

Development of the Mini Rover



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Purpose of the Mini Rover



• Small amounts of nuclear trace have been found in the anulus of the AY-102 waste tank located at the Hanford site. The objective is to develop a miniature inspection tool to inspect the integrity of the waste tanks.



The yellow arrows shown in the diagram represent the path the mini rover will take.



Design Challenges



To be able to successfully traverse the slots, we considered the following design restrictions

Restrictions

- Size.....(see fig. 1)
- Overcome weld seams.....(see fig.2)
- Temperature.....Operational max temp 150F
- Durability..... Multiple successful tests
- Pull force......Greater than 5 lbs. due to tether
- Quality video at lengths.....(see fig.3) Beyond 100'
- Tether.....Must be tethered for emergency egress





Figure 2: Rover testing on weld seam mock-up

Figure 3: Rover sending video feed with 100' tether



Mechanics of the Mini Rover



- In order to achieve the 90-degree angle, we utilized a bevel gear system to transfer the torque and power.
- The unit is designed into a V-shape body to aid in overcoming weld seams and uneven surfaces beyond 1" in forward and reverse direction.
- This unit has magnets strategically placed below the unit to provide sufficient attraction to the surface of the tank, but not actually touching the tank and hindering movement of the rover.







Mini Rover Specs



Body Size

- Length= 4.1"
- Width = 1.6"
- Height= 1.8"

Magnets

- 12 total N42
- 1mm gap from surface.

<u>Motors</u>

- Four motors on the unit which individually drives each wheel.
- Stall torque is rated at 140 oz-in.
- Each motor is geared to 1000:1 ratio for greater torque.
- All four motors turn at 35 RPM's.





Electronics and Power Consumption







Camera and Light's PCB







Dimensions of the camera and light PCB shown above



The Finished Product



Final Rover Design



Final Mini Rover design printed in aluminum.

Mini Rover Control Box





Contractor Approved Test Plan



The mini rover was tested under 4 categories at FIU's mockup.

- 1) Durability Test
- 2)Weld Seam Test
- 3)Corrosion Test
- 4) Emergency Retrieval Test





Durability Test



<u>Rover Pull-O</u>	ff Force	Rover Pull Force	MMR Integrity Observations	Date
4.73	B lbs	5.33 _{lbs}	Normal Conditions	10/27/20

*Data and observations to be observed and recorded before 20 trial runs

Trial	Pass/Fail	Date	Duration
1	Pass	10/27	7:28
2	Pass	10/27	7:34
3	Pass	10/27	7:12
4	Pass	10/27	7:15
5	Pass	10/27	7:07
6	Pass	10/28	7:33
7	Pass	10/28	7:18
8	Pass	10/28	7:15
9	Pass	10/28	7:13
10	Pass	10/28	7:25
11	Pass	10/29	7:29
12	Pass	10/29	7:15
13	Pass	10/29	7:13
14	Pass	10/29	7:17
15	Pass	10/29	7:18
16	Pass	10/30	7:25
17	Pass	10/30	7:13
18	Pass	10/30	7:12
19	Pass	10/30	7:15
20	Pass	10/30	7:09

Rover Pull-Off Force	Rover Pull Force	MMR Integrity Observations	Date
4.76 lbs	5.52 lbs	Normal Conditions	10/30/20

*Data and observations to be observed and recorded after 20 trial runs





Weld Seam Test



<u>Trial</u>	<u>Pass / Fail</u>	Notes	MMR Integrity Observations	Date
1	Pass	Performed As Desired	Normal Conditions	12/ 14 / 20
2	Pass	Performed As Desired	Normal Conditions	12 / 14/ 20
3	Pass	Performed As Desired	Normal Conditions	12 / 14 / 20
4	Pass	Performed As Desired	Normal Conditions	12 / 14 / 20
5	Pass	Performed As Desired	Normal Conditions	12 / 14 / 20
6	Pass	Performed As Desired	Normal Conditions	12 / 14 / 20
7	Pass	Performed As Desired	Normal Conditions	12 / 15 / 20
8	Pass	Performed As Desired	Normal Conditions	12 / 15 / 20
9	Pass	Performed As Desired	Normal Conditions	12 / 15 / 20
10	Pass	Performed As Desired	Normal Conditions	12 / 15 / 20





Corrosion Test





Rover Pull-Off Force	Rover Pull Force	MMR Integrity Observations	Date
4.67 _{1bs}	5.39 _{lbs}	Normal Conditions	11/4/20

After completing of the 108' of rusted surface test, ensure to photograph and document rust build up on the rover



Rover Placed in Mock-up

Condition	Pass / Fail
Forward	Pass
Reverse	Pass

Final Pristine Carbon Steel Plate Test

Rover Pull-Off Force	Rover Pull Force	MMR Integrity Observations	Date
4.46 lbs	5.23 lbs	Normal Conditions	11/4/20





Emergency Retrieval Test

Removal Force Required	MMR Integrity Observations	Date
7.92 _{lbs}	Normal conditions	12/ 18/ 20

Data and observations to be observed and recorded above before 10 trial runs

Trial	Pass/Fail	Date
1	Pass	12/18/20
2	Pass	12/18/20
3	Pass	12/18/20
4	Pass	12/18/20
5	Pass	12/18/20
6	Pass	12/18/20
7	Pass	12/18/20
8	Pass	12/18/20
9	Pass	12/18/20
10	Pass	12/18/20



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Removal Force Required	MMR Integrity Observations	Date
8.12 lbs	Normal conditions	12/ 18/ 20



Our Path Moving Forward



• The Applied Research Center has been developing a miniature rover that can take metal thickness measurements to determine the integrity of the tanks using an ultrasonic sensor.



Advancing the research and academic mission of Florida International University.



Incorporation of the Ultrasonic Sensor



After testing the UT Sensor rover, we are very pleased with the results. We have taken a base line measurement of 6.93mm with a caliper and the results we have received is the same shown in the video below.







Thank you for your time....

Questions?

Advancing the research and academic mission of Florida International University.