

## UNC Charlotte College of Engineering Senior Design Program

### Senior Design Project Description

<b>Company Name</b>	<i>EPRI</i>	<b>Date Submitted</b>	<i>11/15//2019</i>
<b>Project Title</b>	<i>Design of Manual Spent Fuel Pool NDE Sensor Delivery Tool (EPRI SENSOR)</i>	<b>Planned Starting Semester</b>	<i>Spring 2020</i>

#### Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project. 250 hours are expected per person.

Complete the following table if this information is known, otherwise the Senior Design Committee will develop based on the project scope:

<b>Discipline</b>	<b>Number</b>	<b>Discipline</b>	<b>Number</b>
Mechanical/Robotics	3	Electrical	1
Computer	1	Systems	1
Other (        )			

#### Company and Project Overview:

The Electric Power Research Institute (EPRI) conducts research, development, and demonstration projects for the benefit of the public in the United States and internationally. As an independent, nonprofit organization for the public interest, we focus on electricity generation, delivery, and use in collaboration with the electricity sector, its stakeholders and others to enhance the quality of life by making electric power safe, reliable, affordable, and environmentally responsible.

EPRI has collaborated with the electricity sector and its stakeholders since 1972 and our membership has grown to represent approximately 90% of the electric utility revenue generated in the United States and extends to participation in more than 35 countries. The worldwide membership that supports our work comprises more than 1,000 organizations. While most members are electric utilities, others are businesses, government agencies, regulators and public or private entities engaged in some aspect of the generation, delivery, or use of electricity.

Through their advisory roles in EPRI, its research sectors and programs, EPRI members help inform the development of EPRI's annual research portfolio, identify critical and emerging electricity industry issues, and support the application and technology transfer of EPRI's research and development.

#### Project Overview:

There is a growing concern regarding the leakage of spent fuel pools in nuclear power plants. Some plants have experienced leaks since early in plant life. Plant owners need to identify and address these leaks from their fuel pool liners but it is difficult to implement inspection tools due to the harsh radiation (expected at approximately 10,000 r/hr) and high temperature (up to 120°F) environments.

The eddy current array (ECA) testing was identified as a reliable nondestructive testing (NDT) tool to inspect spent fuel pool liners. However, a delivery system is required to transport the eddy current sensor to these hard-to-reach and harsh environment locations that may involve the use of high-end and expensive equipment. In some cases, plants may want to inspect only the upper part of spent fuel pool area, which does not require high-end, expensive, or sophisticated equipment. Therefore, a simple delivery system to transport the eddy current sensor is required.

The goal of this project is to develop a conceptual design of a manual ECA sensor delivery tool for spent fuel pool liner inspection. The delivery tool should be able to payload the eddy current sensor, camera and lighting in order to access and navigate the vertical liner close to pool floor, and also provide positional information utilizing encoder. This project will not fabricate any physical system but build 3D CAD models, animated movie clip and assess the feasibility and applicability to achieve the desired goal.

### **Project Requirements:**

This project would design a manual ECA delivery tool using 3D CAD models that can be operated close to spent fuel pool floor and radiation environment. The requirements of this project are:

- The modelled manual ECA delivery tool shall be capable of operating at up to 3 m stroke toward depth direction.
- The height of delivery tool shall not exceed 10 inch (25.4 cm) to deliver between spent fuel pool floor and fuel rack.
- The ECA delivery tool shall be easy to attach and detach to structures on the side walls (for example, guide fences) that allows easy movement to the next inspection location.
- The delivery tool shall have smooth movement with moving axis to navigate, down (-z) up (z) directions.
- The delivery tool should be able to payload the ECA probe, camera, light and cable loads and be able to climb vertical walls while providing ease of navigation features. The purpose of the camera and light is to monitor the contact of the ECA probe.
- The ECA sensor movement shall be operated by inspector without any motorized gadgets. This is to simplify the overall system in manual operations.
- The ECA probe needs to be in contact with the test surface to commence scanning of the spent fuel pool liner plate. Therefore, it is important that the delivery tool design incorporates a backing force (spring or air pressure) to the ECA probe housing to achieve the required contact of the probe surface to the liner.
- The delivery tool shall be equipped with an encoder to provide positional signal to the NDE sensor location.
- Electronic parts (camera, light, and encoder) may be damaged by radiation. Therefore,



UNC CHARLOTTE

*The WILLIAM STATES LEE COLLEGE of ENGINEERING*

radiation shielding must be considered in the design to minimize damage to the parts.

- The delivery tool shall be designed in such a way that no parts become loose and drop-off during its operation (foreign material exclusion – FME). All parts must be accounted for before the go into the pool and upon withdrawal.
- The material of the delivery system should be Aluminum or equivalent to minimize the weight of tool.
- The power to the camera and lighting shall be supplied from an outside source.
- The final design should include parts that are easily replaceable. Commercially available parts should be considered in the design. In some cases, parts need to be specifically machined. Identify all commercially available and machined parts in a table to be included in the final report. For commercially available parts, provide source and for machined parts, provide design drawings in AutoCAD
- Build 3D CAD modeling and generate movie clips showing the operability.
- Suggest estimated manufacturing cost and bill of materials (BOM)

### **Expected Deliverables/Results:**

- The deliverable will be a 3D CAD modeling files and animated movie clips
- Final Report- The final report should provide all details of the project. It should be written in a manner that will allow the next UNCC team or EPRI to use most of the research information and results to fabricate a final field deployable system. As a minimum, the final report should include following:
  - 
  - Scope-of-work
  - Objective
  - Research and development approach – All steps
  - Radiation and temperature consideration on the parts and overall design
  - Foreign material exclusion (FME)
  - Estimated manufacturing cost and bill of materials (BOM)
  - Identify all commercially available and machined parts in a table to be included in the final report. For commercially available parts, provide source and for machined parts, provide design drawings in AutoCAD
  - Identify challenges and gaps

### **Disposition of Deliverables at the End of the Project:**

- Hand over all deliverables to the EPRI project manager

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

- Mechanical and Electrical
- 3D CAD Design (Solidworks or Inventor)