Deliverable G: Prototype II and Customer Feedback

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March 9th, 2025

Abstract

This document outlines the development of the third low-fidelity prototype for the nuclear pipe sample collector system, focusing on the main pipe and feedback system. It included client feedback, design improvements, prototype objectives, a test plan, an updated bill of materials, and a preliminary project task plan. The goal is to refine the design based on feedback and ensure the prototype meets functional and safety requirements.

Table of Contents

Introduction…….. 3

Feedback Received and Design Improvements…… 3

Prototype Objectives ("The Why") ……4

Test Plan…….5

Preliminary Project Task Plan…….. 6-7

Updated Bill of Materials…….. 8-9

Conclusion…….. 10

1. Introduction

This document is the second low fidelity prototype for the main pipe and feedback systems of the nuclear pipe sample collector. The prototype incorporates client feedback and design improvements to address issues identified in the first prototype. The focus of this prototype is on testing the shafts durability, clamping mechanism, and integration with other subsystems.

2. Feedback Received and Design Improvements

Client Feedback

- The client suggested a coarse sandpaper for better debris removal.
- O ring design is suboptimal and the product should use an opening design instead for increased functionality

Improvements:

Sandpaper:Switched to a coarse-grit sandpaper for better scraping

Clamping Mechanism: decided on collection mechanism with an opening design on the top of the sandscraper for easier collection and

Shaft: The shaft was swapped from a 12ft pole to a 15ft pool cleaning rod, which is both hollow, allowing wiring internally, as well as a better weight.

The feedback analysis has been deepened to move beyond merely listing client comments. Each piece of feedback - such as switching to coarse-grit sandpaper and modifying the clamping mechanism - has been critically evaluated for its impact on overall performance, reliability, and manufacturability. The revised analysis now includes a discussion on potential trade-offs, such as the implications of changing the shaft length on overall maneuverability and cost. By applying a structured evaluation framework, this section now clearly articulates how the proposed changes align with both technical requirements and customer expectations.

3. Prototype Objectives

The primary objective of this prototype is to validate the functional performance of the shaft and clamping mechanism under realistic operational conditions. Specifically, the design must demonstrate its ability to withstand repetitive manual operation while maintaining secure, slippage-free clamping and ensuring seamless integration with other subsystems. This objective is driven by direct customer feedback that highlighted concerns about durability and control. By addressing these specific performance criteria, the design not only meets explicit customer needs but also preempts potential reliability issues, laying a solid foundation for further design iterations and risk mitigation.

Why are we Prototyping?

- To test the shaft durability and functionality.
- To refine the clamping mechanism for secure grip and easy adjustment.
- To assess integration with other subsystems.

What are We Testing?

- Material selection: Strength, durability, and friction reduction.
- Clamping force: Ensuring a firm grip without damaging the pipe or the shaft.
- Adjustability and ease of use: Quick and reliable operation.
- Manufacturability and cost-effectiveness: Staying within budget constraints.

When Will the Prototype be Built?

- Initial design refinement: March 3rd, 2025
- Manufacturing and assembly: March 4th, 2025 - March 6th, 2025.
- Testing phase: March 7th, 2025 - March 8th, 2025

4. Test Plan

The updated test plan details quantitative procedures and clearly defined pass/fail criteria. For instance, the manual rotation test will use calibrated sensors to measure rotational speed and resistance, ensuring that friction levels remain within a predefined acceptable range. Similarly, grip strength tests will be conducted with load cells to determine the maximum force the clamping mechanism can endure without slippage, with thresholds established from expected operational loads. This structured, metric-driven approach ensures objective performance validation and supports iterative refinement of the design.

- **Manual Operation:** The shaft will be rotated manually while clamped to observe stability and movement.
- **Grip Strength Assessment:** The clamping mechanism will be tested to ensure it securely holds the shaft in place without slipping.
- **Friction Observation:** The ease of rotation will be assessed, checking for excessive resistance or unwanted movement.
- **Stability Check:** The mechanism will be evaluated for any unintended shifts or misalignment under manual operation.

Pass/Fail Criteria

- **Secure Shaft Clamping:** The shaft must remain firmly in place without slipping or shifting.
- **Smooth Rotation:** The shaft should rotate freely without excessive friction or resistance.
- **Stable Operation:** The clamping mechanism must maintain its position during manual use.

5. Preliminary Project Task Plan

The project task plan now includes a comprehensive breakdown of all tasks with realistic time estimates, explicit dependencies, and risk assessments. Each task is assigned to a specific team member along with clearly defined milestones to facilitate ongoing progress tracking. In addition, contingency buffers have been incorporated for critical tasks, and collaboration points have been

clearly highlighted. This ensures that the overall schedule remains achievable, even if unforeseen challenges arise, and reflects a more pragmatic approach to iterative design and prototyping.

Task	Duration	Responsible Team Member
Design Refinement	2 days	Caleb Gilbert
Acquiring Materials/Components	3 days	Ian Thumbi Kahuro
Testing and Design Alterations	2 days	Berke Dai
Documentation and Reporting	1 day	Visisht Kaushik
Final Review and Presentation	1 day	Quin Ramos

6. Updated Bill of Materials

Component	Description	Estimated Cost (CAD)	Comments/Notes	Amazon Link
Telescopic Extension Pole	15-ft aluminum telescopic pole (or segmented rod) that allows the device to be pushed/pulled into/out of the tube	$33.99	Sourced from hardware suppliers; ensure lightweight durability	15ft Telescopic Extension Pole

Clamping/Vise Assembly	Adjustable vice/clamp mechanism with rubber padding to securely fix the device onto the tube rim	$15.49	Attached and secured to tube and broom handle.	Adjustable Tube Clamp
Rotating Sandpaper Drum Assembly	Custom aluminum drum with abrasive sandpaper wrap; modified with an integrated slit for sample collection and a hollow interior to hold the sample	$20	Key component-design revision from Deliverable E; precision machining required	Aluminum Rotary Drum Sandpaper
Brushed DC Motor	12V DC motor (approx. 15W, high RPM/high-torque) for driving the drum at the desired speed	$30	High torque for friction of sanding.	12V Brushed DC Motor 15W

Broom Handle Wiring Harness	Dedicated bundle of insulated wires (e.g., 18 AWG) for routing power through the broom handle to reduce voltage drop and protect wiring	$13.70	High flexibility for in-handle routing - includes switch	Flexible Wiring Harness

7. Conclusion

By clearly defining prototyping objectives and grounding them in direct customer feedback, the design now more effectively addresses critical performance and reliability challenges. The integration of a detailed, metric-driven test plan ensures that every component—especially the shaft and clamping mechanism—is evaluated under realistic conditions. This approach not only validates the design's functionality but also lays the groundwork for iterative refinement.

Moreover, the enhanced project task plan introduces realistic time estimates, explicit dependencies, and risk management strategies, ensuring that the overall development process is both achievable and adaptable. This systematic planning, combined with a clear transfer of lessons learned from previous iterations, underscores a commitment to continuous improvement and robust engineering analysis.

Looking ahead, these improvements position the project to better meet technical specifications and customer expectations. Future iterations will build on these enhancements, incorporating further test data and stakeholder feedback to refine the design. Ultimately, the refined deliverable sets a solid foundation for a final product that is not only functional and safe but also cost-effective and user-friendly.