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Improve Odor Control for the UWMS Hard-Sided Fecal Canister and the Alternate Fecal Canister

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Introduction

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- Universal Waste Management System (UWMS) developed a toilet for exploration - flown on Orion's Artemis-2 and demonstrated on ISS
- UWMS design by Collins Aerospace includes Hard-sided Fecal Canister (HFC) for collection of fecal deposits
- Canisters were found to hold 11-13 deposits and with crew of 4 this results in a large number needed for exploration
- NASA developed the Alternate Fecal Canister (AFC) to reduce mass and volume
- AFC provides a 90% volume reduction and a 45% mass reduction



Returned Canister and Odor History

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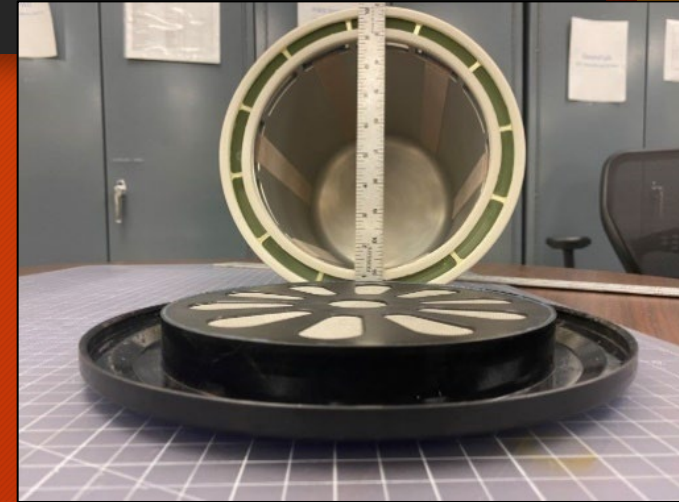
- 1 Hard-sided Canister was used on ISS and returned with no odor issues reported
- During certification, the HFC failed WSTF odor testing, with odor samplers reporting odor around the lid/canister interface perimeter
- Open-cell silicone foam gasket was thought to be cause of odor release
- Subsequent testing with various types of tape showed no improvement
 - Kapton
 - Grey
 - Metal Aluminum



Interface Between Canister and Lid

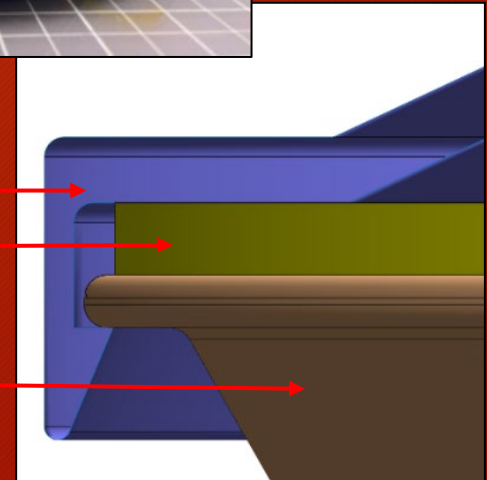
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- AFC required to interface with UWMS and the Odor Bacteria Filter lid created by Collins Aerospace
- AFC consists of only the bottom “bucket” portion and gaskets
- The lid-container interface contains a 0.110” gap meant to be filled with a 0.188” thick foam gasket.
- Replacement options for the gasket must allow sealing and closure of the lid and fit in the available space



Filter Lid
Gasket

Interface
Ring



Lid Interface Cross-Section

Odor Testing Background

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Each odor panel member rates odor potency by assigning an odor value based on the following scale:



Observations and Comments

Panel members select one of four odor characteristics (Pleasant, Neutral, Irritating, Revolting). The following odor characteristics were selected:

Irritating, Neutral, Pleasant

Each panel member may provide general descriptions of the odor. The following descriptions were provided:

Vaguely fruity smell, Pungent, Tomato paste, Plastic-Oily, Tart, Fermenting old veggies/fruit, Musty

Each panel member may provide physical effect descriptions. The following physical effects were provided:

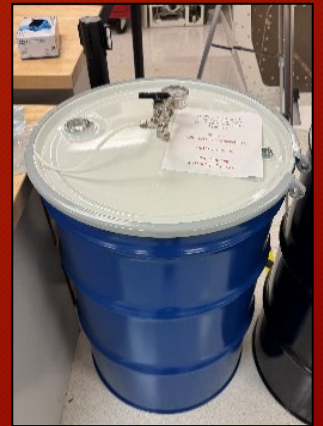
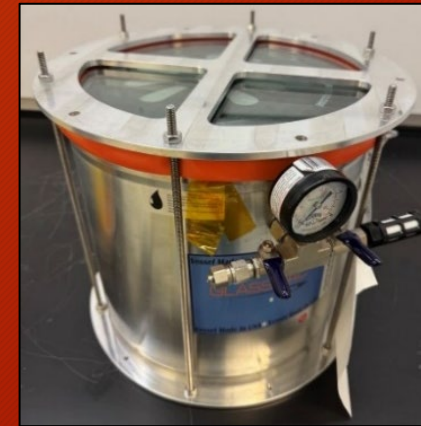
Nauseating

- NASA-STD-6001B defines odor intensity on a 0-4 scale:
 - Gasket material selection requirement was to limit the average odor rating to no greater than 2.5 after 30 days during official odor testing at NASA JSC's White Sands Test Facility
- Test article was delivered by the test team to WSTF which required a 10-12 hour drive to New Mexico
- Because of this, numerous tests were performed at JSC to increase likelihood of a successful official test.

Preliminary Screening Testing at JSC's Habitation Lab

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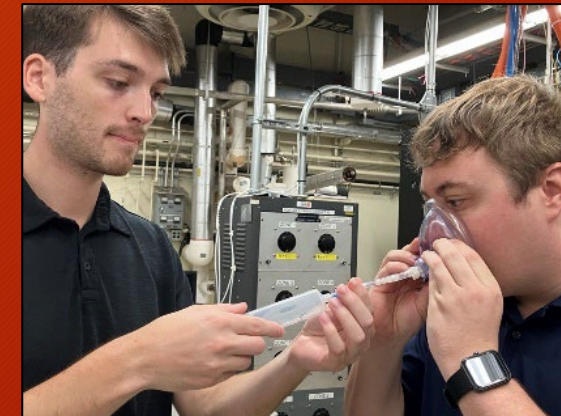
- Water testing was performed on each new gasket candidate to ensure it could form a water-tight seal
- Initial odor testing using a small test chamber and a larger drum volume lasted 2-6 weeks before gasket success or failure could be determined
- Initial odor tests performed using raw onions, but was changed to fecal testing as onions were incomparable
- Actual fecal material donations were obtained from the JSC test subject pool and each canister was loaded with 13 deposits, wipes, gloves and compaction plates to simulate actual use conditions.



Final Screening Test in JSC's Building 33, Chamber N

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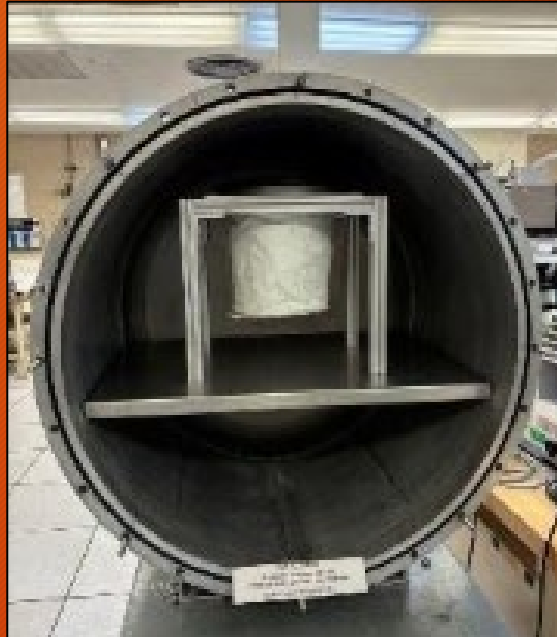
- Kynar® (PVDF) passed initial tests in Hab Lab
- Final JSC screening test performed in Building 33's chamber N to replicate as closely as possible the WSTF test setup
- Kynar® (PVDF) gasket passed 60-day odor testing with an average odor rating below 1.5
- A slight odor was detected coming from the center of the filter lid post-test



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WSTF Odor Testing

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- Kynar® (PVDF) gasket was tested at WSTF using both AFC and HFC assemblies
- After 30 days, the AFC and HFC assemblies both registered an average odor rating below 1.5
- Testing was extended to 60 days with final average odor rating still below 1.5

Compiled Test Data

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- Solid rubbers proved difficult to fit with the filter lid
- Open-cell foam abandoned as the open-celled structure creates air path for odor
- Kynar® (PVDF) closed-cell foam was malleable enough to be packed into the lid-bucket interface, but dense enough to prevent odor permeation

Selected Material

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Gasket	Thickness	Material	AFC Test Passes and Failures					
			Gasket Fit Check	Water Test	Onion Test	Initial Fecal Test	Pre-White Sands Fecal Test	WSTF Fecal Test
HT-800	0.188"	Open-Cell Silicone Foam	✓	X				
HT-800	0.25"	Open-Cell Silicone Foam	✓	X				
HT-870	0.188"	Open-Cell Silicone Foam	✓	✓	N/A	Not tested due to 0.25" failure		
HT-870	0.25"	Open-Cell Silicone Foam	✓	✓	✓	X		
HT-1240	0.125"	Solid Silicone Rubber	✓	X				
RS-720	0.25"	Closed-Cell Silicone Foam	✓	✓	X			
RS-750	0.25"	Closed-Cell Silicone Foam	✓	✓	N/A	X		
Viton	0.188"	Solid Viton	X					
Viton	0.25"	Solid Viton	X					
Neoprene	0.188"	Solid Neoprene	X					
Neoprene	0.25"	Solid Neoprene	X					
EPDM	0.188"	Solid EPDM	X					
EPDM	0.25"	Solid EPDM	X					
Butyl	0.188"	Solid Butyl	X					
Butyl	0.25"	Solid Butyl	X					
Viton	0.188"	Closed-Cell Viton Sponge	✓	✓	N/A	Inconclusive, possible lid failure, promising results for 1 month		
Viton	0.25"	Closed-Cell Viton Sponge	✓	✓	N/A	Put on hold to test Kynar		
R10480S Silicone	0.188"	Closed-Cell Silicone Sponge	✓	✓	N/A	Put on hold to test Kynar		
PVDF (Kynar)	0.188"	Closed Cell Kynar Foam	✓	✓	✓	✓	✓	✓
F30 PVDF (Kynar)	0.25"	Closed Cell Kynar Foam	Some Gaskets too thick, some fit					

Conclusion

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- Odor testing requires use of human fecal material
- Closed-Cell Kynar® (PVDF) foam is a viable material selection for odor control provided sufficient thickness and compression
- Future work:
 - Update AFC design for Artemis-3 with Kynar gasket material
 - Replace gaskets on previously built AFC waiting for manifest to ISS
- Continue work on Fecal Collection and Processing for Moon Base and Exploration

Acknowledgements

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- AFC team acknowledges previous work on fecal collection and storage done from the start of NASA missions as well as the work ongoing now and in the future.
- Space Toilets are truly an evolving design. The evolution leverages Apollo/Gemini, Shuttle, ISS - Russian and US, HLS and Commercial Crew programs, the NASA and contractor teams and the support for those teams in testing, analysis and more who are all concerned with how to manage metabolic waste in space.
- Acknowledging funding from MCO, Orion and future funding for continued progress in this area.
- **BOLDLY GO!**

Questions or Feedback?

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Backup

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