INDUSTRIAL SOLUTIONS LABORATORY

Company Information

Company Name	*Electric Power Research Institute*	**Date Submitted**	*11/11/2024*
Project Title	*Creep Crack Growth Test Frame Design-Build (EPRI_CREEP)*	**Planned Starting Semester**	*Spring 2025*

Senior Design Project Description

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills.

Discipline	Number	Discipline	Number
Mechanical	3-4	Electrical	1
Computer	1	Systems	

Company and Project Overview:

EPRI is a research organization that follows the science to help power society toward a reliable, affordable, and resilient energy future. Rigorously objective in our role and our research, we do not advocate for any specific company, sector, or technology. With a foundational mission to benefit society, EPRI delivers independent, objective thought leadership and industry expertise through a highly collaborative approach.

The Materials program (Program 229) content and research activities support the maintenance of the existing fleet and provide new and emerging insights for new assets and processes. The program library of reports and knowledge regarding the repair of mainstay steels or the life management of 9 wt. % Cr creep strength enhanced ferritic (CSEF) steels is the most extensive of its kind. The program continues to expand its research impact and simultaneously reduce the uncertainty regarding advanced generation high-temperature materials challenges in concentrated solar power systems or supercritical CO2 cycles, validation and assessment of additive manufacturing across multiple end-use applications or identifying damage mechanism(s) in a diverse range of low- or high-temperature failures throughout the energy industry. In support of this ongoing research, recent investments in EPRI laboratories are generating important insights and learnings. The Materials program provides integrated materials selection guidance,

alternative repair approaches, advanced fabrication technologies, and corrosion mitigation strategies to improve equipment performance, reliability, and safety, and its research portfolio is undergoing an immense increase in diversity to addresses an ever-emerging set of issues in energy generating assets.

High temperature components are susceptible to creep crack growth (CCG) under sustained mechanical loads. Thus, it is important to experimentally study the CCG behavior of materials. ASTM E1457 covers the standard test method for measurement of CCG times in metals. Thus, standard testing should adhere to the guidance provided by the standard. A conceptual design for a CCG test frame is provided below in Figure 1.

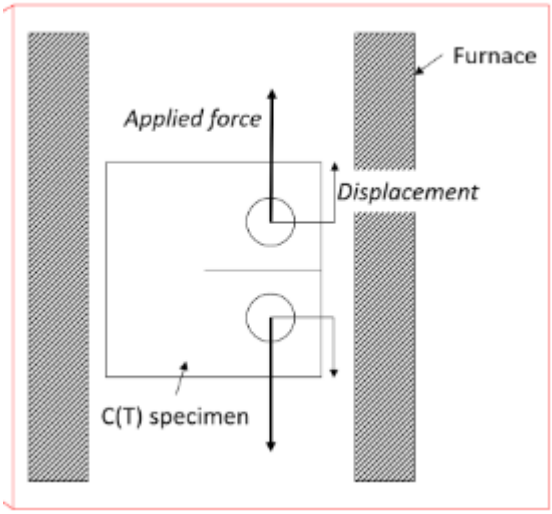

Figure 1: Conceptual design of a creep crack growth frame.

Project Requirements:

There is an opportunity to develop a creep crack growth (CCG) test frame for a lower cost while additionally permitting greater flexibility and experimental control than commercially available test frames. Thus, this project entails designing and building a test frame for performing CCG testing. This includes the physical frame which can accept existing furnaces and extensometry. The test frame may be designed utilizing existing frames and/or components that currently exist in the Advanced Generation Laboratory at EPRI. The frame must permit the guidelines of ASTM E1457 to be followed. The senior design team is expected to provide sufficient justification (hand calcs and/or FEA) supporting their design, drawings for fabrication of load frame components, cost estimates for materials, and build/assemble/test the frame. The senior design team is further expected to produce a plan for the control and data acquisition systems for this frame, either using existing systems within EPRI's Advanced Generation Laboratory or with new systems, supported by adequate justification for the plan.

Expected Deliverables/Results:

- Minimum of weekly project updates (PowerPoint file) documenting progress and collaborating with project sponsors on the frame design. Monthly in-person or WebEx meetings will also be required as the project progresses. This is in addition to the 4 formal course required design reviews.
- Formal report and presentation entailing the design of the physical components of a load frame for performing creep crack growth (CCG) testing. Content must include:
    - Supporting documentation for physical components of the frame compiling all hand calcs (digitized, not handwritten) and/or FEA results
    - Engineering drawing with appropriate, justified GD&T for fabrication of load frame components
    - Cost estimates for materials
    - Sufficiently justified proposal for the control and data acquisition systems on the load frame.
    - A bill of materials list that outlines all required materials and within a budget specified by the project sponsor.
    - **This is the major deliverable expected for the first semester of the project.**
- Procurement of required supplies, materials, and equipment needed to fabricate the load frame during the second semester. Fabrication and assembly assistance will be provided by the project sponsor where required (such as major machining and/or welding needs).
    - Operational test frame with produced raw test data proving 1) control of the frame and 2) elucidation on sources of error and quantification of their impact on subsequent test data.
    - **This is the major deliverable expected for the second semester of the project.**
- All final reports/slides are expected to be submitted no less than 2 weeks prior to deadlines so that content can be reviewed and feedback can be provided and incorporated prior to the deadline.
- 3D CAD models for all components must be provided to project requestor upon completion of the project.

Disposition of Deliverables at the End of the Project:

Students are graded based on their display and presentation of their team's work product. It is mandatory that they exhibit at the Expo, so if the work product was tested at the supporter's location, it must be returned to campus for the Expo. After the expo, the team and supporter should arrange the handover of the work product to the industry supporter. This handover must be concluded within 7 days of the Expo.

List here any specific skills, requirements, specific courses, knowledge needed or suggested (If none please state none):

- Individual/personal commitment to quality
- Desire and drive to learn throughout this process
- Open, honest, and frequent communication and collaboration with project sponsor to develop a world-class product
- Willingness to visit EPRI site as needed to get first-hand experience and familiarity with the current equipment and facilities of the Advanced Generation Laboratory
- Ability to read and interpret technical manuals and drawings and a personal drive to seek out answers to questions as they arise (both learning for yourself and seeking the input of others)
- Beneficial course work
    - Mechanical behavior of materials
    - Machine design, familiarity with machining processes, design for fabrication
    - 3D CAD
    - Experimental methods and techniques
    - Controls design