Josh Hayes:

We're working with something that is exceedingly rare, within a category of accident that is already exceedingly rare. We're working up against a wall here, of we are trying to be prepared, but we want to also prevent complacency with the issue, right? Well, this never happens, so why do we need to worry about it? And it's like, because when it does, it can be significant.

Speaker 2:

This is the ORISE Featurecast. Join host Michael Holtz for conversations with ORISE experts on STEM workforce development, scientific and technical reviews, and the evaluation of radiation exposure and environmental contamination. You'll also hear from ORISE research program participants and their mentors, as they talk about their experiences, and how they are helping shape the future of science. Welcome to the ORISE Featurecast.

Michael Holtz:

Welcome to the ORISE Featurecast. As ever, it is me, your host, Michael Holtz, in the communications department at the Oak Ridge Institute for Science and Education. And Amber Davis, you are my co-host this episode, I'm so glad you're here.

Amber Davis:

Well, thank you so much for having me. I'm excited to have this conversation.

Michael Holtz:

It's been a minute since you co-hosted, so for folks who may not be familiar, Amber has been in the communications department for a couple of years. She's a rock star. We have so much fun doing the work that we do, and part of what we love about what we do, and I think I can speak for you, Amber, is getting to discover the research that our really smart people at ORISE get to do. And Josh Hayes is one of those people. So Josh, welcome to the ORISE Featurecast. We're so glad to have you.

Josh Hayes:

Happy to be here, I'm a little humbled by that. I don't know if I consider myself one of the smart ones, one of the [inaudible 00:02:14] ones.

Michael Holtz:

Well, I'll just say I know it's been a minute since you and I have had a conversation, but I love some of the research that you've done. I love that you are now part of the organization, and I'm just so excited to talk to you about where you've been, how you got here, all of the things. But let's start with, first of all, Josh, who is Josh Hayes in terms of the Oak Ridge Institute for Science and Education?

Josh Hayes:

So my position I hold, I'm the associate manager of health physics, over here at the Radiation Emergency Assistance Center and training site. I have been off and on a part of REAC/TS for, man, a number of years now. I first met these folks back in, it all started with an email to Ronald Goines back in 2017, and just kind of snowballed to, was shaping up to be a career position. I mean, I couldn't be happier being here, but I like to think I'm a part of the machine here, that is seeking the education of the public, the Military, Department of Energy, everybody that is willing to open their ears to us about radiation emergency medicine. I love the mission here. Big fan of REAC/TS in general. [inaudible 00:03:58].

Michael Holtz:

Awesome. Well, from a high level, because you are part of the team at REAC/TS, let's talk ... because REAC/TS is one of those assets that we manage for the Department of Energy, through ORISE. What is REAC/TS, for the rest of the world who may not have any idea what the heck it's we do?

Josh Hayes:

So REAC/TS is a deployable asset for the Department of Energy for the nuclear Emergency Support Team. And when it comes to any sort of nuclear emergency response, the REAC/TS is the medical component of that emergency response. So really where our hallmark is, is that we have a unique conglomeration of physics with medical response. So every deployable team is made up of health physicists, nurses and physicians. And in particular, we have a number of physicians that have a unique overlap of abilities, between radiation emergency medicine and just occupational, is another big aspect of it.

Our director, Carol Iddins, comes from a aerospace flight medicine background, and Dr. Ronald Goines is an OB GYN backgrounds. Mark Irvin has a trauma surgery background, and then Al Wiley actually has a nuclear medicine background. He was actually one of the former directors of REAC/TS, back in the day. So we still work with him, and we're happy to have him on board.

And then our nurses, we have a good variety of backgrounds as far as they go, ICU nurses, flight paramedics, and then our health physicists. And if anybody's not familiar with what a health physicist is, health physics is kind of a unique subset within physics, where we are concerned with radiation protection. And that is, anybody who works with radiologic materials, health physics, health physicists are the individuals that help engineer controls to keep them from injuring themselves, or the public. So all of those aspects combined, we can support nuclear and radiological emergency response, from a medical perspective. So anybody who is impacted physically and medically from, in a particular incident, we can consult with them to help the healthcare providers involved in the response.

Michael Holtz:

That's amazing. And I know one of the hallmarks is that you're deployable, right? If necessary, go to a location where an emergency may be happening. But I know you also are available by phone, and you do a ton of training of medical professionals around the country, and really around the world. I know you all travel quite a bit, to train folks in nuclear emergency response, or radiation emergency response, I should say.

Josh Hayes:

Yeah, actually just came back a couple of days ago from Guam in Korea. That was a long trip home.

Michael Holtz:

Still in recovery mode.

Josh Hayes:

Yeah. I'm still kind of jet lagged from that. I think from the time I left the hotel in Guam, to the time I walked in my door here in Oak Ridge, was about 49 hours.

Michael Holtz:

Oh my gosh.

Josh Hayes:

That was an experience.

Amber Davis:

But hopefully they're all trained up now, and they've got lots of information that they are going to use for the good?

Josh Hayes:

Yeah, hopefully, we had a number of individuals from Anderson Air Force Base as well as the Naval base on Guam. We had some local firefighters from Guam. I think we had some folks from Saipan that came down for that, don't quote me on that. I think we did, I'll take a look at the numbers on that. But yeah, it's been ... working at REAC/TS since ... I actually maintain a log of the courses and the participants that I've dealt with, since I started this full-time job back in 2022. And I often joke with my superiors that the first two years of this job was the longest eight years of my life.

And I don't mean that in a bad way, I don't mean that in a bad way. It was a significant amount of experience in a very short period of time, and I could not be more thankful for it, than I am. But in that period of time, we have taught, we're looking at 68 short courses in three and a half years, totaling about 4,400 course participants. And my actual contact time, time in front of a classroom, has been about 500 hours that I have been lecturing individuals. And that pales in comparison to the cumulative hours from our staff. We really got a rock star team over here, of folks that we're happy to toeas some of the most incredible people that we work with.

Amber Davis:

That's really cool.

Michael Holtz:

Amazing.

Amber Davis:

Yeah. Well, I want to jump in, because I have just been fascinated by a lot of what you all do. I mean, we hear these acronyms all the time with government entities, REAC/TS. What we actually do though, it's a mouthful, but it's so important. And I know that we sometimes get lost in the, oh, radiation, nuclear. But really there's so many aspects that are impacted, when you think about an incident with radiation. And of course you immediately think of health, but then there's the environment, and there's all these other things. Okay, Josh, I've got to ask you something that I've read about since it's coming on board here. And you have worked with some wild boars, because of what happened in Fukushima. So tell me about that, because it's something ordinary folks, I'll call myself an ordinary person, I would never think about wild boars, after something happening like it did in Fukushima. So talk to me, what was your involvement with that?

Josh Hayes:

So I would also consider myself an ordinary person.

Amber Davis:

No, you're extraordinary. I'm ordinary, let's classify.

Josh Hayes:

We're all just part of the machine. So that is one of the more unique experiences that I have had within my life, and that is actually something that directly led to me working in this position that I am now. And if you ever doubt how important that experience was to my life, I will show you, I've got a wild boar tattoo to my forearm.

Michael Holtz:

I love it.

Amber Davis:

Wow. Okay. And you're listening and you can't see it, he did just lift up his arm and he truly has a boar tattoo, like a picture of a boar.

Michael Holtz:

On his [inaudible 00:11:34].

Josh Hayes:

With a cooling tower on its back.

Amber Davis:

Oh my goodness.

Josh Hayes:

It was a very, very formative experience for me. So let me take it back a couple of years, and I'll tell you the story of how that whole thing went down. So I, for whatever fated reason, I have spent a significant amount of my life in the country of Japan. I lived there as a child, my father was a Navy sailor. He worked as a missiles officer, and he was stationed aboard the USS Blue Ridge, in the coast of Japan. So as a kid, I actually lived in Japan for about two years. And then fast forward a couple of years, my father retired out of the Navy. He worked at NORAD, in Colorado Springs, and it was weird to have a Navy guy in a landlocked state, but hey, it is what it is.

And he actually finished his career out working as a civilian at Peterson Air Force Base. But he retired out of the Navy in Colorado Springs. So I grew up largely in Colorado, from about the time I was about sixth or seventh grade on, I was in Colorado, and I enlisted in the United States Marine Corps. And when I enlisted in the Marine Corps, I got stationed in Okinawa, and I was there with 12th Marines Artillery unit for two years. So I was in Japan, Okinawa, Japan, specifically at the time of the Fukushima nuclear disaster. And that kind of sparked an interest in me, being that close. And I was actually a CBRN Marine, which CBRN is an acronym that stands for Chemical, Biological, Radiological and Nuclear Defense Specialists. So I was kind of unconventional warfare, so I was already working with unconventional things. I had some basic knowledge of radiological sciences, kind of working as a radiation technician, maintaining RADIAC equipment for the artillery unit.

So when the disaster happened, kind of a triple disaster, we had a tsunami, an earthquake, and a nuclear disaster. There was a huge response to that. And there was Operation Tomodachi, which Tomodachi is, if I'm not mistaken here, Tomodachi in Japanese means friendship. So there was a response from the Department of Defense, to go up there and help out.

And I was low enough on, that that I didn't really get the opportunity to go up and do much more than dealing with the physical aspects of the tsunami. So digging through debris, and recovering aspects of what happened. And so I didn't really get to do a whole lot, as far as the radiological component goes, and I felt a little bitter about that going forward. And I was just like, I had this training, I had just recently been trained by the United States Army, on technical escort and hazard materials operations.

So I had all these training, all these certificates, and I am literally shoveling debris. And I was grumpy about it, and I was like I decided I needed to make a change. And so I had decided right then and there, that I was not going to seek a career in the Marine Corps, and I was going to seek a career following some education. So I got out of the Marine Corps, and I went to school, and I went to school in Colorado State University, go Rams, and did an undergrad degree in biomedical sciences. And then I actually had originally decided, I originally wanted to go to seek a degree, a doctoral program in molecular neuroscience. And I had applied for it, and I had applied for a master's program in health physics as a backup. And the more I looked into it, and the more I read into that program, the more I realized that that was where I needed to be.

So I never followed up with that molecular neuroscience program. I have no idea if I got into that program or not. But I waited until I got accepted to that health physics program, and I graduated with my undergrad in December. And my last semester in undergrad, I took one of the prerequisites for the health physics master's program, so they could not accept me until they got the final grades for that program. So I actually got an acceptance six days before that program started. So I took a huge leap of faith on that, and had no idea if I was going to get in or not. And I got an email from the graduate coordinator, and this is all going to circle back, I promise.

I got an email from the graduate coordinator, and they were like, Hey, you got accepted the health physics program. Are you interested in accepting it? I said, "Absolutely. Who do I need to talk to? Because I don't know anything, right?" I don't know about the classes, I don't know about the program. I just know that this is what I want to do. And they said, "You should talk to a gentleman named Tom Johnson." And they sent me his email and I emailed him, and he said, "I'm in my office right now. Do you want to come up?" And I was actually working in a building for the Anatomy and Physiology department across the street, and I was working in the basement, and he was in the building across the street on the fourth floor. And I was just like, yeah, I'll be there in five minutes.

So I walked across the street, walked into the building, I walked into his office, we introduced each other, and him and I are fantastic friends to this day. I was actually talking to him last night, but him and I were just talking about how physics, and the program, and how I really wanted to do it. And I noticed that on the wall in his office, there was a map of Japan. And I said, "Do you guys do work with Japan? What's going on with that?" And he goes, "Yeah, yeah, we're working with Fukushima." And I was like, "Fukushima, are you serious?" I was like, "I was part of the response for that in the Marine Corps." And he goes, "No way. So you lived in Japan." He said, "Do you speak any Japanese?" And at the time, I actually spoke a decent amount of Japanese, and it's a very perishable skill. So I wouldn't claim to know any significant amount of Japanese nowadays. I'll leave that to my coworker, Dylan. He's actually a very proficient in Japanese. But I told him, I was like, "Yeah, I lived in Japan for a while in Yokosuka, in Okinawa. And then I was actually part of the Fukushima response," and he was just like, "Cool, what are you doing this summer?" I was like, "I don't know."

And he said, "It sounds like you're going to Fukushima." So he accepted me to the program, and I did a semester of coursework in the master's degree, and then he sent me to Fukushima. And I spent about three months working with a couple of veterinary ophthalmologists, kind of working in the capacity of a veterinary tech, to help them wrangle wild boars. And wild boar, and actually wild mice, just for a random fact here, the Japanese word for wild boars, inoshishi?

And that has burned into my brain forever, inoshishi. But we spent several months that summer, and we were looking at harvesting wild boar out of the jungles of Fukushima. And I think I was just kind of the hired muscle for a while. It's a little bit difficult to see on the camera, but I'm actually six foot two, and I'm about 270 pounds. So I'm kind of a big guy. And the two folks I was working with, Maggie and Sammy, bless their hearts, two of the greatest people I've ever met in my life. They are very small people. Maggie was the brute that was moving the wild boar for them. So there's a couple of pictures of me holding their back legs, holding a boar up, moving them from the cage in the back.

The reason why they were ophthalmologists was that cataracts and cataractogenesis is a hallmark of radiation dose, it's deterministic effect of radiation exposure. So they were looking at the lenses of the eyes, looking for lenticular opacities, trying to figure out if there was a dose response from the exposures that these animals were receiving, in the exclusion zone. And I got some cool data. We didn't really see a whole lot. I mean really across the entire data set, the largest thing, the largest connection we saw, was that as radiocesium went up, the populations of animals went up. And that's largely because humans weren't involved, right?

Amber Davis:

Humans left. So the animals thrived.

Josh Hayes:

So humans left, and the animals thrived.

Amber Davis:

Okay,

Josh Hayes:

Wild boars, coyotes, and rats are three of the species that thrive in the existence of humans. So the fact that humans left is really kind of a brain-tickler of like, these animals are thriving in that population. And we studied three particular animals in that area. We studied wild boars, we studied mice, and we studied macaques. Because macaque monkeys are wild in that area, and we had a good bit of fun with it. I ended up going back to Fukushima a year later, and studied it out there, studied those animals again, focused mostly on mice the second time around. And another individual that I actually overlapped in my master's with was, he's actually a professor at Hirosaki University now, a gentleman named Donovan. I worked with him quite a bit, and he was focused mostly on the boar the second summer I was out there. But one of the formative experiences in my life was working on that project. But really where that ties into how I got linked in with the REAC/TS was, I originally went out there to look at chromosomal changes in the wild boars.

Which, for anybody who is a hobbyist with chromosomal changes, there is a significant amount of laboratory work that goes into looking at chromosome changes. If you've ever talked to Terry, or Maria, or Dr. Bowden-

Amber Davis:

[inaudible 00:22:58].

Josh Hayes:

... There is a significant amount of work, and my hat is off to them on how much work they do, to look at these chromosomal changes. And as a first semester graduate student, I was not prepared for how much work had to be done physically in the laboratory, for looking at these chromosomal changes. And I read into it, I did a lot of prep work, I talked to a lot of people, a very important person to me, someone who was on my scientific committee for my dissertation, as well as my master's, is Dr. Susan Bailey. And she actually works fairly closely with [inaudible 00:23:42]. She had helped me out a lot, and she helped me, she educated me significantly on how all of this works.

But unfortunately I got there, to Japan, and the laboratory was just, it wasn't prepared for the type of work that we wanted to do. And there was a lot of factors that led into that, and we took samples off the animals, we tried to work them up, and it just didn't work out. So as a first semester graduate student, I was working up these samples, and I hit a panic status. I was like, I'm not getting any results, not getting any samples, I don't know what to do. So I sent a very panicked email to Tom Johnson, who was my graduate advisor, and I said, "I don't know what to do." I put my hands up in the air and I was like, please help me. And he sent me several papers, that had just been discussed at the NCRP meeting, as well as the Health Physics Society meeting in Raleigh, North Carolina, in 2017.

And he said, "Read through these, and tell me if there's anything in these that could potentially be an avenue of approach for your project." And within those papers, I found one that was looking at a cellular biomarker for radiation dose, particularly was looking at a species of bat, that was living in a mine that was very rich in a mineral called monazite, which is very high in thorium. So the thorium is a naturally occurring radioactive material. So the dose rates within this mine were actually comparable to what our wild boar, our mice, and our monkeys were receiving in Fukushima. So I was like, this is perfect, this lines up perfectly. So I looked at the principal author on it, and their email was on there for correspondence. So I emailed them, and that was Ronald Goines, and him and I struck a conversation.

I remember this specifically, I was sitting in the back of a van in Takase Gorge, in the exclusion zone in Fukushima, and I emailed him on my iPad, and I was like, I'm panicking, Tom. I had since figured out then that Tom and Ron knew each other through the National Council of Radiation Protection. But emailed him, and I was like, do you think this is a good avenue of approach? What do you think about looking at these? And this particular cellular biomarker was called [inaudible 00:26:21]. It was a bi-lobed nuclei, species of neutrophil.

And I was like, what do you think about this? And he was like, yeah, that sounds great. So I started taking blood samples, and I continued this conversation with him. I came back from Japan, I had all these blood samples, and that all snowballed to where I wound up coming down to REAC/TS, ON the old Methodist Medical Center site.

And him and I worked for a summer analyzing all these samples, and we found a dose response for these wild boar. And that then further snowballed into me going back to Japan, harvesting more of animals. Grand total I think we had 256 or 258 wild boar that are, for lack of better terms, that are living on in our data set, and untold amounts of mice. And then I had working with the Wake Forest Primate Center to look at macaques. And that actually snowballed from my master's research into ... we thought it was promising. So myself and my graduate advisor were like, let's just kind of keep this rolling. So I stayed on for a PhD, and I continued working with the primates at Wake Forest, and continued looking. We found a very strong dose response for that particular cellular biomarker.

And I know Dr. Balaji actually has a continued interest in that. And Ron actually just recently published looking at the relative biological effectiveness for that particular biomarker, with neutron doses. And so long story short, somehow went from mice and boar, to working here at REAC/TS.

Amber Davis:

Yeah. So for those who, I'm going to raise my hand and say, help me. So you're talking about these biomarkers, and this radiation dose exposure to what ... they were just living in the environment where Fukushima happened. Tell me, what did we learn from that? What are you using that knowledge, that understanding with what you're doing at REAC/TS now?

Josh Hayes:

So the intent, and this is not something that is proven yet, for a fieldable assay. We need a lot more data to be able to use this as any sort of practical application of it. But the goal for this biological marker, is to find a field expedient method of assessing dose in an emergency situation, right?

Because right now the gold standard for biodosimetry, is the dicentric chromosome assay. And that's what Dr. Balaji and Maria, and Terry are doing over there at the Cytogenic Biodosimetry laboratory.

And that's what I was working with Susan Bailey at CSU, that is the gold standard. And really what that looks at, is damage to a chromosomal system, damage to the chromosomes. And you have a misrepair, cells are really good at repairing damaged chromosomes, but sometimes there can be a misrepair. And when you have a double strand break in DNA, it can misrepair to where you wind up with two centromeres, and those two centromeres ... and kind of draw this on my whiteboard right here.

Amber Davis:

I love it.

Josh Hayes:

[inaudible 00:29:56] this thing.

Amber Davis:

He's actually going to do a lesson for us up on the whiteboard.

Josh Hayes:

Normal chromosome has a single centromere in the middle. Can you all see that? I can draw a little bit bigger if not. If radiation comes through and breaks that, in particular, it's going to break two chromosomes. It can misrepair it, where you've got two that are adhered together, and that is what's called a dicentric chromosome. So when a cell goes to divide, you've got spindle fibers that come off of centrioles, that bind to those centromeres, and pull those chromosomes apart for those two daughter cells. If you've got two that are bound together like that, that has a fatal chromosome elaboration for that cell, and that cell will therefore pass away. But more importantly for us as far as dosimetry goes, is we can look at these dicentric chromosomes and quantify those, and actually assign that dose. It is ... there is a dose response to it.

The unfortunate side of it, is it takes a significant amount of time to-

Amber Davis:

To figure this out.

Josh Hayes:

... Response. You have to take lymphocytes, I can draw blood out of either of you, and culture that cell, those cells, and induce response using mitogens. And it takes 72, 96 hours, something like that, four days is really what we're looking at to get a response. But when it comes to radiation injuries, we may not have that kind of time. So kind of the goal looking forward, is how do we create an assay that ... and really what we're looking at right now is time to emesis, neutrophil lymphocytic ratios. We're always looking at different ways that we can look at that. And for the Pseudopelger-Huët anomalies, and again, I haven't worked closely with these in quite a while, but with that particular assay, instead of working it up with Mitogens, and several days to create these dicentric chromosome assays, and looking at them under a microscope, you can just take a simple whole blood draw, and plate it, sorry, not plate it, do a smear, a blood smear, and stain it, and look under a light microscopy, and you could potentially have an answer rather rapidly.

One of the challenges we're having with it, is there's a lot of variables that could potentially impact that assay, but that's kind of the direction we were going with it, when I was doing that research. It was a more field expedient method of doing dosimetry from a biological perspective.

Amber Davis:

That's so cool. So radiation damages our DNA, but it's hard to find out quickly how much dose and that is going to affect what kind of damage. So you're trying to figure out how we can do this more efficiently so we can respond to a person impacted?Okay.

Josh Hayes:

Correct, I was, right? And I very much would like to kind of put my foot back into that world about dosimetry, especially now that we're down here on south campus.

Amber Davis:

There, where the cytolab is?

Josh Hayes:

Yeah, there's potential work a lot more with them. And Dr. Balaji and I have talked significantly in the last several years, about how there's a potential for a little bit of a bridge from the health physics side to the radiobiological side. Because most health physicists, and I don't mean this as a slight against any health physicists, I have a deep love for HPs. A lot of HPs like to sit in a dark corner and do math. So sitting and working in a laboratory, working with biological samples is not necessarily in the realm of expertise of a lot of health physicists, because the common joke in the health physics society is that an introverted HP, as they're talking to you, will look at their own feet, and an extroverted HP will look at the other person's feet as they talk.

So working outside of our own realm of expertise tends to be a little bit of a challenge for the health physics folks. And we've been in a big period of growth in REAC/TS, working both internationally, developing our own mission, and expanding our own view of what we're doing. And I think we're working in an extremely positive direction. And I think one of those positive directions is going to be a little bit more of an overlap between the health physics folks, and our CBL folks. I know I very much appreciate whatever ... what they do over there, and I am excited about the future of working with them a little bit more. I know both the health physicists that work full-time underneath me, they have a particular interest in radiobiology, which is the fact that we have three full-time health physicists that are interested in radiobiology is, from my experience talking with HPs, is a bit of a unique thing.

All three of us are preparing to take the CHP exam this summer, and everyone we're talking about, everyone we're talking with about preparation for that exam, the radiobiology portion, and the non-ionizing radiation portion, are neglected parts of that exam. And all three of us were like, "This is the easy part, [inaudible 00:35:56] radiation biology." So it's a bit of a unique thing, and I'm excited to see where we go with it.

Amber Davis:

Yeah, we all should be excited about that, right?

Michael Holtz:

Absolutely.

Amber Davis:

That sounds like it'll benefit all of us.

Michael Holtz:

So Josh, what is it about REAC/TS ... I mean, on the one hand, it sounds like your being at REAC/TS was almost inevitable, but there's also this attraction for the work that REAC/TS does. What is it about REAC/TS that has drawn you to your being there today?

Josh Hayes:

Oh man, I apologize, I'm talking to y'all [inaudible 00:36:41] right now. I'm very excited about this organization. It's a catchall, right? So in health physics, folks tend to find a niche, whether that's linear accelerators, working with medical isotopes, working with reactors, working with military applications of radiologic materials, people tend to find a niche, and they stay there. And that's not a bad thing, because people can get very, very good at what they do. And something that was instilled in me very early in my life by my father, was that a jack of all trades is a master of none. And what most people don't realize is that is half the quote, the full quote is, "Jack of all trades is a master of none, but oftentimes better than a master of one," and working in emergency response, we are ... the hallmark emergency response is that if it exists, there also exists the opportunity for an accident to happen with it.

So being an emergency response, we have the opportunity to interact with all aspects of radiation sciences, everything from non-ionizing radiation from EMF towers. We've gotten calls from folks that are changing light bulbs on our radio frequency towers. We've gotten calls from people working with actinium 225 in medical settings. We've gotten calls from folks working with the lesser talked about aspects of military applications. We've gotten calls from people that are questionably saying that they've been irradiated by satellites. It really is the catch-all. And I think that variety of applications within health physics is what has attracted me to this particular position. And every single time ... I've worked with some people that have not enjoyed the fact that we're on an on-call system, and I genuinely feel sorry for those people.

The ones I work with right now are super excited about it, because every single call is an opportunity for something new. It sucks sometimes that it comes through at 3:00 in the morning, but that's the nature of the job. I might have to slap myself a couple times to wake up, but hey, this might actually be an opportunity for us to make some good, make some changes, do something significant within our field. And we've gotten ... so we joke around about it sometimes, but we've had calls that are unconventional, right? Because you'd expect emergency response to say ... I usually tell this story on our courses, since 1944, we've kept pretty good statistics on radiation accidents, and we consider a significant exposure is anything five times the regulatory limit, right? [inaudible 00:40:10] 50 millisieverts, 5,000 millirem.

And since 1944, we've had 480 accidents that resulted in a significant exposure. And of those 480 accidents, how many of those do you think have been from nuclear reactors? I'm asking you two. What do you think?

Michael Holtz:

Oh, gosh. I imagine it's a relatively small number, it sounds like.

Amber Davis:

Yeah, because we've got Three Mile Island. We have Chernobyl.

Michael Holtz:

Fukushima, Chernobyl.

Amber Davis:

And I actually, I'm writing an article right now about this.

Josh Hayes:

Really?

Amber Davis:

So maybe that's not fair. But like most people, I think there's a misconception with what happens.

Josh Hayes:

There absolutely is. Across 480 accidents, there has been six, right? But if I walk out on the curb, this had a lot more impact when we were going to MMC, we're a little bit closer to town. But if I walk out and there's any random person walking down the sidewalk and I ask them, "Hey, name me a radiation accident," what do you think they're going to say? It's probably going to be Chernobyl, Three Mile Island-

Michael Holtz:

Chernobyl, Three Mile Island or Fukushima probably.

Josh Hayes:

So we're working with something that is exceedingly rare, within a category of accident that is already exceedingly rare. So we're working up against a wall here of, we are trying to be prepared, but we want to also prevent complacency with the issue. Because then [inaudible 00:41:54] "Well, this never happens, so why do we need to worry about it?" It's like, Because when it does, it can be significant. So that education aspects, the variety of it, to circle back to your question on that, it's like that is really what draws me to this job, what keeps me excited about this.

Michael Holtz:

Awesome. I love it. Amber, do you have another question cued up?

Amber Davis:

Well, again, I'm just fascinated by the work that you all do. Again, it's so up here for me, but I love kind of getting down to what does it mean for us? Because I mean, you are answering the phone all times of day and night, answering questions. You've responded to crazy things. As far as what REAC/TS is doing. What would you say, Josh? Are you more answering questions and helping people figure out, "Oh, this isn't a big deal," or, "Okay, you need to do this." Is that what you're doing? Or is the training and the prep with trying to educate emergency responders, what do you say? Where do you spend most of your time?

Josh Hayes:

We spend most of our time doing education. Because that really is the best prevention for an accident, is education. And we work with first responders, we work with medical personnel, nurses, physicians. We work with Department of Defense, we work with military folks, we work with foreign governments. And really what we're trying to do is to ... it kind of boils down to the best time to plan for an emergency radiological accident is three months ago, the second time is right now.

Amber Davis:

Right.

Michael Holtz:

Right.

Josh Hayes:

And we are trying to get in where ... we're trying to get into the right now. So we have worked with a significant number, I mean, I think since I've been in this job, and I've had a bit of a unique experience here, because I came on board post-Covid, so there [inaudible 00:44:07] turnover during Covid. So I was the only health physicist for a little while. Sorry, excuse me, I was the only full-time health physicist for a while.

We had a gentleman that worked with us, is still continued to work with us today that I often refer to as my Mr. Miyagi of health physics, John Crago. And he kept me from drowning, that first year I was in this job, and continues to be a fantastic resource. But I was the only full-time individual for a while, until we hired Megan, and then a little bit later we hired Dylan, and we were able to spread the load a little bit. But in that first year, I worked, I think had seven international courses in that first year. And typically the typical workload is two to three. Three, it tends to be a bit of a full year. Czech Republic, Estonia, Poland, Slovakia, where else was I? Panama, all over the place, working with all these different foreign governments and foreign agencies.

And that education piece, that's largely what we're doing on a day-to-day basis. I find myself working to educate myself, as well as educate my staff that works with me. Just before this call, actually, Megan and Dylan and I were on a call, just working health physics problems, and we're just doing math.

It really just comes down to, what do we know? What do we don't know, and how can we fix that? And that's really what we're trying to do. Because we really want to embody that center of excellence, when it comes to radiological medicine.

Michael Holtz:

Awesome. Josh, on a life outside of REAC/TS, because I know there is one.

Amber Davis:

Is there, Josh, do you do anything else?

Michael Holtz:

I know, right? You're always on the phone. What does life look like for you outside of the day job?

Josh Hayes:

Oh, man. Despite what it may sound like, I have a fairly solid life outside of this office.

Amber Davis:

I'm glad to hear this.

Josh Hayes:

Having gone through grad school where I was working 70, 80 hours a week, I definitely made a point to prioritize my personal life outside of this office. And I am actually married to a beautiful woman named Ginger, and she's actually pregnant right now with our first child.

Amber Davis:

Congratulations.

Josh Hayes:

Extremely excited about that. She's due November with our little girl.

Amber Davis:

Congratulations.

Josh Hayes:

And she somehow tolerates me, with my shenanigans.

Michael Holtz:

The 3:00 AM phone calls.

Josh Hayes:

The 3:00 AM calls. She is gotten used to sleeping through that. But no, no, my personal life is good. I'm a big trail runner, that's kind of what I do in my free time. I run trails, probably 40 or 50 miles a week.

And I'm actually a part of a run team here in east Tennessee, called East Coast Adventures. And we do a number of things, actually on the seventh next month, we have a 24 hour event, where my goal for that is to hit ... it's 24 hours on a single loop within the Miriva Woods.

And my goal for that is 100 kilometers. So my current distance, personal record, PR here, PR is the term, or personal record is 62.17 miles, and my goal is 62.2. I just want to-

Amber Davis:

Oh my goodness.

Josh Hayes:

... Later this year, I actually have a 100 mile race that I'm doing in Arizona, called Javelina Jundred, me and several friends.

Amber Davis:

Isn't that like an ultra, I'm not a runner, but I've heard about these things.

Josh Hayes:

There's some mental illness that goes into it, for sure. Yes. Yeah, that's 100 miles, 30 hours, it'll be a good time. It'll be a good time.

Amber Davis:

Like, how many marathons is that?

Josh Hayes:

Four.

Michael Holtz:

Yeah, it's four.

Amber Davis:

Insane. That's a lot.

Josh Hayes:

Yeah, so actually, a number of us actually ran the Knoxville Marathon last month, in April.

Amber Davis:

Yeah, my husband did that one.

Josh Hayes:

Oh, wonderful, wonderful.

Amber Davis:

But he did the half this time. He likes to do the full, but he did the half this time.

Josh Hayes:

Okay, okay. Yeah-

Amber Davis:

I'm not a runner, I cheer.

Josh Hayes:

Yeah, I'm just a big fan, I've always been ... I've had a bit of an extreme personality my entire life, so I joined the military, so I went Marines, right? I went to college and I got a Ph.D. I don't know, I like to run, so I run ultras, I'm just a bit of extreme personality, and I've always been someone who likes to challenge myself, and I like to find that barrier of failure, so that I can try to push past it, right? And I just enjoy that aspect, we were just in Guam and I found a run shop about a half mile from our hotel, and I went over and checked it out, bought some T-shirts, and I was just talking with the owner of the shop, and turned out they had a half marathon. And that's actually what that running bib is right there, is I found out that they had a half marathon on Guam while we were in town.

Michael Holtz:

While you were there?

Amber Davis:

While you were there?

Josh Hayes:

Yeah. It was like it would be irresponsible of me not to sign up for it. So I signed up for it and I ran, it was 14 miles, actually, a little bit over a half marathon-

Amber Davis:

That is moving, yeah.

Josh Hayes:

And it started at 4:30 in the morning, and it was only registered [inaudible 00:50:32], so I had to be there at 3:00 to sign up for it, and then took a bus to the starting line. And when we finished, when I finished the race, 14 miles took me about two hours and 15 minutes. And so a relatively modest pace on that. I got done, it was 6:45 in the morning, and it was already mid-nineties and 90% humidity.

Michael Holtz:

Oh my god.

Josh Hayes:

I enjoy the challenge when it comes to that. And that's really kind of what I try to adopt in my personal life. And I think that's going to benefit me a lot, especially going into this new venture of fatherhood, is-

Amber Davis:

Yes, sir, buckle up.

Josh Hayes:

Yeah. This kid is going to introduce me to challenges that I never anticipated, and all of my co-workers that have children are very excited to tell me about how I don't know what I'm getting into. I am-

Amber Davis:

No one can tell you either.

Josh Hayes:

Yes, exactly. And you know what? I'm sitting here and I'm excited for it. Right? I'm excited for the challenge of it. I cannot wait to see that little girl.

Amber Davis:

And a girl dad to boot.

Josh Hayes:

Yeah, I'm excited about that too. I think I'm real excited to be a girl dad.

Michael Holtz:

Dr. Josh Hayes wrapped around his little girl's finger. I can see-

Amber Davis:

Oh, for sure.

Josh Hayes:

Six [inaudible 00:51:58], 370 pounds-

Michael Holtz:

Melting at the [inaudible 00:52:07]. I love it.

Amber Davis:

I'll be praying for you, and this is just awesome. I'm so excited.

Michael Holtz:

It's awesome. Absolutely. Well, Josh, thank you for spending this time with us, and letting us get to know more about you and your past research, and your present passion for all things REAC/TS, and your future challenge of welcoming a daughter into the world. I'm so excited for you and for Ginger, and just want to just say again, thank you for this conversation, it has been a joy to spend this time with you.

Josh Hayes:

Yeah, I appreciate it. It's been great talking with you all.

Michael Holtz:

And Amber, thank you again for co-hosting with me, it has been a pleasure as ever.

Amber Davis:

Thank you so much for letting me come ask questions about wild boar. That's just fun.

Michael Holtz:

Any time.

Speaker 2:

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