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Technical Issues Map for the NHI System Interface and Support Systems Area: 3rd Quarter FY 07

S. R. Sherman

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S. R. Sherman

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Idaho National Laboratory
Idaho Falls, Idaho 83415

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ABSTRACT

This document provides a mapping of technical issues associated with development of the Next Generation Nuclear Plant (NGNP) intermediate heat transport loop and nuclear hydrogen plant support systems to the work that has been accomplished or is currently underway. The technical issues are ranked according to priority and by assumed resolution dates. Due to funding limitations, not all high-priority technical issues are under study at the present time, and more resources will need to be dedicated to tackling such issues in the future. This technical issues map is useful for understanding the relative importance of various technical challenges and will be used as a planning tool for future work package planning. The technical map in its present form will be discontinued in FY08 and will be folded into a larger NHI System Interface and Support Systems project management plant and scope baseline statement in FY08.

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1. INTRODUCTION

This document provides a mapping of known technical issues associated with development of the Next Generation Nuclear Plant (NGNP) intermediate heat transport loop and nuclear hydrogen plant support systems to the work that has been accomplished or is currently underway. The technical issues are ranked according to priority and by assumed resolution dates. Due to funding limitations, not all high-priority technical issues are under study at the present time, and more resources will need to be dedicated to resolving such issues in the future. This technical issues map may be useful as a program planning tool for understanding the relative importance of various technical challenges.

The NGNP Project also has responsibility for the development of parts of the intermediate heat transport loop including one or more Intermediate Heat Exchangers (IHX). Work has just begun on IHX development and energy conversion under the NGNP Project and has so far been confined to funding industry trade studies. The results of the industry trade studies will be available towards the end of FY07. No information is yet publicly available from these trade studies, and so the Technical Issues Map is written from the viewpoint of the DOE NHI. Once the results of the industry trade studies become available, it is expected that the list of technical issues and ranking of relative priorities will change significantly, and this Technical Issues Map will be altered accordingly. In recognition of the shared research and development responsibility for the intermediate heat transport loop and the technical implications of choices made by both projects, the Technical Issues Map will be modified from previous versions to include technical issues associated with the IHX.

The Map is presented as a series of tables. One table lists the set of technical issues or technological targets along with their relative importance. Another table lists the set of reports or projects that have been completed or are currently underway. A subsequent table shows the linkage between the set of technical issues and the set of completed or ongoing work. The latest DOE NHI project schedule is shown in Figure 1. Significant dates on the DOE NHI project schedules are: NHI Intermediate heat transport loop fluid down-select, 2009; Begin pilot-scale plant construction, 2011; Begin engineering-scale hydrogen plant construction, 2015. All technical issues are arranged in priority to support either pilot-scale or engineering-scale deployment of nuclear hydrogen production technologies.

The schedule for the companion program, the NGNP Project, is more aggressive, and places the intermediate fluid down select in FY08, the hydrogen pilot plant start-up in 2011, and full-scale combined plant operation by 2018. It is expected that the schedules for the two programs will be reconciled within the next fiscal year (FY08).

Following the Map is an assessment of how well the DOE NHI is performing in resolving the technical issues, and recommendations are given for any changes in research directions (if needed) and for additional projects.

Development of the Map is an attempt to systematically understand and catalog the multitude of technical issues that must be resolved in order to connect a high-temperature nuclear plant to a nuclear-heat-driven hydrogen production plant. The overall thought process going into the selection and solution of specific technical issues is shown in Figure 2. In this figure, component technical issues, system-specific technical issues, and overall plant-wide safety technical questions are addressed in order to arrive at a level of technical detail sufficient to support

detailed design of the NGNP. It is hoped that this Map will prove useful to the greater NGNP-related development programs for future planning, and that it will be illustrative in sorting between issues that are feasibility-related (Go/No-Go) and issues that are more related to plant economics (capital cost improvements, efficiency improvements, etc.). Certainly the feasibility-related issues must be tackled first, but those related to plant economics must ultimately be resolved in order to build a successful and economically competitive NGNP.

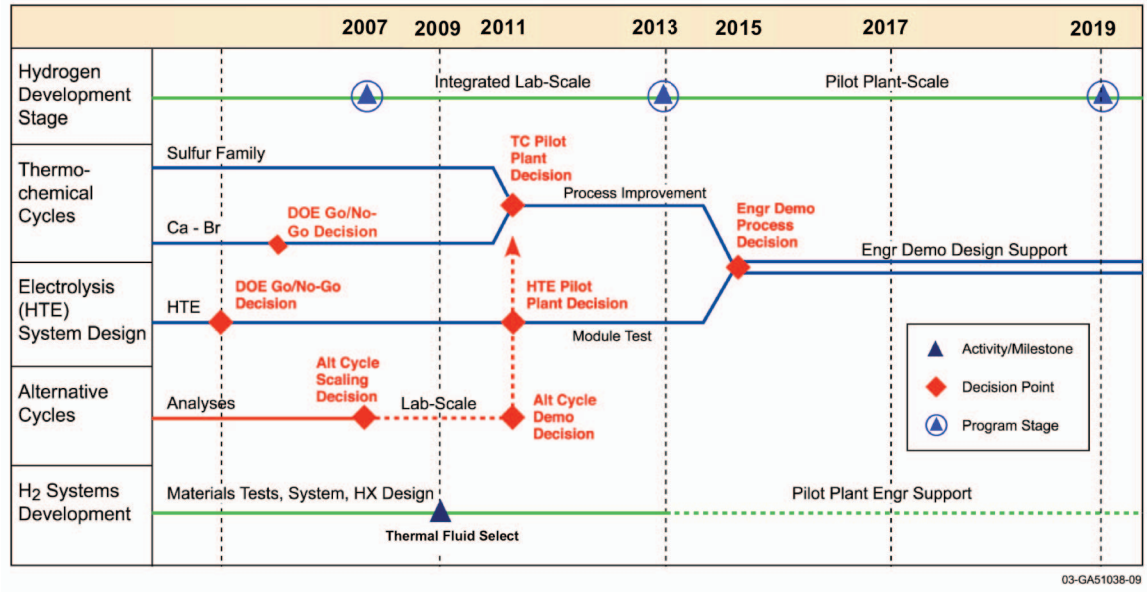


Figure 1. DOE Nuclear Hydrogen Initiative Project Schedule (Fall 2006)

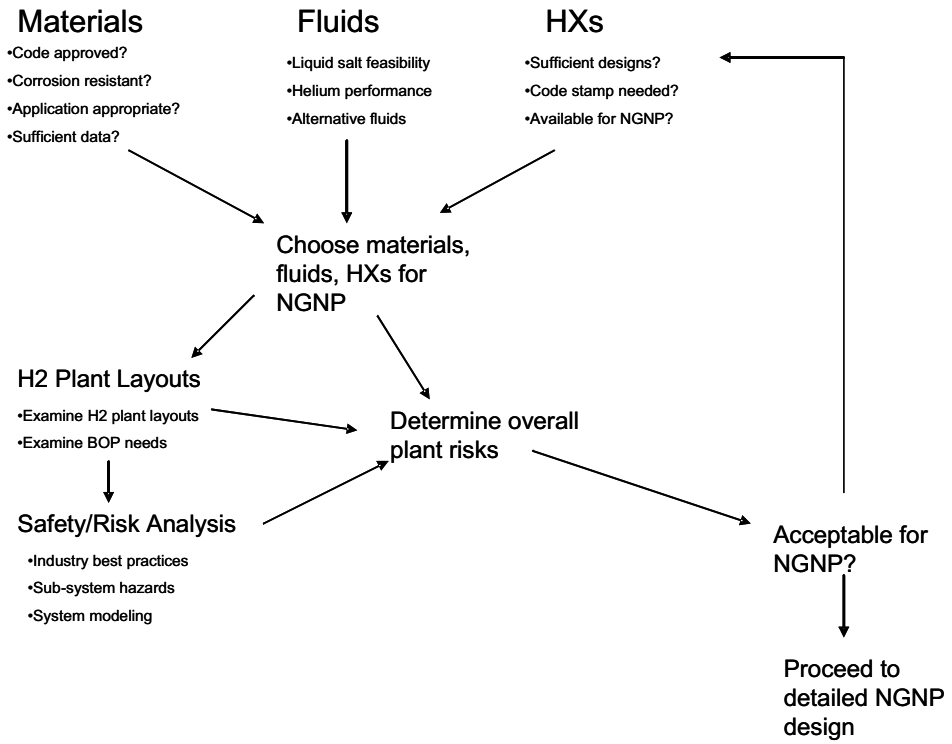


Figure 2. Overall goals for solving technical issues.

2. SET OF TECHNICAL ISSUES

The list of known System Interface and Supporting Systems technical issues is shown in Table 1 and Table 2. This list originated from technical issues described in the document ANL W7500-0002-ES-0, "Reactor/Process Interface Heat Exchanger and Intermediate Loop Technical Issues" and has been updated periodically as some issues were resolved and new ones were discovered. In Table 1 the issues are organized by technical area, while in Table 2, the issues are presented by the year in which they must be resolved. Estimates of the total cost of resolving each issue have not yet been developed, and so there is no linkage between the required resolution date and the cost of resolving the issue. The focus of the list is on the near-term leading up to the 2011 pilot-scale selection in Figure 1. The list is organized under six headings. These headings are: "1. Use of Liquid Salt for Intermediate Heat Transport Loop", "2. Use of Helium for Intermediate Heat Transport Loop", "3. General Materials and Components", "4. Balance-of-Plant and Infrastructure", "5. Safety", and "6. General Operations." The column on the right-hand-side of the table indicates when the technical issue must be resolved to provide the highest quality, lowest risk recommendations to the larger project concerning pilot-plant down selects, overall system designs, and safety. By 2011, the DOE NHI will begin a transition period from applied research and development activities to an organized construction and operation project with a sizeable industrial component. When that happens, research of the technical issues listed below may continue, but the constraints on equipment designs, plant layouts, and other considerations will become more fixed and more costly to alter. Therefore, research money is best directed to solving these issues within the prescribed time instead of waiting until design options have become more limited and resolution of unforeseen problems might be more costly to obtain.

Following the tables, Gantt charts are presented in Figures 3 through 8 for each technical area. These Gantt charts provide some information about the timing and duration of technical tasks, and the dates of select milestones.

Table 1. Set of Technical Issues

Number	Description	Needed by
1. Use of Liquid Salt for Intermediate Heat Transport Loop		
1.	Determine suitability of liquid salt for the NGNP intermediate loop and provide recommendations for/against its use in the engineering-scale demonstration.	2009
1.1	Compare liquid salt intermediate heat transport loop to helium heat transport loop (physical sizes, temperature/pressure distributions, characteristics, materials, equipment, energy costs, etc.)	2009
1.2	Develop system understanding of liquid salt intermediate heat transport loop with necessary support systems (design concepts, steady-state modeling, description of start-up, shutdown, off-normal behaviors and responses, etc.).	2009

Number	Description	Needed by
1.3	Determine redox control technique(s) or corrosion prevention methods/procedures for chosen salt(s) in order to minimize corrosion of intermediate loop containment/devices.	2009
1.4	Recommend heat exchanger designs for a He/Salt IHX and determine implications of using liquid salt on design of H_2SO_4 decomposer and related process heat exchangers.	2009
1.5	Recommend best candidate salt/structural material sets for use in the intermediate heat transport loop.	2008
1.6	Measure liquid salt data and corrosion data, as needed, to fill in "holes." Data must be collected in priority order.	2008
1.7	Assemble liquid salt data and materials corrosion data from literature sources and identify and prioritize physical data "holes."	2007
2. Use of Helium for Intermediate Heat Transport Loop		
2.	Develop system understanding of a practical helium intermediate heat transport loop to support intermediate heat transport fluid down-select (pipe configuration, length limitations, pressure drops, energy consumption, etc.)	2009
2.1	Determine effects of helium environments (commercial purity) on IHX candidate materials and recommend conditions to minimize corrosion/erosion.	2009
2.2	Model and test internal pipe insulation materials and methods for helium transport pipes.	2008
2.3	Recommend heat exchanger designs/materials for He/He IHX and process heat exchangers that are connected to the intermediate loop (excluding the H_2SO_4 decomposer).	2008
3. General Materials and Components		
3.	Provide detailed list of candidate component designs or concepts and suitably matched materials for use in pilot-scale demonstration plant(s) and independent pilot-scale testing.	2011
3.1	Examine use of high performance alloys and ceramics for IHX use (not code approved)	2009
3.2	Initiate assembled heat exchanger tests in the laboratory.	2009
3.3	Obtain high-temp creep, mechanical property data, permeability, manufacturing methods and so on to fill in data "holes" for IHX-suitable materials (code approved or nearly code-approved materials only).	2008
3.4	Obtain high-temp mechanical properties, permeability, and identify manufacturing methods, as needed, for candidate process heat exchanger materials to supplement heat exchanger design efforts.	2008
3.5	Identify designs and materials for high-temp oxygen cooler.	2008

Number	Description	Needed by
3.6	Perform corrosion testing of structural materials (metals, ceramics, cladded/coated samples) exposed to liquid/vapor H_2SO_4 and related chemicals.	On-going
3.7	Perform corrosion testing of structural materials (metals, ceramics, cladded/coated samples) exposed to HIx solutions under flow conditions.	On-going
3.8	Review and assess components shown on hydrogen production process flow sheets (S-I, high-temp electrolysis, and alternative processes if needed) for technical readiness.	2007, 2008, 2009, 2010, 2011
3.9	Revise the NHI Materials and Components Qualification Plan as needed to make it more usable by the program.	2007, 2008, 2009, 2010
3.10	Develop suitable database and begin implementation of the NHI Materials and Components Qualification Plan across the larger research program.	2007
3.11	Develop NHI Materials and Components Qualification Plan	2007
4. Balance-of-Plant and Infrastructure		
4.	Determine baseline balance-of-plant and infrastructure configurations of candidate pilot-scale hydrogen production plants.	2011
4.1	Examine physical and spatial relationships between HTE plant units and the intermediate heat transport loop, and determine minimum heat transfer distances while maximizing distance between nuclear plant and hydrogen production/storage units.	2009
4.2	Examine physical and spatial relationships between S-I plant units and the intermediate heat transport loop, and determine minimum heat transfer distances while maximizing distance between nuclear plant and hydrogen production/storage units.	2008
4.3	Identify environmental permitting requirements for S-I and HTE plants and initiate permitting activities (as needed).	2008
4.4	Identify necessity, operational requirements and equipment options for auxiliary heat source/sink for intermediate loop.	2008
5. Safety		
5.	Submit detailed safety strategy containing defenses-in-depth, risk-based features, and operational recommendations to maximize safety of the combined nuclear plant/hydrogen plant.	2011
5.1	Perform transient analyses of combined plant to look for potential safety problems that would not be present under steady-state operating conditions.	2010

Number	Description	Needed by
5.2	Determine tritium permeation and control strategies to minimize concentrations of tritium in the hydrogen product (must be coordinated with intermediate heat transport fluid selection).	2010
5.3	Examine chemical industry safety "best practices" and begin incorporation of usable information into the DOE NHI R&D plant design process.	2008
5.4	Develop or identify high-temp isolation valve designs or concepts for further testing (applicable to IHX).	2008
6. General Operations		
6.	Develop steady-state and transient modeling capabilities for combined system that are applicable for NRC licensing	2009
6.1	Incorporate economic evaluation capabilities into HyPEP.	2009
6.2	Complete steady-state HyPEP Model to include both S-I and HTE processes.	2008
6.3	Develop transient modeling capabilities for the combined plant that are suitable for safety and operations analysis and the design of control system strategies.	2008
6.4	Complete beta testing of HyPEP model.	2008
6.5	Complete alpha testing of HyPEP model.	2007

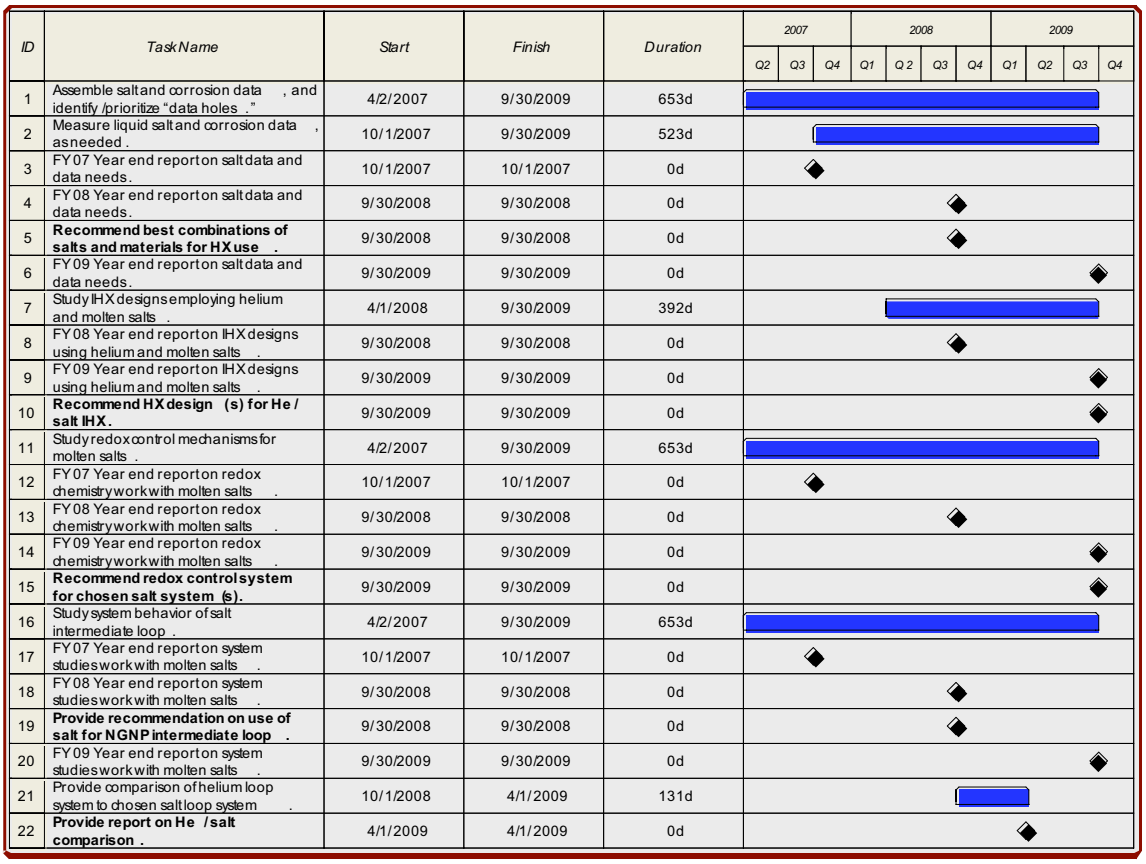
Table 2. Sequential Ordering of Technical Issues and Goals

2007	
1.7	Assemble liquid salt data and materials corrosion data from literature sources and identify and prioritize physical data "holes."
3.8	Review and assess components shown on hydrogen production flow sheets (S-I, high-temp electrolysis, and alternative processes, if needed) for technical readiness.
3.9	Revise the NHI Materials and Components Qualification Plan, as needed, to make it more usable by the program.
3.10	Develop suitable database and begin implementation of the NHI Materials and Components Qualification Plan across the larger research program.
3.11	Develop NHI Materials and Components Qualification plan.
6.5	Complete alpha testing of HyPEP model.
2008	
1.5	Recommend best candidate salt/structural material sets for use in the intermediate heat transport loop.
1.6	Measure liquid salt data and corrosion data, as needed, to fill in "holes." Data must be collected in priority order.
2.2	Model and test internal pipe insulation materials and methods for helium

	transport pipes.
2.3	Recommend heat exchanger designs/materials for He/He IHX and process heat exchangers that are connected to the intermediate loop (excluding the H_2SO_4 decomposer).
3.3	Obtain high-temp creep, mechanical property data, permeability, manufacturing methods and so on to fill in data "holes" for IHX-suitable materials (code-approved or nearly code-approved materials only).
3.4	Obtain high-temp mechanical properties, permeability, and identify manufacturing methods, as needed, for candidate process heat exchanger materials to supplement heat exchanger design efforts.
3.5	Identify designs and materials for high-temp oxygen cooler.
3.8	Review and assess components shown on hydrogen production process flow sheets (S-I, high-temp electrolysis, and alternative processes, if needed) for technical readiness.
3.9	Revise the NHI Materials and Components Qualification Plan as needed to make it more usable by the Program.
4.2	Examine physical and spatial relationships between S-I plant units and the intermediate heat transport loop, and determine minimum heat transfer distances while maximizing distance between nuclear plant and hydrogen production/storage units.
4.3	Identify environmental permitting requirements for S-I and HTE plants and initiate permitting activities, as required.
4.4	Identify necessity, operating requirements and equipment options for auxiliary heat source/sink for intermediate loop.
5.3	Examine chemical industry safety "best practices" and begin incorporation of usable information into the DOE NHI R&D pant design process.
5.4	Develop or identify high-temp isolation valve designs or concepts for further testing (applicable to IHX).
6.2	Complete steady-state HyPEP Model to include both S-I and HTE processes.
6.3	Develop transient modeling capabilities for the combined plant that are suitable for safety and operational analysis and the design of control system strategies.
6.4	Complete beta testing of the HyPEP model.
2009	
1.	Determine suitability of liquid salt for the NGNP intermediate loop and provide recommendations for/against its use in the engineering-scale demonstration.
1.1	Compare liquid salt intermediate heat transport loop to helium heat transport loop (physical sizes, temperature/pressure distribution, characteristics, materials, equipment, energy costs, etc.)
1.2	Develop system understanding of liquid salt intermediate heat transport loop with necessary support systems (design concepts, steady-state modeling, description of start-up, shutdown, off-normal behaviors and responses, etc.)

1.3	Determine redox control technique(s) or corrosion prevention methods/procedures for chosen salt(s) in order to minimize corrosion of intermediate loop containment/devices.
1.4	Recommend heat exchanger designs for He/Salt IHX and determine implications of using liquid salt on design of H_2SO_4 decomposer and related process heat exchangers.
2.	Develop system-level understanding of a practical helium intermediate heat transport loop to support intermediate heat transfer fluid down-select (pipe configuration, length, limitations, pressure drops, energy consumption, etc.)
2.1	Determine effects of helium environments (commercial purity) on IHX candidate materials and recommend conditions to minimize corrosion/erosion.
3.1	Examine use of high performance alloys and ceramics for IHX use (not code approved).
3.2	Initiate assembled heat exchanger testing in the laboratory.
3.8	Review and assess components shown on hydrogen production flow sheets (S-I, high-temp electrolysis, and alternative processes if needed) for technical readiness.
3.9	Revise the NHI Materials and Components Qualification Plan as needed to make it more usable by the program.
4.1	Examine physical and spatial relationships between HTE plant units and the intermediate heat transport loop, and determine minimum heat transfer distances while maximizing distance between nuclear plant and hydrogen production/storage units.
6.	Develop steady-state and transient modeling capabilities for combined system that are applicable for NRC licensing.
6.1	Incorporate economic evaluation capability into HyPEP.
2010	
3.8	Review and assess components shown on hydrogen production process flow sheets (S-I, HTE and alternative processes if needed) for technical readiness.
3.9	Revise the NHI Materials and Components Qualification Plan as needed to make it more usable by the program.
5.1	Perform transient analysis of combined plant to look for potential safety problems that would not be present under steady-state operating conditions.
5.2	Determine tritium permeation and control strategies to minimize concentrations of tritium in the hydrogen product (must be coordinated with the intermediate heat transport fluid selection).
2011	
3.	Provide detailed set of candidate component designs or concepts and suitably matched materials for use in pilot-scale demonstration plant(s) and independent pilot-scale testing.
3.8	Review and assess components shown on hydrogen production flow sheets (S-I, HTE and alternative processes if needed) for technical readiness.

4.	Determine baseline balance-of-plant and infrastructure configurations of candidate pilot-scale hydrogen production plants.
5.	Submit detailed safety strategy containing defense-in-depth, risk-based features, and operational recommendations to maximize safety of the combined plant.



ID	Task Name	Start	Finish	Duration
1	Assemble salt and corrosion data , and identify /prioritize "data holes ."	4/2/2007	9/30/2009	653d
2	Measure liquid salt and corrosion data , as needed .	10/1/2007	9/30/2009	523d
3	FY07 Year end report on salt data and data needs.	10/1/2007	10/1/2007	0d
4	FY08 Year end report on salt data and data needs.	9/30/2008	9/30/2008	0d
5	**Recommend best combinations of salts and materials for HX use .**	9/30/2008	9/30/2008	0d
6	FY09 Year end report on salt data and data needs.	9/30/2009	9/30/2009	0d
7	Study IHX designs employing helium and molten salts .	4/1/2008	9/30/2009	392d
8	FY08 Year end report on IHX designs using helium and molten salts .	9/30/2008	9/30/2008	0d
9	FY09 Year end report on IHX designs using helium and molten salts .	9/30/2009	9/30/2009	0d
10	**Recommend HX design (s) for He / salt IHX.**	9/30/2009	9/30/2009	0d
11	Study redox control mechanisms for molten salts .	4/2/2007	9/30/2009	653d
12	FY07 Year end report on redox chemistry work with molten salts .	10/1/2007	10/1/2007	0d
13	FY08 Year end report on redox chemistry work with molten salts .	9/30/2008	9/30/2008	0d
14	FY09 Year end report on redox chemistry work with molten salts .	9/30/2009	9/30/2009	0d
15	**Recommend redox control system for chosen salt system (s).**	9/30/2009	9/30/2009	0d
16	Study system behavior of salt intermediate loop .	4/2/2007	9/30/2009	653d
17	FY07 Year end report on system studies work with molten salts .	10/1/2007	10/1/2007	0d
18	FY08 Year end report on system studies work with molten salts .	9/30/2008	9/30/2008	0d
19	**Provide recommendation on use of salt for NGNP intermediate loop .**	9/30/2008	9/30/2008	0d
20	FY09 Year end report on system studies work with molten salts .	9/30/2009	9/30/2009	0d
21	Provide comparison of helium loop system to chosen salt loop system .	10/1/2008	4/1/2009	131d
22	**Provide report on He / salt comparison .**	4/1/2009	4/1/2009	0d

Figure 3. Liquid Salt Systems Technical Area

ID	Task Name	Start	Finish	Duration
1	Analyze HX concepts for He /He IHX.	4/2/2007	9/30/2008	392d
2	FY 07 Year end report on IHX analysis .	10/1/2007	10/1/2007	0d
3	FY 08 Year end report on IHX analysis .	9/30/2008	9/30/2008	0d
4	**Recommend He /He IHX design for intermediate loop .**	9/30/2008	9/30/2008	0d
5	Analyze HXs and systems that use alternative fluids (steam, CO2).	10/1/2007	9/30/2008	262d
6	Report on HX and systems using alternative fluids .	9/30/2008	9/30/2008	0d
7	Analyze and test pipe insulation for high-temp systems .	4/2/2007	9/30/2009	653d
8	FY 07 Year end report on pipe insulation .	10/1/2007	10/1/2007	0d
9	Initiate pipe insulation experiments	4/1/2008	4/1/2008	0d
10	FY 08 Year end report on pipe insulation work .	9/30/2008	9/30/2008	0d
11	**Provide recommendation and report on pipe insulation .**	9/30/2009	9/30/2009	0d

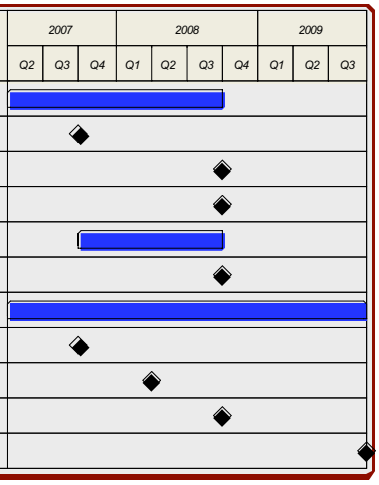


Figure 4. Helium Systems Technical Area

ID	Task Name	Start	Finish	Duration
1	NHI Materials and Components Development Plan	10/2/2006	9/28/2007	260d
2	**Issue Materials and Components Development Plan**	4/2/2007	4/2/2007	0d
3	**Initiate Plan Implementation**	5/30/2007	5/30/2007	0d
4	Develop and test NHI Components Database	1/30/2007	3/28/2008	304d
5	Perform corrosion testing of Hix materials.	4/2/2007	9/30/2008	392d
6	Perform corrosion testing of sulfuric acid materials .	4/2/2007	9/30/2008	392d
7	**Identify best materials for sulfuric acid decomposition section .**	9/30/2008	9/30/2008	0d
8	**Identify best materials for Hix section.**	9/30/2008	9/30/2008	0d
9	Perform testing of materials for high -temp oxygen cooler .	10/1/2007	6/30/2008	196d
10	**Identify best materials for high -temp oxygen cooler .**	6/30/2008	6/30/2008	0d
11	Measure high -temp alloy properties in support of ASME code cases .	4/2/2007	12/30/2010	979d
12	Perform assembled heat exchanger testing .	6/2/2008	12/30/2010	674d
13	Measure ceramic materials properties for HX use .	4/2/2007	12/30/2010	979d
14	FY 07 Year end report on materials progress.	10/1/2007	10/1/2007	0d
15	FY 08 Year end report on materials progress.	9/30/2008	9/30/2008	0d
16	FY 09 Year end report on materials progress.	9/30/2009	9/30/2009	0d
17	FY 10 Year end report on materials progress.	9/30/2010	9/30/2010	0d

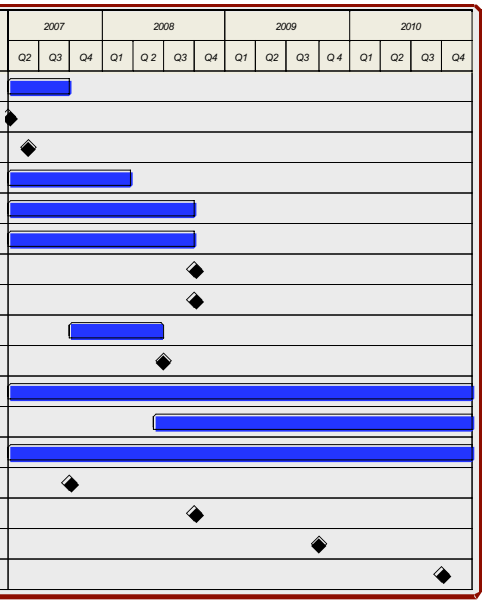


Figure 5. Materials Technical Area

ID	Task Name	Start	Finish	Duration
1	Examine use of auxiliary heat sink / source .	10/1/2007	9/30/2008	262d
2	**Recommend solution for aux . heat sink/source.**	9/15/2008	9/15/2008	0d
3	Review environmental permitting requirements.	6/2/2008	9/30/2009	348d
4	**Provide summary document on permitting needs .**	9/30/2009	9/30/2009	0d
5	Examine physical layout of H 2 plant(s).	10/1/2007	9/30/2009	523d
6	**Provide minimum -risk plant layout(s).**	9/30/2009	9/30/2009	0d
7	Examine BOP requirements and needs for pilot-scale plants	6/1/2009	9/30/2010	349d
8	**Provide report on BOP requirements for pilot -scale plants .**	10/1/2010	10/1/2010	0d

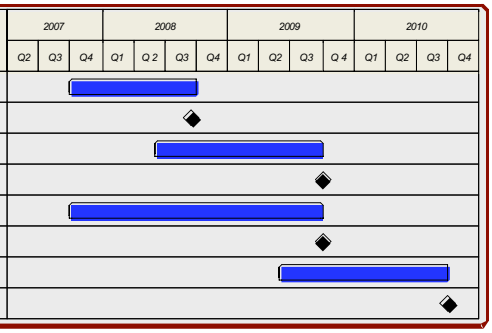


Figure 6. Balance-of-Plant Technical Area

ID	Task Name	Start	Finish	Duration
1	High-temp isolation valve research	10/1/2007	10/1/2010	785d
2	**Recommend isolation valve designs for NGNP.**	10/1/2010	10/1/2010	0d
3	Examine chemical industry safety "best practices"	10/1/2007	9/30/2009	523d
4	**Provide summary report on "best practices" for H 2 plant**	9/30/2009	9/30/2009	0d
5	Examine tritium movement to H 2 plant.	10/2/2006	9/30/2008	522d
6	**Assess tritium implications for NGNP.**	9/30/2008	9/30/2008	0d
7	Perform transient and steady -state analyses of combined plant .	10/1/2007	9/30/2010	784d
8	**Summary report on transient responses.**	9/30/2010	9/30/2010	0d
9	Risk-based safety analyses of combined plant .	4/2/2007	12/30/2010	979d
10	FY 08 Year end report on risk analysis work.	9/30/2008	9/30/2008	0d
11	FY 09 Year end report on risk analysis work.	9/30/2009	9/30/2009	0d
12	FY 10 Year end report on risk analysis work.	9/30/2010	9/30/2010	0d

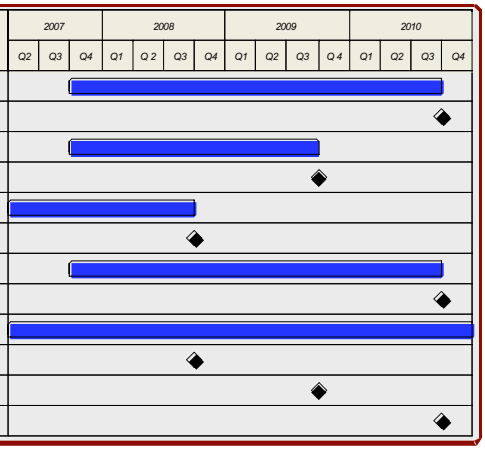


Figure 7. Safety Technical Area

ID	Task Name	Start	Finish	Duration
1	Develop steady -state and transient models	10/2/2006	10/1/2009	784d
2	Complete alpha -testing of HyPEP	10/1/2007	10/1/2007	0d
3	Complete beta -testing of HyPEP	9/30/2008	9/30/2008	0d
4	Initiate transient modeling of integrated system	10/1/2007	10/1/2007	0d
5	Complete steady -state models of HTE and SI process	9/30/2008	9/30/2008	0d
6	Incorporate economic capabilities into HyPEP	10/1/2008	9/30/2009	261d
7	Perform system analyses to support NGNP licensing activities	10/1/2008	10/1/2009	262d

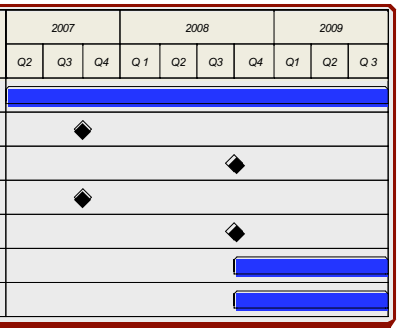


Figure 8. Operations Technical Area

3. SET OF REPORTS AND PROJECTS

The list of past and on-going System Interface and Supporting Systems projects is shown in Table 3. The table provides the project date, the description, and origin (location) for the project. Where reports or documents have been written, report or document titles are provided under the description heading. Where work is underway and reports or project documents have yet to be issues, the work package or NERI project title is provided under the description heading instead.

Table 3. Set of System Interface and Supporting Systems Projects/Reports

Identifier	Description	Origin
FY 2004		
UNLV 1Q_2004	UNLV HTHX Project Quarterly Report, 1Q FY04	UNLV
UNLV 2Q_2004	UNLV HTHX Project Quarterly Report, 2Q FY04	UNLV
UNLV 3Q_2004	UNLV HTHX Project Quarterly Report, 3Q FY04	UNLV
UNLV 4Q_2004	UNLV HTHX Project Quarterly Report, 4Q FY04	UNLV
ANL W7500-001-ES-00	Reactor/Process Interface Requirements	ANL-W
ANL W7500-002-ES-00	Reactor/Process Interface Heat Exchanger and Intermediate Loop Technical Issues	ANL-W
ANL W7500-003-ES-00	Balance of Plant Requirements for a Nuclear Hydrogen Production Plant	ANL-W
INEEL EXT-04-01791	Infrastructure Requirements for a Nuclear Hydrogen Pilot Plant	INEEL
FY 2005		
UNLV 1Q_2005	UNLV HTHX Project Quarterly Report, 1Q FY05	UNLV
UNLV 2Q_2005	UNLV HTHX Project Quarterly Report, 2Q FY05	UNLV
UNLV 3Q_2005	UNLV HTHX Project Quarterly Report, 3Q FY05	UNLV
UNLV 4Q_2005	UNLV HTHX Project Quarterly Report, 4Q FY05	UNLV
UNLV 2005	UNLV HTHX Project FY 2005 Year-End Report	UNLV
INL EXT-05-00137	An Engineering Analysis for Separation Requirements of a Hydrogen Production Plant and High-Temperature Nuclear Reactor, Revision 0	INL
INL EXT-05-00453	Thermal-Hydraulic Analysis of Heat Transfer Fluid Requirements and Characteristics for Coupling a Hydrogen Production Plant to a High-Temperature Nuclear Reactor	INL
INL EXT-05-00690	Engineering Analysis of Intermediate Loop and Process Heat Exchanger Requirements to Include Configuration Analysis and Materials Needs	INL
NERI 05-032	Silicon Carbide Ceramics for Compact Heat Exchangers (3-year project)	Johns Hopkins University
NERI 05-154 1Q	Molten Salt Transport Loop: Materials Corrosion and Heat Transfer Phenomena, 1st Quarterly Report	U of Wis.
NERI 05-154 2Q	Molten Salt Transport Loop: Materials Corrosion and Heat Transfer Phenomena, 2nd Quarterly Report	U of Wis.

Identifier	Description	Origin
FY 2006		
UNLV 1Q_2006	UNLV HTHX Project Quarterly Report, 1Q FY06	UNLV
UNLV 2Q_2006	UNLV HTHX Project Quarterly Report, 2Q FY06	UNLV
UNLV 3Q_2006	UNLV HTHX Project Quarterly Report, 3Q FY06	UNLV
UNLV 4Q_2006	UNLV HTHX Project Quarterly Report, 4Q FY06	UNLV
UNLV Ceramic_2006a	NHI Report: Hydrodynamic, Thermal and Decomposition Performance for Ceramic Sulfuric Acid Decomposer	UNLV
UNLV Ceramic_2006b	Mechanical and Thermal Stress Analysis of Ceramic HTHX	UNLV
UNLV Stripfin_2006	NHI Report: Optimization Studies and Manifold Design of Compact Off-set Strip Fin HTHX	UNLV
GA Corrosion_2006	Corrosion Studies of Construction Materials in HI Decomposition Environment	GA
Ceramatec 2006	FY2006 Materials Characterization and Heat Exchanger Design Development for NHI Applications	Ceramatec
INL EXT-06-11232	Balance of Plant Requirements for a Nuclear Hydrogen Plant, Revision 1	INL
INL EXT-06-11482	Assessment of Codes and Standards Applicable to a Hydrogen Production Plant Coupled to a Nuclear Reactor	INL
INL EXT-05-00137 Rev. 1	An Engineering Analysis for Separation Requirements of a Hydrogen Production Plant and High-Temperature Nuclear Reactor	INL
INL EXT-06-11725	HyPEP FY06 Report: Models and Methods	INL, ANL, KAERI
ORNL TM-2006 563	NHI Materials and Components Development Plan	ORNL, INL
ORNL TM-2006 69	Assessment of Candidate Molten Salt Coolants for the NGNP/NHI Heat-Transfer Loop	ORNL
NERI 05-032	Silicon Carbide Ceramics for Compact Heat Exchangers (3-year project)	Johns Hopkins University
NERI 05-154 3Q	Molten Salt Transport Loop: Materials Corrosion and Heat Transfer Phenomena, 3rd Quarterly Report	U of Wis.
NERI 05-154 Y1	Molten Salt Transport Loop: Materials Corrosion and Heat Transfer Phenomena, Year 1 Report	U of Wis.
NERI 05-154 5Q	Molten Salt Transport Loop: Materials Corrosion and Heat Transfer Phenomena, 5th Quarterly Report	U of Wis.
NERI 05-154 6Q	Molten Salt Transport Loop: Materials Corrosion and Heat Transfer Phenomena, 6th Quarterly Report	U of Wis.
NERI 05-154 7Q	Molten Salt Transport Loop: Materials Corrosion and Heat Transfer Phenomena, 7th Quarterly Report	U of Wis.
NERI 06-024	Ni-Si Alloys for the S-I Reactor/Hydrogen Production Process Interface (3-year project)	U of Mo and INL
NERI 06-041	Dynamic Simulation and Optimization of Nuclear Hydrogen Production Systems (3-year project)	MIT
FY 2007		
INL EXT-07-12746	Tritium Movement and Accumulation in NGNP System Interface and Hydrogen Plant	INL
N-AN07SS0101	Steady State and Transient Modeling of Combined Nuclear Hydrogen Plant	ANL

Identifier	Description	Origin
N-ID07SS0101	UNLV NHI Materials Support	UNLV
N-ID07SS0102	UNLV NHI Momentum/Heat/Mass Transfer	UNLV
N-ID07SS0103	UNLV NHI Liquid Salt Systems	UNLV
N-ID07SS0104	UNLV NHI Materials/Surface Characterization	UNLV
N-ID07SS0105	UNLV NHI Chemistry Support	UNLV
N-ID07SS0106	Measurement of Mechanical Alloy Properties at UNLV – FY06 Carryover	UNLV
N-ID07SS0107	Corrosion and Crack Growth Studies in HIx Solutions at General Atomics – FY06 Carryover	GA
N-ID07SS0108	Numerical Analysis of Advanced Heat Exchanger Concepts at UNV – FY06 Carryover	UNLV
N-ID07SS0109	C-SiC Materials for HTHX's at UC-Berkeley – FY06 Carryover	UCB
N-ID07SS0110	Ceramic Heat Exchanger Development for Application to NHI Hydrogen Production Processes (FY06 Carryover)	Ceramatec
N-ID07SS0111	Ceramic Heat Exchanger Development for Application to NHI Hydrogen Production Processes (FY07 Bridge Package)	Ceramatec
N-ID07SS0112	UNLV RF High Temperature Heat Exchanger Project – FY06 Carryover	UNLV
N-ID07SS0113	The Development of Self-Catalytic Materials for Thermochemical Water Splitting Using the Sulfur-Iodine Process	MIT
N-IN07SS0101	Steady-State and Transient Modeling of Combined Nuclear Hydrogen Plant	INL
N-IN07SS0102	Technical Director and Project Management Support for the DOE NHI	INL
N-OR07SS0101	Development of NHI Materials and Components Test Plan	ORNL
UNLV 1Q_2007	High Temperature Heat Exchanger Project: Quarterly Progress Report, October 1, 2006 through December 31, 2006	UNLV
UNLV 2Q_2007	High Temperature Heat Exchanger Project: Quarterly Progress Report, January 1, 2007 through March 31, 2007	UNLV
UNLV Alloy_2007a	Tensile Property Measurements of Structural Materials for High-Temperature Heat Exchanger Applications	UNLV
GA Corrosion_2007a	FY2006 Year End Report: Corrosion Studies of Construction Materials for HI Decomposition Environment	GA
ANL Model_2007a	Dynamic Modeling Efforts for System Interface Studies	ANL
NERI 05-032	Silicon Carbide Ceramics for Compact Heat Exchangers (3-year project)	Johns Hopkins University
NERI 05-154	Molten Salt Transport Loop: Materials Corrosion and Heat Transfer Phenomena (3-year project)	U of Wis.
NERI 06-024	Ni-Si Alloys for the S-I Reactor/Hydrogen Production Process Interface (3-year project)	U of Mo and INL
NERI 06-041	Dynamic Simulation and Optimization of Nuclear Hydrogen Production Systems (3-year project)	MIT
NERI 07-030	Liquid Salts as Media for Process Heat Transfer	U of Wis.

4. MAPPING OF PROJECTS TO TECHNICAL ISSUES

Table 4 shows the mapping of projects to technical issues. The project identifiers are the same ones used in Tables 2 and 3 to differentiate between projects. If the project identifier box is empty in Table 4, then no projects have yet been pursued to solve the technical issue. The "Resolved?" indicator shows whether the technical issue has been resolved or will be resolved this fiscal year. The "Year Needed" column shows when the particular technical issue must be solved in order to support the construction and operation of pilot-scale and engineering-scale equipment. If the "Year Needed" box is filled with an "On-going" indicator, then the work is expected to be ongoing and does not have a defined resolution.