Needs Identification and Problem Statement

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Introduction

Nuclear reactors are complex machines with an average shelf life of up to 30 years. Towards the end of their lives, sampling fuel channels becomes a relevant and critical process. It is essential in monitoring the longevity, safety and performance of the reactor. The samples collected are used to assess the health and ensure it's up to par with safety codes. There are devices out there tasked with this job that present various problems such as being too complex, expensive and unable to adapt.

These tools matter because accurate samples are required to ensure that the appropriate maintenance is done for all reactors. Essential companies such as CNL are impacted by these results, directly affecting reactor operators and safety inspectors. Ensuring that equipment is up to date can reduce delays, costs and safety risks. Our proposed design will be a new innovated tool, which combats all of these challenges that companies face. In short, our design aims to be precise, easily operational, and rigid whilst being mobile, while also being cost efficient.

Needs Identification

	Need	Importance
1.	The device can communicate the major components of the sample retrieval process in real time.	**5**
2.	The device can obtain and verify the sample without direct contact or viewing from the operator.	**5**
3.	The tool is easy to operate and control.	**4**
4.	The tool is rigid and keeps a stable path.	**5**
5.	The tool can travel at least 15 ft.	**5**
6.	The tool can obtain a sample that is between 30 and 80 mg.	**5**
7.	The device has its own power source.	**5**
8.	The tool can fit in a tube with an inside diameter of 4 inches.	**5**
9.	The tool can be dismantled into parts.	**5**
10.	The device is easy to remove from the channel.	**4**
11.	The sample is easy to extract from the container.	**3**
12.	The tool can be used more than once.	**3**
13.	The tool does not compromise the integrity and stability of the fuel channels.	**3**
14.	The device’s parts and materials are inexpensive.	**2**
15.	The tool does not resemble the Kinectrics CWEST or the CNL scraping tool.	**1**
16.	The tool is made of steel or aluminum.	**1**

Operation and Control

Needs 1-4

The success of the device depends heavily on the level of control during the sampling process. For the sample to meet the weight and depth requirements, the operator needs to know that the tool is working as desired. However, the most significant component of the project is that the operator and the sample never come into contact. This results in two important elements: the ease of operation of the device, and the independent functioning of the tool. Therefore, the needs given the highest priority involve operation and control.

Fuel Channel Constraints

Needs 5-8

The entire sampling process revolves around the fuel channels and the exterior environment. The device needs to follow all constraints given by the client, as the purpose of the product is to test conditions of the tube from a distance, and without contact. If the tool does not fit into the channels, or is not compatible with the area surrounding them, then samples cannot be taken. As a result, the needs corresponding to the fuel channel constraints are given high priority.

Device Assembly

Needs 9-13

Once the sample has been collected, the device needs to ensure that it can be sent to the lab for analysis. For the sample to be moved correctly, the tool must be removed from the fuel channel in a specific way. It must be dismantled into multiple parts, so that the entire device does not have to be transported but can still be used more than once.

Materials and Cost

Needs 14-16

The client is conscious of the budget and suggest certain materials, steel or aluminum. However, the materials are not prioritized over the function and assembly of the product and therefore have low priority.

Problem Statement

Canadian Nuclear Laboratories needs a tool to collect a 30-80 mg sample from a 4” pipe, 15 ft deep, without contact between the operator and the sample. The device is easily controlled, dismantled, and removed without significant damage to the sample or the fuel channels.

Conclusion

Developing such a sampling tool, with the sole purpose of being user-friendly, adhering to the challenges that our consumers face and combating those issues. Such an innovative device includes the balance found between creating a tool that is both durable and adaptable. The tool can be operated by various users and in various settings, by taking user feedback from existing tools and incorporating them into our device, it is both practical and reliable.

In regards to future works, we are exploring a wide variety of options, although in terms of prioritizing them, integrating automation would be at the top. Seeking options to turn this entire sample retrieval process fully automated, we aim for the process to be more efficient, while reducing the number of operators required. Through these future works, we're aiming to evolve, setting higher scales with new tools that boost the maintenance and safety of the reactors and personnel working on them.