NASM AirSpace Season 3 Ep. 3 Planetary Protection Final Transcription

[MUSIC]

Nick Partridge: Hi! And welcome to AirSpace, from the Smithsonian's National Air and Space Museum. I'm Nick.

[MUSIC]

Emily Martin: I'm Emily.

[MUSIC]

Matt Shindell: And I'm Matt. Imagine you're the crew of Apollo 11 and you've just returned to Earth from the moon. What are you greeted with? A hero's welcome: a big brass band, a big celebratory cake and President Nixon, grinning ear to ear. And you would have to watch all of this from inside of an airstream trailer, which had been converted into a quarantine facility that was going to protect the rest of the world from the germs that you might have brought back from the moon.

[MUSIC]

Emily Martin: And everything we know about life in the universe says that when it gets to a hole anywhere, it tends to get everywhere. So, what happens when we send robots and rovers out to search for microbial life out in the solar system? How can we be sure that the evidence of life that we might find on say, Mars or coming out of the geysers of Saturn's Moon, Enceladus, didn't just hitchhike there from Earth? Lots of scrubbing, sanitizing and bunny suits. That's how.

[MUSIC]

Nick Partridge: On today's episode, we're talking about biological protocols for space explorers, both coming and going, to protect life on and off of planet Earth. And we'll speak with NASA's Planetary Protection Officer and our own Apollo Curator on contamination mitigation, then and now; today, on AirSpace.

[MUSIC]

Emily Martin: For as long as we've been thinking about sending spacecraft into space, humans into space, we've been spending a lot of time thinking about how we might contaminate space and how space might contaminate our home.

Nick Partridge: So, I think it's worth remembering things that we didn't know for sure at the onset of the Space Age in the 1950s and '60s, sitting comfortably in our homes, recording this episode today, we are confident in saying there's no life on the moon, but while scientists at the time may have been pretty sure, nobody could say for certain until we got there and took a look around though, a lot of the things that we sort of take for granted are actually enshrined in international law. Things like: don't contamination of celestial bodies, don't put nuclear weapons on the moon, don't claim huge planets for your nation, stuff like that. It's the well-worn, much loved and very often referenced by us, Outer Space Treaty.

Dr. Lisa Pratt: From the very beginning, in the 1960s, with the recognition of the need and then the signing of the Outer Space Treaty, there was an awareness that we needed to have some fundamental international agreements.

Emily Martin: That was Dr. Lisa Pratt.

Dr. Lisa Pratt: I'm NASA's Planetary Protection Officer. Planetary Protection is part of Safety and Mission Assurance at NASA Headquarters in Washington, D.C.

Emily Martin: Lisa's whole job is to make sure that the things that NASA puts into space are clean, and like, really, really clean, to prevent what's called, "forward contamination," which really just means anything we grew here on Earth, any of our sticky, little, grimey grubs don't make it onto let's say, the surface of Mars, by hitchhiking a ride on say, the Perseverance Rover. And you kind of have to think ahead because also, they want to make sure they don't do what's called, "backwards contamination," which is essentially any of these grubby little microbes that maybe originated on Mars, we don't want them coming home with us and contaminating Earth. So, any time we bring home a spacecraft, or some kind of planetary sample, or say a human, we want to make sure that they're not bringing anything with them that we don't want here on Earth.

[Intercom Feedback]

Archival Audio: They're back from the moon. Astronauts Armstrong, Aldrin and Collins landing in the Pacific Ocean, southwest of Hawaii.

Nick Partridge: July of 1969, Neil Armstrong, Buzz Aldrin and Michael Collins land back on Earth. It's the first mission to land on the moon. They're safely back on Earth. They're met with a heroes' welcome that Matt outlined at the top of the episode. That really did happen. You don't have to use your imagination. You can look up the photos of Richard Nixon's ghastly grin. And, the first thing we do is shove them into an airstream trailer for quarantine. And they didn't emerge from quarantine for three weeks. Did we do that with all of the Apollo astronauts? Why did we do that?

Matt Shindell: Well, I think with this first group of astronauts, they aired on the side of pretty extreme caution, right? So, quarantine continued to some extent with the later astronauts, but with this first group of Apollo 11 astronauts, you know, they weren't really sure what to expect and so they had built this whole system of how they could put them into quarantine. We've all seen the iconic photos of the Space Capsule landing, splashing down in the ocean. And after that, you know, they had to be retrieved from the capsule. They had to be scrubbed down and prepared for quarantine.

Archival NASA Audio: The BIG swimmer has completed decontaminating the first astronaut. He is now scrubbing the legs of the second astronaut.

Matt Shindell: Before they hit the Pacific Ocean, in communications, you can hear Jim Lovell in Mission Control joking with Mike Collins in the command module about the quarantine and the mice that were used to test the toxicity of the lunar samples.

Archival NASA Audio:
Jim Lovell: Apollo 11, Houston.
Mike Collins: Go ahead, Ron.

Jim Lovell: This is Jim, Mike. Backup crew is still standing by. I just want to remind you that the most difficult part of your mission is going to be after recovery.
Mike Collins: Well, we're looking forward to all parts of it.
Jim Lovell: Please don't sneeze.
Mike Collins: Yeah, keep the mice healthy.

Matt Shindell: Immediately upon taking them out of the ocean, they're on the deck of the U.S.S. Hornet and they needed then to be put into something that they can then be sealed into and taken to another secure facility. So basically, a transportable quarantine facility.

Teasel Muir-Harmony: It looks just like a traditional airstream trailer and that's part of what I like about it.

Matt Shindell: That airstream is now a part of the museum's collection and is on display at the museum's Udvar Hazy Center.

Teasel Muir-Harmony: My name is Teasel Muir-Harmony and I'm the Curator of the Apollo collection.

Teasel Muir-Harmony: But it was modified so that the astronauts could stay in it after they returned from the moon and it would quarantine them and keep any potential, biological pathogens from escaping and contaminating Earth.

Emily Martin: The idea of moon germs to me is not a humorous idea, but it's a fun idea to think about because the notion of some kind of like negative, parasitic or like, some kind of ugly thing, originating on another planet and like, coming to Earth and wreaking havoc is the story of science fiction.

Matt Shindell: (Laughs).

Teasel Muir-Harmony: And so, thinking about how NASA was concerned about protecting their astronauts and protecting planet Earth feels like science fiction, but also from a scientific perspective, it was really, really smart.

Matt Shindell: One thing too, like to remember here is that we are kind of taking for granted what we know about the moon and, you know, they knew a lot about the moon in the '60s as well, but there was still a lot of open questions about where the moon came from and how it formed and if it had formed somewhere else other than in Earth's orbit. There were still questions about, you know, what secrets it might hold.

Teasel Muir-Harmony: It kind of shows how risk-averse NASA was at the time because even though the chances of them bringing anything home were so low, but they weren't going to take any chances.

Archival NASA Audio: President Nixon, waiving to the astronauts. The curtains have been drawn. And there they are in the rear window. (Applause).

Matt Shindell: Tell me a little bit more about the concerns that the scientists had about contamination. You know, why would we be so concerned about things coming back from the moon or is it more about how we might contaminate the samples coming back?

Teasel Muir-Harmony: Both of those concerns were relevant. In the early 1960s, scientists looked into this issue and they recognized that the risks were really, really low, but they still wanted to be careful and scientists were worried about a sort of a contemporary version of the Columbian Exchange, which is when European explorers brought disease to the Americas, where if the astronauts did bring back the contaminants from the moon, it could be really problematic for life on Earth. And they also wanted to make sure that when they studied the lunar samples, they were studying them without Earth contaminating them.

Emily Martin: There's also the lunar receiving lab that's in Houston and that one was designed for the astronauts and the rocks cuz obviously rocks need their own facility!

[MUSIC]

Matt Shindell: Yeah, of course. They're rockstars.

[MUSIC]

Nick Partridge: After Apollo 14, NASA had a chance to study all of the samples that were coming back from earlier missions and they felt like they had enough data to prove that the astronauts weren't bringing anything back with them and they stopped doing the post-flight quarantines, but that didn't mean that the astronauts were entirely free and clear.

Emily Martin: Every astronaut that goes into space, even now, goes through what's called, "pre-flight health stabilization quarantine period."

Teasel Muir-Harmony: Pre-quarantine was important just primarily to ensure that the astronauts would not get sick in space. This is something that astronauts do today. They really limit their exposure to any type of disease. You wouldn't want to get sick in space. (Laughs). You don't have access to the same medical care you do in other places. And so, pre-flight quarantine is quite important.

Emily Martin: And most of the time, they're talking about what? The common cold. They're not really talking about anything really terrible.

Nick Partridge: So, then and now, if you've seen footage or photos or even segments of movies like in, "Apollo 13," where the astronauts are on one side of the road and all of their families are behind a rope on the other side of the road, that's part of the quarantine. They don't want to put them close to each other where they can transmit germs. They isolate the astronauts from everyone, but a really select group so that they can ensure that nobody does carry a head cold into space with them.

Matt Shindell: The astronauts say that you always feel like you have a head cold when you're in space. And this is one reason why you like spicy foods, right? It's because your sense of taste is affected by the fact that like all of your snot and fluids is just stuck in your head.

Nick Partridge: And all of your blood kinda redistributes all of the stuff that would normally be pulled down towards your body by gravity is now no longer. So, it's kinda like having a head cold, so we're told, to like hanging upside down and all of the blood is rushing to your head. The crew of Apollo 7 had a bad time of it. One of them did have a head cold when they went up into space. They managed to give it to the other two members of the crew and crankiness and to hear some people tell it, near rebellion, but that's a slight exaggeration, ensued as the astronauts grappled with frustrating and debilitating symptoms and the flight controllers on the

ground dealt with three grouchy men in orbit, trying to handle their really, really ambitious workload.

Emily Martin: (Laughs). Well, and it's really hard to treat illnesses in space and you also can't really keep it from spreading amongst the other astronauts, but I think the scene from, "Apollo 13" when Ken Mattingly gets knocked off the mission is the thing that I always think of the most when I think about quarantining and being sick in space.

Audio Clip From the movie, "Apollo 13":
Jim Lovell: You want to break up my crew two days before the launch when we can predict each other's moves, we can read the tone of each other's voices?
Dr. Chuck: Ken Mattingly will be getting seriously ill precisely when you and Haise will be ascending from the lunar surface to rendezvous with him.
Deke Slayton: Jim, that's a lousy time for a fever.
Jim Lovell: All right, now look, Jack Swigert….

Emily Martin: Ken Mattingly got knocked off the Apollo 13 Mission because the whole crew had been exposed to Rubella. And this was before the vaccine and he was the only one who hadn't had it as a kid. So, there's that really interesting scene where he ends up not being allowed to go and kind of getting knocked off the Mission.

Audio Clip From the movie, "Apollo 13":
Ken Mattingly: I mean, I know it's your ass if I get sick up there, but I mean, Jesus!

Nick Partridge: Best case scenario, they do send Sudafed up there with you, but if you've ever tried to operate medium weight machinery while hopped up on cold meds…

Matt Shindell: (Laughs).

Emily Martin: (Laughs).

Nick Partridge: …you know that you probably don't want to be doing that with a spacecraft going around the Earth at 17,500 miles an hour.

Emily Martin: Well, this is something that still happens today right? Like, this isn't… like, they haven't improved this part of flying to space, right? Like, you still do that pre-flight quarantine because if you get sick, there's always backups waiting to go in case somebody can't fly for one reason or another. I mean, there's always gonna be… it's not even an understudy, right? Like, it's just the next person in line, who's been training along with the rest of that crew so they're prepared to take your place if necessary.

Nick Partridge: So, keeping humans on Earth, and humans in space, free from terrestrial or extraterrestrial germs is only half the battle. The other component to the biological protocols that NASA observes in the spirit of Planetary Protection have to do with preventing forward contamination. A lot of space exploration is done by robots like the Perseverance Rover that'll be headed towards Mars this summer. And none of these spacecraft can be made completely sterile. The idea is to get them as clean as possible and to know how not sterile they are when we launch. Keeping robots like Perseverance clean as they're built is a big part of what NASA Planetary Protection Officer, Lisa Pratt does.

Emily Martin: How was the community, the Planetary Science community, the… I don't know… maybe nascent astro-biological community, how are they thinking about planetary protection,

sort of with respect to the Apollo Missions versus say the Viking Missions that were landed on the surface of Mars?

Dr. Lisa Pratt: Because Apollo involved humans and there was a clear understanding that humans themselves carry a, you know, very large, microbiological community and that the Earth/Moon system and our ability to observe the moon made it clear that it was a very unlikely location for carbon and water-based life, which we can just call Earth-like life. So, although there were concerns and there was certainly a quarantine when the astronauts came back, we were much more able to sterilize and clean robotic equipment that was going out to a place that we thought we could contaminate inadvertently, then we were able to be careful about humans bringing something back. But of course, that now changes going forward as we enter into this second era of human exploration because the focus is on Mars. The NASA approach is moon to Mars. Use the moon as a proving ground, but ultimately, both NASA, other national agencies and commercial groups like SpaceX are looking at Mars as a place that we want to explore with humans. And one assumes if we're going to explore with humans, some of those humans might want to come back.

Emily Martin: Planetary Science is global! There are multiple countries and multiple organizations…

Dr. Lisa Pratt: Not to mention private individuals…

Emily Martin: Right!

Dr. Lisa Pratt: …who have the wealth and resources to simply decide they want to do space exploration. So, you're right!

Emily Martin: Right. So, how… so, how are rules sort of decided upon? Of course, NASA has their only guidelines for how missions need to work towards Planetary Protection, depending on the kind of mission. But, within NASA, but also within the global community, there might be some kind of way in which international communities are discussing Planetary Protection.

Dr. Lisa Pratt: Oh, yes Emily. Absolutely. And again, from the very beginning, in the 1960s, with the recognition of the need and then the signing of the Outer Space Treaty. There was an awareness that we needed to have some fundamental international agreements. And then, the U.N. got involved through COPUOUS and they designated COSPAR, the Committee on Space Research as the international forum for discussion and agreement on guidelines for both forward planetary protection and that's what we take with us to another habitable world and backward planetary protection, which is what do we bring back to Earth that might potentially be harmful. So, from that time onward, COSPAR has been the mechanism for all nations who wished to participate to talk about, debate and reach agreements on best practices and guidelines.

[MUSIC]

Emily Martin: We talked about the Outer Space Treaty in how governmental organizations in their space exploration endeavors are following the guidelines that exist in that Treaty so that we can all kinda save space for each other's scientific endeavors. But I think there's a really interesting conversation here about what this means for commercial enterprises because, while some private companies are working with the government and therefore are likely to follow the guidelines of the Outer Space Treaty, there's a lot of other private companies who are not going to be working as contractors for the government who are going to start sending their own people

and their own spaceships into space. And I think there's a really interesting conversation about whether or not they're going to be held to the same standards.

Archival Audio: Five, four, three, two, one, zero. Ignition. Lift off! There's the Falcon 9 and crew Dragon. Go NASA! Go SpaceX!

Nick Partridge: We talked in another episode about how the horse may have already left the barn, to use an expression that Matt favors, when spacecraft, for instance, recently crashed into the moon. It was not supposed to do that. It was supposed to do a soft landing, but it was carrying a payload of tardiegrades.

Emily Martin: A.K.A water bears.

Nick Partridge: Water bears. Yeah. The little water bear critters that are known to be able to survive in some pretty extreme circumstances.

Matt Shindell: Right. And, you know, even prior to that, we've already talked about Apollo on this episode. And if you think about bringing contaminants to the moon, nothing brings more contaminants than a living human, right? We're covered in bacteria and during those missions, we actually left human waste on the moon. And so, you know, it kind of is a tricky subject in which, you know, we've made little violations here and there. And, as we move forward, if and when we send humans to Mars, the question's gonna be, how do we actually protect the parts of Mars that we want to study scientifically from human contamination, while still exploring Mars with humans. It's going to be a really delicate balance.

Nick Partridge: And, Dear Reader, please know that the human waste left on the moon was in bags. It wasn't just strewn about. That would have been horrifying.

Matt Shindell: (Laughs).

[MUSIC]

Nick Partridge: So, Matt, you've seen more spacecraft up close than I have. How do you clean them? Paper towels and Windex?

Matt Shindell: Well, you know, it's not that far off, at least not parts of it. Like, so, the Viking Lander that we have in our collection, the versions of that that were sent to Mars as the first U.S. landers back in the 1970s, they were wiped down with antimicrobial fluid with wipes. And then, they were actually baked at high temperatures as well to try and kill any residual microbes. And they were wiped, you know, pretty much continuously day after day until they were finally launched.

Dr. Lisa Pratt: I think everybody understands that we use high temperatures as much as possible in the same way that we think about autoclaving or cooking as ways to kill microbes. We also make extensive use of a solution that a year ago most people had never heard of, but now, everybody knows about it.

Emily Martin: What is it?
Dr. Lisa Pratt: And that's 70% Isopropyl Alcohol.

Emily Martin: Hmmm.

Dr. Lisa Pratt: The thing that is recommend for hand sanitizer right now…

Emily Martin: Right.

Dr. Lisa Pratt: …because of COVID. And 70% Isopropyl Alcohol is the thing that is used more than anything else to clean a spacecraft as we assemble it. So, individual components that will tolerate being heated to temperatures well above the boiling point of water, so temperatures in the range of 130 to 150 degrees Centigrade if apart, can tolerate that or even a small device, that's our first line of defense is…

Emily Martin: Right.

Dr. Lisa Pratt: …heat for a sufficient number of hours that it kills all known terrestrial organisms, but not everything can handle that kind of heating. And then we turn to either Isopropyl Alcohol or, another thing people are hearing about more and more, Hydrogen Peroxide, that we use.

Emily Martin: I'm a big fan of Hydrogen Peroxide.

Dr. Lisa Pratt: Yeah! Me too! And we like to use it….

Emily Martin: As a little kid, they would always dump it on my knees when I skinned them.

Dr. Lisa Pratt: Exactly!

Emily Martin: Yeah.

Dr. Lisa Pratt: So, that's another one that we use very carefully, but vaporized Hydrogen Peroxide because it's not a liquid, it's a vapor, can get into some nooks and crannies that you can't get to any other way. And if all of those things are not possible, well, then we try to use some kind of radiation.

Emily Martin: Right.

Dr. Lisa Pratt: You know, ultraviolet radiation or gamma or something else. And those are, you know, many of those are methods tried and true from the food industries and from the pharmaceutical practices.

Nick Partridge: We're all more aware these days of things like hand sanitizers, disinfectant and how they play a role in our daily lives, but these techniques that they use to keep spacecraft as clean as humanly possible, these are kind of time-worn techniques that are pretty ubiquitous in other industries. To use two personal examples of mine: If you've ever sterilized a baby bottle or had a tattoo artist send some of the components of their equipment through an autoclave, then this is not an entirely alien concept so to speak.

Emily Martin: (Laughs). Right. It's right up there with my new found hobby of kombucha brewing. There's a certain level of cleanliness you need to achieve in order to make this all not yucky at the end. And I've thrown out a few batches. I'm not going to lie. So, the role in which these things play in how we sort of sanitize… like, yeah. They come straight out of the medical field and out of those food services of how we do a better job of trying to keep things clean. On the other hand, if you're working on your Sourdough bread, you're gunna want a little additional yeast in the air so that you get a really nice starter. These are fun ways in which contamination actually helps along the lines of what Lisa mentioned. If you can't keep something as clean as

you need it to be, you need to at least be able to characterize how clean it's not so that when you do send that spacecraft out there, you have a sense of what you actually contributed to the system.

Matt Shindell: One cautionary tale from the history of space exploration is the Surveyor 3 camera that the Apollo 12 astronauts brought back with them after visiting it on the moon. And when the scientists received it and were looking at it, treating it as a lunar sample, they saw a little bit of bacteria on the lens of that camera. And the idea was that, well, this bacteria must have gotten on to this lunar lens before we sent it to the moon. And then, once it was on the moon, it actually was able to kind of survive in a dormant state and then come back to Earth and still be viable. So, this would have been remarkable because Surveyor had actually been sitting on the moon for three years before the Apollo 12 astronauts went and recovered it. If that bacteria actually stayed in a viable state for that long in the conditions of the moon, which are very, very harsh to life, then that would be pretty remarkable. But, in fact, as years went on, they determined that maybe in fact they had been wrong about where that bacteria came from. That probably it was actually they weren't handling it as sanitarily as they should have been and they may have deposited the bacteria on it when it returned from Earth in the actual sample handling facility. So, you know, the questions of where bacteria come from get really complicated if your system from start to finish isn't completely closed and that obviously is something incredibly difficult to manage.

[MUSIC]

Nick Partridge: AirSpace comes to you from the Smithsonian's National Air and Space Museum. You can follow us on Twitter and Instagram @AirSpacePod. AirSpace is produced by Katie Moyer and Jennifer Weingart. Mix by Tarek Fouda. Special thanks to Andrew Fletcher. Distributed by PRX.

[MUSIC]

Nick Partridge: Something I've heard in clean rooms and never in a consumer setting that I really think we should look into for our homes are doormats that have an adhesive layer, so that they just pull off all the grime off your shoes so that you have to vacuum your hardwood floors less. Again, maybe this is just a personal thing for me.

Emily Martin: Well, you have hardwood floors, so I'm jealous about that.

Nick Partridge: (Laughs). They're wood veneer. Hardwood is maybe aggrandizing them.

Emily Martin: (Laughs). Or as they say…. What do they say… luxury vinyl planked. Trying to make it sound fancy.

Nick Partridge: That's exactly what we've got.

Emily Martin: (Laughs).

Nick Partridge: That's 100% exactly what we've got.

Emily Martin: (Laughs).

Nick Partridge: We'll just label it space age material next time.