



### **Company Information**

<b>Company Name</b>	<i>Framatome Inc.</i>	<b>Date Submitted</b>	<i>October 30, 2023</i>
<b>Project Title</b>	<i>Design of In-Pipe Crawler Inspection Tooling (FRAM_CRAWLER2)</i>	<b>Planned Starting Semester</b>	<i>Spring 2024</i>

### **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.

<b>Discipline</b>	<b>Number</b>	<b>Discipline</b>	<b>Number</b>
Mechanical	3	Electrical	1
Computer	1	Systems	

#### **Company and Project Overview:**

Framatome, a prominent provider of cutting-edge solutions for the commercial nuclear power generation industry, recognizes the utmost significance of rejuvenating aging and deteriorating piping infrastructure. Their core mission revolves around tackling the substantial challenges encountered by nuclear power plants, notably the wear and tear experienced by buried and subterranean piping systems.

In partnership with experts in the field, Framatome has developed a turnkey solution for rehabilitating these underground pipes. This innovative approach involves the application of a Spray In Place (SIP) liner to the inner diameter of the pipe system. Not only does this solution extend the operational life of existing small and large bore service water piping, but it also eliminates the need for costly excavation and complete pipe replacement.

Framatome's collaboration with the University of North Carolina at Charlotte (UNCC) for a 2024 senior design project has technical objectives to enhance the current capabilities of the existing Framatome In-Pipe Crawler deployment system(s). This project's primary goal is to incorporate



nondestructive examination (NDE) equipment and tooling to provide a visual-surface and UT thickness measurements. Examples of visual-based surface inspections along with ultrasonic-based thickness methods will provide a comprehensive assessment of the applied liner and host pipe. Required examinations are crucial for ensuring the liner application is successful by verifying the proper liner thickness has been applied and is free of critical installation defects and anomalies. Moreover, integration of NDE solutions will also provide inspection capabilities for subsequent in-service inspection needs and requirements.

This dual inspection process is essential to the integrity and effectiveness of Framatome's liner application method. It ensures that the liner can be applied to the pipes in need of rehabilitation and, furthermore, that the application is executed with precision, meeting the required thickness and quality specifications.

### **Project Requirements:**

Framatome is actively engaged in the development of a comprehensive spray-in-place liner delivery system, encompassing various critical components such as the in-pipe crawler platform, spin-cast liner application tools, surface preparation tools, inspection equipment, as well as the associated umbilicals and external equipment. The primary robotic/crawler system, initially developed by a previous senior design team and subsequently enhanced in a second iteration by Framatome, will serve as the baseline design for the current senior design team.

The primary objective for the senior design team is to build upon the existing design provided by Framatome and further develop the necessary inspection tooling for this crawler.

The project's scope entails the following tasks:

1. **Research and Develop Remote Thickness Measurement Technology:** Investigate various established and innovative technologies for accurately measuring the thickness of the SIP liner against the existing host metallic pipes. The team will be responsible for designing both the mechanical and software interfaces required for the crawler to conduct thickness measurements within the pipe. Framatome will collaborate on these thickness measurement options, drawing from their prior experience with this instrumentation.
2. **Explore Remote Camera Solutions:** Research and integrate camera options and mechanisms for controlling pan and tilt movements. The selected camera must offer a minimum resolution of 1080p, with preference given to Ethernet cameras to reduce signal interference over extended umbilical cable distances.
3. **Integrate New Technology with Existing Software:** Interface the newly developed technology seamlessly with the current Python-based ground control application, which runs on Windows. The existing application code will be made available to the team. Additionally, this application communicates with the crawler via RS485 and Modbus, necessitating compatibility with RS485 signals. (Microcontrollers like the ESP32 can be efficiently controlled via RS485.)



4. **Design an Attachment Interface:** Develop an easily attachable interface for mounting the inspection system onto the crawler.

The specific specifications associated with the in-pipe crawler, tooling, and project requirements will be provided at the project's outset.

**Expected Deliverables/Results:**

1. **Integrated Inspection Tooling:** A fully developed and integrated inspection tooling system designed for the in-pipe crawler, encompassing both hardware and software components.
2. **Thickness Measurement Technology:** Implementation of a reliable technology for accurately measuring SIP liner thickness against the metal substrate within the pipes, complete with mechanical and software interfaces.
3. **Camera Solution:** Selection and implementation of an appropriate camera system, meeting or exceeding minimum resolution requirements, with a mechanism for controlling pan and tilt movements.
4. **Integration with Ground Control Application:** Successful integration of the inspection technology with the existing Python-based ground control application, ensuring compatibility with RS485 signals and Modbus communication.
5. **Attachment Interface:** Development and implementation of a user-friendly interface for secure mounting of the inspection system onto the crawler.
6. **Documentation and Project Report:** Comprehensive technical documentation per UNCC guidelines.

**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):**

1. Strong Problem-Solving Skills and Mechanical Aptitude
2. Machine Shop Access with CNC Qualifications (Preferred)
3. Experience with Arduino, Python, and Serial Communication
4. Proficient with SolidWorks CAD Software (Preferred)