INTERAGENCY AGREEMENT	1. IAA NO. NRC-HQ-60-15-T-0023/M0001	PAGE 1 OF 2

2. ORDER NO.	3. REQUISITION NO. RES-16-0140	4. SOLICITATION NO.

5. EFFECTIVE DATE 02/01/2016	6. AWARD DATE 02/01/2016	7. PERIOD OF PERFORMANCE 09/17/2015 TO 09/30/2019

8. SERVICING AGENCY
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9. DELIVER TO
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ROCKVILLE MD 20852

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12. ISSUING OFFICE
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WASHINGTON DC 20555-0001

13. LEGISLATIVE AUTHORITY
Energy Reorganization Act of 1974

14. PROJECT ID

15. PROJECT TITLE
SEE BLOCK #18

16. ACCOUNTING DATA
2016-X0200-FEEBASED-60-60D001-11-6-213-1032-253D

17. ITEM NO.	18. SUPPLIES/SERVICES	19. QUANTITY	20. UNIT	21. UNIT PRICE	22. AMOUNT
	NRC-HQ-25-14-D-0001 – NRC-HQ-60-15-T-0023 Task Order Title: Strategic Approach for Obtaining Material and Component Aging Information Master IAA: NRCHQ2514D0001 Summary of Changes: The purpose of this modification is to: (1) Request incorporation of the attached SOW changes into the current task order agreement and (2) provide incremental funding in the amount of $60,000.00, thereby increasing the total Continued ...				

23. PAYMENT PROVISIONS	24. TOTAL AMOUNT $60,000.00

25a. SIGNATURE OF GOVERNMENT REPRESENTATIVE (SERVICING)	26a. SIGNATURE OF GOVERNMENT REPRESENTATIVE (CONTRACTING) Jeffrey R. Mitchell
25b. NAME AND TITLE	25c. DATE
	26b. CONTRACTING OFFICER JEFFREY R. MITCHELL
	26c. DATE 2/1/2016

TEMPLATE - ADM001 SUNSI REVIEW COMPLETE APR - 7 2016 ADM002

obligations for this task order from $73,165.00 to $133,165.00.

The changes to the SOW (Rev. 1) do not impact the period of performance or the current authorized ceiling. Therefore, a new proposal is not needed.

Obligation with this Action: $60,000.00
Total Obligations to Date: $133,165.00
Authorized Ceiling Amount: $163,529.00

All other terms and conditions remain unchanged.

Attachments:
Statement of Work (Rev. 1 - tracked changes)
Statement of Work (Rev. 1 - changes incorporated)

DUNS: 040535809
ALC: 31000001
TAS: 31X0200.320

STATEMENT OF WORK

NRC Agreement Number	NRC Agreement Modification Number	NRC Task Order Number (If Applicable)	NRC Task Order Modification Number (If Applicable)
NRC-HQ-25-14-D-0001	N/A	NRC-HQ-60-15-T-0023	M0001

Project Title		
Strategic Approach for Obtaining Material and Component Aging Information		
Job Code Number	**B&R Number**	**DOE Laboratory** Pacific Northwest National Laboratory (PNNL)
NRC Requisitioning Office Nuclear Regulatory Research (RES)		

NRC Form 187, Contract Security and Classification Requirements ☐ Applicable ☒ Not 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)**

1.0 BACKGROUND

Regulatory Context:

The NRC has established a license renewal process that will allow nuclear power plants (NPP) to renew their licenses for an additional 20 years, via 10 CFR 54.31(d) stating that "a renewed license may be subsequently renewed." The biggest challenges for the NRC and the industry will be addressing the major technical issues for this second "subsequent" license renewal (SLR) beyond 60 years. As summarized in SECY-14-0016, the NRC staff believe that the most significant technical issues challenging power reactor operation beyond 60 years are related to:

- Reactor pressure vessel (RPV) neutron embrittlement at high fluence
- Irradiation assisted degradation (IAD) of reactor internals and primary system components
- Concrete and containment degradation

- Electrical cable qualification and condition assessment.

Understanding the causes and control of degradation mechanisms forms the basis for developing aging management programs (AMPs) to ensure the functionality and safety margins of NPP systems, structures, and components (SSC). The resolution to these issues should provide reasonable assurance of safe operation of the components in the scope of license renewal during the subsequent period of extended operation.

Because of the cost and inefficiency of piecemeal sampling, there is a need for a strategic and systematic approach to sampling materials from SSC in decommissioning plants. The envisioned work addresses both passive and active components. In that sense, it addresses aging management of passive components under the license renewal rule, 10 CFR 54, as well as the maintenance of active components covered by the maintenance rule, 10CFR50.65, as seen in Figure 1 below.

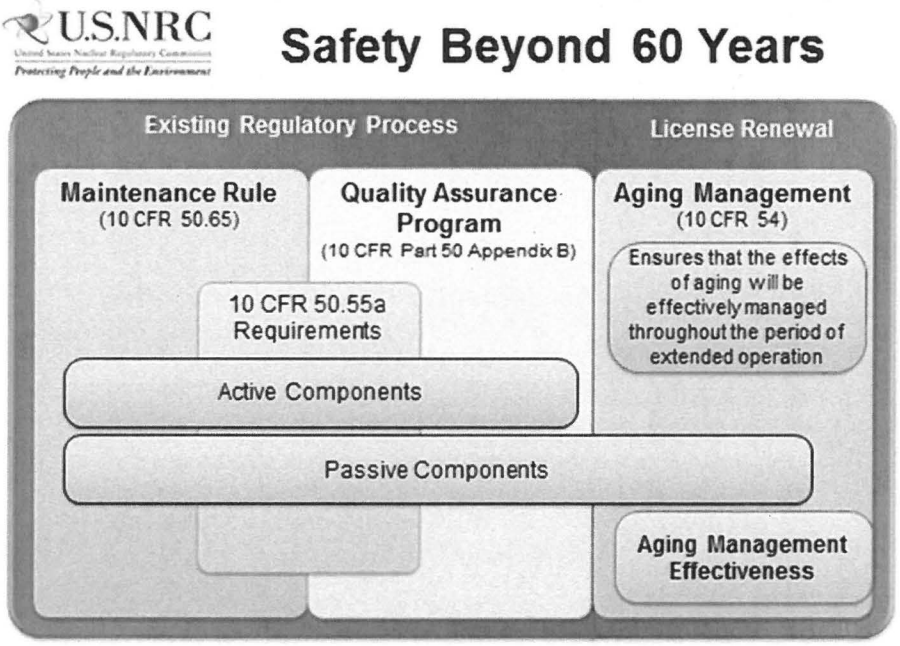

Figure 1: Relationship between aging management of active and passive components (from NRR/RES presentation to ACRS, 2014)

In the past few years, four plants have ceased operation or announced that they will cease operation: Crystal River Unit 3 (PWR), Kewaunee (PWR), San Onofre Units 2 & 3 (PWR), and Vermont Yankee (BWR). These plants comprise a range of reactor types, containments, and SSCs important to safety. The primary objective of this project is to develop a long-range strategy for obtaining information from these plants as they go through decommissioning. The focus will be on timely acquisition of experiential real-world aging-degradation information that

can significantly improve the agency's risk-informed and performance-based regulatory approach, but has been very difficult or impossible to obtain from the operating reactor fleet.

Technical Context:

Creating a roadmap for obtaining information from designated NPPs as they go through decommissioning is complementary to ongoing NRC research in developing technical information to support evaluating SLR as well as data collection and testing of ex-plant materials.

Material degradation has traditionally been managed reactively in response to events and operating experience, rather than proactively to prevent failures. For the NPPs currently entering their first license renewal period from 40-60 years, and submitting SLR applications, it is necessary to evaluate potential degradation mechanisms out to 80 years of operation. Evaluation of material properties in SSCs from actual decommissioned NPPs will provide a basis for comparison with results of laboratory tests and calculations to resolve the four issues listed above.

The proactive management of materials degradation (PMMD) information tool was originally created at PNNL for RES (POC: Amy Hull) to give an expert opinion of the possible future degradation mechanisms on a subcomponent/material specific basis (PNNL-17779)[i]. Combined with the LER database, the PMMD information tool allows one to not only react to past events, but to anticipate future issues. The original PMMD information tool was based on NUREG/CR-6923, "Proactive Materials Degradation Assessment (PMDA)," for the first license renewal period, so it is now appropriate to integrate information from the excel databases from the recently-published five volumes of NUREG/CR-7153, "Expanded Materials Degradation Assessment (EMDA)" for SLR. At this juncture, there is demonstrated industry interest in NPP long-term operation (LTO) and regulatory interest in SLR.

2.0 OBJECTIVES

Understanding and managing material and component degradation is a key need for the continued safe and reliable operation of NPPs, but has significant uncertainties. In many cases, the scientific basis for understanding and predicting long-term environmental degradation behavior of materials in NPPs is incomplete. A strategic approach to examination and testing of materials and components from decommissioned reactors can dramatically increase our knowledge-acquisition rate in this very important area.

There are three inter-related objectives to this work:

(1) Develop a long-range strategy for obtaining information from decommissioned NPPs as well as providing the flexibility to get ex-plant components from operating plants as well. The focus will be on timely acquisition of experiential real-world aging-degradation information that can significantly improve the agency's risk-informed and performance-based regulatory approach, but has been very difficult or impossible to obtain from the operating reactor fleet.

(2) Construct a strategic plan and specifications for obtaining unique and significant materials aging degradation information from diverse sources (operating experience, other nuclear facilities, other long-lived industrial plants, other materials organizations such as ASM and NACE) that will inform the NRC's age-related regulatory oversight in the future. Implementation of this plan and specifications, in cooperation with industry and DOE partners can be accomplished over time, through individual research projects as the identified plants progress through their decommissioning process. This exploratory research is expected to provide fundamental insights on reactor materials degradation and information addressing potential technical issues or identified gaps to support anticipated future NRC needs.

(3) Update the PMMD information tool to incorporate LTO/SLR-relevant information so that it can be better used to inform prioritization in the ex-plant material strategic plan.

3.0 SCOPE OF WORK

There are a number of technical gaps that this project seeks to address. Most importantly, the current piecemeal approach can be replaced with a strategic plan that is more comprehensive, broader in scope, and more risk-informed. The strategic plan for inspections and/or testing developed in this project will be useful guidance for obtaining key measurements of degradation in a variety of areas. These measurements will be valuable on their own and will also be useful in basic research on the underlying mechanisms and modes of degradation, and for validation of modeling and simulation tools. Data and information developed from implementation of the strategic plan will also be useful in evaluating aging management and mitigation strategies proposed by the industry.

Many sources of materials degradation information will be queried, including human repositories of knowledge both within NRC and within the industry. Both the PMDA and EMDA present information in terms of component or material degradation susceptibility and currently available knowledge for degradation mitigation or prevention. A component with high degradation susceptibility/low knowledge would be the strongest candidate for proactive actions. It is necessary to be able to understand this before prioritizing ex-plant materials sampling available from a given retired NPP. Previously, under the auspices of NRC contracts (i.e., JCN N6029, N6907), PNNL used the large amount of information presented in the PMDA report to develop a web-based platform to facilitate analysis through interactive visualizations that offer intuitive ways to explore the information. PNNL shall explore the viability of adding materials degradation susceptibility data presented in the EMDA Report.

Such an information tool (Figure 2 below) is expected to save considerable staff efforts to understand and apply the PMDA and EMDA insights to regulatory review of licensee information. PNNL shall develop a web-based modified scalable reasoning system (SRS) for tracking, disposition, and resolution of critical issues, such as determining the appropriate SSC

from which to acquire cast austenitic stainless steel (CASS) material of specific composition and radiation dose.

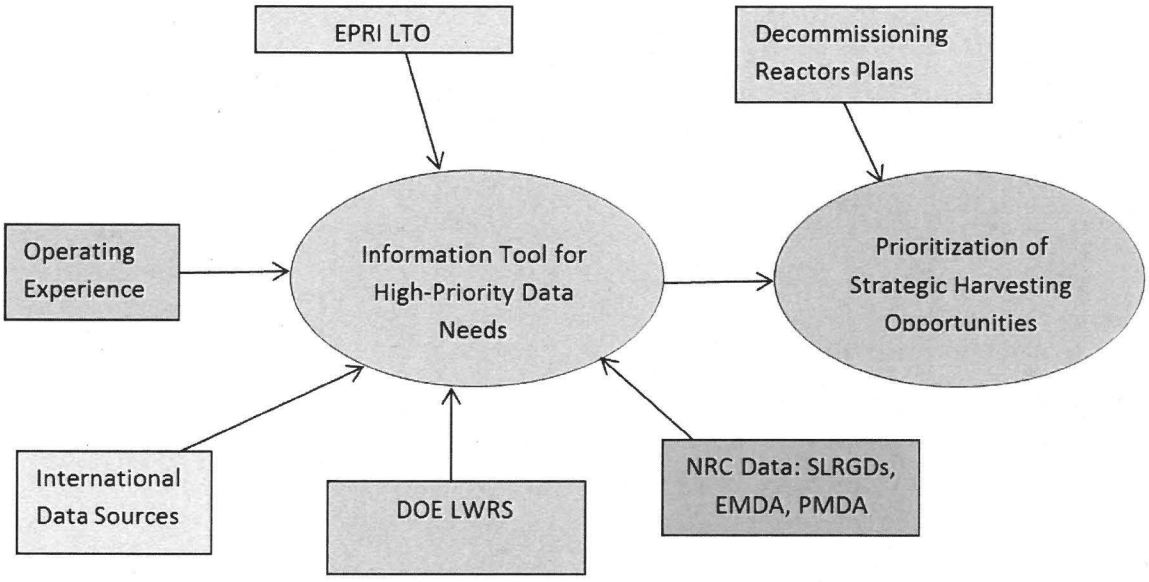

Figure 2: Pre-conceptual Architecture of prognostic tool to track and resolve critical technical issues for SLR

As shown in Figure 2 above, the information tool was originally envisioned as integrating domestic and international operating experience and experimental information as well as information from the EPRI LTO, DOE Light Water Reactor Sustainability (LWRS) program, and NRC sources such as EMDA, PMDA, and SLR guidance documents (SLRGDs) and precursors. The international data sources that might provide effective data feed include the cable aging data and knowledge (CADAK, http://cadak.hrp.no/cadak.) project and the Component Operational Experience, Degradation and Ageing Programme (CODAP, http://www.oecd-nea.org/jointproj/codap.html), both sponsored by OECD/NEA. The Atlas constructed by PNNL from the Program to Assess the Reliability of Emerging Non-destructive Technology (PARENT) and the Program to Inspect Nickel Alloy Components (PINC) Atlas is an international database containing a vast array of SCC crack morphology and NDE information. PNNL shall investigate whether this is an appropriate framework to track issue resolution associated with SLR. This is a much broader objective than just developing a strategic roadmap for harvesting SSCs.

The general tasks and their duration are described in Table 1.

Table 1: Task Description and Duration

Task	Task Title/Description	Duration (Months)
Task 1	Scoping Study and technical literature review	18
Task 2	Decision Making on Specific Confirmatory Research Needed to Address Gaps (optional)	6
Task 3	Confirmatory Research Addressing Technical Gaps (optional)	33
Task 4	Development of Independent Decision Making Tools (optional)	33

The conditional tasks shall be conducted, as detailed in Figure 3 below. A decision on further optional research outlined in Tasks 2, 3, and 4 will be made after completion of Task 1 depending on the outcome and recommendation from the conclusion of specific tasks. The overall nexus between the scoping study and other potential tasks is shown in Figure 3.

The PNNL staff shall not restrict their activities solely to these descriptions and shall be flexible in using their technical knowledge and experience in proposing additions, deletions, or deviations from the prescribed requirements as research progresses.

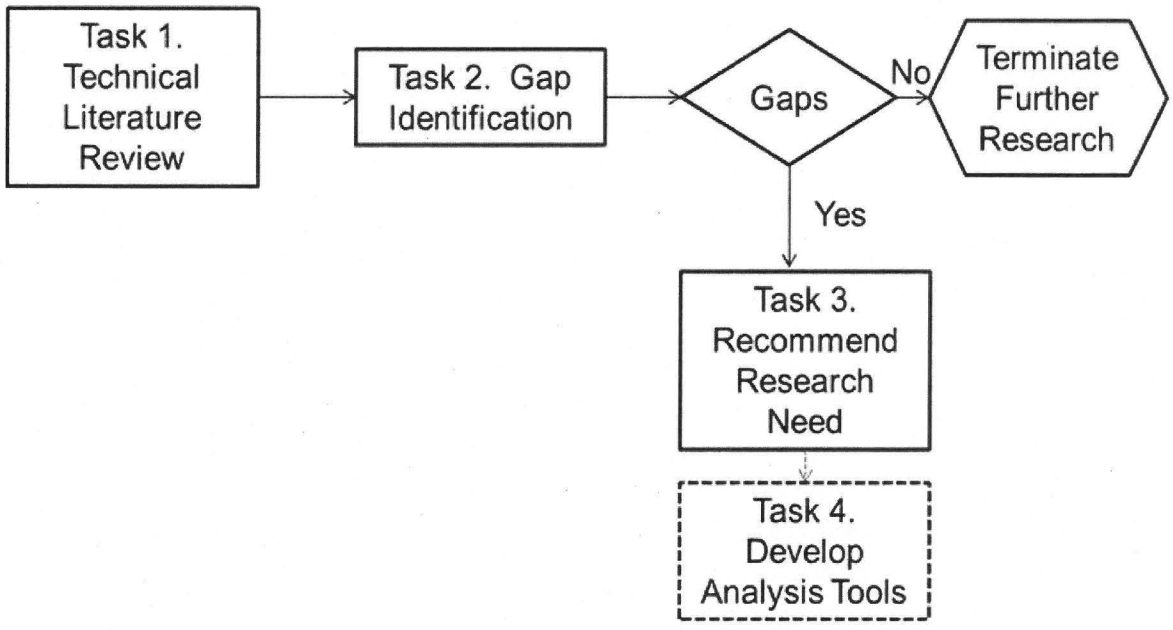

Figure 3: Schematic of the Overall Research

4.0 SPECIFIC TASKS

Task 1 is the scoping study. Tasks 2-4 are optional. NRC plans to revise the SOW for these tasks based on the outcome of Task 1. The time at which the tasks begin and end will be dependent on available information and NRC's ongoing evaluation of testing priorities. NRC staff does not require that PNNL necessarily perform the tasks be performed sequentially following the order in which they are listed. For the test matrix described in this section, nearly all subtasks will have to be tested in tandem with another subtask in order to complete the program within the requested period of performance. PNNL and the NRC CORs will continually review the testing plan during monthly status update teleconferences.

PNNL shall, in the first stage of Task 1, develop a questionnaire and help the NRC staff conduct interviews with focus groups from various technical disciplines within NRC. PNNL shall, in the second stage of Task 1, assist the NRC staff conduct one or two public workshops. PNNL shall analyze and combine the results of the first two phases into a final strategic plan in the third stage. This strategic plan will provide a prioritization of strategic harvesting opportunities. PNNL shall help the NRC staff develop the ex-plant harvesting strategic plan in cooperation with industry and other federal agencies such as DOE as well as any international counterparts that may be interested in participation.

In Tasks 2-4, PNNL may be assigned optional tasks to identify requirements to further elucidate the risk assessment of component degradation. Such research should also provide technical data and information, as necessary, to request the national codes and standards bodies (such as ASME, ASTM, or NACE) to re-examine requirements for structural materials for passive components in light water reactors (LWRs) and in assessing material degradation during service and its effect on design safety margin of components. The PNNL principal investigator (PI) for this project shall attend ASME, ASTM, or NACE Code Committee meetings, as appropriate and as approved by the COR during the course of this research. The PI shall provide adequate information to support an IAEA international cooperative research program (ICRP) on this subject to bring worldwide resources to address this research need.

The specific tasks are as follows:

Task 1 – Literature Review and Assessment of Greatest Needs in Sampling of Ex-plant Materials

NRC recently completed a research program to investigate material degradation after extended operation. To investigate aging degradation mechanisms, aging degradation effects, and the relative susceptibility to degradation, PNNL shall perform a comparison of available information.

PNNL shall conduct the Task 1 scoping study and provide all resources necessary to accomplish the subtasks and deliverables. Task 1 shall be performed in stages as shown in the Task-specific subsections below.

The activities required for this task are:

Task 1.1 – Conduct Materials Aging Degradation Literature Review

PNNL shall selectively review both domestic and international sources of technical information of generic nature with respect to anticipated material degradation in NPPs during LTO, extrapolating to 80 years of operation. The objective is to identify other issues not in PMDA/EMDA, such as related to active components or spent fuel storage systems, and to determine what is being done to address LTO issues. NRC will provide guidance on appropriate information to review.

Task 1.2 – Evaluate Availability of Ex-Plant Material and Information

PNNL shall evaluate what relevant ex-plant material is projected to be available for potential harvesting. PNNL shall work with the NRC COR to develop a questionnaire and interview the cognizant individuals at the plants who possess critical knowledge.

Task 1.3 – Develop Questionnaire and Conduct Interviews with Prospective NRC Stakeholders

PNNL shall develop a questionnaire and work with NRC staff to conduct interviews with focus groups from various technical disciplines within NRC. This would include the SLR Expert Panels for a sample of different aging management programs (AMPs) as well as other NRC technical advisory groups. PNNL shall have a comprehensive approach to all the possible stakeholders interested in harvesting materials from decommissioned plants. The objective of this initial scoping study is to assess interest in issues concerning both passive and active component degradation. The questionnaire will address, as a minimum, (1) the perceived needs for ex-plant materials, (2) the perceived utility of the existing information tool and how and where this prognostic tool should be maintained (NRC, contractor, cloud). During the early brainstorming and scoping study, PNNL shall also consider degradation of SSC materials associated with extended long-term storage of used fuel.

Task 1.4 – Develop Questionnaire and Conduct Interviews with Prospective External Stakeholders

Based on interactions with NRC staff in Task 1.3 above, PNNL shall propose a preliminary strategic approach to sampling representative ex-plant materials during one or two presentations at public workshops to further refine the concept of what would be needed in a useful interrogatory tool linking aging-degradation research objectives with available resources for ex-plant materials. The searchable information tool shall be available via an interactive web page.

Task 1.5 –Conduct Scoping Analysis on Viability of Searchable Information Tool

Task 1.5.1 PNNL shall briefly consider available approaches to creating a preliminary database that will link the highest susceptibility/lowest knowledge anticipated degradation scenarios with potential availability of ex-plant materials. As part of this subtask, PNNL shall review the status and viability of the PMMD information tool created as part of the PMMD project (conducted at PNNL under previous NRC contracts (i.e., JCN N6029, N6907). The goals of the PMMD project were to identify reactor components that could reasonably be expected to experience future degradation, estimate the susceptibility of components to various degradation mechanisms, and assess the degree of knowledge available to develop mitigative strategies. It was anticipated that this information could be used to guide regulatory actions related to license renewal and subsequent license renewal. The PMMD panel evaluated 3863 components (2203 for PWRs, 1603 for BWRs) for their susceptibility to 16 degradation mechanisms (Figure 4 below). Because of the unwieldiness of the source material, a searchable information tool (pmmd.pnl.gov) was developed to make this information usable to NRC staff and others.

Task 1.5.2 PNNL shall work with the NRC to create a proposal to develop a platform for the searchable database methodology (selected in Task 1.5.1) that can be supported within NRC.

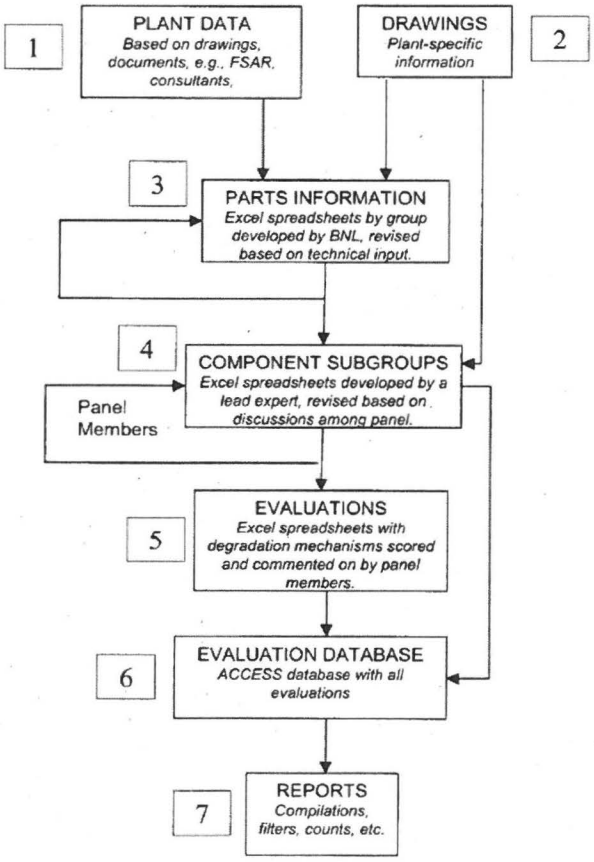

Figure 4. Flowchart for files created and used in PMMD infotool

Task 1.6 – Provide Archival Summary Document of Findings from Task 1

PNNL shall analyze and review the reports generated from the work conducted under Tasks 1.1 through 1.5 and provide a stand-alone technical letter report (TLR) documenting the major findings.

Optional Task 2 – Decision Making on Specific Research Need to Address Gaps

If the Task 1 scoping study succeeds in determining previously unidentified significant knowledge gaps that need further attention, more work will be done in the context of Task 2, pending the approval from the NRC Contract Officer (CO). Thus, Task 2 is optional pending the outcome of Task 1 and requires NRC activation. The activities required for this task are:

Task 2.1 – Gap Identification

PNNL shall identify specific information and technical data gaps from the execution of Task 1 and document these gaps. In identifying the gaps, PNNL shall include an examination of the current ASME B&PV Code or other industry practices that the NRC has endorsed with respect to addressing the specific degradation mechanism in the design and the assurance of the retention of the design margin during the period of licensed reactor operation time.

Task 2.2 – Determine Significance and Disposition of Technical Gaps

PNNL shall determine whether or not there are any technical gaps from the execution of Task 2.1. If there are no gaps and if it is determined that the current ASME Code or other industry practices ensure that the design margin for components are adequate, recommend termination of further research in this topic by NRC. If specific information and technical gaps are identified then proceed to Task 3 after getting approval from the NRC Contract Officer (CO).

Optional Task 3 – Research Addressing Technical Gaps Related to Material Degradation

If critically important information and technical gaps are identified in Task 2, Task 3 is activated after getting approval from the NRC CO. Thus, Task 3 is optional pending the outcome of Task 2. The activities required for this task are:

Task 3.1 – Recommend Specific Laboratory Experimentation and Analytical Model Development

PNNL shall work with NRC subject matter experts (SMEs) to recommend specific laboratory experimentation and analytical model development, which may address the information gap identified in Task 2.1. If novel nondestructive evaluation methods (such as the next-generation acoustic emission technology which reportedly can 'hear' crack initiation) become available to identify progressing reactor material degradation by the time Task 3 is initiated, PNNL shall

recommend inservice inspection (ISI) technology enablers which will be suitable for detecting the material changes resulting from different stressors. PNNL shall work with NRC SMEs to recommend the need for developing tools for detection and assessment of potential degradation of the design safety margin to independently confirm the licensee's technical basis for LTO.

Task 3.2 – Review Adequacy of Existing Codes and Standards

PNNL shall conduct a review of existing applicable ASME B&PV Codes that may need to be revised as a result of Task 2.1 and PNNL shall work with NRC SMEs to engage relevant ASME Code Committees for assessing future path. PNNL shall propose other Codes and Standards that should be reviewed (such as but not limited to, ANS, ASTM, and NACE codes and standards).

Optional Task 4 – Investigate Development of Independent Decision Making Tools

Task 4 is optional pending the outcome of Tasks 1 – 3. If gaps are identified under Task 2 and appropriate research needed to inform the gaps are also identified under Task 3, NRC expects that the industry will perform the needed research and provide NRC the data for regulatory decisions.

Depending on the outcome of Tasks 2 and 3 and ensuing industry research, the decision-making tool development may be complex and truly involve multi-year, multi-disciplinary long term research. It is expected, however, that the decision making tool may include: (a) Material and component condition after different stressors; (b) Better knowledge of specific degradation and its potential for reducing the design safety margin for the components; (c) Incorporation of plant data into the various material, inspection, and structural integrity evaluation models; and (f) An integration of all these aspects into the regulatory decision making process to consider the risk contribution due to material degradation.

Specific subtasks for this task will be established later in this research. PNNL shall investigate the feasibility of developing a modern visualization confirmatory analysis research tool for aging management of safety-significant SSC degradation in NPPs. As currently envisioned, this could provide a knowledge management and strategic planning tool for conducting gap assessments and prioritizing R&D resources related to NPP LTO. This research will leverage the work previously performed by PNNL on the PMMD Information Tool, sponsored by RES.

RES/DE would benefit from a R&D gap assessment, strategic planning and knowledge management tool to enhance the tracking, disposition, resolution of technical issues that surface as industry moves towards SLR. Such a database would save staff time in addressing the degradation challenges for NPP passive components, spent fuel pools, and independent spent fuel storage installations (ISFIs). The proposed LTO issues visualization tool can incorporate, up-to-date information on critical issues associated with cable, concrete and RPV aging. Work is actively progressing on developing SLR guidance documents with unresolved technical issues arising almost on a daily basis. These could be captured by the proposed service-oriented analytic framework. The existing PMMD database containing detailed information about susceptibility, knowledge, and confidence associated with hundreds of degradation scenarios can be augmented with aging risk indices, when developed by the DOE LWRS research. This will enable a better understanding of service life projections of NPP SSC.

5.0 DELIVERABLES AND/OR MILESTONES SCHEDULE

All deliverables shall be in the form of technical letter reports or alternatives previously discussed and determined acceptable by the COR. Based on the detailed tasks provided in Section 4.0 of this Statement of Work, PNNL shall estimate the number of Figures/Tables or other copyrighted information from technical journals, etc. and shall incorporate this estimation in the cost proposal in addressing the SOW. PNNL shall also estimate reasonable effort by their technical editing staff in order to provide the NRC tech-edited draft final and final reports.

Task Number	**Deliverable/Milestone Description** *(include NRC acceptance criteria if applicable)*	**Due Date** *(if any)*
All	Monthly Letter Status Report (MLSR)	20th day of each month
1.1	PNNL to provide Report 1.1. Draft TLR to NRC on Subtask (1.1) reviewing anticipated NPP LTO materials degradation and prognostics	NLT 9 months after contract award
1.1	NRC to provide comments to contractor on Report 1.1 on NPP LTO materials degradation and prognostics	NLT 1 month after receiving draft Report 1.1 from PNNL
1.2	PNNL to provide Report 1.2. Draft TLR to NRC on Subtasks (1.2-1.4) concerning availability of ex-plant material and information, and a systematic approach to harvesting ex-plant materials.	NLT 12 months after contract award
1.2	NRC to provide comments to contractor on Report 1.2 concerning availability of ex-plant material and information, and a systematic approach to harvesting ex-plant materials.	NLT 1 month after receiving draft Report 1.2 from PNNL
1.3	Summary Report 1.3. Draft TLR to NRC including information from Subtasks (1.1-1.5). *(Note: At the discretion of COR, a decision may also be made to publish Summary Report 1 as a NUREG/CR rather than as a TLR, depending on the significance of the literature review and research assessment results).*	NLT 16 months after contract award
1.3	The Contractor will make a technical presentation to the NRC staff on Summary Report 1.3 at NRC Headquarters in Rockville, MD.	When the draft Summary Report 1.3 is delivered to NRC.
1.3	NRC to provide comments to contractor on Summary Report 1.3.	NLT 2 months after receiving draft Summary Report 1.3 from PNNL
1.3	DOE Contractor to publish Summary Report 1.3 as TLR. Deliver 12 hard copies to the NRC COR, in addition to an electronic file.	NLT 2 months after receiving NRC comments
Task 2 is optional pending outcome of Task 1.		
2	PNNL to provide Report 2 Draft TLR to NRC based on results from Subtask (2.1) concerning technical gap identification and subtask (2.2) determination of significance and disposition of gaps	NLT 24 months after original contract award
2	NRC to provide comments to contractor on Report 2 concerning technical gap identification, significance, and disposition	NLT 1 month after receiving draft Report 2 from PNNL
2	PNNL to publish TLR Report 2 technical gap identification, significance, and disposition. Deliver 12 hard copies to the NRC COR, in addition to an electronic file.	NLT 1 month after receiving NRC comments
Task 3 is optional pending outcome of Task 2		

3.1	PNNL to provide Report 3.1 Draft TLR to NRC based on results from Subtasks (3.1 and 3.2) concerning specific laboratory experimentation, analytical model development, and adequacy of existing codes and standards for SLR.	NLT 46 months after contract award
3.1	NRC to provide comments to contractor on Report 3.1 concerning specific laboratory experimentation and analytical model development	NLT 1 month after receiving draft Report 3.1 from PNNL
3.1	PNNL to publish TLR Report 3.1 concerning specific laboratory experimentation, analytical model development, and adequacy of existing codes and standards for SLR. Deliver 12 hard copies to the NRC COR, in addition to an electronic file.	NLT 1 month after receiving NRC comments
Task 4 is optional pending outcome of Task 1 and partially pending on Task 2 and 3.		
4	PNNL to provide Report 4 Draft TLR to NRC documenting development of prognostic tool to track and resolve critical SLR technical issues	NLT 46 months after contract award
4	NRC to provide comments to contractor on Report 4 reviewing development of prognostic tool to track and resolve critical SLR technical issues	NLT 1 month after receiving draft Report 3.2 from PNNL
4	PNNL to publish TLR Report 4 reviewing development of prognostic tool to track and resolve critical SLR technical issues R. Deliver 12 hard copies to the NRC COR, in addition to an electronic file.	NLT 1 month after receiving NRC comments

6.0 TECHNICAL AND OTHER SPECIAL QUALIFICATIONS REQUIRED

Specific qualifications for this effort include senior materials engineers and metallurgists who have in-depth knowledge of reactor pressure vessel and core internal materials subjected to irradiation and stress at elevated temperature, and effects of water chemistry on structural reactor materials. The personnel involved should have in-depth experience, knowledge, and demonstrated contributions in the areas of mechanical deformation, material degradation phenomena, such as corrosion, stress corrosion cracking and irradiation effects. The contract personnel should be well-versed in the use of nuclear power plant ASME B&PV Codes and Standards, Industry Guidance Documents, such as those of NEI, EPRI, NRC's Regulatory Guides and NRC's License Renewal Guidance Documents (such as NUREGs 1800, 1801, and 1950) Information Notice (IN), Regulatory Issue Summary (RIS), Generic Letter (GL), Generic Issue (GI) for licensing review by the NRC staff.

The contract personnel should also be aware of the safety evaluation reports (SER) written by the NRC staff on industry guidance documents, as applicable. The contract personnel should have previous experience developing appropriate software architecture for proposed R&D planning tool.

7.0 MEETINGS AND TRAVEL

The PNNL Principal Investigator and one other engineer shall visit the NRC Headquarters in Rockville, MD and present the overall research outcome to the staff and share in technical

discussions. Any suggestions from the staff, as appropriate, may be considered for the final report by the PI. No other domestic or foreign travel is permitted under the initial scoping study.

8.0 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 shall 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 shall electronically submit a Monthly Letter Status Report (MLSR) by the 20th day of each month to Amy Hull, the Contracting Officer Representative (COR), to Matthew Hiser and Joseph Kanney, the technical monitors, 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 shall 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.

MLSR should be distributed additionally to the Chief, Corrosion and Metallurgy Branch, RES, the Director, Division of Engineering, RES. Other required distribution will be communicated at the start of this research program.

The MLSR shall 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 shall include the information discussed in Attachment 1. The preferred MLSR format can also be found in Attachment 1.

9.0 PERIOD OF PERFORMANCE

The period of performance for this work is September 17, 2015 – September 30, 2019.

10.0 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: Dr. Amy B. Hull
Agency: U.S. Nuclear Regulatory Commission
Office: Office of Nuclear Regulatory Research
Mail Stop: T-10D49
Washington, DC 20555-0001
E-Mail: amy.hull@nrc.gov
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Alternate Contracting Officer's Representative
Name: Matthew Hiser
Agency: U.S. Nuclear Regulatory Commission
Office: Office of Nuclear Regulatory Research
Mail Stop: T-10 A36
Washington, DC 20555-0001
E-Mail: Matthew.Hiser@nrc.gov
Phone: 301-251-7601

11.0 MATERIALS REQUIRED (TYPE N/A IF NOT APPLICABLE)
N/A

12.0 NRC-FURNISHED PROPERTY/MATERIALS

PNNL will transfer NRC furnished property and materials acquired under previous contracts (i.e., JCN N6029, N6907) to this task order. NRC will provide additional information from EMDA and SLR databases.

13.0 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 shall review all research products with these criteria in mind.

14.0 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.

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.

15.0 OTHER CONSIDERATIONS (TYPE N/A IF NOT APPLICABLE)

References

1. Bond LJ, SR Doctor, and TT Taylor. 2008. *Proactive Management of Materials Degradation - A Review of Principles and Programs.* PNNL-17779, Pacific Northwest National Laboratory, Richland, WA.
2. Bond, LJ, TT Taylor, SR Doctor, AB Hull, and SH Malik, (2008) *Proactive Management of Materials Degradation for nuclear power plant systems.* Proc. Int. Conf. Prognostics and Health Management 2008, Denver, CO, October 6-9. IEEE Reliability Society,# OP-20-01 120
3. Chopra, OK, et al, *Managing Aging Effects on Dry Cask Storage Systems for Extended Long-Term Storage and Transportation of Used Fuel*, Rev. 0, FCRD-USED-2012-000119, 2012.
4. EPRI 3002000576, *Long-Term Operations: Assessment of R&D Supporting AMPs for LTO*, Aug. 2013 (80pp).
5. NEI, *Roadmap for Subsequent License Renewal*, Dec. 2013. (45pp)
6. NEI, *Second License Renewal Roadmap*, May 2015. (22pp).
7. NUREG/CR-6923, *Expert Panel Report on Proactive Materials Degradation Assessment*, 2007 (3895pp, ML063520517)
8. NUREG/CR-7153, *Expanded Materials Degradation Assessment*, 5 volumes, October 2014 (861pp)
9. SECY-14-0016, *Ongoing Staff Activities to Assess Regulatory Considerations for Power Reactor Subsequent License Renewal*, January 31, 2014 (25pp)
10. Taylor, WB, CE Carpenter, KJ Knobbs, S Malik, *Using Technology to Support Proactive Management of Materials Degradation for the U.S. Nuclear Regulatory Commission*, Proceedings of the ASME Pressure Vessels & Piping Division/K-PVP Conference, PVP 2010, July 18-22, 2010. Bellevue, WA, USA. Paper PVP2010-26063.
11. *The Scalable Reasoning System: Lightweight Visualization for Distributed Analytics*, IEEE Symposium on Visual Analytics Science & Technology, 978-1-4244-2935-6/08

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

Applicable Publications **(Type N/A if not applicable)**
N/A

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