~~PREDECISIONAL~~

Statement of Work

NRC Agreement Number	NRC Agreement Modification Number	NRC Task Order Number (If Applicable)	NRC Task Order Modification Number (If Applicable)
Project Title Primary Water Stress Corrosion Cracking Crack Initiation Testing			
Job Code Number	B&R Number	DOE Laboratory PNNL	
NRC Requisitioning Office			
NRC Form 187, Contract Security and Classification Requirements ☐ Applicable ☐ Note Applicable		☐ Involves Proprietary Information ☐ Involves Sensitive Unclassified	
☐ Non Fee-Recoverable		☐ Fee-Recoverable (If checked, complete all applicable sections below)	
Docket Number (If Fee-Recoverable/Applicable)		Inspection Report Number (If Fee Recoverable/Applicable)	
Technical Assignment Control Number (If Fee-Recoverable/Applicable)		Technical Assignment Control Number Description (If Fee-Recoverable/Applicable)	

1. Background

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Primary water stress corrosion cracking (PWSCC) is a notable concern for pressure-boundary integrity in pressurized water reactors (PWRs). In general, the nickel-based alloys and weld materials have shown susceptibility to stress corrosion cracking (SCC). The initiation of SCC in nickel alloys and weld materials is not well-understood; research efforts in this area will provide direct support for NRC regulatory stances and programs. This notable Operational Experience (OpE), such as at V.C. Summer (2000), Arkansas Nuclear One Unit 1 (2001), Davis Besse (2002), and Wolf Creek (2006), have raised concerns that PWSCC may result in the loss of intended function of the reactor pressure boundary. In these cases, cracking or leaking occurred within nickel alloy materials due to PWSCC. One of the efforts to mitigate the effects of PWSCC has been to replace 600/82/182 nickel alloy components with less susceptible 690/52/152 materials. It is noted that higher chromium content in materials appears to reduce susceptibility; the specific mechanism, however, is not well characterized. Additionally, other variables to the material may result in increased susceptibility. Therefore, a systematic, intuitive approach to examine crack initiation of nickel alloys is needed.

There is an existing research program on crack initiation of nickel alloys at Pacific Northwest National Laboratory (PNNL), under a DOE contract regarding Light Water Reactor Sustainability (LWRS.) However, the information gained from the LWRS project differs in scope and goals, and thus, there is a knowledge gap regarding crack initiation characterization. Results from the LWRS reports indicate a focus on the mechanistic path of crack initiation and related surface effects; the proposed research efforts of the NRC would produce a data set suitable for estimating the probabilistic crack initiation times, and how material variability changes such initiation times.

Typically, NRC staff has used a deterministic approach to address relief requests and regulatory technical bases for inspection frequencies, assuming initial flaw presence. Probabilistic approaches such as those previously reviewed by the NRC Office of Nuclear Regulatory Research (RES), MRP-105 and MRP-113, were not generally accepted by the NRC. However, with the development of xLPR Version 2.0, an acceptable probabilistic methodology will have been created that meets NRC expectations. Specific focus for Alloy 600/182/82 materials is for cracking at cold leg temperatures, as well as direct support for xLPR. The crack initiation model was one of the largest uncertainties associated with Version 1.0. Similar uncertainty is expected with Version 2.0. Industry is developing multiple programs to provide additional information to address crack initiation in nickel base alloys. Therefore it is necessary that the NRC monitor these programs and initiate a validation program to ensure all potential configurations are evaluated. To complete these activities and support future revisions of xLPR, the NRC must develop a program to monitor and perform crack initiation testing of nickel-based alloys. The data produced by the proposed research project will aid in the development and validation of xLPR Version 2.0, to incorporate such data in to the Leak Before Break (LBB) model.

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2. Objective

The objective of this program is to develop the necessary infrastructure and resources to proceed with an NRC-directed research program in developing data relevant to nickel alloy-based component integrity in the primary system, and perform crack initiation testing. The material requirements provided by this program will enable research that will directly support existing programs within the NRC and provide a basis for inspection requirements and aging management of nickel alloy components. This Statement of Work reflects the NRC commitment as outlined in a Memorandum of Understanding (MOU) addendum, dated XX/XX/XXXX, (NUMBER ASSIGNED), to provide the startup materials, plans, and equipment necessary to perform crack initiation testing of nickel alloy materials.

Information and data obtained may be used to enhance the NRC's regulatory approach to passive components of the primary system, and potentially impact the regulation of new reactor designs. Nickel alloys are used in components such as CRDM, pressurizer, and reactor coolant system nozzles, as well comprising the weld materials used to attach such components to the primary system.

3. Scope of Work

The DOE Laboratory must provide all resources necessary to accomplish the tasks and deliverables described in this statement of work (SOW). There are two tasks associated within this scope and one additional task upon the exercise of contract option:

1.) The DOE Laboratory shall develop a test plan, and the NRC will review the test plan for acceptability.

2.) The DOE Laboratory shall design, assemble, validate, and service the necessary equipment to support the test plan.

3.) (Option) The DOE Laboratory shall perform materials testing of nickel alloy materials and their associated weld materials, e.g. A600, 82/182 weld materials.

4. Specific Tasks

The DOE Laboratory must perform the following tasks:

Task 1: Test Plan Development

The DOE Laboratory, given the technical expertise in the realm of PWSCC, shall develop an initial test plan for nickel alloy materials that will provide data for crack initiation. The DOE Laboratory shall align this test plan in a manner that directly supports the User Needs of the

NRC, and the NRC will provide feedback with regards to alignment and research goals. The DOE Laboratory will also provide suggestions and adjustments to the test plan, to be implemented at the discretion of the NRC staff. The DOE Laboratory shall list the necessary materials, equipment, timelines, and personnel in the test plan. The DOE Laboratory shall include specific definitions, means of determination, and/or criteria regarding critical values, such as initiation times and sample characteristics. This test plan shall be furnished in a letter report consistent with NRC document guidelines, and must detail assumptions, expectations, potential issues and research gaps, and the justifications for each.

The test plan must also include details of, and justifications for, any major assumptions. The initial test plan must be designed to utilize as close as possible to full capacity of the testing equipment, as detailed in Task 2, and the total duration of the test plan should be the full period of performance. The initial test plan should outline and justify specimen preparation techniques, and treatment of specimens.

It is expected that Test Plan Development shall be an ongoing process, and the NRC will provide timely feedback regarding suggested changes.

Task 2: Infrastructure Requirements

The DOE Laboratory shall design, assemble, and validate testing equipment (systems) capable of carrying out the Test Plan as described in Task 1. Two (2) systems shall be constructed for crack initiation testing, with the capability to test approximately thirty (36) concurrent specimens each. The DOE Laboratory shall also design and employ a validation technique to prove as-designed efficacy. The DOE Laboratory shall submit a letter report detailing the validation techniques, including details of, and justifications for, any major assumptions within the testing system. Additionally, the DOE Laboratory shall provide the necessary staff to service and maintain the testing systems, as needed for the proper function of such systems.

Task 3: (Option) Nickel Alloy Materials Testing

Contingent upon exercise of contract option, the DOE Laboratory shall provide, test, and analyze nickel alloy materials. The DOE Laboratory shall be responsible to procure sample specimens as outlined in the detailed test plan. The materials to be tested include nickel alloy 600/182/82 and 690/152/52. Additionally, some of these specimens may be heterogeneous, containing 600 or 690 base metal welded to their respective weld materials. The DOE Laboratory shall prepare and submit monthly status reports, consistent with NRC document guidelines, detailing research progress, including any pertinent data as produced. The monthly reports must also include any recommendations or modifications to the test plan, and the justifications for such. The DOE Laboratory shall prepare and submit a final letter report upon conclusion of the research program, outlining the details of the final test plan, data, statistical analysis, and other information as agreed upon between the DOE Laboratory and NRC. All reports must conform to the guidance provided by the NRC regarding document construction.

~~PREDECISIONAL~~

5. Technical and Other Special Qualifications Required

Specialized experience must include expertise in such areas as engineering and materials science. Knowledge in welds and weld techniques is also desired.

Task 1, test plan development, requires knowledge in materials science and engineering to design an appropriate test plan for nickel alloy materials in the area of crack initiation. Additionally, knowledge of nuclear systems is required, as the materials proposed for testing under the test plan must be subject to conditions which approximate the primary water environment. A valid test plan will include justification for test plan design, scope, and expectations.

Task 2, infrastructure requirements, requires specialized knowledge in designing, assembling, and validating the necessary test plan equipment, outlined in Task 1. This knowledge may include electrical, materials, chemical, mechanical, or other engineering disciplines. The testing equipment is highly specialized for the particular application of PWSCC crack initiation. Additionally, specific knowledge of the equipment and related systems is required to provide support, maintenance, and service for the equipment after assembly.

Task 3 (Option), upon exercise of contract option, nickel alloy materials testing, requires specialized knowledge of mechanical engineering, materials engineering, or materials science. Monthly status reports must be prepared, detailing progress of current and planned testing, data, and recommendations to adjust the test plan as needed. Additionally, post-processing or preparation of data in a usable fashion may be required, and requires knowledge of statistics. The precise details of Task 3 will be outlined, initially, under the deliverable of Task 1. It is expected that during the execution of Task 3, revision of the Test Plan will occur at agreement of the NRC, based on recommendations with the DOE Laboratory.

6. Deliverables and/or Milestones SCHEDULE

Deliverable Number	**Deliverable/Milestone Description** (include NRC acceptance criteria if applicable)	Due Date *(if any)*
1	The DOE Laboratory shall create and provide an initial test plan.	Within one (1) month of the contract award
2	The NRC will review and provide comments on the initial test plan	Within ten (10) business days of receipt of the test

		plan, Deliverable 1
3	The DOE Laboratory shall design, assemble, and validate testing equipment suitable for crack initiation testing as required by the MOU (INFO)	Within twelve (12) months of the contract award
4	The DOE Laboratory shall provide an initial report detailing the test plan, equipment specifications, and validation of equipment	Within twelve (12) months of the contract award
5	The NRC shall review the equipment validation procedure and provide comments	Within ten (10) business days of
6 (under exercise of option)	The DOE Laboratory shall provide Monthly Status Reports detailing the progress of the research program	Monthly, beginning three (3) months after completion of Task 2
7 (under exercise of option)	The DOE Laboratory shall provide a final report, detailing overall results and data encompassing the entire research program	Within thirty (30) days of research program completion

7. Meetings and Travel

Project Related Travel

Travel Description for FY 2014-2016	Location	Date	Days	Number of Attendees
FY 2015				
Program Review at NRC	Rockville, MD	June 2015	2	1
FY 2016 (Option Year 1)				
Program Review at NRC	Rockville, MD	June 2016	2	1
NGC-EAC Annual Meeting	TBD	TBD	5	1
FY 2017 (Option Year 2)				

Program Review at NRC	Rockville, MD	June 2017	2	1
NGC-EAC Annual Meeting	TBD	TBD	5	1
FY 2018 (Option Year 3)				
Program Review at NRC	Rockville, MD	June 2018	2	1
NGC-EAC Annual Meeting	TBD	TBD	5	1
FY 2019 (Option Year 4)				
Program Review at NRC	Rockville, MD	June 2019	2	1
NGC-EAC Annual Meeting	TBD	TBD	5	1

All travel requires written Government approval from the CO, unless otherwise delegated to the COR.

Foreign travel for the DOE laboratory personnel requires a 60-day lead time for NRC approval. For prior approval of foreign travel, the DOE laboratory shall submit an NRC Form 445, "Request for Approval of Official Foreign Travel." NRC Form 445 is available in the MD 11.7 Documents library and on the NRC Web site at: http://www.nrc.gov/reading-rm/doc-collections/forms/. Foreign travel is approved by the NRC Executive Director for Operations (EDO).

8. Reporting Requirements

The DOE Laboratory is responsible for structuring the deliverable to follow agency standards. The current agency standard is Microsoft Office Suite 2010. The current agency Portable Document Format (PDF) standard is Adobe Acrobat 9 Professional. Deliverables must be submitted free of spelling and grammatical errors and conform to requirements stated in this section.

Monthly Letter Status Reports

In accordance with Management Directive 11.7, NRC Procedures for Placement and Monitoring of Work with the U.S. Department of Energy, the DOE Laboratory must electronically submit a Monthly Letter Status Report (MLSR) by the 20th day of each month to the Contracting Officer Representative (COR) with copies to the Contracting Officer (CO) and the Office Administration/Division of Contracts to ContractsPOT.Resource@nrc.gov. If a project is a task ordering agreement, a separate MLSR must be submitted for each task order with a summary project MLSR, even if no work has been performed during a reporting period. Once NRC has determined that all work on a task order is completed and that final costs are acceptable, a task order may be omitted from the MLSR.

The MLSR must include the following: agreement number; task order number, if applicable; job code number; title of the project; project period of performance; task order period of performance, if applicable; COR's name, telephone number, and e-mail address; full name and address of the performing organization; principal investigator's name, telephone number, and e-mail address; and reporting period.

In addition to the Monthly Letter Status Reports, the DOE Laboratory shall also submit documents as described in the above Tasks, using the guidance for MLSRs when applicable.

9. Period of Performance

The estimated period of performance for this work is from the estimated award date, September 2014, until September 2015. With the exercise of Option Years, the period of performance may extend to September 2019.

10. Contracting Officer's Representative

The COR monitors all technical aspects of the agreement/task order and assists in its administration. The COR is authorized to perform the following functions: assure that the DOE Laboratory performs the technical requirements of the agreement/task order; perform inspections necessary in connection with agreement/task order performance; maintain written and oral communications with the DOE Laboratory concerning technical aspects of the agreement/task order; issue written interpretations of technical requirements, including Government drawings, designs, specifications; monitor the DOE Laboratory's performance and notify the DOE Laboratory of any deficiencies; coordinate availability of NRC-furnished material and/or GFP; and provide site entry of DOE Laboratory personnel.

Contracting Officer's Representative

~~PREDECISIONAL~~

Name: Matthew Rossi

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Alternate Contracting Officer's Representative

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11. MATERIALS REQUIRED (TYPE N/A IF NOT APPLICABLE)

The DOE Laboratory shall be responsible for purchasing all equipment associated with Task 2. However, the specific details of this equipment are at the discretion of the DOE Laboratory, due to the custom nature of the testing system.

12. NRC-Furnished Property/MATERIALS

N/A

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13. RESEARCH QUALITY

Upon exercise of the contract option, the following applies regarding research quality:

The quality of NRC research programs are assessed each year by the Advisory Committee on Reactor Safeguards. Within the context of their reviews of RES programs, the definition of quality research is based upon several major characteristics:

Results meet the objectives (75% of overall score)

Justification of major assumptions (12%)

Soundness of technical approach and results (52%)

Uncertainties and sensitivities addressed (11%)

Documentation of research results and methods is adequate (25% of overall score)

Clarity of presentation (16%)

Identification of major assumptions (9%)

It is the responsibility of the DOE Laboratory to ensure that these quality criteria are adequately addressed throughout the course of the research that is performed. The NRC COR will review all research products with these criteria in mind.

14. STANDARDS FOR CONTRACTORS WHO PREPARE NUREG-SERIES MANUSCRIPTS

N/A

15. OTHER CONSIDERATIONS

N/A

References

N/A

Access to Non-NRC Facilities/Equipment

N/A

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Applicable Publications

N/A

Controls over document handling and non-disclosure of materials

N/A

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Statement of Work

NRC Agreement Number	NRC Agreement Modification Number	NRC Task Order Number (If Applicable)	NRC Task Order Modification Number (If Applicable)

Project Title Primary Water Stress Corrosion Cracking Crack Initiation Testing		
Job Code Number	B&R Number	DOE Laboratory PNNL
NRC Requisitioning Office		

NRC Form 187, Contract Security and Classification Requirements ☐ Applicable ☐ Note Applicable	☐ Involves Proprietary Information ☐ Involves Sensitive Unclassified
☐ Non Fee-Recoverable	☐ Fee-Recoverable (If checked, complete all applicable sections below)
Docket Number (If Fee-Recoverable/Applicable)	Inspection Report Number (If Fee Recoverable/Applicable)
Technical Assignment Control Number (If Fee-Recoverable/Applicable)	Technical Assignment Control Number Description (If Fee-Recoverable/Applicable)

1. Background

~~PREDECISIONAL~~

Primary water stress corrosion cracking (PWSCC) can affect nickel-based alloys in pressurized water reactors (PWRs) at locations such as dissimilar metal welds between stainless and low-alloy steel, control rod drive mechanism penetrations in the reactor pressure vessel upper head, and at instrument penetrations in the lower head. Operational events where PWSCC led to leakage of primary water have occurred at V.C. Summer (2000), Arkansas Nuclear One Unit 1 (2001), Davis Besse (2002), and Wolf Creek (2006), among others. Many plants have systematically replaced components fabricated from the nickel-based Alloy 600 and Alloy 82 or 182 weld metals with higher chromium-content alloys, which are thought to be more resistant to PWSCC, particularly Alloy 690 and variants of Alloy 52 and 152 weld metals.

The evolution of PWSCC can be divided into periods of initiation and propagation. During the initiation period, processes such as passive film rupture and penetrative oxidation serve as precursors to the formation of a macroscopically stable crack. During the propagation period, the crack growth is controlled by fracture mechanics. While the initiation period may be much longer than the propagation period for a plant component, most NRC research to date has focused on crack propagation because staff uses a deterministic approach to address relief requests and regulatory technical bases for inspection frequencies, assuming initial flaw presence. Probabilistic approaches such as those previously reviewed by the NRC Office of Nuclear Regulatory Research (RES), MRP-105 and MRP-113, were not generally accepted by the NRC. Other organizations, including the U.S. Department of Energy (DOE), Knolls Atomic Power Laboratory, and international groups have pursued more robust initiation testing programs, but data are still limited and have not led to well-supported analytical models that could be used to predict the time to crack initiation after a component enters service.

The development of the Extremely Low Probability of Rupture (xLPR) code by NRC and the Electric Power Research Institute, however, has highlighted the need for additional initiation data to provide confirmatory support for the model assumptions. Data may also support the technical bases for new inspection requirements for nickel-based alloys. The purpose of this project is to obtain such data for these alloys by establishing a testing program at Pacific Northwest National Laboratory (PNNL). PNNL performs PWSCC growth rate testing under contract to NRC, and over a number of years, established a strong knowledge base and a high level of technical capability. PNNL also conducts PWSCC initiation testing under sponsorship of DOE, which supports particular interests of the Light Water Reactor Sustainability Program. This program will build upon these already established efforts.

2. Objective

The objective of this program is to obtain PWSCC initiation data for nickel-based alloys, including Alloys 600/82/182 and Alloys 690/52/152. The data will support the xLPR code development and the technical bases for in-service inspection requirements of the materials.

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3. Scope of Work

~~In an addendum to the Memorandum of Understanding (MOU) between RES and EPRI, dated XX/XX/XXXX, (NUMBER ASSIGNED), NRC agreed to fund the development of a test plan and construction of testing facilities to acquire PWSCC data, while EPRI agreed to fund the performance of the testing in an amount equivalent to NRC's costs for the test plan and facilities. Additional costs are to be shared by NRC and EPRI.~~ PNNL shall be responsible for submitting a test plan and designing, assembling, and validating the required testing equipment (systems) to carry out such a test plan. In addition, one optional task has been included, the execution of portions of the test plan. Section 4 of this statement of work describes these three tasks in greater detail. ~~The first two tasks represent the development of a test plan and construction of testing facilities, as agreed in the MOU. The optional third task may be exercised to fund NRC's share of the test program after EPRI's costs meet NRC's costs for the first two tasks.~~

4. Specific Tasks

PNNL must perform the following tasks:

Task 1: Test Plan Development
PNNL shall develop a test plan to meet the following requirements:

- Two (2) test machines will be used, each of which has the capability to test at least thirty (30) specimens in simulated primary water. One test machine will be used for Alloys 600/82/182 and the other for Alloys 690/52/152. The test plan will describe the equipment used for the test machines and criteria for validating its functionality.
- The test plan will describe materials to be tested, including such information as alloy chemistry, heat treatment, level of cold work, surface finish, and other relevant parameters.
- The test plan will describe the experimental procedure, including criteria for determining when a crack has initiated in a specimen.
- The test plan will describe any post-test material examination and characterization, to include microscopy and other microstructural characterization.
- The test plan will propose a schedule for conducting the tests, based on previous PNNL experience with initiation testing of these alloys. The test plan will include options for test periods of two, three, or four years after the test machines are operable.

This test plan shall be furnished in a letter report consistent with NRC document guidelines, and must detail assumptions, expectations, potential issues and research gaps, and the justifications for each.

Task 2: Construction and Validation of Test Machines
PNNL shall design, assemble, and validate testing equipment (systems) capable of carrying out the Test Plan as described in Task 1. Two (2) systems shall be constructed for crack initiation testing, with the capability to test at least thirty (30) concurrent specimens each. PNNL shall also design and employ a validation technique to prove as-designed efficacy. PNNL shall submit a letter report detailing the validation techniques, including details of, and justifications for, any major assumptions within the testing system. Additionally, the PNNL shall provide the necessary staff to service and maintain the testing systems, as needed for the proper function of such systems.

Task 3: (Option) Nickel Alloy Materials Testing
Contingent upon exercise of contract option, PNNL shall execute portions of the test plan directed by NRC. The specific testing requirements will be agreed upon by PNNL and NRC prior to the exercise of this option.

5. Technical and Other Special Qualifications Required

This project requires knowledge of the metallurgy and PWSCC behavior of nickel-based alloys, including the effects of temperature, stress level, thermo-mechanical processing, welding parameters, and fracture mechanics. Prior experience with PWSCC testing is also required to demonstrate the ability to acquire and interpret data.

6. Deliverables and/or Milestones SCHEDULE

Deliverable Number	**Deliverable/Milestone Description** (include NRC acceptance criteria if applicable)	Due Date *(if any)*
1	PNNL shall create and provide a test plan.	Within one (1) month of the contract award
2	PNNL shall design, assemble, and validate testing equipment suitable for crack initiation testing	Within twelve (12) months of the contract award
3	PNNL shall provide a report detailing the as-built	Within one (1) month of completion of

	equipment setup and validation	Deliverable 2
4 (under exercise of option)	PNNL shall provide a draft NUREG/CR report, detailing overall results and data encompassing the entire research program	TBD, subject to agreement by PNNL and the NRC
5 (under exercise of option)	PNNL shall provide a final NUREG/CR report, detailing overall results and data encompassing the entire research program	TBD, subject to agreement by PNNL and the NRC

7. Meetings and Travel

Project Related Travel

Travel Description for FY 2014-2016	**Location**	**Date**	**Days**	**Number of Attendees**
FY 2015				
Program Review at NRC	Rockville, MD	June 2015	2	1
FY 2016				
Program Review at NRC	Rockville, MD	June 2016	2	1
Present findings at ICG-EAC Annual Meeting	TBD	TBD	5	1
FY 2017				
Program Review at NRC	Rockville, MD	June 2017	2	1
Present findings at ICG-EAC Annual Meeting	TBD	TBD	5	1
FY 2018				
Program Review at NRC	Rockville, MD	June 2018	2	1

Present findings at ICG-EAC Annual Meeting	TBD	TBD	5	1
FY 2019				
Program Review at NRC	Rockville, MD	June 2019	2	1
Present findings at ICG-EAC Annual Meeting	TBD	TBD	5	1

All travel requires written Government approval from the CO, unless otherwise delegated to the COR.

Foreign travel for PNNL personnel requires a 60-day lead time for NRC

approval. For prior approval of foreign travel, PNNL shall submit an

NRC Form 445, "Request for Approval of Official Foreign Travel." NRC Form 445 is

available in the MD 11.7 Documents library and on the NRC Web site at:

http://www.nrc.gov/reading-rm/doc-collections/forms/. Foreign travel is approved by the NRC Executive Director for Operations (EDO).

8. Reporting Requirements

PNNL is responsible for structuring the deliverable to follow agency standards. The current agency standard is Microsoft Office Suite 2010. The current agency Portable Document Format (PDF) standard is Adobe Acrobat 9 Professional. Deliverables must be submitted free of spelling and grammatical errors and conform to requirements stated in this section.

Monthly Letter Status Reports

In accordance with Management Directive 11.7, NRC Procedures for Placement and Monitoring of Work with the U.S. Department of Energy, PNNL must electronically submit a Monthly Letter Status Report (MLSR) by the 20th day of each month to the Contracting Officer Representative (COR) with copies to the Contracting Officer (CO) and the Office Administration/Division of Contracts to ContractsPOT.Resource@nrc.gov. If a project is a task ordering agreement, a separate MLSR must be submitted for each task order with a summary project MLSR, even if no work has been performed during a reporting period. Once NRC has determined that all work on

a task order is completed and that final costs are acceptable, a task order may be omitted from the MLSR.

The MLSR must include the following: agreement number; task order number, if applicable; job code number; title of the project; project period of performance; task order period of performance, if applicable; COR's name, telephone number, and e-mail address; full name and address of the performing organization; principal investigator's name, telephone number, and e-mail address; and reporting period.

In addition to the Monthly Letter Status Reports, PNNL shall also submit documents as described in the above Tasks, using the guidance for MLSRs when applicable.

9. Period of Performance

The estimated period of performance for this work is from the estimated award date, September 2014, until September 2015. With the exercise of Option Years, the period of performance may extend to September 2019.

10. Contracting Officer's Representative

The COR monitors all technical aspects of the agreement/task order and assists in its administration. The COR is authorized to perform the following functions: assure that PNNL performs the technical requirements of the agreement/task order; perform inspections necessary in connection with agreement/task order performance; maintain written and oral communications with PNNL concerning technical aspects of the agreement/task order; issue written interpretations of technical requirements, including Government drawings, designs, specifications; monitor PNNL's performance and notify PNNL of any deficiencies; coordinate availability of NRC-furnished material and/or GFP; and provide site entry of DOE Laboratory personnel.

Contracting Officer's Representative

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Alternate Contracting Officer's Representative

Name: Greg Oberson

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Office: Nuclear Regulatory Research, Division of Engineering, Corrosion and Metallurgy

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Washington, DC 20555-0001

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Phone: (301) 251-7675

11. MATERIALS REQUIRED

PNNL shall be responsible for purchasing all equipment associated with Task 2. However, the specific details of this equipment are at the discretion of PNNL, due to the custom nature of the testing system.

12. NRC-Furnished Property/MATERIALS

N/A

13. RESEARCH QUALITY

Upon exercise of the contract option, the following applies regarding research quality:

The quality of NRC research programs are assessed each year by the Advisory Committee on Reactor Safeguards. Within the context of their reviews of RES programs, the definition of quality research is based upon several major characteristics:

Results meet the objectives (75% of overall score)

- Justification of major assumptions (12%)
- Soundness of technical approach and results (52%)
- Uncertainties and sensitivities addressed (11%)

Documentation of research results and methods is adequate (25% of overall score)

- Clarity of presentation (16%)
- Identification of major assumptions (9%)

It is the responsibility of PNNL to ensure that these quality criteria are adequately addressed throughout the course of the research that is performed. The NRC COR will review all research products with these criteria in mind.

14. STANDARDS FOR CONTRACTORS WHO PREPARE NUREG-SERIES MANUSCRIPTS

Upon exercise of the contract option, the following applies regarding NUREG-series manuscripts:

The U.S. Nuclear Regulatory Commission (NRC) began to capture most of its official records electronically on January 1, 2000. The NRC will capture each final NUREG-series publication in its native application. Therefore, please submit your final manuscript that has been approved by your NRC Project Manager in both electronic and camera-ready copy.

The final manuscript shall be of archival quality and comply with the requirements of NRC Management Directive 3.7 “NUREG-Series Publications.” The document shall be technically edited consistent with NUREG–1379, Rev. 2 (May 2009) "NRC Editorial Style Guide." The goals of the "NRC Editorial Style Guide" are readability and consistency for all agency documents.

All format guidance, as specified in NUREG-0650, “Preparing NUREG-Series Publications," Rev. 2 (January 1999), will remain the same with one exception. You will no longer be required to include the NUREG-series designator on the bottom of each page of the manuscript. The NRC will assign this designator when we send the camera-ready copy to the printer and will place the designator on the cover, title page, and spine. The designator for each report will no

longer be assigned when the decision to prepare a publication is made. The NRC's Publishing Services Branch will inform the NRC Project Manager for the publication of the assigned designator when the final manuscript is sent to the printer.

For the electronic manuscript, the Contractor shall prepare the text in Microsoft Word, and use any of the following file types for charts, spreadsheets, and the like.

File Types to be Used for NUREG-Series Publications	
File Type	File Extension
Microsoft®Word®	.doc
Microsoft® PowerPoint®	.ppt
Microsoft®Excel	.xls
Microsoft®Access	.mdb
Portable Document Format	.pdf

This list is subject to change if new software packages come into common use at NRC or by our licensees or other stakeholders that participate in the electronic submission process. If a portion of your manuscript is from another source and you cannot obtain an acceptable electronic file type for this portion (e.g., an appendix from an old publication), the NRC can, if necessary, create a tagged image file format (file extension.tif) for that portion of your report. Note that you should continue to submit original photographs, which will be scanned, since digitized photographs do not print well.

If you choose to publish a compact disk (CD) of your publication, place on the CD copies of the manuscript in both (1) a portable document format (PDF); (2) a Microsoft Word file format, and (3) an Adobe Acrobat Reader, or, alternatively, print instructions for obtaining a free copy of Adobe Acrobat Reader on the back cover insert of the jewel box.

15. OTHER CONSIDERATIONS

N/A

References

N/A

~~PREDECISIONAL~~

Access to Non-NRC Facilities/Equipment

N/A

Applicable Publications

N/A

Controls over document handling and non-disclosure of materials

N/A

~~PREDECISIONAL~~

Statement of Work

NRC Agreement Number	NRC Agreement Modification Number	NRC Task Order Number (If Applicable)	NRC Task Order Modification Number (If Applicable)
Project Title Crack Initiation Testing for Primary Water Stress Corrosion Cracking			
Job Code Number	B&R Number	DOE Laboratory PNNL	
NRC Requisitioning Office			
NRC Form 187, Contract Security and Classification Requirements ☐ Applicable ☐ Note Applicable		☐ Involves Proprietary Information ☐ Involves Sensitive Unclassified	
☐ Non Fee-Recoverable		☐ Fee-Recoverable (If checked, complete all applicable sections below)	
Docket Number (If Fee-Recoverable/Applicable)		Inspection Report Number (If Fee Recoverable/Applicable)	
Technical Assignment Control Number (If Fee-Recoverable/Applicable)		Technical Assignment Control Number Description (If Fee-Recoverable/Applicable)	

1. Background

~~PREDECISIONAL~~

The purpose of this project is to obtain crack initiation data for reactor component nickel based alloys by establishing a testing program at Pacific Northwest National Laboratory (PNNL). PNNL performs primary water stress corrosion crack (PWSCC) growth rate tests under contract to NRC, and over a number of years, has established a strong knowledge base and a high level of technical capability. PNNL also conducts PWSCC initiation testing under sponsorship of DOE Light Water Reactor Sustainability Research (LWRS), which supports particular interests of the Light Water Reactor Sustainability Program. This research will build upon these already established efforts.

Primary water stress corrosion cracking (PWSCC) can occur in nickel-based alloy component in pressurized water reactors (PWRs) at locations such as dissimilar metal welds between stainless and low-alloy steel, control rod drive mechanism penetrations in the reactor pressure vessel upper head, and at instrument penetrations in the lower head. In the U.S., PWSCC has led to coolant leakage at V.C. Summer (2000), Arkansas Nuclear One Unit 1 (2001), Davis Besse (2002), and Wolf Creek (2006), among others. Many plants have systematically replaced components fabricated from the nickel-based Alloy 600 and Alloy 82 or 182 weld metals with higher chromium-content alloys, which are thought to be more resistant to PWSCC, particularly Alloy 690 and variants of Alloy 52 and 152 weld metals.

The evolution of PWSCC can be divided into periods of initiation and propagation. During the initiation period, processes such as the rupture of passive oxide film and internal (grain boundary) oxidation serve as precursors to the formation of a macroscopically stable crack. During the propagation period, the crack growth is affected by the electro chemical and mechanical (stress-related) interactions. While the initiation period may be much longer than the propagation period for a plant component, most NRC research to date has focused on crack propagation because staff uses a deterministic approach to address relief requests and regulatory technical bases for inspection frequencies, assuming the presence of a postulated initial flaw. Probabilistic approaches such as EPRI MRP-105 and MRP-113 were reviewed by the NRC staff were not accepted. To better understand the process of crack initiation, several organizations, including the U.S. Department of Energy (DOE), Knolls Atomic Power Laboratory (KAPL), and international groups have pursued more robust initiation testing programs, but data are still limited and have not led to well-supported analytical models that could be used to predict the time to crack initiation after a component enters service.

The development of the Extremely Low Probability of Rupture (xLPR) code by NRC and the Electric Power Research Institute, however, has highlighted the need for additional data to support model assumptions. Data may also support the technical bases for new inspection requirements for nickel-based alloy components. The NRC is seeking testing plans and equipment capable of producing viable (as defined by reproducibility, and the identification and/or establishment of accuracy, precision, and bias) data to further develop xLPR. This data may include, but is not limited to, crack initiation times; effects of cold work; dilution zone effects; and surface effects.

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2. Objective

The objective of this program is to obtain PWSCC initiation data for reactor component nickel-based alloys, including Alloys 600/82/182 and Alloys 690/52/152. The data will support the xLPR code development and the technical bases for in-service inspection requirements of the materials.

3. Scope of Work

PNNL shall be responsible for submitting a plan for designing~~,~~; procuring materials and components, including dedicated data capture and analysis capability~~,~~; assembling~~,~~; and pre-testing ~~to verify and validate (V&V)~~ the equipment and data acquisition and analysis (systems) to carry out such a plan. In addition, one optional task has been included, the execution of portions of the test plan. Section 4 of this statement of work describes these three tasks in greater detail.

Data produced under the Test Plan (Task 1, listed below) should address the needs of the NRC with respect to producing viable data suitable for use in xLPR. Ultimately, the data should a) correlate to Operation Experience data, b) provide a statistical basis to predict crack initiation times, and c) provide a correlation between the variability of materials and crack initiation times.

4. Specific Tasks

PNNL must perform the following tasks:

Task 1: Test Plan Development
PNNL shall develop a test plan to meet the following requirements:

- Two (2) test machines will be used, each of which has the capability to test at least thirty (30) specimens in simulated primary water. One test machine will be used for Alloys 600/82/182 and the other for Alloys 690/52/152. The test plan will describe the equipment used for the test machines and criteria for ~~validating~~ evaluating its functionality. The test equipment shall include capability to simulate reactor coolant environment (coolant loop, pressure and temperature) in a highly controlled manner. The equipment shall also include appropriate automatic data acquisition and analysis system, preferably with proven commercial software.

~~PREDECISIONAL~~

- The test plan will describe materials to be tested, including such information as alloy chemistry, heat treatment, level of cold work, surface finish, and other relevant parameters.
- The test plan will describe the experimental procedure, including specimen geometries, qualification, any applicable Standards or Codes, and must also include criteria for determining when a crack has initiated in a specimen. The test plan must include evaluations of experiments for viability, ~~verification and validation~~, and descriptions of the means to do so. ASTM Standards may apply to the viability of the test plan, which should be documented in the Test Plan.
- The test plan must include details and expectations of the data collected. This includes, but is not limited to, means of data viability ~~verification and validation~~, and correlation to Operating Experience data. ~~As part of data verification and validation, the reproducibility and portability of data must also be considered.~~
- The test plan will describe any post-test material examination and characterization, to include microscopy and other microstructural characterization.
- The test plan will propose a schedule for conducting the tests, based on previous PNNL experience with initiation testing of these alloys. The test plan will include options for test periods of two, three, or four years after the test machines are operable.

This test plan shall be furnished in a letter report consistent with NRC document guidelines, and must detail assumptions, expectations, potential issues and research gaps, and the justifications for each.

Task 2: Construction and Viability ~~Verification and Validation~~ of Test Machines

PNNL shall design, procure materials and components, assemble, and ~~verify and validate~~prove the viability of testing equipment (systems) capable of carrying out the Test Plan as described in Task 1. Two (2) systems shall be constructed for crack initiation testing, with the capability to test at least thirty (30) concurrent specimens each. PNNL shall also design and employ a validation technique to prove as-designed efficacy. PNNL shall submit a letter report detailing the viability~~V&V techniques~~, including details of, and justifications for, any major assumptions within the testing system. ASTM Standards may apply to the viability of the system, which should be documented in the letter report. Additionally, the PNNL shall provide the necessary staff to service and maintain the testing systems, as needed for the proper function of such systems.

~~V&V~~Viability analysis must be performed prior to proceeding to Task 3, upon exercise of the option. This may require the use of Standards and/or Codes, and must be documented in the letter report.

~~PREDECISIONAL~~

Task 3: (Option) Nickel Alloy Materials Testing
Contingent upon exercise of contract option, PNNL shall execute portions of the test plan directed by NRC. The specific testing requirements will be agreed upon by PNNL and the NRC prior to the exercise of this option. As part of this effort, PNNL shall provide recommendations to modify the test plan on the basis of data produced, data needs, and alignment with project goals. These recommendations shall be implemented at the agreement of PNNL and the NRC.

Task 4: (Option) NUREG-series Manuscript
Contingent upon exercise of contract option, PNNL shall produce a NUREG-series manuscript detailing the overall results and data encompassing the entire research program. PNNL must include an estimation of any potential costs for copyright permission for using data from external copyrighted sources, prior to exercise of the Option and execution of this Task.

5. Technical and Other Special Qualifications Required

This project requires high knowledge of the metallurgy and PWSCC behavior of nickel-based alloys used for nuclear reactor components, including the effects of temperature, stress level, thermo-mechanical processing, welding parameters, and fracture mechanics. Prior experience with PWSCC testing is also required to plan, design and assemble suitable test assembly and demonstrate the ability to acquire and interpret test data.

6. Deliverables and/or Milestones SCHEDULE

Deliverable Number	**Deliverable/Milestone Description** (include NRC acceptance criteria if applicable)	Due Date *(if any)*
1	PNNL shall create and provide a test plan.	Within one (1) month of the contract award
2	PNNL shall design, assemble, and validate testing equipment suitable for crack initiation testing	Within twelve (12) months of the contract award
3	PNNL shall provide a report detailing the as-built equipment setup and validation	Within one (1) month of completion of Deliverable 2
4 (under exercise of Task 3	PNNL shall provide recommendations for changes to the test plan	TBD, subject to agreement by PNNL

option)		and the NRC
5 (under exercise of Task 4 option)	PNNL shall provide a draft NUREG/CR report, detailing overall results and data encompassing the entire research program	TBD, subject to agreement by PNNL and the NRC
6 (under exercise of Task 4 option)	PNNL shall provide a final NUREG/CR report, detailing overall results and data encompassing the entire research program	TBD, subject to agreement by PNNL and the NRC

7. Meetings and Travel

Project Related Travel

Travel Description for FY 2014-2016	**Location**	**Date**	**Days**	**Number of Attendees**
FY 2015				
Program Review at NRC	Rockville, MD	June 2015	2	1
FY 2016 (Option)				
Program Review at NRC	Rockville, MD	June 2016	2	1
Present findings at ICG-EAC Annual Meeting	TBD	TBD	5	1
FY 2017 (Option)				
Program Review at NRC	Rockville, MD	June 2017	2	1
Present findings at ICG-EAC Annual Meeting	TBD	TBD	5	1
FY 2018 (Option)				

Program Review at NRC	Rockville, MD	June 2018	2	1
Present findings at ICG-EAC Annual Meeting	TBD	TBD	5	1
FY 2019 (Option)				
Program Review at NRC	Rockville, MD	June 2019	2	1
Present findings at ICG-EAC Annual Meeting	TBD	TBD	5	1

All travel requires written Government approval from the CO, unless otherwise delegated to the COR.

Foreign travel for PNNL personnel requires a 60-day lead time for NRC approval. For prior approval of foreign travel, PNNL shall submit an

NRC Form 445, "Request for Approval of Official Foreign Travel." NRC Form 445 is

available in the MD 11.7 Documents library and on the NRC Web site at:

http://www.nrc.gov/reading-rm/doc-collections/forms/. Foreign travel is approved by the NRC Executive Director for Operations (EDO).

8. Reporting Requirements

PNNL is responsible for structuring the deliverable to follow agency standards. The current agency standard is Microsoft Office Suite 2010. The current agency Portable Document Format (PDF) standard is Adobe Acrobat 9 Professional. Deliverables must be submitted free of spelling and grammatical errors and conform to requirements stated in this section.

Monthly Letter Status Reports

In accordance with Management Directive 11.7, NRC Procedures for Placement and Monitoring of Work with the U.S. Department of Energy, PNNL must electronically submit a Monthly Letter Status Report (MLSR) by the 20th day of each month to the Contracting Officer Representative (COR) with copies to the Contracting Officer (CO) and the Office Administration/Division of Contracts to ContractsPOT.Resource@nrc.gov. If a project is a task ordering agreement, a separate MLSR must be submitted for each task order with a summary project MLSR, even if no

work has been performed during a reporting period. Once NRC has determined that all work on a task order is completed and that final costs are acceptable, a task order may be omitted from the MLSR.

The MLSR must include the following: agreement number; task order number, if applicable; job code number; title of the project; project period of performance; task order period of performance, if applicable; COR's name, telephone number, and e-mail address; full name and address of the performing organization; principal investigator's name, telephone number, and e-mail address; and reporting period.

In addition to the Monthly Letter Status Reports, PNNL shall also submit documents as described in the above Tasks, using the guidance for MLSRs when applicable.

9. Period of Performance

The estimated period of performance for this work is from the estimated award date, September 2014, until September 2015. With the exercise of Option Years, the period of performance may extend to September 2019.

10. Contracting Officer's Representative

The COR monitors all technical aspects of the agreement/task order and assists in its administration. The COR is authorized to perform the following functions: assure that PNNL performs the technical requirements of the agreement/task order; perform inspections necessary in connection with agreement/task order performance; maintain written and oral communications with PNNL concerning technical aspects of the agreement/task order; issue written interpretations of technical requirements, including Government drawings, designs, specifications; monitor PNNL's performance and notify PNNL of any deficiencies; coordinate availability of NRC-furnished material and/or GFP; and provide site entry of DOE Laboratory personnel.

Contracting Officer's Representative

Name: Matthew Rossi

Agency: U.S. Nuclear Regulatory Commission

Office: Nuclear Regulatory Research, Division of Engineering, Corrosion and Metallurgy

Mail Stop: CSB 05C07

Washington, DC 20555-0001

E-Mail: matthew.rossi@nrc.gov

Phone: (301) 251-7646

Alternate Contracting Officer's Representative

Name: Greg Oberson

Agency: U.S. Nuclear Regulatory Commission

Office: Nuclear Regulatory Research, Division of Engineering, Corrosion and Metallurgy

Mail Stop: CSB 05A24

Washington, DC 20555-0001

E-Mail: greg.oberson@nrc.gov

Phone: (301) 251-7675

11. MATERIALS REQUIRED

PNNL shall be responsible for purchasing all equipment associated with Task 2. However, the specific details of this equipment are at the discretion of PNNL, due to the custom nature of the testing system.

12. NRC-Furnished Property/MATERIALS

N/A

13. RESEARCH QUALITY

Upon exercise of the contract option, the following applies regarding research quality:

The quality of NRC research programs are assessed each year by the Advisory Committee on Reactor Safeguards. Within the context of their reviews of RES programs, the definition of quality research is based upon several major characteristics:

Results meet the objectives (75% of overall score)

Justification of major assumptions (12%)

Soundness of technical approach and results (52%)

Uncertainties and sensitivities addressed (11%)

Documentation of research results and methods is adequate (25% of overall score)

Clarity of presentation (16%)

Identification of major assumptions (9%)

It is the responsibility of PNNL to ensure that these quality criteria are adequately addressed throughout the course of the research that is performed. The NRC COR will review all research products with these criteria in mind.

14. STANDARDS FOR CONTRACTORS WHO PREPARE NUREG-SERIES MANUSCRIPTS

Upon exercise of the contract option, the following applies regarding NUREG-series manuscripts:

The U.S. Nuclear Regulatory Commission (NRC) began to capture most of its official records electronically on January 1, 2000. The NRC will capture each final NUREG-series publication in its native application. Therefore, please submit your final manuscript that has been approved by your NRC Project Manager in both electronic and camera-ready copy.

The final manuscript shall be of archival quality and comply with the requirements of NRC Management Directive 3.7 “NUREG-Series Publications.” The document shall be technically edited consistent with NUREG–1379, Rev. 2 (May 2009) "NRC Editorial Style Guide." The goals of the "NRC Editorial Style Guide" are readability and consistency for all agency documents.

All format guidance, as specified in NUREG-0650, “Preparing NUREG-Series Publications," Rev. 2 (January 1999), will remain the same with one exception. You will no longer be required to include the NUREG-series designator on the bottom of each page of the manuscript. The NRC will assign this designator when we send the camera-ready copy to the printer and will place the designator on the cover, title page, and spine. The designator for each report will no

longer be assigned when the decision to prepare a publication is made. The NRC's Publishing Services Branch will inform the NRC Project Manager for the publication of the assigned designator when the final manuscript is sent to the printer.

For the electronic manuscript, the Contractor shall prepare the text in Microsoft Word, and use any of the following file types for charts, spreadsheets, and the like.

File Types to be Used for NUREG-Series Publications	
File Type	File Extension
Microsoft®Word®	.doc
Microsoft® PowerPoint®	.ppt
Microsoft®Excel	.xls
Microsoft®Access	.mdb
Portable Document Format	.pdf

This list is subject to change if new software packages come into common use at NRC or by our licensees or other stakeholders that participate in the electronic submission process. If a portion of your manuscript is from another source and you cannot obtain an acceptable electronic file type for this portion (e.g., an appendix from an old publication), the NRC can, if necessary, create a tagged image file format (file extension.tif) for that portion of your report. Note that you should continue to submit original photographs, which will be scanned, since digitized photographs do not print well.

If you choose to publish a compact disk (CD) of your publication, place on the CD copies of the manuscript in both (1) a portable document format (PDF); (2) a Microsoft Word file format, and (3) an Adobe Acrobat Reader, or, alternatively, print instructions for obtaining a free copy of Adobe Acrobat Reader on the back cover insert of the jewel box.

15. OTHER CONSIDERATIONS

N/A

References

N/A

Access to Non-NRC Facilities/Equipment

N/A

Applicable Publications

N/A

Controls over document handling and non-disclosure of materials

N/A

~~PREDECISIONAL~~

Statement of Work

NRC Agreement Number	NRC Agreement Modification Number	NRC Task Order Number (If Applicable)	NRC Task Order Modification Number (If Applicable)
Project Title Primary Water Stress Corrosion Cracking Crack Initiation Testing			
Job Code Number	B&R Number	DOE Laboratory PNNL	
NRC Requisitioning Office			
NRC Form 187, Contract Security and Classification Requirements ☐ Applicable ☐ Note Applicable		☐ Involves Proprietary Information ☐ Involves Sensitive Unclassified	
☐ Non Fee-Recoverable		☐ Fee-Recoverable (If checked, complete all applicable sections below)	
Docket Number (If Fee-Recoverable/Applicable)		Inspection Report Number (If Fee Recoverable/Applicable)	
Technical Assignment Control Number (If Fee-Recoverable/Applicable)		Technical Assignment Control Number Description (If Fee-Recoverable/Applicable)	

1. Background

~~PREDECISIONAL~~

Primary water stress corrosion cracking (PWSCC) is a notable concern for pressure-boundary integrity in pressurized water reactors (PWRs). In general, the nickel-based alloys and weld materials have shown susceptibility to stress corrosion cracking (SCC). The initiation of SCC in nickel alloys and weld materials is not well-understood; research efforts in this area will provide direct support for NRC regulatory stances and programs. This notable Operational Experience (OpE), such as at V.C. Summer (2000), Arkansas Nuclear One Unit 1 (2001), Davis Besse (2002), and Wolf Creek (2006), have raised concerns that PWSCC may result in the loss of intended function of the reactor pressure boundary. In these cases, cracking or leaking occurred within nickel alloy materials due to PWSCC. One of the efforts to mitigate the effects of PWSCC has been to replace 600/82/182 nickel alloy components with less susceptible 690/52/152 materials. It is noted that higher chromium content in materials appears to reduce susceptibility; the

There is an existing research program on crack initiation of nickel alloys at Pacific Northwest National Laboratory (PNNL), under a DOE contract regarding Light Water Reactor Sustainability (LWRS.) However, the information gained from the LWRS project differs in scope and goals, and thus, there is a knowledge gap regarding crack initiation characterization. Results from the LWRS reports indicate a focus on the mechanistic path of crack initiation and related surface effects; the proposed research efforts of the NRC would produce a data set suitable for estimating the probabilistic crack initiation times, and how material variability changes such initiation times.

Typically, NRC staff has used a deterministic approach to address relief requests and regulatory technical bases for inspection frequencies, assuming initial flaw presence. Probabilistic approaches such as those previously reviewed by the NRC Office of Nuclear Regulatory Research (RES), MRP-105 and MRP-113, were not generally accepted by the NRC. However, with the development of xLPR Version 2.0, an acceptable probabilistic methodology will have been created that meets NRC expectations. Specific focus for Alloy 600/182/82 materials is for cracking at cold leg temperatures, as well as direct support for xLPR. The crack initiation model was one of the largest uncertainties associated with Version 1.0. Similar uncertainty is expected with Version 2.0. Industry is developing multiple programs to provide additional information to address crack initiation in nickel base alloys. Therefore it is necessary that the NRC monitor these programs and initiate a validation program to ensure all potential configurations are evaluated. To complete these activities and support future revisions of xLPR, the NRC must develop a program to monitor and perform crack initiation testing of nickel-based alloys. The data produced by the proposed research project will aid in the development and validation of xLPR Version 2.0, to incorporate such data in to the Leak Before Break (LBB) model.

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2. Objective

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The objective of this program is to develop the necessary infrastructure and resources to proceed with an NRC-directed research program in developing data relevant to nickel alloy-based component integrity in the primary system, and perform crack initiation testing. The material requirements provided by this program will enable research that will directly support existing programs within the NRC and provide a basis for inspection requirements and aging management of nickel alloy components. This Statement of Work reflects the NRC commitment as outlined in a Memorandum of Understanding (MOU) addendum, dated XX/XX/XXXX, (NUMBER ASSIGNED), to provide the startup materials and equipment necessary to perform crack initiation testing of nickel alloy materials, and testing of such materials to obtain data.

Information and data obtained may be used to enhance the NRC's regulatory approach to passive components of the primary system, and potentially impact the regulation of new reactor designs. Nickel alloys are used in components such as CRDM, pressurizer, and reactor coolant system nozzles, as well comprising the weld materials used to attach such components to the primary system.

3. Scope of Work

The DOE Laboratory must provide all resources necessary to accomplish the tasks and deliverables described in this statement of work (SOW). There are three tasks associated within this scope:

1.) The DOE Laboratory shall develop a test plan, and the NRC will review the test plan for acceptability.

2.) The DOE Laboratory shall design, assemble, validate, and service the necessary equipment to support the test plan.

3.) The DOE Laboratory shall perform physical testing on nickel alloy materials to study crack initiation and related changes due to environment and sample variations.

4. Specific Tasks

The DOE Laboratory must perform the following tasks:

<u>Task 1: Test Plan Development</u>
The DOE Laboratory, given the technical expertise in the realm of PWSCC, shall develop an initial test plan for nickel alloy materials that will provide data for crack initiation. The DOE Laboratory shall align this test plan in a manner that directly supports the User Needs of the NRC, and the NRC will provide feedback with regards to alignment and research goals. The

DOE Laboratory will also provide suggestions and adjustments to the test plan, to be implemented at the discretion of the NRC staff. The DOE Laboratory shall list the necessary materials, equipment, and personnel in the test plan. This test plan shall be furnished in a letter report consistent with NRC document guidelines, and must detail assumptions, expectations, potential issues and research gaps, and the justifications for each.

Task 2: Infrastructure Requirements

The DOE Laboratory shall design, assemble, and validate testing equipment (systems) capable of carrying out the Test Plan as described in Task 1. Two (2) systems shall be constructed for crack initiation testing. The DOE Laboratory shall also design and employ a validation technique to prove as-designed efficacy. The DOE Laboratory shall submit a letter report detailing the validation techniques, including assumptions and justifications within the testing system.

Task 3: Nickel Alloy Materials Testing

The DOE Laboratory shall provide, test, and analyze nickel alloy materials. The DOE Laboratory shall be responsible to procure sample specimens as outlined in the detailed test plan. The materials to be tested include nickel alloy 600/182/82 and 690/152/52. Additionally, some of these specimens may be heterogeneous, containing 600 or 690 base metal welded to their respective weld materials. The DOE Laboratory shall prepare and submit monthly status reports, consistent with NRC document guidelines, detailing research progress, including any pertinent data as produced. The DOE Laboratory shall prepare and submit a final letter report upon conclusion of the research program, outlining the details of the final test plan, data, statistical analysis, and other information as agreed upon between the DOE Laboratory and NRC. All reports must conform to the guidance provided by the NRC regarding document construction.

5. Technical and Other Special Qualifications Required

Specialized experience must include expertise in such areas as engineering and materials science. Knowledge in welds and weld techniques is also desired.

Task 1, test plan development, requires knowledge in materials science and engineering to design an appropriate test plan for nickel alloy materials in the area of crack initiation. Additionally, knowledge of nuclear systems is required, as the materials proposed for testing under the test plan must be subject to conditions which approximate the primary water environment. A valid test plan will include justification for test plan design, scope, and expectations.

Task 2, infrastructure requirements, requires specialized knowledge in designing, assembling, and validating the necessary test plan equipment, outlined in Task 1. This knowledge may include electrical, materials, chemical, mechanical, or other engineering disciplines. The testing

equipment is highly specialized for the particular application of PWSCC crack initiation. Additionally, specific knowledge of the equipment and related systems is required to provide support, maintenance, and service for the equipment after assembly.

Task 3, nickel alloy materials testing, requires specialized knowledge of mechanical engineering, materials engineering, or materials science. Monthly status reports must be prepared, detailing progress of current and planned testing, data, and recommendations to adjust the test plan as needed. Additionally, post-processing or preparation of data in a usable fashion may be required, and requires knowledge of statistics.

6. Deliverables and/or Milestones SCHEDULE

Deliverable Number	**Deliverable/Milestone Description** (include NRC acceptance criteria if applicable)	Due Date *(if any)*
1	The DOE Laboratory shall create and provide an initial test plan.	Within one (1) month of the contract award
2	The NRC will review and provide comments on the initial test plan	Within ten (10) business days of receipt of the test plan, Deliverable 1
3	The DOE Laboratory shall design, assemble, and validate testing equipment suitable for crack initiation testing as required by the MOU (INFO)	Within twelve (12) months of the contract award
4	The DOE Laboratory shall provide an initial report detailing the test plan, equipment specifications, and validation of equipment	Within twelve (12) months of the contract award
5	The NRC shall review the equipment validation procedure and provide comments	Within ten (10) business days of
6	The DOE Laboratory shall provide monthly reports on the status of testing systems, suggested test plan adjustments (if warranted), and overall progress	Monthly, starting three (3) months after completion of Deliverable 3
7	The DOE Laboratory shall provide technical reports and	

	data resulting from crack initiation testing	
8	The DOE Laboratory shall prepare a Technical Letter Report which summarizes the research program and results.	At the conclusion of the program, no later than 5 years after contract award.

7. Meetings and Travel

Project Related Travel

Travel Description for FY 2014-2016	Location	Date	Days	Number of Attendees
FY 2014				
Kickoff Meeting / Lab Visit at PNNL	Richland, WA	Sept. 2014	1	2
FY 2015				
National Society Meeting?	TBD	TBD	TBD	2
Program Review at NRC	Rockville, MD	June 2015	2	1
FY 2016				
National Society Meeting?	TBD	TBD	TBD	2
Program Review at NRC	Rockville, MD	June 2016	2	1
FY 2017				
National Society Meeting?	TBD	TBD	TBD	2
Program Review at NRC	Rockville, MD	June 2017	2	1

All travel requires written Government approval from the CO, unless otherwise delegated to the COR.

Foreign travel for the DOE laboratory personnel requires a 60-day lead time for NRC approval. For prior approval of foreign travel, the DOE laboratory shall submit an NRC Form 445, "Request for Approval of Official Foreign Travel." NRC Form 445 is available in the MD 11.7 Documents library and on the NRC Web site at: http://www.nrc.gov/reading-rm/doc-collections/forms/. Foreign travel is approved by the NRC Executive Director for Operations (EDO).

8. Reporting Requirements

Hide Guidance

List and describe any specific reporting requirements. Specify the nature of the report, required report content and format, due date, location for submission, and NRC personnel receiving the report.

- The requirement to deliver computer generated reports and software must clearly indicate the application on which the reports or software must operate.
- If the NRC wants to review and approve a draft of a final report, indicate the responsibility of the DOE Laboratory to submit a copy of the draft report and the NRC's responsibility to return the draft report with comments on specific dates.

The DOE Laboratory is responsible for structuring the deliverable to follow agency standards. The current agency standard is Microsoft Office Suite 2010. The current agency Portable Document Format (PDF) standard is Adobe Acrobat 9 Professional. Deliverables must be submitted free of spelling and grammatical errors and conform to requirements stated in this section.

Monthly Letter Status Reports

In accordance with Management Directive 11.7, NRC Procedures for Placement and Monitoring of Work with the U.S. Department of Energy, the DOE Laboratory must electronically submit a Monthly Letter Status Report (MLSR) by the 20th day of each month to the Contracting Officer Representative (COR) with copies to the Contracting Officer (CO) and the Office Administration/Division of Contracts to ContractsPOT.Resource@nrc.gov. If a project is a task

ordering agreement, a separate MLSR must be submitted for each task order with a summary project MLSR, even if no work has been performed during a reporting period. Once NRC has determined that all work on a task order is completed and that final costs are acceptable, a task order may be omitted from the MLSR.

The MLSR must include the following: agreement number; task order number, if applicable; job code number; title of the project; project period of performance; task order period of performance, if applicable; COR's name, telephone number, and e-mail address; full name and address of the performing organization; principal investigator's name, telephone number, and e-mail address; and reporting period. At a minimum, the MLSR must include the information discussed in Attachment 1. The preferred format for a MLSR can also be found in Attachment 1.

Comment [A]: ?

In addition to the Monthly Letter Status Reports, the DOE Laboratory shall also submit documents as described in the above Tasks, using the guidance for MLSRs when applicable.

9. Period of Performance

The estimated period of performance for this work is 5 years from date of agreement award. The estimated award date is September, 2014.

10. Contracting Officer's Representative

The COR monitors all technical aspects of the agreement/task order and assists in its administration. The COR is authorized to perform the following functions: assure that the DOE Laboratory performs the technical requirements of the agreement/task order; perform inspections necessary in connection with agreement/task order performance; maintain written and oral communications with the DOE Laboratory concerning technical aspects of the agreement/task order; issue written interpretations of technical requirements, including Government drawings, designs, specifications; monitor the DOE Laboratory's performance and notify the DOE Laboratory of any deficiencies; coordinate availability of NRC-furnished material and/or GFP; and provide site entry of DOE Laboratory personnel.

Contracting Officer's Representative

Name: Matthew Rossi

Agency: U.S. Nuclear Regulatory Commission

~~PREDECISIONAL~~

Office: Nuclear Regulatory Research, Division of Engineering, Corrosion and Metallurgy

Mail Stop: CSB 05C07

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Name: Greg Oberson

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Mail Stop: CSB 05A24

Washington, DC 20555-0001

E-Mail: greg.oberson@nrc.gov

Phone: (301) 251-7675

11. MATERIALS REQUIRED (TYPE N/A IF NOT APPLICABLE)

N/A

12. NRC-Furnished Property/MATERIALS (TYPE N/A IF NOT APPLICABLE)

N/A

13. RESEARCH QUALITY (TYPE N/A IF NOT APPLICABLE)

The quality of NRC research programs are assessed each year by the Advisory Committee on Reactor Safeguards. Within the context of their reviews of RES programs, the definition of quality research is based upon several major characteristics:

Results meet the objectives (75% of overall score)

Justification of major assumptions (12%)

Soundness of technical approach and results (52%)

Uncertainties and sensitivities addressed (11%)

Documentation of research results and methods is adequate (25% of overall score)

Clarity of presentation (16%)

Identification of major assumptions (9%)

It is the responsibility of the DOE Laboratory to ensure that these quality criteria are adequately addressed throughout the course of the research that is performed. The NRC COR will review all research products with these criteria in mind.

14. STANDARDS FOR CONTRACTORS WHO PREPARE NUREG-SERIES MANUSCRIPTS (TYPE N/A IF NOT APPLICABLE)

The U.S. Nuclear Regulatory Commission (NRC) began to capture most of its official records electronically on January 1, 2000. The NRC will capture each final NUREG-series publication in its native application. Therefore, please submit your final manuscript that has been approved by your NRC Project Manager in both electronic and camera-ready copy.

The final manuscript shall be of archival quality and comply with the requirements of NRC Management Directive 3.7 “NUREG-Series Publications.” The document shall be technically edited consistent with NUREG–1379, Rev. 2 (May 2009) "NRC Editorial Style Guide." The goals of the "NRC Editorial Style Guide" are readability and consistency for all agency documents.

All format guidance, as specified in NUREG-0650, “Preparing NUREG-Series Publications," Rev. 2 (January 1999), will remain the same with one exception. You will no longer be required to include the NUREG-series designator on the bottom of each page of the manuscript. The NRC will assign this designator when we send the camera-ready copy to the printer and will place the designator on the cover, title page, and spine. The designator for each report will no longer be assigned when the decision to prepare a publication is made. The NRC's Publishing Services Branch will inform the NRC Project Manager for the publication of the assigned designator when the final manuscript is sent to the printer.

For the electronic manuscript, the Contractor shall prepare the text in Microsoft Word, and use any of the following file types for charts, spreadsheets, and the like.

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File Types to be Used for NUREG-Series Publications	
File Type	File Extension
Microsoft®Word®	.doc
Microsoft® PowerPoint®	.ppt
Microsoft®Excel	.xls
Microsoft®Access	.mdb
Portable Document Format	.pdf

This list is subject to change if new software packages come into common use at NRC or by our licensees or other stakeholders that participate in the electronic submission process. If a portion of your manuscript is from another source and you cannot obtain an acceptable electronic file type for this portion (e.g., an appendix from an old publication), the NRC can, if necessary, create a tagged image file format (file extension.tif) for that portion of your report. Note that you should continue to submit original photographs, which will be scanned, since digitized photographs do not print well.

If you choose to publish a compact disk (CD) of your publication, place on the CD copies of the manuscript in both (1) a portable document format (PDF); (2) a Microsoft Word file format, and (3) an Adobe Acrobat Reader, or, alternatively, print instructions for obtaining a free copy of Adobe Acrobat Reader on the back cover insert of the jewel box.

15. OTHER CONSIDERATIONS (TYPE N/A IF NOT APPLICABLE)

Hide Guidance

Include here any other relevant information for the performance of the SOW that does not fit elsewhere.

References (Type N/A if not applicable)

Hide Guidance

If necessary, provide reference by document number(s) and title(s) to all applicable documents invoked elsewhere in the SOW. When applicable, reference Government regulations and codes that are mandatory. Include the chapter and section to pinpoint what is applicable to this SOW.

Access to Non-NRC Facilities/Equipment **(Type N/A if not applicable)**

Hide Guidance

If the DOE Laboratory will need to obtain access to non-NRC facilities/equipment, these requirements should also be described.

Applicable Publications (Type N/A if not applicable)

Hide Guidance

List any publications, manuals, and/or regulations that the DOE Laboratory must abide by.

EXAMPLE OF APPLICABLE PUBLICATIONS:

The DOE Laboratory must abide by applicable regulations, publications, manuals, and local policies and procedures listed below.

(Insert NUREG publication #)

(Insert IEEE publication #)

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Controls over document handling and non-disclosure of materials **(Type N/A if not applicable)**

Hide Guidance

Include any document handling and/or non-disclosure requirements for information (i.e., proprietary or sensitive unclassified) not covered in the standard DOE terms and condition

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Experimental Plan for the Joint NRC/EPRI Project on Crack Initiation Testing for Primary Water Stress Corrosion Cracking

M. B. Toloczko and S. M. Bruemmer
Pacific Northwest National Laboratory

April 16, 2015

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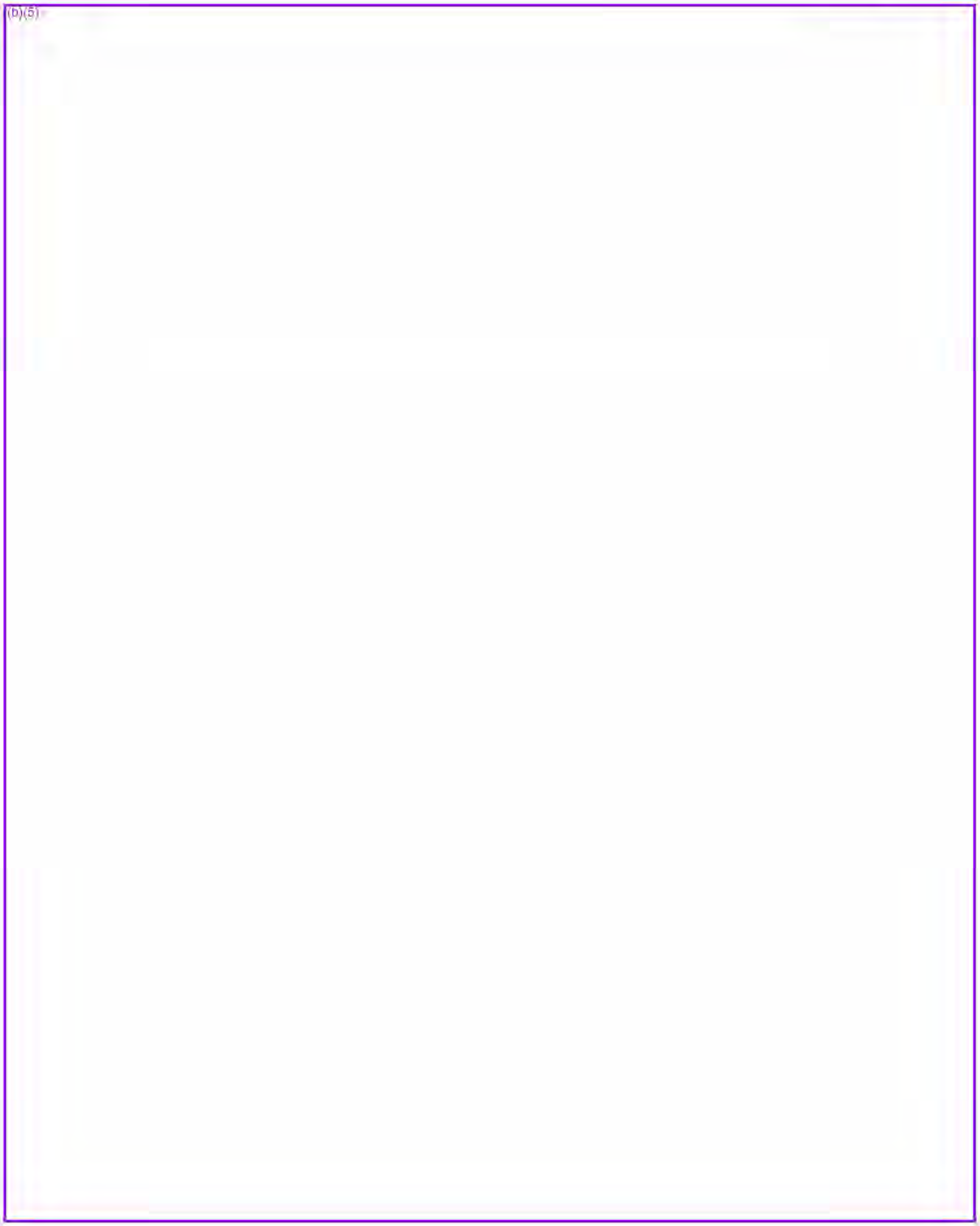

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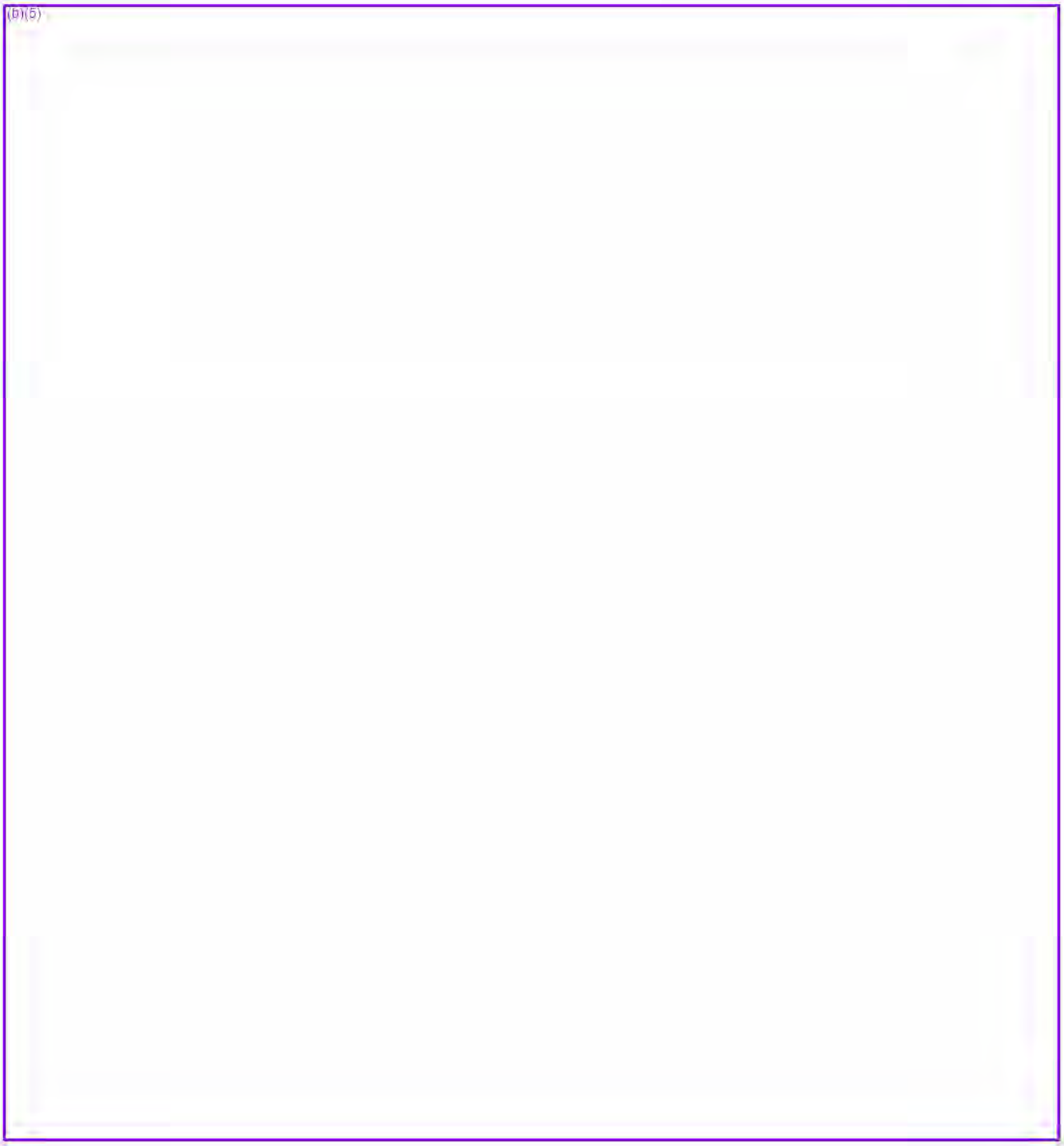

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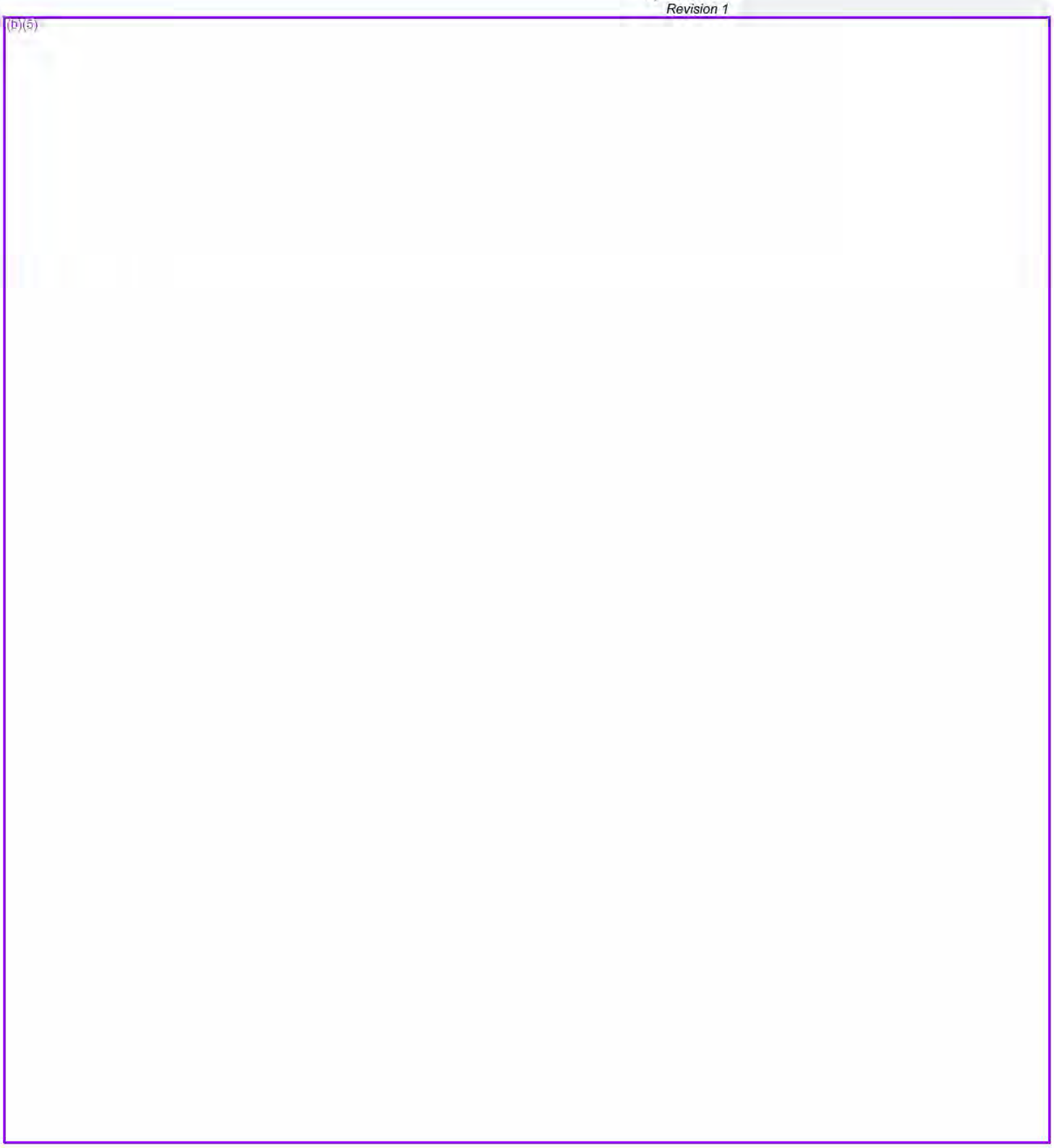

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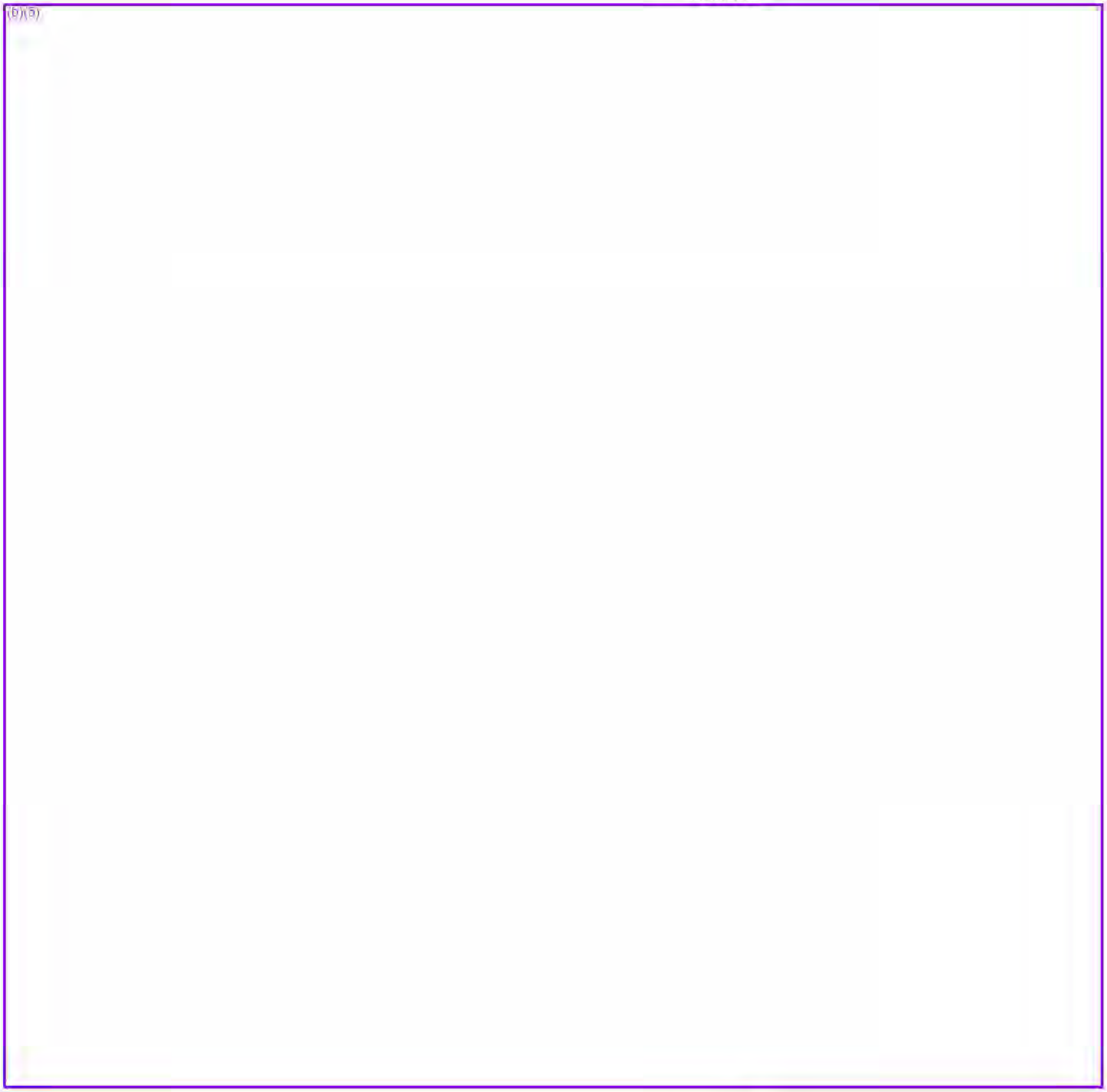

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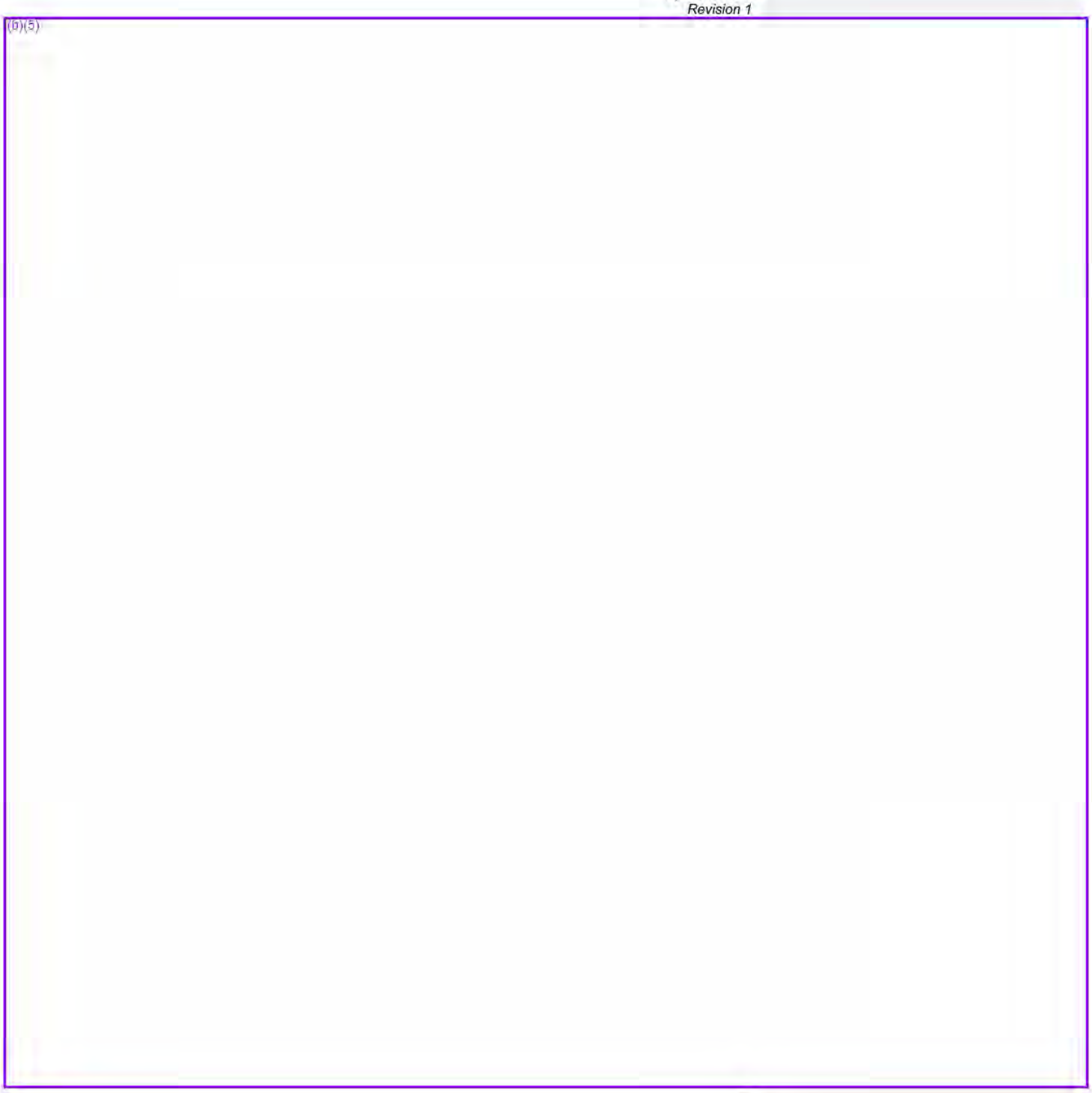

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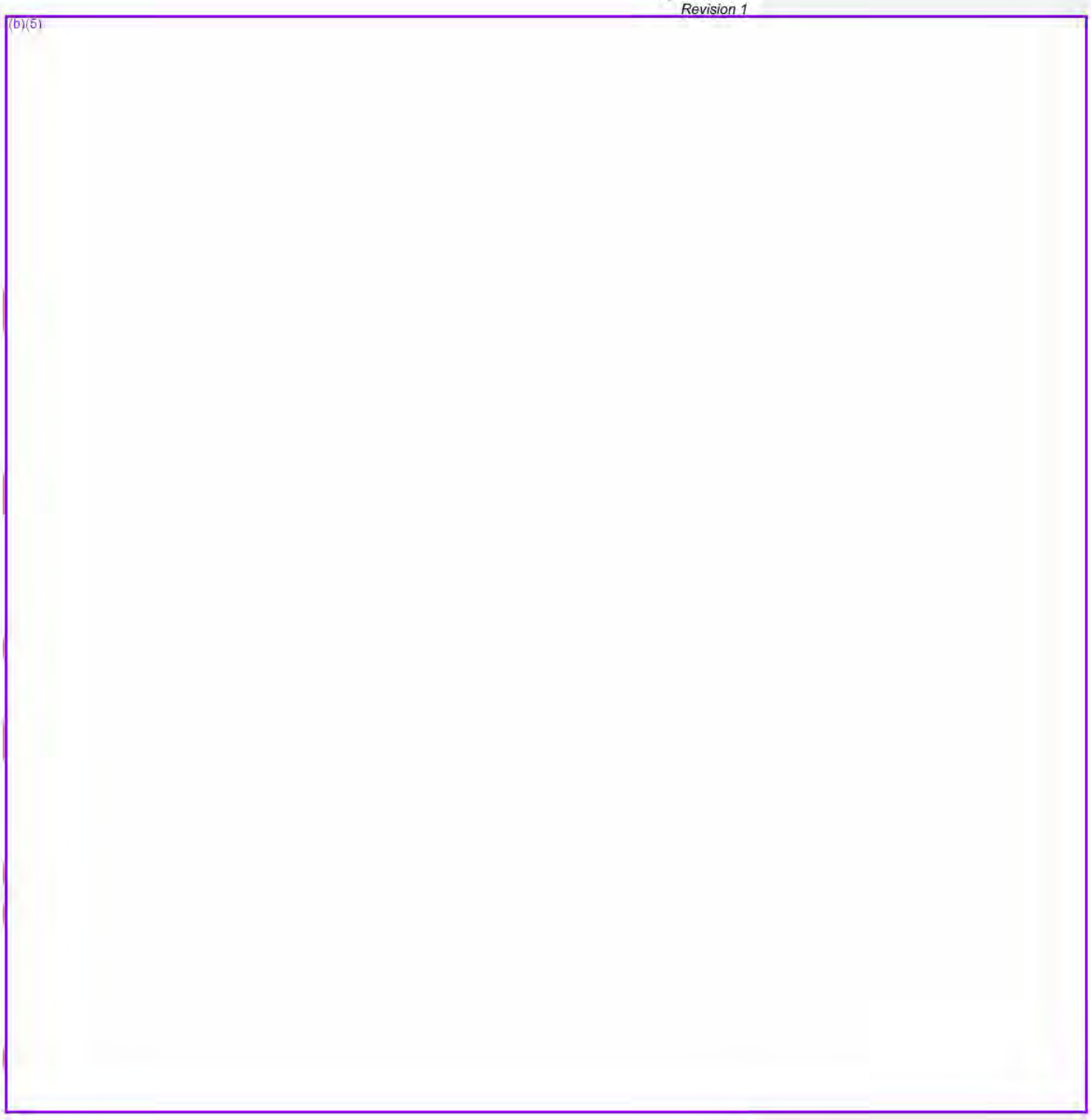

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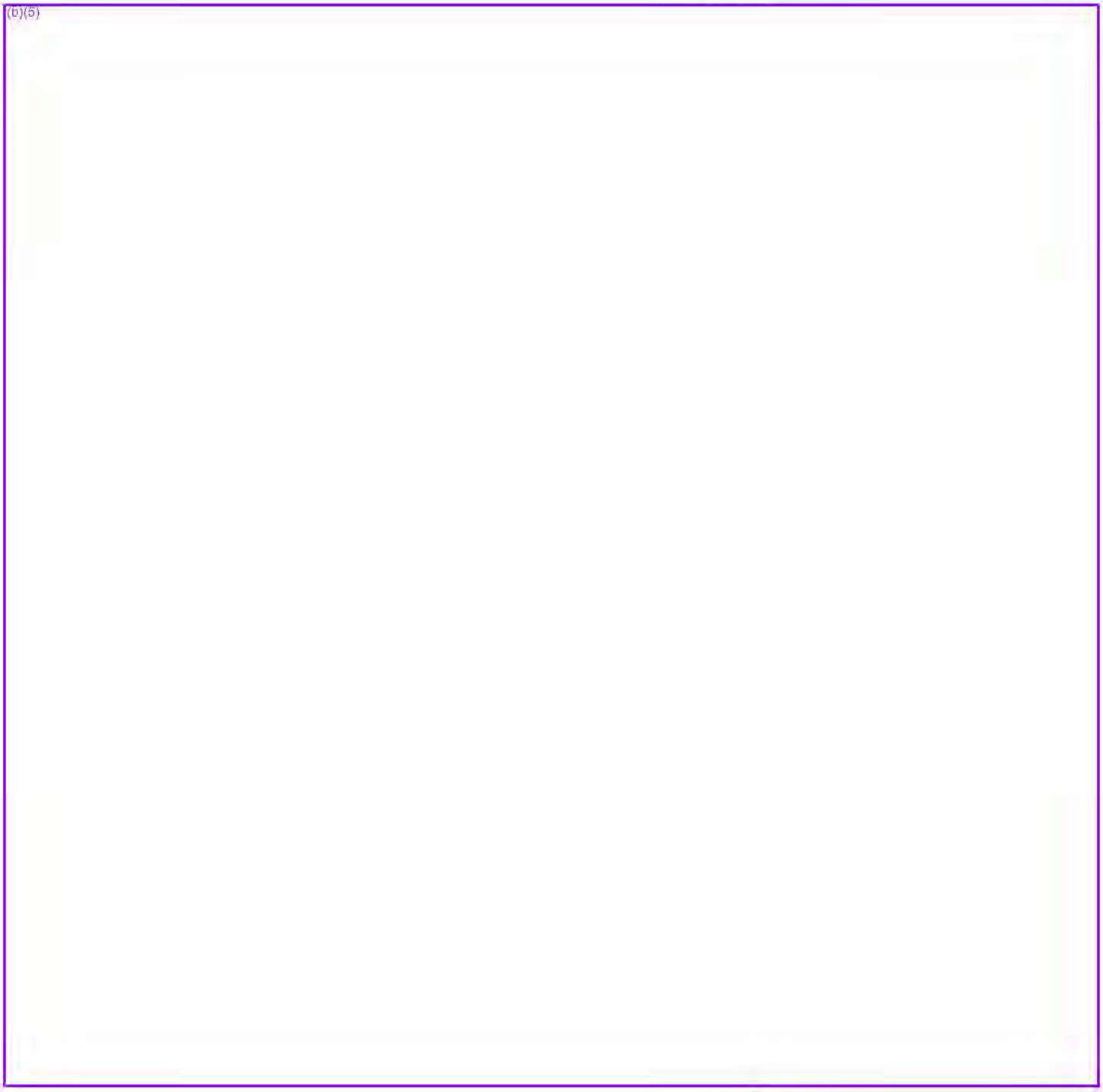

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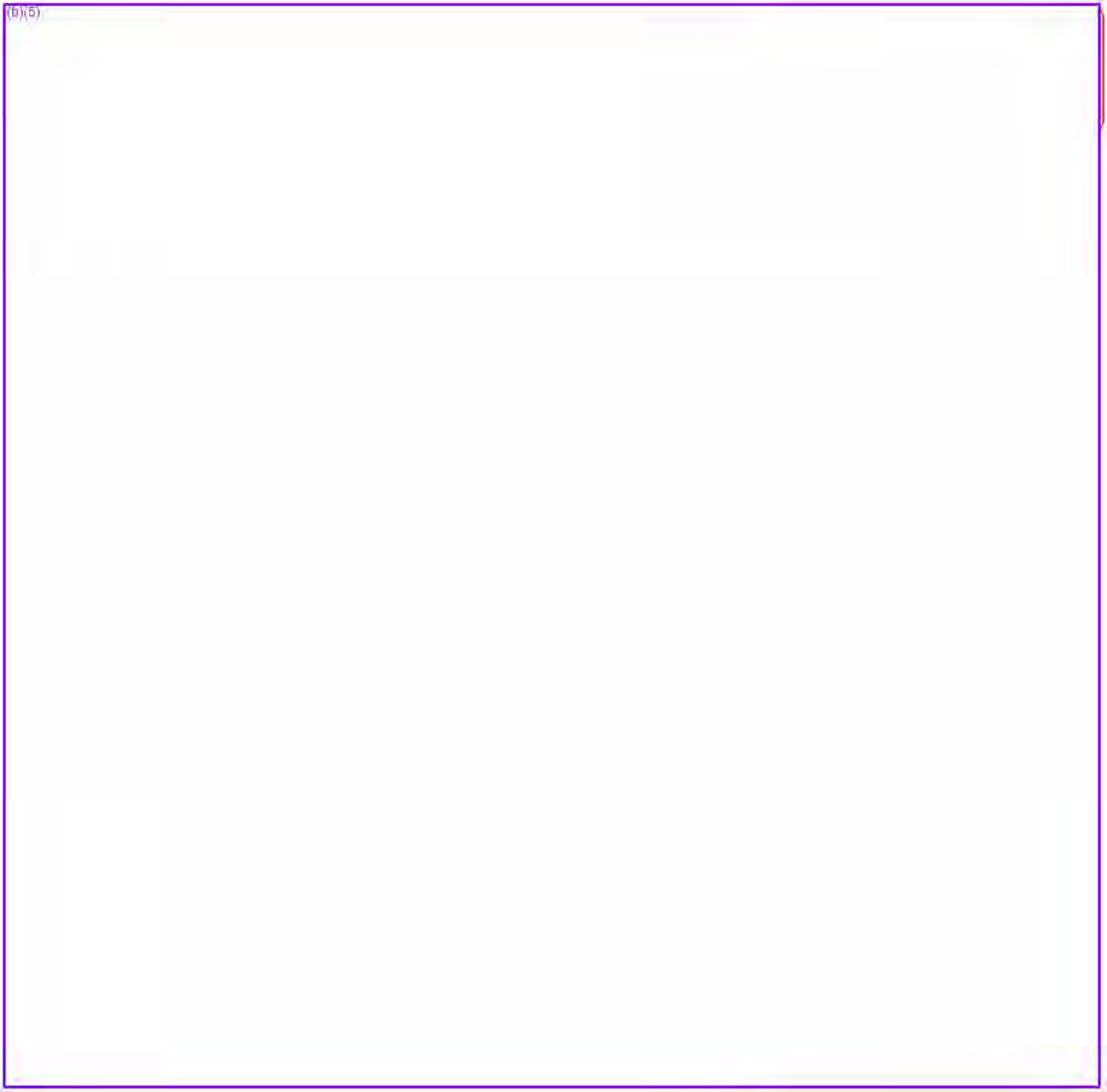

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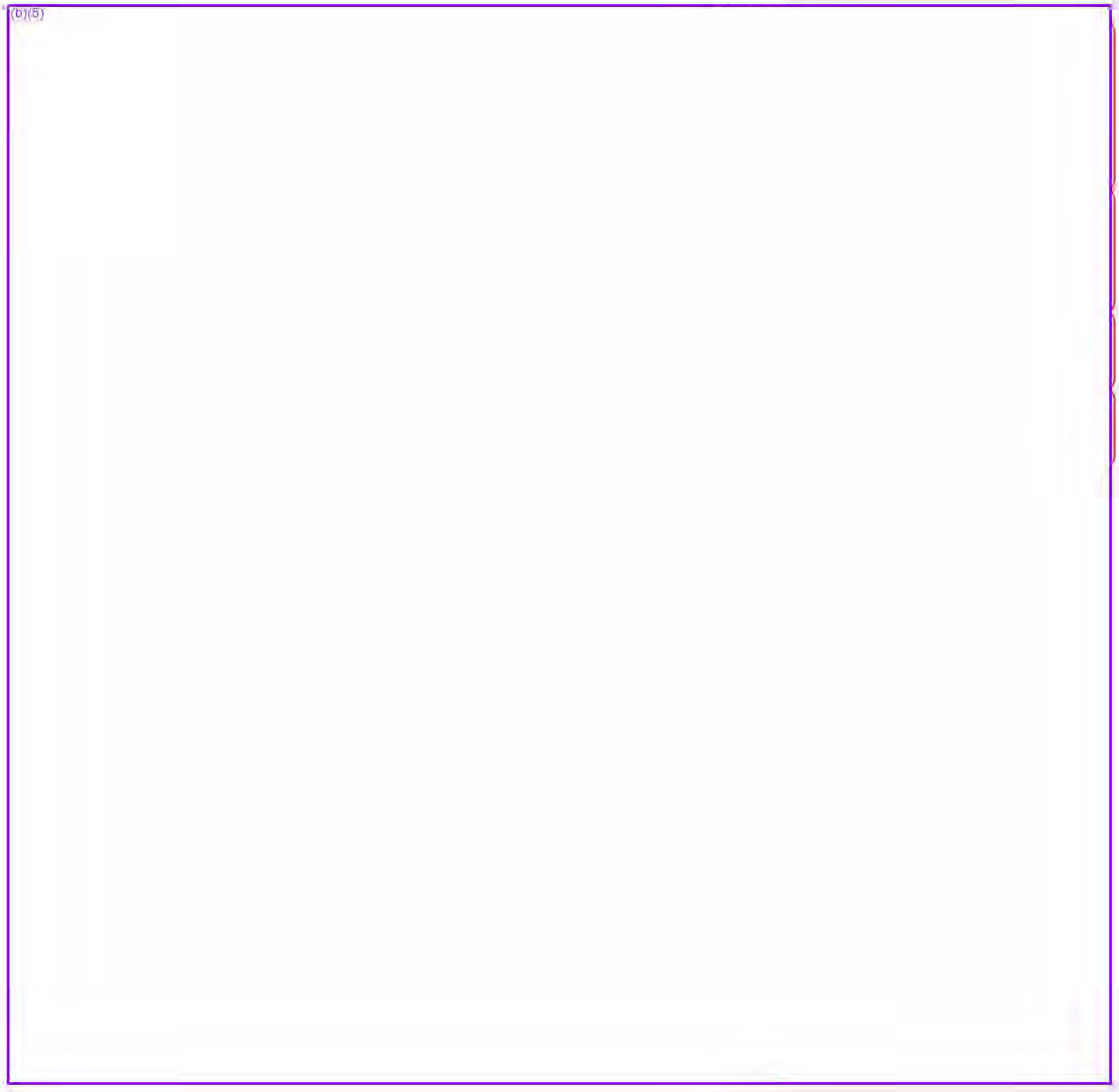

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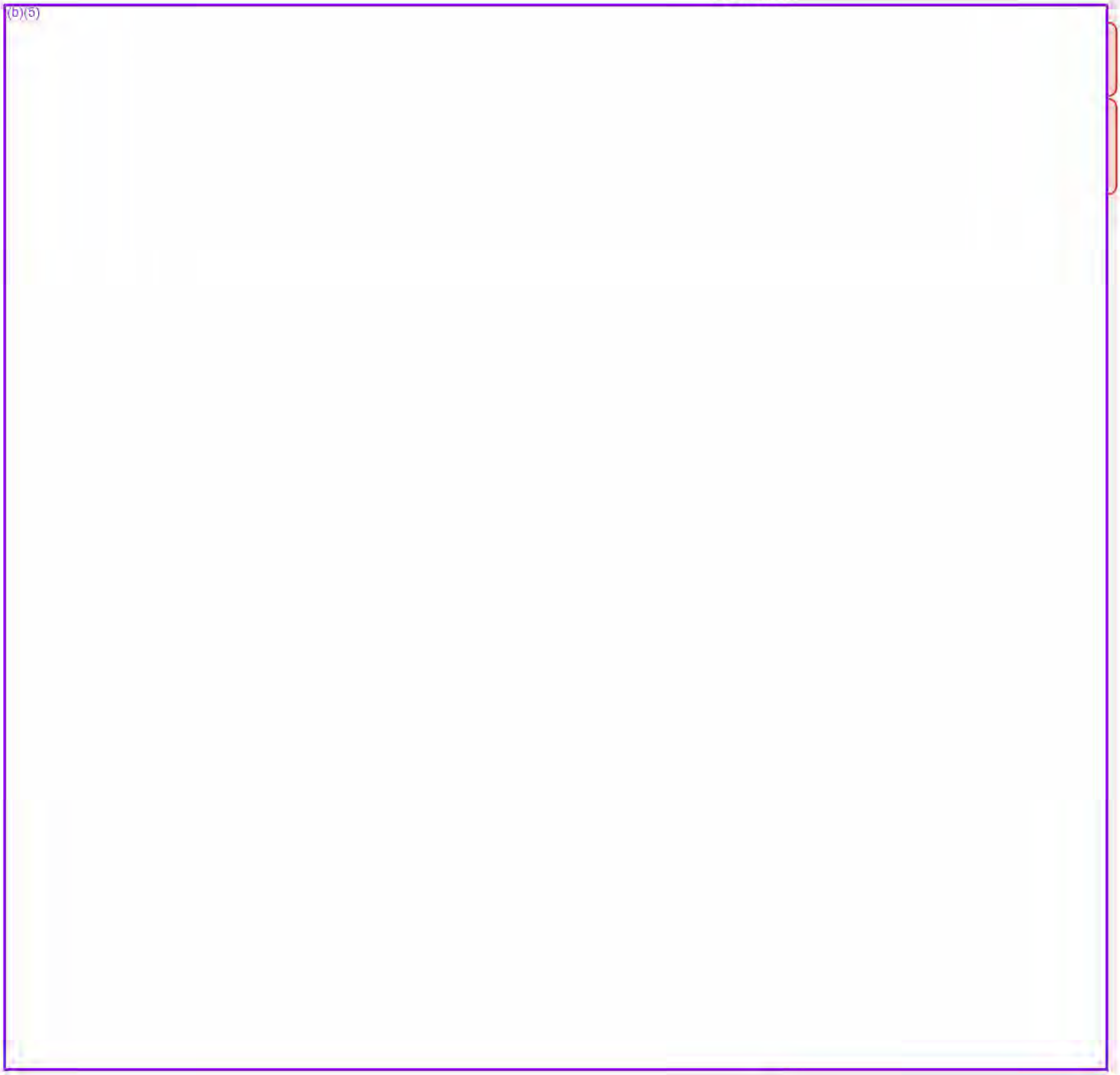

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Appendix

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Experimental Plan for the Joint NRC/EPRI Project on Crack Initiation Testing for Primary Water Stress Corrosion Cracking

M. B. Toloczko and S. M. Bruemmer
Pacific Northwest National Laboratory

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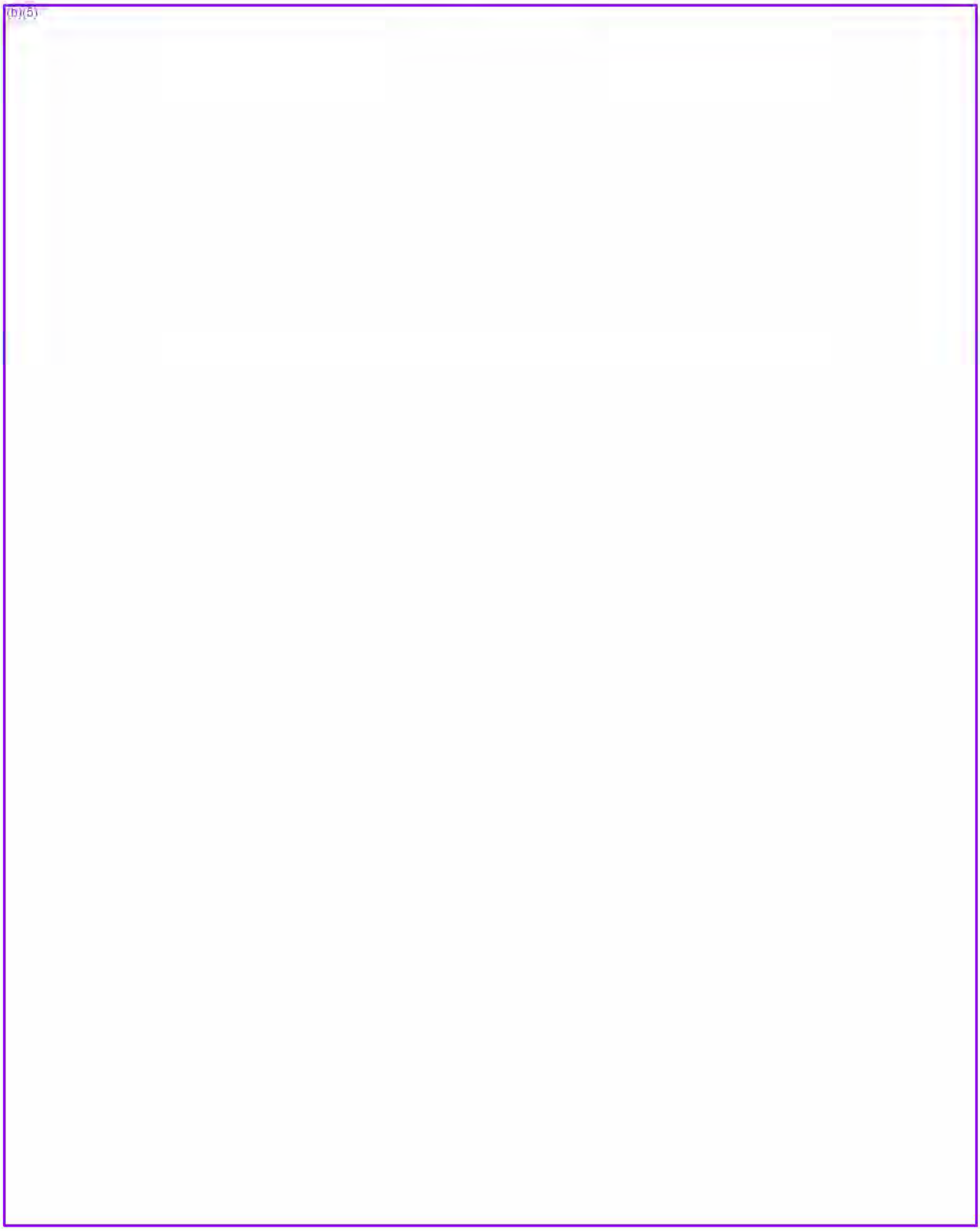

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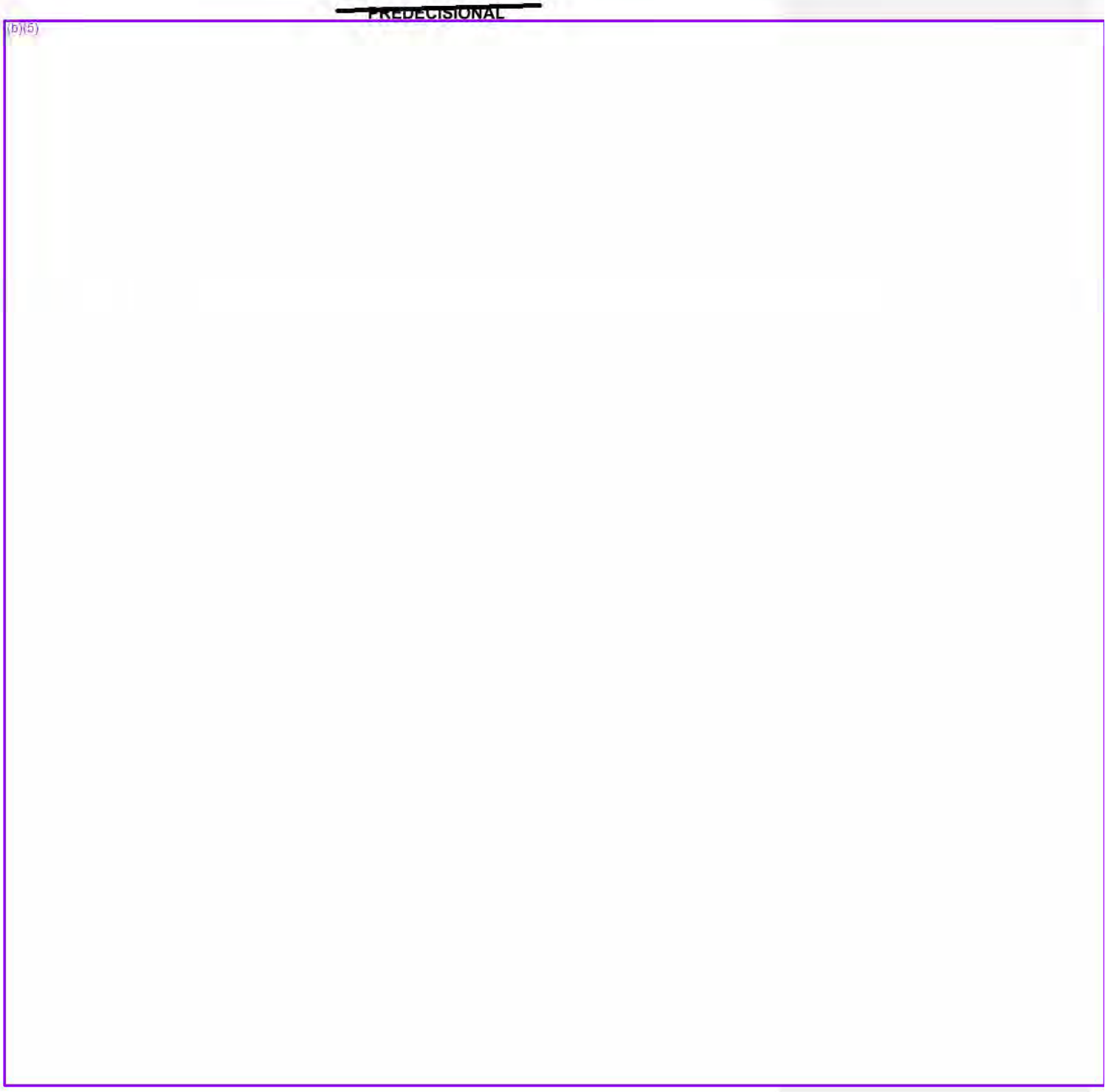

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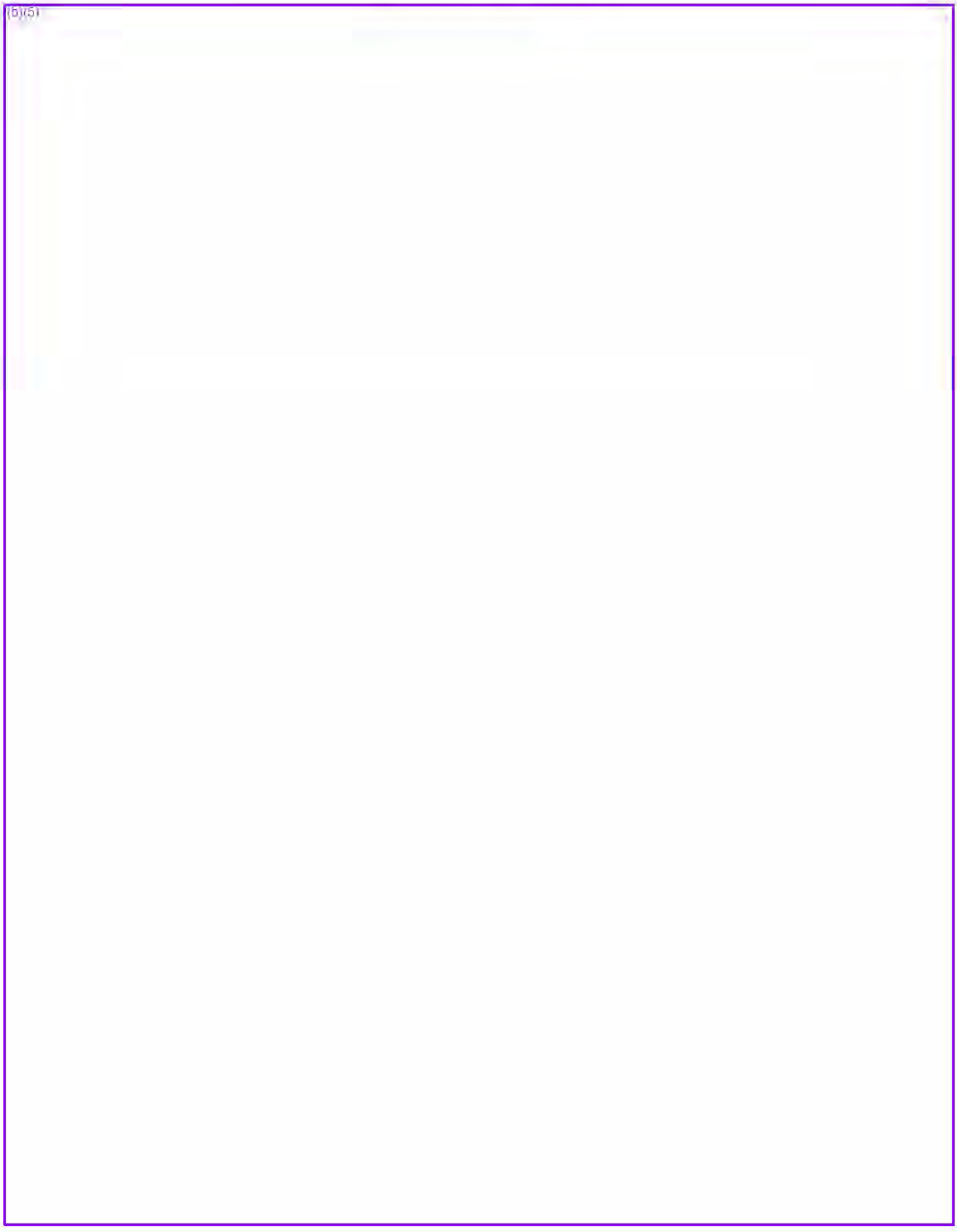

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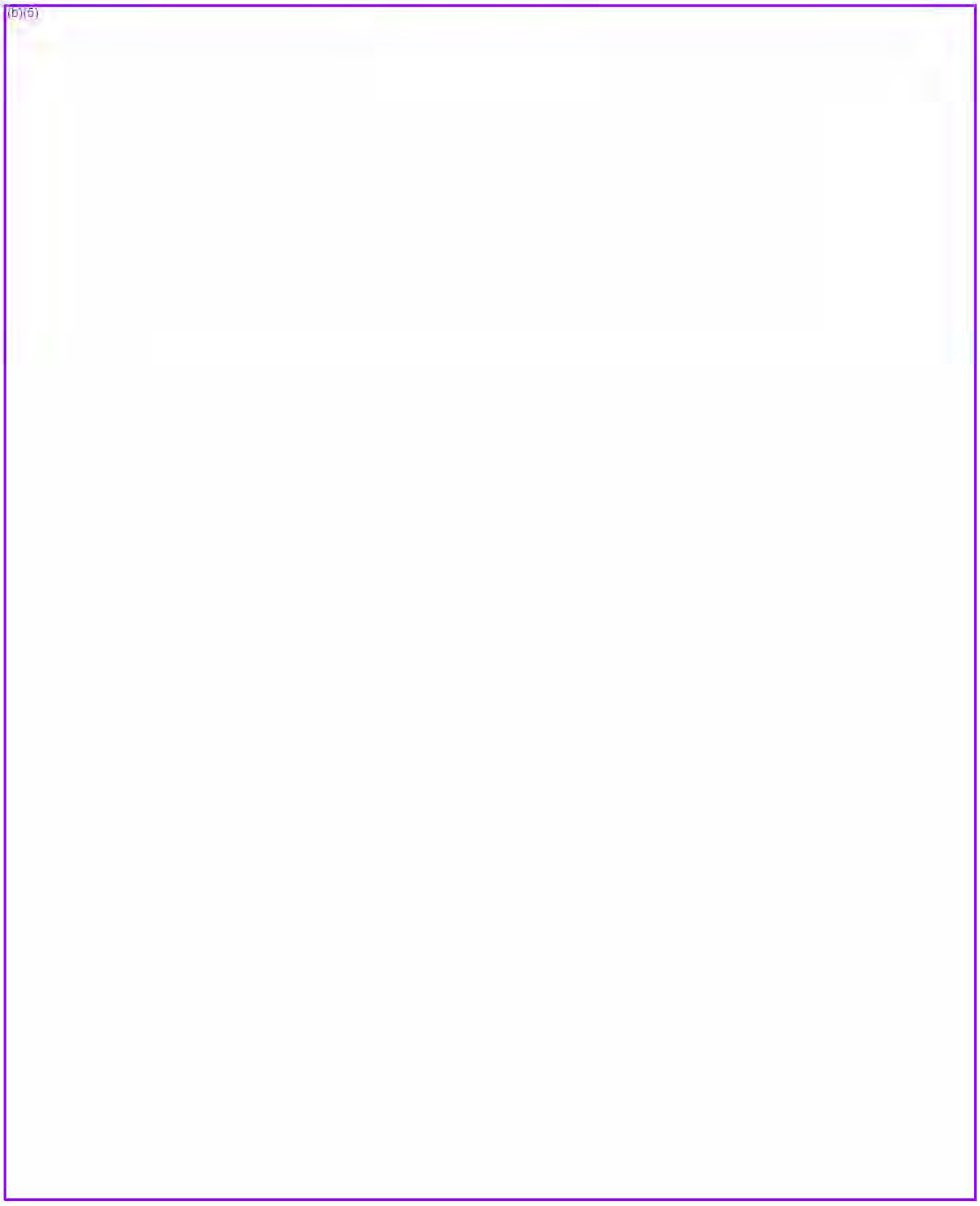

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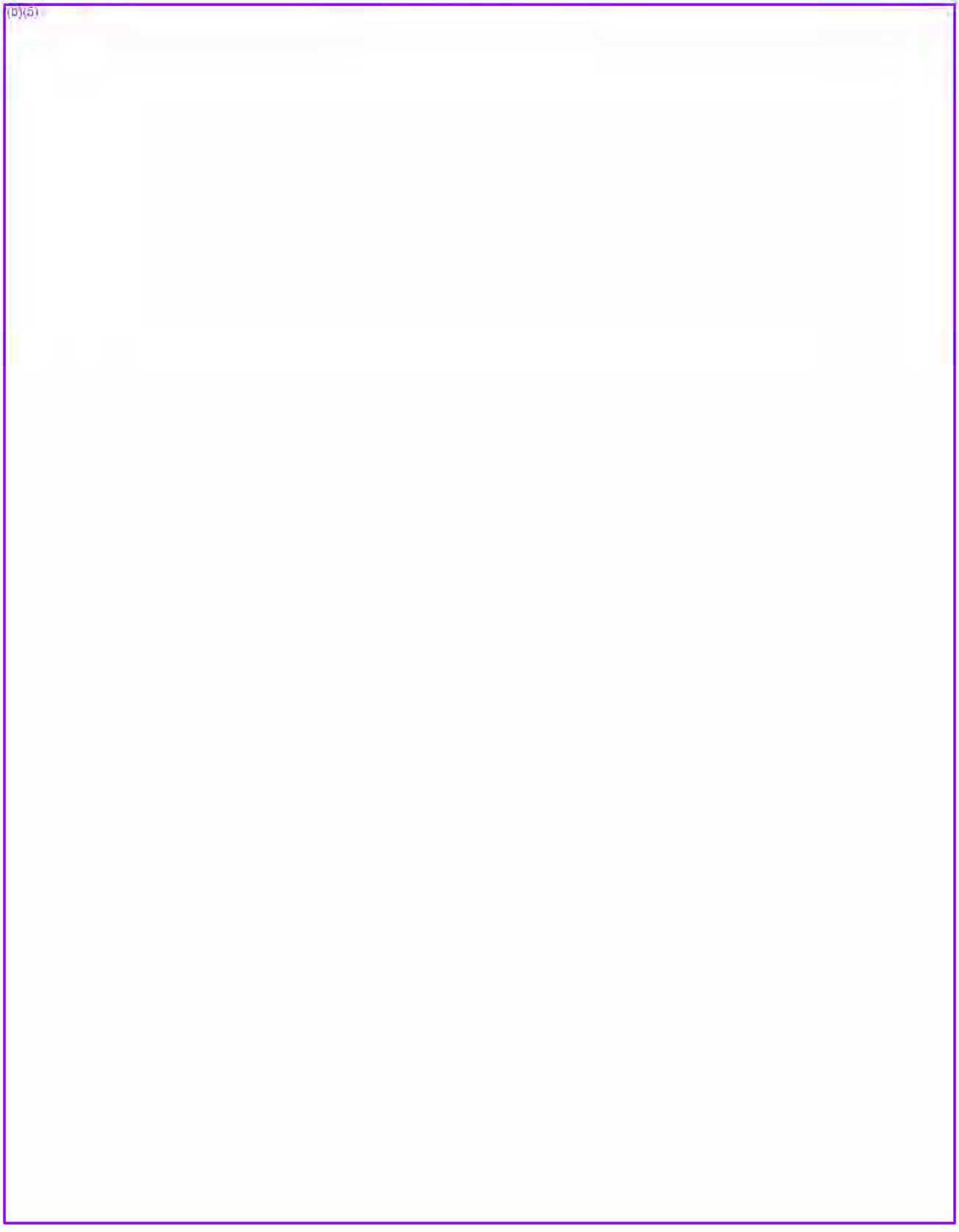

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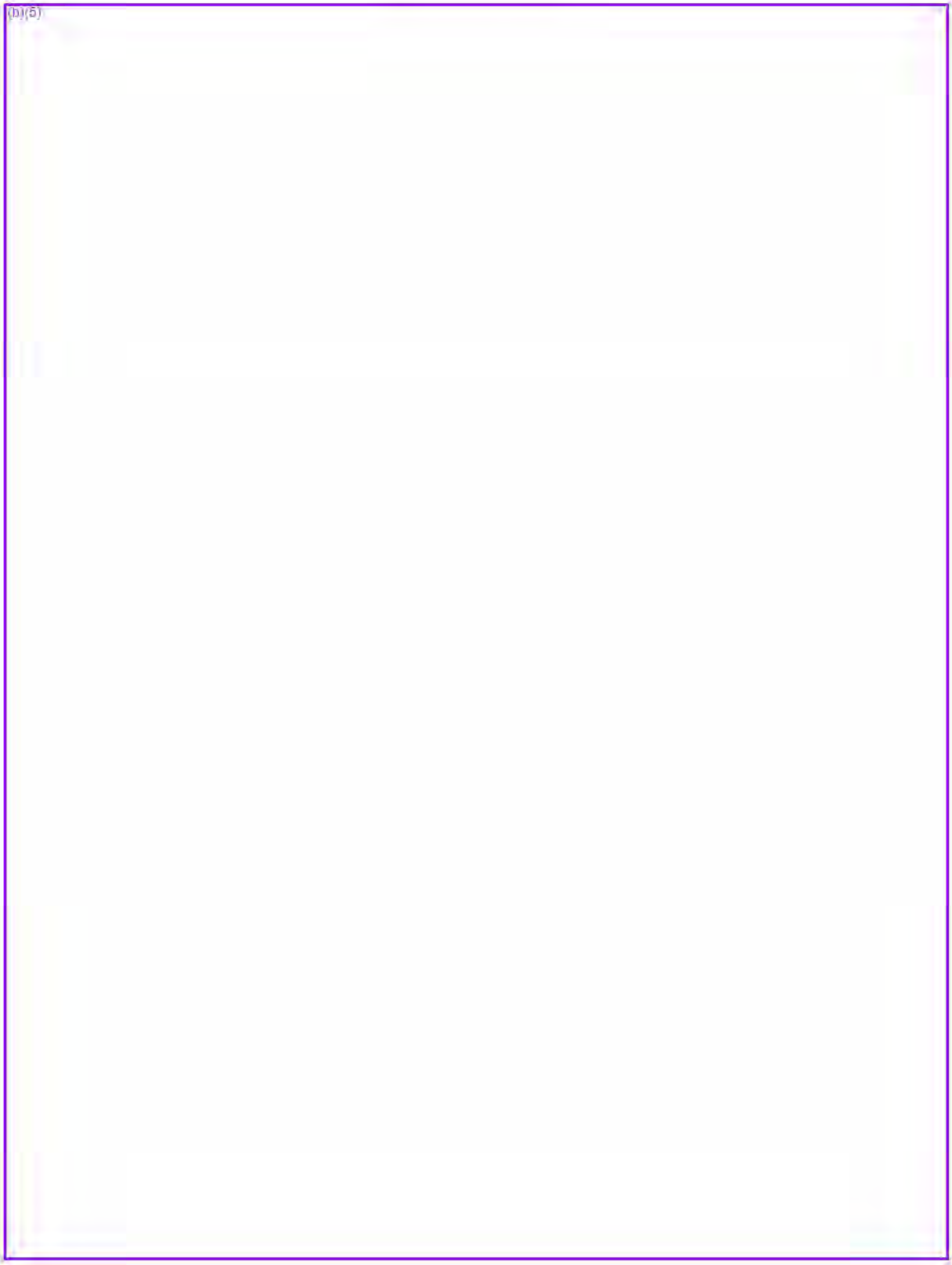

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Experimental Plan for the Joint NRC/EPRI Project on Crack Initiation Testing for Primary Water Stress Corrosion Cracking

M. B. Toloczko and S. M. Bruemmer
Pacific Northwest National Laboratory

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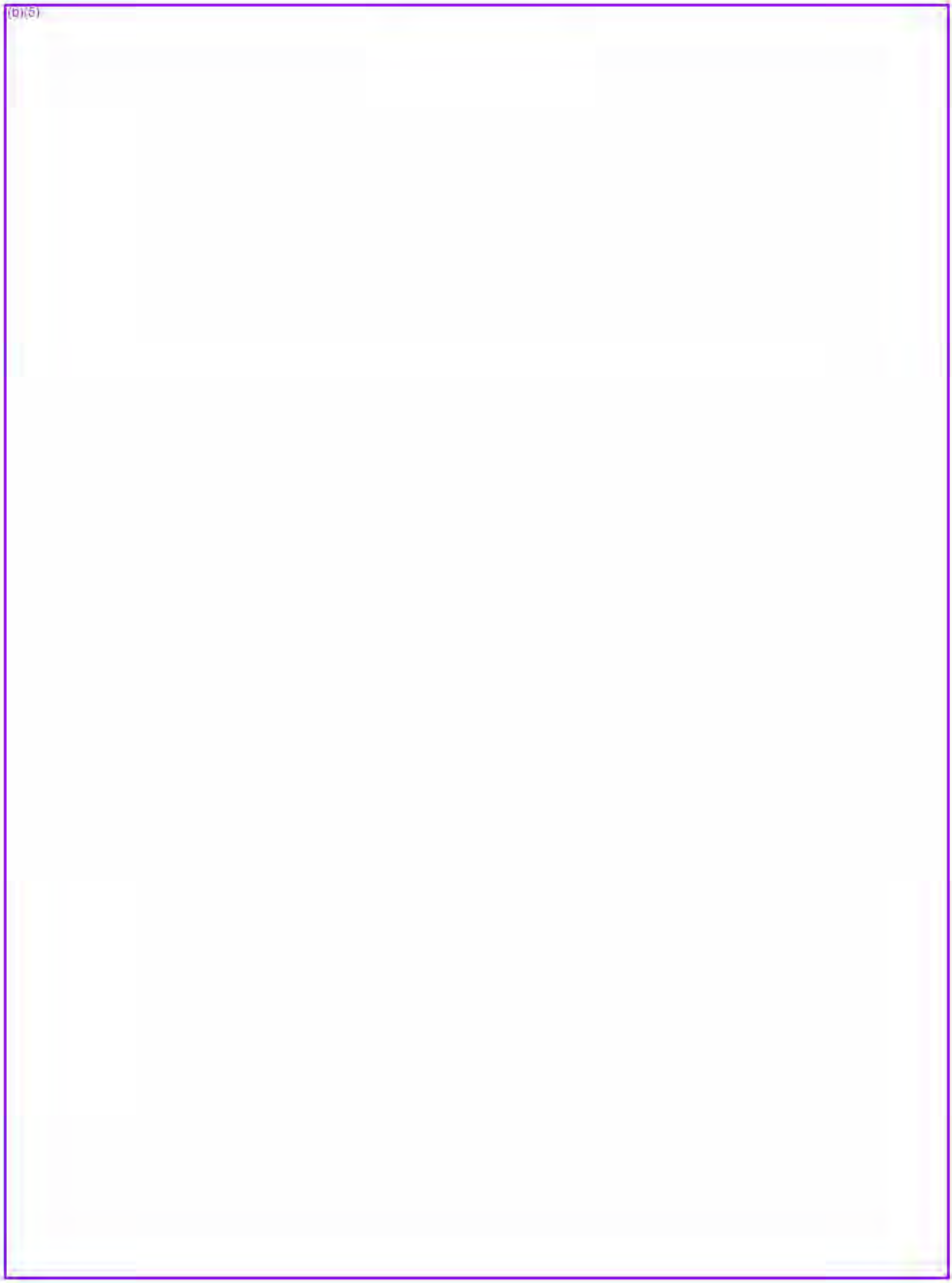

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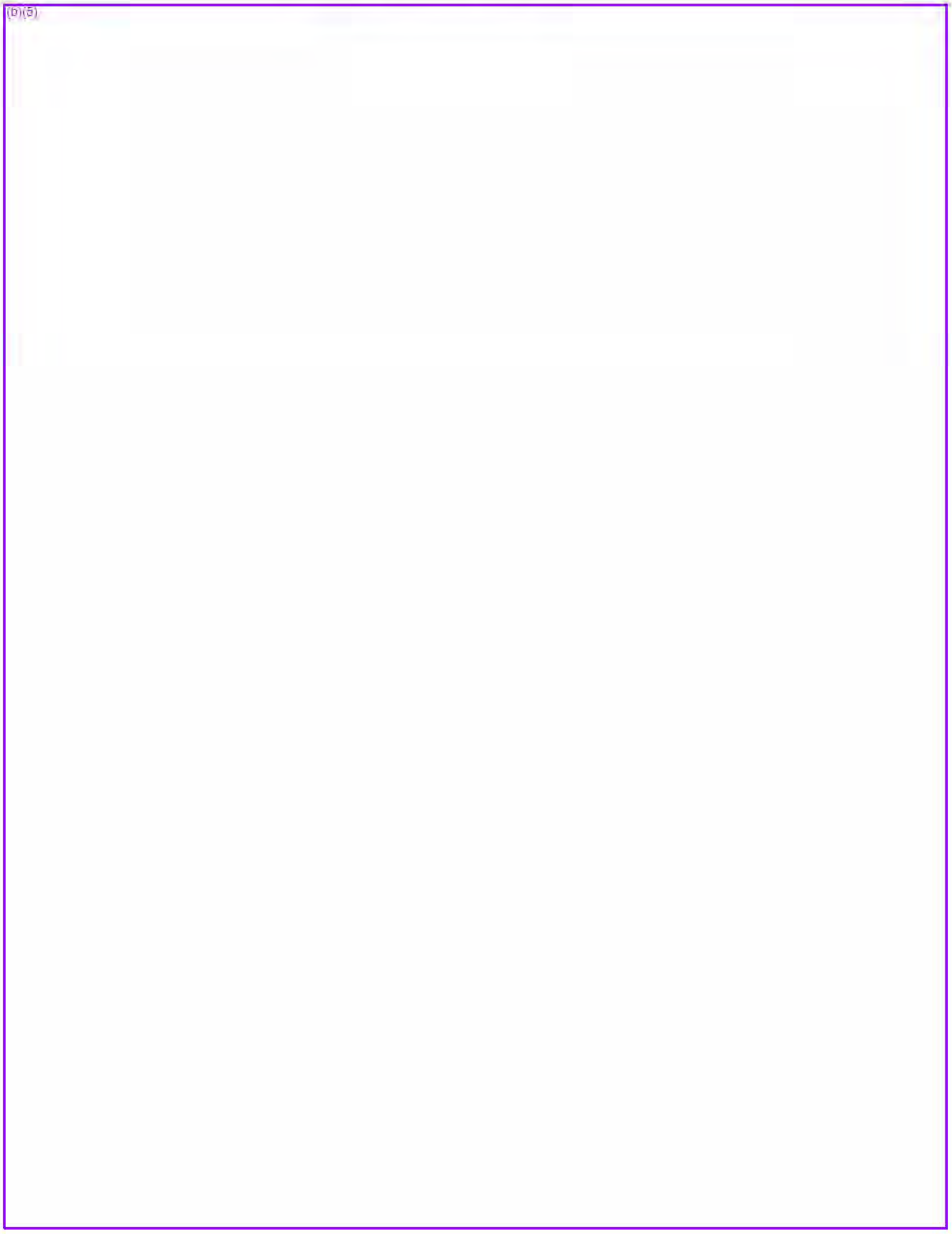

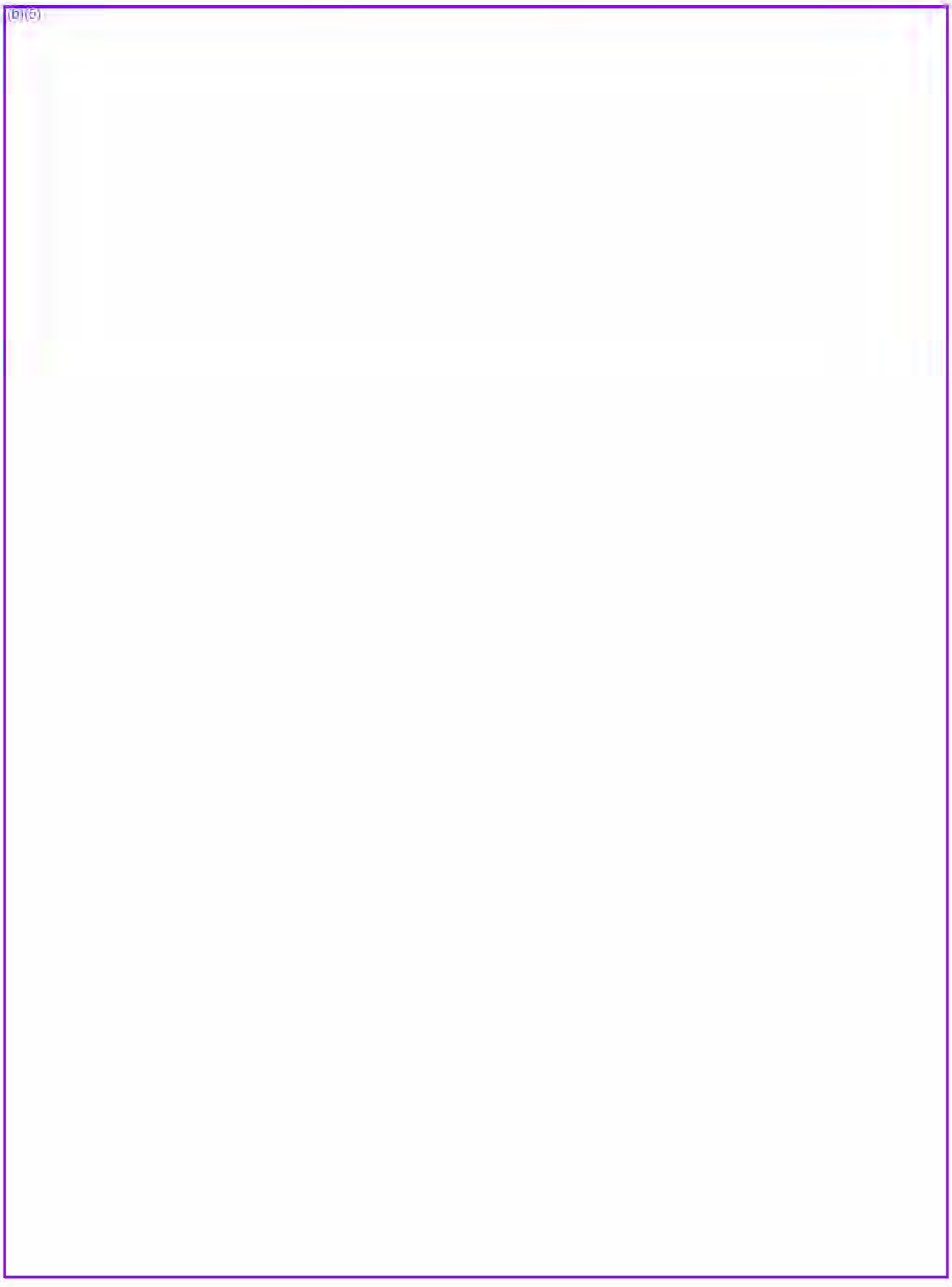
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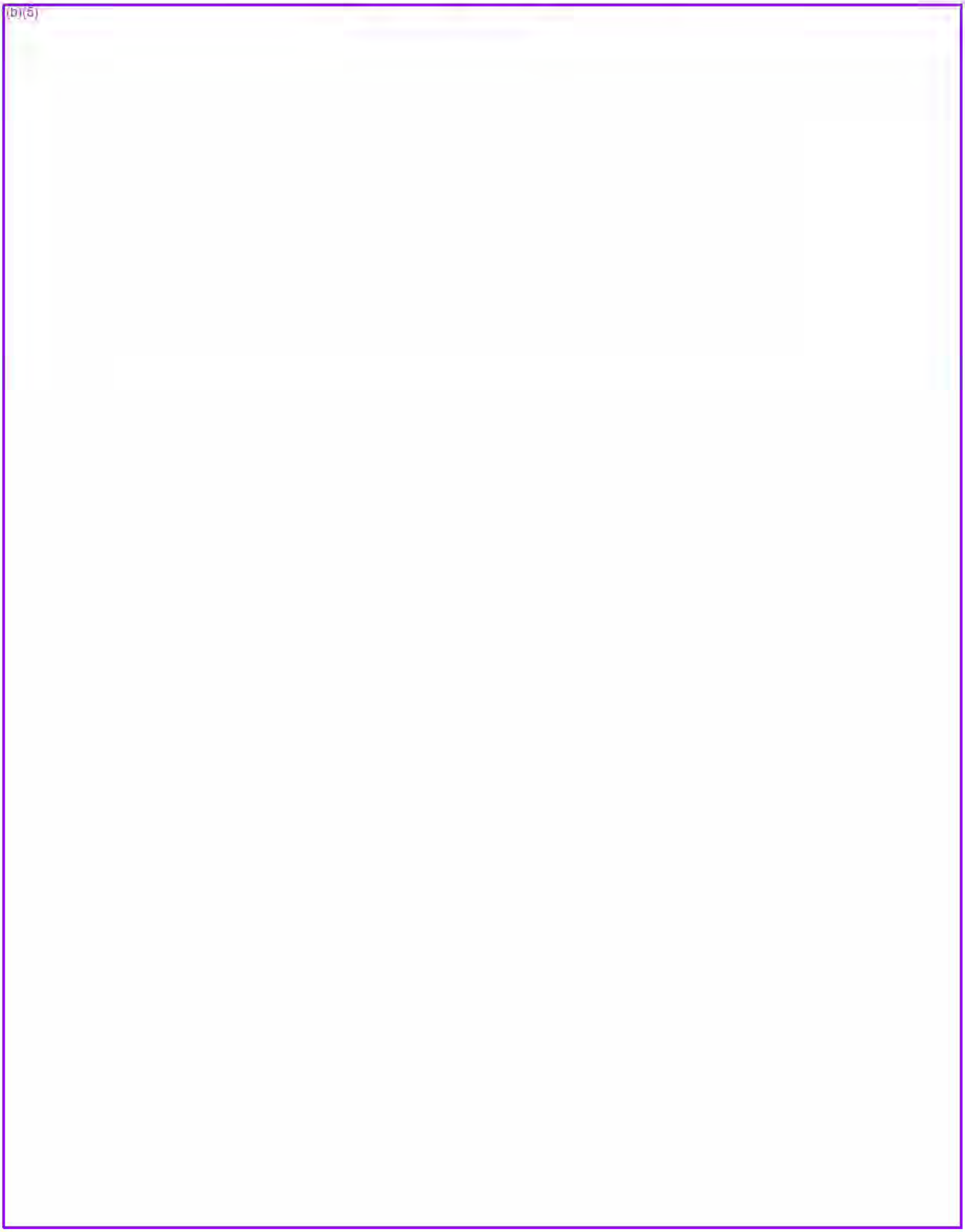

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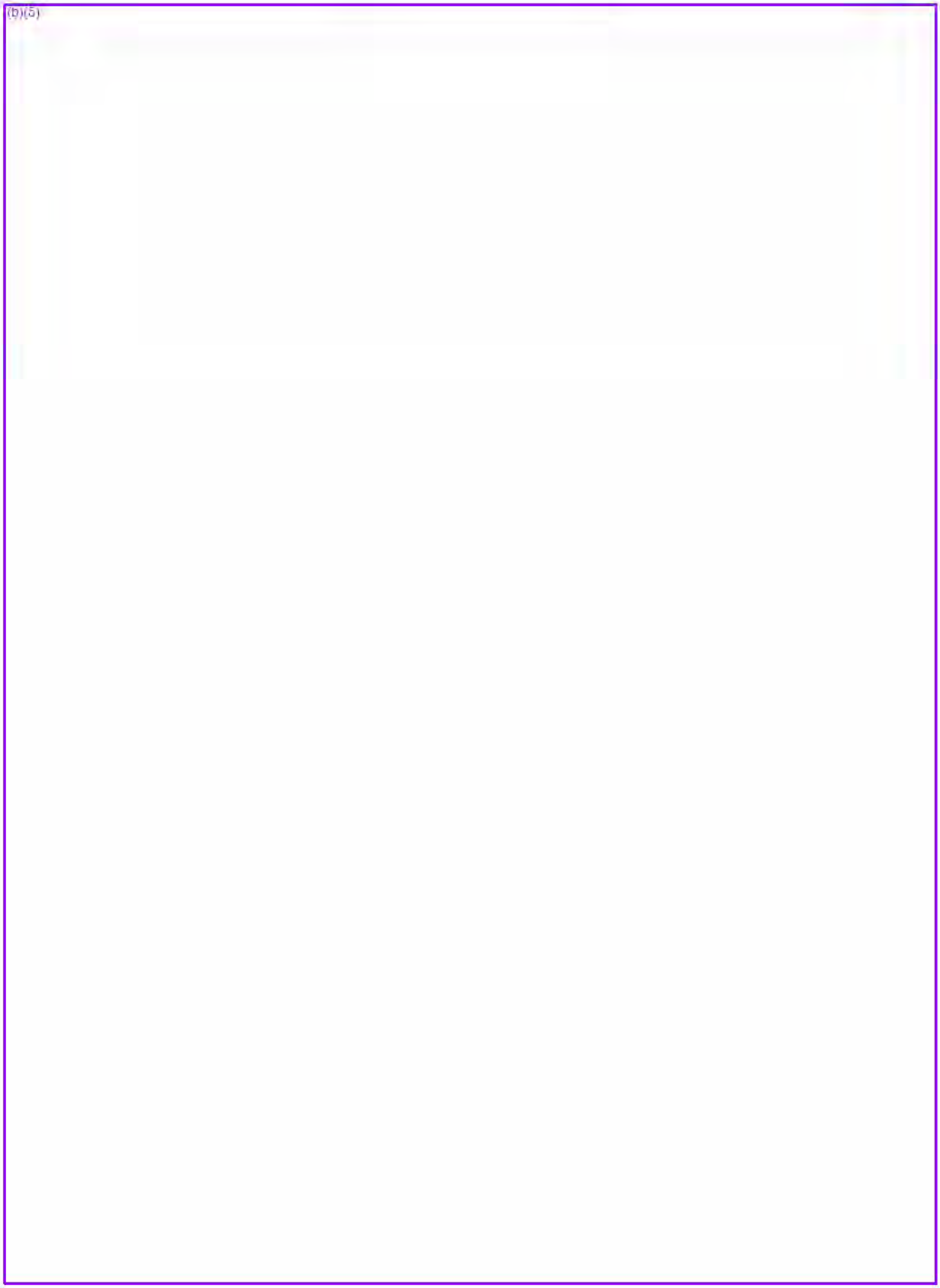

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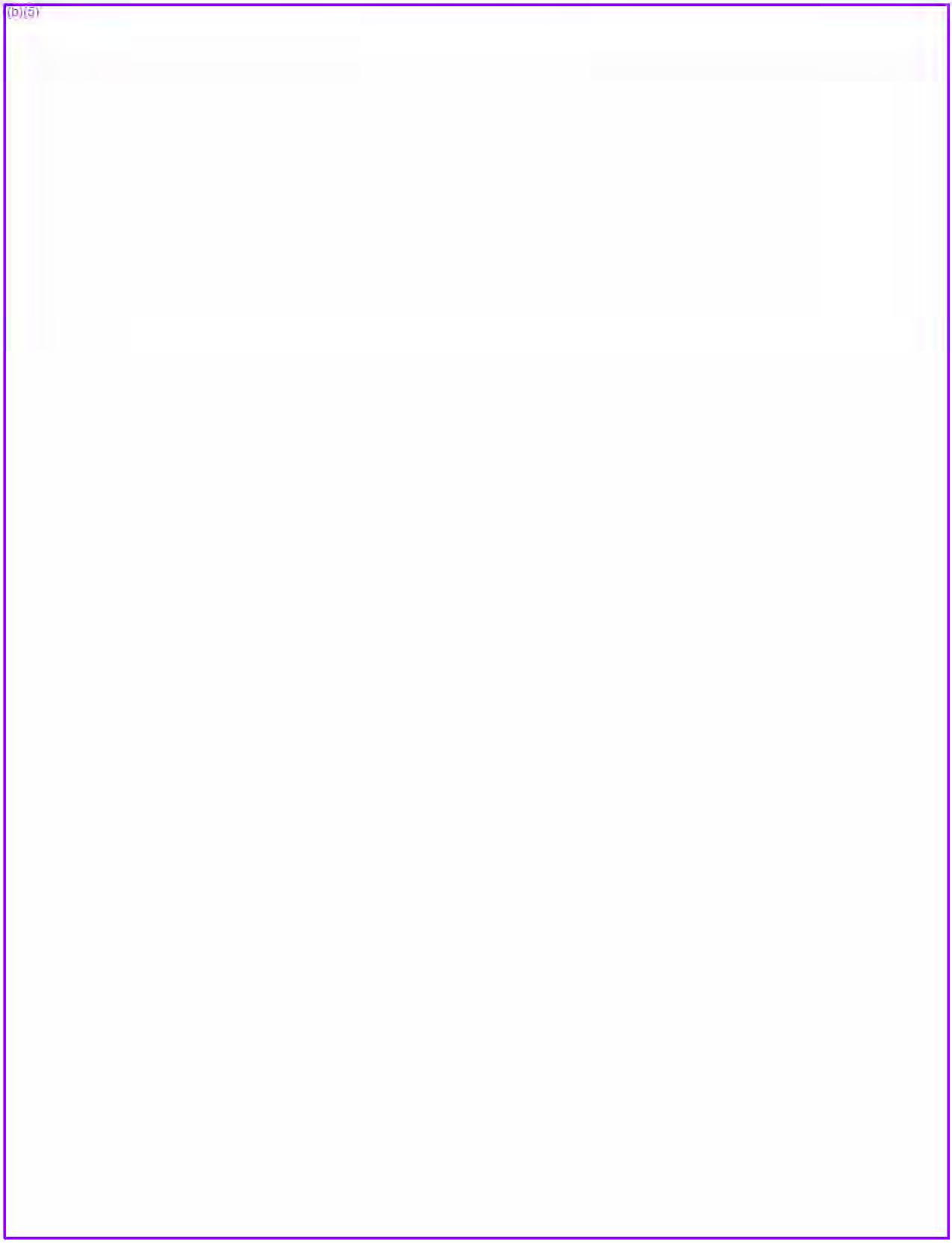

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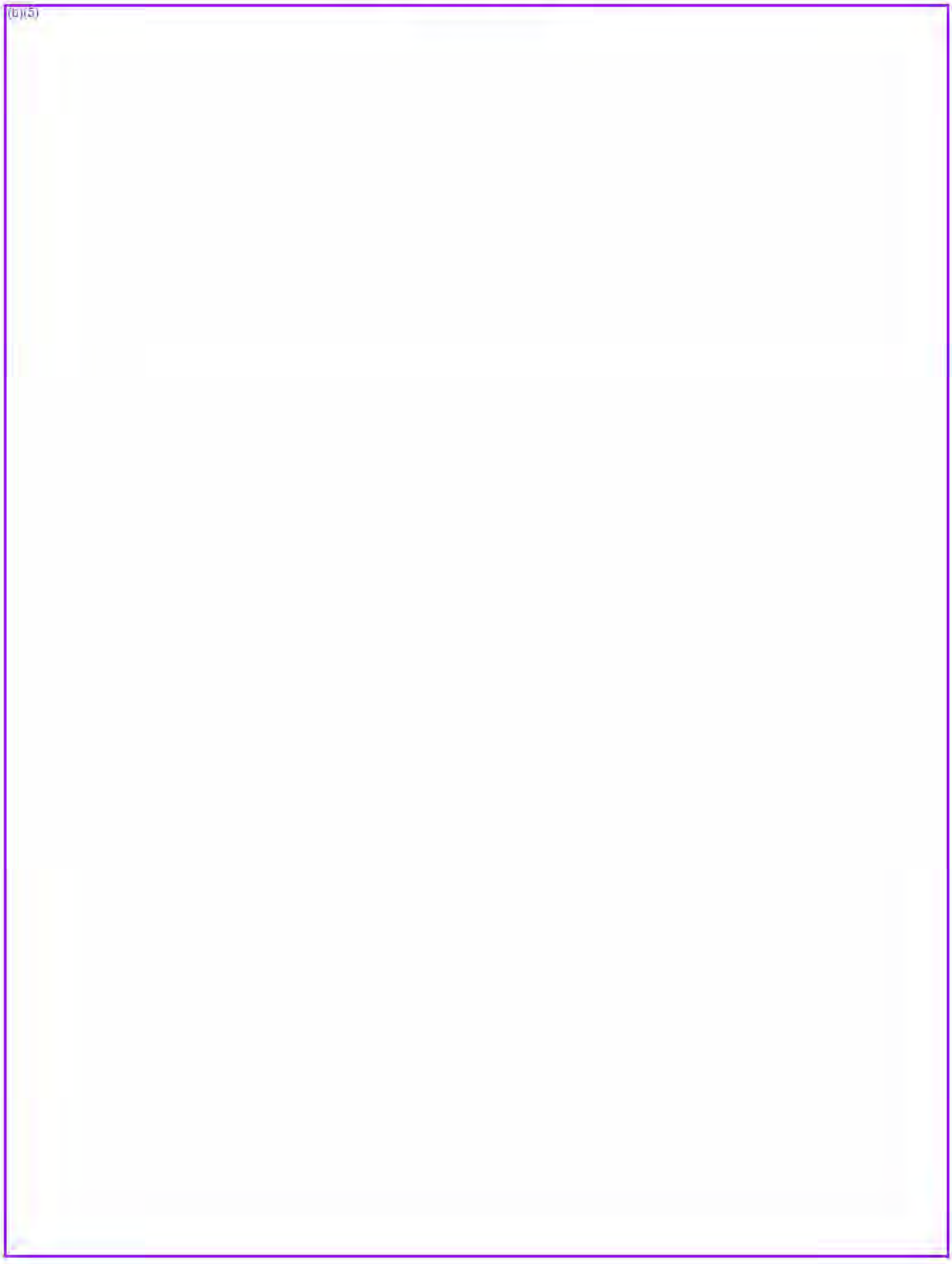

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STANDARD TERMS AND CONDITIONS TO BE ATTACHED TO ALL NRC INTERAGENCY AGREEMENTS AWARDED TO DEPARTMENT OF ENERGY (DOE) NATIONAL LABORATORIES

All work performed for NRC at a DOE laboratory is conducted under the terms and conditions of the DOE contract in place to manage and operate that laboratory. The below set of terms and conditions provide additional guidance in specific areas that are particular to work performed for NRC and supplement the DOE contract provisions.

1. Technical Direction

The NRC Contracting Officer's Representative (COR), as named in the NRC Statement of Work (SOW), is responsible for ensuring that the services required under this project are delivered in accordance with the terms of the SOW. All technical direction instructions to the DOE Laboratory must be issued through the COR.

Technical direction includes interpreting technical specifications, providing needed details, and suggesting possible lines of inquiry. Technical direction must not constitute new work or affect overall project cost or period of performance. Technical direction must be confirmed in writing to the DOE Laboratory, a copy provided to the DOE Site Office or the DOE Field Office, and a copy placed in the NRC Program Office project file.

2. Key Personnel

The individual(s) identified as key personnel in the Technical Proposal, is (are) considered essential to the successful performance of the work. The DOE Laboratory agrees that these personnel shall not be removed from the project or replaced without complying with the following:

- If one or more of the key personnel, for whatever reason, becomes or is expected to become unavailable for work under this contract for a continuous period exceeding 30 workdays, or is expected to devote substantially less effort to the work than indicated in the proposal or initially anticipated, the DOE Laboratory shall immediately notify the Contracting Officer (CO) in NRC's Acquisition Management Division of its intent to make key personnel replacements.

- All requests for approval of substitutions on a project shall be in writing and shall provide detailed explanation of the circumstances necessitating the proposed substitutions. The request shall contain a complete résumé for the proposed substitute and other information requested by the NRC office to approve or disapprove the proposed substitution. The NRC will evaluate such requests and promptly notify the DOE Laboratory of its approval or disapproval thereof in writing.

- The project may be terminated if the office determines that:

  Suitable and timely replacements of key personnel who have been reassigned, terminated, or have otherwise become unavailable for the project is not reasonably forthcoming.

  The resultant reduction of effort or expertise would be so substantial as to impair the successful completion of the project or work order.

3. Billing Requirements

DOE shall bill NRC monthly for costs paid in support of NRC projects by the agreement number and task order number (if applicable). The DOE shall bill and collect from NRC by an electronic transfer of funds through the U.S. Treasury Intergovernmental Payment and Collection System (IPAC).

The DOE voucher shall identify the NRC Agreement Number and the NRC Task Order number (if applicable). The DOE voucher, as a minimum, shall indicate the month that costs were incurred and the dollar amount of these costs. In some instances because of accrual accounting and other adjustments, the amounts may differ slightly from the original accrual amount.

When monthly letter status report (MLSR) costs differ from the amount billed, DOE shall provide an explanation of the difference on the voucher.

The DOE voucher shall be sent to support the IPAC funds transfer. The instructions must identify the billable activities as specified by 10 CFR Part 170. The DOE voucher and other required documentation shall be submitted to—

NRC Payments
U.S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Mailstop O3-E17A
Rockville, MD 20852-2738

Electronic Commercial Vendor and IPAC Payments:
Effective immediately, commercial vendors and Federal entities should use the new electronic mailing addresses shown below:

Invoice and training billing Email address – NRCPayments@NRC.gov
IPAC billing Email address – NRCIPAC.Resource@NRC.gov

4. Monthly Letter Status Reports (MLSR)

In accordance with MD 11.7, the DOE laboratory shall submit a Monthly Letter Status Report (MLSR) by the 20th day of each month to:

- NRC Contracting Officer's Representative

With copies to the following:

- Office of Administration/Acquisition Management Division (electronic copy only) to ContractsPOT.Resource@nrc.gov

The MLSR should contain at a minimum all of the information required in the instructions for completing Monthly Letter Status Reports as defined in Attachment 1 of the NRC SOW.

5. Limitation of Funds

NRC is not obligated to reimburse DOE for costs incurred by its contractors in excess of the total amount obligated by an appropriately executed interagency agreement form. The NRC CO in NRC's Acquisition Management Division will formally notify the appropriate DOE Site Office or the DOE Field Office of any projects that are intended to be phased out or terminated as soon as such intent is known, preferably at least 30 days before the proposed termination date. For work orders with fixed performance periods, the DOE Site Office or the DOE Field Office should assume that the program will terminate on the last day of the period specified in the award form unless notified otherwise.

If at any time the Laboratory has reason to believe that the costs will exceed the total amount authorized, the Laboratory must notify NRC and the DOE Site Office or the DOE Field Office. In the absence of formal NRC instructions to continue or to terminate a work order, the DOE Site Office or the DOE Field Office contract officer or his or her designee will notify NRC by e-mail or other suitable written means when the accrued costs of any NRC work order approaches 75 percent of the authorized funding level for a project or task order (TO).

The notification should include the estimated date when the accrued costs will equal the authorized funds, and may, if appropriate, recommend or request the NRC action desired. The notification should be sent to the appropriate NRC CO and COR with a copy to DOE. After this notification, the NRC will evaluate costs incurred against technical progress and, if necessary, will:

- Increase funding authorization
- Change the scope of the work
- Change the period of performance
- Terminate the project

The performance of work shall be completed within the period stated in the most current authorization document. When the DOE Laboratory anticipates that the work cannot be completed within the fixed time period, it shall notify the NRC CO and COR in writing and send a copy of the notice to the DOE Site Office or the DOE Field Office. Notification shall be made in sufficient time to allow for the issuance of a modification to the agreement, authorizing an extension of the work period to the date necessary to complete the authorized work. If the period of performance is not extended, the office shall notify DOE and the DOE Laboratory via issuance of a modification which should contain closeout instructions, including the reconciliation of any excess funds.

6. Organizational Conflict of Interest

Upon submitting a proposal to the NRC, each DOE Laboratory would continue to acknowledge the disclosure requirements of: 1) MD 11.7, "Organizational Conflict of Interest"; and 2) the provisions of the Memorandum of Understanding (MOU) between DOE and NRC, dated 1998 (which states, in part, that DOE recognizes that Section 170A of the Atomic Energy Act of 1954, as amended, requires that NRC be provided with disclosures on potential conflicts when NRC obtains technical, consulting, research and other supporting services). DOE further recognizes that the assignment of NRC work to DOE laboratories must satisfy NRC's organizational conflict of interest (OCOI) standards.

Therefore, each DOE Laboratory, in its proposal to NRC (which will be incorporated into an interagency agreement between NRC and DOE), is required to make an assertion per #1 or #2

of Part A below for themselves and all subcontractors proposed prior to their award. If the Laboratory selects #1, then, it must also fill out the accompanying Part B – whereby the Laboratory must, again, make an assertion by answering each of the five (5) NRC OCOI provisions per the NRC Acquisition Regulation (NRCAR).

PART A:

"In accordance with [INSERT NAME OF DOE LABORATORY OR SUBCONTRACTOR] role in, and responsibility for, disclosing its relationships with organizations which conduct business in the same and/or similar technical area as described by the present and/or ongoing NRC project's scope of work, and in accordance with the NRC clause as stated herein, [INSERT NAME OF DOE LABORATORY OR SUBCONTRACTOR] hereby asserts that it has examined its relationships with all such organizations, and has also examined its current and future/planned work, and where appropriate, its past work (generally for the previous five years), for DOE and other organizations, and [INSERT NAME OF DOE LABORATORY OR SUBCONTRACTOR] states the following:

1) [INSERT NAME OF DOE LABORATORY OR SUBCONTRACTOR] hereby discloses the following relationships _____ [state the name of persons, organizations, and business relationships, etc. **] _____ that may give rise to a potential OCOI. (DOE Laboratory or subcontractor must answer the questions in Part B below);

Or

2) [INSERT NAME OF DOE LABORATORY OR SUBCONTRACTOR] to the best of its knowledge and belief, asserts that it has no current work, planned work, and where appropriate, past work for DOE and others (to mean - organizations in the same and/or similar technical area as the present and/or ongoing NRC project scope of work); and [INSERT NAME OF DOE LABORATORY OR SUBCONTRACTOR] hereby asserts that it is not aware of any same/similar technical work that would give rise to any potential OCOI as defined in the Atomic Energy Act of 1954, as amended, and in the NRC/DOE MOU.

Signed: _____

PART B:

In accordance with [INSERT NAME OF DOE LABORATORY OR SUBCONTRACTOR] role/responsibility regarding OCOI disclosure, as stated in Part A, above [INSERT NAME OF DOE LABORATORY OR SUBCONTRACTOR] further discloses, to the best of its knowledge and belief, that:

1) [INSERT NAME OF DOE LABORATORY OR SUBCONTRACTOR] and/or any of its organizational affiliates* as defined in Part A above [does/does not] provide advice and recommendations to the NRC in the same technical area (e.g., fire protection, PRA, seismic, vulnerability analysis, fracture mechanics) where it is also providing consulting assistance to any organization regulated by NRC. If [INSERT NAME OF DOE LABORATORY OR SUBCONTRACTOR] "does" - the [INSERT NAME OF DOE LABORATORY OR SUBCONTRACTOR] hereby discloses such organization(s) in Part A above;

2) [INSERT NAME OF DOE LABORATORY OR SUBCONTRACTOR] and/or any of its organizational affiliates as defined in Part A above [does/does not] provide advice and

recommendations to the NRC on the same or similar matter (e.g., particular licensing amendment, particular EIS, particular high level waste repository site) on which it is also providing assistance to any organization regulated by NRC. If [INSERT NAME OF DOE LABORATORY OR SUBCONTRACTOR] "does" - the [INSERT NAME OF DOE LABORATORY OR SUBCONTRACTOR] hereby discloses such organization(s) in Part A above;

3) [INSERT NAME OF DOE LABORATORY OR SUBCONTRACTOR] and/or any of its organizational affiliates as defined in Part A above [will/will not] be required to evaluate its own products or services, or has been substantially involved in the development or marketing of the products or services of another entity. If [INSERT NAME OF DOE LABORATORY OR SUBCONTRACTOR] "does" - the [INSERT NAME OF DOE LABORATORY OR SUBCONTRACTOR] hereby discloses such organization(s) in Part A above;

4) [INSERT NAME OF DOE LABORATORY OR SUBCONTRACTOR] and/or any of its organizational affiliates as defined in Part A above [does/does not] have a conflicting role, given the award of the present and/or ongoing NRC project, in which its judgment or the judgment of any of its organizations may be biased in relation to its work for NRC. If [INSERT NAME OF DOE LABORATORY OR SUBCONTRACTOR] "does" – the [INSERT NAME OF DOE LABORATORY OR SUBCONTRACTOR] hereby discloses such conflicting role(s) with organization(s) in Part A above;

5) [INSERT NAME OF DOE LABORATORY OR SUBCONTRACTOR] and/or any of its organizational affiliates as defined in Part A above [are/are not] soliciting or performing concurrent work at an applicant or licensee site, while performing work in the same/similar technical area for NRC at the same site. If [INSERT NAME OF DOE LABORATORY OR SUBCONTRACTOR] "does" – then the [INSERT NAME OF DOE LABORATORY OR SUBCONTRACTOR] hereby discloses such organization(s) in Part A above."

Signed: _____

*Organization affiliate – Business concerns which are affiliates (related) to each other when either directly or indirectly, one concern or individual controls or has the power to control another, or when a third party (i.e. parent firm) has the power to control both.

** The Atomic Energy Act of 1952 uses the term “person” to mean any entity – e.g., sole proprietorship, partnership, joint venture, corporation; university; limited partnership, subchapter S corporation; limited liability company, etc.

7. Incompatibility Between Regular Duties and Private Interests

(a) Employees of a management and operating contractor shall not be permitted to make or influence any decision on behalf of the contractor which directly or indirectly affects the interest of the Government, if the employee’s personal concern in the matter may be incompatible with the interest of the Government. For example: An employee of a contractor will not negotiate, or influence the award of, a subcontract with a company in which the individual has employment relationship or significant financial interest; and an employee of a contractor will not be assigned the preparation of an evaluation for DOE or for any DOE contractor of some technical aspect of the work of another organization with which the individual has an employment relationship, or significant financial interest, or which is a competitor of an organization (other than the contractor who is the individual’s regular employer) in which the individual has an employment relationship or significant financial interest.

(b) The contractor shall be responsible for informing employees that they are expected to disclose any incompatibilities between duties performed for the contractor and their private interests and to refer undecided questions to the contractor.

8. Intellectual Property Rights

The statutory, regulatory, and procedural intellectual property policies of DOE will be applicable to the work falling under this work order—

- Provided that information concerning disclosures of inventions identified as having been conceived or first actually reduced to practice under Commission-funded work will be reported to the Commission, and the Commission will be kept advised as to their status.

- Except that the Commission reserves the right to control title to inventions as to any rights that vest in the Commission under statute. If DOE and DOE's contractor, where the contractor has such rights, should determine not to protect these inventions either domestically or abroad, the Commission will have the right to protect these inventions.

- Provided that if the technology covered by an invention disclosure upon which DOE intends to file a patent application on behalf of the U.S. Government is deemed by the Commission to fall within the Commission's mission, that is, when the technology relates to nuclear facilities and materials safety, safeguards, and environmental protection in support of the Commission's licensing and regulatory functions, the Commission may so notify DOE and a determination will be made by the parties as to which party will file the patent application or applications.

- Provided that neither party shall grant an exclusive patent license on an agency owned invention without the approval of the other party.

9. Acquired Material, Equipment, or Software (Property)

In accordance with Management Directive 11.7, the Laboratory proposal must include a description of the property required for project performance that has an estimated acquisition cost of $500 or more. The proposal must also identify the potential development of NRC-funded software during the project. NRC-funded software is software specifically developed for NRC by the Laboratory and is generally the deliverable for the project.

After the NRC reviews the list of property and NRC-funded software included in the Laboratory proposal, any questions regarding the acquisition of property or the development of NRC-funded software will be addressed with the Laboratory during negotiations. After negotiating project terms and conditions, NRC shall issue an agreement authorizing the work and approving acquisition of property or development of NRC-funded software.

Laboratories shall submit a written request to the NRC project manager for approval to develop additional NRC-funded software or purchase additional property with an estimated acquisition cost of $500 or more after work initiation. The project manager shall approve or disapprove the acquisition or development of any additional items in writing.

DOE Laboratories shall report property, including software, with an acquisition cost of $500 or more in the monthly letter status report in the month the property or software was acquired.

DOE laboratories shall forward an electronic copy of all monthly letter status reports to the NRC Office of Administration, Acquisition Management Division: ContractsPOT.Resource@nrc.gov, in addition to the NRC COR. DOE Laboratories shall provide the information listed in the Monthly Letter Status Report instructions for each item reported as appropriate, in the monthly letter status report.

10. Dissemination of Project Information/Publication Requirements

(a) Prior to any dissemination, display, publication, presentation, or release of papers, articles, reports, summaries, or abstracts developed under the NRC/DOE Agreement, the DOE Laboratory shall submit them to the NRC for review and comment. NRC shall have a review and comment period of at least [60] days, after which both an NRC and DOE Laboratory representative at the lowest management level, shall attempt to resolve any differing viewpoints or statements which are the subject of NRC objection. If the matter cannot be resolved at that level, the issue shall be brought up to the next management level in both organizations until an agreement can be reached or it reaches the Office Director level. Matters which cannot be resolved at this level shall be submitted for resolution to the Laboratory's Technology Partnership Ombudsman (as set forth in the Laboratory's Management and Operating contract with DOE or NNSA pursuant to § (p) of Department of Energy Acquisition Regulation (DEAR) 970.5227-3 "Technology Transfer Mission" (Aug 2002)). In the event resolution cannot be achieved by the Ombudsman, the NRC may direct the Laboratory/DOE to not publish the work as a NUREG/CR, but publish as a Laboratory report without the NRC office name or Project Manager's name listed on the report, and with a Disclaimer conspicuously noted on the report, article, summary, abstract or related document that the Laboratory/DOE intends to release, display, disseminate or publish to other persons, the public or any other entities:

> "The views expressed in this [paper, journal article, report, summary, or abstract] do not represent those of the U.S. Nuclear Regulatory Commission."

(b) The NRC and DOE agree to handle all classified information provided or developed during the course of this project in accordance with all applicable laws and regulations governing the handling of such information. In the event NRC determines during its review and comment period that a draft Laboratory paper, article, report, summary, or abstract contains classified information regarding the work performed for NRC, NRC, in addition to commenting on the subject matter, shall also direct the Laboratory/DOE to direct an authorized classification authority to appropriately review, classify and mark the product, pursuant to nationally acceptable standards/guidelines. Under these circumstances, the Laboratory will either publish the work solely as a classified product pursuant to NRC direction, or not publish the work in any format. In cases where classification of the product is in dispute, NRC may consult with DOE's Office of Classification; however NRC retains the ultimate authority over the classification of the product.

(c) In addition, travel costs to present papers or reports developed under the NRC/DOE Agreement may not be authorized if the NRC program manager determines that presentation of the paper does not support the NRC program or project. Such determination will not affect payment of the contract work costs.

(d) The DOE Laboratory contractor, to the extent it is permitted to and asserts copyright therein, grants a royalty-free, nonexclusive, irrevocable worldwide license to the Government to use, reproduce, modify, distribute, prepare derivative works, release, display or disclose the articles,

reports, summaries, abstracts, and related documents developed under the Agreement, for any governmental purposes and to have or authorize others to do so.

11. Review and Approval of Reports

The Laboratory/DOE shall comply with the terms and conditions of the agreement regarding the contents of the draft and final reports, summaries, data and related documents, to include correcting, deleting, editing, revising, modifying, formatting and supplementing and of the information contained therein. Corrective actions shall not be undertaken unless sufficient funding from NRC is available to cover the costs of the corrective actions. Performance under the agreement shall not be deemed accepted or completed until it complies with NRC's directions.

Identification/Marking of Sensitive Unclassified and Safeguards Information. DOE shall comply with the requirements stated MD's 12.7 "NRC Safeguards Information Security Program" as follows:

a) Classification Clause

To the extent that the performance of work under this work order involves classified information, the following clause is applicable:

- In the performance of work under this work order, DOE shall ensure that a DOE authorized classifier shall assign classification levels to all documents, material, and equipment originated or generated by the performing organization in accordance with classification guidance furnished by the Commission. Each subcontract and purchase order issued hereunder involving the generation of classified documents, material, or equipment shall include a provision to the effect that in the performance of such subcontract or purchase order, a DOE authorized classifier shall assign classification levels to all such documents, material, and equipment in accordance with classification guidance furnished by the NRC.

- When appropriate, the attached NRC Form 187, "Contract Security and/or Classification Requirements," is a part of this work order. It is the responsibility of the NRC office originating the work order to review the classification assigned and to refer any problems to the NRC Division of Security Operations (DSO), NSIR, for resolution.

b) Safeguards Information, Unclassified Controlled Nuclear Information, or Unescorted Access to Protected and Vital Areas of Nuclear Power Plants

To the extent that the performance of work under this work order involves Safeguards Information (SGI), the following clause is applicable:

> In the performance of the work under this project, DOE shall assure that the DOE laboratory shall mark and protect all documents, material, and equipment originated, generated, or received by the performing organization in accordance with the provisions of Section 147 of the Atomic Energy Act of 1954, as amended, its implementing regulations (10 CFR 73.21), "Protection of Safeguards Information: Performance Requirements." Further guidance on the protection of Safeguards Information and examples of proper marking of cover; title page, and back cover are contained in NRC Management Directive (MD) 12.7, "NRC

Safeguards Information Security Program" and the NRC Guide to Marking Safeguards Information.

To the extent that performance of work under this work order involves unclassified controlled nuclear information (UNCI), the following clause is applicable:

In the performance of the work under this project, DOE shall assure that the DOE laboratory shall mark and protect all documents, material, and equipment originated, generated, or received by the performing organization in accordance with the provisions of Section 148 of the Atomic Energy Act of 1954, as amended, is implementing DOE regulations, and DOE orders and guidance.

It is the responsibility of the NRC office originating the work to indicate whether the work will involve SGI or unescorted access to protected and vital areas of nuclear power plants. An NRC Form 187, "Contract Security and/or Classification Requirements," shall be completed to indicate such access.

c) Proprietary Information

In connection with the performance of work under this work order, NRC may furnish for DOE review, evaluation, or other use certain trade secrets or confidential or privileged commercial or financial information determined by the office to be exempt from public inspection or disclosure. A synopsis of such information must be submitted in writing to the DOE contracting officer for reaching agreement with the office on the acceptance and use of the information. Up-to-date guidance on the protection of proprietary information used in reports prepared by the DOE laboratory on proper marking of cover, title page, and back cover may be obtained from the NRC COR.

Proprietary or other privileged information may be provided by the office on an individual basis to DOE laboratory employees working as NRC consultants with the understanding that it shall be protected from disclosure and shall be returned to the office upon completion of the work. Any such claimed proprietary data will be appropriately identified and marked as such. The use of proprietary information in reports prepared by consultants requires protection. Further information may be obtained from the NRC COR.

d) Other Sensitive Unclassified Non-Safeguards Information (SUNSI)

Information other than safeguards, unclassified controlled nuclear, proprietary information, and pre-decisional information may at times be determined to be sensitive. The use of such information in reports requires the specific NRC designation and protection as prescribed by the NRC SUNSI policy. Further information may be obtained from the NRC COR.

12. Sensitive Information Work Efforts

To the extent that the performance under this work order involves classified information, the following clauses are applicable:

- Responsibilities. DOE and the DOE contractor (performing organization) shall be responsible for safeguarding Restricted Data, Formerly Restricted Data, and other National Security Information and for protecting it against sabotage, espionage, loss, and theft in accordance with applicable NRC and DOE security regulations and requirements.

- Transmission of Classified Matter. Except as otherwise expressly provided, DOE or the DOE contractor shall, upon completion or termination of the work order, transmit to the NRC program office all classified matter in its possession or in the possession of any person under its control in connection with performance of this project or work order. If retention of any classified matter is required by DOE or the DOE contractor, DOE must obtain the approval of the NRC program office and complete a certificate of possession specifying the classified matter to be retained.

- Regulations. DOE and the DOE contractors shall be responsible for compliance with all applicable NRC and DOE security regulations and requirements.

- Definition of Restricted Data. The term “Restricted Data,” as used in this clause, means all data concerning (1) the design, manufacture, or utilization of atomic weapons; (2) the production of special nuclear material; or (3) the use of special nuclear material in the production of energy, but does not include data declassified or removed from the Restricted Data category pursuant to Section 142 of the Atomic Energy Act of 1954, as amended.

- Definition of Formerly Restricted Data. The term “Formerly Restricted Data,” as used in this clause, means classified information related primarily to the military utilization of atomic weapons that can be adequately safeguarded as National Security Information, subject to the restrictions on transmission to other countries and regional defense organizations that apply to Restricted Data.

- Definition of National Security Information. National Security Information is information that has been determined pursuant to Executive Order 13526 or any predecessor order to require protection against unauthorized disclosure and is so designated.

- Security Clearance of Personnel. DOE and DOE laboratories shall not permit any individual to have access to Restricted Data, Formerly Restricted Data, or National Security Information, except in accordance with the Atomic Energy Act of 1954, as amended, Executive Orders 12968 and 10865, and DOE regulations or requirements applicable to the particular type or category of classified information to which access is required.

- Safeguards Information Access. DOE and DOE laboratories shall not permit any individual to have access to Safeguards Information, except in accordance with 10 Code of Federal Regulations Part 73.22 and NRC Management Directive 12.7.

- Liability. It is understood that the unauthorized disclosure or the failure to properly safeguard Restricted Data, Formerly Restricted Data, or National Security Information that may come to the DOE or to any person under an NRC/DOE work order in connection with work under the work order may subject the performing organization, and its agents, employees, or subcontractors, to administrative sanctions and criminal liability under the laws of the United States. (See the Atomic Energy Act of 1954, as amended [42 U.S.C. 2011et seq.], 18 U.S.C. 793 and 794; and Executive Orders 13526 and 12968.)

- Subcontracts and Purchase Orders. Except as otherwise authorized in writing by the Commission, DOE shall insert provisions similar to the foregoing in all subcontracts and purchase orders under this project or work order.

13. Software Development

Systems development efforts shall comply with applicable Government-wide Federal Information Processing Standards developed by the National Institute of Standards and Technology, applicable public laws, Office of Management and Budget circulars, and NRC policies and procedures. Particular attention is necessary to incorporate security features in the design of systems that process sensitive data. The format of software deliverables is specified in NRC Bulletin 0904-4. If any deliverable is provided on diskette, the diskette shall be scanned for viruses by the contractor and verified to be free of viruses before delivery to NRC. All software development, modification, or maintenance tasks shall follow general guidance provided in NUREG/BR-0167, “Software Quality Assurance Program and Guidelines.” NRC shall advise the DOE Patent Counsel with respect to any rights in the software that NRC desires under any particular project, which rights include NRC imposing restrictions on use, and distribution of the software by DOE or the Laboratory.

14. Copyright in Computer Software and Codes

In the event that a DOE Laboratory desires to assert a copyright of any computer software or computer code funded in whole or in part by NRC, the Laboratory shall request, in writing, the written approval of the cognizant NRC division director or designee before advising DOE's patent counsel of the Laboratory’s desire to seek the copyright.

If NRC determines that public health and safety or other programmatic considerations dictate that the DOE Laboratory contractor should not be given permission to copyright the computer software or code, the NRC CO, after consultation with the NRC Office of the General Counsel (OGC) and the division director or designee, shall so advise the Laboratory in writing.

Alternatively, if permission to copyright computer software or a computer code is granted, the cognizant NRC CO, after consultation with OGC and division director or designee, shall provide the Laboratory with written notice of that decision. In those cases in which the cognizant NRC CO determines that the rights retained by the Government pursuant to the copyright provisions of the Laboratory contract should be modified to protect NRC's interests, NRC will advise DOE's patent counsel of NRC's desire to modify DOE's standard policy with respect to permission for a contractor to assert copyright in that code. DOE and NRC will then jointly determine the appropriate provisions for the code. The DOE patent counsel shall provide the Laboratory with written notice, with a copy to the cognizant NRC division director or designee, of that joint determination. The Laboratory may then proceed to assert copyright.

In no case shall the DOE Laboratory take action relating to assertion of copyright until the NRC CO provides written approval to the Laboratory’s request to assert copyright. Further, DOE shall not permit a contractor to assert copyright of an NRC-funded computer code or computer software without the written approval of the cognizant NRC division director or designee. Where NRC has not granted permission to copyright, NRC recognizes that once a Laboratory has delivered to NRC a developed version of a particular code, the Laboratory may exercise the existing right that both the Laboratory and other parties have to further develop, without NRC funds, software codes that are in the public domain and to copyright the new, non-NRC-funded versions of these codes without NRC approval.

15. Appropriate Use of Government Furnished Information Technology (IT) Equipment and/or its Services/Access

When the NRC work at a DOE site requires electronic processing of information, DOE will follow NIST Special Publication (SP) 800-37 Rev. 1 or later, and SP 800-53 Rev. 3 or later (which are based on FIPS-199 and FIPS-200). For those specific projects with electronic processing of Safeguards Information (SGI), Restricted Data (RD) and/or Unclassified Nuclear Information (UCNI), the NRC shall provide DOE with the appropriate requirements that must be met on a project by project basis. In addition, for those specific projects that require classified electronic information processing, DOE will follow the CNSS policy, directives, instructions, and guidance.

16. NRC Information Technology Security Training

Agencies/Contractors shall ensure that their employees, consultants, and subcontractors with access to the NRC's information technology (IT) equipment and/or IT services complete NRC's online initial and refresher IT security training requirements to ensure that their knowledge of IT threats, vulnerabilities, and associated countermeasures remains current. Both the initial and refresher IT security training courses generally last an hour or less and can be taken during the employee's regularly scheduled work day. Agency/Contractor shall ensure that their employees, consultants, and subcontractors, with access to the NRC's IT equipment, complete the Information Security (INFOSec) Awareness Training annually; no later than December 31st.

Agency/Contractor employees, consultants, and subcontractors shall complete the NRC's online, "Computer Security Awareness" course on the same day that they receive access to the NRC's IT equipment and/or services, as their first action using the equipment/service. For those Agency/Contractor employees, consultants, and subcontractors who are already working under an existing agreement/contract, the online training must be completed in accordance with agency Network Announcements issued throughout the year.

Agency/Contractor employees, consultants, and subcontractors who have been granted access to NRC information technology equipment and/or IT services must continue to take IT security refresher training offered online by the NRC throughout the term of the agreement/contract. Agency/Contractor employees will receive notice of NRC's online IT security refresher training requirements through agency-wide notices.

The NRC reserves the right to deny or withdraw Agency/Contractor use or access to NRC IT equipment and/or services should the Agency/Contractor violate the Agency/Contractor's responsibility under this clause.

17. Contract Security Requirements for Unescorted Access to Nuclear Power Plants

If performance under this work order involves unescorted access to protected and vital areas of nuclear power plants or access to nuclear power reactor SGI, individual contractors requiring access to protected and vital areas of nuclear power plants or access to nuclear power reactor SGI shall be approved for unescorted access in accordance with the following procedures:

17.1 Temporary Approval

The contractor (DOE laboratory employees and laboratory contractors) does not need a temporary approval if he or she has a valid Government clearance, for example, a DOE "Q" or "L" clearance. If the contractor employee does not have such a clearance, the contractor shall submit the information discussed below within 30 calendar days following contract award, modification, or proposal of new personnel for contract tasks. This information shall be provided

for each person proposed to perform tasks requiring unescorted access to nuclear power plants or access to nuclear power reactor SGI. If access to SGI is needed, and unescorted access is not required, the provisions of 10 CFR 73.22 must be followed as a condition for access to SGI. The information shall be provided to the NRC Division of Facilities and Security (DFS) through the NRC COR and consists of the following:

- A completed Personnel Security Forms Packet, including an SF 86, "Questionnaire for National Security Positions," and copies of the individual's 5-year employment and education history checks, including verification of the highest degree obtained

- A reference from at least one additional person not provided by the individual

- Results of a psychological evaluation (This is not a requirement of the background check that is required for access to SGI.

- Form FD-258, ORIMDNRC000Z (Fingerprint Card)

- A certification that the contractor has found all checks acceptable

The results of a psychological examination that uses a reliable written personality test or any other professionally accepted clinical evaluation procedure shall be used to evaluate a subject's trustworthiness, reliability, and stability. The contractor shall review all required information for accuracy, completeness, and legibility, except Part 2 of the SF 86, which must be completed in private and submitted, along with the Form FD-258 by the individual to the contractor in a sealed envelope, or the individual shall be fingerprinted by the subject utility, and the contractor shall be subject to the utility's access authorization program. As described in this section, DFS shall conduct criminal history and credit checks and a security assurance interview with the individual. On the basis of the results of these checks, DFS shall determine the individual's eligibility for temporary access and indicate an objection or no objection to NRC pending completion of the required background investigation.

17.2 Final Approval

Final approval shall be granted if:

- The individual has completed processing (by the Office of Personnel Management) of the required investigation resulting in NRC endorsement for unescorted access at all nuclear facilities for the life of the contract.

- The contractor has obtained unescorted access authorization (other than temporary access) at the specific utility through that utility's access authorization program, resulting in unescorted access at a specific facility.

- The individual possesses a valid Government-issued clearance as verified by DFS.

- A valid Government-issued clearance is defined as a U.S. Government-issued security clearance equivalent to or higher than an NRC "L" clearance (i.e., Secret) based on a comparable investigation not more than 10 years old. The investigation specified in MD 11.7, Section 11.12.2 may involve an National Agency Check and Inquiries (NACI) or other investigation as deemed necessary by DFS in accordance with 10 CFR Part 10, 10 CFR 73.22, NRC MD's 12.3, "NRC Personnel Security Program" and 12.7 "NRC Safeguards

Information Security Program." Any question regarding the individual's eligibility for unescorted access to protected or vital areas of nuclear power facilities will be resolved in accordance with the provisions set forth in MD 12.3, which are incorporated into the work order by reference as though fully set forth therein. The contractor shall, for each contractor individual approved for access under the provisions of this section, submit to DFS through NRC a signed statement from the individual that he or she understands his or her responsibility to report information bearing on his or her continued eligibility for access authorization as specified in MD 12.3. Access to SGI not also involving unescorted access to protected and vital areas of nuclear power plants shall require the submission of a completed Personnel Security Forms Packet to DFS through NRC and will require a Background Check in accordance with 10 CFR Part 73.22 and MD 12.7. Any questions regarding the individual's eligibility for access to nuclear power reactor SGI shall be resolved in accordance with the provisions set forth in MD 12.7, which is incorporated into this contract by reference as though fully set forth herein. On the basis of the review of the applicant's security forms by DFS and/or the receipt of adverse information by NRC, the individual may be denied access to nuclear power reactor SGI until a final determination of his or her eligibility for access is made under the provisions of MD 12.7.

17.3 Fitness for Duty

Pursuant to NRC policy, all individuals proposed for work under this contract who require unescorted access to nuclear power plants shall be subject to the requirements of the licensee's fitness-for-duty program (10 CFR Part 26).

17.4 Basic Exposure Control and Personnel Dosimetry Training Requirements

The contractor shall certify that personnel working under the scope of this contract have completed basic exposure control and personnel dosimetry training sufficient to meet the requirements of commercial nuclear power plants for unescorted access. Site specific training obtained at each site shall still be required during the performance of work under this contract in addition to the basic training.

17.5 Subcontractor Information—Subcontracting

The DOE organization shall notify the issuing NRC CO in writing reasonably in advance of entering into any major or significant technical service subcontract not contained in the original proposal. "Major or significant'' must be used with judgment and related to the total value of the project and/or impact on the results. This advance notification shall include the following:

- A description of services to be called for by the subcontract

- Identification of the proposed subcontractor

- The proposed subcontract costs (in total)

- A signed conflict of interest statement

The NRC CO may require additional specific subcontractor information or limitations. The NRC CO will issue a modification to the agreement upon approval of the subcontracting effort.

18. Information on NRC Cooperative Programs with Foreign Governments and Organizations and With U.S. Industry

DOE facilities, contractors, and subcontractors working on NRC cooperative programs with foreign governments and organizations and with U.S. industry perform this work with the understanding that draft or formal reports on this work are to be available only to participants in the program until public availability is authorized by the NRC office. Reports or codes (including data) on this work shall be issued as "Draft Preliminary Reports (Codes)" until the office authorizes issuance of the report as a formal report with the designation NUREG/IA-XXXX for international agreement reports or NUREG/CR-XXXX for contractor reports. Details of the handling of reports may be obtained from the NRC COR.

19. Stop-Work Order

The NRC CO may, at any time, by modification to the agreement to the DOE CO, require the DOE Laboratory to stop all or any part of the work called for by this work order for a period of up to 90 days after the order is delivered to the DOE Laboratory, and for any further period to which the parties may agree. Any such order will be specifically identified as a "stop-work order" issued pursuant to this clause. Upon receipt of such an order, the DOE Laboratory shall forthwith comply with its terms and take all reasonable steps to minimize the incurrence of cost allocable to the work covered by the order during the period of work stoppage.

Within a period of 90 days after a stop-work order is delivered to DOE or within any extension of that period to which the parties shall have agreed the office shall either:

- Cancel the stop-work order

- Terminate the work covered by this work order

If a stop-work order issued under this clause is cancelled or the period of the stop-work order or any extension thereof expires, DOE will authorize its contractor to resume work. An adjustment will be made in the delivery schedule or cost, or both, and the work order must be modified in writing accordingly. If a stop-work order is not cancelled and the work covered by the order is terminated in accordance with the terms of this work order, costs resulting from the stop-work order will be allowed in arriving at the termination settlement.

20. Termination

Circumstances may arise in which either NRC or DOE wishes to terminate performance of a project in whole or in part. If both parties agree, the work order may be terminated. If DOE wishes to terminate the project, it shall advise the cognizant NRC CO. If NRC wishes to terminate the project, the cognizant NRC CO will advise the cognizant DOE Site Office or the DOE Field Office and send a copy of the termination agreement to the DOE Laboratory.

Within 60 days after the effective date of the termination of the work order, the DOE Laboratory shall submit a termination settlement proposal to the cognizant NRC CO, through the cognizant DOE Site Office or the DOE Field Office. When additional time is required to compile all outstanding costs, such as subcontractor costs, the DOE Site Office or the DOE Field Office shall provide a written notification to the NRC CO that includes a proposed due date for the final settlement proposal. In the event of disagreement between the parties, the cognizant NRC CO will make the final decision. The DOE Laboratory shall not incur new obligations for the

terminated portion of the project after the effective date and must cancel as many outstanding obligations as possible. NRC will allow full credit to the DOE Laboratory for obligations properly incurred by the recipient before termination.

INTERAGENCY AGREEMENT	1. IAA NO. NRC-HQ-60-14-D-0014	PAGE 1 OF 2

2. ORDER NO.	3. REQUISITION NO.	4. SOLICITATION NO.
	RES-14-0428	

5. EFFECTIVE DATE	6. AWARD DATE	7. PERIOD OF PERFORMANCE
08/13/2014	08/13/2014	08/18/2014 TO 10/31/2015

8. SERVICING AGENCY
PACIFIC NORTHWEST NAT LAB
ALC:
DUNS: +4:
US DEPARTMENT OF ENERGY
PACIFIC NORTHWEST SITE OFFICE
PO BOX 350 MS K9-42
RICHLAND WA 99352

POC Genice Madera
TELEPHONE NO. 509-372-4010

9. DELIVER TO
MATTHEW ROSSI
MAIL STOP CSB C5 C11
11555 ROCKVILLE PIKE
ROCKVILLE MD 20852

10. REQUESTING AGENCY
ACQUISITION MANAGEMENT DIVISION
ALC: 310001
DUNS: 040535809 +4:
US NUCLEAR REGULATORY COMMISSION
ONE WHITE FLINT NORTH
11555 ROCKVILLE PIKE
ROCKVILLE MD 20852-2738

POC Jeffrey R. Mitchell
TELEPHONE NO. 301-287-0955

11. INVOICE OFFICE
US NUCLEAR REGULATORY COMMISSION
ONE WHITE FLINT NORTH
11555 ROCKVILLE PIKE
MAILSTOP O3-E17A
NRCIPACRESOURCENRCGOV
ROCKVILLE MD 20852-2738

12. ISSUING OFFICE
US NRC - HQ
ACQUISITION MANAGEMENT DIVISION
MAIL STOP 3WFN-05-C64MP
WASHINGTON DC 20555-0001

13. LEGISLATIVE AUTHORITY
Energy Reorganization Act of 1974

14. PROJECT ID

15. PROJECT TITLE
CRACK INITIATION TESTING FOR PRIMARY WATER STRESS

16. ACCOUNTING DATA
201-X0200-FEEBASED-60-60D001-11-6-213-1032-253D

17 ITEM NO.	18. SUPPLIES/SERVICES	19. QUANTITY	20. UNIT	21. UNIT PRICE	22. AMOUNT
	The NRC and the DOE Lab (PNNL) hereby enter into this Agreement, NRC-HQ-60-14-D-0014, for the project entitled, "Crack Initiation Testing for Primary Water Stress Corrosion Cracking." The performance period for this agreement shall commence on August 18, 2014 and will expire on October 31, 2015. Consideration and Obligations: (a) Authorized Cost Ceiling $985,000.00 Continued ...				

23. PAYMENT PROVISIONS	24. TOTAL AMOUNT
	$649,000.00

25a. SIGNATURE OF GOVERNMENT REPRESENTATIVE (SERVICING)	26a. SIGNATURE OF GOVERNMENT REPRESENTATIVE (REQUESTING)
	Jeffrey R. Mitchell

25b. NAME AND TITLE	25c. DATE	26b. CONTRACTING OFFICER	26c. DATE
		JEFFREY R. MITCHELL	8/13/2014

(b) The amount presently obligated with respect to this DOE Agreement is $649,000.00. When and if the amount(s) paid and payable to the DOE Laboratory hereunder shall equal the obligated amount, the DOE Laboratory shall not be obligated to continue performance of the work unless and until the NRC Contracting Officer shall increase the amount obligated with respect to this DOE Agreement. Any work undertaken by the DOE Laboratory in excess of the obligated amount specified above is done so at the DOE Laboratory's sole risk.

The following documents are hereby made part of this Agreement:
Attachment No. 1: Statement of Work
Attachment No. 2: DOE Standard Terms and Conditions

PNNL's proposal dated July 23, 2014 is incorporated by reference.

NRC CONTRACTING OFFICERS REPRESENTATIVE (COR):
Matthew Rossi and Greg Oberson
PNNL PROJECT MANAGER: Stephen Bruemmer
Master IAA: N/A

00001 AUTHORIZED COST CEILING 985,000.00
Line Item Ceiling$985,000.00
Incrementally Funded Amount: $649,000.00

This agreement is entered into pursuant to the authority of the Energy Reorganization Act of 1974, as amended (42 U.S.C 5801 et seq.). This work will be performed in accordance with the NRC/DOE Memorandum of Understanding dated November 24, 1998. To the best of our knowledge, the work requested will not place the DOE and its contractor in direct competition with the domestic private sector.

[ ] Fee Recoverable Work
[x] Non-fee Recoverable Work

The total amount of award: $985,000.00. The obligation for this award is shown in box 24.

Attachment No. 1
Statement of Work

NRC Agreement Number **NRC-HQ-60-14-D-0014**	NRC Agreement Modification Number	NRC Task Order Number (If Applicable)	NRC Task Order Modification Number (If Applicable)
Project Title Crack Initiation Testing for Primary Water Stress Corrosion Cracking			
Job Code Number	B&R Number	DOE Laboratory PNNL	
NRC Requisitioning Office Office of Nuclear Regulatory Research			
NRC Form 187, Contract Security and Classification Requirements ☐ Applicable ☒ Note Applicable		☐ Involves Proprietary Information ☐ Involves Sensitive Unclassified	
☒ Non Fee-Recoverable		☐Fee-Recoverable (If checked, complete all applicable sections below)	
Docket Number (If Fee-Recoverable/Applicable)		Inspection Report Number (If Fee Recoverable/Applicable)	
Technical Assignment Control Number (If Fee-Recoverable/Applicable)		Technical Assignment Control Number Description (If Fee-Recoverable/Applicable)	

1. Background

The purpose of this project is to obtain crack initiation data for reactor component nickel based alloys by establishing a testing program at Pacific Northwest National Laboratory (PNNL).

PNNL performs primary water stress corrosion crack (PWSCC) growth rate tests under contract to NRC and, over a number of years, has established a strong knowledge base and a high level of technical experimental and analytical capability. PNNL also conducts PWSCC initiation testing under the sponsorship of the Department of Energy's (DOE's) Light Water Reactor Sustainability Research (LWRS). This research will build upon these already established efforts.

Primary water stress corrosion cracking (PWSCC) can occur in nickel-based alloy components in pressurized water reactors (PWRs) at locations such as dissimilar metal welds that join stainless and low-alloy steel control rod drive mechanism penetrations in the reactor pressure vessel upper head, and at instrument penetrations in the lower head. In the U.S., PWSCC has led to coolant leakage at V.C. Summer (2000), Arkansas Nuclear One Unit 1 (2001), Davis Besse (2002), and Wolf Creek (2006), among others. Many plants have systematically replaced components fabricated from the nickel-based Alloy 600 and Alloy 82 or 182 weld metals with higher chromium-content alloys, which are considered to be more resistant to PWSCC, particularly Alloy 690 and variants of Alloy 52 and 152 weld metals.

The evolution of PWSCC can be divided into periods of initiation and propagation. During the initiation period, processes such as the rupture of passive oxide film and internal (grain boundary) oxidation serve as precursors to the formation of macroscopically stable cracks. During the propagation period, the crack growth is affected by the electro chemical and mechanical (stress-related) interactions. While the initiation period may be much longer than the propagation period for a plant component, most NRC research to date has focused on crack propagation because staff assumes the presence of a postulated initial flaw to evaluate relief requests and to develop regulatory technical bases for inspection frequencies. Probabilistic approaches incorporating consideration of PWSCC initiation, such as EPRI MRP-105 and MRP-113, were reviewed by the NRC staff and were not accepted. To better understand the process of crack initiation, several organizations, including the DOE, Knolls Atomic Power Laboratory (KAPL), and international groups have pursued more robust initiation testing programs, but data are still limited and have not led to well-supported analytical models that could be used to predict the time to crack initiation after a component enters service.

The development of the Extremely Low Probability of Rupture (xLPR) computational code by NRC and the Electric Power Research Institute, however, has highlighted the need for additional data to support model assumptions. Data may also support the technical bases for new inspection requirements for nickel-based alloy components. The NRC is seeking testing plans and equipment (destructive and nondestructive examination) capable of producing viable (as defined by reproducibility, and the identification and/or establishment of accuracy, precision, and bias) data to further develop xLPR. This data may include, but is not limited to, effects of cold work; effects of the dilution zone of alloying element; and, the effects of surface morphology on crack initiation time distribution.

2. Objective

The objective of this program is to obtain PWSCC initiation data for reactor component nickel-based alloys, including Alloys 600/82/182 and Alloys 690/52/152. The data will support the development of the xLPR code and the technical bases for formulating inservice inspection requirements of nickel-based alloys.

3. Scope of Work

PNNL shall be responsible for submitting a plan for designing the experimental apparatus and test plan; procuring necessary materials and components, including dedicated data capture and analysis capability; assembling; and pre-testing the equipment and data acquisition and analysis (systems) for viability in carrying the test plan. Section 4 of this statement of work describes these tasks in greater detail.

The general scope is divided into the following tasks:

Task 1: Design a test plan
Deliverable(s): A letter report detailing the test plan, which demonstrates testing and data viability.

Task 2: Design and assemble testing apparatus
Deliverable(s): A letter report detailing the system specifications, assembly of the apparatus, possible testing conditions, such as temperature, pressure, chemistry of the test environment, including controls, measurement and analysis test systems, and a demonstration of the system viability.

4. Specific Tasks

PNNL must perform the following tasks:

<u>Task 1: Test Plan Development</u>

Data produced under the Test Plan should address the need mentioned in Section 1 above with respect to producing viable data suitable for use in xLPR. Ultimately, the data should be able to: a) correlate with Operation Experience data; b) provide a statistical basis to provide an informed description of the distribution in crack initiation times; and, c) provide a correlation between the material variables, test variables and crack initiation times.

PNNL shall develop a test plan to meet the following requirements:

- Two (2) test machines will be used, each of which has the capability to test at least thirty (30) specimens in simulated primary water (PWR conditions). One test machine will be used for Alloys 600/82/182 and the other for Alloys 690/52/152. The test plan will describe the equipment used for the test machines and criteria for evaluating its functionality. The test equipment shall include capability to simulate reactor coolant environment (coolant loop, pressure and temperature) in a highly controlled manner.

The equipment shall also include an appropriate automatic data acquisition and analysis system, preferably with proven commercial software.

- The test plan will describe materials to be tested, including such information as alloy chemistry, heat treatment, level of cold work, surface finish, and other relevant parameters.
- The test plan will describe the experimental procedure, including specimen geometries, any applicable Standards or Codes, and must also include criteria for determining when a crack has initiated in a specimen. The test plan must include evaluations of experiments for viability, and a description of the means to do so. ASTM Standards may apply to the viability of the test plan, which should be documented in the test plan.
- The test plan must include details and expectations of the data collected. This includes, but is not limited to, means of data viability and collection of data from Operation Experience.
- The test plan will describe any planned pre- and post-test sample qualification and analysis, e.g. material examination and characterization necessary to interpret the testing results and will include microscopy and microstructural characterization.
- The test plan will propose a schedule for conducting the tests, based on previous PNNL experience with initiation testing of these alloys.

This test plan shall be furnished in a letter report consistent with NRC document guidelines, and must detail assumptions, expectations, potential issues and research gaps, and the justifications for each.

Task 2: Construction and Viability of Test Machines

PNNL shall design, procure materials and components, assemble, and prove the viability of testing equipment (systems) capable of carrying out the Test Plan as described in Task 1. Two (2) systems shall be constructed for crack initiation testing, each with the capability to test at least thirty (30) concurrent specimens. PNNL shall also design and implement a program to prove as-designed efficacy. PNNL shall submit a letter report detailing the system viability, including details of, and justifications for, any major assumptions within the testing system. ASTM Standards may apply to the viability of the system, which should be documented in the letter report. Additionally, PNNL shall provide the necessary staff to service and maintain the testing systems, as needed, for the proper function of such systems.

5. Technical and Other Special Qualifications Required

This project requires unique knowledge of the metallurgy and PWSCC behavior of nickel-based alloys used for nuclear reactor components, including the effects of temperature, stress level, thermo-mechanical processing, microstructure, chemical composition, and welding parameters. Prior experience with PWSCC testing is also required to plan, design, assemble, and prove viability of suitable test assemblies and demonstrate the ability to acquire and interpret test data.

6. Deliverables and/or Milestones SCHEDULE

Deliverable Number	**Deliverable/Milestone Description** (include NRC acceptance criteria if applicable)	Due Date *(if any)*
1	PNNL shall create and provide a test plan.	Within three (3) months of the contract award
2	PNNL shall design, assemble, and prove the viability of testing equipment suitable for crack initiation testing	Within twelve (12) months of the contract award
3	PNNL shall provide a report detailing the as-built equipment setup and viability	Within one (1) month of completion of Deliverable 2

7. Meetings and Travel

Project Related Travel

Travel Description for FY 2014-2016	**Location**	**Date**	**Days**	**Number of Attendees**
FY 2015				
Program Review at NRC	Rockville, MD	June 2015	2	1

All travel requires written Government approval from the CO, unless otherwise delegated to the COR.

Foreign travel for PNNL personnel requires a 60-day lead time for NRC approval. For prior approval of foreign travel, PNNL shall submit an

NRC Form 445, “Request for Approval of Official Foreign Travel.” NRC Form 445 is

available in the MD 11.7 Documents library and on the NRC Web site at:

http://www.nrc.gov/reading-rm/doc-collections/forms/. Foreign travel is approved by the NRC Executive Director for Operations (EDO).

8. Reporting Requirements

PNNL is responsible for structuring the deliverable to follow agency standards. The current agency standard is Microsoft Office Suite 2010. The current agency Portable Document Format

(PDF) standard is Adobe Acrobat 9 Professional. Deliverables must be submitted free of spelling and grammatical errors and conform to requirements stated in this section.

Monthly Letter Status Reports

In accordance with Management Directive 11.7, NRC Procedures for Placement and Monitoring of Work with the U.S. Department of Energy, PNNL must electronically submit a Monthly Letter Status Report (MLSR) by the 20th day of each month to the Contracting Officer Representative (COR) with copies to the Contracting Officer (CO) and the Office Administration/Division of Contracts to ContractsPOT.Resource@nrc.gov. If a project is a task ordering agreement, a separate MLSR must be submitted for each task order with a summary project MLSR, even if no work has been performed during a reporting period. Once NRC has determined that all work on a task order is completed and that final costs are acceptable, a task order may be omitted from the MLSR.

The MLSR must include the following: agreement number; task order number, if applicable; job code number; title of the project; project period of performance; task order period of performance, if applicable; COR's name, telephone number, and e-mail address; full name and address of the performing organization; principal investigator's name, telephone number, and e-mail address; and reporting period.

In addition to the Monthly Letter Status Reports, PNNL shall also submit documents as described in the above Tasks, using the guidance for MLSRs when applicable.

9. Contracting Officer's Representative

The COR monitors all technical aspects of the agreement/task order and assists in its administration. The COR is authorized to perform the following functions: assure that PNNL performs the technical requirements of the agreement/task order; perform inspections necessary in connection with agreement/task order performance; maintain written and oral communications with PNNL concerning technical aspects of the agreement/task order; issue written interpretations of technical requirements, including Government drawings, designs, specifications; monitor PNNL's performance and notify PNNL of any deficiencies; coordinate availability of NRC-furnished material and/or GFP; and provide site entry of DOE Laboratory personnel.

Contracting Officer's Representative

Name: Matthew Rossi

Agency: U.S. Nuclear Regulatory Commission

Office: Nuclear Regulatory Research, Division of Engineering, Corrosion and Metallurgy

Mail Stop: CSB 05C07

Washington, DC 20555-0001

E-Mail: matthew.rossi@nrc.gov

Phone: (301) 251-7646

Alternate Contracting Officer's Representative

Name: Greg Oberson

Agency: U.S. Nuclear Regulatory Commission

Office: Nuclear Regulatory Research, Division of Engineering, Corrosion and Metallurgy

Mail Stop: CSB 05A24

Washington, DC 20555-0001

E-Mail: greg.oberson@nrc.gov

Phone: (301) 251-7675

10. MATERIALS REQUIRED

PNNL shall be responsible for purchasing all equipment associated with Task 2. However, the specific details of this equipment are at the discretion of PNNL, due to the custom nature of the testing system.

11. NRC-Furnished Property/MATERIALS

N/A

12. RESEARCH QUALITY

N/A

13. STANDARDS FOR CONTRACTORS WHO PREPARE NUREG-SERIES MANUSCRIPTS

N/A

14. OTHER CONSIDERATIONS

N/A

References

N/A

Access to Non-NRC Facilities/Equipment

N/A

Applicable Publications

N/A

Controls over document handling and non-disclosure of materials

N/A

MONTHLY LETTER STATUS REPORT

Reporting Period Start Date **March 28, 2015**	**Reporting Period End Date** **April 24, 2015**	
NRC Agreement Number **NRC-HQ-60-14-D-0014**	**Task Order Number (if applicable)** **N/A**	**Common Cost Center Code**
Project Title **Crack Initiation Testing for Primary Water Stress Corrosion Cracking**		
Period of Performance Start Date **August 18, 2014**	**Period of Performance End Date** **October 31, 2015**	
COR **Eric Focht**	**Telephone** **(301) 251-7649**	**E-mail** **eric.focht@nrc.gov**
DOE Laboratory **Pacific Northwest National Laboratory (PNNL)**		
DOE Site Address **Pacific Northwest Site Office, PO Box 350/MS K9-42, Richland, WA 99352**		
Principal Investigator **Stephen Bruemmer**	**Telephone** **(509) 371-7361**	**E-mail** **stephen.bruemmer@pnnl.gov**

Financial Status Section

A. Overall Funding

Current Monthly Costs:	$57,871
Total Ceiling Amount:	$985,000
Total Amount of Funds Obligated to Date:	$984,638
Total Amount of Funds Expended to Date:	$610,175
Percentage of Funds Expended to Date:	62%
Balance of Obligated Funds Remaining:	$374,463
Total Estimated Encumbered Costs:	$142,441
Balance Available Less Estimated Encumbered Costs:	$232,022

B. DOE Laboratory Acquired Property

No single item costing more than $5,000 was received this month. The autoclave and the remaining portion of the load train are the two most expensive items and are not expected to arrive until the end of April or early May.

Description*	Quan.	Manufacturer	Model Number	Serial Nums.	Tot. Acq. Cost ($)	Receipt Date	Property Identification Number

* Asterisk is to be added to item description to indicate sensitive software.

C. NRC-Funded Software Developed

Nothing in this area.

Name*	Function	Development Cost ($)	Computer Language Used	Operating System	Location of System	Date Software Completed	Date of Scheduled Replacement/Useful Life
N/A							

*Asterisk is to be used to indicate sensitive software.

Technical Status Section

A. Deliverables/Milestones Schedule

Deliverable	Description	Planned Completion Date	Revised Completion Date (if applicable)	Actual Completion Date
1	Test plan will be completed and submitted to the NRC for review.	Within 3 months of the contract award	not applicable	11/19/2014
2	Two SCC initiation test systems will be designed and assembled, and test viability demonstrated.	Within 12 months of the contract award	on track	
3	A technical letter report will be submitted to the NRC detailing the test equipment and capabilities for SCC initiation experimentation.	Within one 1 month of completion of Deliverable 2	on track	

B. Progress During Reporting Period

Task 1 - Identification and Acquisition of Materials for the Test Matrix

Overview of Material Requirements

For the current draft test plan, one autoclave is expected to be dedicated to alloy 600/182 tests and the other for alloy 690/152/52(x) tests. Each autoclave can hold 36 specimens. The tentative loading plan for these autoclave systems is as follows:

Alloy 600/182 autoclave

- First loading: Four different alloy 182 welds. For each weld, there will be 6 specimens in the 15% CF condition and 3 in the as-welded condition.
- Second loading: Stress effects will be considered with specimens loaded to a fraction of the yield stress. Current plan is the same four alloy 182 welds, all in a 15% CF condition. Exact number of specimens for each weld is to-be-determined.
- Third loading: Four heats of alloy 600. Each heat will have 9 specimens in the 15% CF condition.

Alloy 690/152/52(x) autoclave

- First and only loading: Four heats of alloy 690 with 3 specimens per heat and four heats of alloy 152/52(x) with six specimens per heat. All specimens will be in the 15% CF condition.

Progress on Acquisition of Materials and Forging

The candidate four heats/welds for each class of material are shown in Table 1. Items in bold red are still being acquired. The KAPL weld, G.O. Carlson alloy 600, and a second piece of the ENSA DPM alloy 52M arrived this month. The only material yet to be delivered is the EPRI alloy 152M V-groove that is expected in July.

Table 1. Candidate heats/welds for each class of material.

Alloy 182	
NRC/PNNL Phase 2B DMW Mockup	NRC/PNNL Flawtech DMW Mockup
Studsvik Buildup	KAPL U-Groove
Alloy 600	
Spec. Met. NX6106XK-11 MA Plate	ATI 522068 MA Bar
G.O. Carlson 33375-2B MA Plate	WNP5 CRDM Tube
Alloy 152/52	
MHI Alloy 152 U-Groove Mockup	MHI Alloy 52 U-Groove Mockup
ENSA DPM Alloy 52M Butter	**EPRI Alloy 152M V-Groove**
Alloy 690	
Valinox RE243 TT CRDM Tube	Valinox WP142 TT CRDM Tube
TK-VDM 114092 TT Plate	Allvac B25K-2 MA Bar

Roughly 50 blocks need to be prepared and forged for this program. Rather than preparing and forged all the blocks at once, the work is being broken down in to smaller overlapping groups. It is anticipated that three rounds of preparation and forging will be required to obtain sufficient material for all the specimens that are needed. Two rounds of forging have been completed with photos of each set of forged material shown in Figures 1-4. A third round of forging will take place in June or early July to forge the alloy 182 KAPL U-groove weld and the G.O. Carlson 33375-2B alloy 600 plate material. The goal is to have all the materials needed by the end of July for the first SCC initiation loadings (alloy 182 and alloy 690/152/52 materials).

A summary of all materials acquisitions and forging activities is listed in the attached table at the end of the document.

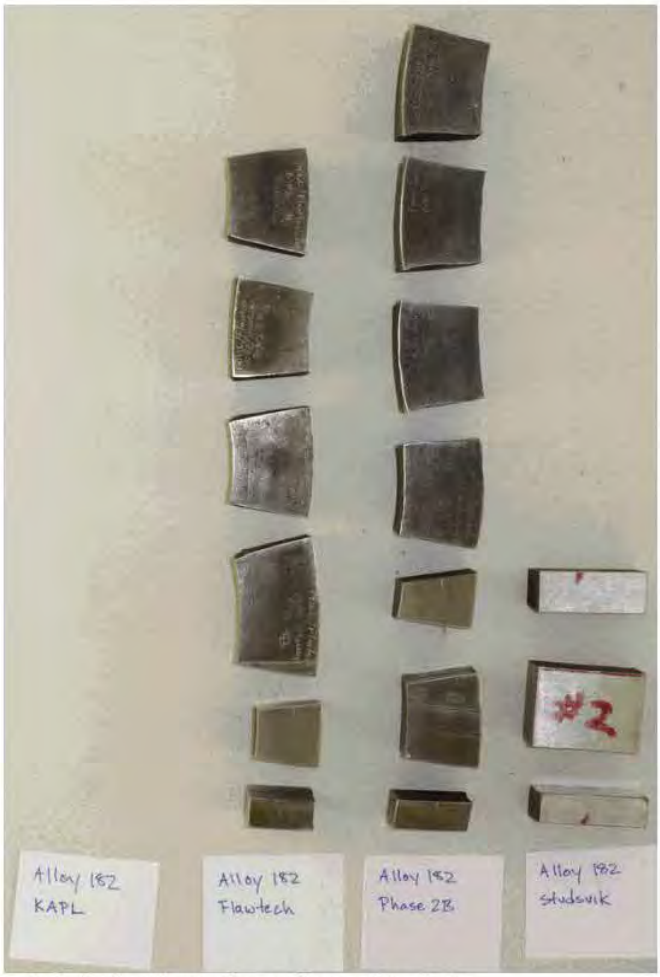

Figure 1. Alloy 182 materials that have been forged to-date.

Figure 2. Alloy 600 materials that have been forged to-date.

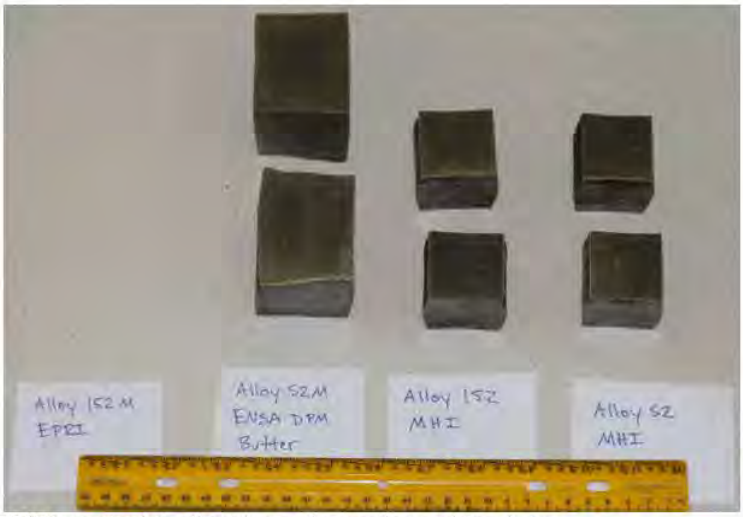

Figure 3. Alloy 152/52 materials that have been forged to-date.

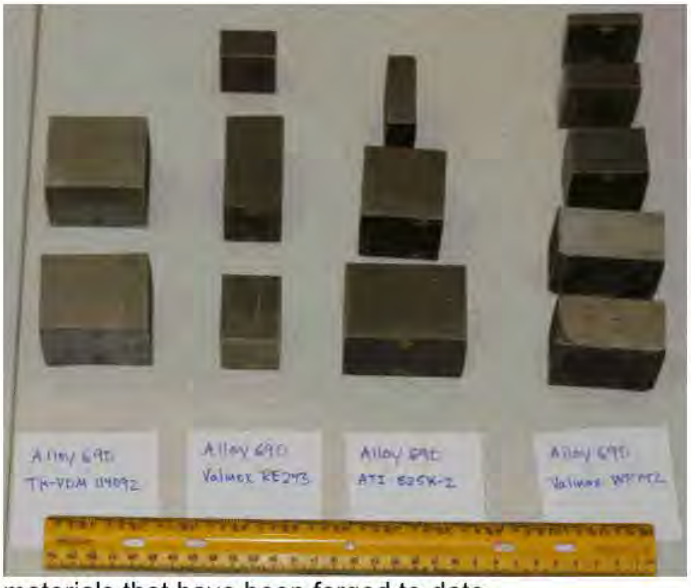

Figure 4. Alloy 690 materials that have been forged to-date.

Material Characterizations

As part of materials characterization activities, SCC CGR tests have been or will be performed on the materials to determine the range of SCC crack growth susceptibility. While SCC initiation is not expected for the alloy 690/152/52 materials, SCC crack growth susceptibility is important to assess to help understand whether the materials being tested are representative. Among the alloy 690/152/52 materials that have been selected for this study, all but the ENSA DPM alloy 52M butter and the EPRI alloy 152M V-groove have been SCC tested in their as-made condition.

All of the alloy 600/182 materials are expected to be SCC crack growth rate tested in their as-made condition. The alloy 600 NX6106XK-11, the Flawtech alloy 182, and the Studsvik alloy

182 are all currently being SCC CGR tested and are showing average or high SCC susceptibility. Testing of the Phase 2B alloy 182 and the KAPL alloy 182 is expected to be begin in early June. Since the alloy 600 materials will not undergo SCC initiation until later in the program, their susceptibility will be assessed after starting the initiation tests on the alloy 690/152/52 and alloy 182 materials.

Other characterization activities include determining the hardness and yield strength of the cold-forged materials and surveying the microstructures of all the materials. For the welds, the microstructure survey will include determination of the flaw concentration, if any. Optical metallography, SEM examinations, hardness measurements, and YS measurements are all underway.

Task 2 - Develop Experimental Test Plan

A suggested test plan was completed and submitted on time. Comments have been received back from an expert panel that has reviewed the proposal. Responses to these comments were prepared and provided to the NRC and EPRI in February. After discussions with the NRC and EPRI in March, the test plan document was revised and submitted to the NRC for a second round of review. After receiving any final comments from the NRC, the test plan will be provided to EPRI for comment, and then presumably it will go back to the Expert Panel for any final comment.

Task 3 - Design, Construction, and Validation of SCC Initiation Test Systems

Overview

These test systems will be closely based on a 36 tensile specimen test system designed and constructed for the DOE-NE LWRS program. The DOE-NE LWRS system can monitor 12 specimens for in-situ SCC initiation. The key design change underway for the new systems is increasing the number of specimens that can be instrumented for in-situ detection of SCC initiation or for in-situ detection of failure. A larger diameter autoclave with more ports for wiring feedthroughs is being designed and constructed to enable this. Changes are also being made to the load line and the wiring feedthroughs to make the task of instrumenting all 36 specimens potentially manageable.

The test systems are built in-house at PNNL using a combination of off-the-shelf and custom-made parts. Each test system is constructed of ~140 unique parts from ~30 different vendors. A spreadsheet showing the status of all items needed to build the test system is attached at the end of this document.

Laboratory expansion is needed to make room for these two new test systems along with two more test systems for another NRC program. A lab adjacent to the current SCC lab has been made available for this. New electrical drops, specialty gas drops, pressure relief lines, and chilled water lines be installed, and an increase in room ventilation is also needed to accommodate the waste heat released by the test systems. Since this new lab space has a low ceiling that cannot accommodate the large multi-specimen initiation test systems, several existing SCC CGR test systems, which are not as tall, will be moved into the new lab space, and the new multi-specimen SCC initiation systems will be installed in the existing SCC lab.

The first phase of the test system assembly involves fabricating major components such as the heater controllers and load frames. This work is all being done in-house by PNNL crafts.

The second phase of test system assembly will include having the pipefitters install the stainless steel tubing, filtration equipment, and glass columns on to each water board. This will be followed by installation of the high pressure pumps. Research staff, with assistance from crafts support, will install the autoclaves and servo electric load frame in the test frames. Research staff will also finish installing the electronics into each electronics rack. The goal for completing the second phase is late March.

In order to begin the second phase of test system assembly, two of the existing SCC CGR test systems in the current lab space will have to be moved into the new lab space being constructed adjacent to the existing one. If completion of the new lab space gets delayed, it may be necessary to either delay assembly of the new SCC initiation test systems, or move the existing SCC CGR test systems into temporary storage while the new lab space is being completed. Discussion with NRC project managers may be needed to determine the appropriate action.

The final stages of assembly will include installation of the load train, installation of the DCPD wiring, and making all the connections from the electronics rack to either the test frame or waterboard. Each system will then be ready to shakedown testing. Activities were will include leak-checking of all stainless steel connections, programming the heater and chilled water controllers, loading autoclave with dummy specimens, heating autoclave and preheater up to operating temperatures, and checking the servo-electric load frame and DCPD system for proper operation. These steps to completion of assembly are summarized in Table 1.

Updates

All of the test system components have been ordered, and roughly 98% of those components have been delivered to PNNL. The most expensive item that has yet to be received is the autoclave. Receipt of the autoclave was expected in April, however the manufacturer recently advised PNNL that the delivery date had slipped to May due to more rapid tool wear than anticipated when fabricating this very large autoclave. Construction of the test system continues with current progress shown in Figure 5. Table 2 shows the timeline for all the activities needed to complete the test systems.

Figure 5. Construction progress for the two multispecimen SCC initiation test systems at PNNL.

Table 2. Timeline for assembly of the SCC initiation test systems.

Activity	Planned Start	Actual Start	Planned Completion	Actual Completion	Comments
Order Parts Components	9/1/14	9/1/14	12/31/14	3/27/15	Completed
Phase 1 System Assembly	12/1/14	12/1/14	1/31/15	3/13/15	Completed
Lab Mods	2/1/15	2/23/15	3/1/15	4/10/15	Completed
Phase 2 System Assembly	1/31/15-3/1/15	est. 4/13/15	4/1/15	est. 5/29/15	
Final System Assembly	4/1/15	est. 6/1/15	5/1/15	est. 7/15/15	
Shakedown Testing	5/1/15	est. 7/15/15	6/10/15	est. 8/15/15	
First Project Test Setup	6/10/15	est. 9/1/15	7/1/15	est. 9/15/15	
First SCC Initiation Tests	7/1/15	est. 9/30/15	1/1/16	est. 4/1/16	

C. Travel

None.

D. Description of Estimated Encumbered Costs

Encumbered costs for this month represent items that have been ordered but not yet received. Expected receipt dates are on schedule.

Type	PO No.	Vendor	Description	Burdened Commitment
B2B	251240	Pacific Office Solutions	Misc Parts	$90
B2B	256825	Grainger Industrial	Drop-In Anchor Non-Flange Type Material	$40
BNW Procurements	247979	High Pressure Equip Co	Autoclave	$98,797
BNW Procurements	252254	Advanced Industrial	Bushings for Specimens ends	$1,952
BNW Procurements	255719	Applied Test Systems	Misc parts such as: End link, Threaded Ball, Socket Bushing, Post Bolt, Socket Plate, Rod Support, Top support plate, Tri-arm etc.	$31,268
Subcontracts	251544	General Electric Global	Cold Forging of Materials for initiation test specimens	$10,295
		Commitments as of 4-24-15		$142,441

E. Anticipated and Encountered Problem Areas

None.

F. Plans for the Next Reporting Period

Task 1 - Materials acquisitions and forging will continue with the majority of the effort directed at having additional materials forged. Work will continue for characterizing SCC response of alloy 182 and alloy 600 to aid in material selection.

Task 2 - Original scope complete and test plan revisions have been made. Revised draft currently at NRC for comment and then will go to EPRI and Expert Panel.

Task 3 - Parts acquisition and test system construction will continue.

Travel and Meetings - None planned.

Spending Plan

Month/Year	13-Oct	13-Nov	13-Dec	14-Jan	14-Feb	14-Mar	14-Apr	14-May	14-Jun	14-Jul	14-Aug	14-Sep
Planned ($)											100,000	580,638
Revised ($)											0	21,936
Actual ($)											0	21,936
Variance (%)											0.00%	0.00%
Month/Year	**14-Oct**	**14-Nov**	**14-Dec**	**15-Jan**	**15-Feb**	**15-Mar**	**15-Apr**	**15-May**	**15-Jun**	**15-Jul**	**15-Aug**	**15-Sep**
Planned ($)	0	0	0	60,000	60,000	50,000	40,000	30,000	20,000	15,000	15,000	14,362
Revised ($)	71,694	55,422	143,260	140,515	54,635	64,843	65,000	65,000	65,000	70,000	65,000	55,000
Actual ($)	71,694	55,422	143,260	140,515	54,635	64,843	57,871					
Variance (%)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-10.97%					
Month/Year	**15-Oct**											
Planned ($)	0											
Revised ($)	47,696											
Actual ($)												
Variance (%)	-100.00%											
TOTAL												
Planned ($)	**985,000**											
Revised ($)	**985,000**											
Actual ($)	**610,175**											

Variance Narrative - None.

NRC/EPRI SCC Initiation Program Materials Matrix as of 4/24/2015.

Alloy Class and Material Name	Top 4 Candidate?	Reason	Description/Form	Dimensions	Alloy Vendor	Heat Number	CMTR?	Weld Fabricator	WPS	At PNNL?	Number of Possible Specimens	Microstructure Characterized?	Have SCC CGR Data?	# CF Initiation Specimens Needed	# CF CT Specimens Needed	# CF Initiation Specimens Per Block	# CF Blocks Needed	Number of Blocks Forged	Additional Forged Blocks Needed	CF Slice removed for Met, EBSD, HV?
Alloy 182																				
PNNL/NRC Phase 2B Mockup	**yes**	**well-documented mockup**	LAS-SS DMW with alloy 182 butter and fill	circumferential pipe buttweld, 15" OD x 1.5" wall	TBD	TBD	TBD	EWI	yes	yes	50	no	preparing to machine AW CTs	18	1	3	7	7	**0**	complete
PNNL/Flawtech/NRC Mockup	**yes**	**well-documented mockup**	LAS-SS DMW with alloy 182 butter and fill	circumferential pipe buttweld, 14" OD x 1.5" wall	Spec. Met.	844305	yes	Flawtech	yes	yes	90	no	in-progress	18	1	3	7	7	**0**	complete
Studsvik	**yes**	**well-documented mockup**	alloy 182 buildup	3"tall x 2.75" x 5"long	TBD	TBD	TBD	ENSA	yes	yes	64	no	in-progress	18	1	10	2	2	**0**	complete
KAPL	**yes**	**well-documented mockup**	alloy 182 U-groove	1.5"wide x 1.5"tall x 8"long	Techalloy	823030	yes	KAPL	yes	yes	25	no	preparing to machine AW CTs	18	1	6	4	0	**4**	planned
EPRI weld	?		alloy 182 U-groove	TBD	TBD	TBD	yes	TBD	yes	no	TBD	no	no	TBD						
CRDM J-groove	no	too challenging to forge and extract initiation specimens	alloy 182 J-groove from dismantled partially built PWR	8.15" ID x 0.XX" thick x XX"tall	unknown	unknown	no	unknown	no	yes	none	no	no							
Alloy 600																				
PNNL Plate #1 (MA)	**yes**	**prior SCCI data from LWRS**	2" thick plate	9.6x15x2" thick	Spec. Met.	NX6016XK-11	yes	N/A	N/A	yes	300	Met, SEM, TEM	in-progress	12	1	6	3	3	**0**	complete
PNNL Plate #3 (MA)	**yes**	**using for NRC Peening program**	3" thick plate	3x18x3" thick	ATI	522068	yes	N/A	N/A	yes	50	Met	preparing to machine AW CTs	12	1	6	3	3	**0**	planned
KAPL Plate (MA)	**yes**	**vintage material**	vintage 2" thick plate	4x12x2" thick	G.O. Carlson	33375-2B	yes	N/A	N/A	yes	50	no	planned	12	1	6	3	0	**3**	planned
CRDM Tube	**yes**	**service material**	From dismantled partially built PWR	4.15"OD x 0.70" wall x 8" long	unknown	unknown	no	N/A	N/A	yes	50	Met	preparing to machine AW CTs	12	1	5	2	2	**0**	planned
Forori Bar	no	under consideration	6" dia. bar	6" OD x 12" long	Forori	31507	yes	N/A	N/A	expected 05/2015	100	Met	no							planned
PNNL Plate #2 (MA)	no	other better candidates	2" thick plate	9x24x2" thick	ATI	521616	yes	N/A	N/A	yes	300	Met	no					3		
Alloy 152/52																				
MHI alloy 152 U-groove	**yes**	**have SCC CGR data**	U-groove weld joining SS	1.8"tall x 2"wide x 2.5" long	TK-VDM?	307380	yes	MHI	yes	yes	15	Met, SEM	yes	9	2	6	2	2	**0**	planned
MHI alloy 52 U-groove	**yes**	**have SCC CGR data**	U-groove weld joining SS	1.8"tall x 2"wide x 2.5" long	Spec. Met.	NX2686JK	yes	MHI	yes	yes	15	Met, SEM	yes	9	2	6	2	2	**0**	planned
ENSA DPM alloy 52M butter	**yes**	**sufficient material available**	Double bevel 690-LAS DMW, alloy 52M butter	0.75"tall x 2.7"wide x 4" long	unknown	unknown	no	ENSA	yes	yes	20	Met, SEM	no	9	2	3	4	2	**2**	planned
EPRI alloy 152M	**yes**	**favorable geometry, sufficient material**	TBD	TBD	TBD	TBD	yes	TBD	yes	expected 07/2015	TBD	no	no	9	2	3	4	0	**4**	planned
KAPL alloy 52M NG	no	too narrow	narrow gap weld joining alloy 690	1.8"tall x 0.5"wide x 1.1" long	Spec. Met.	NX5286TX	yes	KAPL	yes	yes	6	no	yes							
EPRI alloy 52i	no	not enough material	V-groove weld	1.8"tall x 0.75"-1.75"wide x 1.5" long	TK-VDM	183773	yes	unknown		yes	9	no	no					1		
ENSA DPM alloy 52 fill	no	alloy 52 with prior SCC experience already identified	Double bevel 690-LAS DMW, alloy 52 fill	1.5"tall x 0.5"-1.8"wide x 4" long	Spec. Met.	NX4156JK	yes	ENSA	yes	yes	20	Met, SEM	in-progress					1		
NRC alloy 52MSS NG	no	too narrow	narrow gap weld joining alloy 690	2"tall x 0.4-0.6" wide x 2.8" long	Spec. Met.	NX17W3DK	yes	PCI	yes	yes	TBD	no	yes							
Alloy 690																				
Valinox Alloy 690 CRDM RE243 (TT)	**yes**	**significant SCC CGR data**	CRDM	4.4"OD x 1.35"wall x 6" long	Valinox	RE243	no	N/A	N/A	yes	>20	Met, SEM, TEM, APT	yes	9	1	6	2	2	**0**	complete
Valinox Alloy 690 CRDM WP142 (TT)	**yes**	**have SCC CGR data, and substantial material**	CRDM	4.56"OD x 1.20"wall x 4" long	Valinox	WP142	no	N/A	N/A	yes	>20	Met, SEM, TEM	yes	9	1	6	2	2	**0**	complete
TK-VDM 114092 plate (TT)	**yes**	**have SCC CGR data**	plate	2"tall x 4"wide x 2.5" long	TK-VDM	114092	yes	N/A	N/A	yes	>20	Met, SEM, TEM	yes	9	1	6	2	2	**0**	planned
ATI/Allvac B25K-2 (MA)	**yes**	**have SCC CGR data**	plate	3"thick x 5.5"wide x 2.2" long	ATI/Allvac	B25K-2	yes	N/A	N/A	yes	>20	Met, SEM, TEM	yes	9	1	6	2	2	**0**	complete
Doosan CRDM bar (TT)	no	insufficient material for additional tests	CRDM	8"OD x 2.5" long	TI-VDM	133458	yes	N/A	N/A	yes	18	Met, SEM, TEM	yes					3		
EPRI NX8625HG21 (TT)	no	no SCC data, other better candidates	plate	13x13x1.5" thick	Spec. Met.	NX8625HG21		N/A	N/A	yes	>20	Met	no							

MONTHLY LETTER STATUS REPORT

Reporting Period Start Date **November 22, 2014**		**Reporting Period End Date** **December 26, 2014**
NRC Agreement Number **NRC-HQ-60-14-D-0014**	**Task Order Number (if applicable)** **N/A**	**Common Cost Center Code**
Project Title **Crack Initiation Testing for Primary Water Stress Corrosion Cracking**		
Period of Performance Start Date **August 18, 2014**		**Period of Performance End Date** **October 31, 2015**
COR **Eric Focht**	**Telephone** **(301) 251-7649**	**E-mail** **eric.focht@nrc.gov**
DOE Laboratory **Pacific Northwest National Laboratory (PNNL)**		
DOE Site Address **Pacific Northwest Site Office, PO Box 350/MS K9-42, Richland, WA 99352**		
Principal Investigator **Stephen Bruemmer**	**Telephone** **(509) 371-7361**	**E-mail** **stephen.bruemmer@pnnl.gov**

Financial Status Section

A. Overall Funding

Current Monthly Costs:	$143,260
Total Ceiling Amount:	$985,000
Total Amount of Funds Obligated to Date:	$850,638
Total Amount of Funds Expended to Date:	$292,312
Percentage of Funds Expended to Date:	34%
Balance of Obligated Funds Remaining:	$558,326
Total Estimated Encumbered Costs:	$213,427
Balance Available Less Estimated Encumbered Costs:	$344,899

B. DOE Laboratory Acquired Property

Two items were received this month that were more than $5,000 as listed below. Smaller items with shorter lead times have been arriving as well. Many of the more expensive items will arrive in January and are expected to be costed in February. The autoclave and the load train are the two most expensive items and are not expected to arrive until the end of February.

Description*	Quan.	Manufacturer	Model Number	Serial Nums.	Tot. Acq. Cost ($)	Receipt Date	Property Identification Number
High Pressure Metering Pump, Pulsa Series 7440	2	Unit Process Company	7440-S-E, Flat Diaphragm, 316 SS, 8 GPH, 3200 PSI, 175 SPM, Flat Teflon	AB976791-1, AB976791-2	$13,892	12/10/2014	To be assigned during test system construction (in about two months).

* Asterisk is to be added to item description to indicate sensitive software.

C. NRC-Funded Software Developed

Nothing in this area.

Name*	Function	Development Cost ($)	Computer Language Used	Operating System	Location of System	Date Software Completed	Date of Scheduled Replacement/Useful Life
N/A							

*Asterisk is to be used to indicate sensitive software.

Technical Status Section

A. Deliverables/Milestones Schedule

Deliverable	Description	Planned Completion Date	Revised Completion Date (if applicable)	Actual Completion Date
1	Test plan will be completed and submitted to the NRC for review.	Within 3 months of the contract award	not applicable	11/19/2014
2	Two SCC initiation test systems will be designed and assembled, and test viability demonstrated.	Within 12 months of the contract award	on track	
3	A technical letter report will be submitted to the NRC detailing the test equipment and capabilities for SCC initiation experimentation.	Within one 1 month of completion of Deliverable 2	on track	

B. Progress During Reporting Period

Task 1 - Identification and Acquisition of Materials for the Test Matrix

Overview of Material Requirements

One autoclave is expected to be dedicated to alloy 600/182 tests and the other for alloy 690/152/52(x) tests. Each autoclave can hold 36 specimens. The tentative loading plan for these autoclave systems is as follows:

Alloy 600/182 autoclave

- First loading: Four heats of alloy 182. Each heat will have 6 specimens in the 15% CF condition and 3 in the as-welded condition.
- Second loading: Same four heats of alloy 182. Stress effects will be considered. Exact number of specimens for each heat of material is to-be-determined.
- Third loading: Four heats of alloy 600. Each heat will have 9 specimens in the 15% CF condition.

Alloy 690/152/52(x) autoclave

- First and only loading: Four heats of alloy 690 with 3 specimens per heat and three heats of alloy 152/52(x) with six specimens per heat. All specimens will be in the 15% CF condition.

Acquisition of Materials

Efforts to obtain sufficient amounts of all the necessary types of materials are underway. Desired heats of materials or weldments have already been identified with most materials already obtained. For this month, additional alloy 600, alloy 152, and alloy 52 have been acquired. Still in the process of obtaining additional alloy 690 plate from EPRI, and in discussion with EPRI on fabrication of an alloy 152M weldment. A summary of all materials acquisitions is as follows with updated items shown in blue.

Alloy 182 Material Acquisition: Goal is to obtain 4 separate alloy 182 welds, possibly obtain and assess additional welds to select "best" set of 4.

(1) PNNL/NRC Phase 2B Mockup Weld - LAS-SS DMW with alloy 182 butter and fill. Can extract 3.3 specimens/inch of arc length. >15" available = ~50 specimens. *In possession of weldment.*

(2) PNNL/Flawtech/NRC Pipe Weld Mockup - LAS-SS DMW with alloy 182 butter and fill. Can extract 0.36 specimens/deg of arc length. ~270 degrees available = ~97 specimens. *In possession of weldment.*

(3) Studsvik Weld from EPRI - 3x2.75x5" long linear weld. Can obtain 8 specimens/0.6" = 64 specimens. *In possession of weldment.*

(4) KAPL Mockup Weld for PNNL - Alloy 182 joining alloy 2" tall 600 plate. Can extract 2 specimens/0.6" of length. ~8 inches available = ~25 specimens. *Available in Feb. 2015.*

(5) PNNL CRDM J-Groove weld - Taken from an uncommissioned PWR. *Determining the feasibility of extracting weld material for initiation specimens.*

(6) EPRI Alloy 182 Weld - Being fabricated by WRTC (Greg Fredrick). Completion date unknown. *Determining availability.*

Alloy 600 Material Acquisition: Goal is for 4 separate alloy heats, one of which should be a CRDM heat.

(1) PNNL Plate #1 - Special Metals Heat NX6106XK-11 (9.6x15x2" thick). Have SCC initiation data. Preparing to obtain SCC CGR data. ~300 specimens possible. *In possession of plate. Possible material for multi-lab round robin.*

(2) PNNL Plate #2 - ATI Heat 521616 (6x24x2" thick). ~300 specimens possible. *In possession of plate. Possible material for multi-lab round robin.*

(3) PNNL Plate #3 - ATI Heat 522068 (3x18x3" thick). ~50 specimens possible. *In possession of plate.*

(4) KAPL Plate - 1995 Vintage. Heat 33375-2B (4x24x2" thick). ~200 specimens possible. *Will ship as part of KAPL alloy 182 weld, so it will be available in Feb. 2015.*

(5) Additional Plate Heats - *KAPL may have additional vintage material available.*

(6) CRDM Tube - A 10" long piece of a 4.15" OD x 0.70" wall CRDM tube from an uncommissioned PWR has been obtained. This is sufficient material to make 90 initiation specimens. *In possession of the tubing.*

Alloy 52M/152/52 Material Acquisition: Goal is to obtain 4 separate welds, possibly obtain and assess additional welds to select "best" set of 4.

(1) Alloy 152 MHI U-Groove Weld Mockup (307380) for Kewanee. Enough at PNNL for 15 specimens. Has been SCC CGR tested in as-welded and 20% CF condition. *In possession of weldment.*

(2) Alloy 52 MHI U-Groove Weld Mockup (NX2686JK). Enough for 9 specimens. Has been SCC CGR tested. *In possession of weldment.*

(3) KAPL Alloy 52M Narrow Gap Weld (NX5285TK). Enough for 6 specimens. Has been SCC CGR tested. *In possession of weldment.*

(4) Alloy 52i heat 187775 V-Groove Weldment received from EPRI (1 piece 1.75" long). Enough for 9 specimens. Not previously SCC tested. *In possession of weldment.*

(5) ENSA Divider Plate Mockup Alloy 52 DM Bevel Weld from EPRI Database. Joining alloy 690 to LAS. Alloy 52M butter and alloy 52 fill. SCC CGR testing of alloy 52 fill is underway. Enough for at least 20 specimens each from alloy 52M butter and alloy 52 fill. *In possession of weldment.*

(6) Alloy 52MSS Narrow Gap Weld. Obtained from NRC. Enough for 18 specimens. Has been SCC tested. *In possession of weldment.*

(7) EPRI Alloy 152M weld. In discussion with EPRI on weld geometry. ***ETA not yet provided.***

Alloy 690 Material Acquisition: Goal is for at least 4 separate alloy 690 heats including CRDM tubing and plate heats.

(1) Valinox Alloy 690TT CRDM Tube Heat RE243 at PNNL. Enough for >20 specimens. Has been SCC CGR tested in as-received and several different CW conditions. *In possession of tubing.*

(2) Valinox Alloy 690TT CRDM Tube. Other heats at PNNL. Enough for >20 specimens. Has been tested in as-received condition. *In possession of tubing.*

(3) TK-VDM (Doosan) Alloy 690TT CRDM Bar Heat 133454. Enough for 12 specimens. Has been SCC CGR tested in as-received and CW conditions. ***Some at PNNL, some being obtained from EPRI.***

(4) TK-VDM 114092 Plate Material. Enough for >20 specimens. Has been SCC CGR tested in as-received and CW conditions. ***In the process of obtaining from EPRI.***

(5) ATI/Allvac B25K-2 Plate Material. Enough for >20 specimens. Has been SCC CGR tested in as-received and CW conditions. *In possession of plate.*

(6) Additional Plate Material. EPRI NX8625HG21 Alloy 690TT (12"x12"x1.34" thick). Has not been SCC tested at PNNL. *In possession of plate.*

Dissimilar Metal Welds: Of possible interest to the NRC

(1) PNNL/NRC Phase 2B Mockup Weld - LAS-SS DMW with alloy 182 butter and fill. Can extract 3.3 specimens/inch of arc length. 5.5" available for DMW dilution zone studies = 18 specimens. *In possession of weldment.*

(2) ENSA Divider Plate Alloy 52 DMW Mockup - LAS-690 DMW with alloy 52M butter and fill. ***Obtaining additional material from EPRI.***

Forging of Materials

Roughly 45 blocks need to be prepared and forged for this program. Rather than preparing all the blocks and then having them all forged at once, the work is being broken down in to smaller overlapping groups. It is anticipated that three rounds of preparation and forging will be required to obtain sufficient material for all the specimens that are needed. Preparation for the first round of forging is underway. A summary of forging activities is listed below. Updated items are shown in blue.

Alloy 182 Specimen Preparation

(1) PNNL/NRC Phase 2B Mockup Weld - 6 cold-forged specimens are needed for first round of initiation testing and 2-3 needed to determine yield strength. Two blocks are being prepared. *This is sufficient material.*

(2) PNNL/Flawtech/NRC Pipe Weld Mockup - 6 cold-forged specimens are needed for first round of initiation testing and 2-3 needed to determine yield strength. Two blocks are being prepared. *This is sufficient material.*

(3) Studsvik Weld from EPRI - 6 cold-forged specimens are needed for first round of initiation testing and 2-3 needed to determine yield strength. Two blocks are being prepared. *This is sufficient material.*

(4) KAPL Mockup Weld for PNNL - *Available in Feb. 2015. Blocks for forging will be extracted when it becomes available.*

(5) PNNL CRDM J-Groove Weld - *In the process of extracting the weldment from the pressure vessel.*

(6) EPRI Alloy 182 Weld - ***Determining availability of this weldment.***

Alloy 600 Specimen Preparation

(1) PNNL Plate #1 (Special Metals Heat NX6106XK-11) - 9 cold-forged specimens are needed for initiation testing, 2-3 are needed to determine yield strength, and one CT

specimen is needed for SCC CGR characterization. Three blocks are being prepared. *This is sufficient material for all these specimens.*

(2) PNNL Plate #2 (ATI Heat 521616) - 9 cold-forged specimens are needed for initiation testing, 2-3 are needed to determine yield strength, and one CT specimen is needed for SCC CGR characterization. Three blocks are being prepared. *This is sufficient material for all these specimens.*

(3) PNNL Plate #3 (ATI Heat 522068) - *No action taken yet, but likely not needed.*

(4) KAPL Plate (Heat 33375-2B, 1995 vintage) - *Will be available in Feb. 2015. Will forge when it becomes available.*

(5) Additional Plate Heats - *No action taken, but likely not needed.*

(6) PNNL CRDM Tube - *Sectioning material for forging.*

Alloy 52M/152/52 Specimen Preparation

(1) Alloy 152 MHI U-Groove Weld Mockup (307380) for Kewanee - *No action taken yet.*

(2) Alloy 52 MHI U-Groove Weld Mockup (NX2686JK) for Kewanee - *No action taken yet.*

(3) KAPL Alloy 52M Narrow Gap Weld (NX5285TK) - *No action taken yet.*

(4) Alloy 52i heat 187775 V-Groove Weldment received from EPRI - 6 cold-forged specimens are needed for the first round of initiation testing, 2-3 are needed to determine yield strength. *One block is being prepared.*

(5) ENSA Divider Plate Mockup Alloy 52 DM Weld from EPRI DB - 6 cold-forged specimens are needed for the first round of initiation testing, 2-3 are needed to determine yield strength. *One block is being prepared. Another block will be prepared.*

(6) Alloy 52MSS obtained from the NRC - *No action taken yet.*

(7) EPRI Alloy 152M weld - *Determining availability of weldment. No action taken yet.*

Alloy 690 Specimen Preparation

(1) Valinox Alloy 690TT CRDM Tube Heat RE243 at PNNL - 3 cold-forged specimens are needed for initiation testing, 2-3 are needed to determine yield strength. *Two blocks are being prepared.* This is sufficient for all the required specimens.

(2) Valinox Alloy 690TT CRDM Tube - 3 cold-forged specimens are needed for initiation testing, 2-3 are needed to determine yield strength. *Two blocks are being prepared.* This is sufficient for all the required specimens.

(3) TK-VDM (Doosan) Alloy 690TT CRDM Bar Heat 133454 - 3 cold-forged specimens are needed for initiation testing, 2-3 are needed to determine yield strength. *One block is being prepared. A second one will be prepared.*

(4) TK-VDM 114092 Plate Material - *No action taken yet.*

(5) ATI/Allvac B25K-2 Plate Material - 3 cold-forged specimens are needed for initiation testing, 2-3 are needed to determine yield strength. *Two blocks are being prepared.* This is sufficient for all the required specimens.

(6) Additional Plate Material - *No action taken yet. Likely not needed.*

Material Characterizations

0.5T compact tension specimens are currently being machined from as-welded Phase 2B, Flawtech, and Studsvik alloy 182 material. The expectation is that these CT specimens will received back from the machine shop by mid-January and that SCC testing will begin by early February. The plan is to test two specimens in tandem and one specimen by itself.

SCC CGR tests may also be performed on the cold-forged alloy 182 material to gauge the increase in SCC initiation susceptibility.

Task 2 - Develop Experimental Test Plan

A suggested test plan was completed and submitted on time.

Task 3 - Design, Construction, and Validation of SCC Initiation Test Systems

These test systems will be closely based on a 36 tensile specimen test system designed and constructed for the DOE-NE LWRS program. The DOE-NE LWRS system can monitor 12 specimens for in-situ SCC initiation. The key design change underway is increasing the number of specimens that can be instrumented for in-situ detection of SCC initiation or for in-situ detection of failure. A larger diameter autoclave with more ports for wiring feedthroughs is being designed and constructed to enable this. Changes are also being made to the load line and the wiring feedthroughs to make the task of instrumenting all 36 specimens potentially manageable.

The test systems are built in-house at PNNL using a combination of off-the-shelf and custom-made parts. Each test system is constructed of ~140 unique parts from ~30 different vendors. A spreadsheet showing the status of all items needed to build the test system is attached at the end of this document. Ordering of the parts continued this month with the longest lead time items being ordered first.

Laboratory expansion for the new test systems is underway. A lab adjacent to the current SCC lab has been made available and is being prepared for installation of test systems. New electrical drops, specialty gas drops, pressure relief lines, and chilled water lines will need to be installed. An increase in room ventilation may also be needed to accommodate the waste heat released by the test systems. Since this new lab space is somewhat small, rather than install the large initiation test systems in it, two existing SCC CGR test systems, which are not as tall, will be moved into the lab, and the two new systems will be installed in the existing SCC lab that has more room.

As of 12/26/2014, approximately 97% of test system components have been ordered, and roughly 80% of those components have been procured. Several large orders have arrived in the past month. These include the high pressure pumps, framing for the load frames, and UPSes.

Assembly of the test systems is in the early stages with the initial work orders into crafts services for fabrication of several items. Fabrication of heater controllers for the electronics rack (to control heating and cooling of the preheater, autoclave, and building chilled water) is already underway. The carpenters and millwrights have work orders to construct the waterboards and the unistrut stands. These are the support for the glass column, filtration, and mixing loop.

Millwrights and welders will also handle the load frame fabrication and painting. These three work orders are expected to be completed by the end of January.

In order to begin the second phase of test system assembly, three of the existing SCC test systems in the current lab space will have to be moved out of the way and ideally into the new lab space being constructed adjacent to the existing one. If the new space is not complete, it may be necessary to either delay assembly of the new SCC initiation test systems, or move the existing SCC test systems into temporary storage while the new lab space is being constructed. Discussion with NRC project managers may be needed to determine the appropriate action.

The second phase of test system assembly will include having the pipefitters install the stainless steel tubing, filtration equipment, and glass columns on to each water board. This will be followed by installation of the high pressure pumps. Research staff, with assistance from crafts support, will install the autoclaves and servo electric load frame in the test frames. Research staff will also finish installing the electronics into each electronics rack. The goal for completing the second phase is late March.

The final stages of assembly will include installation of the load train, installation of the DCPD wiring, and making all the connections from the electronics rack to either the test frame or waterboard. Each system will then be ready to shakedown testing. Activities were will include leak-checking of all stainless steel connections, programming the heater and chilled water controllers, loading autoclave with dummy specimens, heating autoclave and preheater up to operating temperatures, and checking the servo-electric load frame and DCPD system for proper operation. These steps to completion of assembly are summarized in Table 1.

Table 1. Timeline for assembly of the SCC initiation test systems.

Activity	Planned Start	Actual Start	Planned Completion	Actual Completion	Comments
Order Parts Components	9/1/14	9/1/14	12/31/14		On schedule
Phase 1 System Assembly	12/1/14	12/1/14	1/31/15		Just started
Lab Mods	2/1/15		3/1/15		
Phase 2 System Assembly	1/31/15-3/1/15		4/1/15		
Final System Assembly	4/1/15		5/1/15		
Shakedown Testing	5/1/15		6/10/15		
First Project Test Setup	6/10/15		7/1/15		
First SCC Initiation Tests	7/1/15		1/1/16		

C. Travel

Mychailo Toloczko attended the EPRI PWSCC Collaboration Meeting and SCC Initiation Expert Panel Meeting in Tampa, FL where he presented and discussed the NRC/EPRI SCC Initiation test plan.

D. Description of Estimated Encumbered Costs

Encumbered costs for this month represent items that have been ordered but not yet received. Expected receipt dates are on schedule.

E. Anticipated and Encountered Problem Areas

None.

F. Plans for the Next Reporting Period

Task 1 - Materials acquisitions and forging will continue. The majority of the acquisition activities will be directed at obtaining useful amounts of alloy 152/52/52M welds. Inquiries will be made with GEG and EPRI about additional materials. The first round of blocks are expected to be sent to GEG for forging.

Task 2 - Complete.

Task 3 - Design, acquisition, and laboratory modification activities will continue. Construction of test systems is not expected to start until after January 1, 2015.

Travel and Meetings - None planned.

Spending Plan

Month/Year	13-Oct	13-Nov	13-Dec	14-Jan	14-Feb	14-Mar	14-Apr	14-May	14-Jun	14-Jul	14-Aug	14-Sep
Planned ($)											100,000	580,638
Revised ($)											0	21,936
Actual ($)											0	21,936
Variance (%)											0.00%	0.00%
Month/Year	14-Oct	14-Nov	14-Dec	15-Jan	15-Feb	15-Mar	15-Apr	15-May	15-Jun	15-Jul	15-Aug	15-Sep
Planned ($)	0	0	0	60,000	60,000	50,000	40,000	30,000	20,000	15,000	15,000	14,362
Revised ($)	71,694	55,422	130,000	100,000	120,000	120,000	100,000	80,000	60,000	50,000	40,000	35,948
Actual ($)	71,694	55,422	143,260									
Variance (%)	0.00%	0.00%	10.20%									
TOTAL												
Planned ($)	985,000											
Revised ($)	985,000											
Actual ($)	292,312											

Variance Narrative - None.

MONTHLY LETTER STATUS REPORT

Reporting Period Start Date **January 24, 2015**		**Reporting Period End Date** **February 20, 2015**
NRC Agreement Number **NRC-HQ-60-14-D-0014**	**Task Order Number (if applicable)** **N/A**	**Common Cost Center Code**
Project Title **Crack Initiation Testing for Primary Water Stress Corrosion Cracking**		
Period of Performance Start Date **August 18, 2014**		**Period of Performance End Date** **October 31, 2015**
COR **Eric Focht**	**Telephone** **(301) 251-7649**	**E-mail** **eric.focht@nrc.gov**
DOE Laboratory **Pacific Northwest National Laboratory (PNNL)**		
DOE Site Address **Pacific Northwest Site Office, PO Box 350/MS K9-42, Richland, WA 99352**		
Principal Investigator **Stephen Bruemmer**	**Telephone** **(509) 371-7361**	**E-mail** **stephen.bruemmer@pnnl.gov**

Financial Status Section

A. Overall Funding

Current Monthly Costs:	$54,635
Total Ceiling Amount:	$985,000
Total Amount of Funds Obligated to Date:	$850,638
Total Amount of Funds Expended to Date:	$487,461
Percentage of Funds Expended to Date:	57%
Balance of Obligated Funds Remaining:	$363,177
Total Estimated Encumbered Costs:	$128,963
Balance Available Less Estimated Encumbered Costs:	$234,214

B. DOE Laboratory Acquired Property

No single item costing more than $5,000 was received this month. The autoclave and the load train are the two most expensive items and are not expected to arrive until the end of February or in mid-March.

Description*	Quan.	Manufacturer	Model Number	Serial Nums.	Tot. Acq. Cost ($)	Receipt Date	Property Identification Number

* Asterisk is to be added to item description to indicate sensitive software.

C. NRC-Funded Software Developed

Nothing in this area.

Name*	Function	Development Cost ($)	Computer Language Used	Operating System	Location of System	Date Software Completed	Date of Scheduled Replacement/Useful Life
N/A							

*Asterisk is to be used to indicate sensitive software.

Technical Status Section

A. Deliverables/Milestones Schedule

Deliverable	Description	Planned Completion Date	Revised Completion Date (if applicable)	Actual Completion Date
1	Test plan will be completed and submitted to the NRC for review.	Within 3 months of the contract award	not applicable	11/19/2014
2	Two SCC initiation test systems will be designed and assembled, and test viability demonstrated.	Within 12 months of the contract award	on track	
3	A technical letter report will be submitted to the NRC detailing the test equipment and capabilities for SCC initiation experimentation.	Within one 1 month of completion of Deliverable 2	on track	

B. Progress During Reporting Period

Task 1 - Identification and Acquisition of Materials for the Test Matrix

Overview of Material Requirements

For the current draft test plan, one autoclave is expected to be dedicated to alloy 600/182 tests and the other for alloy 690/152/52(x) tests. Each autoclave can hold 36 specimens. The tentative loading plan for these autoclave systems is as follows:

Alloy 600/182 autoclave

- First loading: Four different alloy 182 welds. For each weld, there will be 6 specimens in the 15% CF condition and 3 in the as-welded condition.
- Second loading: Stress effects will be considered with specimens loaded to a fraction of the yield stress. Current plan is the same four alloy 182 welds, all in a 15% CF condition. Exact number of specimens for each weld is to-be-determined.
- Third loading: Four heats of alloy 600. Each heat will have 9 specimens in the 15% CF condition.

Alloy 690/152/52(x) autoclave

- First and only loading: Four heats of alloy 690 with 3 specimens per heat and four heats of alloy 152/52(x) with six specimens per heat. All specimens will be in the 15% CF condition.

Acquisition of Materials and Forging Progress

The candidate four heats/welds for each class of material are shown in Table 1. Items in bold red are still being acquired. The KAPL U-Groove alloy 182 and G.O. Carlson 33375-2B alloy 600 MA plate are expected to arrive at the beginning of the April reporting period. Availability of the alloy 152M V-groove is still being determined.

Table 1. The candidate heats/welds for each class of material.

Alloy 182	
NRC/PNNL Phase 2B DMW Mockup	NRC/PNNL Flawtech DMW Mockup
Studsvik Buildup	**KAPL U-Groove**
Alloy 600	
Spec. Met. NX6106XK-11 MA Plate	ATI 522068 MA Bar
G.O. Carlson 33375-2B MA Plate	WNP5 CRDM Tube
Alloy 152/52	
MHI Alloy 152 U-Groove Mockup	MHI Alloy 52 U-Groove Mockup
ENSA DPM Alloy 52M Butter	**EPRI Alloy 152M V-Groove**
Alloy 690	
Valinox RE243 TT CRDM Tube	Valinox WP142 TT CRDM Tube
TK-VDM 114092 TT Plate	Allvac B25K-2 MA Bar

Roughly 50 blocks need to be prepared and forged for this program. Rather than preparing and forged all the blocks at once, the work is being broken down in to smaller overlapping groups. It is anticipated that three rounds of preparation and forging will be required to obtain sufficient material for all the specimens that are needed. The first round of forging has been completed, and preparations for the next round of forging are underway. Blocks are being cut and are expected to be sent out for forging by the end of the next reporting period. The goal is to have all the materials needed by the end of April for the first SCC initiation loadings (alloy 182 and alloy 690/152/52 materials).

A summary of all materials acquisitions and forging activities is listed in the attached table at the end of the document.

Material Characterizations

As part of materials characterization activities, SCC CGR tests will be performed on some of the materials to determine if they have an acceptable level of SCC susceptibility for the initiation testing. The focus is on the alloy 182 and the alloy 600 materials, out of which only heat NX6106XK-11 was surveyed for SCC response prior to its selection. The SCC CGR response will be measured in the as-received condition for this program. Some of the alloy 600 materials may be SCC tested in the forged condition in support of the DOE-NE LWRS program. CT specimens have been machined from the Flawtech and Studsvik alloy 182 material and are being loaded in tandem into NRC CGR Test System #3 for testing. Machining of a CT specimen from the KAPL and Phase 2B alloy 182 welds will take place after the KAPL weld arrives in late March. These specimens will be loaded in tandem into NRC CGR Test System

#5. Each pair of specimens is expected to take four months to survey the SCC CGR response. SCC CGR testing of NX6106XK-11 is underway while machining of CT specimens from the other heats is in early stages of preparation.

Other materials characterization activities are determining the hardness and yield strength of the cold-forged materials and surveying the microstructures of all the materials. For the welds, the microstructure survey will include determination of the flaw concentration, if any. These activities will begin in March.

Task 2 - Develop Experimental Test Plan

A suggested test plan was completed and submitted on time. Comments have been received back from an expert panel that has reviewed the proposal. Responses to these comments were prepared and provided to the NRC in February.

Task 3 - Design, Construction, and Validation of SCC Initiation Test Systems

Overview

These test systems will be closely based on a 36 tensile specimen test system designed and constructed for the DOE-NE LWRS program. The DOE-NE LWRS system can monitor 12 specimens for in-situ SCC initiation. The key design change underway for the new systems is increasing the number of specimens that can be instrumented for in-situ detection of SCC initiation or for in-situ detection of failure. A larger diameter autoclave with more ports for wiring feedthroughs is being designed and constructed to enable this. Changes are also being made to the load line and the wiring feedthroughs to make the task of instrumenting all 36 specimens potentially manageable.

The test systems are built in-house at PNNL using a combination of off-the-shelf and custom-made parts. Each test system is constructed of ~140 unique parts from ~30 different vendors. A spreadsheet showing the status of all items needed to build the test system is attached at the end of this document.

Laboratory expansion is needed to make room for these two new test systems along with two more test systems for another NRC program. A lab adjacent to the current SCC lab has been made available for this. New electrical drops, specialty gas drops, pressure relief lines, and chilled water lines be installed, and an increase in room ventilation is also needed to accommodate the waste heat released by the test systems. Since this new lab space has a low ceiling that cannot accommodate the large multi-specimen initiation test systems, several existing SCC CGR test systems, which are not as tall, will be moved into the new lab space, and the new multi-specimen SCC initiation systems will be installed in the existing SCC lab.

The first phase of the test system assembly involves fabricating major components such as the heater controllers and load frames. This work is all being done in-house by PNNL crafts.

The second phase of test system assembly will include having the pipefitters install the stainless steel tubing, filtration equipment, and glass columns on to each water board. This will be followed by installation of the high pressure pumps. Research staff, with assistance from crafts support, will install the autoclaves and servo electric load frame in the test frames. Research

staff will also finish installing the electronics into each electronics rack. The goal for completing the second phase is late March.

In order to begin the second phase of test system assembly, two of the existing SCC CGR test systems in the current lab space will have to be moved into the new lab space being constructed adjacent to the existing one. If completion of the new lab space gets delayed, it may be necessary to either delay assembly of the new SCC initiation test systems, or move the existing SCC CGR test systems into temporary storage while the new lab space is being completed. Discussion with NRC project managers may be needed to determine the appropriate action.

The final stages of assembly will include installation of the load train, installation of the DCPD wiring, and making all the connections from the electronics rack to either the test frame or waterboard. Each system will then be ready to shakedown testing. Activities were will include leak-checking of all stainless steel connections, programming the heater and chilled water controllers, loading autoclave with dummy specimens, heating autoclave and preheater up to operating temperatures, and checking the servo-electric load frame and DCPD system for proper operation. These steps to completion of assembly are summarized in Table 1.

Updates

Approximately 98% of test system components have been ordered, and roughly 85% of those components have been delivered to PNNL. The most expensive item that has yet to be received (but has been ordered) is the autoclave. Receipt is expected in April, and is one of the last items needed for assembly.

Assembly of the test systems is underway with the work orders provided to crafts services. Fabrication of heater controllers (to control heating and cooling of the preheater, autoclave, and building chilled water) and the load frames was completed during this reporting period. Building modifications for the new laboratory space are expected to begin on February 23 and complete on March 31. Table 1 shows the timeline for all the activities needed to complete the test systems.

Table 1. Timeline for assembly of the SCC initiation test systems.

Activity	Planned Start	Actual Start	Planned Completion	Actual Completion	Comments
Order Parts Components	9/1/14	9/1/14	12/31/14		On schedule
Phase 1 System Assembly	12/1/14	12/1/14	1/31/15		Underway
Lab Mods	2/1/15	est. 2/23/15	3/1/15	est. 3/31/15	
Phase 2 System Assembly	1/31/15-3/1/15	est. 3/1/15	4/1/15		
Final System Assembly	4/1/15		5/1/15		
Shakedown Testing	5/1/15		6/10/15		
First Project Test Setup	6/10/15		7/1/15		
First SCC Initiation Tests	7/1/15		1/1/16		

C. Travel

None.

D. Description of Estimated Encumbered Costs

Encumbered costs for this month represent items that have been ordered but not yet received. Expected receipt dates are on schedule.

Type	PO No.	Vendor	Description	Burdened Commitment
B2B	251240	Pacific Office Solutions	Misc Parts	$175
B2B	252465	Grainger Industrial	faceshield	$45
BNW Procurements	247396	Laboratory Testing	Pre-heater part	$6,386
BNW Procurements	247979	High Pressure Equip	Autoclave	$98,797
BNW Procurements	251585	Glas-Col, LLC	Autoclave heating mantle	$11,256
BNW Procurements	252254	Advanced Industrial	Bushings for Specimens ends	$12,304
		Commitments as of 2-20-15		$128,963

E. Anticipated and Encountered Problem Areas

None.

F. Plans for the Next Reporting Period

Task 1 - Materials acquisitions and forging will continue with the majority of the effort directed at having additional materials forged. Work will continue for characterizing SCC response of alloy 182 and alloy 600 to aid in material selection.

Task 2 - Original scope complete, however there are ongoing discussions on responding to the Expert Panel review of the test plan. These discussions are expected to last several more months.

Task 3 - Design, acquisition, test system construction, and laboratory modification activities will continue.

Travel and Meetings - None planned.

Spending Plan

Month/Year	13-Oct	13-Nov	13-Dec	14-Jan	14-Feb	14-Mar	14-Apr	14-May	14-Jun	14-Jul	14-Aug	14-Sep
Planned ($)											100,000	580,638
Revised ($)											0	21,936
Actual ($)											0	21,936
Variance (%)											0.00%	0.00%
Month/Year	14-Oct	14-Nov	14-Dec	15-Jan	15-Feb	15-Mar	15-Apr	15-May	15-Jun	15-Jul	15-Aug	15-Sep
Planned ($)	0	0	0	60,000	60,000	50,000	40,000	30,000	20,000	15,000	15,000	14,362
Revised ($)	71,694	55,422	130,000	100,000	120,000	120,000	100,000	80,000	60,000	50,000	40,000	35,948
Actual ($)	71,694	55,422	143,260	140,515								
Variance (%)	0.00%	0.00%	10.20%	40.51%								
TOTAL												
Planned ($)	985,000											
Revised ($)	985,000											
Actual ($)	432,827											

Variance Narrative - None.

Alloy Class and Material Name	Top 4 Candidate?	Reason	Description/Form	Dimensions	Alloy Vendor	Heat Number	CMTR?	Weld Fabricator	WPS	At PNNL?	Number of Possible Specimens	Microstructure Characterized?	Have SCC CGR Data?	# CF Initiation Specimens Needed	# CF CT Specimens Needed	# CF Initiation Specimens Per Block	# CF Blocks Needed	CF Slice removed for Met, EBSD, HV?	Number of Blocks Forged	Additional Forged Blocks Needed
Alloy 182																				
PNNL/NRC Phase 2B Mockup	**yes**	**well-documented mockup**	LAS-SS DMW with alloy 182 butter and fill	circumferential pipe buttweld, 15" OD x 1.5" wall	TBD	TBD	TBD	EWI	yes	yes	50	no	preparing to machine AW CTs	18	1	3	7	in-progress	2	**5**
PNNL/Flawtech/NRC Mockup	**yes**	**well-documented mockup**	LAS-SS DMW with alloy 182 butter and fill	circumferential pipe buttweld, 14" OD x 1.5" wall	Spec. Met.	844305	yes	Flawtech	yes	yes	90	no	AW CTs machined	18	1	3	7	in-progress	1	**6**
Studsvik	**yes**	**well-documented mockup**	alloy 182 buildup	3"tall x 2.75" x 5"long	TBD	TBD	TBD	ENSA	yes	yes	64	no	AW CTs machined	18	1	10	2	in-progress	2	**0**
KAPL	**yes**	**well-documented mockup**	alloy 182 U-groove	1.5"wide x 1.5"tall x 8"long	Techalloy	823030	yes	KAPL	yes	3/27/15	25	no	preparing to machine AW CTs	18	1	6	4	planned	0	**4**
EPRI weld	?	?	TBD	TBD	TBD	TBD	yes	yes	no	TBD	no	no	TBD							
CRDM J-groove	no	too challenging to forge and extract initiation specimens	alloy 182 J-groove from dismantled partially built PWR	8.15" ID x 0.84" thick x XX"tall	unknown	unknown	no	unknown	no	yes	none	no	no							
Alloy 600																				
PNNL Plate #1 (MA)	**yes**	**prior SCCI data from LWRS**	2" thick plate	9.6x15x2" thick	Spec. Met.	NX6016XK-11	yes	N/A	N/A	yes	300	Met, SEM, TEM	in-progress	12	1	6	3	in-progress	3	**0**
PNNL Plate #3 (MA)	**yes**	**using for NRC Peening program**	3" thick plate	3x18x3" thick	ATI	522068	yes	N/A	N/A	yes	50	Met	preparing to machine AW CTs	12	1	6	3	planned	0	**3**
KAPL Plate (MA)	**yes**	**vintage material**	vintage 2" thick plate	4x8x2" thick	G.O. Carlson	33375-2B	yes	N/A	N/A	3/27/15	50	no	planned	12	1	6	3	planned	0	**3**
CRDM Tube	**yes**	**service material**	From dismantled partially built PWR	4.15"OD x 0.70" wall x 8" long	unknown	unknown	no	N/A	N/A	yes	50	Met	preparing to machine AW CTs	12	1	5	3	planned	0	**3**
PNNL Plate #2 (MA)	no	other better candidates	2" thick plate	6x15x2" thick	ATI	521618	yes	N/A	N/A	yes	300	Met	no						3	
Alloy 152/52																				
MHI alloy 152 U-groove	**yes**	**have SCC CGR data**	U-groove weld joining SS	1.8"tall x 2"wide x 2.5" long	TK-VDM?	307380	yes	MHI	yes	yes	15	Met, SEM	yes	9	2	6	2	planned	0	**2**
MHI alloy 52 U-groove	**yes**	**have SCC CGR data**	U-groove weld joining SS	1.8"tall x 2"wide x 2.5" long	Spec. Met.	NX2686JK	yes	MHI	yes	yes	15	Met, SEM	yes	9	2	6	2	planned	0	**2**
ENSA DPM alloy 52M butter	**yes**	**sufficient material available**	Double bevel 690-LAS DMW, alloy 52M butter	0.75"tall x 2.7"wide x 4" long	unknown	unknown	no	ENSA	yes	yes	20	Met, SEM	no	9	2	3	4	planned	0	**4**
EPRI alloy 152M	**yes**	**favorable geometry, sufficient material**	TBD	TBD	TBD	TBD	yes	TBD	yes	no	TBD	no	no	9	2	3	4	planned	0	**4**
KAPL alloy 52M NG	no	too narrow	narrow gap weld joining alloy 690	1.8"tall x 0.5"wide x 1.1" long	Spec. Met.	NX5295TK	yes	KAPL	yes	yes	6	no	yes							
EPRI alloy 52i	no	not enough material	V-groove weld	1.8"tall x 0.75-1.75"wide x 1.5" long	TK-VDM	787715	yes	unknown		yes	0	no	no						1	
ENSA DPM alloy 52 fill	no	alloy 52 with prior SCC experience already identified	Double bevel 690-LAS DMW, alloy 52 fill	1.6"tall x 0.5-1.6"wide x 45° long	Spec. Met.	NX4196JK	yes	ENSA	yes	yes	80	Met, SEM	in-progress						1	
NRC alloy 52MSS NG	no	too narrow	narrow gap weld joining alloy 690	3"tall x 0.4-0.6" wide x 2.8" long	Spec. Met.	NX77W3UK	yes	PCI	yes	yes	18	no	yes							
Alloy 690																				
Valinox Alloy 690 CRDM RE243 (TT)	**yes**	**significant SCC CGR data**	CRDM	4.4"OD x 1.35"wall x 6" long	Valinox	RE243	no	N/A	N/A	yes	>20	Met, SEM, TEM, APT	yes	9	1	6	2	in-progress	2	**0**
Valinox Alloy 690 CRDM WP142 (TT)	**yes**	**have SCC CGR data, and substantial material**	CRDM	4.56"OD x 1.20"wall x 4" long	Valinox	WP142	no	N/A	N/A	yes	>20	Met, SEM, TEM	yes	9	1	6	2	in-progress	2	**0**
TK-VDM plate (TT)	**yes**	**have SCC CGR data**	plate	2"tall x 4"wide x 2.5" long	TK-VDM	114092	yes	N/A	N/A	EPRI	>20	Met, SEM, TEM	yes	9	1	6	2	planned	0	**2**
ATI/Allvac B25K-2 (MA)	**yes**	**have SCC CGR data**	plate	3"thick x 5.5"wide x 2.2" long	ATI/Allvac	B25K-2	yes	N/A	N/A	yes	>20	Met, SEM, TEM	yes	9	1	6	2	in-progress	2	**0**
Doosan CRDM bar (TT)	no	insufficient material for additional tests	CRDM	6"OD x 2.5" long	TK-VDM	133454	yes	N/A	N/A	yes	12	Met, SEM, TEM	yes						1	
EPRI NX8625HG21 (TT)	no	no SCC data, other better candidates	plate	12x12x1.38" thick	Spec. Met.	NX8625HG21		N/A	N/A	yes	>20	no	no							

PNNL 36 Specimen Initiation Test System Purchases for NRC Initiation Program (Per System)

System/Item	Unit Cost	min # needed	extras	Total Cost	Delivery (incl shipping)
autoclave load train support structure	$10,000.00	1		$10,000.00	8 weeks
Counterweight system	$5,000.00	1		$5,000.00	5 weeks
autoclave head support plate	$800.00	1		$800.00	6 weeks
Skala support plate	$800.00	1		$800.00	6 weeks
Load Frame	$5,000.00	1		$5,000.00	3 weeks
glass column end plate	$250.00	2		$500.00	6 weeks
Band Heater for preheater	$62.15	2		$124.30	3 weeks
Watlow temperature controller for preheater	$322.00	1		$322.00	3 weeks
Watlow temperature controller for AC blanket	$402.00	3		$1,206.00	3 weeks
Process HX temp controller	$312.00	1		$312.00	3 weeks
Online UPS	$865.99	1		$865.99	2 weeks
Online UPS	$194.25	1		$194.25	2 weeks
End Link	$433.00	6		$2,598.00	10 weeks
Wide Link Specimen Holder	$589.00	18		$10,602.00	10 weeks
Wide Link Specimen Holder	$516.00	18		$9,288.00	10 weeks
Narrow Link Specimen Holder	$339.00	15		$5,085.00	10 weeks
Button Head Pin with Safety Wire Hole	$110.00	90		$9,900.00	10 weeks
Button Head Short	$125.00	18		$2,250.00	10 weeks
loading box	$800.00	1		$800.00	10 weeks
retainer for 3/4" Omniseal	$375.00	1		$375.00	10 weeks
bushing pairs	$60.00	72	11	$4,980.00	4 weeks
Micropump (brand) micropump service kit	$254.70	3		$764.10	2 weeks
Control Valve Spring	$4.73	5		$23.65	2 weeks
Control Valve Poppet	$16.52	5		$82.60	2 weeks
Control Valve Guide	$6.83	5		$34.15	2 weeks
micropump head	$577.80	1		$577.80	2 weeks
Micropump (brand) micropump	$1,043.10	1		$1,043.10	2 weeks
demineralizer holder	$374.33	1		$374.33	2 weeks
demineralizer cartridge	$88.13	1		$88.13	2 weeks
submicron filter	$81.25	2		$162.50	2 weeks
Tescom back pressure regulator (5-50 psi)	$975.00	1		$975.00	3 weeks
Conax feedthrough - 4 hole	$116.00	1	1	$232.00	2 weeks
Conax feedthrough - 8 hole	$173.00	3	1	$692.00	2 weeks
Conax feedthrough - 8 hole repl. Packing	$37.00	1		$37.00	2 weeks
Conax feedthrough - 4 hole repl. packing	$21.00	1		$21.00	2 weeks
Ceramic (TI2) wire sheath (4 ft)	$36.12	120		$4,334.40	8 weeks
Brooks Sho-Rate water flow meter	$444.00	1		$444.00	3 weeks
rectangle carboy with spigot	$258.75	1		$258.75	1 week
fluid injection pump motor	$731.00	1		$731.00	6 weeks
fluid injection pump adapter kit	$32.00	1		$32.00	2 weeks
fluid injection pump head	$515.00	1		$515.00	2 weeks
fluid injection pump head replacement lip seal	$3.80	5		$19.00	2 weeks
fluid injection pump head replacement gland washer	$3.80	5		$19.00	2 weeks
DB9 to DB9 ribbon cable (Skala to PC)	$1.00	1	1	$2.00	1 week
custom parallel port cable	$1.00	1	1	$2.00	1 week
custom MUX <-> DVM interconnect	$1.00	1	1	$2.00	1 week
gas bubbler for mixing column	$50.00	1		$50.00	6 weeks
solid state polarity switching modules	$1.00	1		$1.00	2 weeks
autoclave heating mantle	$1,420.00	3		$4,260.00	8-10 weeks
autoclave insulating cap	$512.00	1		$512.00	8-10 weeks
PID Coolant Temperature Controller	$1,552.00	1		$1,552.00	2 weeks
safety head for rupture disk	$124.00	1		$124.00	2 weeks
12 liter autoclave	$41,620.00	1		$41,620.00	12 weeks
autoclave spare gasket kit	$215.00	4		$860.00	6 weeks
1-1/4 Cap Screw	$99.00	8		$792.00	6 weeks
ASME pressure qualification for autoclaves	$1,800.00	1		$1,800.00	6 weeks
3" Swivel Stem Casters for Pulsafeeder	$5.12	4		$20.48	1 week
Skala servo-electric testing system	$29,600.00	1		$29,600.00	2 weeks
preheater body for high pressure water	$2,585.00	1		$2,585.00	5 weeks
CW System: Grade 8 Alloy Steel Hex Head Cap Screw Zinc Yellow Pltd, 3/4"-10 Thrd, 2-1/2" L, Fully Thrd	$1.65	10		$16.50	1 week
CW System: 3/4" - 10 SS Nut	$0.70	10		$7.00	1 week
CW System: 300 Series SS MS35338 Split Lock Washer 3/4" Screw Size, Dash #146, 1.27" OD	$0.39	10		$3.90	1 week
CW System: Ultra-Coated Grade 8 Steel SAE Flat Washer 3/4" Screw Size, 1-15/32" OD, .12"-.18" Thick	$0.18	20		$3.60	1 week
CW System: Grade 8 Alloy Steel Hex Head Cap Screw Zinc Yellow- Plated, 1/4"-20 Thread, 1-1/4" Length	$0.12	25		$3.00	1 week
CW System: Grade 8 Steel Nylon-Insert Hex Locknut Znc- Yellow Pltd, 1/4"-20 Thrd Sz, 7/16" W, 5/16" H	$0.05	25		$1.25	1 week
CW System: Zinc & Yellow Grade 8 Steel Flat Washer SAE, 1/4" Screw Size, 5/8" OD, .05"-.08" Thick	$0.03	25		$0.75	1 week
CW System: Type 316 Stainless Steel Heavy Hex Nut 1"-8 Thread Size, 1-5/8" Width, 63/64" Height	$7.80	1		$7.80	1 week
CW System: Grade 8 Alloy Steel Hex Head Cap Screw Zinc Yellow- Plated, 1"-8 Thread, 8" Length	$10.50	1		$10.50	1 week
CW System: 300 Series SS MIL Spec Flat Washer 1" Size, 2" OD, .06"-.10" Thk, NASM/MS15795-826	$0.95	4		$3.80	1 week
3/4-10 x 1 1/2 hex bolt grade 8	$1.05	8		$8.40	1 week
3/4-10 x 2 1/2 hex bolt stainless steel	$2.90	4		$11.60	1 week
3/4-10 x 2 1/4 hex bolt stainless steel	$2.54	4		$10.16	1 week
1/2"-13 x 1 1/4" SS bolts: autoclave to plate	$0.48	4		$1.92	1 week
1/2"-13 x 2 1/4" SS bolts: Skala to plate	$0.94	3		$2.82	1 week
3/4 flat washer f436	$0.16	16		$2.56	1 week
1/2" SS washers: betw autoclave and plate	$0.26	7		$1.82	1 week
3/4-10 hex nut stainless steel	$0.70	16		$11.20	1 week
1/2" malleable bevel washers	$0.60	16		$9.60	2 week
LCD monitor for PC	$192.00	1		$192.00	2 weeks
PCI-GPIB board + one 2 meter 488 cable	$625.00	1		$625.00	2 weeks
1 meter IEEE488 cable	$80.00	2		$160.00	5 weeks
Crydom solid state relays for solid state switch	$75.18	4	4	$601.44	1 week
Crydom solid state relays for power to heaters	$44.05	2	2	$176.20	1 week
external power switch for Watlow controllers	$0.69	4	1	$3.45	1 week
light socket for blanket/preheat power indicator	$8.76	4	1	$43.80	1 week
panel mount fuse holders	$2.08	2	1	$6.24	1 week
0.5 A fast acting fuses	$0.15	2	2	$0.60	1 week
12 AWG power cords for heaters (25 ft)	$47.04	5		$235.20	1 week
18 AWG power cord for Watlows (xx ft)	$7.14	1		$7.14	1 week
DCPD MUX Card replacment channel	$2.19	3		$6.57	1 week
DCPD MUX Card replacment bank relay	$2.12	3		$6.36	1 week
RG-174/U cable 50 ft	$92.22	1		$92.22	1 week
BNC female RG-174 panel plug isolated pomona	$3.85	20		$77.00	1 week
BNC male RG-174 plug amphenol	$2.88	20		$57.60	1 week
Electronics Racks	$1,270.50	1		$1,270.50	12 weeks
Type J TC female round panel jacks	$2.40	3	1	$9.60	1 week
Type J 20 AWG twisted shielded TC wire 50 ft	$75.00	1		$75.00	1 week
Type J standard size male plug w/label	$2.50	6	1	$17.50	1 week
Type J standard size female plug w/label	$3.60	3	1	$14.40	1 week
Type J Inconel sheathed TCs with 18" probe	$34.00	3	1	$136.00	1 week
low pressure gauge (60 psi)	$160.00	3		$480.00	2 weeks
low pressure gauge (60 psi)	$145.00	1		$145.00	2 weeks
high pressure gauge (3000 psi)	$200.00	2		$400.00	9 weeks
Heinemann 20A breaker/switch for preheater	$34.07	2		$68.14	2 weeks
clear lens for power indicator light	$4.70	20		$94.00	1 week
red cluster based LED indicator light	$6.56	4	1	$32.80	10 weeks
Blacoh Sentry pulsation dammper	$1,935.00	1		$1,926.00	3 weeks
Replacement bladder for Blacoh	$567.00	1		$567.00	1 week
Blacoh inlet stabilizer	$573.00	1		$573.00	5 weeks
SS tubing (oxygen service)	$3,059.75	1		$3,059.75	1 week
custom SS switch power cable	$1.00	1	1	$2.00	1 week
strain relief bushings for large power cord	$1.00	5		$5.00	1 week
strain relief bushing for small power cord	$1.00	2		$2.00	1 week
15 or 20 terminal barrier strips	$1.00	2		$2.00	1 week
hookup wire	$1.00	1		$1.00	1 week
wire connectors	$1.00	1		$1.00	1 week
wire straps and holders	$1.00	1		$1.00	1 week
Heinemann 30A breaker/switch for blanket	$24.05	0		$0.00	2 weeks
1/4" Omniseal	$75.67	1		$75.67	6 weeks
glass column	$975.00	2		$1,950.00	2 weeks
glass column gaskets	$18.00	1.5		$27.00	2 weeks
glass column flange/coupling	$70.00	0.5		$35.00	2 weeks
platinum wire - 0.020" (24 awg)	$82.10	60		$4,926.00	3 week
platinum wire - 0.032" (20 awg)	$204.80	40		$8,192.00	3 week
all Swagelok fittings (oxygen service)	$10,827.07	1		$10,827.07	3 weeks
Swagelok BPR	$551.84	1		$551.84	5 weeks
Agilent current source	$2,293.56	1		$2,293.56	3 weeks
Agilent voltmeter	$4,008.44	1		$4,008.44	2 weeks
Agilent MUX	$1,608.16	1		$1,608.16	2 weeks
Agilent MUX card	$483.00	1		$483.00	2 weeks
Thornton conductivity sensor flow chamber	$268.00	5		$1,340.00	3 weeks
Thornton conductivity sensor	$431.00	2		$862.00	3 weeks
M300 Thornton Multiparameter	$1,678.00	1		$1,678.00	3 weeks
M300 Multiparameter panel mount kit	$63.00	1		$63.00	3 weeks
M300 parameter 5' patch cord	$92.00	2		$184.00	3 weeks
Pulsafeeder pump	$6,153.90	1		$6,153.90	5 weeks
Pulsafeeder service kit	$775.00	1		$775.00	5 weeks
Pulsafeeder input shaft cover plate shim set	$14.00	2		$28.00	5 weeks
Pulsalube oil #1, 1GAL (for servicing)	$53.00	2		$106.00	5 weeks
PTFE wire sheath - 24 awg - 4 ft	$13.55	9		$121.95	1 week

COLOR CODING

- Items that need configuring
- Items in Process of ordering
- Quote Request Sent
- Order Placed
- Item Arrived
- Items Manufactured On Site/or GE

MONTHLY LETTER STATUS REPORT

Reporting Period Start Date **December 27, 2014**		**Reporting Period End Date** **January 23, 2015**
NRC Agreement Number **NRC-HQ-60-14-D-0014**	**Task Order Number (if applicable)** **N/A**	**Common Cost Center Code**
Project Title **Crack Initiation Testing for Primary Water Stress Corrosion Cracking**		
Period of Performance Start Date **August 18, 2014**		**Period of Performance End Date** **October 31, 2015**
COR **Eric Focht**	**Telephone** **(301) 251-7649**	**E-mail** **eric.focht@nrc.gov**
DOE Laboratory **Pacific Northwest National Laboratory (PNNL)**		
DOE Site Address **Pacific Northwest Site Office, PO Box 350/MS K9-42, Richland, WA 99352**		
Principal Investigator **Stephen Bruemmer**	**Telephone** **(509) 371-7361**	**E-mail** **stephen.bruemmer@pnnl.gov**

Financial Status Section

A. Overall Funding

Current Monthly Costs:	$140,515
Total Ceiling Amount:	$985,000
Total Amount of Funds Obligated to Date:	$850,638
Total Amount of Funds Expended to Date:	$432,827
Percentage of Funds Expended to Date:	51%
Balance of Obligated Funds Remaining:	$417,811
Total Estimated Encumbered Costs:	$111,817
Balance Available Less Estimated Encumbered Costs:	$305,995

B. DOE Laboratory Acquired Property

No single item costing more than $5,000 was received this month. The autoclave and the load train are the two most expensive items and are not expected to arrive until the end of February or in mid-March.

Description*	Quan.	Manufacturer	Model Number	Serial Nums.	Tot. Acq. Cost ($)	Receipt Date	Property Identification Number

* Asterisk is to be added to item description to indicate sensitive software.

C. NRC-Funded Software Developed

Nothing in this area.

Name*	Function	Development Cost ($)	Computer Language Used	Operating System	Location of System	Date Software Completed	Date of Scheduled Replacement/Useful Life
N/A							

*Asterisk is to be used to indicate sensitive software.

Technical Status Section

A. Deliverables/Milestones Schedule

Deliverable	Description	Planned Completion Date	Revised Completion Date (if applicable)	Actual Completion Date
1	Test plan will be completed and submitted to the NRC for review.	Within 3 months of the contract award	not applicable	11/19/2014
2	Two SCC initiation test systems will be designed and assembled, and test viability demonstrated.	Within 12 months of the contract award	on track	
3	A technical letter report will be submitted to the NRC detailing the test equipment and capabilities for SCC initiation experimentation.	Within one 1 month of completion of Deliverable 2	on track	

B. Progress During Reporting Period

Task 1 - Identification and Acquisition of Materials for the Test Matrix

Overview of Material Requirements

For the current draft test plan, one autoclave is expected to be dedicated to alloy 600/182 tests and the other for alloy 690/152/52(x) tests. Each autoclave can hold 36 specimens. The tentative loading plan for these autoclave systems is as follows:

Alloy 600/182 autoclave

- First loading: Four different alloy 182 welds. For each weld, there will be 6 specimens in the 15% CF condition and 3 in the as-welded condition.
- Second loading: Stress effects will be considered with specimens loaded to a fraction of the yield stress. Current plan is the same four alloy 182 welds, all in a 15% CF condition. Exact number of specimens for each weld is to-be-determined.
- Third loading: Four heats of alloy 600. Each heat will have 9 specimens in the 15% CF condition.

Alloy 690/152/52(x) autoclave

- First and only loading: Four heats of alloy 690 with 3 specimens per heat and three heats of alloy 152/52(x) with six specimens per heat. All specimens will be in the 15% CF condition.

Acquisition of Materials and Forging Progress

Efforts to obtain sufficient amounts of all the necessary types of materials continues. Desired heats of base metals or weldments have already been identified with most materials already obtained. For this month, additional alloy 690 (heats 133454 and 114092), alloy 52 and 52M (both from the ENSA divider plate mockup) have been acquired from EPRI. At this point, the minimum number (or more) of heats or welds for each alloy variant has been obtained. The only target materials that have yet to be obtained are an alloy 182 weld and alloy 152M weld, both being produced by EPRI. Based on discussions with EPRI, these are expected to be available within two months.

Roughly 45 blocks need to be prepared and forged for this program. Rather than preparing and forged all the blocks at once, the work is being broken down in to smaller overlapping groups. It is anticipated that three rounds of preparation and forging will be required to obtain sufficient material for all the specimens that are needed. The first round of forging has been completed, and preparations for the next round of forging is underway. The goal is to have all the materials needed by the end of March for the first SCC initiation loadings (alloy 182 and alloy 690/152/52 materials).

A summary of all materials acquisitions and forging activities is listed in the attached table at the end of the document.

Material Characterizations

As part of materials selection activities, SCC CGR tests will be performed on some of the materials to determine an acceptable range of SCC susceptibility for the initiation testing. The focus is on the alloy 182 and the alloy 600 materials, only one of which had been surveyed for SCC response prior to its selection. The selection of these materials will be performed by surveying the SCC CGR response in their as-received condition.

The four candidate alloy 182 welds are the Phase 2B, Flawtech, Studsvik, and KAPL welds. CT specimens are currently being machined from Phase 2B, Flawtech, and Studsvik alloy 182 material. The expectation is that these CT specimens will be received back from the machine shop by early February. Machining of a CT specimen from the KAPL weld will take place after it arrives in late February. Tests on these four welds will began after a SCC lab power outage that is required as part of the laboratory expansion work discussed below. The current outlook is that this outage will take place in early March. The plan is to test two specimens in tandem, thus requiring the use of two SCC CGR test systems.

The target alloy 600 materials are heats NX6106XK-11, 522068, 33375-2B, and the CRDM heat. SCC CGR testing of NX6106XK-11 is underway while machining of CT specimens from the other heats is in early stages of preparation.

Other important materials characterization activities are determining the yield strength of the cold-forged materials and surveying the microstructures of the welds to determine the flaw concentration, if any. These will begin in March.

Task 2 - Develop Experimental Test Plan

A suggested test plan was completed and submitted on time. Comments have been received back from an expert panel that has reviewed the proposal. Responses to these comments are being prepared and will be provided to the NRC in February.

Task 3 - Design, Construction, and Validation of SCC Initiation Test Systems

Overview

These test systems will be closely based on a 36 tensile specimen test system designed and constructed for the DOE-NE LWRS program. The DOE-NE LWRS system can monitor 12 specimens for in-situ SCC initiation. The key design change underway for the new systems is increasing the number of specimens that can be instrumented for in-situ detection of SCC initiation or for in-situ detection of failure. A larger diameter autoclave with more ports for wiring feedthroughs is being designed and constructed to enable this. Changes are also being made to the load line and the wiring feedthroughs to make the task of instrumenting all 36 specimens potentially manageable.

The test systems are built in-house at PNNL using a combination of off-the-shelf and custom-made parts. Each test system is constructed of ~140 unique parts from ~30 different vendors. A spreadsheet showing the status of all items needed to build the test system is attached at the end of this document.

Laboratory expansion is needed to make room for these two new test systems along with two more test systems for another NRC program. A lab adjacent to the current SCC lab has been made available for this. New electrical drops, specialty gas drops, pressure relief lines, and chilled water lines be installed, and an increase in room ventilation is also needed to accommodate the waste heat released by the test systems. Since this new lab space has a low ceiling that cannot accommodate the large multi-specimen initiation test systems, several existing SCC CGR test systems, which are not as tall, will be moved into the new lab space, and the new multi-specimen SCC initiation systems will be installed in the existing SCC lab.

The first phase of the test system assembly involves fabricating major components such as the heater controllers and load frames. This work is all being done in-house by PNNL crafts.

The second phase of test system assembly will include having the pipefitters install the stainless steel tubing, filtration equipment, and glass columns on to each water board. This will be followed by installation of the high pressure pumps. Research staff, with assistance from crafts support, will install the autoclaves and servo electric load frame in the test frames. Research staff will also finish installing the electronics into each electronics rack. The goal for completing the second phase is late March.

In order to begin the second phase of test system assembly, two of the existing SCC CGR test systems in the current lab space will have to be moved into the new lab space being

constructed adjacent to the existing one. If completion of the new lab space gets delayed, it may be necessary to either delay assembly of the new SCC initiation test systems, or move the existing SCC CGR test systems into temporary storage while the new lab space is being completed. Discussion with NRC project managers may be needed to determine the appropriate action.

The final stages of assembly will include installation of the load train, installation of the DCPD wiring, and making all the connections from the electronics rack to either the test frame or waterboard. Each system will then be ready to shakedown testing. Activities were will include leak-checking of all stainless steel connections, programming the heater and chilled water controllers, loading autoclave with dummy specimens, heating autoclave and preheater up to operating temperatures, and checking the servo-electric load frame and DCPD system for proper operation. These steps to completion of assembly are summarized in Table 1.

Updates

Approximately 97% of test system components have been ordered, and roughly 80% of those components have been delivered to PNNL. The most expensive item that has yet to be received (but has been ordered) is the autoclave. Receipt is expected in April, however it is one of the last items needed for assembly.

Assembly of the test systems is underway with the work orders provided to crafts services. Fabrication of heater controllers for the electronics rack (to control heating and cooling of the preheater, autoclave, and building chilled water) and the frames continued for this reporting period. Waterboards have been completed while fabrication of the unistrut stands to support the waterboards is still underway.

Table 1. Timeline for assembly of the SCC initiation test systems.

Activity	Planned Start	Actual Start	Planned Completion	Actual Completion	Comments
Order Parts Components	9/1/14	9/1/14	12/31/14		On schedule
Phase 1 System Assembly	12/1/14	12/1/14	1/31/15		Just started
Lab Mods	2/1/15		3/1/15		
Phase 2 System Assembly	1/31/15-3/1/15		4/1/15		
Final System Assembly	4/1/15		5/1/15		
Shakedown Testing	5/1/15		6/10/15		
First Project Test Setup	6/10/15		7/1/15		
First SCC Initiation Tests	7/1/15		1/1/16		

C. Travel

None.

D. Description of Estimated Encumbered Costs

Encumbered costs for this month represent items that have been ordered but not yet received. Expected receipt dates are on schedule.

E. Anticipated and Encountered Problem Areas

None.

F. Plans for the Next Reporting Period

Task 1 - Materials acquisitions and forging will continue with the majority of the effort directed at having additional materials forged. Work will continue for characterizing SCC response of alloy 182 and alloy 600 to aid in material selection.

Task 2 - Complete.

Task 3 - Design, acquisition, and laboratory modification activities will continue.

Travel and Meetings - None planned.

Spending Plan

Month/Year	13-Oct	13-Nov	13-Dec	14-Jan	14-Feb	14-Mar	14-Apr	14-May	14-Jun	14-Jul	14-Aug	14-Sep
Planned ($)											100,000	580,638
Revised ($)											0	21,936
Actual ($)											0	21,936
Variance (%)											0.00%	0.00%
Month/Year	14-Oct	14-Nov	14-Dec	15-Jan	15-Feb	15-Mar	15-Apr	15-May	15-Jun	15-Jul	15-Aug	15-Sep
Planned ($)	0	0	0	60,000	60,000	50,000	40,000	30,000	20,000	15,000	15,000	14,362
Revised ($)	71,694	55,422	130,000	100,000	120,000	120,000	100,000	80,000	60,000	50,000	40,000	35,948
Actual ($)	71,694	55,422	143,260	140,515								
Variance (%)	0.00%	0.00%	10.20%	40.51%								
TOTAL												
Planned ($)	985,000											
Revised ($)	985,000											
Actual ($)	432,827											

Variance Narrative - None.

Alloy Class and Material Name	Description/Form	Dimensions	Alloy Vendor	Heat Number	CMTR?	Weld Fabricator	WPS	At PNNL?	Number of Possible Specimens	Microstructure Charcterized?	Have SCC CGR Data?	To Be Forged?	Amount Currently Forged
Alloy 182													
4 heats needed. As-Received specimens needed: 3 for tensile properties, 3 for initiation tests. Cold-Forged specimens needed: 3 for tensile properties, 15 for initiation tests.													
PNNL/NRC Phase 2B Mockup	LAS-SS DMW with alloy 182 butter and fill	circumferential pipe buttweld, 15" OD x 1.5" wall	TBD	TBD	TBD	EWI	yes	yes	50	no	in-progress	yes	Enough for 12 specimens
PNNL/Flawtech/NRC Mockup	LAS-SS DMW with alloy 182 butter and fill	circumferential pipe buttweld, 14" OD x 1.5" wall	Spec. Met.	844305	yes	Flawtech	yes	yes	90	no	in-progress	yes	Enough for 12 specimens
Studsvik	alloy 182 buildup	3"tall x 2.75" x 5"long	TBD	TBD	TBD	ENSA	yes	yes	64	no	in-progress	yes	Enough for 12 specimens
KAPL	alloy 182 U-groove	1.5"wide x 1.5"tall x 8"long	TBD	TBD	yes	KAPL	yes	3/1/15	25	no	in-progress	yes	
CRDM J-groove	alloy 182 J-groove from dismantled partially built PWR	4.15" ID x XX" thick x XX" tall	unknown	unknown	no	unknown	no	yes	TBD	no	no	probably	
EPRI weld	TBD	TBD	TBD	TBD	yes		yes	no	TBD	no	no	TBD	
Alloy 600													
4 heats needed. As-Received specimens needed: None. Cold-Forged specimens needed: 3 for tensile properties, 9 for initiation tests.													
PNNL Plate #1	2" thick plate	9.6x15x2" thick	Spec. Met.	NX6016XK-11	yes	N/A	N/A	yes	300	Met, SEM, TEM	in-progress	yes	Enough for 18 specimens
PNNL Plate #2	2" thick plate	6x24x2" thick	ATI	521616	yes	N/A	N/A	yes	300	Met	no	yes	Enough for 18 specimens
PNNL Plate #3	3" thick plate	3x18x3" thick	ATI	522068	yes	N/A	N/A	yes	50	Met	no	yes	
KAPL Plate	vintage 2" thick plate	4x8x2" thick	TBD	33375-2B	yes	N/A	N/A	3/1/15	50	no	no	yes	
CRDM Tube	From dismantled partially built PWR	4.15"OD x 0.70" wall x 10" long	unknown	unknown	no	N/A	N/A	yes	50	no	no	yes	
Alloy 152/52													
4 heats needed. As-Received specimens needed: None. Cold-Forged specimens needed: 3 for tensile properties, 6 for initiation tests.													
MHI alloy 152	U-groove weld joining SS	1.8"tall x 2"wide x 2.5" long	TBD	307380	yes	MHI	yes	yes	15	Met, SEM	yes	yes	
MHI alloy 52	U-groove weld joining SS	1.8"tall x 2"wide x 2.5" long	Spec. Met.	NX2686JK	yes	MHI	yes	yes	15	Met, SEM	yes	yes	
KAPL alloy 52M	narrow gap weld joining alloy 690	TBD	Spec. Met.	NX5285TK	yes	KAPL	yes	yes	6	no	yes		
EPRI alloy 52i	V-groove weld	TBD	TK-VDM	187775	yes	unknown		yes	9	no	no		Enough for 6 specimens
ENSA DPM alloy 52M butter	Double bevel 690-LAS DMW, alloy 52M butter	TBD	unknown	unknown	no	ENSA	yes	yes	20	Met, SEM	no		
ENSA DPM alloy 52 fill	Double bevel 690-LAS DMW, alloy 52 fill	TBD	Spec. Met.	NX4196JK	yes	ENSA	yes	yes	20	Met, SEM	in-progress		Enough for 6 specimens
NRC alloy 52MSS	narrow gap weld joining alloy 690	TBD	Spec. Met.	NX77W3UK	yes	PCI	yes	yes	18	no	yes		
EPRI alloy 152M	TBD	TBD	TBD	TBD	yes	TBD	yes	no	TBD	no	no		
Alloy 690													
4 heats needed. As-Received specimens needed: None. Cold-Forged specimens needed: 3 for tensile properties, 6 for initiation tests.													
Valinox Alloy 690 CRDM RE243	CRDM		Valinox	RE243	no	N/A	N/A	yes	>20	Met, SEM, TEM, APT	yes	yes	Enough for 12 specimens
Valinox Alloy 690 CRDM WP142	CRDM		Valinox	WP142	no	N/A	N/A	yes	>20	Met, SEM, TEM	yes	yes	Enough for 12 specimens
Doosan CRDM bar	CRDM		TK-VDM	133454	yes	N/A	N/A	yes	12	Met, SEM, TEM	yes	yes	Enough for 6 specimens
TK-VDM plate	plate		TK-VDM	114092	yes	N/A	N/A	EPRI	>20	Met, SEM, TEM	yes	yes	
ATI/Allvac B25K-2	plate		ATI/Allvac	B25K-2	yes	N/A	N/A	yes	>20	Met, SEM, TEM	yes	yes	Enough for 12 specimens
EPRI NX8625HG21	plate	12x12x1.34" thick	Spec. Met.	NX8625HG21		N/A	N/A	yes	>20	no	no	no plan	
Dissmilar Metal Welds													
Number of weldments and specimens needed is TBD.													
PNNL/NRC Phase 2B DMW	U-groove SS-LAS DMW, alloy 182 butter	circumferential pipe buttweld, 15" OD x 1.5" wall	TBD	TBD	TBD	EWI	yes	yes	20	no	no		
PNNL/Flawtech/NRC Mockup	LAS-SS DMW with alloy 182 butter	circumferential pipe buttweld, 14" OD x 1.5" wall	Spec. Met.	844305	yes	Flawtech	yes	yes	20	no	no		
ENSA Alloy 52M/52 DPM	Double V alloy 690-LAS DMW, alloy 52M butter	linear double V weld	unknown	unknown	no	ENSA	yes	yes	20	Met, SEM	no		

PNNL 36 Specimen Initiation Test System Purchaces for the NRC Initiation Program

System/Item	Unit Cost	min # needed	extras	Total Cost	Delivery (incl shipping)
autoclave load train support structure	$20,000.00	1		$20,000.00	8 weeks
Counterweight system	$5,000.00	1		$5,000.00	5 weeks
autoclave head support plate	$800.00	1		$800.00	6 weeks
Skala support plate	$800.00	1		$800.00	6 weeks
Load Frame	$5,000.00	1		$5,000.00	3 weeks
glass column end plate	$250.00	2		$500.00	6 weeks
Band Heater for preheater	$62.15	2		$124.30	3 weeks
Watlow temperature controller for preheater	$322.00	1		$322.00	3 weeks
Watlow temperature controller for AC blanket	$402.00	3		$1,206.00	3 weeks
Process HX temp controller for LWRSP	$312.00	1		$312.00	3 weeks
Online UPS	$865.99	1		$865.99	2 weeks
Online UPS	$194.25	1		$194.25	2 weeks
End Link	$433.00	6		$2,598.00	10 weeks
Wide Link Specimen Holder	$589.00	18		$10,602.00	10 weeks
Wide Link Specimen Holder	$516.00	18		$9,288.00	10 weeks
Narrow Link Specimen Holder	$339.00	15		$5,085.00	10 weeks
Button Head Pin with Safety Wire Hole	$110.00	90		$9,900.00	10 weeks
Button Head Short	$125.00	18		$2,250.00	10 weeks
loading box	$800.00	1		$800.00	10 weeks
retainer for 3/4" Omniseal	$375.00	1		$375.00	10 weeks
bushing pairs	$60.00	72	11	$4,980.00	4 weeks
Part 2 Ceramic Socket Ball	$800.00	6		$4,800.00	4 weeks
Micropump (Brand) micropump service kit	$254.70	3		$764.10	2 weeks
Control Valve Spring	$4.73	5		$23.65	2 weeks
Control Valve Poppet	$16.52	5		$82.60	2 weeks
Control Valve Guide	$6.83	5		$34.15	2 weeks
micropump head	$577.80	1		$577.80	2 weeks
Micropump (brand) micropump	$1,043.10	1		$1,043.10	2 weeks
demineralizer holder	$374.33	1		$374.33	2 weeks
demineralizer cartridge	$88.13	1		$88.13	2 weeks
submicron filter	$81.25	2		$162.50	2 weeks
Tescom back pressure regulator (5-50 psi)	$975.00	1		$975.00	3 weeks
Conax feedthrough - 4 hole	$116.00	1	1	$232.00	2 weeks
Conax feedthrough - 8 hole	$173.00	3	1	$692.00	2 weeks
Conax feedthrough - 8 hole repl. Packing	$37.00	1		$37.00	2 weeks
Conax feedthrough - 4 hole repl. packing	$21.00	1		$21.00	2 weeks
Ceramic (TIZ) wire sheath (4 ft)	$36.12	120		$4,334.40	8 weeks
Brooks Sho-Rate water flow meter	$444.00	1		$444.00	3 weeks
rectangle carboy with spigot	$258.75	1		$258.75	1 week
fluid injection pump motor	$731.00	1		$731.00	6 weeks
fluid injection pump adapter kit	$32.00	1		$32.00	2 weeks
fluid injection pump head	$515.00	1		$515.00	2 weeks
fluid injection pump head replacement lip seal	$3.80	5		$19.00	2 weeks
fluid injection pump head replacement gland washer	$3.80	5		$19.00	2 weeks
DB9 to DB9 ribbon cable (Skala to PC)	$1.00	1	1	$2.00	1 week
custom parallel port cable	$1.00	1	1	$2.00	1 week
custom MUX <-> DVM interconnect	$1.00	1	1	$2.00	1 week
gas bubbler for mixing column	$50.00	1		$50.00	6 weeks
solid state polarity switching modules	$1.00	1		$1.00	2 weeks
autoclave heating mantle	$1,420.00	3		$4,260.00	8-10 weeks
autoclave insulating cap	$512.00	1		$512.00	8-10 weeks
PID Coolant Temperature Controller	$1,552.00	1		$1,552.00	2 weeks
safety head for rupture disk	$124.00	1		$124.00	2 weeks
12 liter autoclave	$41,620.00	1		$41,620.00	12 weeks
autoclave spare gasket kit	$215.00	4		$860.00	6 weeks
1-1/4 Cap Screw	$99.00	8		$792.00	6 weeks
ASME pressure qualification for autoclaves	$1,800.00	1		$1,800.00	6 weeks
3" Swivel Stem Casters for Pulsafeeder	$5.12	4		$20.48	1 week
Skala servo-electric testing system	$29,600.00	1		$29,600.00	2 weeks
preheater body for high pressure water	$2,585.00	1		$2,585.00	5 weeks
CW System: Grade 8 Alloy Steel Hex Head Cap Screw Zinc Yellow Pltd, 3/4"-10 Thrd, 2-1/2" L, Fully Thrd	$1.65	10		$16.50	1 week
CW System: 3/4" - 10 SS Nut	$0.70	10		$7.00	1 week
CW System: 300 Series SS MS35338 Split Lock Washer 3/4" Screw Size, Dash #146, 1.27" OD	$0.39	10		$3.90	1 week
CW System: Ultra-Coated Grade 8 Steel SAE Flat Washer 3/4" Screw Size, 1-15/32" OD, .12"-.18" Thick	$0.18	20		$3.60	1 week
CW System: Grade 8 Alloy Steel Hex Head Cap Screw Zinc Yellow- Plated, 1/4"-20 Thread, 1-1/4" Length	$0.12	25		$3.00	1 week
CW System: Grade 8 Steel Nylon-Insert Hex Locknut Znc- Yellow Pltd, 1/4"-20 Thrd Sz, 7/16" W, 5/16" H	$0.05	25		$1.25	1 week
CW System: Zinc & Yellow Grade 8 Steel Flat Washer SAE, 1/4" Screw Size, 5/8" OD, .05"-.08" Thick	$0.03	25		$0.75	1 week
CW System: Type 316 Stainless Steel Heavy Hex Nut 1"-8 Thread Size, 1-5/8" Width, 63/64" Height	$7.80	1		$7.80	1 week
CW System: Grade 8 Alloy Steel Hex Head Cap Screw Zinc Yellow- Plated, 1"-8 Thread, 8" Length	$10.50	1		$10.50	1 week
CW System: 300 Series SS MIL Spec Flat Washer 1" Size, 2" OD, .06"-.10" Thk, NASM/MS15795-826	$0.95	4		$3.80	1 week
3/4-10 x 1 1/2 hex bolt grade 8	$1.05	8		$8.40	1 week
3/4-10 x 2 1/2 hex bolt stainless steel	$2.90	4		$11.60	1 week
3/4-10 x 2 1/4 hex bolt stainless steel	$2.54	4		$10.16	1 week
1/2"-13 x 1 1/4" SS bolts: autoclave to plate	$0.48	4		$1.92	1 week
1/2"-13 x 2 1/4" SS bolts: Skala to plate	$0.94	3		$2.82	1 week
3/4 flat washer f436	$0.16	16		$2.56	1 week
1/2" SS washers: betw autoclave and plate	$0.26	7		$1.82	1 week
3/4-10 hex nut stainless steel	$0.70	16		$11.20	1 week
1/2" malleable bevel washers	$0.60	16		$9.60	2 week
LCD monitor for PC	$192.00	1		$192.00	2 weeks
PCI-GPIB board + one 2 meter 488 cable	$625.00	1		$625.00	2 weeks
1 meter IEEE488 cable	$80.00	2		$160.00	5 weeks
Crydom solid state relays for solid state switch	$75.18	4	4	$601.44	1 week
Crydom solid state relays for power to heaters	$44.05	2	2	$176.20	1 week
external power switch for Watlow controllers	$0.69	4	1	$3.45	1 week
light socket for blanket/preheat power indicator	$8.76	4	1	$43.80	1 week
panel mount fuse holders	$2.08	2	1	$6.24	1 week
0.5 A fast acting fuses	$0.15	2	2	$0.60	1 week
12 AWG power cords for heaters (25 ft)	$47.04	5		$235.20	1 week
18 AWG power cord for Watlows (xx ft)	$7.14	1		$7.14	1 week
DCPD MUX Card replacment channel	$2.19	3		$6.57	1 week
DCPD MUX Card replacment bank relay	$2.12	3		$6.36	1 week
RG-174/U cable 50 ft	$92.22	1		$92.22	1 week
BNC female RG-174 panel plug isolated pomona	$3.85	20		$77.00	1 week
BNC male RG-174 plug amphenol	$2.88	20		$57.60	1 week
Electronics Racks	$1,270.50	1		$1,270.50	12 weeks
Type J TC female round panel jacks	$2.40	3	1	$9.60	1 week
Type J 20 AWG twisted shielded TC wire 50 ft	$75.00	1		$75.00	1 week
Type J standard size male plug w/label	$2.50	6	1	$17.50	1 week
Type J standard size female plug w/label	$3.60	3	1	$14.40	1 week
Type J Inconel sheathed TCs with 18" probe	$34.00	3	1	$136.00	1 week
low pressure gauge (60 psi)	$160.00	3		$480.00	2 weeks
low pressure gauge (60 psi)	$145.00	1		$145.00	2 weeks
high pressure gauge (3000 psi)	$200.00	2		$400.00	9 weeks
Heinemann 20A breaker/switch for preheater	$34.07	2		$68.14	2 weeks
clear lens for power indicator light	$4.70	20		$94.00	1 week
red cluster based LED indicator light	$6.56	4	1	$32.80	10 weeks
Blacoh Sentry pulsation dammper	$1,926.00	1		$1,926.00	3 weeks
Replacement bladder for Blacoh	$567.00	1		$567.00	1 week
Blacoh inlet stabilizer	$573.00	1		$573.00	5 weeks
SS tubing (oxygen service)	$3,059.75	1		$3,059.75	1 week
custom SS switch power cable	$1.00	1	1	$2.00	1 week
strain relief bushings for large power cord	$1.00	5		$5.00	1 week
strain relief bushing for small power cord	$1.00	2		$2.00	1 week
15 or 20 terminal barrier strips	$1.00	2		$2.00	1 week
hookup wire	$1.00	1		$1.00	1 week
wire connectors	$1.00	1		$1.00	1 week
wire straps and holders	$1.00	1		$1.00	1 week
Heinemann 30A breaker/switch for blanket	$24.05	0		$0.00	2 weeks
1/4" Omniseal	$75.67	1		$75.67	6 weeks
glass column	$975.00	2		$1,950.00	2 weeks
glass column gaskets	$18.00	1.5		$27.00	2 weeks
glass column flange/coupling	$70.00	0.5		$35.00	2 weeks
platinum wire - 0.020" (24 awg)	$82.10	60		$4,926.00	3 week
platinum wire - 0.032" (20 awg)	$204.80	40		$8,192.00	3 week
all Swagelok fittings (oxygen service)	$10,827.07	1		$10,827.07	3 weeks
Swagelok BPR	$551.84	1		$551.84	5 weeks
Agilent current source	$2,293.56	1		$2,293.56	3 weeks
Agilent voltmeter	$4,008.44	1		$4,008.44	2 weeks
Agilent MUX	$1,608.16	1		$1,608.16	2 weeks
Agilent MUX card	$483.00	1		$483.00	2 weeks
Thornton conductivity sensor flow chamber	$268.00	5		$1,340.00	3 weeks
Thornton conductivity sensor	$431.00	2		$862.00	3 weeks
M300 Thornton Multiparameter	$1,678.00	1		$1,678.00	3 weeks
M300 Multiparameter panel mount kit	$63.00	1		$63.00	3 weeks
M300 parameter 5' patch cord	$92.00	2		$184.00	3 weeks
Pulsafeeder pump	$6,153.90	1		$6,153.90	5 weeks
Pulsafeeder service kit	$775.00	1		$775.00	5 weeks
Pulsafeeder input shaft cover plate shim set	$14.00	2		$28.00	5 weeks
Pulsalube oil #1, 1GAL (for servicing)	$53.00	2		$106.00	5 weeks
Direct I/O to control serial port	$22.00	1		$22.00	1 week
PTFE wire sheath - 24 awg - 4 ft	$13.55	9		$121.95	1 week

COLOR CODING

- Items that need configuring
- Items in Process of ordering
- Quote Request Sent
- Order Placed
- Item Arrived
- Items Manufactured On Site/or GE

MONTHLY LETTER STATUS REPORT

Reporting Period Start Date **June 27, 2015**		**Reporting Period End Date** **July 24, 2015**
NRC Agreement Number **NRC-HQ-60-14-D-0014**	**Task Order Number (if applicable)** **N/A**	**Common Cost Center Code**
Project Title **Crack Initiation Testing for Primary Water Stress Corrosion Cracking**		
Period of Performance Start Date **August 18, 2014**		**Period of Performance End Date** **October 31, 2015**
COR **Eric Focht**	**Telephone** **(301) 251-7649**	**E-mail** **eric.focht@nrc.gov**
DOE Laboratory **Pacific Northwest National Laboratory (PNNL)**		
DOE Site Address **Pacific Northwest Site Office, PO Box 350/MS K9-42, Richland, WA 99352**		
Principal Investigator **Stephen Bruemmer**	**Telephone** **(509) 371-7361**	**E-mail** **stephen.bruemmer@pnnl.gov**

Financial Status Section

A. Overall Funding

Current Monthly Costs:	$47,738
Total Ceiling Amount:	$985,000
Total Amount of Funds Obligated to Date:	$984,638
Total Amount of Funds Expended to Date:	$840,264
Percentage of Funds Expended to Date:	85%
Balance of Obligated Funds Remaining:	$144,374
Total Estimated Encumbered Costs:	$0
Balance Available Less Estimated Encumbered Costs:	$144,374

B. DOE Laboratory Acquired Property

No single item costing more than $5,000 was received this month.

Description*	Quan.	Manufacturer	Model Number	Serial Nums.	Tot. Acq. Cost ($) [unburdened]	Receipt Date	Property Identification Number
Low Pressure Back Pressure Regulators	2	BRANOM INSTRUMENTS	26-2360-24-043	01665317, 01665322	$2,164	5/12/15	Will become part of the complete test system that will receive a single property identification number
High Pressure Back Pressure Regulators	2	BRANOM INSTRUMENTS	26-1763-24-114	01674017, 01674016	$2,649	5/12/15	See above
Load train support pieces	2 sets	Applied Test Systems	N/A	N/A	$25,987	7/16/15	See above

* Asterisk is to be added to item description to indicate sensitive software.

C. NRC-Funded Software Developed

Nothing in this area.

Name*	Function	Development Cost ($)	Computer Language Used	Operating System	Location of System	Date Software Completed	Date of Scheduled Replacement/Useful Life
N/A							

*Asterisk is to be used to indicate sensitive software.

Technical Status Section

A. Deliverables/Milestones Schedule

Deliverable	Description	Planned Completion Date	Revised Completion Date (if applicable)	Actual Completion Date
1	Test plan will be completed and submitted to the NRC for review.	Within 3 months of the contract award	not applicable	11/19/2014
2	Two SCC initiation test systems will be designed and assembled, and test viability demonstrated.	Within 12 months of the contract award	October 30, 2015	
3	A technical letter report will be submitted to the NRC detailing the test equipment and capabilities for SCC initiation experimentation.	Within one 1 month of completion of Deliverable 2	on track	

B. Progress During Reporting Period

A no-cost time extension through January 31, 2016 was awarded during this reporting period.

Task 1 - Identification and Acquisition of Materials for the Test Matrix

Overview of Material Requirements

For the current draft test plan, one autoclave is expected to be dedicated to alloy 600/182 tests and the other for alloy 690/152/52(x) tests. Each autoclave can hold 36 specimens. The tentative loading plan for these autoclave systems is as follows:

Alloy 600/182 autoclave

- First loading: Four different alloy 182 welds. For each weld, there will be 6 specimens in the 15% CF condition and 3 in the as-welded condition.
- Second loading: Stress effects will be considered with specimens loaded to a fraction of their yield stress. Current plan is the same four alloy 182 welds, all in a 15% CF condition. The exact number of specimens for each weld is to-be-determined.
- Third loading: Four heats of alloy 600. Each heat will have 9 specimens in the 15% CF condition.

Alloy 690/152/52(x) autoclave

- First and only loading: Four heats of alloy 690 with 3 specimens per heat and four heats of alloy 152/52(x) with 6 specimens per heat. All specimens will be in the 15% CF condition.

Progress on Acquisition of Materials and Forging

The candidate four heats/welds for each class of material are shown in Table 1. All materials have been received.

Table 1. Candidate heats/welds for each class of material.

Alloy 182	
NRC/PNNL Phase 2B DMW Mockup	NRC/PNNL Flawtech DMW Mockup
Studsvik Buildup	KAPL U-Groove
Alloy 600	
Spec. Met. NX6106XK-11 MA Plate	ATI 522068 MA Bar
G.O. Carlson 33375-2B MA Plate	WNP5 CRDM Tube
Alloy 152/52	
MHI Alloy 152 U-Groove Mockup	MHI Alloy 52 U-Groove Mockup
ENSA DPM Alloy 52M Butter	EPRI Alloy 152M U-Groove
Alloy 690	
Valinox RE243 TT CRDM Tube	Valinox WP142 TT CRDM Tube
TK-VDM 114092 TT Plate	Allvac B25K-2 MA Bar

Roughly 50 blocks of material need to be prepared and forged for this program. Rather than preparing and forged all the blocks at once, the work is being broken down into smaller overlapping groups. Forging status for each of the materials is tracked in Table 2. Forging of the alloy 182 KAPL U-groove, the alloy 600 33375-2B plate, and the alloy 52M ENSA DPM butter were all completed this month. The only remaining item to be forged is the alloy 152M EPRI U-groove. Preparations are underway with completion expected in late August. A summary of all materials acquisitions and forging activities is listed in the attached table at the end of the document.

Table 2. Status of forging for each of the materials.

Alloy 182	
NRC/PNNL Phase 2B DMW Mockup*	**NRC/PNNL Flawtech DMW Mockup**
Studsvik Buildup	**KAPL U-Groove**
Alloy 600	
Spec. Met. NX6106XK-11 MA Plate	**ATI 522068 MA Bar**
G.O. Carlson 33375-2B MA Plate	**WNP5 CRDM Tube**
Alloy 152/52	
MHI Alloy 152 U-Groove Mockup	**MHI Alloy 52 U-Groove Mockup**
ENSA DPM Alloy 52M Butter	**EPRI Alloy 152M U-Groove****
Alloy 690	
Valinox RE243 TT CRDM Tube	**Valinox WP142 TT CRDM Tube**
TK-VDM 114092 TT Plate	**Allvac B25K-2 MA Bar**

* Green = complete

** Blue = in-progress

Tensile Testing for Gauge Diameter Determination

Because the multispecimen test system applies the same load to each specimen, in order to have each material at its yield strength for the initiation test, the yield strength needs to be measured at 360°C in advance so that an appropriate gauge diameter can be selected for the planned applied load (1000 lbs). This activity ramped up last month with measurements completed on all the cold forged materials except the alloy 600 33375-2B and the EPRI alloy 152M that was just received this reporting period. Testing of these two materials and the as-welded alloy 182 materials will be performed next month. Preliminary yield strength numbers are provided in Table 3. For some materials, two tests were conducted with the 0.2% offset yield strength typically differing by no more than 20 MPa.

Material Characterizations

As part of materials characterization activities, SCC CGR tests have been or will be performed on the materials to determine the range of SCC crack growth susceptibility. While SCC initiation is not expected for the alloy 690/152/52 materials, knowing the SCC crack growth susceptibility is important to help understand whether the materials being tested are representative. Among the alloy 690/152/52 materials that have been selected for this study, all but the ENSA DPM alloy 52M butter and the EPRI alloy 152M V-groove have been SCC tested in their as-made condition with all showing high resistance that is typical of non-CW alloy 690 and alloy 152/52.

All of the alloy 600/182 materials are expected to be SCC crack growth rate tested in their as-made condition. The alloy 600 NX6106XK-11, the Flawtech alloy 182, and the Studsvik alloy 182 are all currently being SCC CGR tested and are showing average or high SCC susceptibility. Testing of the Phase 2B alloy 182 and the KAPL alloy 182 began in late July. This test is starting at a low stress intensity of 10 MPa$\sqrt{m}$ to provide crack growth rates were found to be relevant to the critical crack length for SCC initiation in cold worked alloy 600. Since the alloy 600 materials will not undergo SCC initiation testing until later in the program, their SCC crack growth rate susceptibility will be assessed after starting the initiation tests on the alloy 690/152/52 and alloy 182 materials.

Other characterization activities include determining the hardness and surveying the microstructures. For the welds, the microstructure survey will include determination of the flaw concentration, if any. Optical metallography, SEM examinations, and hardness measurements are all underway. Hardness and SCC CGR measurements are being populated in Table 3. For this month, hardness measurements were completed on the alloy 152 and alloy 52 MHI materials.

Task 2 - Development of Experimental Test Plan

A suggested test plan was completed and submitted on time. Comments have been received back from an expert panel that has reviewed the proposal. Responses to these comments were prepared and provided to the NRC and EPRI in February. After discussions with the NRC and EPRI in March, the test plan document was revised and submitted to the NRC for a second round of review. Final comments from the NRC on the revised test plan were received in July. The test plan will be updated for these final comments in August and then will be provided to EPRI for their comment. It is expected that it will lastly go back to the Expert Panel for any final comment.

Table 3. Hardness, 360°C yield strength, and SCC CGR results for the candidate materials.

Material	ID	Condition	Hardness (kg/mm^2)	YS@360°C (MPa)	SCC CGR (mm/s)†
Alloy 182 Buildup	Studsvik	AW	*	*	~1e-07**
		15%CF	240-345	550	
Alloy 182 Nozzle DMW	Flawtech 844305	AW	*	*	~3e-08**
		15%CF	225-345	520	
Alloy 182 Nozzle DMW	Phase 2B	AW	*	*	**
		15%CF	225-330	480	
Alloy 182 V-Groove	KAPL 823030	AW	*	*	**
		15%CF	*	585	
Alloy 600 Plate	NX6016XK-11	MA	*	310	~3e-08**
		15%CF	265	575	*
Alloy 600 Plate	522068	MA			
		15%CF	*	450	
Alloy 600 Plate	33375-2B	MA			
		15%CF	*	*	
Alloy 600 CRDM	WNP5	MA			
		15%CF	*	520	
Alloy 152 U-groove	MHI 307380	AW			<1e-09
		15%CF	225-345	520	
Alloy 52 U-Groove	MHI NX2686JK	AW			<1e-09
		15%CF	225-315	485	
Alloy 52M Butter	ENSA DPM Butter	AW			
		15%CF	*	435	
Alloy 152M U-Groove	EPRI	AW			
		15%CF	*	*	
Alloy 690 CRDM	RE243	TT	155		<1e-09
		15%CF	240	425	
Alloy 690 CRDM	WP142	TT	163		<1e-09
		15%CF	247	470	
Alloy 690 Plate	114092	TT	165		<1e-09
		15%CF	*	575	
Alloy 690 Plate	B25K-2	MA	173		1.1e-09
		15%CF	270	515	

† 25-30 MPa$\sqrt{m}$
* Specimens being prepared
** Ongoing test

Task 3 - Design, Construction, and Validation of SCC Initiation Test Systems

Overview

These test systems will be closely based on a 36 tensile specimen test system designed and constructed for the DOE-NE LWRS program. The DOE-NE LWRS system can monitor 12 specimens for in-situ SCC initiation. The key design change underway for the new systems is increasing the number of specimens that can be instrumented for in-situ detection of SCC initiation or for in-situ detection of failure. A larger diameter autoclave with more ports for wiring feedthroughs is being designed and constructed to enable this. Changes are also being made to the load line and the wiring feedthroughs to make the task of instrumenting all 36 specimens potentially manageable.

The test systems are built in-house at PNNL using a combination of off-the-shelf and custom-made parts. Each test system is constructed of ~140 unique parts from ~30 different vendors. A spreadsheet showing the status of all items needed to build the test system is attached at the end of this document.

Laboratory expansion is needed to make room for these two new test systems along with two more test systems for another NRC program. A lab adjacent to the current SCC lab has been made available for this. New electrical drops, specialty gas drops, pressure relief lines, and chilled water lines be installed, and an increase in room ventilation is also needed to accommodate the waste heat released by the test systems. Since this new lab space has a low ceiling that cannot accommodate the large multi-specimen initiation test systems, several existing SCC CGR test systems, which are not as tall, will be moved into the new lab space, and the new multi-specimen SCC initiation systems will be installed in the existing SCC lab. This activity was completed on 4/13/2015.

The first phase of the test system assembly involves fabricating major components such as the heater controllers and load frames. This work was done in-house by PNNL crafts and is complete.

The second phase of test system assembly includes having the pipefitters install the stainless steel tubing, filtration equipment, and glass columns on to each water board. This will be followed by installation of the high pressure pumps. Research staff, with assistance from crafts support, will install the autoclaves and servo electric load frame in the test frames. Research staff will also finish installing the electronics into each electronics rack.

The final stages of assembly will include installation of the load train, installation of the DCPD wiring, and making all the connections from the electronics rack to either the test frame or waterboard. Each system will then be ready to shakedown testing. Activities were will include leak-checking of all stainless steel connections, programming the heater and chilled water controllers, loading autoclave with dummy specimens, heating autoclave and preheater up to operating temperatures, and checking the servo-electric load frame and DCPD system for proper operation. These steps to completion of assembly are summarized in Table 4.

Updates

Phase 2 activities continue to take place at a slower than desired pace due in part to late arrival of some key equipment but also due in part to lack of Crafts personnel availability. Crafts personnel have been authorized to work overtime as needed to stop any further slippage of the target dates. The time needed to complete the remaining activities was carefully considered with Table 4 showing the updated timeline for all the activities needed to complete the test systems and begin the first tests.

Table 4. Timeline for assembly of the SCC initiation test systems.

Activity	Planned Start	Actual Start	Planned Completion	Actual Completion	Comments
Order Parts Components	9/1/14	9/1/14	12/31/14	3/27/15	Completed
Phase 1 System Assembly	12/1/14	12/1/14	1/31/15	3/13/15	Completed
Lab Mods	2/1/15	2/23/15	3/1/15	4/10/15	Completed
Phase 2 System Assembly	1/31/15-3/1/15	est. 4/13/15	4/1/15	est. 8/19/15	
Final System Assembly	4/1/15	est. 8/19/15	5/1/15	est. 9/02/15	
Shakedown Testing	5/1/15	est. 9/02/15	6/10/15	est. 9/29/15	
First Project Test Setup	6/10/15	est. 9/30/15	7/1/15	est. 10/18/15	
First SCC Initiation Tests	7/1/15	est. 10/18/15	1/1/16	est. 5/1/16	

C. Travel

None.

D. Description of Estimated Encumbered Costs

No reportable encumbered costs for this month.

E. Anticipated and Encountered Problem Areas

None.

F. Plans for the Next Reporting Period

Task 1 - Materials acquisitions, forging, and specimen fabrication will continue with the majority of the effort directed at preparing initiation specimens for the first autoclave loadings. Work will continue for characterizing SCC response, yield strength measurements, and hardness measurements to aid in material selection and validation.

Task 2 - Original scope complete, test plan revisions have been made, and comments have been received back from the NRC. After incorporating their comments, the updated test plan will go to EPRI and Expert Panel for their final review.

Task 3 - Parts acquisition and test system construction will continue.

Travel and Meetings - A project status meeting will be held at PNNL with EPRI personnel either near the end of the August reporting period or near the start of the September reporting period. NRC personnel will attend by teleconference.

Spending Plan

Month/Year	13-Oct	13-Nov	13-Dec	14-Jan	14-Feb	14-Mar	14-Apr	14-May	14-Jun	14-Jul	14-Aug	14-Sep
Planned ($)											100,000	580,638
Revised ($)											0	21,936
Actual ($)											0	21,936
Variance (%)											0.00%	0.00%
Month/Year	14-Oct	14-Nov	14-Dec	15-Jan	15-Feb	15-Mar	15-Apr	15-May	15-Jun	15-Jul	15-Aug	15-Sep
Planned ($)	0	0	0	60,000	60,000	50,000	40,000	30,000	20,000	15,000	15,000	14,362
Revised ($)	71,694	55,422	143,260	140,515	54,635	64,843	65,000	65,000	65,000	70,000	65,000	55,000
Actual ($)	71,694	55,422	143,260	140,515	54,635	64,843	57,871	51,403	130,948	47,738		
Variance (%)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-10.97%	-20.92%	101.46%	-31.80%		
Month/Year	15-Oct											
Planned ($)	0											
Revised ($)	47,696											
Actual ($)												
Variance (%)	-100.00%											
TOTAL												
Planned ($)	985,000											
Revised ($)	985,000											
Actual ($)	840,264											

Variance Narrative - None.

NRC/EPRI SCC Initiation Program Materials Matrix as of 7/24/2015.

Alloy Class and Material Name	Top 4 Candidate?	Reason	Description/Form	Dimensions	Alloy Vendor	Heat Number	CMTR?	Weld Fabricator	WPS	At PNNL?	Number of Possible Specimens	Microstructure Characterized?	Have SCC CGR Data?	# CF Initiation Specimens Needed	# CF CT Specimens Needed	# CF Initiation Specimens Per Block	# CF Blocks Needed	Number of Blocks Forged	Additional Forged Blocks Needed	CF Slice removed for Met, EBSD, HV?
Alloy 182																				
PNNL/NRC Phase 2B Mockup	**yes**	**well-documented mockup**	LAS-SS DMW with alloy 182 butter and fill	circumferential pipe buttweld, 15" OD x 1.5" wall	TBD	TBD	TBD	EWI	yes	yes	50	no	In-progress	18	1	3	7	7	**0**	complete
PNNL/Flawtech/NRC Mockup	**yes**	**well-documented mockup**	LAS-SS DMW with alloy 182 butter and fill	circumferential pipe buttweld, 14" OD x 1.5" wall	Spec. Met.	844305	yes	Flawtech	yes	yes	90	no	yes	18	1	3	7	7	**0**	complete
Studsvik	**yes**	**well-documented mockup**	alloy 182 buildup	3"tall x 2.75" x 5"long	TBD	TBD	TBD	ENSA	yes	yes	64	no	yes	18	1	10	2	2	**0**	complete
KAPL	**yes**	**well-documented mockup**	alloy 182 U-groove	1.5"wide x 1.5"tall x 8"long	Techalloy	823030	yes	KAPL	yes	yes	25	no	In-progress	18	1	6	4	4	**0**	complete
EPRI weld		under consideration	alloy 182 groove	TBD	TBD	TBD	yes	TBD	yes	yes	TBD	no	no							
CRDM J-groove	no	too challenging to forge and extract initiation specimens	alloy 182 J-groove from dismantled partially built PWR	4.15"OD x 0.XX" thick x XX"tall	unknown	unknown	no	unknown	no	yes	none	no	no							
Alloy 600																				
PNNL Plate #1 (MA)	**yes**	**prior SCCI data from LWRS**	2" thick plate	9.6x15x2" thick	Spec. Met.	NX6016XK-11	yes	N/A	N/A	yes	300	Met, SEM, TEM	In-progress	12	1	6	3	3	**0**	complete
PNNL Plate #3 (MA)	**yes**	**using for NRC Peening program**	3" thick plate	3x18x3" thick	ATI	522068	yes	N/A	N/A	yes	50	Met	planned	12	1	6	3	3	**0**	complete
KAPL Plate (MA)	**yes**	**vintage material**	vintage 2" thick plate	4x12x2" thick	G.O. Carlson	33375-2B	yes	N/A	N/A	yes	50	no	planned	12	1	6	3	3	**0**	complete
CRDM Tube	**yes**	**service material**	From dismantled partially built PWR	4.15"OD x 0.70" wall x 8" long	unknown	unknown	no	N/A	N/A	yes	50	Met	planned	12	1	5	2	2	**0**	complete
Foroni Bar	no	under consideration	6" dia. bar	6"OD x 12" long	Foroni	31907	yes	N/A	N/A	yes	100	No	no							planned
PNNL Plate #2 (MA)	no	other better candidates	2" thick plate	8x24x2" thick	ATI	521616	yes	N/A	N/A	yes	300	Met	no					3		
Alloy 152/52																				
MHI alloy 152 U-groove	**yes**	**have SCC CGR data**	U-groove weld joining SS	1.8"tall x 2"wide x 2.5" long	TK-VDM?	307380	yes	MHI	yes	yes	15	Met, SEM	yes	9	2	6	2	2	**0**	complete
MHI alloy 52 U-groove	**yes**	**have SCC CGR data**	U-groove weld joining SS	1.8"tall x 2"wide x 2.5" long	Spec. Met.	NX2686JK	yes	MHI	yes	yes	15	Met, SEM	yes	9	2	6	2	2	**0**	complete
ENSA DPM alloy 52M butter	**yes**	**sufficient material available**	Double bevel 690-LAS DMW, alloy 52M butter	0.75"tall x 2.7"wide x 4" long	unknown	unknown	no	ENSA	yes	yes	20	Met, SEM	no	9	2	3	4	4	**0**	complete
EPRI alloy 152M	**yes**	**favorable geometry, sufficient material**	TBD	TBD	TBD	TBD	yes	TBD	yes	yes	>40	no	no	9	2	3	4	0	**4**	planned
KAPL alloy 52M NG	no	too narrow	narrow gap weld joining alloy 690	1.8"tall x 0.5"wide x 1.1" long	Spec. Met.	NX5285TK	yes	KAPL	yes	yes	6	no	yes							
EPRI alloy 52i	no	not enough material	V-groove weld	1.8"tall x 0.75-1.25"wide x 1.5" long	TK-VDM	187775	yes	unknown		yes	9	no	no					1		
ENSA DPM alloy 52 fill	no	alloy 52 with prior SCC experience already identified	Double bevel 690-LAS DMW, alloy 52 fill	1.5"tall x 0.5-1.6"wide x 3" long	Spec. Met.	NX4196JK	yes	ENSA	yes	yes	20	Met, SEM	in-progress					1		
NRC alloy 52MSS NG	no	too narrow	narrow gap weld joining alloy 690	2"tall x 0.4-0.6" wide x 3.8" long	Spec. Met.	NX77W3UK	yes	PCI	yes	yes	18	no	yes							
Alloy 690																				
Valinox Alloy 690 CRDM RE243 (TT)	**yes**	**significant SCC CGR data**	CRDM	4.4"OD x 1.35"wall x 6" long	Valinox	RE243	no	N/A	N/A	yes	>20	Met, SEM, TEM, APT	yes	9	1	6	2	2	**0**	complete
Valinox Alloy 690 CRDM WP142 (TT)	**yes**	**have SCC CGR data, and substantial material**	CRDM	4.56"OD x 1.20"wall x 4" long	Valinox	WP142	no	N/A	N/A	yes	>20	Met, SEM, TEM	yes	9	1	6	2	2	**0**	complete
TK-VDM 114092 plate (TT)	**yes**	**have SCC CGR data**	plate	2"tall x 4"wide x 2.5" long	TK-VDM	114092	yes	N/A	N/A	yes	>20	Met, SEM, TEM	yes	9	1	6	2	2	**0**	complete
ATI/Allvac B25K-2 (MA)	**yes**	**have SCC CGR data**	plate	3"thick x 5.5"wide x 2.2" long	ATI/Allvac	B25K-2	yes	N/A	N/A	yes	>20	Met, SEM, TEM	yes	9	1	6	2	2	**0**	complete
Doosan CRDM bar (TT)	no	insufficient material for additional tests	CRDM	6"OD x 2.5" long	TK-VDM	133454	yes	N/A	N/A	yes	12	Met, SEM, TEM	yes					1		
EPRI NX8625HG21 (TT)	no	no SCC data, other better candidates	plate	12x12x1.24" thick	Spec. Met.	NX8625HG21		N/A	N/A	yes	>20	no	no							

MONTHLY LETTER STATUS REPORT

Reporting Period Start Date **May 23, 2015**		**Reporting Period End Date** **June 26, 2015**
NRC Agreement Number **NRC-HQ-60-14-D-0014**	**Task Order Number (if applicable)** **N/A**	**Common Cost Center Code**
Project Title **Crack Initiation Testing for Primary Water Stress Corrosion Cracking**		
Period of Performance Start Date **August 18, 2014**		**Period of Performance End Date** **October 31, 2015**
COR **Eric Focht**	**Telephone** **(301) 251-7649**	**E-mail** **eric.focht@nrc.gov**
DOE Laboratory **Pacific Northwest National Laboratory (PNNL)**		
DOE Site Address **Pacific Northwest Site Office, PO Box 350/MS K9-42, Richland, WA 99352**		
Principal Investigator **Stephen Bruemmer**	**Telephone** **(509) 371-7361**	**E-mail** **stephen.bruemmer@pnnl.gov**

Financial Status Section

A. Overall Funding

Current Monthly Costs:
Total Ceiling Amount:
Total Amount of Funds Obligated to Date:
Total Amount of Funds Expended to Date:
Percentage of Funds Expended to Date:
Balance of Obligated Funds Remaining:
Total Estimated Encumbered Costs:
Balance Available Less Estimated Encumbered Costs:

B. DOE Laboratory Acquired Property

No single item costing more than $5,000 was received this month. The autoclave and the remaining portion of the load train are the two most expensive items and are not expected to arrive until the end of April or early May.

Description*	Quan.	Manufacturer	Model Number	Serial Nums.	Tot. Acq. Cost ($)	Receipt Date	Property Identification Number
Autoclave	2	High Pressure Equipment	803173	D0373633-1 D0373633-2	$79,048	06/10/2015	Will become part of the complete test system that will receive a single property identification number

* Asterisk is to be added to item description to indicate sensitive software.

C. NRC-Funded Software Developed

Nothing in this area.

Name*	Function	Development Cost ($)	Computer Language Used	Operating System	Location of System	Date Software Completed	Date of Scheduled Replacement/Useful Life
N/A							

*Asterisk is to be used to indicate sensitive software.

Technical Status Section

A. Deliverables/Milestones Schedule

Deliverable	Description	Planned Completion Date	Revised Completion Date (if applicable)	Actual Completion Date
1	Test plan will be completed and submitted to the NRC for review.	Within 3 months of the contract award	not applicable	11/19/2014
2	Two SCC initiation test systems will be designed and assembled, and test viability demonstrated.	Within 12 months of the contract award	on track	
3	A technical letter report will be submitted to the NRC detailing the test equipment and capabilities for SCC initiation experimentation.	Within one 1 month of completion of Deliverable 2	on track	

B. Progress During Reporting Period

Task 1 - Identification and Acquisition of Materials for the Test Matrix

Overview of Material Requirements

For the current draft test plan, one autoclave is expected to be dedicated to alloy 600/182 tests and the other for alloy 690/152/52(x) tests. Each autoclave can hold 36 specimens. The tentative loading plan for these autoclave systems is as follows:

Alloy 600/182 autoclave

- First loading: Four different alloy 182 welds. For each weld, there will be 6 specimens in the 15% CF condition and 3 in the as-welded condition.
- Second loading: Stress effects will be considered with specimens loaded to a fraction of their yield stress. Current plan is the same four alloy 182 welds, all in a 15% CF condition. The exact number of specimens for each weld is to-be-determined.
- Third loading: Four heats of alloy 600. Each heat will have 9 specimens in the 15% CF condition.

Alloy 690/152/52(x) autoclave

- First and only loading: Four heats of alloy 690 with 3 specimens per heat and four heats of alloy 152/52(x) with six specimens per heat. All specimens will be in the 15% CF condition.

Progress on Acquisition of Materials and Forging

The candidate four heats/welds for each class of material are shown in Table 1. The only material yet to be delivered is the EPRI alloy 152M V-groove that is expected in early July.

Table 1. Candidate heats/welds for each class of material.

Alloy 182	
NRC/PNNL Phase 2B DMW Mockup	NRC/PNNL Flawtech DMW Mockup
Studsvik Buildup	KAPL U-Groove
Alloy 600	
Spec. Met. NX6106XK-11 MA Plate	ATI 522068 MA Bar
G.O. Carlson 33375-2B MA Plate	WNP5 CRDM Tube
Alloy 152/52	
MHI Alloy 152 U-Groove Mockup	MHI Alloy 52 U-Groove Mockup
ENSA DPM Alloy 52M Butter	EPRI Alloy 152M V-Groove
Alloy 690	
Valinox RE243 TT CRDM Tube	Valinox WP142 TT CRDM Tube
TK-VDM 114092 TT Plate	Allvac B25K-2 MA Bar

Roughly 50 blocks need to be prepared and forged for this program. Rather than preparing and forged all the blocks at once, the work is being broken down into smaller overlapping groups. Forging status for each of the materials is tracked in Table 2. There is no change in status for the forging this month with all the blue items still in-progress. Forged blocks for all the blue materials are expected next reporting period. A summary of all materials acquisitions and forging activities is listed in the attached table at the end of the document.

Table 2. Status of forging for each of the materials.

Alloy 182	
NRC/PNNL Phase 2B DMW Mockup*	**NRC/PNNL Flawtech DMW Mockup**
Studsvik Buildup	**KAPL U-Groove****
Alloy 600	
Spec. Met. NX6106XK-11 MA Plate	**ATI 522068 MA Bar**
G.O. Carlson 33375-2B MA Plate	**WNP5 CRDM Tube**
Alloy 152/52	
MHI Alloy 152 U-Groove Mockup	**MHI Alloy 52 U-Groove Mockup**
ENSA DPM Alloy 52M Butter	**EPRI Alloy 152M V-Groove*****
Alloy 690	
Valinox RE243 TT CRDM Tube	**Valinox WP142 TT CRDM Tube**
TK-VDM 114092 TT Plate	**Allvac B25K-2 MA Bar**

* Green = complete
** Blue = in-progress
*** Red = waiting on material

Material Characterizations

As part of materials characterization activities, SCC CGR tests have been or will be performed on the materials to determine the range of SCC crack growth susceptibility. While SCC initiation is not expected for the alloy 690/152/52 materials, knowing the SCC crack growth susceptibility is important to help understand whether the materials being tested are representative. Among the alloy 690/152/52 materials that have been selected for this study, all but the ENSA DPM alloy 52M butter and the EPRI alloy 152M V-groove have been SCC tested in their as-made condition with all showing high resistance that is typical of non-CW alloy 690 and alloy 152/52.

All of the alloy 600/182 materials are expected to be SCC crack growth rate tested in their as-made condition. The alloy 600 NX6106XK-11, the Flawtech alloy 182, and the Studsvik alloy 182 are all currently being SCC CGR tested and are showing average or high SCC susceptibility. Testing of the Phase 2B alloy 182 and the KAPL alloy 182 is expected to be begin in early July. Since the alloy 600 materials will not undergo SCC initiation testing until later in the program, their SCC crack growth rate susceptibility will be assessed after starting the initiation tests on the alloy 690/152/52 and alloy 182 materials.

Other characterization activities include determining the hardness and yield strength of the cold-forged materials and surveying the microstructures of all the materials. For the welds, the microstructure survey will include determination of the flaw concentration, if any. Optical metallography, SEM examinations, hardness measurements, and YS measurements are all underway. Yield strength, hardness, and SCC CGR measurements are being populated in Table 3.

Updates

Progress this month consisted of machining of specimens for yield strength testing. Specimens from four different 15% CF materials have been machined and are expected to be YS tested in July.

Task 2 - Development of Experimental Test Plan

A suggested test plan was completed and submitted on time. Comments have been received back from an expert panel that has reviewed the proposal. Responses to these comments were prepared and provided to the NRC and EPRI in February. After discussions with the NRC and EPRI in March, the test plan document was revised and submitted to the NRC for a second round of review. After receiving any final comments from the NRC (expected in July), the test plan will be provided to EPRI for comment, and then presumably it will go back to the Expert Panel for any final comment.

Table 3. Hardness, 360°C yield strength, and SCC CGR results for the candidate materials.

Material	ID	Condition	Hardness (kg/mm^2)	YS@360°C (MPa)	SCC CGR (mm/s)†
Alloy 182 Buildup	Studsvik	AW	*		~1e-07**
		15%CF	240-345	*	
Alloy 182 Nozzle DMW	Flawtech 844305	AW	*		~3e-08**
		15%CF	225-345	*	
Alloy 182 Nozzle DMW	Phase 2B	AW	*		*
		15%CF	225-330	*	
Alloy 182 V-Groove	KAPL 823030	AW	*		*
		15%CF	*		
Alloy 600 Plate	NX6016XK-11	MA	*	310	~3e-08**
		15%CF	265	*	*
Alloy 600 Plate	522068	MA			
		15%CF	*	*	
Alloy 600 Plate	33375-2B	MA			
		15%CF			
Alloy 600 CRDM	WNP5	MA			
		15%CF	*	*	
Alloy 152 U-groove	MHI 307380	AW			<1e-09
		15%CF	*	*	
Alloy 52 U-Groove	MHI NX2686JK	AW			<1e-09
		15%CF	*	*	
Alloy 52M Butter	ENSA DPM Butter	AW			
		15%CF	*	*	
Alloy 152M V-Groove	EPRI	AW			
		15%CF			
Alloy 690 CRDM	RE243	TT	155		<1e-09
		15%CF	240	*	
Alloy 690 CRDM	WP142	TT	163		<1e-09
		15%CF	247	*	
Alloy 690 Plate	114092	TT	165		<1e-09
		15%CF	*	*	
Alloy 690 Plate	B25K-2	MA	173		1.1e-09
		15%CF	270	*	

† 25-30 MPa√m
* Specimens being prepared
** Ongoing test

Task 3 - Design, Construction, and Validation of SCC Initiation Test Systems

Overview

These test systems will be closely based on a 36 tensile specimen test system designed and constructed for the DOE-NE LWRS program. The DOE-NE LWRS system can monitor 12 specimens for in-situ SCC initiation. The key design change underway for the new systems is increasing the number of specimens that can be instrumented for in-situ detection of SCC initiation or for in-situ detection of failure. A larger diameter autoclave with more ports for wiring feedthroughs is being designed and constructed to enable this. Changes are also being made to the load line and the wiring feedthroughs to make the task of instrumenting all 36 specimens potentially manageable.

The test systems are built in-house at PNNL using a combination of off-the-shelf and custom-made parts. Each test system is constructed of ~140 unique parts from ~30 different vendors. A spreadsheet showing the status of all items needed to build the test system is attached at the end of this document.

Laboratory expansion is needed to make room for these two new test systems along with two more test systems for another NRC program. A lab adjacent to the current SCC lab has been made available for this. New electrical drops, specialty gas drops, pressure relief lines, and chilled water lines be installed, and an increase in room ventilation is also needed to accommodate the waste heat released by the test systems. Since this new lab space has a low ceiling that cannot accommodate the large multi-specimen initiation test systems, several existing SCC CGR test systems, which are not as tall, will be moved into the new lab space, and the new multi-specimen SCC initiation systems will be installed in the existing SCC lab. This activity was completed on 4/13/2015.

The first phase of the test system assembly involves fabricating major components such as the heater controllers and load frames. This work was done in-house by PNNL crafts and is complete.

The second phase of test system assembly includes having the pipefitters install the stainless steel tubing, filtration equipment, and glass columns on to each water board. This will be followed by installation of the high pressure pumps. Research staff, with assistance from crafts support, will install the autoclaves and servo electric load frame in the test frames. Research staff will also finish installing the electronics into each electronics rack.

The final stages of assembly will include installation of the load train, installation of the DCPD wiring, and making all the connections from the electronics rack to either the test frame or waterboard. Each system will then be ready to shakedown testing. Activities were will include leak-checking of all stainless steel connections, programming the heater and chilled water controllers, loading autoclave with dummy specimens, heating autoclave and preheater up to operating temperatures, and checking the servo-electric load frame and DCPD system for proper operation. These steps to completion of assembly are summarized in Table 4.

Updates

The autoclaves were received this reporting period, leaving only the internal support for the load train to be received. It is now expected in mid-July. Phase 2 activities continue to take place at a slower than desired pace. At the current rate of progress, the start of the first tests may be delayed to early October. Table 4 shows the updated timeline for all the activities needed to complete the test systems and begin the first tests.

Table 4. Timeline for assembly of the SCC initiation test systems.

Activity	Planned Start	Actual Start	Planned Completion	Actual Completion	Comments
Order Parts Components	9/1/14	9/1/14	12/31/14	3/27/15	Completed
Phase 1 System Assembly	12/1/14	12/1/14	1/31/15	3/13/15	Completed
Lab Mods	2/1/15	2/23/15	3/1/15	4/10/15	Completed
Phase 2 System Assembly	1/31/15-3/1/15	est. 4/13/15	4/1/15	est. 7/31/15	
Final System Assembly	4/1/15	est. 7/31/15	5/1/15	est. 9/04/15	
Shakedown Testing	5/1/15	est. 9/04/15	6/10/15	est. 9/25/15	
First Project Test Setup	6/10/15	est. 9/25/15	7/1/15	est. 10/09/15	
First SCC Initiation Tests	7/1/15	est. 10/09/15	1/1/16	est. 4/1/16	

C. Travel

None.

D. Description of Estimated Encumbered Costs

Encumbered costs for this month represent items that have been ordered but not yet received. We are in communication with the vendors on the delivery dates for these items.

PO No.	Vendor	Description	Burdened Commitment
255719	Applied Test Systems	Misc parts such as: End link, Threaded Ball, Socket Bushing, Post Bolt, Socket Plate, Rod Support, Top support plate, Tri-arm etc.	
	Commitments as of 6-26-15		

E. Anticipated and Encountered Problem Areas

None.

F. Plans for the Next Reporting Period

Task 1 - Materials acquisitions and forging will continue with the majority of the effort directed at having additional materials forged. Work will continue for characterizing SCC response, yield strength measurement, and hardness measurement to aid in material selection.

Task 2 - Original scope complete and test plan revisions have been made. Revised draft currently at NRC for comment and then will go to EPRI and Expert Panel.

Task 3 - Parts acquisition and test system construction will continue.

Travel and Meetings - None planned.

Spending Plan

Month/Year	13-Oct	13-Nov	13-Dec	14-Jan	14-Feb	14-Mar	14-Apr	14-May	14-Jun	14-Jul	14-Aug	14-Sep
Planned ($)											100,000	580,638
Revised ($)											0	21,936
Actual ($)											0	21,936
Variance (%)											0.00%	0.00%
Month/Year	**14-Oct**	**14-Nov**	**14-Dec**	**15-Jan**	**15-Feb**	**15-Mar**	**15-Apr**	**15-May**	**15-Jun**	**15-Jul**	**15-Aug**	**15-Sep**
Planned ($)	0	0	0	60,000	60,000	50,000	40,000	30,000	20,000	15,000	15,000	14,362
Revised ($)	71,694	55,422	143,260	140,515	54,635	64,843	65,000	65,000	65,000	70,000	65,000	55,000
Actual ($)	71,694	55,422	143,260	140,515	54,635	64,843	57,871	51,403	130,948			
Variance (%)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-10.97%	-20.92%	101.46%			
Month/Year	**15-Oct**											
Planned ($)	0											
Revised ($)	47,696											
Actual ($)												
Variance (%)	-100.00%											
TOTAL												
Planned ($)	**985,000**											
Revised ($)	**985,000**											
Actual ($)	**792,526**											

Variance Narrative - None.

NRC/EPRI SCC Initiation Program Materials Matrix as of 6/26/2015.

Alloy Class and Material Name	Top 4 Candidate?	Reason	Description/Form	Dimensions	Alloy Vendor	Heat Number	CMTR?	Weld Fabricator	WPS	At PNNL?	Number of Possible Specimens	Microstructure Characterized?	Have SCC CGR Data?	# CF Initiation Specimens Needed	# CF CT Specimens Needed	# CF Initiation Specimens Per Block	# CF Blocks Needed	Number of Blocks Forged	Additional Forged Blocks Needed	CF Slice removed for Met, EBSD, HV?
Alloy 182																				
PNNL/NRC Phase 2B Mockup	**yes**	**well-documented mockup**	LAS-SS DMW with alloy 182 butter and fill	circumferential pipe buttweld, 15" OD x 1.5" wall	TBD	TBD	TBD	EWI	yes	yes	50	no	machining AW CTs	18	1	3	7	7	**0**	complete
PNNL/Flawtech/NRC Mockup	**yes**	**well-documented mockup**	LAS-SS DMW with alloy 182 butter and fill	circumferential pipe buttweld, 14" OD x 1.5" wall	Spec. Met.	844305	yes	Flawtech	yes	yes	90	no	in-progress	18	1	3	7	7	**0**	complete
Studsvik	**yes**	**well-documented mockup**	alloy 182 buildup	3"tall x 2.75" x 5"long	TBD	TBD	TBD	ENSA	yes	yes	64	no	in-progress	18	1	10	2	2	**0**	complete
KAPL	**yes**	**well-documented mockup**	alloy 182 U-groove	1.5"wide x 1.5"tall x 8"long	Techalloy	823030	yes	KAPL	yes	yes	25	no	machining AW CTs	18	1	6	4	0	**4**	planned
EPRI weld		under consideration	alloy 182 groove	TBD	TBD	TBD	yes	TBD	yes	no	TBD	no	no	TBD						
CRDM 3-groove	no	too challenging to forge and extract initiation specimens	alloy 182 3-groove from dismantled partially built PWR	4.15" ID x 0.XX" thick x XX"tall	unknown	unknown	no	unknown	no	yes	none	no	no							
Alloy 600																				
PNNL Plate #1 (MA)	**yes**	**prior SCCI data from LWRS**	2" thick plate	9.6x15x2" thick	Spec. Met.	NX6016XK-11	yes	N/A	N/A	yes	300	Met, SEM, TEM	in-progress	12	1	6	3	3	**0**	complete
PNNL Plate #3 (MA)	**yes**	**using for NRC Peening program**	3" thick plate	3x18x3" thick	ATI	522068	yes	N/A	N/A	yes	50	Met	preparing to machine AW CTs	12	1	6	3	3	**0**	in-progress
KAPL Plate (MA)	**yes**	**vintage material**	vintage 2" thick plate	4x12x2" thick	G.O. Carlson	33375-2B	yes	N/A	N/A	yes	50	no	planned	12	1	6	3	0	**3**	planned
CRDM Tube	**yes**	**service material**	From dismantled partially built PWR	4.15"OD x 0.70" wall x 8" long	unknown	unknown	no	N/A	N/A	yes	50	Met	preparing to machine AW CTs	12	1	5	2	2	**0**	in-progress
Forged Bar	no	under consideration	6" dia. bar	6"OD x 12" long	Forgmt	31207	yes	N/A	N/A	yes	100	Met	no							planned
PNNL Plate #2 (MA)	no	other better candidates	2" thick plate	9x24x2" thick	ATI	521618	yes	N/A	N/A	yes	300	Met	no					3		
Alloy 152/52																				
MHI alloy 152 U-groove	**yes**	**have SCC CGR data**	U-groove weld joining SS	1.8"tall x 2"wide x 2.5" long	TK-VDM?	307380	yes	MHI	yes	yes	15	Met, SEM	yes	9	2	6	2	2	**0**	in-progress
MHI alloy 52 U-groove	**yes**	**have SCC CGR data**	U-groove weld joining SS	1.8"tall x 2"wide x 2.5" long	Spec. Met.	NX2686JK	yes	MHI	yes	yes	15	Met, SEM	yes	9	2	6	2	2	**0**	in-progress
ENSA DPM alloy 52M butter	**yes**	**sufficient material available**	Double bevel 690-LAS DMW, alloy 52M butter	0.75"tall x 2.7"wide x 4" long	unknown	unknown	no	ENSA	yes	yes	20	Met, SEM	no	9	2	3	4	2	**2**	in-progress
EPRI alloy 152M	**yes**	**favorable geometry, sufficient material**	TBD	TBD	TBD	TBD	yes	TBD	yes	expected 07/2015	TBD	no	no	9	2	3	4	0	**4**	planned
KAPL alloy 52M NG	no	too narrow	narrow gap weld joining alloy 690	1.8"tall x 0.5"wide x 1.1" long	Spec. Met.	NA5288TH	yes	KAPL	yes	yes	8	no	yes							
EPRI alloy 52i	no	not enough material	V-groove weld	1.8"tall x 2.75-1.75"wide x 1.5" long	TK-VDM	107775	yes	unknown		yes	8	no	no					1		
ENSA DPM alloy 52 fill	no	alloy 52 with prior SCC experience already identified	Double bevel 690-LAS DMW, alloy 52 fill	1.5"tall x 0.5-1.5"wide x 4" long	Spec. Met.	NX4196JK	yes	ENSA	yes	yes	20	Met, SEM	in-progress					1		
NRC alloy 52MSS NG	no	too narrow	narrow gap weld joining alloy 690	2"tall x 0.4-0.6" wide x 7.8" long	Spec. Met.	NX25W3JK	yes	PCI	yes	yes	10	no	yes							
Alloy 690																				
Valinox Alloy 690 CRDM RE243 (TT)	**yes**	**significant SCC CGR data**	CRDM	4.4"OD x 1.35"wall x 6" long	Valinox	RE243	no	N/A	N/A	yes	>20	Met, SEM, TEM, APT	yes	9	1	6	2	2	**0**	complete
Valinox Alloy 690 CRDM WP142 (TT)	**yes**	**have SCC CGR data, and substantial material**	CRDM	4.56"OD x 1.20"wall x 4" long	Valinox	WP142	no	N/A	N/A	yes	>20	Met, SEM, TEM	yes	9	1	6	2	2	**0**	complete
TK-VDM 114092 plate (TT)	**yes**	**have SCC CGR data**	plate	2"tall x 4"wide x 2.5" long	TK-VDM	114092	yes	N/A	N/A	yes	>20	Met, SEM, TEM	yes	9	1	6	2	2	**0**	in-progress
ATI/Allvac B25K-2 (MA)	**yes**	**have SCC CGR data**	plate	3"thick x 5.5"wide x 2.2" long	ATI/Allvac	B25K-2	yes	N/A	N/A	yes	>20	Met, SEM, TEM	yes	9	1	6	2	2	**0**	complete
Doosan CRDM bar (TT)	no	insufficient material for additional tests	CRDM	6"OD x 2.5" long	TK-VDM	113189	yes	N/A	N/A	yes	12	Met, SEM, TEM	yes					1		
EPRI NX8625HG21 (TT)	no	no SCC data, other better candidates	plate	12x12x1.34" thick	Spec. Met.	NX8625HG21		N/A	N/A	yes	>20	no	no							