



### **Company Information**

<b>Company Name</b>	<i>Framatome Inc.</i>	<b>Date Submitted</b>	<i>11/12/2021</i>
<b>Project Title</b>	<i>In-pipe Crawler Integration Design (FRAM_CRAWLER)</i>	<b>Planned Starting Semester</b>	<i>Spring 2022</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	1-2
Computer	1	Systems	
Other ( )			

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

Framatome is a provider of innovative solutions to the commercial nuclear power generation industry. This includes addressing significant challenges that nuclear power plants face, such as degradation of buried and underground piping. Framatome has jointly developed a turnkey underground piping rehabilitation solution based on the application of a Spray In Place (SIP) liner applied to the inner diameter of the pipe system. This solution can rehabilitate (in place) existing underground small and large bore service water piping to extend the operability of these assets, without having to incur the extremely costly efforts associated with excavating and replacing underground piping. To support this solution, the envisioned UNC Charlotte senior design project primarily focuses on integration of key end-effectors/tools onto robotic platforms with engineering/systems consideration for umbilical management/optimization.

The application of Framatome's SIP liner system within underground piping requires use of numerous tooling and equipment, all of which must be capable of entering into and traversing within piping with attached umbilicals. Tooling deployed within piping will include surface

cleaning tooling, liner application tooling, and inspection tooling. To support deployment of these tools, an in-pipe crawler will be used to position tooling within piping and assist in tooling movement. Integration of this in-pipe crawler and the tooling units is critical to efficient execution of the in-pipe liner system and is the focus of this project.

Below are images of some of the in-pipe tooling to be used for liner application.



*Figure 1: Spin Cast Skid – Liner Application*



*Figure 2: Abrasive Blasting Skid – Pipe Cleaning*



Figure 3: In-Pipe Visual Inspection

### **Project Requirements:**

Specifically, Framatome is working on a spray in place liner solution that is delivered via a spin-cast system integrated with robotic/crawler drive unit. This robotic crawler is intended to support all aspects of liner application, including pre-application cleaning and priming, installation of the spray-in-place liner leveraging the spin-cast methodology, and subsequent inspections to ensure proper application meeting Code specified requirements. As clarification, the primary robotic/crawler system is being investigated outside of the scope of the UNC Charlotte project. The objective for the senior design team is to work from the Framatome developed technical requirements document (TRD) (in-process of revision) and focus on the integration of end-effector devices/payloads such as blasting technologies, spin-cast tooling, and non-destructive examination equipment (including visual testing cameras, dry film thickness instruments, and volumetric ultrasonic transducers).

In addition, to support the application of the liner, the crawler unit must be accompanied by an umbilical and tether system to support cleaning efforts and removal of debris, constantly supply liner product (a two-part solution) to target location for application, and support NDE cabling/transmission of data. Miscellaneous contents of umbilical also include power, controls, air supply, etc. It is imperative that these umbilical systems must be designed properly or optimized to reduce drag, not kink when navigating bends, be supportive of elevation changes within the pipe run (e.g. vertical zones), and be able to move in and out of the pipe freely as the application process requires multiple layers by iterative movements within the pipe.

The scope of this project will be to:

- 1) Develop an understanding of Framatome's buried and underground pipe rehabilitation



solution.

- 2) Design the interface between the robotic delivery system and the various end effectors/skids that are used for the applications described above. This may include design modifications to the current skids and/or crawler.
- 3) Develop mechanical methods to reduce drag and forces on the umbilical systems. This will include design that accommodate all expected umbilicals.

Specifications associated with the in-pipe crawler, tooling, and liner application process will be shared at start of project.

**Expected Deliverables/Results:**

- Drawings of crawler-tooling integration design
- Calculations associated with crawler-tooling integration design
- Drawings of umbilical optimization design
- Calculations associated with umbilical optimization design
- Prototype of integration design (Framatome to provide crawler and tooling)
- Prototype of umbilical optimization (Framatome to provide umbilicals)
- Testing and verification inside various pipe diameters.

**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):**

This project is expected to require coordination of Mechanical, Electrical and Systems Engineering disciplines. Students should have good machine design skills / knowledge.