 58

Total : 58 manhours

Support Requirements:

Output: To support Special Studies Report Issue

Input: None Required

NGNP TASK SHEET

Task 13.2 Hydrogen production technology assessment per technology

Subtask No. 13.2.1 Title: Finalize discriminating criteria and assign weights

Subtask No. 13.2.2 Title: HyS assessment

Subtask No. 13.2.3 Title: SI assessment

Subtask No. 13.2.4 Title: HTE assessment

Subtask No. 13.2.5 Title: Prepare assessment matrix

Subtask No. 13.2.6 Title: Write trade study report and presentation

Subtask No. 13.2.7 Title: Presentation

Subtask No. 13.2.8 Title: Incorporate comments

The **focus** of this study is the pre-conceptual design of a **commercial hydrogen plant based on NGNP technology**, not the NGNP prototype to be built at the INL site in Idaho.

The **purpose** of this study is two-fold:

1) Assess the three leading water-splitting technologies according to a variety of important commercial criteria.

2) Choose a reference water-splitting technology for the pre-conceptual commercial design and thus recommend the first to be demonstrated at the INL NGNP site.

Lead Responsibility: Shaw

Reporting Requirements: A section of the activity report describing the methodology used in the evaluation, each of the evaluation criteria and the reasons for assigning each score to each technology for each criterion. This section will also include a semi-quantitative decision matrix chart.

Resource Forecast:

- Manhours (total, including all support and planning) : **460 manhours**
 - Subtasks
 - Shaw : 184
 - WEC : 60
 - TI : 96
 - APCI : 120
- Travel Required (**Yes / No**) (Travel for 50% review not included)
- Materials and Services: **None Required**
- Other Direct Costs: **None Required**

Schedule Forecast and Support Requirements:

- See attached Microsoft Project File

Subtask No. 13.2.1 Title: Finalize discriminating criteria and assign weights

A preliminary set of discriminating criteria are listed below:

- The stage of development of the process technology
- Ease of scaling from the current demonstrated size to a commercial plant
- Energy efficiency as calculated in subtask 20.7.4
- Whether all required materials of construction are available and economic
- Risks in development from current stage to commercial operation
- Risk of expansion of cost and schedule from current estimates
- Additional purification requirements that have not been piloted
- Required utility infrastructure
- Ease of siting the technology in a variety of locations
- Inherent operability
- Possible safety, health and environmental risks

These criteria will be reviewed and adjusted and appropriate weights will be assigned to each by consensus of the team members (Shaw, APCI and TI).

Reporting Requirements: None

Resource Forecast:

Shaw	: 32
APCI	: 20
TI	: 8
Total	: 60 manhours

Support Requirements:

Output: None

Input: None Required

Subtask No.13.2.2 Title: HyS assessment

Subtask No.13.2.3 Title: SI assessment

Subtask No.13.2.4 Title: HTE assessment

Each of the three leading water-splitting technologies will be assessed semi-quantitatively according to the criteria as identified and weighted in Subtask 13.2.1. All of these are important in the consideration of a new commercial technology:

- The stage of development of the process technology
- Ease of scaling from the current demonstrated size to a commercial plant
- Energy efficiency as calculated in subtask 20.7.4
- Whether all required materials of construction are available and economic
- Risks in development from current stage to commercial operation
- Risk of expansion of cost and schedule from current estimates
- Additional purification requirements that have not been piloted

Required utility infrastructure
Ease of siting the technology in a variety of locations
Inherent operability
Possible safety, health and environmental risks

Reporting Requirements: None

Resource Forecast:

Shaw	:	60
APCI	:	52
TI	:	80
WEC	:	52
Total	:	244 manhours

Support Requirements:

Output: None

Input: None Required

Reporting subtasks:

SubTask No.13.2.5 Title: Prepare evaluation matrix

Once the assessments are complete, the team will gather for a day either by phone, web conference or as an adjunct to one of our regular meetings to prepare an evaluation matrix.

Subtask No. 13.2.6 Title: Prepare presentation

Subtask No. 13.2.7 Title: Write trade study report

A presentation and the trade study report will be prepared in time for the January monthly meeting

Subtask No. 13.2.8 Title: Presentation

A presentation on this study will be given at the monthly meeting, January 9&10, 2007.

Subtask No. 13.2.8 Title: Incorporate comments

Reporting Requirements: None

Resource Forecast:

Shaw	:	92
APCI	:	48
TI	:	8
WEC	:	8
Total	:	156 manhours

Support Requirements:

Output: To support the remainder of Activity 13.

Input: None Required

NGNP ACTIVITY SHEET for SHAW

Activity No. 21 **Title: Supporting Sizing and Miscellaneous Calculations**

Task No. 21.1	Title: Nuclear Heat Source Facility
Task No. 21.2	Title: Power Conversion
Task No. 21.3	Title: Hydrogen Plant
Task No. 21.4	Title: Balance of Plant Facility

Lead Responsibility: Shaw Environmental & Infrastructure, Inc.

Description: The purpose of this task activity is to collect, organize and index the final calculations developed for the pre-conceptual design report. Execution of this task will be contingent on project records management.

Reporting Requirements: The products associated with this task shall include an Appendix to the design report containing the various final calculations organized by task, as noted above. Calculations developed utilizing specialty software will be documented accordingly.

Resource Forecast:

The labor for this Activity/Task:

- Shaw: 60manhours
- Travel Required **None**
- Materials and Services **None**
- Other Direct Costs **None**

Schedule Forecast:

- Duration: 1 weeks
- Prerequisite Milestone(s): Completion of prototype pre-conceptual design.

Support Requirements:

- Related Activity/Tasks to be completed first: All tasks relating the pre-conceptual prototype design.
- Support Team Responsibilities: WEC, PBMR, TI: Provide final design calculations and ancillary documentation.

Next Activity/Tasks requiring this effort: None

NGNP ACTIVITY SHEET for PBMR

Activity No. 4 Title: Reactor and Reactor Systems

Task No. 4.1 Title: Reactor Systems (Pebble Bed Only)
Task No. 4.2 Title: Vessel Systems
Task No. 4.3 Title: Fuel Handling and Storage System

Lead Responsibility: PBMR (Pty) Ltd.

Description: The purpose of this Activity is to provide a description, functional overview and design codes for the Reactor Unit, primary vessels systems and the Fuel Handling and Storage System.

Reporting Requirements: The product of the activity will be a slide presentation and an accompanying report summarizing the results and conclusions.

Resource Forecast:

- The Labor for this Special Study (Including project management and administrative costs):
 - PBMR: 100 manhours
 - M-Tech Industrial: 340 manhours
 - TI: 130 manhours
- Travel required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 10 weeks
- Milestone(s): Minor – Draft presentation and overall report after 8 weeks
 Major – Final presentation and overall report after 10 weeks

Support Requirements:

- Related Activity/Tasks to be completed first: **None**
- Support Team Responsibilities:
 - PBMR: review of presentation and draft document
 - M-Tech: Prepare presentation and document
 - TI: review of presentation and draft document
- Next Activity/Tasks requiring this effort: **None**

NGNP TASK SHEET

Task No. 4.1 Title: Reactor Systems (Pebble Bed)

SubTask No. 4.1.1 Title: Reactor Core

SubTask No. 4.1.2 Title: Reactor Internals and Hot Coolant Duct

Lead Responsibility: PBMR (Pty) Ltd.

Description: The objective of this task is to provide a design description and functional overview of the Reactor Core, Reactivity Control and Shutdown system, Reactor Internals and the hot coolant duct. The major components of the reactor System are identified and their modes of operation are described.

Reporting Requirements: The product of the activity will be a slide presentation and an accompanying report summarizing the results and conclusions.

Resource Forecast:

- The Labor for this Special Study:
 - PBMR: 40 manhours
 - M-Tech Industrial: 120 manhours
 - TI: 30 manhours
- Travel required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 2 weeks
- Milestone(s): Minor – Draft section after 2 weeks

Support Requirements:

- Related Activity/Tasks to be completed first: **None**
- Support Team Responsibilities:
 - PBMR: provide input and critical review of document
 - M-Tech: prepare documentation
 - TI: provide input and review of document
- Next Activity/Tasks requiring this effort: **None**

NGNP TASK SHEET

Task No. 4.2 Title: Vessel Systems

- SubTask No. 4.2.1 Title:** Geometry
- SubTask No. 4.2.2 Title:** Reactor Size
- SubTask No. 4.2.3 Title:** Size Optimization
- SubTask No. 4.2.4 Title:** Reactor Vessel Design
- SubTask No. 4.2.5 Title:** Cross Vessels
- SubTask No. 4.2.6 Title:** IHX Vessel
- SubTask No. 4.2.7 Title:** Selection of Vessel Materials
- SubTask No. 4.2.8 Title:** Vessel Support Arrangement

Lead Responsibility: PBMR (Pty) Ltd.

Description: The objective of this task is to provide a design description of the various vessel systems. This includes the Reactor vessel, the IHX Vessel and the Cross Vessel. It will also include a description of the required cooling mechanism to keep these components within their material specifications. Geometries and elevations for the various components will be provided together with layout drawings. Material selection for the various vessels and the supports for these vessels will also be addressed in this task.

Reporting Requirements: The product of the activity will be a slide presentation and an accompanying report summarizing the results and conclusions.

Resource Forecast:

- The Labor for this Special Study:
 - PBMR: 40 manhours
 - M-Tech Industrial: 160 manhours
 - TI: 80 manhours
- Travel required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 4 weeks
- Milestone(s): Minor – Draft section after 4 weeks

Support Requirements:

- Related Activity/Tasks to be completed first: **None**
- Support Team Responsibilities:
 - PBMR: provide input and critical review of document
 - M-Tech: preparation of documentation
 - TI: provide input and review of document
- Next Activity/Tasks requiring this effort: **None**

NGNP TASK SHEET

Task No. 4.3 Title: Fuel Handling and Storage System

Lead Responsibility: PBMR (Pty) Ltd.

Description: The objective of this task is to provide a design description of the Fuel Handling and Storage system. Topics covered in this task are:

- System Overview
- Components and Functional Description
- Core Loading during commissioning and start-up
- Sphere Circulation and Storage
- Defueling, unloading and refueling
- Operating Modes

Reporting Requirements: The product of the activity will be a slide presentation and an accompanying report summarizing the results and conclusions.

Resource Forecast:

- The Labor for this Special Study:
 - PBMR: 20 manhours
 - M-Tech Industrial: 60 manhours
 - TI: 20 manhours
- Travel required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 2 weeks
- Milestone(s): Minor – Draft section after 2 weeks

Support Requirements:

- Related Activity/Tasks to be completed first: **None**
- Support Team Responsibilities:
 - PBMR: provide input and critical review of document
 - M-Tech: prepare the document
 - TI: review of document
- Next Activity/Tasks requiring this effort: **None**

NGNP ACTIVITY SHEET for PBMR

Activity No. 10 Title: Reactor Fuel

Task No. 10.1 Title: Design and Qualification

Task No. 10.2 Title: Waste management and Recycling

Lead Responsibility: PBMR (Pty) Ltd.

Description: The purpose of this Activity is to provide a design description of the Reactor fuel design. Topics covered in this activity are Fuel Design and Qualification as well as Waste management and Recycling of the fuel.

Reporting Requirements: The product of the activity will be a slide presentation and an accompanying report summarizing the results and conclusions.

Resource Forecast:

- The Labor for this Special Study(Including project management and administrative costs):
 - PBMR: 80 manhours
 - M-Tech Industrial: 160 manhours
 - TI: 80 manhours
 - WEC: 120 manhours
 - NFS: 375 manhours
- Travel required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 8 weeks
- Milestone(s): Minor – Draft presentation and overall report after 6 weeks
 Major – Final presentation and overall report after 8 weeks

Support Requirements:

- Related Activity/Tasks to be completed first: **None**
- Support Team Responsibilities:
 - M-Tech: preparation and integration of task documents
 - PBMR to provide review of integrated report
 - WEC to provide review of integrated report
 - NFS to provide review of integrated report
 - TI: to provide review of integrated report
- Next Activity/Tasks requiring this effort: **None**

NGNP TASK SHEET

Task No. 10.1 Title: Design and Qualification

- SubTask No. 10.1.1 Title:** Suppliers
- SubTask No. 10.1.2 Title:** Shipping/Transportation
- SubTask No. 10.1.3 Title:** Fuel Fabrication
- SubTask No. 10.1.4 Title:** Particle Design
- SubTask No. 10.1.5 Title:** Fuel Element Design
- SubTask No. 10.1.6 Title:** Normal operational and accident Fuel Testing and Qualification
- SubTask No. 10.1.7 Title:** Fission Product Source Term Testing and Qualification

Lead Responsibility: PBMR (Pty) Ltd.

Description: The objective of this task is to address fuel design and qualification. The following topics will be addressed for the Fuel design:

- Fuel Suppliers,
- Shipping/Transportation of Fuel,
- Fuel Specification,
- Fabrication of fuel sphere, and
- Coated Particle design.

Testing and qualification requirements for the fuel during normal and accident conditions will also be addressed.

Reporting Requirements: The product of the activity will be a slide presentation and an accompanying report summarizing the results and conclusions.

Resource Forecast:

- The Labor for this Special Study:
 - PBMR: 80 manhours
 - M-Tech Industrial: 140 manhours
 - TI: 80 manhours
 - WEC: 120 manhours
 - NFS: 130 manhours
- Travel required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 6 weeks
- Milestone(s): Minor – Draft section after 6 weeks

Support Requirements:

- Related Activity/Tasks to be completed first: **None**
- Support Team Responsibilities:
 - PBMR and WEC: provide input and critical review of document
 - M-Tech: preparation of document
 - NFS: provide input and review of document
 - TI: review of document
- Next Activity/Tasks requiring this effort: **None**

NGNP TASK SHEET

Task No. 10.2 Title: Waste management and Recycling

- Task No.** 10.2.1 **Title:** What is generated?
- Task No.** 10.2.2 **Title:** Fuel Waste Management
- Task No.** 10.2.3 **Title:** Interim Storage
- Task No.** 10.2.4 **Title:** Long term storage
- Task No.** 10.2.5 **Title:** Final disposition

Lead Responsibility: PBMR (Pty) Ltd.

Description: The objective of this task is to address waste management and recycling of the reactor fuel. Topics covered in this task are:

- Description on what waste is generated,
- Management of fuel waste,
- Interim Storage,
- Long term storage, and
- Final disposition

Reporting Requirements: The product of the activity will be a slide presentation and an accompanying report summarizing the results and conclusions.

Resource Forecast:

- The Labor for this Special Study:
 - M-Tech Industrial: 20 manhours
 - NFS: 245 manhours
- Travel required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 6 weeks
- Milestone(s): Minor – Draft section after 6 week

Support Requirements:

- Related Activity/Tasks to be completed first: **None**
- Support Team Responsibilities:
 - NFS: preparation of document
 - M-Tech: review of document
- Next Activity/Tasks requiring this effort: **None**

NGNP TASK SHEET

Task No. 6.1 Title: Core Conditioning System

SubTask No. 6.1.1 Title: Core Conditioning Heat Exchangers

SubTask No. 6.1.2 Title: Core Conditioning Circulators

SubTask No. 6.1.3 Title: Core Conditioning System Control

Lead Responsibility: PBMR (Pty) Ltd.

Description: The objective of this task is to provide a design description and functional overview of the Core Conditioning System. The major components of the Core Conditioning System are identified and described, including the heat exchangers, circulator and valves. The operational conditions and modes of operation will be defined and described.

Reporting Requirements: The product of the activity will be a slide presentation and an accompanying report summarizing the results and conclusions.

Resource Forecast:

- The Labor for this Special Study:
 - PBMR: 20 manhours
 - M-Tech Industrial: 80 manhours
 - TI: 20 manhours
- Travel required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 4 weeks
- Milestone(s): Minor – Draft section after 2 weeks
Minor – Draft section after 4 weeks

Support Requirements:

- Related Activity/Tasks to be completed first: **None**
- Support Team Responsibilities:
 - PBMR: provide input and critical review of document
 - M-Tech: prepare documentation
 - TI: review of document
- Next Activity/Tasks requiring this effort: **None**

NGNP TASK SHEET

Task No. 6.2 Title: Reactor Cavity Cooling System (RCCS)

Lead Responsibility: PBMR (Pty) Ltd.

Description: The objective of this task is to provide a design description and functional overview of the Reactor Cavity Cooling System (RCCS). The topics covered in this task include:

- General description and overview
- Identify main components and describe their functions
- Operational conditions and operating Modes
- Control and Instrumentation

Reporting Requirements: The product of the activity will be a slide presentation and an accompanying report summarizing the results and conclusions.

Resource Forecast:

- The Labor for this Special Study:
 - PBMR: 20 manhours
 - M-Tech Industrial: 80 manhours
 - TI: 20 manhours
- Travel required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 4 weeks
- Milestone(s): Minor – Draft section after 2 weeks
Minor – Draft section after 4 weeks

Support Requirements:

- Related Activity/Tasks to be completed first: **None**
- Support Team Responsibilities:
 - PBMR: provide input and critical review of document
 - M-Tech: prepare documentation
 - TI: review of document
- Next Activity/Tasks requiring this effort: **None**

NGNP TASK SHEET

Task No. 6.3 Title: Spent Fuel Cooling System

Lead Responsibility: PBMR (Pty) Ltd.

Description: This topic will be covered under Task 4.3 which describes the Fuel Handling and Storage System.

NGNP TASK SHEET

Task No. 6.4 Title: Nuclear Island Cooling System

Lead Responsibility: PBMR (Pty) Ltd.

Description: The objective of this task is to provide a design description and functional overview of the Nuclear Island Cooling System.

The topics covered in this task include:

- System Overview and description
- Identify main components and provide a functional overview
- Layouts for various subsystems
- Operational conditions and operating modes
- Control and Instrumentation

Reporting Requirements: The product of the activity will be a slide presentation and an accompanying report summarizing the results and conclusions.

Resource Forecast:

- The Labor for this Special Study:
 - PBMR: 20 manhours
 - M-Tech Industrial: 80 manhours
 - TI: 20 manhours
- Travel required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 4 weeks
- Milestone(s): Minor – Draft section after 2 weeks
Minor – Draft section after 4 weeks

Support Requirements:

- Related Activity/Tasks to be completed first: **None**
- Support Team Responsibilities:
 - PBMR: provide input and critical review of document
 - M-Tech: prepare documentation
 - TI: review of document
- Next Activity/Tasks requiring this effort: **None**

NGNP TASK SHEET

Task No. 6.5 Title: Helium Services System

SubTask No. 6.5.1 Title: Helium Purification Train

SubTask No. 6.5.2 Title: Helium Transfer and Storage Train

Lead Responsibility: PBMR (Pty) Ltd.

Description: The objective of this task is to provide a design description and functional overview of the Helium Services System. This includes the various subsystems of the system, including the Helium purification system, helium make-up system, helium storage system. The topics covered for each subsystem include:

- Overview description
- Identify main components and provide a functional overview
- Operational conditions and characteristics
- Operational modes

Reporting Requirements: The product of the activity will be a slide presentation and an accompanying report summarizing the results and conclusions.

Resource Forecast:

- The Labor for this Special Study:
 - PBMR: 20 manhours
 - M-Tech Industrial: 100 manhours
 - TI: 40 manhours
- Travel required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 5 weeks
- Milestone(s): Minor – Draft section after 3 weeks
Minor – Draft section after 5 weeks

Support Requirements:

- Related Activity/Tasks to be completed first: **None**
- Support Team Responsibilities:
 - PBMR: provide input and critical review of document
 - M-Tech: prepare documentation
 - TI: review of document
- Next Activity/Tasks requiring this effort: **None**

NGNP TASK SHEET

Task No. 6.6 Title: Radioactive Waste and Decontamination System

Lead Responsibility: PBMR (Pty) Ltd.

Description: The objective of this task is to provide a design description of the Radioactive Waste and Decontamination system. The topics covered include:

- Overview description
- Identify main components and provide a functional overview
- Operational conditions
- Describing waste handling including Gaseous Waste, Liquid Waste and Solid Waste
- Operational modes

Reporting Requirements: The product of the activity will be a slide presentation and an accompanying report summarizing the results and conclusions.

Resource Forecast:

- The Labor for this Special Study:
 - PBMR: 20 manhours
 - M-Tech Industrial: 80 manhours
 - TI: 20 manhours
- Travel required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 4 weeks
- Milestone(s): Minor – Draft section after 2 weeks
Minor – Draft section after 4 weeks

Support Requirements:

- Related Activity/Tasks to be completed first: **None**
- Support Team Responsibilities:
 - PBMR: provide input and critical review of document
 - M-Tech: prepare documentation
 - TI: review of document
- Next Activity/Tasks requiring this effort: **None**

NGNP TASK SHEET

Task No. 6.12 Title: Nuclear System Electrical System

Lead Responsibility: PBMR (Pty) Ltd.

Description: The objective of this task is to provide a design description of the Nuclear System Electrical System. The topics covered include:

- General Overview and functional description
- Network connections and layout
- Identify main components and provide a functional overview
- Operational conditions

Reporting Requirements: The product of the activity will be a slide presentation and an accompanying report summarizing the results and conclusions.

Resource Forecast:

- The Labor for this Special Study:
 - PBMR: 20 manhours
 - M-Tech Industrial: 80 manhours
 - WEC: 20 manhours
- Travel required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 4 weeks
- Milestone(s): Minor – Draft section after 2 weeks
Minor – Draft section after 4 weeks

Support Requirements:

- Related Activity/Tasks to be completed first: **None**
- Support Team Responsibilities:
 - PBMR: provide input and critical review of document
 - M-Tech: prepare documentation
 - WEC: review of document
- Next Activity/Tasks requiring this effort: **None**

NGNP ACTIVITY SHEET for PBMR

Activity No. 5 Title: Power Generation System

Task No. 5.1 Title: Cycle Operational Conditions

Task No. 5.2 Title: Components

Lead Responsibility: PBMR (Pty) Ltd.

Description: The purpose of this Activity is to provide a design description of the power generation system. The cycle operational conditions are determined (pressures, temperatures and flow rates) for the power conversion unit and the requirements for the various components are provided.

Reporting Requirements: The product of the activity will be a slide presentation and an accompanying report summarizing the results and conclusions.

Resource Forecast:

- The Labor for this Special Study(Including project management and administrative costs):
 - PBMR: 120 manhours
 - M-Tech Industrial: 280 manhours
 - TI: 130 manhours
- Travel required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 10 weeks
- Milestone(s): Minor – Draft presentation and overall report after 8 weeks
 Major – Final presentation and overall report after 10 weeks

Support Requirements:

- Related Activity/Tasks to be completed first: **None**
- Support Team Responsibilities:
 - M-Tech to prepare and integrate various documents in tasks
 - PBMR: provide input and review of integrated report
 - TI: to provide review of integrated report
- Next Activity/Tasks requiring this effort: **None**

NGNP TASK SHEET

Task No. 5.1 Title: Cycle Operational Conditions

SubTask No. 5.1.1 Title: Pressures, Temperatures, Working Fluids

SubTask No. 5.1.2 Title: Interstage Cooling

SubTask No. 5.1.3 Title: Waste Heat Rejection

Lead Responsibility: PBMR (Pty) Ltd.

Description: The operational cycle parameters are determined for the power conversion system. The cycle parameters include pressures, temperatures, flow rates, working fluid and an energy balance for the plant. Cooling and leak flow requirements for the various components will be taken into account when performing these calculations. An optimization study will be performed to determine the optimum cycle parameters.

Reporting Requirements: The product of the activity will be a slide presentation and an accompanying report summarizing the results and conclusions.

Resource Forecast:

- The Labor for this Special Study:
 - PBMR: 80 manhours
 - M-Tech Industrial: 170 manhours
 - TI: 90 manhours
- Travel required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 5 weeks
- Milestone(s): Minor – Draft section after 5 weeks

Support Requirements:

- Related Activity/Tasks to be completed first: **None**
- Support Team Responsibilities:
 - M-Tech to perform analysis and prepare documents
 - PBMR provide input and critical review of document
 - TI: provide input and review of draft
- Next Activity/Tasks requiring this effort: **Task 5.2**

NGNP TASK SHEET

Task No. 5.2 Title: Components

- SubTask No. 5.2.1 Title:** Turbomachinery
- SubTask No. 5.2.2 Title:** Heat Exchangers
- SubTask No. 5.2.3 Title:** Recuperator
- SubTask No. 5.2.4 Title:** Coolers
- SubTask No. 5.2.5 Title:** Ducting and Diffusers

Lead Responsibility: PBMR (Pty) Ltd.

Description: The objective of this task is to provide design descriptions for the various power conversion systems. Component specifications and constraints will be provided for the turbomachinery, heat exchangers, ducting and diffusers.

Reporting Requirements: The product of the activity will be a slide presentation and an accompanying report summarizing the results and conclusions.

Resource Forecast:

- The Labor for this Special Study:
 - PBMR: 40 manhours
 - M-Tech Industrial: 110 manhours
 - TI: 40 manhours
- Travel required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 3 weeks
- Milestone(s): Minor – Draft section after 3 week

Support Requirements:

- Related Activity/Tasks to be completed first: **Task 5.1**
- Support Team Responsibilities:
 - M-Tech to perform analysis and prepare documents
 - PBMR provide input and critical review of document
 - TI: provide input and review of draft
- Next Activity/Tasks requiring this effort: **None**

NGNP ACTIVITY SHEET for PBMR

Activity No. 14 Title: Overall NGNP Operation

Task No.	14.1	Title: Nuclear Heat Source Performance
Task No.	14.2	Title: Operating Modes
Task No.	14.3	Title: Transient Operation and Control
Task No.	14.4	Title: Waste Stream

Lead Responsibility: PBMR (Pty) Ltd.

Description: The objective of this activity is to provide a description of the overall NGNP operation. Various modes of operation will be defined and described for the Nuclear Heat Source operation together with the hydrogen production plant and power conversion system.

Reporting Requirements: The product of the activity will be a slide presentation and an accompanying report summarizing the results and conclusions.

Resource Forecast:

- The Labor for this Special Study:
 - PBMR: 170 manhours
 - M-Tech Industrial: 480 manhours
 - TI: 200 manhours
 - Shaw: 124 manhours
 - WEC: 164 manhours
- Travel required
 - One 3-day meeting with team members at Boston
 - PBMR: 1 person (JNB to Boston)
 - M-Tech Industrial: 1 person (JNB to Boston)
 - TI: 2 people (TI-SAN to Boston)
 - WEC: 1 person (Pittsburg to TI-SAN)
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 16 weeks
- Milestone(s): Minor – Draft presentation and overall report after 14 weeks
Major – Final presentation and overall report after 16 weeks

Support Requirements:

- Related Activity/Tasks to be completed first: **None**
- Support Team Responsibilities:
 - M-Tech to integrate the various tasks into a single report
 - PBMR to provide review of integrated report
 - TI: to provide review of integrated report

- SHAW: to provide review of integrated report
 - WEC: to provide review of integrated report
- Next Activity/Tasks requiring this effort: **None**

NGNP TASK SHEET

Task No. 14.1 Title: Nuclear Heat Source Performance

SubTask No. 14.1.1 Title: Design Point

SubTask No. 14.1.2 Title: Performance Uncertainties

Lead Responsibility: PBMR (Pty) Ltd.

Description: This task will determine the performance parameters of the Nuclear Heat Source. The design envelope for the various components will be determined. This includes operation at the nominal design point and at various reduced power capabilities. Input and design uncertainties will be evaluated to determine the expected performance variance from the nominal design condition of the plant.

Reporting Requirements: The product of the activity will be a slide presentation and an accompanying report summarizing the results and conclusions.

Resource Forecast:

- The Labor for this Special Study:
 - PBMR: 60 manhours
 - M-Tech Industrial: 160 manhours
 - TI: 70 manhours
 - Shaw: 24 manhours
 - WEC: 24 manhours
- Travel required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 4 weeks
- Milestone(s): Minor – Draft section after 4 weeks

Support Requirements:

- Related Activity/Tasks to be completed first: **None**
- Support Team Responsibilities:
 - PBMR provide input and critical review of document
 - M-Tech Industrial to perform the various analysis
 - Shaw to provide uncertainty parameters for the hydrogen plant
 - WEC to provide uncertainty parameters for the hydrogen plant
 - TI: review of draft section
- Next Activity/Tasks requiring this effort: **Task 14.1, 14.3**

NGNP TASK SHEET

Task No. 14.2 Title: Operating Modes

SubTask No. 14.2.1 Title: Philosophy of nuclear Heat Source Operational Control

SubTask No. 14.2.2 Title: Operating Modes

SubTask No. 14.2.3 Title: Nuclear Heat Source / Power Conversion System / Hydrogen Plant Inter-Dependencies

Lead Responsibility: PBMR (Pty) Ltd.

Description: The objective of this task is to determine the various operating modes and states for the overall NGNP plant. This includes all expected transients and transitions for normal operational conditions and for various accident conditions. The overall NGNP control philosophy will be described and the inter-dependencies between the nuclear heat source, power conversion system and hydrogen plant will be evaluated and described.

Reporting Requirements: The product of the activity will be a slide presentation and an accompanying report summarizing the results and conclusions.

Resource Forecast:

- The Labor for this Special Study:
 - PBMR: 60 manhours
 - M-Tech Industrial: 140 manhours
 - TI: 70 manhours
 - Shaw: 100 manhours
 - WEC: 60 manhours
- Travel required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 4 weeks
- Milestone(s): Minor – Draft section after 4 week

Support Requirements:

- Related Activity/Tasks to be completed first: **Task 14.1**
- Support Team Responsibilities:
 - PBMR provide input and critical review of document
 - TI: review of draft
- Next Activity/Tasks requiring this effort: **Task 14.3**

NGNP TASK SHEET

Task No. 14.3 **Title:** Transient Operation and Control

- SubTask No. 14.3.1 Title:** Bypass Valve System
- SubTask No. 14.3.2 Title:** Turbomachinery Speed
- SubTask No. 14.3.3 Title:** Helium Inventory System
- SubTask No. 14.3.4 Title:** Reactor Power
- SubTask No. 14.3.5 Title:** Core Outlet Temperature

Lead Responsibility: PBMR (Pty) Ltd.

Description: The objective of this task is to define the transient behavior of the overall NGNP plant. The various control mechanism will be evaluated, e.g. Reactor power changes, helium inventory, bypass valve configurations and reactor outlet temperature changes.

Reporting Requirements: The product of the activity will be a slide presentation and an accompanying report summarizing the results and conclusions.

Resource Forecast:

- The Labor for this Special Study:
 - PBMR: 40 manhours
 - M-Tech Industrial: 160 manhours
 - TI: 60 manhours
- Travel required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 4 weeks
- Milestone(s): Minor – Draft section after 4 week

Support Requirements:

- Related Activity/Tasks to be completed first: **Task 14.1**
- Support Team Responsibilities:
 - PBMR provide input and critical review of document
 - TI: review of draft
- Next Activity/Tasks requiring this effort: **Task 14.2**

NGNP TASK SHEET

Task No. 14.4 Title: Waste Stream

SubTask No. 14.4.1 Title: Identification of Nuclear System Waste Streams

SubTask No. 14.4.2 Title: Waste Stream

SubTask No. 14.4.3 Title: Elimination

SubTask No. 14.4.4 Title: Reduction

SubTask No. 14.4.5 Title: Disposal

Lead Responsibility: PBMR (Pty) Ltd.

Description: The objective of this task is to identify all nuclear waste streams and provide the strategy to address waste elimination, reduction and disposal.

Reporting Requirements: The product of the activity will be a slide presentation and an accompanying report summarizing the results and conclusions.

Resource Forecast:

- The Labor for this Special Study:
 - PBMR: 10 manhours
 - M-Tech Industrial: 20 manhours
 - WEC: 80 manhours
- Travel required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 2 weeks
- Milestone(s): Minor – Draft section after 2 week

Support Requirements:

- Related Activity/Tasks to be completed first: **None**
- Support Team Responsibilities:
 - PBMR provide review of section
 - WEC Industrial to produce waste stream section
 - M-Tech to provide input and review of section
- Next Activity/Tasks requiring this effort: **None**

NGNP ACTIVITY SHEET for PBMR

Activity No. 7 Title: Maintainability

Task No. 7.1 Title: Maintenance Requirements for Key Systems, Vessel Systems and Components

Task No. 7.2 Title: Primary Circuit Radioactive Contamination

Task No. 7.3 Title: Occupational Dose

Task No. 7.4 Title: Inspectability

Task No. 7.5 Title: Critical Equipment Access Requirements

Lead Responsibility: PBMR (Pty) Ltd.

Description:

The purpose of this Activity is to define, evaluate and integrate the different maintenance challenges and issues for key systems and plant components to ensure the maintainability of the NGNP. The maintenance requirements for the key system, vessel systems and components described in, but not limited to, Activities 4: Reactor and Reactor Systems as well as Activity A: Primary Heat Transport System and Activity 5: Task 5.2 Components will be defined. The maintainability of the NGNP and especially the primary circuit will be assessed. This will entail a preliminary analysis of the possible radioactive contamination of the primary circuit components and trade offs between direct and indirect coupling. An investigation into the access requirements for critical equipment needed to ensure maintainability of the plant will also be performed as well as the impact that inspectability has on the maintenance activities and maintainability of the plant. The occupational dose during maintenance activities on key systems and components will be calculated to ensure that the occupational doses for personnel performing maintenance are within specified limits.

Reporting Requirements:

The products of this activity will be included in the preconceptual design report and will include lists of key systems and components, maintenance specification, plans and schedules, as well as access requirements.

Resource Forecast:

- Manhours (Including project management and administrative costs)
 - PBMR: 60 manhours
 - M-Tech: 160 manhours
 - TI: 32 manhours
 - SHAW: 20 manhours
 - WEC 32 manhours
- Travel Required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 6 weeks
- Milestone(s): Major – Final report after 6 weeks.

Support Requirements:

- Related Activity/Tasks to be completed first: Various inputs from other activities such as Activity 4: Reactor and Reactor systems; Activity 5: Power Generation Systems; Activity 14: Overall NNGNP Operation and Activity A: Primary Heat Transport System are required before the maintenance specifications of the key systems and components can be defined.
- Support Team Responsibilities: (from DOR chart)
 - PBMR: Technical inputs and review
 - M-Tech: Technical inputs and review
 - TI: Review
 - SHAW: Review
 - WEC: Review
- Next Activity/Tasks requiring this effort: **None**

NGNP TASK SHEET

Task No. 7.1 Title: Maintenance Requirements for Key Systems, Vessel Systems and Components

Lead Responsibility: M-Tech

Description:

The purpose of this Activity is to define the maintenance requirements for the key system, vessel systems and components as defined in, but not limited to, Activities 4 Reactor and Reactor Systems as well as Activity A: Primary Heat Transport System and Activity 5 Task 5.2 Components.

Reporting Requirements:

The products of this task are a list of the defined Key System, Vessel Systems and Components as well as the maintenance requirements for each of these systems or components that will be included in the preconceptual design report.

Resource Forecast:

- Manhours
 - M-Tech: 32 manhours
 - PBMR: 12 manhours
 - TI: 8 manhours
 - WEC 8 manhours
 - Shaw: 4 manhours
- Travel Required: No
- Materials and Services: None
- Other Direct Costs: None

Schedule Forecast:

- Duration: 4 weeks
- Milestone(s): Minor – Draft list after 2 weeks.
Major – Final list after 4 weeks.

Support Requirements:

- Related Activity/Tasks to be completed first: Various inputs from other activities such as Activity 4: Reactor and Reactor systems; Activity 5: Power Generation Systems; Activity 14: Overall NGNP Operation and Activity A: Primary Heat Transport System are required before the maintenance specifications of the key systems and components can be defined.
- Support Team Responsibilities:
 - PBMR: Technical inputs and review
 - TI: Technical inputs and review
 - WEC: Review
- Next Activity/Tasks requiring this effort: None

NGNP TASK SHEET

Task No. 7.2 Title: Maintainability Assessment

SubTask No. 7.2.1 Title: Primary Circuit Radioactive Contamination

SubTask No. 7.2.2 Title: Primary Circuit components

Lead Responsibility: M-Tech

Description:

The purpose of this Activity is to assess the maintainability of the NGNP and especially the primary circuit. This will entail a preliminary analysis of the possible radioactive contamination of the primary circuit components and trade offs between direct and indirect coupling.

Reporting Requirements:

The products of this activity will be included in the preconceptual design report.

Resource Forecast:

- Manhours
 - M-Tech: 38 manhours
 - PBMR: 14 manhours
 - TI: 4 manhours
 - WEC 4 manhours
 - Shaw: 4 manhours
- Travel Required No
- Materials and Services: None
- Other Direct Costs: None

Schedule Forecast:

- Duration: 4 weeks
- Milestone(s): Minor – Draft report after 2 weeks.
Major – Final report after 4 weeks.

Support Requirements:

- Related Activity/Tasks to be completed first:
 - Activity 5: Power Generation System as well as Activity A: Primary Heat Transport System.
- Support Team Responsibilities:
 - PBMR: Technical inputs and review
 - TI: Technical inputs and review
 - WEC: Review
- Next Activity/Tasks requiring this effort: None

NGNP TASK SHEET

Task No. 7.3 Title: Occupational Dose

Lead Responsibility: M-Tech

Description:

The purpose of this Activity is to calculate the occupational dose during maintenance activities on key systems and components to ensure that the occupational doses for personnel performing maintenance are within specified limits.

Reporting Requirements:

The products of this activity will be included in the preconceptual design report.

Resource Forecast:

- Manhours
 - PBMR: 10 manhours
 - M-Tech: 28 manhours
 - TI: 8 manhours
 - WEC 8 manhours
 - Shaw: 4 manhours
- Travel Required No
- Materials and Services: None
- Other Direct Costs: None

Schedule Forecast:

- Duration: 4 in weeks
- Milestone(s): Minor – Draft report after 2 weeks.
 Major – Final report after 4 weeks.

Support Requirements:

- Related Activity/Tasks to be completed first:
 - Activity 14: Overall NNGP Operation and Activity 7 Task 7.1 and 7.2
- Support Team Responsibilities:
 - PBMR: Technical inputs and review
 - TI: Technical inputs and review
 - WEC: Review
- Next Activity/Tasks requiring this effort: None

NGNP TASK SHEET

Task No. 7.4 Title: Inspectability

Lead Responsibility: M-Tech

Description:

The purpose of this Activity is to define and investigate the impact that inspectability has on the maintenance activities and maintainability of the plant.

Reporting Requirements:

The products of this activity will be included in the preconceptual design report.

Resource Forecast:

- Manhours
 - PBMR: 10 manhours
 - M-Tech: 28 manhours
 - TI: 8 manhours
 - WEC 8 manhours
 - Shaw: 4 manhours
- Travel Required No
- Materials and Services: None
- Other Direct Costs: None

Schedule Forecast:

- Duration: 4 in weeks
- Milestone(s): Minor – Draft report after 2 weeks.
Major – Final report after 4 weeks.

Support Requirements:

- Related Activity/Tasks to be completed first:
 - Activity 7 Task 7.1 and 7.2
- Support Team Responsibilities:
 - PBMR: Technical inputs and review
 - TI: Technical inputs and review
 - WEC: Review
- Next Activity/Tasks requiring this effort: None

NGNP TASK SHEET

Task No. 7.5 Title: Critical Equipment Access Requirements

Lead Responsibility: M-Tech

Description:

The purpose of this Activity is to define the access requirements for critical equipment needed to ensure maintainability of the plant.

Reporting Requirements:

The products of this activity will be included in the preconceptual design report.

Resource Forecast:

- Manhours
 - PBMR: 14 manhours
 - M-Tech: 34 manhours
 - TI: 4 manhours
 - WEC 4 manhours
 - Shaw: 4 manhours
- Travel Required No
- Materials and Services: None
- Other Direct Costs: None

Schedule Forecast:

- Duration: 4 in weeks
- Milestone(s): Minor – Draft report after 2 weeks.
 Major – Final report after 4 weeks.

Support Requirements:

- Related Activity/Tasks to be completed first:
 - Activity 7 Task 7.1 and 7.2
- Support Team Responsibilities:
 - PBMR: Technical inputs and review
 - TI: Technical inputs and review
 - WEC: Review
- Next Activity/Tasks requiring this effort: None

NGNP ACTIVITY SHEET

Activity No. 8

Title: Safety

Task No. 8.1

Title: Safety Features

Task No. 8.2

Title: Nuclear Heat Source Safety Assessment

Lead Responsibility: PBMR

Description:

The purpose of this activity is to describe the key safety features of the PBMR-based reactor design for the NGNP including inherent and passive design and safety characteristics, including the containment philosophy, structures, systems and components required for safety, and the role of the operator. This will include the human performance aspects of the main control room design.

Additionally, a preconceptual perspective of the safety performance will be provided through use of a risk-informed licensing framework using representative frequency-consequence risk diagrams for the PBMR. A summary of safety hazards from the process heat plant systems and components and their potential impact to the nuclear island will be provided. An evaluation of the overall plant safety and licensability will be provided based on the NGNP preconceptual design configuration.

Reporting Requirements:

The products of this activity are two reports:

- The Inherent and Passive Design and Safety Features of the PBMR
- Safety Performance and Licensability of the PBMR

Resource Forecast:

- The Summary Labor for this Activity(Including project management and administrative costs):
 - TI: 100 manhours
 - PBMR: 240 manhours
 - W: 40 manhours
 - M-Tech: 24 manhours
- Travel required: Two US plane trips and four nights lodging etc.
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 8 weeks
- Milestone(s): Completion of Task 8.1
Completion of Task 8.2/Activity 8

Support Requirements:

- Related Activity/Tasks to be completed first: This task requires the completion or substantial progress on Activity 15: Licensing and Permitting; and Task 13.1: Hydrogen Plant Requirements
- Support Team Responsibilities:
 - W: provide input on Licensing
 - Shaw: provide input Hydrogen Plant layout and hazards
 - TI: Provide input on BOP transient performance to primary system; new risk issues
- Next Activity/Tasks requiring this effort: Special Study 20.6

NGNP ACTIVITY TASK SHEET

Task No. 8.1

Title: Safety Features

Lead Responsibility: PBMR

Description:

The purpose of this task is to describe the key inherent safety features of the PBMR-based reactor design for the NGNP, including inherent and passive design and safety characteristics, and the confinement of radionuclides in a multi-barrier set of containment features and systems; discuss the use of a risk-informed, performance-based licensing approach to identifying and classifying safety-related Structures, Systems, and Components (SSCs); and identify the principle safety-related SSCs required. Also, the general role of the operator will be described for design basis accidents and for investment protection as a background for control and instrument system philosophies. This will include the human performance aspects of the main control room design.

The design of the basic PBMR electric power plant provides the foundation for the NGNP inherent and passive safety features for the reactor, its support systems and structures.

Reporting Requirements:

The product of this task is one report:

- The Inherent and Passive Design and Safety Features of the PBMR

Resource Forecast:

- The Labor for this Task:
 - TI: 20 manhours
 - PBMR: 140 manhours
 - W: 20 manhours
 - M-Tech: 24 manhours
- Travel required: **None**.
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 3 weeks
- Milestone(s): Completion of Task 8.1

Support Requirements:

- Related Activity/Tasks to be completed first: None
- Support Team Responsibilities:
 - W: provide input on Licensing
 - Shaw: provide input Hydrogen Plant layout and hazards
 - TI: Provide input on BOP transient performance to primary system; new risk issues

- Next Activity/Tasks requiring this effort: Special Study 20.6

NGNP ACTIVITY TASK SHEET

Task No. 8.2

Title: Nuclear Heat Source Safety Assessment

Lead Responsibility: PBMR

Description:

The purpose of this task is to provide a preconceptual safety perspective of a risk-informed licensing framework for the PBMR-based reactor design for the NGNP., through the use of representative frequency-consequence risk diagrams Event sequences will be described for several events such as pressurized loss of forced cooling, depressurized loss of forced cooling, and reactivity insertion events. This will provide an understanding of the basic response of the PBMR to transient and accident conditions and provide a sense of accident consequences relative to regulatory acceptance criteria. A summary of expected hazards from the process heat plant systems and components and their potential impact to the nuclear island will be provided. From the basic understanding of the PBMR safety performance, an evaluation of the overall plant safety and licensability will be provided.

The performance of the basic PBMR electric power plant provides the foundation of the NGNP safety assessment and safety performance. Direct Brayton cycle performance will be reflected where the performance is expected to be typical of the NGNP. Qualitative and/or quantitative discussions of performance differences in an indirect cycle will be provided.

Reporting Requirements:

The products of this task are one report:

- Safety Performance and Licensability of the PBMR

Resource Forecast:

- The Labor for this Task:
 - TI: 80 manhours
 - PBMR: 100 manhours
 - W: 20 manhours
- Travel required: Two US plane trips and four nights lodging etc.
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 5 weeks
- Milestone(s): Completion of Task 8.1
Completion of Task 8.2/Activity 8

Support Requirements:

- Related Activity/Tasks to be completed first: This task requires the completion or substantial progress on Activity 15: Licensing and Permitting; and Task 13.1: Hydrogen Plant Requirements
- Support Team Responsibilities:
 - W: provide input on Licensing
 - Shaw: provide input Hydrogen Plant layout and hazards
 - TI: Provide input on BOP transient performance to primary system; new risk issues
- Next Activity/Tasks requiring this effort: Special Study 20.6

NGNP ACTIVITY SHEET for PBMR

Activity No. 12 Title: Reactor Simulator

Task No. 12.1	Title: Simulator Design Requirements
Task No. 12.2	Title: Simulator Design
Task No. 12.3	Title: Simulator Operations

Lead Responsibility: PBMR

Description: The purpose of this task is to integrate the specified design requirements for the NGNP reactor simulator with the simulator design and operation requirements to ensure that the plant simulator for the NGNP can be used to:

- Test designs and control philosophies before plant construction and commissioning to ensure safe plant operation,
- Test the impact of modifications on the plant after commissioning,
- Train plant operators and test their skill levels before they operate the actual plant,

Reporting Requirements: The products of this activity will be included in the preconceptual design report and will include Task deliverables such as the simulator design requirements, the simulator design and the simulator operational specification.

Resource Forecast:

- Manhours(Including project management and administrative costs):
 - PBMR: 30 manhours
 - M-Tech: 270 manhours
- Travel Required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: Defined at Task level
- Milestone(s): Defined at Task level

Support Requirements:

- Related Activity/Tasks to be completed first:
 - Activity 14: Overall NGNP plant operation
- Support Team Responsibilities:
 - PBMR: Review
 - M-Tech: Technical input and review
- Next Activity/Tasks requiring this effort: **None**

NGNP TASK SHEET

Task No. 12.1 Title: Simulator Design Requirements

Lead Responsibility: M-Tech

Description:

The purpose of this activity is to define the Simulator design requirements and specifications. This will include the definition of the communication backbone; the definition of the scheduling and synchronizing the simulator components through control signals and messages; the specification of user controls in the simulator through the Operating, Instructor and Engineering Stations; handling user security and logins; defining all communication between the simulator components and the Database; and various other requirements.

Reporting Requirements: The product of this Task will be a Simulator Requirement Specification that will be integrated into the preconceptual design report.

Resource Forecast:

- Manhours
 - PBMR 10 manhours
 - M-Tech 110 manhours
- Travel Required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 4 weeks
- Milestone(s): Minor – draft specification completed in 2 weeks.
 Major – final specification completed in 4 weeks.

Support Requirements:

- Related Activity/Tasks to be completed first:
 - Activity 14: Overall NGNP Operation needs to be finalized before the simulator design requirements can be finalized.
- Support Team Responsibilities:
 - M-Tech: Technical input and review
- Next Activity/Tasks requiring this effort: **None**

NGNP TASK SHEET

Task No. 12.2 Title: Simulator Design

Lead Responsibility: M-Tech

Description:

The purpose of this activity is to perform a preconceptual design of the simulator for the NGNP and its subsystems. In this Task a layout of the proposed simulator will be developed showing the various modules of the simulator and their communication interfaces. Scoping studies will be done to verify the feasibility of various approaches and techniques as well as coupling of thermal-fluid and chemical modeling tools.

Reporting Requirements: The product of this Task will be a preconceptual Simulator design that will be integrated into the preconceptual design report.

Resource Forecast:

- Manhours
 - PBMR 10 manhours
 - M-Tech 110 manhours
- Travel Required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 4 weeks
- Milestone(s): Minor – draft specification completed in 2 weeks.
 Major – final specification completed in 4 weeks.

Support Requirements:

- Related Activity/Tasks to be completed first:
 - Activity 12 Task 12.1: Simulator Design Requirement needs to be finalized before the simulator design can be finalized.
- Support Team Responsibilities:
 - M-Tech: Technical input and review
- Next Activity/Tasks requiring this effort: **None**

NGNP TASK SHEET

Task No. 12.3 Title: Simulator Operations

Lead Responsibility: M-Tech

The purpose of this activity is to specify the operations modes of the NGNP simulator. In this Task a breakdown of the various simulator operating modes will be shown and feasibility studies with regards to operational speed etc. will be performed.

Reporting Requirements: The product of this Task will be an operational specification for the simulator that will be integrated into the preconceptual design report.

Resource Forecast:

- Manhours
 - PBMR 10 manhours
 - M-Tech 50 manhours
- Travel Required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 2 weeks
- Milestone(s): Minor – draft specification completed in 1 week.
 Major – final specification completed in 2 weeks.

Support Requirements:

- Related Activity/Tasks to be completed first:
 - Activity 12 Task 12.2: Simulator Design needs to be finalized before the simulator design can be finalized.
- Support Team Responsibilities:
 - M-Tech: Technical input and review
- Next Activity/Tasks requiring this effort: **None**

NGNP TASK SHEET

Special Study No. 20.2 Title: Prototype Power Level Study

Lead Responsibility: PBMR

Description: The purpose of this activity is to investigate various Reactor power levels for the Prototype plant as well as the Commercial plant in order to determine the optimum power level for the NGNP reactor. This will include the reference to the power level of the hydrogen plant.

The study will include scoping calculation to quantify the impact of the power level on design conditions such temperature distribution in components. Sensitivity analyses for power levels and temperature will be performed as well as preliminary accident analyses such as Depressurized Loss of Coolant incidents.

Reporting Requirements: The product of the activity will be a slide presentation and a report summarizing the results of the investigation.

Resource Forecast:

- Manhours
 - PBMR: 80 manhours
 - M-Tech: 240 manhours
 - TI: 80 manhours
- Travel Required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 8 weeks
- Milestone(s): Major – final report completed in 8 weeks.

Support Requirements:

- Related Activity/Tasks to be completed first: None
- Support Team Responsibilities:
 - M-Tech: Technical inputs and review
 - TI: Technical inputs and review
- Next Activity/Tasks requiring this effort: None

NGNP TASK SHEET

Special Study No. 20.4 Title: Power Conversion System (PCS) Trade Study

- SubTask No. 20.4.1 Title: High Efficiency PCS Configuration Options**
- SubTask No. 20.4.2 Title: Cycle Operational Conditions**
- SubTask No. 20.4.3 Title: Components**
- SubTask No. 20.4.4 Title: Important Considerations for the Program Decision Process**
- SubTask No. 20.4.5 Title: Silver fission Product**
- SubTask No. 20.4.6 Title: Low Risk Conversion Capability**
- SubTask No. 20.4.7 Title: Capital and Life Cycle Costs**
- SubTask No. 20.4.8 Title: References**

Lead Responsibility: PBMR

Description: The purpose of this activity is to investigate various Power Conversion Systems (PCS) configurations and layouts in terms of number of shafts, direct (Brayton) vs. indirect cycle (Rankine). This will be done to evaluate the cycle efficiency, operating conditions, component layout as well as Industry readiness and maturity for manufacturing. This activity will also link to research and development activities. Attention will also be given in this study to fission product i.e. silver as well as capital and life cycle cost estimations.

Reporting Requirements: The product of the activity will be a report summarizing the each of the subtasks.

Resource Forecast:

- Manhours
 - PBMR: 80 manhours
 - M-Tech: 240 manhours
 - TI: 80 manhours
- Travel Required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: 8 weeks
- Milestone(s): Major – final report completed in 8 weeks.

Support Requirements:

- Related Activity/Tasks to be completed first: None
- Support Team Responsibilities:
 - M-Tech: Technical inputs and review
 - TI: Technical inputs and review
- Next Activity/Tasks requiring this effort: None

NGNP TASK SHEET

Special Study No. 20.5 Title: Primary and Secondary Cycle Concept Study

Lead Responsibility: PBMR

Description: This work will be done as part of Task C, Task 20.3 and Task 204.

Reporting Requirements: The product of the activity will be a report summarizing the results of the investigation.

Resource Forecast:

- Manhours: **None**
- Travel Required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: N/A
- Milestone(s): N/A

Support Requirements:

- Related Activity/Tasks to be completed first: **None**
- Support Team Responsibilities:
- Next Activity/Tasks requiring this effort: **None**

NGNP ACTIVITY SHEET FOR A. KADAK

Activity No. 19 Title: Research and Development

Task No. 19.1 Title: Reactor Design, Fabrication and Construction

Task No. 19.2 Title: R&D to Support Reactor Start-Up

**Task No. 19.3 Title: R&D to Support Demonstration/
Commercialization**

**Task No. 19.4 Title: High Temperature Materials for Reactor Systems
(Piping, Valves, Vessels, etc)**

Task No. 19.5 Title: Instrumentation

Task No. 19.6 Title: Materials Outline Specifications

Lead Responsibility: Andrew Kadak

Description:

The focus of this activity is to establish the critical R&D needs and plans for the NGNP that are associated with near-term commercialization and to identify long term R&D needs for high temperature reactor enhancement allowing for even higher temperature, higher burnup and additional process heat application operations. This effort will build upon the existing PBMR technology development plans for the next generation plant designs and the evolving plans for the process heat plant designs. This latter topic is extremely broad encompassing safety and operational performance of the hydrogen plant design and operations. The R&D needs task is divided into 6 major tasks with many subtasks in each area. This will require a broad review of enabling technologies, a review of research being conducted by other international partners of Generation IV to avoid unnecessary duplication of effort and the identification of long term R&D needs based on the Design Data Needs generated as part of this contract.

The plan for identifying research needs for the Next Generation Nuclear Plant will take place in four phases.

Phase 1: Review of Existing Research and Development Needs and Plans

The first phase will be a review of all available national and international R&D needs and plans for high temperature gas reactors and hydrogen production that currently exist and/or research programs that are underway. This review will entail a tabulation by category (design, fuel, safety, materials, control, etc) and by specific research area, the research needs and a determination as to whether these needs are currently being met through existing research programs. The sources for this compendium of research plans include Idaho National Laboratory, Department of Energy, Nuclear Regulatory Commission, PBMR, Generation IV VHTR research plans, and any available research programs from the HTR-TN, Japan, Korea, France and China. These sources should provide a complete picture of currently identified research needs for high temperature gas

reactors. The identified R&D will be mapped against the statement of work for tasks 19.1 through 19.6 as well as the table of contents list generated for Section 19 of the final report. The final report will however address the R&D needs by “system” to be sure that it is identified with a needed task to support the successful deployment of the NGNP.

Phase 2: Prioritization for Enabling and Enhancing R&D

Once this list is compiled and sorted by area as detailed in the suggested outline for the NGNP pre-conceptual design project description, they will then be evaluated to assess those that are enabling, namely near-term, must-have research programs, or enhancing-those that, if conducted over a longer period of time, would allow for enhanced performance of the NGNP. This evaluation will be dictated by the design data needs generated as part of this project. The key is to develop R&D plans that integrate the nuclear side of the plant with the hydrogen production technologies that would allow for a scalable demonstration of the integrated hydrogen production plant and nuclear facilities. There will also be a comparison to the research needs identified by the International Technical Review Group’s assessment about the NGNP for near term deployment. It should be noted that the PBMR enabling research program will be the base line from which to evaluate near term needs since they appear to be the nearest to actual construction. The attached flow chart identifies the logic of the review which integrates the R&D planning process with the scope of work identified and special studies leading to an R&D plan that will support NGNP and commercialization of the design.

Phase 3: Implementation of R&D Plans

The third element will be to identify how to accomplish enabling research by reviewing the existing R&D programs that are being conducted on the topics judged to be enabling; to identify those that are planned but not yet been started: to identify facilities worldwide that could be used for such research and, separately, to identify those new facilities and/or programs that are needed to complete the enabling R&D. Enhancing R&D would be reviewed similarly but considered separately.

Phase 4: Cost and Schedule

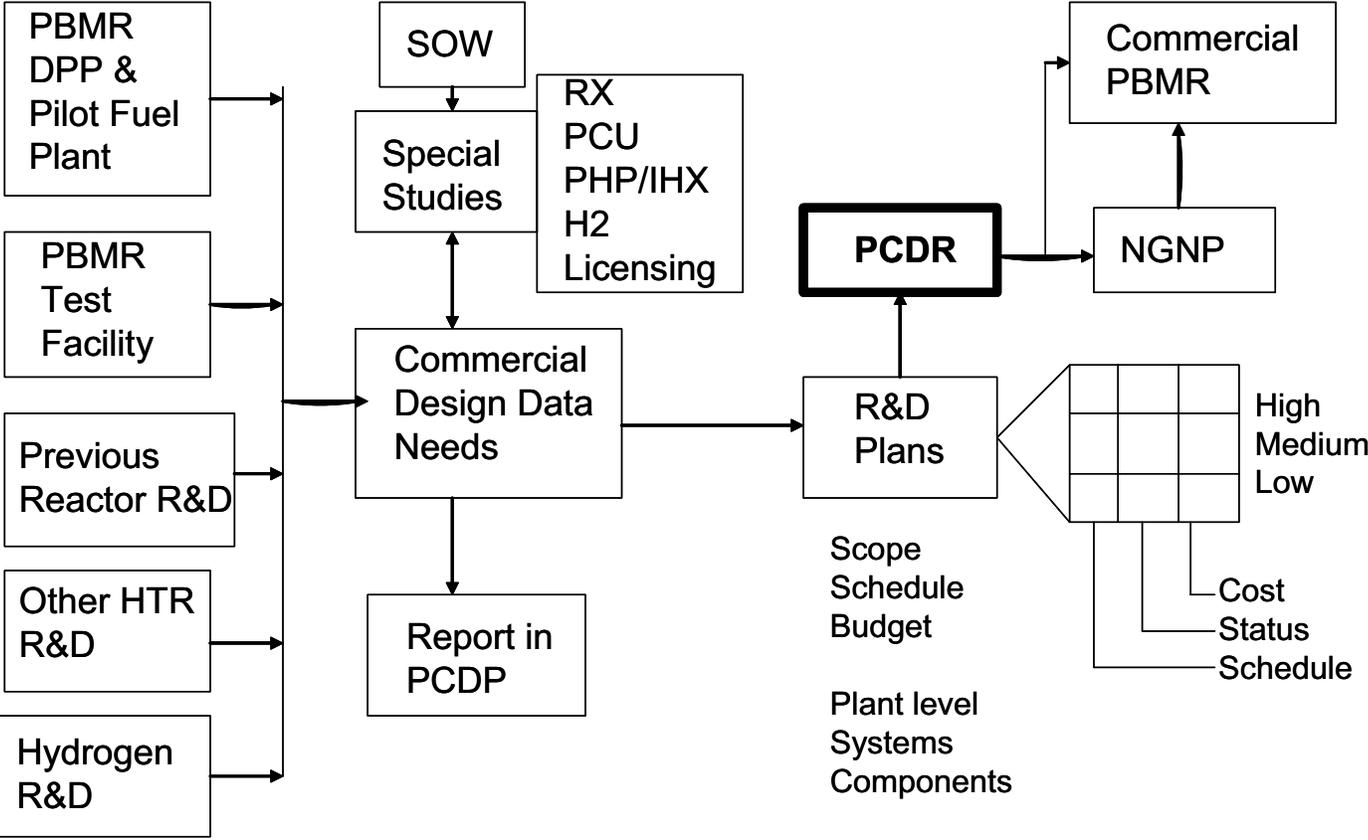
Once this information is compiled, an estimated cost and schedule will be developed for enabling research. Once this is completed, a similar exercise and priority ranking will be conducted for the enhanced research and development, namely identifying those that are important to enhancing performance for the NGNP and the associated hydrogen production facilities. This effort is judged to be secondary to the purposes of early demonstration and commercialization of the NGNP and thus will be scoping in nature.

NGNP R&D Flow Chart

Existing R&D

NGNP

PCDR



Reporting Requirements:

The product of this work is a report clearly identifying near term and long term R&D needs. The plan for accomplishing the near and long term needs is to be the subject of future work.

Resource Forecast: (Role up of all Subtasks)

The labor for this Activity/Task (manhours):

Kadak:	560
PBMR:	260
M-Tech:	340
WEC:	148
Shaw:	140
TI:	180
APCI:	70

Total R&D: 1698

- Travel Required: See Specific Activity Sheets

Materials and Services: **None**

Other Direct Costs **None**

Schedule Forecast:

Duration:	38 Weeks
Milestone(s):	Draft reports issues as noted in MS Project Plan
Final Report:	May 21, 2007

Meetings with INL and teams through out the period

Support Requirements:

- Related Activity/Tasks to be completed first:

Compile all necessary reports
 Support Team Responsibilities:
 Have other team members provide R&D input needs
 Have Team review needs report

Next Activity/Tasks requiring this effort:

Final R&D Needs Report by May 21, 2007

NGNP TASK SHEET

Task No. 19.1 **Title: Reactor Design, Fabrication and Construction**

Lead Responsibility: Andrew Kadak

Description:

The purpose of this activity is to review the near term R&D needs in the area of design, fabrication and construction of the NGNP plant proposed. This will include an evaluation of technology gaps to allow for the early deployment of the NGNP. Of particular interest will be the necessary analysis code validation requirements to allow for licensing, TRISO fuel, review of material requirements for high temperature operations, status of component technologies including intermediate heat exchangers for process heat applications and high temperature valves, turbines and compressors for helium application, hydrogen production technologies, etc. A review of the state of the art will be made to assess technology readiness for the near term and possible R&D needed for enhancements in the long term after the demonstration plant is operating. The deliverable of this activity will be a project report identifying design, fabrication and construction R&D needs for enabling early deployment and long term enhancements. Reports to be reviewed include but are not limited to: Generation IV Roadmap R&D needs, INL reports on Design Validation R&D, Nuclear Hydrogen plan, ITRG report, INL NGNP Research and Development plans and the PBMR near term deployment R&D needs. The thrust of this effort will be to identify critical enabling R&D needs for initial deployment followed by a long term R&D plan for future enhancements to allow for improved operations including higher temperatures with improved technologies.

Reporting Requirements:

The product of this work is a report clearly identifying near term and long term R&D needs. The plan for accomplishing the near and long term needs is to be the subject of future work.

Resource Forecast: (for this Task/Activity only)

The labor for this Task/Activity (manhours):

Kadak:	60
PBMR:	60
WEC:	20
Shaw:	30
TI:	30
M-Tech:	60
Total:	260

Travel Required:

INL Two day meeting to review results

Meeting with WEC, Shaw, Air Products, PBMR - 1 day meeting - US

Materials and Services: **None**

Other Direct Costs **None**

Schedule Forecast:

See MS Project Schedule for R&D

Support Requirements:

Related Activity/Tasks to be completed first:

Compile all necessary reports

Support Team Responsibilities:

- Have other team members provide R&D input needs
- Have Team review needs report

Next Activity/Tasks requiring this effort:

Final R&D Needs Report by May 07

NGNP TASK SHEET

Task No. 19.2 Title: R&D to Support Reactor Start-Up

Lead Responsibility: Andrew Kadak

Description:

The purpose of this activity is to review the near term R&D needs in the area of Reactor Start-Up. Since this area is not well developed in traditional research plans, the focus of this effort will be to build upon the PBMR commissioning plan plus interact with those groups who have actually started-up and are operating high temperature helium cooled reactors. This includes the Japan Atomic Energy Research Institute that operates the HTTR and Tshinghua University's HTR-10. What will be of particular interest are the challenges at achieving low leakage of helium, neutronic verifications of core conditions, refueling systems and system monitoring. A review will be made of startup test procedures to establish the ability to confirm system parameters and validation of parameters assumed in safety analysis. Initial safety tests will also be reviewed to validate consistency with the safety case. R&D needs could focus in the area of additional monitoring instrumentation to allow for demonstration of key process and safety parameters. The thrust of this effort will be to identify critical enabling R&D needs for initial deployment followed by a long term R&D plan for future enhancements to allow for improved operations including higher temperatures with improved technologies.

Reporting Requirements:

The product of this work is a report clearly identifying near term and long term R&D needs. The plan for accomplishing the near and long term needs is to be the subject of future work.

Resource Forecast: (for this Task/Activity only)

The labor for this Activity/Task (manhours):

Kadak:	40
WEC:	8
TI:	40
M-Tech:	60
PBMR:	40
Total:	180

Travel Required:

Possible: Japan: HTTR three day meeting to review startup issues to be tied into other R&D scope issues.

Meeting with WEC, Shaw, Air Products, PBMR - 1 day meeting - US

Materials and Services: **None**

Other Direct Costs: **None**

Schedule Forecast:

See MS Project Schedule

Support Requirements:

Related Activity/Tasks to be completed first:

Communicate with operators and find operations startup papers and reports.

Support Team Responsibilities:

- Have other team members provide R&D input needs
- Have Team review needs report

Next Activity/Tasks requiring this effort:

Final R&D Needs Report by May 07

NGNP TASK SHEET

Task No. 19.3 Title: R&D to Support Demonstration/Commercialization

Lead Responsibility: Andrew Kadak

Description:

The focus of this activity is to establish the critical R&D needs for the NGNP that are associated with near-term commercialization. This effort will build upon the existing PBMR technology development plans for the generation plant designs and the evolving plans for the process heat plant designs. This latter topic is extremely broad encompassing safety and operational performance of the hydrogen plant design and operations. This task is divided into 11 discrete tasks each of which requires extensive review of the status of the technology and R&D needs. The first major challenge is to acquire basic design information from PBMR regarding the design of their plant and to identify design needs for demonstration. Additionally, the status of hydrogen production plant options needs to be assessed followed by the compilation of the list of technology gaps for each. One of the key tasks is Task 19.3.11 which is to identify flexibility in the basic design to accommodate future R&D needs.

Reporting Requirements:

The product of this work is a report identifying any needs for R&D to allow for early demonstration and R&D needs for commercialization including a plan for role out of the technology to potential investors.

Resource Forecast: (for this Task/Activity only)

The labor for this Activity/Task (manhours):

Kadak:	300
PBMR:	40
WEC:	50
APCI:	30
Shaw:	30
TI:	40
MTech:	90

Total: 580

Travel Required:

Meeting with WEC, Shaw, Air Products, PBMR - 1 day meeting - US

Materials and Services: **None**

Other Direct Costs: **None**

Schedule Forecast:

See MS Project Schedule for R&D Tasks

Support Requirements:

Related Activity/Tasks to be completed first:

Basic conceptual design information to establish R&D needs

Support Team Responsibilities:

PBMR input

Air Products

Shaw

WEC

- Have Team review needs report

Next Activity/Tasks requiring this effort:

Final R&D Needs Report by May 07

NGNP TASK SHEET

**Task No. 19.4 Title: High Temperature Materials for Reactor Systems
(Piping, Valves, Vessels, etc)**

Lead Responsibility: Andrew Kadak

Description:

The purpose of this activity is to review the near and long term R&D needs in the area of High Temperature Materials for Reactor Systems. There have been many studies prepared outlining the material research needs. Key components include the intermediate heat exchangers needed for hydrogen production and high temperature valves and piping systems. The core barrel is another key component as is the graphite behavior under the radiation and high temperature conditions experienced in the reactor system. The most comprehensive studies have been prepared by the Generation IV R&D needs and INL in their overall research plan. Since the objective of this project is to deploy the NGNP at the earliest possible time, the materials R&D effort will also involve an extensive review of current R&D projects underway for plants in the final design and licensing phases which include the PBMR in South Africa and the HTR-PM in China. These projects have identified near term R&D needs to support licensing and operations. It is the intent of this effort to prioritize material R&D needs and categorize critical R&D issues and then establish a list of longer term R&D enhancement opportunities. Identify cooperative research programs to save time and money and avoid duplication.

Reporting Requirements:

The product of this work is a report prioritizing materials needs for near and long term R&D.

Resource Forecast: (for this Task/Activity only)

The labor for this Activity/Task (manhours):

Kadak:	60
PBMR:	40
WEC:	30
Shaw:	30
TI:	30
M-Tech:	90

Total: 280

Travel Required:

INL two day review meeting
Meeting with WEC, Shaw, PBMR - 1 day meeting - US

Materials and Services: **None**

Other Direct Costs: **None**

Schedule Forecast:

See MS Project Schedule for R&D Tasks

Support Requirements:

Related Activity/Tasks to be completed first:

PMBR and HTR-10 near term research programs

Support Team Responsibilities:

PBMR input

WEC materials experts

TI input

- Have Team review needs report

Next Activity/Tasks requiring this effort:

Final R&D Needs Report by May 07

NGNP TASK SHEET

Task No. 19.5 Title: Instrumentation

Lead Responsibility: Andrew Kadak

Description:

The purpose of this activity is to review the near and long term R&D needs in the area of Instrumentation. There have been many studies prepared outlining the instrumentation research needs. The focus of this effort will be to categorize the basic instrumentation needs for reactor control include neutron and temperature detectors as needed for reactor operations. Instrumentation needs for the hydrogen plant(s) will be reviewed as well. The most comprehensive studies have been prepared by the Generation IV R&D needs and INL in their overall research plan. Since the objective of this project is to deploy the NGNP at the earliest possible time, the instrumentation R&D effort will also involve an extensive review of current R&D projects underway for plants in the final design and licensing phases which include the PBMR in South Africa and the HTR-PM in China. These projects have identified near term R&D needs to support licensing and operations. It is the intent of this effort to prioritize material R&D needs and categorize critical R&D issues and then establish a list of longer term R&D enhancement opportunities. Identify cooperative research programs to save time and money and avoid duplication.

Reporting Requirements:

The product of this work is a report prioritizing R&D instrumentation needs for near and long term R&D.

Resource Forecast: (for this Task/Activity only)

The labor for this Activity/Task (manhours):

Kadak:	40
PBMR:	40
WEC:	20
APCI:	20
Shaw:	20
TI:	20
M-Tech:	20

Total: 180

Travel Required:

INL two day review meeting

Meeting with WEC, Shaw, TI, Air Products, PBMR - 1 day meeting - US

Materials and Services: **None**

Other Direct Costs: **None**

Schedule Forecast:

See MS Project Schedule for R&D Tasks

Support Requirements:

Related Activity/Tasks to be completed first:

- PMBR and HTR-10 near term research programs

Support Team Responsibilities:

- PBMR input
- Have Team review needs report

Next Activity/Tasks requiring this effort:

Final R&D Needs Report by May 07

NGNP TASK SHEET

Task No. 19.6 Title: Materials Outline Specifications

Lead Responsibility: Andrew Kadak

Description:

The purpose of this activity is to review the near and long term R&D needs in the area of Materials Outline Specifications for the reactor island, electrical power interface, the intermediate heat exchanger, and the hydrogen plant. It is assumed that this means what the specifications for materials need to be in order to allow for the design and construction to proceed. Should the material availability not meet the needs, additional research would be needed to support the design requirements of the plants - nuclear and hydrogen. Some studies have been produced outlining fundamental functional requirements. These studies will be reviewed to outline materials needed for the applications.

Reporting Requirements:

The product of this work is a draft list of material specifications for the conceptual design proposed with any additional R&D identified to support the specifications.

Resource Forecast: (for this Task/Activity only)

The labor for this Activity/Task (manhours):

Kadak:	60
PBMR:	40
WEC:	20
APCI:	20
Shaw:	30
TI:	20
M-Tech:	20
Total:	210

Travel Required:

INL two day review meeting
Meeting with WEC, Shaw, Air Products, PBMR - 1 day meeting - US

Materials and Services: **None**

Other Direct Costs: **None**

Schedule Forecast:

See MS Project Schedule for R&D Tasks

Support Requirements:

Related Activity/Tasks to be completed first:

- Basic pre-conceptual design

Support Team Responsibilities:

PBMR input

WEC

TI

Air Products

Have Team review needs report

Next Activity/Tasks requiring this effort:

Final R&D Needs Report by May 07

Activity No. 22 Title: Design Requirements

Lead Responsibility: Technology Insights

Description: The purpose of this activity is to identify and establish top level design requirements for the NGNP. Prior work in this area will be utilized as input including:

- EPRI ALWR Requirements Document
- INEEL NGNP High Level Functions and Requirements
- DOE Utility/User Incentives, Policies and Requirements for the GT-MHR
- User Requirement Specification for the PBMR Demonstration Unit

This information will be supplemented with input from PBMR based process heat plant project initiative with emphasis on hydrogen production applications. The output of the this Activity feeds directly into the Activity C task to prepare a Plant Design Requirements Document (PDRD) that allocates the functional requirements to the major NGNP systems (aka System Requirements Manual). .

Reporting Requirements: The product of this activity is a subsection in the PDRD, which is a major section of the Pre-conceptual Design Report (PCDR).

Resource Forecast:

- The Labor for this Task/Activity:
 - TI: 160manhours
- Materials and Services: None
- Other Direct Costs: None

Schedule Forecast:

- Duration: 6 weeks
- Milestone(s): Major –sections of PDRD and PCDR.

Support Requirements:

- Related Activity/Tasks to be completed first: None
- Support Team Responsibilities: Shaw and APCI: provide process industry input; PBMR: provide PBMR top level requirements
- Next Activity/Tasks requiring this effort: Activity C PDRD Task

Task No. 3.2 Nuclear Heat Source Arrangement

Subtask No. 3.2.1	Reactor & Reactor Systems
Subtask No. 3.2.2	Reactor Support Systems
Subtask No. 3.2.3	Heat Transport Systems

Lead Responsibility: Technology Insights

Description:

The purpose of this activity is to provide a summary description of the Nuclear Heat Source (NHS), as input to the NGNP Preconceptual Design Report. The design features to be described are to be developed within other activities, as noted below. Development of the documentation will be organized within three major subtasks, as follows:

- Reactor and Reactor Systems – Includes the Reactor, Vessel System, Fuel Handling and Storage System and other systems, structures and components (SSCs) to be developed in Activity 4.
- Reactor Support Systems – Reactor/Nuclear Island-related SSCs, including auxiliary cooling systems, service systems, control and protection systems and buildings and structures to be developed in Activity 6
- Heat Transport Systems – The SSCs to be developed in Activities A and B that transfer and transport the thermal energy produced in the reactor to (but not including) the Power Generation System and the Process Coupling Heat Exchanger (PCHX) at the interface with the Hydrogen Production Unit (HPU).

The documentation to be produced will comprise text and illustrations (drawings and other figures) that comprise sections of the Preconceptual Design Report.

Reporting Requirements:

This task will provide inputs to the applicable sections of the Preconceptual Design Report.

Resource Forecast:

- The Labor for this Task/Activity:
 - TI: 180manhours
 - PBMR: 40manhours
 - W: 40manhours
- Travel required: None
- Materials and Services: None
- Other Direct Costs: None

Schedule Forecast:

- Duration: 5 weeks
- Milestone(s): Report section

Support Requirements:

- Related Activity/Tasks to be completed first: This task requires the completion or partial completion of
 - Activity 20.3, HT Process Heat Transfer and Transport Study
 - Activity C, Plant-Level Systems Integration
 - Activity 4, Reactor and Reactor Systems (Partial)
 - Activity 6, Reactor Support Systems and BOP (Partial)
 - Activity A, Primary Heat Transport System (Partial)
 - Activity B, Secondary Heat Transport System (Partial)
- Support Team Responsibilities:
 - PBMR/MTech: Text and illustrations inputs
 - W: Review
- Next Activity/Tasks requiring this effort:
 - Activity 1, Preconceptual Design Report

Activity No. C Title: Plant-Level Design and Integration

Task No. C.1 Title: Plant Design Requirements Document

Task No. C.2 Title: Plant-Level Design Integration

Task No. C.3 Title: Plant-Level Assessments

Lead Responsibility: Technology Insights

Description: This activity provides for the top level systems engineering and integration of the NGNP Plant. Key plant-level functions and requirements are developed, documented and allocated within Task C.1. The top level requirements are developed in Activity 22 as input to this task. These requirements become the basis for the NGNP design and are appropriately allocated to the major plant systems and in some cases to lower-level systems, structures and components (SSCs). In support of the latter, an important objective will be the establishment of interface criteria for the reactor and its support systems, the heat transport systems, the electrical generation plant and the hydrogen production plant. The top level requirements, the major system and key SSC functions and requirement allocations, and the interface requirements are summarized in the Plant Design Requirements Document (PDRD).

Based upon the key functions and requirements of Task C.1, Task C.2 provides for overall integration of the NGNP design. During this preconceptual design phase, the focus of design integration will be key design selections that define the overall configuration of the nuclear heat source and its physical and functional interfaces with both the electrical power conversion system and process plant. This subtask will take initial inputs from the special studies of Task 20.

Subtask C.3 completes the plant level design and integration activity by providing for plant-level assessments that confirm how well the plant meets its overall design goals (e.g., performance, reliability, maintainability, etc.). During the preconceptual phase, these plant level assessments will be addressed at a relatively high level, using prior experience from similar or analogous applications where detailed data are not available. The special studies of Activity 20 provide the initial input to this task.

Reporting Requirements: The products of this activity are the inputs to the preconceptual design report and related slide presentations.

Resource Forecast (including supporting subtasks):

- The Labor for this Task/Activity:
 - TI: 280manhours
 - PBMR: 100manhours
 - W: 80manhours
 - Shaw: 80manhours
 - Kadak: 24manhours
- Materials and Services: None
- Other Direct Costs: None

Schedule Forecast:

- Duration: 25weeks
- Milestone(s): PDRD and corresponding section in PCDR

Support Requirements:

- Related Activity/Tasks to be completed first:
 - Inputs to plant-level functions and requirements resulting from top-level trade studies, Activity 20
- Support Team Responsibilities:
 - PBMR: provide input to and review of draft
 - Shaw: provide input to and review of draft
 - W: provide input to and review of draft
 - Kadak: review of draft
- Next Activity/Tasks requiring this effort:
 - Activity 1, Summary (PCDR)
 - Activity 3, Overall NGNP Plant Site Description

NGNP ACTIVITY SHEET

Task No. C.1 Title: Plant Design Requirements Document

Lead Responsibility: Technology Insights

Description: Key plant-level functions and requirements are developed, documented and allocated within Task C.1. The top level requirements are developed in Activity 22 as input to this task. These requirements become the basis for the NGNP design and are appropriately allocated to the major plant systems and in some cases to lower-level systems, structures and components (SSCs). In support of the latter, an important objective will be the establishment of interface criteria for the reactor and its support systems, the heat transport systems, the power generation system and the hydrogen production unit. The top level requirements, the major system and key SSC functions and requirement allocations, and the interface requirements are summarized in the Plant Design Requirements Document (PDRD). The PDRD will include the following major systems and key SSCs:

- Reactor System and Related Systems
 - Reactivity Control Systems
 - Fuel Handling System
 - Helium Purification System
 - Core Conditioning System
 - Reactor Cavity Cooling System
 - Fuel Storage
- Primary Heat Transport System
 - Intermediate Heat Exchanger
 - Primary Circulator
 - Vessel System
- Secondary Heat Transport System
 - Secondary Circulator
 - Ducts and Valves
- Power Generation System
- Hydrogen Production Unit
- Plant Systems
 - Operational Control System
 - Investment Protection System
 - Safety Protection System
 - Plant Cooling Water Systems
 - Other BOP Systems
- Reactor Building and other Plant Buildings

Reporting Requirements: The products of this activity are the PDRD and the corresponding section of the Pre-Conceptual Design Report.

Resource Forecast (including supporting subtasks):

- The Labor for this Task/Activity:

- TI: 105manhours
- PBMR: 22manhours
- W: 26manhours
- Shaw: 26manhours
- Kadak: 8manhours
- Materials and Services: None
- Other Direct Costs: None

Schedule Forecast:

- Duration: 7weeks
- Milestone(s): Major – final tables of Functions, Requirements and Interfaces
Major -- PDRD

Support Requirements:

- Related Activity/Tasks to be completed first:
 - Project Criteria, Activity 22
 - Inputs to plant-level functions and requirements resulting from top-level trade studies, Activity 20
- Support Team Responsibilities:
 - PBMR: provide input to and review of draft
 - Shaw: provide input to and review of draft
 - W: provide input to and review of draft
 - Kadak: review of draft
- Next Activity/Tasks requiring this effort: All

Task No. C.2 Title: Plant-Level Design Integration**Lead Responsibility: Technology Insights**

Description: Based upon the key functions and requirements of Task C.1, Task C.2 provides for overall integration of the NGNP design. During this preconceptual design phase, the focus of design integration will be key design selections that define the overall configuration of the nuclear heat source and its physical and functional interfaces with both the electrical power generation system and hydrogen production unit. This task will take initial inputs from the special studies of Task 20. Specifically, the PBMR and the hydrogen production unit power levels from the recommendations of Task 20.2 and NGNP plant configured from the recommendation of Task 20.3 with the power generation system from Task 20.4 and the hydrogen production process from Tasks 20.7 and 13.2.

Reporting Requirements: The product of this activity is the corresponding section in the Preconceptual Design Report.

Resource Forecast (including supporting subtasks):

- The Labor for this Task/Activity:
 - TI: 92manhours
 - PBMR: 22manhours
 - W: 27manhours
 - Shaw: 27manhours
- Materials and Services: None
- Other Direct Costs: None

Schedule Forecast:

- Duration: 7weeks
- Milestone(s): Major – section in PCDR

Support Requirements:

- Related Activity/Tasks to be completed first:
 - Inputs from Tasks 20.2, 20.3, 20.4, 20.7, and 13.2
- Support Team Responsibilities:
 - PBMR: provide input to and review of draft
 - Shaw: provide input to and review of draft
 - W: provide input to and review of draft
- Next Activity/Tasks requiring this effort: All

Task No. C.3 Title: Plant-Level Assessments**Lead Responsibility: Technology Insights**

Description: This task completes the integration task by providing for plant-level assessments that confirm how well the plant meets its overall design goals (e.g., performance, reliability, maintainability, etc.). The special studies of Activity 20 provide the initial input to this task. During the preconceptual phase, these plant level assessments will be addressed at a relatively high level, using prior experience from similar or analogous applications where detailed data are not available. The plant level heat balance is performed in this task.

Reporting Requirements: The product of this activity is the corresponding section in the Preconceptual Design Report.

Resource Forecast (including supporting subtasks):

- The Labor for this Task/Activity:
 - TI: 83manhours
 - PBMR: 56manhours
 - W: 27manhours
 - Shaw: 27manhours
 - Kadak: 16manhours
- Materials and Services: None
- Other Direct Costs: None

Schedule Forecast:

- Duration: 7weeks
- Milestone(s): Major – section in PCDR

Support Requirements:

- Related Activity/Tasks to be completed first:
 - Assessments resulting from top-level trade studies, Task 20 and specific plant level assessments such as Task 9 Availability and Task 8 Safety
- Support Team Responsibilities:
 - PBMR: provide heat balance input to and review of draft
 - Shaw: provide input to and review of draft
 - W: provide input to and review of draft
 - Kadak: review of draft
- Next Activity/Tasks requiring this effort: Activity 1 PCDR

Activity A Primary Heat Transport System (PHTS)

Task	A.1	IHX
Task	A.2	Primary Circulator
Task	A.3	Ducts

Lead Responsibility: Technology Insights

Description:

This activity provides for the preconceptual design and integration of the Primary Heat Transport System (PHTS), which is comprised of three main parts – the IHX, the Primary Circulator and Check Valve and the Ducts and Insulation. Overall integration of the PHTS is addressed in this task. Design of the IHX, primary circulator and ducts are separately addressed in lower-level tasks. Overall integration activities include allocation of top level functions and requirements from the plant level to the respective systems and components and the coordination of top level trade studies leading to the selection of key features.

Reporting Requirements:

The products of this activity will be appropriate inputs to the preconceptual design report and related slide presentations.

Resource Forecast:

- **The Labor for this Task/Activity (including Tasks A.1 through A.3):**
 - **TI: 480manhours**
 - **PBMR: 175manhours**
 - **MTech: 175manhours**
 - **WEC: 180manhours**
- **Travel required:**
 - **Overall integration: None**
 - **Supporting Tasks: See respective Task sheets**
- **Materials and Services: None**
- **Other Direct Costs: None**

Schedule Forecast:

- **Duration: 12weeks**
- **Milestone(s):**
 - **Overall integration: Minor – completion of top-level trade studies and allocation of requirements to SSCs after 3 weeks**
 - **Supporting Tasks: See respective Task sheets**

Support Requirements:

- **Related Activity/Tasks to be completed first:**
 - **Task 20.3, HT Process Heat Transfer and Transport Study**

- **Task C.2, Plant-Level Design Integration**
- **Support Team Responsibilities:**
 - **PBMR/MTech: Support for trade studies and review**
 - **WEC: Review**
- **Next Activity/Tasks requiring this effort:**
 - **Task 3.2, Nuclear Heat Source (NHS) Arrangement**

Task A.1 Primary Heat Transport System (PHTS) - IHX

Subtask	A.1.1	IHX Functions and Requirements
Subtask	A.1.2	IHX Preconceptual Design

Lead Responsibility: Technology Insights

Description:

This activity provides for the design of the Intermediate Heat Exchanger (IHX) to the preconceptual level. It includes the heat transfer (HT) core of the IHX, plus the integral manifolds that interface the IHX HT core with the primary and secondary heat transport system (PHTS/SHTS) ducts and the IHX-mounted supports that interface with the enclosing vessel. Other IHX features (e.g., local insulation) will be included, where appropriate. The IHX, which transfers thermal energy from the PHTS to the SHTS, is a critical component from both the design and R&D aspects. This activity will be initiated by identifying and documenting the key functions and requirements of the IHX. Important inputs from the plant/system level will include heat transport duties and the temperature and pressure requirements of the PHTS and SHTS during normal and transient operations.

Trade studies will be conducted in Subtask 20.3.3 under Activity 20, Special Studies to select an IHX configuration, including the heat transfer geometry, and materials of construction. In this Task, other key IHX features and interfaces with the enclosing vessels and the ducts of the primary and secondary heat transport systems will be defined after evaluation of alternatives and options. Ceramic IHX designs will include evaluation of preconceptual ceramic-to-metal transitions designs. The design will be developed in sufficient detail to support preconceptual technical and economic evaluations and to develop the scope of supporting R&D requirements.

Reporting Requirements:

The products of this activity will be appropriate inputs to the Preconceptual Design Report and related slide presentations.

Resource Forecast:

- **The Labor for this Task/Activity:**
 - **TI: 190manhours**
 - **PBMR: 25manhours**
 - **MTech: 25manhours**
 - **W: 180manhours**
- **Travel required:**
 - **One 2-day meeting with team members at W-CHA**
 - **TI: 1 person (SAN to CHA); 1 person (BNA to CHA)**
 - **PBMR: 1 person (JNB to CHA)**
 - **W: 1 person (BDL to CHA)**
- **Materials and Services: None**
- **Other Direct Costs: None**

Schedule Forecast:

- **Duration:** 12weeks
- **Milestone(s):** Minor – Functions and requirements after 6 weeks
Major – inputs to preconceptual design report and presentations after 8 weeks

Support Requirements:

- **Related Activity/Tasks to be completed first:**
 - Plant-level requirements resulting from top-level trade studies, specifically Subtask 20.3.3
- **Support Team Responsibilities:**
 - PBMR/MTech: provide requirements input and review of draft
 - W: IHX/vessel integration
- **Next Activity/Tasks requiring this effort:** None

Task A.2 Primary Heat Transport System (PHTS) – Circulator and Check Valve

Subtask A.2.1	Title: PHTS Circulator
Subtask A.2.2	Title: PHTS Check Valve

Lead Responsibility: Technology Insights

Description:

This activity provides for the design of the primary circulator and the associated check valve to the preconceptual level. The primary circulator provides for helium circulation in the primary loop, thus, transporting thermal energy from the reactor to the IHX. The check valve prevents reverse flow of helium when the primary circulator is not operating and helium circulation is being provided by the Core Conditioning System. Both the circulator and check valve are considered present state-of-the-art under normal operating conditions.

The influence of off-normal transients will be further evaluated within this activity. This activity will be initiated by identifying and documenting the key functions and requirements of the circulator and check valve. This activity description presupposes the requirement for a check valve. The valve mode of operation is yet to be determined, as positively actuated or self-actuated by reverse flow. Input to these design decisions will be provided through the trade studies under Activity 20 in Task 20.3, HT Process Heat Transfer and Transport Study and Task 20.6, Licensing and Permitting Study.

Design activities will primarily consist of sizing (thermal-hydraulic and electrical power requirements) and laying out the principal physical interfaces with the PHTS ducts and vessels. The design will be developed in sufficient detail to support preconceptual technical and economic evaluations.

Reporting Requirements:

The products of this activity will be appropriate inputs to the preconceptual design report and related slide presentations.

Resource Forecast:

- **The Labor for this Task/Activity:**
 - **TI: 100manhours**
 - **PBMR: 75manhours**
 - **MTech: 75manhours**
- **Travel required: None**
- **Materials and Services: None**
- **Other Direct Costs: None**

Schedule Forecast:

- **Duration: 12weeks**
- **Milestone(s): Minor – draft presentation for DOE/INL meeting after 6 weeks**

Major – final presentation and report after 8 weeks

Support Requirements:

- **Related Activity/Tasks to be completed first: Special Studies 20.3 and 20.6**
- **Support Team Responsibilities:**
 - **PBMR/MTech: provide input and review of draft**
- **Next Activity/Tasks requiring this effort: None**

Task A.3 Primary Heat Transport System (PHTS) – Ducts and Insulation

Subtask A.3.1	Hot Leg Duct
Subtask A.3.2	Cold Leg Duct

Lead Responsibility: Technology Insights

Description:

This activity provides for the design of the PHTS internal ducts and associated insulation and supports to the preconceptual level. The hot leg primary PHTS ducting provides for physical routing of the primary helium from its interface with the core graphite structures at the core outlet to the primary inlet manifold of the IHX. While the high temperatures seen in this region are challenging, there is precedent in both the German and Japanese HTGR programs that have gone before. A key consideration will be assuring isolation of the primary pressure boundary from these temperatures. The cold leg ducting that returns the helium from the primary IHX outlet manifold to the circulator and, thence, to the reactor is viewed as less challenging, due to lower temperatures. This activity will be initiated by identifying and documenting the key functions and requirements of the ducts and insulation. Design activities will initially focus on confirming the coaxial layout that is presently viewed as the reference. The design will be developed in sufficient detail to support preconceptual technical and economic evaluations.

Reporting Requirements:

The products of this activity will be appropriate inputs to the preconceptual design report and related slide presentations.

Resource Forecast:

- **The Labor for this Task/Activity:**
 - **TI: 190manhours**
 - **PBMR: 75manhours**
 - **MTech: 75manhours**
- **Travel required**
 - **One 2-day meeting with team members at TI-SAN**
 - **TI: 1 person (BNA to SAN)**
 - **PBMR: 1 person (JNB to SAN)**
 - **MTech: 1 person (JNB to SAN)**
- **Materials and Services: None**
- **Other Direct Costs: None**

Schedule Forecast:

- **Duration:** 12weeks
- **Milestone(s):** **Minor – draft presentation for DOE/INL meeting after 6 weeks**
Major – final presentation and report after 8 weeks

Support Requirements:

- **Related Activity/Tasks to be completed first:**
 - **Plant-level requirements resulting from top-level trade studies, specifically Subtask 20.3.3**
- **Support Team Responsibilities:**
 - **PBMR/MTech: provide input and review of draft**
- **Next Activity/Tasks requiring this effort: None**

Activity B Title: Secondary Heat Transport System (SHTS)

Task	B.1	Functions and Requirements
Task	B.2	Ducts
Task	B.3	Valves
Task	B.4	Circulator

Lead Responsibility: Technology Insights**Description:**

This activity provides for the design of the SHTS to the preconceptual level. The role of the SHTS will vary, depending upon the outcome of plant level design selections and the corresponding functions and requirements that are assigned to the SHTS. Based on these higher-level inputs, all of the above identified subtasks may not be required. The functions of and requirements for the SHTS will be resolved in Subtask B.1. The SHTS ducts (B.2) are those that convey the secondary working fluid (assumed to be helium) from the IHX to the point use at the interfaces with the power conversion unit (PCU) and/or point of process coupling. As with the PHTS ducts, the higher temperatures pose challenges, but with precedent available from earlier development programs. A key tradeoff will address whether the ducts should be parallel or coaxial. The need for isolation valves (B.3) is to be verified and, if retained, their functions and requirements (e.g., degree of leaktightness) will be appropriately defined.

Depending upon the specific energy utilization systems identified through plant level design and integration studies (Activity 20: Task. 20.3, HT Process Heat Transfer and Transport Study, and Task 20.6, Licensing and Permitting Study), there may or may not be a requirement for a circulator (B.4) (e.g., the compressor of a Brayton cycle PCU would fulfill that function). This activity will be initiated by identifying and documenting the key functions and requirements of the SHTS, as an outcome of plant level trade studies. Design activities will be undertaken to define the principal features of the SHTS and to lay out the principal interfaces with the PHTS (IHX) and PCU/process. The design will be developed in sufficient detail to support preconceptual technical and economic evaluations.

Reporting Requirements:

The products of this activity will be appropriate inputs to the preconceptual design report and related slide presentations.

Resource Forecast:

- **The Labor for this Task/Activity:**
 - **TI: 380manhours**
 - **PBMR: 100manhours**
 - **MTech: 80manhours**

- **Travel required**
 - **One 2-day meeting with team members at TI-SAN**
 - **TI: 1 person (BNA to SAN)**
 - **PBMR: 1 person (JB to SAN)**
 - **MTech: 1 person (JB to SAN)**
- **Materials and Services: None**
- **Other Direct Costs: None**

Schedule Forecast:

- **Duration: 12weeks**
- **Milestone(s): Minor – draft presentation for DOE/INL meeting after 6weeks**
Major – final presentation and report after 8 weeks

Support Requirements:

- **Related Activity/Tasks to be completed first:**
 - **Tasks 20.3 and 20.6Special Studies**
- **Support Team Responsibilities:**
 - **PBMR/MTech: provide input and review of draft**
- **Next Activity/Tasks requiring this effort:**
 - **Task 3.2 Nuclear Heat Source (NHS) Arrangement**

Activity No. 9.0 Title: Availability

Subtask No. 9.1	Title: Definition of Availability Metrics for NGNP
Subtask No. 9.2	Title: Reactor and Primary Heat Transport System
Subtask No. 9.3	Title: Secondary Heat Transport and Power Generation System
Subtask No. 9.4	Title: Hydrogen Plant

Lead Responsibility: Technology Insights

Description: The purpose of this Activity is to assess the PBMR NGNP plant reliability, availability, and capacity factor performance. The scope of these assessments includes both planned and forced outages and the impact of these outages on the expected availability and capacity factor performance. The subtask breakdown includes a subtask for availability methodology definition and additional subtasks based a high level description of the plant as reflected in the Final Report Outline.

Traditional definition of availability and capacity factor metrics are for single use energy production machines. In Subtask 9.1 the approach for defining the availability performance metrics for a dual purpose machine (electric and hydrogen production) will be worked out. (Planned and forced outages may impact electric production only, hydrogen production only, or both.) Subtask 9.2 covers the reactor system, the primary heat transport system and their major support systems. Subtask 9.3 covers the secondary heat transport system, the Power Generation System, and the associated support systems for this system. The expected performance associated with planned maintenance outages and forced outages of the turbo-machine overhauls and the capability to “shadow” some of these outages with other systems maintenance will be considered. Subtask 9.4 includes the availability and capacity factor impacts associated with the Hydrogen System.

Reporting Requirements: The product of the activity will be a slide presentation and an accompanying report summarizing the results and conclusions.

Resource Forecast:

- The Labor for this Task/Activity:
 - **TI: 190manhours**
 - **PBMR: 80manhours**
 - **W: 40manhours**
 - **Shaw: 40manhours**
- Travel required: **None**
- Materials and Services: **None**
- Other Direct Costs: **None**

Schedule Forecast:

- Duration: **8 weeks**
- Milestone(s): **Minor – draft presentation for DOE/INL meeting after 4 weeks**
Major – final presentation and report after 8 weeks

Support Requirements:

- Related Activity/Tasks to be completed first: **Design information and maintenance requirements for the PBMR NGNP.**
- Support Team Responsibilities:
 - **PBMR: provide design and maintenance input for PBMR scope of supply**
 - **W: Provide design and maintenance input for Westinghouse scope of supply**
 - **Shaw: Provide design and maintenance input for Shaw scope of supply**
- Next Activity/Tasks requiring this effort: **None**

Activity No. 11 Title: Reactor Complexity, Issues and Risks**Task No. 11.1 Title: Design and Operational Complexity****Task No. 11.2 Title: NHS Technology Issues****Task No. 11.3 Title: Project Risk****Lead Responsibility: TI**

Description: The purpose of this Activity is to evaluate the overall PBMR NGNP nuclear heat source (NHS) with respect to design and operational complexity, technology issues and project risk. The design and operational evaluation will include consider aspects of its construction, operation, maintenance and decommissioning. Overall coordination and documentation will be provided by this summary activity. Specific analyses will be accomplished within the framework of the three supporting tasks.

Trade studies in Activities 20 will address specific design options, and their combined result will be an overall NHS that fulfills the Project criteria. The Design and Operational Complexity review will evaluate that resulting design as a whole and how the multiple components and subsystems work together. The NHS Technology Issues task will address the state of readiness of key systems, structures and components and the respective development challenges and uncertainties. Finally, the Project Risk task will address project level risks, including funding, scheduling and management issues that are addressed in the project criteria.

Reporting Requirements: The product of the activity is a report evaluating Complexity, Issues and Risks. The report will be incorporated into the Preconceptual Design Report as a major section.

Resource Forecast:

- **The Labor for this Task/Activity (including supporting subtasks):**
 - **TI: 300manhours**
 - **PBMR: 176manhours**
 - **W: 144manhours**
 - **Shaw: 136manhours**
 - **M-Tech: 48manhours**
 - **Kadak: 24manhours**
- **Travel required:**
 - **One 2-day meeting with team members at W**
 - **TI: 2 persons (SAN to BDL)**
 - **W: 1 person (PIT to BDL)**
 - **US PBMR: 1 person (ATL to BDL)**
 - **One 2-day meeting with team members at Shaw**
 - **TI: 2 persons (SAN to BOS)**
 - **US PBMR: 1 person (ATL to BOS)**
- **Materials and Services: None**
- **Other Direct Costs: None**

Schedule Forecast:

- **Duration:** 10 weeks
- **Milestone(s):** Minor – draft report for team review after 8 weeks
Major – final report after 10 weeks

Support Requirements:

- **Related Activity/Tasks to be completed first:** This activity requires completion or substantial progress on the Special Studies of Activity 20, plus completion of supporting Tasks 11.1, 11.3 and 11.3.
- **Support Team Responsibilities:**
 - **PBMR:** critical review of draft report
 - **W:** critical review of draft report
 - **Shaw:** critical review of draft report
 - **M-Tech:** critical review of draft report
 - **APCI:** review of draft report
 - **Kadak:** review of draft report
- **Next Activity/Tasks requiring this effort:** Preconceptual Design Report

Task No. 11.1 Title: Design and Operational Complexity

Lead Responsibility: TI

Description: The NHS that is developed in Activities 4, A, B and 6 (Reactor, Primary & Secondary Heat Transport and Plant Support Systems) will consist of conceptual designs of components and subsystems. These components and subsystems will be itemized and ranked by apparent complexity. Complexity is apparent in physical configurations and designs, and it is also manifest in control systems. A minimum of complexity is desired, in principle, especially for features that address safety and licensing requirements.

Complexity will be considered in the following areas:

- **Fabrication**
- **Construction/Installation**
- **Pre-operational Trials and Initial Startup**
- **Operation**
- **Maintenance**
- **Replacement**
- **Decommissioning**

For the components and subsystems ranked highest in complexity there will be a consensus quantitative evaluation. These evaluations will yield a relative probability of the complex feature failing to meet the design criteria. From this review a consequence of the failure will also be established. (These will be the consequences in terms of cost impact and not safety-related consequences.) These findings will be combined into a quantified relative risk in Task 11.3.

Reviews of the most complex components and subsystems will also include suggested alternative potential improvements to reduce complexity.

Reporting Requirements: Itemized at Activity level.

Resource Forecast:

- **The Labor for this Task/Activity:**
 - **TI: 120manhours**
 - **PBMR: 92manhours**
 - **W: 50manhours**
 - **Shaw: 56manhours**
 - **M-Tech: 48manhours**
- **Travel required: Itemized at Activity level.**
- **Materials and Services: None**
- **Other Direct Costs: None**

Schedule Forecast:

- **Duration: 3 weeks**
- **Milestone(s): Itemized at Activity level.**

Support Requirements:

- **Related Activity/Tasks to be completed first: This task requires the completion or substantial progress on the Special Studies of Activity 20.**
- **Support Team Responsibilities:**
 - **PBMR: provide input**
 - **W: provide input**
 - **Shaw: provide input**
 - **M-Tech: provide input**
- **Next Activity/Tasks requiring this effort: Tasks 11.2 and 11.3**

Task No. 11.2 Title: NHS Technology Issues

Lead Responsibility: TI

Description: Issues that effect integrated overall NHS function in addition to the issue of general complexity will be evaluated in terms of the confidence they will meet their design criteria. Probability of not fulfilling the criteria will be estimated by consensus.

In qualitative terms, the technology issues that are apparent at this time are the following:

- **IHX lifetime and replacement**
- **NHS isolation valves at high temperature**
- **Scale-up of reactor power per Special Study 20.2**
- **Increase core outlet temperature to 950C**

Reporting Requirements: Itemized at Activity level.

Resource Forecast:

- **The Labor for this Task/Activity:**
 - **TI: 90manhours**
 - **PBMR: 42manhours**
 - **W: 60manhours**
 - **Shaw: 40manhours**
 - **Kadak: 24manhours**
- **Travel required: Itemized Travel required: Itemized at Activity level.**
- **Materials and Services: None**
- **Other Direct Costs: None**

Schedule Forecast:

- **Duration: 3 weeks**
- **Milestone(s): Itemized at Activity level.**

Support Requirements:

- **Related Activity/Tasks to be completed first: This task requires the completion of Task 11.1 and completion or substantial progress on the Special Studies Activity 20.**
- **Support Team Responsibilities:**
 - **PBMR: provide input**
 - **W: provide input**
 - **Shaw: provide input**
- **Next Activity/Tasks requiring this effort: Task 11.3**

Task No. 11.3 Title: Project Risks

Lead Responsibility: TI

Description: Project risk is defined as risk of not meeting the criteria set forth in Activity 22. The criteria of concern and categories of risk are the project schedule, construction cost and performance. The performance criteria are further divided into areas concerning component and subsystem lifetime, maintainability, availability, initial and continued regulatory compliance, operating cost, safety, security and safeguards. Failure consequences can be quantified as the dollar penalty of construction delay, excess construction cost, performance degradation, premature failure and repair or replacement, higher maintenance and/or operating cost, unplanned shutdown and operating fines. The overall impact of identified risks is the product of their probability times the cost of the failure.

The results from Task 11.1, which analyzes complexity, and Task 11.2, which reviews other technology issues, will be input to the risk analysis. Potential failures with the highest evaluated economic consequences and the highest evaluated probabilities will be ranked. Risks will be calculated. The result along with narrative interpretations will present the picture of project risks.

Reporting Requirements: Itemized at Activity level.

Resource Forecast:

- **The Labor for this Task/Activity:**
 - **TI: 90manhours**
 - **PBMR: 42manhours**
 - **W: 34manhours**
 - **Shaw: 40manhours**
- **Travel required: Itemized at Activity level.**
- **Materials and Services: None**
- **Other Direct Costs: None**

Schedule Forecast:

- **Duration: 4 weeks**
- **Milestone(s): Itemized at Activity level.**

Support Requirements:

- **Related Activity/Tasks to be completed first: This task requires the completion of Tasks, 11.1 and 11.2 and completion or substantial progress on the Special Studies Activity 20.**
- **Support Team Responsibilities:**
 - **PBMR: provide input**
 - **W: provide input**
 - **Shaw: provide input**
- **Next Activity/Tasks requiring this effort: Activity 11.**

NGNP ACTIVITY SHEET

Activity No. 20 **Title: Special Studies**

Task No. 20.1	Title: Reactor Type Comparison Study
Task No. 20.2	Title: Prototype Power Level Study
Task No. 20.3	Title: High Temperature Process Heat, Transfer and Transport Study
Task No. 20.4	Title: Power Conversion System (PCS) Trade Study
Task No. 20.6	Title: Licensing and Permitting Study
Task No. 20.7	Title: NNGP By-Products Study

Lead Responsibility: TI

Description: This Activity provides for special studies supporting the development and evaluation of the overall PBMR NNGP. Over all coordination is provided by this summary activity. Specific studies and analyses will be accomplished within the framework of supporting tasks.

In general, the supporting tasks herein are of two types. Tasks 20.3 and 20.4 are trade studies addressing key design options. Their results are key plant and system level design selections that become the basis for additional design and evaluation in other tasks. The remaining tasks provide for various evaluations of the specific preconceptual design that is selected.

Reporting Requirements: Detailed in supporting tasks

Resource Forecast:

- The Labor for this Activity:
 - TI: 100 manhours
- Travel required: None for this Activity

Schedule Forecast:

- Duration: 14 weeks
- Milestone(s): Detailed in supporting tasks

Support Requirements: Detailed in supporting tasks

- Related Activity/Tasks to be completed first: Detailed in supporting tasks
- Support Team Responsibilities: Detailed in supporting tasks
- Next Activity/Tasks requiring this effort: Detailed in supporting tasks

Activity No. 20.1 Title: Special Study - Reactor Type Comparison

- | | |
|--------------------|--|
| Subtask No. 20.1.1 | Title: Discriminating Criteria |
| Subtask No. 20.1.2 | Title: Reactor Type Fundamentals and Comparative Assessments |
| Subtask No. 20.1.3 | Title: Overall Assessment |

Lead Responsibility: Technology Insights

Description: The purpose of this Activity is to compare the pebble bed and prismatic types of modular high temperature gas-cooled reactors. The subtasks include identification of important discriminating criteria and considerations, the assessment of the pebble bed and prismatic reactor types, and other specific considerations. The reactor type comparison subtask will discuss the fundamental differences of the two fuel element types and distinguish those differences from other design selections that are designer choices. The subtask will also address specific considerations that flow from the selection of the fuel type. The third Overall Assessment subtask will summarize the reactor type alternatives relative to the discriminating criteria.

Reporting Requirements: The product of the activity will be a slide presentation and an accompanying report summarizing the results and conclusions.

Resource Forecast:

- The Labor for this Task/Activity:
 - TI: 160manhours
 - PBMR: 100manhours
 - W: 20manhours
 - Kadak: 20manhours
- Materials and Services: None
- Other Direct Costs: None

Schedule Forecast:

- Duration: 14 weeks
- Milestone(s): Minor – draft presentation for DOE/INL meeting after 8 weeks
Major – final presentation and report after 14 weeks

Support Requirements:

- Related Activity/Tasks to be completed first: None
- Support Team Responsibilities:
 - PBMR: provide input and critical review of draft
 - W: review of draft
 - Kadak: review of draft
- Next Activity/Tasks requiring this effort: None

Activity No. 20.3 Special Study - High Temperature Process Heat, Transfer and Transport

Subtask No. 20.3.1	Heat Transport System Configuration
Subtask No. 20.3.2	Secondary Heat Transport System Working Fluid
Subtask No. 20.3.3	Intermediate and Process Coupling Heat Exchangers
Subtask No. 20.3.4	Implications of Radionuclide Transport via HTS
Subtask No. 20.3.5	Market/Industry Leader/Supplier Inputs

Lead Responsibility: Technology Insights

Description:

The purpose of this Activity is to examine a number of topics specific to the process heat application that involve heat transfer and energy transport from the pebble bed reactor to the Power Conversion System (PCS) and the Hydrogen Production Unit (HPU). The overall objective is to recommend a reference Heat Transport System (HTS) architecture to be applied in the NGNP preconceptual design (Subtask 1). The remaining subtasks support and provide input to this overall objective. The Secondary HTS (SHTS) working fluid evaluation (Subtask 2) will compare the relative merits of helium, liquid salts, and others. Subtask 3 will evaluate the technology status and issues associated with the Intermediate Heat Exchanger (IHX) and Process Coupling Heat Exchanger (PCHX) and their implications for the overall HTS layout. Subtask 4 will consider the implications of IHX/PCHX leaks and tritium diffusion through intact HTS barriers. One outcome will be recommendations regarding the relative pressures in the Primary HTS (PHTS) and SHTS and between the SHTS and the PCS (for options with indirect PCS coupling via the IHX) and/or the HPU. In Subtask 5, owner/operator and supplier issues will be addressed as inputs to the overall HTS configuration.

Reporting Requirements: The products of this activity will be:

1. Presentations in PowerPoint format summarizing the results of the respective subtasks and recommendations regarding the overall HTS configuration.
2. Inputs to applicable sections of the Preconceptual Design Report.

Resource Forecast:

- The Labor for this Task/Activity:
 - **TI: 240manhours**
 - **PBMR: 40manhours**
 - **W: 20manhours**
 - **Shaw: 20manhours**
- Travel required: **None**
- Materials and Services: **None**

- Other Direct Costs: **None**

Schedule Forecast:

- Duration: **10 weeks**
- Milestone(s): **Major – final report after 10 weeks**

Support Requirements:

- Related Activity/Tasks to be completed first: **None**
- Support Team Responsibilities:
 - **PBMR: provide input and critical review of draft**
 - **W and Shaw: review of draft**
- Next Activity/Tasks requiring this effort: **None**

Subtask No. 20.3.1 Heat Transport System Configuration

This task will consider layout options for energy transport from the reactor to the PCS and HPU. The result of this evaluation will be a recommendation for the reference heat transport architecture for the NGNP preconceptual design. A number of PHTS/SHTS layout options will be developed in parallel with the remaining subtasks of this special study. Criteria for selection of the preferred architecture will also be developed in parallel. The results of other subtasks will provide inputs regarding the working fluid (20.3.2), HX capabilities and limitations (20.3.3), the significance and implications of radionuclides (20.3.4) and owner/operator and supplier inputs (20.3.5).

Subtask No. 20.3.2 Secondary Heat Transport System Working Fluid

An evaluation will be made of the working fluid options for the secondary heat transport system (SHTS). Fluid options to be considered will include liquid salts, liquid metals and selected gases, including helium, CO₂ and N₂. The evaluation will consider thermal energy transport properties, heat transfer properties, materials compatibility, operations and maintenance characteristics and safety. A recommendation will be made as to the reference SHTS heat transport fluid for the NGNP. This subtask provides an input to Subtask 20.3.3 which includes selection of the reference heat transport architecture for coupling of the reactor to the PCU and HPU.

Subtask No. 20.3.3 Intermediate and Process Coupling Heat Exchangers

The IHX and PCHX are generally recognized as key technical and economic barriers to the realization of practical nuclear-based H₂ production. Within this subtask, alternate HX designs and their implications for selecting a reference HTS architecture will be evaluated. This work is organized within the following subtasks:

Subtask No. 20.3.3.1 Heat Exchanger Design Options

This subtask will evaluate HX designs (e.g., shell & tube, compact) and summarize their pros and cons with respect to application in the NGNP.

Subtask No. 20.3.3.2 High Temperature Materials

The environmental requirements for components in the heat transport path between the reactor and the PCU/HPU will be identified and matched with the characteristics of candidate materials. The candidate materials will be evaluated with respect to applicability and adequacy for the proposed service and the availability of codes and standards to guide design, manufacture installation and operation.

Subtask No. 20.3.3.3 Code & Standards

This subtask will evaluate the availability and/or applicability of industrial codes and standards as a basis for the design of the heat transport pathway between the reactor and the PCU/HPU. Where codes and standards are found to be unavailable and/or inadequate an approach to resolution will be identified as a basis for defining Design Data Needs (DDNs). The options to be considered will include development of the required codes and standards, adoption of existing standards and qualification by testing. The availability/applicability of codes and standards will be considered in selecting the architecture for coupling the reactor to the PCU and HPU.

Subtask No. 20.3.3.4 R&D Considerations

This subtask will evaluate the R&D implications of HX design and materials options as input to the selection process.

Subtask No. 20.3.4 Implications of Radionuclide Transport via HTS

This subtask considers the characteristics of radionuclide transport from the primary helium circuit to the PCU and HPU as input to the selection of the heat transport architecture for coupling of the reactor to the PCU and HPU. Specific mechanisms to be addressed are leaks via the intermediate and process coupling heat exchangers and tritium diffusion through intact heat transfer surfaces. The results will influence decisions regarding the relative normal operating pressures of the PHTS, SHTS and HPU, materials selections and provisions for monitoring and/or mitigating tritium diffusion.

Subtask No. 20.3.5 Market/Industry Leader/Supplier Inputs

Through this subtask, user and supplier input will be obtained as input to the configuration of the heat transport architecture.