

Project Deliverable B: Need Identification and Problem Statement

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Abstract

This document goes through the design requirements, and current models of a pipe cleaning and scraping device. The device will be able to take a metal sample from inside a nuclear fuel channel to determine its hydrogen concentration. The document begins with an introduction to the problem, going through how and why nuclear technicians need to confirm the condition of the fuel channels. Followed by a section looking into the exact needs and design criteria of the device. The document will then go into the problem statement, and some starting ideas for our design. Finally there is benchmarking to compare other designs, and help come to a conclusion.

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1 Introduction

Utility operators need to confirm that their fuel channels are still in suitable condition to operate properly. The approach that the company is going to use is taking a sample and analyzing the sample. To do this, they require a tool that will allow them to scrape and collect a sample from the inside of a fuel channel. This sample will then be sent to a lab to determine its hydrogen concentration.

2 Needs Identification

This section describes the needs of the client, which were recorded and interpreted from the first client meeting.

2.1 List of needs ordered by priority

- Must fit in a tube with a diameter of 101.6 mm
- Must be able to reach 4.572 m into the tube from the inlet
- Must be reliable and capable of collecting the sample without excess damage to the fuel channel
- Must collect a representative sample that is within 30-80 mg
- No contact can occur between the operator of the tool and the sample itself
- Must notify the operator of the action that the tool is currently carrying out (e.g. extending, scraping, retrieving, etc.)
- Design must be modular (can be broken down for easy transport)
- Tool must be fail-safe and reusable
- Should be user-friendly and safe to handle for an operator that has a college diploma
- Environmentally friendly materials
- Powered using clean energy
- \$100 budget

3 Problem Statement

There is a need for a tool that will allow nuclear Engineers to scrape and collect a metal sample 4.572 m from the inlet of a fuel channel with a diameter of 101.6 mm. The sample will be able to be extracted from the device without coming in contact with the operator.

4 Benchmarking

To strengthen our understanding of client needs and this design project, we researched similar innovations. The client presented existing solutions, however, they also made it clear that the purpose of this project is to create a design that is different from already existing ones. Despite this, benchmarking is advantageous as it allows us to learn more about the features of current solutions and how they meet various client needs.

4.1 Kinectrics CWEST

Kinectrics CWEST is a solution that the client mentioned during the client meeting. The technology includes an electric motor which allows for a rotating cutting head, as well as hydraulic clamps and cutter actuator for aligning the tool and extending the cutters. It first performs an oxide cut to eliminate unrepresentative material, and then takes the actual sample. The tool has 8 compartments, which allows for up to 8 samples to be taken from one fuel tube, and is reusable.

5 Potential Ideas

- Tool feedback: Using sensors and lights to indicate the current status of the tool to the operator
- Modularity: Body of the tool consisting of multiple sections (about 1 metre each) that can be connected and disconnected for easy transport

6 Questions

- What kind of metal are the fuel channels made of?

7 Conclusion

This report provides an overview of the identified client needs, and the problem statement that was formulated based on those needs. It also touches on existing solutions, and a few potential ideas to meet client needs.

8 References

1. "CNL successfully completes Gentilly-1 sampling campaign." *Canadian Nuclear Laboratories*, 2 January 2024, CNL successfully completes Gentilly-1 sampling campaign. Accessed 26 January 2025.
2. "Fuel Channel Inspection & Maintenance." *Kinetrics.com*, Kinetrics, 2025, <https://www.kinetrics.com/capabilities/products/nuclear-generation-products/fuel-channel-inspection-maintenance>. Accessed 26 January 2025.