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UNITED STATES NUCLEAR REGULATORY COMMISSION'S
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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RADIATION PROTECTION AND NUCLEAR MATERIALS

SUBCOMMITTEE

+ + + + +

TUESDAY

JUNE 23, 2015

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, at 8:30 a.m., Michael T. Ryan, Subcommittee Chairman, presiding.

COMMITTEE MEMBERS:

MICHAEL T. RYAN, Subcommittee Chairman

JOHN W. STETKAR, ACRS Chairman

RONALD G. BALLINGER, Member

DENNIS C. BLEY, Member-at-Large

CHARLES H. BROWN, JR., Member

DANA A. POWERS, Member

JOY REMPE, Member

STEPHEN P. SCHULTZ, Member

GORDON R. SKILLMAN, Member

DESIGNATED FEDERAL OFFICIAL:

MAITRI BANERJEE

ALSO PRESENT:

AL ADAMS, NRR

MARY ADAMS, NMSS

DAVID BACK, SC&A

MIKE BALAZEK, NRR

TOM BOYLE, RES

VANN BYNUM, SHINE

JIM COSTEDIO, SHINE

BILL DERSHOWITZ, Golder Associates

MIRELA GAVRILAS, NRR

MILTON GORDEN, SC&A

BILL HENNESSY, SHINE

ALAN HULL, Golder Associates

CATHERINE KOLB, SHINE

TOM KRZEWINSKI, Golder Associates

STEVE LYNCH, NRR

STEVE MARSCHKE, SC&A

IRWIN PRATER, Sargent & Lundy

ERIC VAN ABEL, SHINE

ABRAHAM WEITZBERG, Information Systems Laboratories

TAREK ZAKI, NRR

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P R O C E E D I N G S

8:31 a.m.

CHAIRMAN RYAN: This is a two-day meeting of the ACRS Subcommittee on Radiation Protection and Nuclear Materials. I'm Michael Ryan, Chairman of the Radiation Protection and Nuclear Materials Subcommittee.

ACRS members in attendance are Dennis Bley, John Stetkar, Dana Powers, Ron Ballinger, Joy Rempe, Harold Ray -- I haven't seen Steve. Yes, there's Steve. Steve Schultz, Dick Skillman, and Charles Brown. Ms. Maitri Banerjee is the Designated Federal Official for today's meeting.

We have members of the SHINE Medical Technologies team to brief the Subcommittee regarding their construction permit application for a radioisotope production facility in the city of Janesville, Wisconsin for producing molybdenum-99. We also expect to hear from the NRC staff regarding their review of this application. Seven chapters of

the SHINE application, Chapters 1, 2, 4, 5, 6A, 7, and 8 are scheduled for discussion today and tomorrow, as noted in the agenda.

The rules for participation in today's meeting were announced in the Federal Register on June 10th, 2015. The meeting was announced as an open/closed meeting, meaning parts of the meeting may be closed to the public to protect information proprietary to SHINE or its vendors. We have designated a 15-minute session to discuss proprietary information toward the end of the meeting, as shown on the agenda. This session will be closed to the public.

We have two bridge-lines established, one for the public to hear the deliberations and unpublished line to allow certain SHINE and NRC staff personnel to participate remotely. The bridge number and password for the first line were published in the agenda on the NRC website. And to minimize disturbance, the public line will be kept in a listen-in only mode.

Before closing the meeting to the public, we will open the public bridge-line to provide an opportunity for members of the public attending the

meeting in person or through the bridge-line to make a statement or provide comments. The Designated Federal Official will check to see if any stakeholder is on the line and inform the Chairman.

Before we go into closed session, I will ask the NRR staff and SHINE to confirm that only people with due clearance and need-to-know are in the room. Thank you very much.

After the public comment period, technicians at the booth will disconnect the public telephone bridge-line.

Dr. Corradini, a member of the advisory committee, is present. Dr. Corradini has a conflict of interest regarding certain parts of the briefing because of his work with the University of Wisconsin, and he will limit his participation in compliance with NRC regulations.

I invite Ms. Gavrilas of NRR to introduce and present and start the briefing.

MS. GAVRILAS: Good morning. My name is Mirela Gavrilas. I'm the Deputy for Research and Test Reactors in the Division of Policy and Rulemaking in NRR. And I just, I'm here to give an overview of the two-day meeting, so I'll start with

the very beginning. There are about 50,000 medical procedures conducted daily in the United States that involve technetium-99 metastable. Technetium is the ideal medical imaging isotope. It has a strong monoenergetic gamma. It has a short half-life, and it works very well with binding agents that allow it to target specific functions and organs within the body.

There are -- just for context, the worldwide usage is about twice that of the United States. So we consume half of the world's supply.

In 2009, there were shortages of technetium-99, and that was the first big shortage. There was a subsequent one about a year, a year and a half later. But as a consequence of that, Congress passed the American Medical Isotope Production Act in 2012, and the Act had three objectives: ensure a reliable domestic supply of molybdenum-99, the precursor to technetium-99; eliminate highly-enriched uranium -- most of the technetium used to be produced on highly-enriched uranium, and the U.S. policy aimed to eliminate highly-enriched uranium from production of moly -- and eliminate market subsidies.

So where does the NRC come in? Our role under AMIPA is to license new facilities, their productions/utilization facilities, such as SHINE who's the forerunner and who's in front of us today; and we just docketed a couple of weeks ago a second application from Northwest Medical Isotopes.

We also process amendments for existing research and test reactors that made changes to alter or produce moly. We have such amendments from OSU in front of us.

So what's the process for new facilities? The process is, it's two-phased. First, we approve a construction permit, and then we look at the operating license and we grant them operating license.

We are now in the midst of the construction permit review for SHINE. That's what we're here to talk to you about.

Just for context, the construction permit is a far higher-level review than the operating license review. The details that are necessary for construction permit are far fewer. It's far more general. However, the dialogue that we've had with SHINE has been such that they know which areas will

be closely scrutinized under the operating license review.

A bit of timeline, and you'll hear more from Steve in a few minutes. We received part one of SHINE's construction permit application in March 2013. We received part two in May 2013. And we've had a couple of challenges initially, such as we had a hard time docketing the application. We had one deficiency that they promptly addressed. We had the government shutdown in that period of time. And most importantly was we needed to have a direct final rule to include SHINE under Part 50 because it's not the reactor, so we needed to explicitly include it. And the ACRS has been briefed on that. You've all heard about that.

Even with all of that, we're close to meeting the 24-month timeline for the construction permit. So it's been a great effort, and I will say that there's two things that are responsible for how well this review is going: the staff was well prepared, dedicated, and had the resources that we needed; and the second thing is SHINE is a good applicant. They're thorough, they're precise, and they're very responsive.

So today we're here to show you the first seven chapters of the SER that we're preparing. We'd like to share with you our conclusions and receive feedback from you on how we've done so far.

A bit of a caveat. We're not rushing it. We're trying to be as efficient when it comes to timeliness as possible. So what you receive now, the chapters that you have in front of you, are not quite as good as we'd like them to be in the final SER. Chapter 4 is the closest to what we'd like to see in the SER. But in the interest of time, we're here today. And so the substance is there. The form might not quite be what we want it to be. And most importantly, we have no open items in the chapters that we're sharing with you today.

With that, I'd like to introduce the staff. And these two gentlemen you'll see in front of you very soon. One is Steve Lynch. He's the PM for SHINE. He is one of the best PMs I ever worked with, and he's also the coordinator for all the moly activities within the agency. And it's a huge effort. It covers every office, big and small, of this agency, including a couple of regions. You know, we're dealing with Region III and Region II.

Next to Steve, and he'll also be at the table, we have Al Adams, who is our encyclopedia of everything research and test reactor-related. He has been with research and test reactors for 29 years. He has a wealth of regulatory and technical experience that he brings to this endeavor.

In the audience, I think I saw her earlier, I'm not sure if she's here, is Mary Adams from NMSS. So Mary has led the Part 70-related aspects of the review, and she'll also be in front of you a substantial amount of time.

And by way of contractor, our principal investigator is Terry Gitnick, and I know she's here. Terry is in the audience, and she has several people from Information Systems Laboratory, as well as SC&A. And you're going to meet all these folks, and they'll talk to you. Abraham Weitzberg, Chris Heysel, Stephen Alexander, Steve Marschke, Milton Gorden, and David Back. And in addition to that, we have Tom Boyle from research who has actually led Chapter 4 that I discussed a bit earlier that gives you an idea of where we want to be.

And with that, I'll pass it to SHINE for remarks.

CHAIRMAN RYAN: Thank you. Gentlemen, please.

MR. BYNUM: Well, good morning. I'm Vann Bynum. I'm the Chief Operating Officer for SHINE Medical Technologies. I want to thank Mirela for that outstanding introduction. She did a fantastic job, and it's not surprising.

The staff has done, I think, a very good job of communicating with us throughout this process, and it's been difficult. As she noted, we've had a few challenges as we've gone through the application, and we've managed to work together to get through all those challenges. And that brings us to where we are today, and I'm very pleased to be here.

By way of background, I've been at SHINE for three and a half years. I came to SHINE from Los Alamos National Laboratory where I did a number of different jobs working in weapons programs, managing infrastructure, and a few other little odds and ends like you typically do at a national lab.

Prior to that, I worked at Waste Isolation Pilot Plant and helping the permitting process for that facility. It had nothing to do with kitty litter I'll add for the record. And then prior

to that, I worked at the Rocky Flats plant just outside of Denver, Colorado.

I've had a number of varies experiences, and I have to tell you this is the absolute most fun one that I've ever had. It's been a real ride. I'm looking forward to it, and I know, working together, that we can ensure that we're solving this problem in a very timely manner and ensuring the safety of the public and our workers and the environment.

As Mirela said, we've got a long way yet to go. We don't have everything that you would like to see because we're not at the operational licensing phase yet. But I'm sure you'll see, as we go through this, just how far we have gone and that we've identified the essential elements that are necessary for the construction permit.

And with that, we can introduce our staff or we can introduce them as we go through, Mr. Chairman, whatever --

CHAIRMAN RYAN: It's up to you.

MR. BYNUM: Why don't we just introduce the staff as we go through then?

CHAIRMAN RYAN: That's fine.

MR. BYNUM: So we'll just move right in

to Chapter 1 if you're ready.

CHAIRMAN RYAN: We're ready.

MR. BYNUM: Okay. So SHINE Medical Technologies is a privately-held company. We are based in Monona, Wisconsin, which is a suburb of Madison. We were created solely for the purpose of designing, constructing, and building and operating the medical isotope facility that we're here to talk about today.

The purpose of that facility is to produce moly-99. As Mirela said, that decays into technetium-99, which is used in over 40 million medical procedures every year.

And it's a very essential medical tool, and there are no good substitutes. The only producer in the Western Hemisphere is scheduled to shut down in the coming years, and so that's going to create a huge shortage once again. The rest of the producers across the world are getting very old, with the exception of one, the Australians. And so we're anticipating, as we go forward, there's going to be additional shortages. And so that's part of what drives us.

So our design consists of a single-

integrated facility with two major components, the first component being the radiation facility where we actually irradiate in a subcritical fashion the low-enriched uranium solutions, and we'll be talking a lot more about that, as we go forward. And we also have a regular isotope production facility where we recover the medical isotopes from that irradiated solution and purify them and prepare them for shipment.

And then, of course, like all facilities, we've got a --

CHAIRMAN RYAN: And just a quick question on that point. When you say you process the material for use, is there a further processing by somebody else or is it ready for use in patients?

MR. BYNUM: It goes to what's called a generator manufacturer, and so that's what separates the moly-99 from the technetium-99 in the radiopharmacies. So our product will be ready to go into those generators.

CHAIRMAN RYAN: Okay, great.

MR. BYNUM: So it still has one additional thing that has to be done before it goes into the patient.

CHAIRMAN RYAN: Thank you. That's helpful.

MR. BYNUM: But it's not like the system that happens now with Chalk River and Nordion where they do initial processing at Chalk River, and then it goes to Nordion for purification. As we'll talk about later, we do all of that under one roof --

CHAIRMAN RYAN: Great. That will be helpful. Thank you.

MR. BYNUM: Okay. The location that we've selected is an undeveloped 91-acre parcel in Janesville, Wisconsin, which is, it's at the very southern reaches of Janesville in Rock County, Rock County, Wisconsin. I almost said Illinois.

This picture will give you an idea of where we're located. The map highlighted in red is Rock County, just sitting up to the -- I have to get my directions correct. Madison sits here. The plant will be here. And then perspective-wise, this is Chicago.

So the next slide, Jim. This is an aerial view of the site. Outlined in red is the property boundaries for the site. That's the 91 acres that I mentioned. You can see just to your

left is the Southern Wisconsin Regional Airport. Yes, we actually did site it near an airport, and we did that on purpose because these isotopes decay at about 1 percent an hour, so the transportation time is very important to us.

And the other thing that was essential for us is access to interstate highway. So we can go right just a little over a mile and get on interstate highway and, if necessary, go to alternate airports in Chicago or Madison.

MEMBER BLEY: That runway that I'd guess I'd call 050 is, you're right past the end of the runway; is that right?

MR. BYNUM: That's correct.

MEMBER BLEY: Okay.

MR. BYNUM: There is US 51, this highway, in between us and the airport. These hash marks are different airport FAA restrictions as far as height for the facility. So we've had to consider that in designing our plant.

This just gives you a little closer view of the site. This site has been historically farmed. It's soybeans right now, if you want to go out and see it. We've also, NRC has been out to do the

environmental site audit, and we got to walk through corn at that time. You couldn't see much because the corn is higher than all of us, well, at least higher than some of us. And that's the area around it, too. So we've got the airports. This is a relatively sparsely-populated area.

Next slide. This gives you an idea, an architect's conception of what we're proposing to build. Main production facility in the center with a waste shipping and staging building for shipments, the warehouse production facility, administration building, and the other necessary infrastructure to operate a facility such as this.

I mentioned the two components of the facility: the IF, which is the radiation facility, and the RPF, the radioisotope production facility. We have developed a new method for making these isotopes. Traditionally, It's been taking highly-enriched coupons, irradiating them in the reactor to create fission, and then taking those coupons out, dissolving them and processing them.

So we've developed a non-reactor base subcritical fission process where we use an accelerator, a DT accelerator, to drive fission in a

low-enriched uranium solution. And that gives us a number of advantages. One, we're operating subcritically, so we avoid some of the hazards that we might have in a critical process.

Secondly is we use an aqueous solution. That allows us to reprocess our solution, reprocess our targets, therefore decreasing the amount of waste that we have in the facility being generated.

MEMBER BLEY: I'd like to interrupt you for just a second --

MR. BYNUM: Sure.

MEMBER BLEY: -- with a question I don't expect you to answer now, but I hope over the next two days I get an answer that makes me completely comfortable. You're a non-reactor but you're an almost reactor. I mean, you're pretty close by NRC definition. By other people's definition, that's a reactor. But I know the staff struggled with this, and you came out with a license.

As I read through -- we divided up all the chapters to facilitate getting an end to the process, so I haven't read everything yet. In the ones I did read, every once in a while it's a we're a non-reactor so we don't have to do this or we don't

have a requirement in this area. And when I read the conduct of ops, you know, safety is pretty much subsumed under radiation protection if you're just a materials facility that stores or processes materials.

I would hope in the safety analysis, which I haven't read yet, and in all your thinking, you've looked at all the possible ways you can come up with that you can cross the boundary between being a non-reactor and being a reactor and looked at the conditions from which that could occur either by fluke or by changes in environment or by failures of equipment or by things people might do. And I notice you protect against criticality both by geometry and by administrative procedures, the ways people might misconstrue or do something wrong within those procedures that might get us into a place in which this behaves quite differently.

So I'm looking for that, and I'm looking to be confident that there's either no ways that could happen or you've considered them carefully and looked at the consequences, and we can understand that.

MR. BYNUM: Sure, absolutely. At a very high-level, a couple of items related to your

question just in a couple more slides. And you're right. I'm not going to be the one to answer all of your questions. I'm going to depend on Eric Van Abel, who has been the nuclear engineer that's designed a lot of this as far as the safety systems required to ensure that we have complete control over that process and can give everyone confidence that we understand the accidents that could happen and that we've established a robust system of controls that will ensure that it doesn't happen.

You'll also find, as we talk about the accident analysis, that we've considered, I hope, all these accidents. I'm sure by the time we finish this review, we'll find out whether we've considered all of these accidents or not. We believe that we have, and I think that you'll be pleasantly surprised and confident with the releases that we've calculated that are possible given those accident scenarios.

MEMBER BLEY: Okay.

MR. BYNUM: So it's yet to be proven, but we believe that we'll be able to show you that.

It was a key thing, and Mirela touched on this earlier, when we first started out it was not clear are we a production facility or are we a

utilization facility, are we a reactor, are we not a reactor? That definition has some specific implications for us, not only just in which set of regulations apply but what kind of waste we generate. If we're not a reactor, we don't generate spent nuclear fuel, so that's been a very important distinction for us.

But the staff had to go through and ensure that we had a clear path for the regulatory basis. And so that was the direct final rulemaking, and that defined all our IUs, IUs being the radiation units which Eric will give you a better description later about what that comprises, our utilization facilities. And this panel looked at that previously.

We have eight of the radiation units in the facility, all in the IF. And we'll show you in just a moment a depiction of that.

The RPF is where we prepare the feed material. It's also where we process that material to recover the radioisotopes, re-handle the waste, and prepare that waste for shipment. And then it's also where we prepare our products for shipping out.

This part of the facility is more

traditional processing facility. We have glove-boxes. We have hot cells. We do transfers through pipe and trench, things of that nature which has been done traditionally for many years.

Next. This is a -- yes?

MEMBER BLEY: We don't spend much of our lives in your process, so if you can use, say the words instead of the acronyms, it would be helpful.

MEMBER REMPE: I'd like to second that.

MR. VAN ABEL: And, unfortunately, it gets worse as we go along.

MEMBER POWERS: Well, Dennis doesn't spend many time your facilities, but I do spend --

MR. BYNUM: I'm sorry?

MEMBER POWERS: -- a substantial amount of time in process facilities, we do go through the trade study, engineering study that you do. But this is an extremely peculiar design. I'm much more familiar with either separated facilities so that you don't have the possibility of cross-contamination between the different units or facilities of a nested nature so that you have in leakage always in to the highest facility. I wonder if you could explore that systems engineering that leads to this what, to me,

is a peculiar design for a process facility.

MR. BYNUM: Well, first, it's not simply a process facility. It is a process and an irradiation facility, and that was one of our --

MEMBER POWERS: It is a process facility. Let's face it.

MR. BYNUM: Okay. And one of the things that we considered is we did not want to ship irradiated material with fission products outside of the facility, so that's part of what drove us to put it into an integrated facility.

And the concept that you described of basically contamination control in a traditional process facility, a flow from less contaminated to more contaminated areas, is built into this design. There are four different ventilation zones within the design, and we'll talk a lot more with you about that at future discussions. But it is all designed so we have that flow from less contamination to more contamination.

Is there more that you want to hear right now about that, or do you want to wait and hear more when we actually discuss the HVAC system?

MEMBER POWERS: There's philosophical

challenges here. You're making assertions, and I just don't see how, quantitatively, you arrived at this kind of design. Now, I don't have to. I can look at it. But I look at it in the context of where, mentally, I'm comparing it to other process facilities I know. So if you can explain to me at all how you arrived at this in some sort of a quantitative sense. You say, well, we don't want to do this. Well, that's fine, but you may have to do that in order to achieve a level of safety, quantified safety, that's acceptable.

MR. BYNUM: Without getting into exactly how we ended up with the specific design that we did, I believe that when we talk to you at the future about the accident analysis, I am confident that we'll satisfy your concerns about the safety of the design. We are well within the regulatory requirements, and we have a very robust system.

MEMBER POWERS: And it says that repeatedly in these charts, but I have yet to see anything that quantitatively demonstrates that it is, in fact, robust.

MR. BYNUM: I understand that, and I believe that we'll have to wait on that discussion

until we get into the accident analysis to really address your question to give you the quantitative answer to the robustness. So I'll describe this design just a little bit more, and then we'll continue on.

As I said, the radiation facility is really in two components. I mean, the facility is in two components. The radiation facility is in this area outlined in blue. I had mentioned before we have eight radiation units. Each of these radiation units sits in its own individual water pool, and then they have an off-gas system that sits just adjacent to that.

The rest of the green outline is the isotope production area where the traditional chemical processing. Exterior to this, we have the support facility, such as the control room, change-out rooms, all the other things that you would expect to see in a facility like this.

CHAIRMAN RYAN: A quick question, and it might be along the lines that Dr. Powell was just mentioning on those units. That's a good example for me to think about they're all, you know, loaded with radioactive material in one step of the process or

another. Are those isolated from one another in the event of an accident? Are those units going to interact with each other?

MR. BYNUM: Eric, you want to address that?

MR. VAN ABEL: Sure. The units themselves are all separate individual cells, so they're all separate confinement --

CHAIRMAN RYAN: Okay. So how will they react in a, I don't know, pick a thing, a fire or an earthquake or --

MR. VAN ABEL: For a fire, there's separate fire zones, so they're separated from each other, a fire event.

CHAIRMAN RYAN: What kind of fire event? What kind of fire event?

MR. VAN ABEL: I don't have the details right in front of me, but we analyzed fires in the radioisotope production facility spreading into the irradiation facility and fires originating in an IU cell and in the irradiation facility.

CHAIRMAN RYAN: But I guess it would be helpful, at least for me and I think for Dr. Powers, to understand some of the analytical results or that

drove you to these conclusions that you're presenting to us today. Just a thought.

MEMBER POWERS: What was the fire protection standard you used when you said you analyzed fire?

MR. VAN ABEL: I don't have that in front of me. I don't know that. We can get back to you on that.

MR. BYNUM: We'll have to get that to you.

CHAIRMAN RYAN: Thank you.

MR. BYNUM: Okay. So let's move on to the next slide, please. A little bit about the operating characteristics and how we propose to operate the facility. The radiation units are operated in a batch mode. They operate for approximately five and a half days. We have a short cool down period, and then the solution is pumped out of the radiation units over into the extraction and purification areas where it goes through a number of different processes that we'll be describing to you a little later where it also is in a batch mode.

The waste processing will be run just as necessary. We've got two different waste storage tanks where we'll store the waste until we accumulate

enough, and then we'll process that. There are no liquid wastes that will be released from the facility. Everything is either recycled, the liquids are recycled or either goes out as solidified waste. And that's one of the things that we committed to the community. They're very concerned about could we get radioactive materials in their sewage treatment system. So we have no connections from the radiologically-controlled area out into the sanitary sewer system.

CHAIRMAN RYAN: Just out of curiosity, what's your waste outlet going to be? When you finally make a waste product, where do you send it?

MR. BYNUM: It will be either to Waste Control Specialists in Irving, Texas or Energy Solutions in Clive, Utah.

CHAIRMAN RYAN: Thank you.

MEMBER STETKAR: Vann, those times, the throughput times, if I did the math correctly, that means you're processing a batch in the recovery facility about once every 18 hours; is that right?

MR. BYNUM: Yes.

MEMBER STETKAR: Okay, thank you.

MR. BYNUM: And that will depend, that

depends all on customer needs. Unfortunately --

MEMBER STETKAR: But I mean if you're running flat out, 100 percent, it's about once every 18 hours you're --

MR. BYNUM: Our capacity can, design capacity, not our license capacity, but our design capacity can be met with six of these irradiation units. You know, it's not realistic to believe all eight of them are going to be operating all the time because there's going to be downtime, breaks --

MEMBER STETKAR: But, again, if I think about the design and I think about the systems, they're designed for an 18-hour cycle time, if you will?

MR. BYNUM:

MEMBER STETKAR: Okay, thank you.

MR. BYNUM: Okay. Jim, let's move to the next one. So we have a number of engineered safety features that we have included in the design. We have a primary system boundary that's enclosed within confinement boundaries of the irradiation unit cell and the target solution vessel off-gas system. I have to pause and retranslate acronyms into actual words myself. That's all within the shielded cell,

and Eric will be showing you some descriptions of those later and give you a much better description than I will here.

And then the radioisotope production facility confinement areas, we have hot cell enclosures, gloveboxes, etcetera, and trench and vault enclosures for the process tanks and piping.

Next. So we defined a robust system of automatic controls to ensure it can maintain the plant in a safe condition. So we had mentioned earlier, someone said about administrative controls. We do have administrative controls, but we also have a robust system of engineered controls, and that's our first defense.

So the target solution vessel has safety-related reactivity protection system. Eric will go into great detail about it today and how it functions.

The accidents within the radiation facility are mitigated by a system called the engineered safety feature actuation system, which Eric will also be describing. And then Catherine will be describing how the radioactive material and the radioisotope production facility is protected by the radiological integrated control system.

And, finally, all of these things are electrically operated, and Bill will be talking about how we have emergency power through uninterruptible electrical power supply.

MR. HENNESSY: Chapter 7 will be tomorrow.

MR. BYNUM: Tomorrow. Sorry. Thank you.

MEMBER BROWN: A number of these features that you were talking about look to me like you're going to be talking about them tomorrow, as opposed to today? Is that -- the TRPS and stuff like that in the Chapter 7 purview would be discussed tomorrow? Okay. I just want --

MR. BYNUM: That's correct. The two days sort of run together for me.

MEMBER BROWN: That's fine. Not a problem.

MEMBER REMPE: We'll get into details, I'm sure, later in the discussions. But at a high level, when I'm looking at something like the ~~high-reaching~~ hydrogen concentration and how it was evaluated in an accident, it sounded like you came to like 3.99 percent when 4 percent is like a limit where

we worry about detonation. So that isn't much margin, and what was the philosophy in developing your system with respect to margin? Were you looking at, well, this is the limit and I'm going to just get within a percent or less than a percent off? I mean, it looked like that you were just coming right to it, and I was curious about how you decided to develop the design with respect to margin.

MR. BYNUM: No, it's not our intent to operate right at limits. That's not a good sound philosophy. And so there were a number of things that we had to consider, and we also had to look at what were the conservatisms built into the various analyses. And we'll get into those, we're not into that in this meeting. But --

MR. VAN ABEL: No, I can touch on the --

MR. BYNUM: Touch on that.

MEMBER REMPE: Did you always say, well, I'm going to try to -- safety margin where you're using and your thought process in the design, and maybe it will have several examples as we go through this, but is there a higher level of what you used for safety philosophy that you can share with us now or without getting into the details so much?

MR. VAN ABEL: Yes. I mean, overall, the design is done very conservatively. I think you'll see as we start talking through it, you know, we use the most conservative things whenever possible. It's always easier to do these things simply and conservatively in my opinion than try to find a very complex code and get down to a specific answer that may have more uncertainty.

My philosophy is always to go as simple as possible and bound things easily. Like for the pool heat-up calculation, we just did adiabatic volume of water. We assumed no heat loss in the pool and looked at how much heat capacity was available in the pool. So, in general, it's to be very conservative.

MEMBER BALLINGER: With respect to the hydrogen issue, there's a big difference between flammability, deflagration, and a detonation.

MR. VAN ABEL: Yes.

MEMBER BALLINGER: The last two are really dependent on the design configuration of the system. The flammability limit, you can do a calculation of hydrogen that's produced. So, I mean, how much detail had you gone into with respect to the

design of the system with respect to mitigating against deflagration or detonation?

MR. VAN ABEL: So for the hydrogen, yes, the deflagration is, you know, roughly four percent, depending on --

MEMBER BALLINGER: Is it four percent? What's the flammability, what's the lower flammability limit?

MR. VAN ABEL: Roughly, four percent.

MEMBER BALLINGER: Four percent, okay.

MR. VAN ABEL: And the -- I forgot what the question was. Sorry.

MEMBER BALLINGER: Have you thought through the design with respect to deflagration versus detonation?

MR. VAN ABEL: Yes. So our intention is not to have any scenario where we could have detonation, and we have a maximum credible deflagration that we consider, which we can talk about later when we talk about the TSV off-gas system, which is a system that does recombination of hydrogen. But the intention is, during normal operations, it's maintained below the LFL and the system will withstand any deflagration since we never

intended for there to be any deflagrations in the system.

MEMBER BALLINGER: But nothing is ever actually intended.

MR. VAN ABEL: Yes. But we're designing it as a robust pressure barrier.

MEMBER POWERS: I have never seen a process facility where the design limit on hydrogen was the lower flammability limit. Really, every facility I have ever seen, the design limit is well below the LFL.

MR. VAN ABEL: The target operating condition of the TSV off-gas system is two percent hydrogen.

MEMBER POWERS: All the way up to two percent.

MR. VAN ABEL: Yes. There's some competing things with the TSF off-gas system that actually can be a safety concern, as well. The faster you float gas over the surface, the more droplet entrainment and solution pickup you're going to get because the higher gas velocities increase entrainment. So there's some competing effects there that make it less desirable to try to go down very

low in hydrogen. But the two percent is also based on conservative efficiencies and conservative flow rates, so the actual operating point should be significantly less than two percent, as well.

MEMBER BALLINGER: Even in the dissolver?

MR. VAN ABEL: The dissolver --

MEMBER BALLINGER: You have to dissolve the uranium in metal, right?

MR. VAN ABEL: Yes.

MEMBER BALLINGER: And so you're going to produce a lot of hydrogen and dissolve it?

MR. VAN ABEL: Yes. We haven't done the design on the sweep gas flow yet.

MEMBER BALLINGER: Okay.

MEMBER STETKAR: By the way, before you continue, this is another kind of nit on philosophy, but if you could help me I would appreciate it. I took the opportunity now because orally you used the word "credible" for the first time. In the document, you use the term "credible" a lot. I would like you, if you can, quantify for me what credible means to you in each of those instances when you use it, especially in today's session, because what is

conceptually credible to one person could be fairly routine or non-credible, depending on your viewpoint, to another person. So if you could, please, for me at least, quantify what you mean by credible. Thank you.

MR. VAN ABEL: Certainly.

MR. BYNUM: Okay. We'll move on in my short introduction. We will have a radiation protection program to protect the health and safety of our workers that complies with the regulatory requirements. We also will have a waste management program providing for the control of the gaseous liquid and solid radioactive waste. As you had asked before, yes, we've actually looked at our waste streams and looked at their disposition paths, so that we understand that, too.

Next, Jim. So there are some R&D activities that are required by the regulations to be described in the application. We have those on this slide, and I'll touch briefly on those. But in addition to these activities, SHINE and its supporting team members have developed either full or near-full capacity full-scale mockups and demonstration units for many of our processes. And

so we’re benefitting from those. So they’re not required as part of the application, but we just did want to make the Committee aware that we’re doing that so that we get operational history and can refine our operating parameters associated with those.

But the two that are required are that we’re doing testing and evaluation of material that’s used in the target solution for containing the target solution and other materials of construction. It’s being performed at Oak Ridge National Lab, and those materials are tested both in "as-received" and "as-fabricated" step states so that we can understand better how the materials will perform over the design life of the plant.

There’s also occasionally a concern about precipitation within solutions, so we’re having some testing done at Argonne National Laboratory to verify that the conditions, under the design conditions that we will not have precipitation of uranyl peroxide in our systems. All this testing, both at Oak Ridge and at Argonne, will be finished by the end of 2016, so well in advance of when we’ll be operating the plant.

Last slide.

MEMBER BALLINGER: So, again, along the

lines of what John was saying, you're designing it so that you don't get precipitation of the peroxide, but do you have a plan to deal with it if you do?

MR. BYNUM: Yes.

MEMBER BLEY: Where will that come up so we can understand it?

MR. BYNUM: That will come up, it will come up in the accident analysis for one area, right?

MEMBER STETKAR: And this is a criticality issue I assume; is that right?

MR. BYNUM: Yes.

MEMBER STETKAR: I don't think that was one of the three design basis accidents that were defined. We'll be interested in understanding that better.

MR. BYNUM: Sure.

MEMBER SKILLMAN: I'd like to ask you a question before you go much further.

MR. BYNUM: Sure.

MEMBER SKILLMAN: I don't know if it was ten years ago or five years ago or sixteen years ago, someone had an idea to build this facility and someone had a conceptual process in his or her mind, and that probably grew from a single individual to a couple of

individuals to a consortium. Kind of building on Dr. Powers' question, where was the system engineering? Where was the investment of the recognition of what the process is intended to produce coupled with the recognition that other facilities have done work like this and have learned from operating experience? Can you describe to us how that came together and how what you're presenting here provides a facility that really takes into account lessons learned, common sense, safety engineering, so that when we're done with your summary we've got some confidence that what you are proposing is a mature, solid concept?

MR. BYNUM: Well, that's an outstanding question, and I'll give you a little bit of the history of how we evolved into that. You're right. This concept did come up with basically one and then a second person, and that was back in 2009 - 2010. Neither of those folks had ever worked in a nuclear facility, and I sort of wish that I had brought their initial sketch because I would show you just how far we've evolved from that initial concept to where we are today.

As those two individuals got started, then they started adding a few others. I came on as

a consultant to the company. My background, as I mentioned before, is running nuclear facilities, both the Rocky Flats plant and, at one point in my career, I was responsible for all facilities at Los Alamos National Lab, including the weapons production facilities there. So I brought some of that knowledge, and we started evolving it.

Now, not just me. We brought in a number of people from varied experiences. We brought in someone who came in from nuclear reactors, I mean naval reactors out of Idaho. We brought in a person that's worked in a number of processing facilities across the country. But we also reached out to the national labs who have supported these type facilities all over the place, most notably George Vandegrift from Argonne National Lab. And we also -- and George had working for him the gentleman that ran the Cintichem plant in New York, which produced moly-99. And if you look at our process, which Catherine will describe later, we basically adopted that same process that Cintichem plant used for decades. So we have incorporated those lessons learned and the history that they had and found out what worked and what didn't work.

Does that help, that explanation, at all?

MEMBER SKILLMAN: Well, you've added a little more detail. I guess I'm sitting here saying why should I be highly confident that the concept that's being presented is as safe as the Advisory Committee on Reactor Safeguards would expect it to be? And I think that's the tone of the questions that you're hearing from me and from my colleagues.

MR. BYNUM: Absolutely. And I hate to keep putting this off, but I think you're not going to get that confidence until we really talk about the accidents analysis.

MEMBER SKILLMAN: And that's Chapter 13, so maybe we should be talking about that at some point earlier rather than later. Thank you.

MR. BYNUM: As I mentioned previously, the facility is designed so that we don't have any liquid discharges out of the facility. That was an important thing for us. And as I've been questioned a few times, we maintain we have a robust system of engineered and administrative controls to ensure the safety of the public, the environment, and our workers. And you'll hear more of that as we go through all the presentations over this meeting and

at future meetings.

And with that, unless there's additional questions --

CHAIRMAN RYAN: So I guess that means your waste water and any other supply water? Excuse me. Your waste water from any other process water has to be very carefully isolated. In fact, it has to be almost a completely independent system, I guess.

MR. BYNUM: The waste water is independent.

CHAIRMAN RYAN: Completely?

MR. BYNUM: Right. As I mentioned, there are no connections from the radiologically-controlled area to the sanitary sewer system at all.

CHAIRMAN RYAN: And that's just not by piping, that's by separate buildings? Is that --

MR. BYNUM: They're adjacent buildings.

CHAIRMAN RYAN: Adjacent but not connected?

MR. BYNUM: Right.

CHAIRMAN RYAN: Okay.

MR. BYNUM: Not in the way that you would have liquid flow. We have a drain system that you'll

hear more about so that if we do have liquid release within the radiologically-controlled area, that is all captured within that building and goes to critically safe tanks that then we'll process back through as waste.

CHAIRMAN RYAN: Okay. So the radiological system is just basically isolated completely?

MR. BYNUM: Yes.

CHAIRMAN RYAN: I see. Thank you.

MEMBER BLEY: Just to chase that a little, and I read a bit and I heard you say a little bit. I have two questions. The first one is my understanding now is any water that's used inside the nuclear processes will be perhaps clean, but it will be re-used and that won't be cleaned and then discharged somehow.

MR. BYNUM: Well, it will be cleaned and reused or it will be used as water to make grout to grout the other waste going out.

MEMBER BLEY: Okay. It will go into the grout. Okay.

MR. BYNUM: Right.

MEMBER BLEY: But you do have fresh water

coming into that facility to use.

MR. BYNUM: That's correct.

MEMBER BLEY: Have you looked at what happens after you've been operating several years, and maybe you've collected some things in various places, now you have a rupture in that fresh water line and you flood the building and you just have too much water, what do you do with that? Do you have ways, notable ways to cut off that flow and protect from the flooding issue? Does that come up as something you've looked at?

MR. BYNUM: We have looked at being able to handle water in a flood situation. We have looked at what happens when we have the --

MEMBER BLEY: No, I'm talking about internal flood.

MR. BYNUM: Yes, right. Such as the fire protection system going off --

MEMBER BLEY: Yes.

MR. BYNUM: -- and our systems are designed to be able to handle that amount of water without it going out --

MEMBER BLEY: Well, at some point, you've assumed you stop it.

MR. BYNUM: Yes, absolutely.

MEMBER BLEY: That’s kind of what I’m getting at is how do you stop it and have you looked at that to make sure you’re able to stop any of those, identify and stop any of those kinds of flood events? And it’s not part of the accident analysis, so it must be somewhere.

MR. BYNUM: Sure. I don’t know those details off the top of my head.

MEMBER BLEY: There’s a couple of places where this comes up for me. I mean, this is one. In electric power, it comes up because, oh, well, we don’t need a 1E because we’ve got uninterruptible power supplies. And it kind of reads like it will last forever, but they don’t. So somewhere you’ve got time analysis on, elsewhere you say how long the batteries will last, but there’s a built-in assumption that either I’m going to get power back from somewhere else or I absolutely won’t need it after some point in time.

MR. BYNUM: That’s right.

MEMBER BLEY: And that sort of thing is not clear. So there are these kind of, at least for me so far, dangling pieces that, yes, we’re okay,

we've got room for the water. Well, that has assumptions built into it. Well, we've got the uninterruptible power supply, but that's got a time limit on it, as well. And I haven't seen where you've considered that. I'll be looking for it, and if you can point us to places in the documentation that cover it, that would be good. But I haven't found them yet.

MR. BYNUM: With respect to the power, you'll be hearing more about that later because we are going to talk about the power, how the uninterruptible power supply is structured and how we can also bring in additional power if that becomes necessary.

The water system, we'll have to get back to you and give you some more details on that.

MEMBER BLEY: Okay. And there's probably other things just like this.

MR. BYNUM: Sure.

MEMBER BLEY: Because these kind of assume we're okay, but that's got some time limit, and I'm wondering what your thoughts are beyond that.

MR. BYNUM: Right.

MEMBER SKILLMAN: Vann, let me ask this

question. After the Fukushima event, did the SHINE team circle back around and ask themselves what does that event mean to us?

MR. BYNUM: Yes, sir, we did. We've read the reports on Fukushima. We've look at it. I don't know, Eric, if there's any specifics that you would want to comment on that.

MEMBER SKILLMAN: I'd be curious if you made changes and what changes you might have made as a consequence of discovering what happened in Japan.

MR. VAN ABEL: I don't think we made any direct changes, not that I can think of.

MR. BYNUM: We did discuss it. Like I said, we read the reports, looked at what happened. I can't cite to you any specific change that we made as a result of that. We did look hard, again, at our earthquake analysis for example to ensure that we've got a good seismic analysis for the facility. We looked at our power supplies and ability of all of our equipment to continue operating in the event, all the safety related equipment to continue operating in an event of either a manmade or natural disaster. And we were still convinced that these systems would execute their function and keep us within the release

limits.

MEMBER SKILLMAN: Okay, thank you.

MEMBER SCHULTZ: Vann, before we leave, just to continue some of the theme that we've heard this morning, I'm interested, and I know we're not going to discuss it in the next few days in detail, but where you describe that the radiological consequences are within the limits of Part 20, I'm very interested to understand, again, the design philosophy that's being used to establish what that means in terms of margin, in terms of what you're calling protection to the workers in both normal operation and postulated accident. So as we walk through that side of the application, again, a better understanding, since we're talking about moving to construction, the design philosophy that's been used to establish what you're describing within the limits. What margins have been provided? What confidence has been provided to achieve those margins is important to us.

MR. BYNUM: And we will get into some of those as we go through. For example, we'll talk to you about the design criteria that we're using for shielding so that we can ensure, as our workers move

around the facility, that the doses that they'll be exposed to are what we consider well within those limits. So we'll talk about what measure we actually set to ensure that happens. And we can talk about some other related ones that, hopefully, will give you more confidence that what we've designed can be operated safely.

So, Mr. Chairman, I think the agenda said that NRC would present. So we'll get out of the way and let them . . .

CHAIRMAN RYAN: We're scheduled for a break after this presentation.

MR. BYNUM: Yes.

CHAIRMAN RYAN: Okay, sure.

MEMBER STETKAR: By the way, for those of you who aren't familiar with our mike setup, when the green light is on you're on. If you could, if possible, when you're not speaking, leave the mike off. There's a little press area right at the base of the mike to turn it -- there you go. The reason we do that is these mikes are really, really sensitive and people on the bridgelines can hear you rustling paper or anything. So if you could remember to turn it on when you want to speak and turn it off when you

don't.

MS. GAVRILAS: This is Mirela Gavrilas of the staff. Can I make a brief remark by way of context before we get into our presentation? We are not prepared, we, the staff, are not prepared today to answer things outside of the chapters that are in front of you. So for example, we don't have the staff here who can answer hydrogen questions and such.

The other remark I'd like to make is they'll get more into this. At this point, you know, for construction permit, we'd love to hear all your questions. We definitely want to hear all your questions. But the way the regulations are written, the applicant can say approximately, about, and that is good enough. But that said, we would love to hear all your questions at this point so that we can pay attention to those things as things progress.

CHAIRMAN RYAN: Thank you. That's very helpful.

MS. BANERJEE: Well, can I add something, Chairman?

CHAIRMAN RYAN: Yes, please.

MS. BANERJEE: Maitri Banerjee, the DFO.

What I'm doing is trying to write down all the questions that are being asked that are not answered so that, by the time we are done with three sets of meetings that we have scheduled, we have heard answers to most of the questions, the ones that can be answered at the construction permit stage, of course. Thank you.

MEMBER BLEY: Lest that be misconstrued, a number of our questions are more general in nature and they'll continue. So just getting a specific answer on one of them isn't like checking off a regulatory box. We're putting technical issues on the table that will continue throughout the whole process beyond construction permit.

MEMBER STETKAR: And as a second caveat, I need to remind everybody that this is a subcommittee meeting. It is not the ACRS full committee. So anything you hear from individual members at this meeting are those individual members' opinions and questions. That doesn't mean that you shouldn't try to answer them, obviously. But, no, the caution is don't construe these as ACRS Committee questions or action items because we only communicate through our letters to the Commission.

MS. GAVRILAS: But, again, it's very valuable to us to hear all your questions right now.

MEMBER STETKAR: You will. I just need to get all of the legal clarifications out on the record. That's all.

MR. LYNCH: All right. I'll get started. I'm going to give you an introduction to the facility. This is a companion presentation to what SHINE went over, but I'm going to be less focused on some of the physical design attributes in this presentation and more on some of our regulatory considerations that we apply to reviewing this facility.

So you've heard most of this already. So SHINE has requested the specific licensing action that they've asked for the NRC is for a construction permit to construct their facility just outside of Janesville, Wisconsin. If granted, what this would allow them to do is build eight commercial non-power-utilization facilities and one production facility, as described in 10 CFR Part 50. And the utilization facilities are going to be the accelerator, subcritical driven, operating assemblies that you've heard us mention that will be part of the irradiation

facility and the hot cell structures that will separate out the molybdenum-99 from other fission products will comprise the radioisotope production facility.

So both these, we'll talk about the irradiation facility and the radioisotope production facility. They're both housed under a single building, so the processes are separate but they are co-located on the same site.

A few comments that I would like to make regarding the irradiation facility that houses the irradiation units. So when we got the application in, you know, one of our first philosophical discussions was what do we call these things? They look a lot like subcritical aqueous homogeneous reactors. You know, power levels, they're similar to many of our existing research reactors. Safety considerations look the same. We still have decay heat to look at and the accident scenarios that are similar.

But, unfortunately, because they're subcritical, they did not meet the definition of a nuclear reactor as described in Part 50. In order to be a nuclear reactor per the regulations, you have

to have a self-sustaining neutron chain reaction. So what that meant was we could not license them as a utilization facility under Part 50.

So we did consider briefly, well, could we license this under Part 70? However, Part 70 is much more stringent on their margins of subcriticality. And with what SHINE was proposing, that did not seem to work.

So what we did was we went through a direct final rule, added SHINE's irradiation units to our definition of utilization facility. So in effect, we are applying all of the same regulatory standards to SHINE that we would apply to other non-power reactors.

Right now, I'll let Mary Adams from NMSS comment --

MEMBER BROWN: In a number of these chapters, they commented this is not a heterogeneous or whatever the words were reactor, blah, blah, blah, on and on and on. So they don't have to do this because it's not --

MR. LYNCH: So what that is, that's an artifact of how our guidance was set up. So our guidance was, so our interim staff guidance provided

for heterogeneous reactors, which are the existing research reactors that we have, and that was part one. So if you have a heterogeneous reactor, you would fill out that part of the application. But SHINE does not, they essentially have an aqueous homogeneous reactor, so they filled out that part of the application. So all they were saying, essentially, is, no, we don't have a trigger reactor on our site, so we didn't fill out that part of the evaluation. So they only filled it out for their facility.

MEMBER BLEY: I'd like to be a little more precise. When they say we're a non-reactor and, therefore, we didn't do something, would those same words, would the same things they're saying be equally applicable if they said we're a non-power reactor and we don't have to do the same thing? Are there any things, what I'm asking you is are there any things that a research reactor would have to do that they're avoiding because they're a non-reactor? I'm not sure about that.

MR. LYNCH: So how we're applying it, how we are applying the regulations right now and for the purposes of construction, no. All of the same

standards and regulations that we would apply to a research reactor we are applying to SHINE. And based on what I've read in their application, they are meeting those standards.

When we get into the operating license stage, the regulations start getting a little bit more nuanced where they do call out specifically research reactors and non-power reactors do this, power reactors do that. One of our efforts that we're doing in parallel to all of this right now is we're trying to adjust the regulations to make sure that all of those instances where the regulations might say non-power reactor but we want it to apply to SHINE, we're going to make those adjustments in the regulations to make sure that all of those apply.

MEMBER BLEY: You're actually going to have a rulemaking?

MR. LYNCH: Potentially. We're going to consult with our legal counsel and ask them what the best path forward is to --

MEMBER BLEY: Are you going to start with something like an interim staff guidance document?

MR. LYNCH: Potentially. So where we're at in that process right now is we've just done a

complete review of Part 50. We've come up with a list of some regulations that we're in the process of tidying up, and we're going to present that to our legal counsel hopefully in the next week or so and come up with a path forward. There will probably be some paper written about that. And if we need to augment our guidance, we can do that, as well.

MEMBER BLEY: Just a for example, we'll be talking about the electric power systems later. But they don't require a reliable off-site power source, I don't believe. Is that the same rule that applies to a research reactor?

MR. LYNCH: Yes.

MEMBER BLEY: Okay.

MR. ADAMS: For research reactors, a lot of that depends on the design features of the reactor. You know, research reactors range from 5 watts to 20 megawatts. What we had done is, when we started down this path, we believe --

MEMBER BLEY: This is near the higher end of that, even though it's not a critical facility.

MR. ADAMS: Well, you know --

MEMBER BLEY: It's a megawatt and a half or something, right?

MR. ADAMS: Well, when you add them all up, it's about a megawatt. Each individual facility is in the 100-kilowatt range.

MEMBER BROWN: You mean each IU.

MR. ADAMS: Each IU. So that --

MR. BYNUM: Excuse me. We're getting into proprietary --

CHAIRMAN RYAN: Thank you.

MR. ADAMS: What we did is we saw the possibility for an applicant coming in with liquid homogeneous reactors. We went to the Office of Research with the user's need and asked them to develop an ISG for liquid homogeneous reactors and also, at the same time, we developed an ISG for medical facilities. So both of those ISGs were developed. Research went out, gathered worldwide experts on liquid homogeneous reactors from the international community. They got the graybeards from DOE because they had a history of running these facilities. And we wrote an ISG, 21537, which emphasized what additions and subtractions would be needed for a liquid homogeneous reactor.

We did the same thing in the area of the medical isotope facilities. We went out and gathered

experts. For example, the manager of the Cintichem worked for NRC for several years working on our guidance document.

So we developed these guidance documents for a technical yardstick for these irradiation facilities which look a lot like liquid homogeneous reactors, you know, with the exception that they don't go critical. We're using as a technical yardstick primarily that guidance that was developed for the liquid homogeneous reactors. And for the medical facility part, we're using that guidance that we developed specifically for the medical production facilities.

MEMBER BLEY: Okay. I think we have both of those, but, if we don't, we ought to make sure we have both of those ISGs until you get to whatever you're aiming at next.

MR. LYNCH: Yes. So the ISGs, I think, as far as the technical content, cover it all. We're just looking at a few nuances to make sure that the regulations line up with all of the technical --

MR. ADAMS: What you're going to see next is not going to be revolution. It's going to be a small evolution on where we are.

MR. LYNCH: Yes, it's going to be most things, like if they call that a non-power reactor in the regulations, but we think SHINE needs to be in on that, too, because the regulations weren't meant to just exclude these types of facilities. We may make those adjustments. But that's coming.

MEMBER BLEY: We'd like to follow that, and I think the last research reactor we looked at I know this came up for us because we're much more closely familiar with the power operating reactor conditions, and some of those we were really questioning until we looked at the consequences. And I think that convinced us it was reasonable.

MR. LYNCH: Yes. And, you know, a good time for us to update you on all this might be, I think the next time we're supposed to come up in August and we'll probably be a lot further along in that process. So we can make that a definite topic when we come back.

MEMBER REMPE: So I was glad to hear Al talk about you have gone and talked to people at the national labs who've run similar facilities like this before because, throughout this documentation is, yes, this is a unique facility, it's different than

anything else. In addition to the U.S. places where similar facilities have existed that were critical reactors, what about the international community? Did you look at some of the operating experience from the ARGUS reactor and the French facilities?

MR. ADAMS: You know, I believe research looked at that when they were developing the ISG. Also, when we wrote NUREG-1537 in 1996, we wrote it for the facilities that were operating at that point in time. NRC has licensed about a dozen liquid homogeneous reactors over the years, so this is not a technology we have not seen before. And, you know, what's different about SHINE is they both, you know, they bolted known technologies together to create this that we have, you know, we haven't seen accelerator-driven subcritical. But the NRC has a history of licensing liquid homogeneous reactors. The last one shut down. I remember, you know, being the project manager while it was in operation and taking it through decommissioning.

So until the late 1980s, there were liquid homogeneous reactors running at universities licensed by NRC. So it's not like we were starting from no knowledge base whatsoever.

MR. LYNCH: All right. Mary, did you want to make a few comments on the high level? And after Mary talks about the radioisotope production facility, I'm going to, the presentation is going into licensing process and some more specifics on regulations that we're applying.

MS. ADAMS: I'm Mary Adams from the Division of Fuel Cycle Safety and Environmental Review in the Office of Nuclear Materials Safety and Safeguards. I'm the project manager of the team that reviewed the radioisotope production facility, the RPF part of the facility.

Fuel Cycle decided early on, there's been some discussion about that, that Part 70 wasn't suitable for licensing the irradiation facilities because SHINE was proposing to operate with a margin of subcriticality that just didn't work for us under Part 70. That seemed to be a universal agreement. We argued about it for a while, but that's what we came up with.

Part 70, specifically, 70.61(d) says that you have to have an acceptable margin of subcriticality. What we've accepted so far in our fuel cycle facilities is a subcriticality margin of

about 0.05 and that’s too big for SHINE. So maybe we could have gotten there, but it’s better, I think, that we didn’t try.

So we talked a lot about the irradiation facility this morning. The SHINE facility also includes the radioisotope production facility that consists of ten processes, which you haven’t actually described. I was going to say that you had already described them. But there’s the target solution preparation system, which is the uranyl nitrate dissolution system that produces the target solution in the first place; the uranyl nitrate conversion system that’s a clean-up process after the target solution has been through the irradiator a number of times. There’s the noble gas removal system that will capture noble gasses from the process. There, of course, is a process vessel ventilation system. There’s the radioactive liquid waste evaporation and immobilization systems. There’s liquid waste storage system. There’s an organic liquid waste storage system. There’s also a radioactive drain system. All of these processes will have special nuclear material present, and the fuel cycle, of course, is concerned about criticality safety and

chemical safety and fire safety and radiation safety in all of those processes that are outside the irradiation units.

Chapter 1 of the PSAR presented information at a level of detail that's appropriate for general staff familiarization and understanding of the proposed RPF. It doesn't have a lot of detail in it. That's what Chapter 1 is supposed to do, just sort of get us familiar with the site.

The RPF description includes drawings of the layouts of the buildings and structures within the controlled area boundary. The RPF process overview summarizes the major chemical and mechanical processes involving radioactive material based, in part, on information presented in the accident analysis in Chapter 13, which you don't have yet. This summary information is consistent with the more detailed information presented in later chapters of the preliminary safety analysis report.

NMSS staff are somewhat familiar with processes like those proposed in the RPF. Some of our fuel cycle facilities also use uranyl nitrate in chemical forms and uranium in oxide forms and uranium in metal forms. Of course, the garden variety fuel

cycle facilities, Westinghouse, General Electric, use low-enriched uranium at enrichments up to about five percent. SHINE is talking about something quite a bit more enriched than that. Fuel cycle also licenses NFS and BWXT that use enrichments higher than the normal five percent.

So our ears are to the ground on criticality safety at a lot of enrichments. And one of our major RAI comments to SHINE about the criticality safety analysis, which you won't see in this particular collection of SER chapters -- that will come later -- is that we had a lot of questions about validation of criticality codes at this particular enrichment that we're talking about.

MEMBER STETKAR: Mary, I'm just going to give you a hint that somewhere along in here we're going to take a break, so I'll leave that to you to maybe pick a good place.

MS. ADAMS: Yes, okay.

MEMBER STETKAR: But if you can finish, that's fine.

MR. ADAMS: I'm doing the Hillary Clinton thing. When she gave her talk to Congress, she had, like, one page. All right. SHINE's proposed safety

criteria are pretty straightforward. It complies with 10 CFR 20, which you all know about, for occupational dose limits and radiation dose limits for individual members of the public. SHINE also agreed to conform to the performance criteria in the interim staff guidance, which we've had some talk about, by performing an integrated safety analysis and designated items relied on for safety, which we're now calling safety-related structure systems and components. Fuel cycle doesn't care what you call them, as long as they are available and reliable and do what they're supposed to do.

SHINE's proposed margin of subcriticality in the RPF has not really been resolved yet, but we're still working on that. NMSS staff have requested that the margin of subcriticality analysis focus on criticality experiments near the enrichment range proposed to be used in the SHINE facility. The safety program evaluation would go in SER Chapter 6, which you'll see later in September I think.

The only deviation from the ISA criteria, which we've determined is acceptable, if SHINE proposed to use the same criteria that are in 70.61

that we would find that acceptable. What SHINE has agreed to do, with one exception, is that they propose more stringent radiation safety criteria. They've proposed that the RPF will be designed such that no accident will have a consequence to a worker or individual member of the public that would be greater than the annual dose limits in 10 CFR Part 20, Subparts C and D. These Part 20 accident criteria are more conservative than the ISG acceptance criteria, so staff finds them acceptable. NMSS staff also considered chemical safety hazards since the RPF processes use chemicals, such as nitric acid and sulfuric acid and tributyl phosphate and others like that.

So as far as Chapter 1 was concerned, we think we got what we needed from Chapter 1. And, of course, we'll do much more detailed analyses in later chapters of the safety evaluation report.

MEMBER POWERS: One of the persistent difficulties that you have in any process facility that uses nitric acid and tributyl phosphate, of course, is the red oil issue. And I think it's safe to say that, it's very safe to say I don't understand red oil very well. It may be safe to say that no one

understands red oil very well. We have an operational cure for red oil processes, which is extreme cleanliness, no accumulation of aging mixtures of nitric acid and tributyl phosphate in irradiated circumstances. And we see at facilities such as the MOX facility down at Savannah River site extreme efforts going to assure that you do not have accumulations of nitric acid and tributyl phosphate with irradiated, in an irradiation field.

When we look at this facility, you don't see that emphasis. You know, in the MOX facility, that constituted fully half, maybe more, of their total liquid systems design was avoiding the accumulation of tributyl phosphate and nitric acid in places where it could be irradiated. And you just don't see that emphasis here. Is that distressing to you, or that might not matter or they don't have the problem? What is the situation with red oil?

MS. ADAMS: Does somebody else want to answer that? We did, we asked that question from day one.

MR. BYNUM: So I'm Vann Bynum again. We have engaged both George Vandegrift from Argonne who has extensive experience in both PUREX and UREX and

also the Savannah River folks looking at the red oil problem, and it was their consensus that, given the doses that the TBP and dodecane will receive in our system and the fact that we intend to replace them on an annual basis that we were far beyond the areas where red oil would be formed.

MEMBER POWERS: So we will base our judgment here on an expert opinion.

MR. BYNUM: That's an opinion based on them looking at the history of what is known about red oil formation.

MEMBER POWERS: What is known about red oil is that every time we have an incident, a correction was made in the system that works just fine until you have another incident. That is an absolute fact.

MR. LYNCH: Okay. So do we want to go into the licensing process now, or did you want to use this as an opportunity to take a break? Okay, all right. So what I wanted to highlight here was two processes that we're going through that we haven't seen very often at the NRC, especially in recent years, is we're going through Part 50 with both the construction permit application and an

operating license application. So right now for SHINE, we're considering the construction permit.

Two main components of this were the environmental report and the preliminary safety analysis report. When we get to the operating license stage, there's going to be a lot of things that we'll be looking at that were not part of the construction permit. Some of this is plans for operation, details on how SHINE will respond to emergencies at the facility, technical specifications. We'll have an update to the environmental report and we'll see a physical security plan for the first time.

Right now, our goal is still to complete each of these reviews in 18 to 24 months.

As I mentioned, we're following the Part 50 licensing process for production and utilization facilities. The irradiation units where the target irradiation is performed will be at the utilization facilities, and fission product separation will happen in the production facility.

Also, this will be at the operating license stage most likely. Once material is on site, there will be separate licenses for special nuclear

material, byproduct material, and source material.

And what I wanted to touch on were the specific requirements for construction permits. There aren't a whole lot of them, but they are kind of nuanced, which keeps us on our toes. First of all, SHINE is going to be licensed as a commercial facility under 10 CFR 50.22 or Section 103 of the Atomic Energy Act. This is in contrast to our existing non-power facilities that are licensed under Section 104 of the Atomic Energy Act for research and development.

The primary regulation that we're evaluating SHINE's application against is 50.34(a), which talks about the contents of the preliminary safety analysis report. And the emphasis here is on preliminary. Throughout the regulations, they're really looking for that, you know, first conceptual design of the facility.

The emphasis in 50.34(a) is the regulations want a design basis --

MEMBER POWERS: You used the term "conceptual design." Are you using that formally, or is that just loose language?

MR. LYNCH: That's loose language. What

it does ask for is approximate dimensions. That's the language I believe the regulations actually say. They are looking for approximate dimensions of the design of components.

But what the 50.34(a) is really looking for is having a design basis, principal design criteria, and an identification of those structure systems and components that require additional research and development. That's at the heart of it. The other two big regulations that we're holding their design to are the dose requirements in Part 20.

And after looking at all of these requirements and evaluating their application, we look at, you know, 10 CFR 50.35 which talks about what are the criteria, what does the Commission need to determine to actually issue the construction permit, and I'll talk about that in a little more detail on the next slide.

But the other thing I want to make note of here is there are a number of regulations that don't apply to SHINE that are specific to nuclear power reactors. One of the most significant among these are Appendix A to Part 50, the general design criteria.

So while the general design criteria don't apply to SHINE, what this really means is, you know, we're not prescribing the principal design criteria for this facility. They are still required by 50.34 to have principal design criteria. We are just not enumerating those design criteria for them.

That being said, SHINE has looked at the GDCs and has taken some best practices that they've seen and applied them to their facility.

Also, somewhat significantly, a 10 CFR Part 100, you know, siting and accident dose criteria, do not apply to these facilities. They only apply, the Part 100 only applies to nuclear power reactors in testing facilities. That being said, our standard review plan does cover siting characteristics that we are evaluating against the requirements in Part 20.

So looking at the regulator basis for issuing a construction permit in 50.35, this kind of highlights the main points of 50.34 that I was talking about. When we're going to decide can we issue a construction permit, we have to come to these conclusions: that we've got some principal design criteria, any technical information or design

information that SHINE has said can be left until later. We need to make sure that we agree with that, but they don't need it right now. We look at, you know, did they identify all of the research that needs to be completed and can the facility be constructed without undue risk to the health and safety of the public?

Also significant, 50.35, I didn't put it on the slide, but it is in the regulations that issuing a construction permit does not constitute the NRC signing off on the safety of the facility. That is what is determined at the operating license stage. What we're determining right now is do we have enough information to let SHINE start digging a hole and pouring some concrete, and do we have reasonable assurance that the methodologies that they're applying to the design of the facility will allow the facility to continue to still stand once they do their operating license application?

MEMBER SKILLMAN: Steve, let me interrupt you, please, for a minute. What consideration has been given to 10 CFR 50 Appendix B?

MR. LYNCH: So as far as quality assurance goes, so, again, that's one of those

examples of an appendix that only applies to nuclear power reactors. However, SHINE is required by the regulations to develop a quality assurance plan --

MEMBER SKILLMAN: Just a minute. It applies to more than just power reactors. If you built a centrifuge facility, you would quickly find Part 70 drives you to Appendix B to 10 CFR 50. And so Appendix B has much wider applicability than just a power reactor.

MR. LYNCH: What we've used, we've used ANSI Standard 15.8 for quality assurance, which follows the general outline of Appendix B, and that's what we're evaluating against. And that's similar, it's the same quality assurance standards that we are applying to all non-power reactors. So we're using 50.34, which requires them to have a quality assurance plan, and we use, in our standard review plan we use, I think it's Reg Guide 2.6 and then ANSI Standard 15.8 to evaluate the quality assurance for non-power facilities.

MEMBER SKILLMAN: For the SSCs, Mary talked about, she said not too concerned about the title but she wants to make sure that the devices that are called upon to do safety functions do what

they're supposed to do. Concrete and seismic facility, these facilities are filled with water. They've got to stick together if there's going to be an earthquake. It seems to me that there is an overriding philosophy of quality. If you're going to build a big strong facility that can be subjected to earthquakes, you've got to be able to inspect the concrete you're putting in it to make sure that the concrete is not going to fail.

So how do you know with an ANSI standard you're getting as good as a Part 50 Appendix B structure?

MR. LYNCH: I think the answer to this is we've been using this standard with all the non-power reactors. I don't think we've had an issue to date with that. We do, as far as -- we do have a construction inspection program that we're developing to look at concrete as it's getting poured. And one thing I emphasized because I think the most important thing you can have is a good quality assurance plan when you're doing your design.

So far, NRO has been helping us do the quality assurance review. And to this point, they've been satisfied with the quality assurance standards

that have been applied. We can get someone to come in, get a quality assurance expert to talk in here about everything that they reviewed. Our details on reviewing quality assurance we'll talk about in Chapter 12 in August. But I can get a little bit more information for you, as well, in the meantime.

MEMBER SKILLMAN: Thank you, Steve.

MR. LYNCH: All right. We've talked a lot about this already, so I'm just going to touch on it. Primary standard review plan is NUREG-1537 for non-power reactors, and this was developed in the mid 90s for the existing fleet of research and text reactors. And, honestly, I've been impressed with how well it's held up. We have augmented it with interim staff guidance for specifics on production facilities and aqueous homogeneous reactors, which has incorporated some best practices from NUREG-1520 that we used for reviewing fuel cycle facilities.

Also in our reviews, we are using applicable standards and codes, as well as the engineering judgment of our technical reviewers, to determine what is necessary for construction permit.

One of the challenges that we have had in general has been, you know, what is necessary for

construction permit? We have the regulations that are fairly broad, but there isn't specific guidance for reviewing a construction permit. So a lot of it is we have our operating license, essentially standard review plans, and figuring out where do we draw the line. For me, a lot of it has been I want to see an identification of methodologies. I want SHINE to identify to me in places where they have not finished their design, do they know how to get to the finish line? That's a lot of what I'm looking for.

MEMBER POWERS: When you look at their processes, do you look at it through a lens of systems engineering or do you have some other philosophy that you approach? Because, I mean, what we're dealing with here is first-of-a-kind engineering by a group of individuals that, by their own admission, are inexperienced in this area. And catechisms of systems engendering don't pop out of their presentation. Maybe they're there and just not articulated, which is not a bad idea because it's a fairly arcane language. But do you look at it through that lens?

MR. LYNCH: You know, we are looking for the relationship of how, you know -- this has been a

challenge as far as there's a lot of information as far as how the facility is going to operate that we are deferring until we get a better idea of the processes. But, you know, I have seen in the reviews that we've been doing that with each chapter we've looked at we are looking at the implications on other systems throughout the facility. But a lot of our design philosophy, especially with non-power reactors, is are you going to stay within your dose requirements for both occupational and accident analysis, is your facility designed to prevent radiation release?

Right here, I just wanted to outline all of the chapters that we looked at in NUREG-1537 for our standard review plan. I've highlighted the chapters that we're covering over the next two days. Right now, we're going over Chapter 1. Next, you're going to hear about site characteristics. We're going to talk about nuclear processes in the facility description. We're going to discuss coolant systems, engineered safety features, instrumentation and control, and I'll look at electrical power systems today.

Going forward, when we come back in

August and September, we're going to go over more detail on design of structure systems and components. We'll talk about radiation protection. We'll talk about the accident analysis. Those are some of the big topics that will be coming up when we come back later in the summer.

Just high-level. So, as Mary mentioned, there aren't acceptance criteria for Chapter 1, per se. But there are some general things we look at as we get introduced to the facility. You know, first among those, did SHINE ask for a licensing action that was in line with the Atomic Energy Act and the regulations that we have in 10 CFR. I think, for the most part, we're pretty satisfied that they've done that. We do look at, you know, when you're putting your facility up, does it share equipment with any other facilities? Since this is new construction, there are no other facilities that SHINE will be sharing systems with.

As far as -- we look at comparisons to other technologies. The irradiation units, while there is nothing exactly like them, we do look at, you know, some of our past licensing experience with aqueous homogeneous reactors and looking at what

we've put together in our ISG for that.

Regarding the radioisotope production facility, as we've discussed, the molybdenum purification uranium extraction systems are similar to other facilities around the world. So we are, indeed, looking to those other facilities for comparison.

And as SHINE mentioned, there won't be high-level nuclear waste at the site or spent nuclear fuel, so the Nuclear Waste Policy Act is not applicable.

And just a quick update on where we are with the review. So we're nearing completion of our technical review of the PSAR. We have one outstanding RAI that we're expected to have resolved in July of this year. And Mirela brought this up. The chapters we're presenting on at these meetings today and tomorrow, we have no open items. We've determined that they're technically complete for the purposes of issuing a construction permit, and there are no outstanding RAIs.

And our goal right now is still to complete our safety evaluation report by October of this year.

CHAIRMAN RYAN: Thank you. Are there any questions? All right. Thank you very much.

MR. LYNCH: Thank you.

CHAIRMAN RYAN: And with that, we're scheduled for break at 9:45 to 10:10, so why don't we make it 10:15 to 10:25? 10:25.

(Whereupon, the above-referred to matter went off the record at 10:09 a.m. and resumed at 10:25 a.m.)

CHAIRMAN RYAN: We'll now come to order. I need some guidance on the microphone. Thank you. With that, I'll turn it back to the presenters.

MR. COSTEDIO: I'm Jim Costedio. I'm the licensing manager for SHINE. We just want to make sure -- is Golder on the line? The folks from Golder? Alan Hull.

MS. BANERJEE: There were three people.

CHAIRMAN RYAN: Is it open?

MS. BANERJEE: I ask him to keep it open. Let me go make sure.

CHAIRMAN RYAN: Okay. Thank you. We appreciate it.

(Pause.)

CHAIRMAN RYAN: Is there anyone else from

Golder besides Bill on?

MR. HULL: Yes, this is Alan Hull. I'm on the line.

CHAIRMAN RYAN: Thanks, Alan.

With that, I'll turn the presentation back to the presenters.

MS. KOLB: Good morning. My name is Catherine Kolb. I'm the engineering supervisor for the Radioisotope Production Facility portion of our plants.

I have a degree in chemical engineering from the University of Wisconsin. And prior to joining SHINE, I was an engineer. And then a senior reactor operator at the Byron Generating Station.

To my right are support individuals if you could introduce yourselves?

MR. KRZEWINSKI: Yes. Good morning. I'm Tom Krzewinski with Golder Associates.

MR. PRATER: Good morning. I'm Irwin Prater. I'm with Sargent Lundy out of Chicago.

MS. KOLB: Thanks. So, now I'll be talking about Chapter 2, Site Characteristics. Will be talking about geography and demography; nearby industrial, transportation and military facilities;

meteorology; hydrology and geology, seismology and geotechnical engineering.

This is a map similar to the one that Vann showed earlier. The site is located in the city of Janesville in Rock County, Wisconsin.

If you could go back just a little bit, as you can see, US-51 is about 0.3 miles to the west. The interstates, I-90 and 39, is about two miles to the east. The Rock River is about two miles west and southwest. It kind of curves around the site. And the Southern Wisconsin Regional Airport is across the US-51 from the sites.

The next slide, please. Slide 20. This is a closeup of the facility again. The site boundary is the property line around the perimeter of the site.

It is also the -- it depicts the area directly under the facility operating license and the owner controlled area.

That light green square in the middle is the approximate area where the site will be. That's the geologically characterized area.

And next slide. We're talking about population distribution. The resident and transient

population was estimated within five miles of the SHINE sites.

We used information from the 2010 US Census. And for areas close to the site we used field reconnaissance and aerial photography as well.

The transient populations were estimated based on the typical times people would be present at major employers, schools and other facilities such as medical facilities and lodging and recreational facilities.

And the future population was extrapolated out to 2050 using the 2010 data. And that was based on the comprehensive plans from the cities of Janesville and Beloit for the areas within the city limits. Those are the light yellow areas on the map.

And for the remaining areas, those were based on the Wisconsin Department of Administration. Provides states and county population projections. We used those for the extrapolating of the population.

MEMBER SCHULTZ: Catherine, how far out do those plans go? Do they go out to 2050?

MS. KOLB: Let's see.

MEMBER SCHULTZ: The city plans that you described.

MS. KOLB: The city plan -- do you have my notes? 2030 -- no, we used them out to -- so, I think -- I believe that they went out to 2030 for the sites, but we used them for an additional couple years. But we can check on those details. I don't have that exactly in my notes.

(Pause.)

MS. KOLB: The combined resident and transient population --

MEMBER BLEY: I think somebody has got a mic turned on who's not talking and they're hitting it with paper.

MEMBER STETKAR: The line is open.

MEMBER BLEY: Okay. So, maybe you on the line could mute your phones, unless you're going to talk.

(Pause.)

MS. KOLB: So, the combined resident and transient population, the weighted transient population is 51,000 within five miles of the sites using the 2010 numbers. And it's projected to grow to approximately 80,000 by 2050.

Next slide. We also investigated nearby industrial, transportation and military facilities. In this slide, we have examples of industrial facilities near the sites. There are more than these, but these are some of the ones that had, you know, quantities of chemicals and other things that we analyzed that I'll be talking about later.

There are natural gas pipelines within five miles of the site operated by two companies. There's the Rock River that I mentioned previously.

The highways that we mentioned, there's also several -- there's two Wisconsin state route highways also.

There are three railroads within five miles. There are two airports. The Southern Wisconsin Regional Airport, which we've mentioned before. There's also a Mercy Hospital heliport within five miles. And there are also Federal airways that are within the area of the sites.

Next slide. Okay. We analyzed air traffic and aircraft hazard analysis for the facility. We used the methodology from DOE standard 3014-96, which is an accident analysis for aircraft crash at hazardous facilities, a DOE standard.

We performed the analysis for airways and airports. The only airport that met the screening criteria is the Southern Wisconsin Regional Airport based on the number of flights and the distance, because it is approximately 0.4 miles away.

The other airports on this drawing, on this slide, that is a ten-mile radius circle. So, there are other small, private airports with sporadic operations or low numbers of operations. And those screened out using the criteria in the DOE standard.

MEMBER STETKAR: Catherine.

MS. KOLB: Yes.

MEMBER STETKAR: Can you keep this slide up here for a while?

MS. KOLB: Sure.

MEMBER STETKAR: I'm going to give you a bunch of questions on the aircraft crash analyses, because I've never looked at a facility that was this close to an airport.

MS. KOLB: Okay.

MEMBER STETKAR: And I've done a bunch of aircraft crash analyses. So, why doesn't this diagram that you have show all of the airways? And why does it show V-216 in a different location from

its actual location?

I pulled up the air navigation charts for this area and V-216, for example, does not go to the east-northeast. It goes to the west-southwest from the waypoint.

And there are several other VFR routes or low-altitude IFR routes that converge on the VOR waypoint, which is kind of where the V9-177, V-177 and J-90 should converge.

So, why is this incomplete?

MS. KOLB: Yes, this is --

MR. HENNESSY: I'm Bill Hennessy. I'm the engineering manager for SHINE and I'm going to help Catherine out a little bit on this question.

We noticed also that Victor-216 was coming in from the wrong -- what appeared to be the wrong direction when compared to the current charts that we used.

MEMBER STETKAR: Not appeared. It is from the wrong direction.

MR. HENNESSY: Yeah. I don't know when they did this analysis if it was different. So, we can't answer that. This is, you know, what we have, but -- and there are other VFR routes as well. The

ones that were --

MEMBER STETKAR: There are indeed.

MR. HENNESSY: Pardon?

MEMBER STETKAR: There are indeed.

MR. HENNESSY: Yes.

MEMBER STETKAR: I counted one, two, three, four, five more that aren't shown on this --

MR. HENNESSY: Right.

MEMBER STETKAR: -- chart.

MR. HENNESSY: With respect to airways in the methodology if you have one airway, you might as well have a million, because --

MEMBER STETKAR: Okay. I'll ask about that later. I just want to get the depiction of the facts in the PSR -- PSAR correct.

MR. HENNESSY: Uh-huh.

MEMBER STETKAR: We'll talk about methods later. This is a factual depiction as if these are the only airways and these are their locations, and this is not correct. Thank you.

And for reference, the VOR, the waypoint at the KJVBL VOR is -- if I pulled out my Google Maps and found it in the middle of the field, it's located 5.3 miles south-southwest from the center point of

the intersection of the two main runways at the airport.

So, all of these airways that I'm talking about here, the ones that are shown, V9-177, V-177 and the five others that aren't shown and V-216, the set points of those airways, they converge on that waypoint. So, they are all -- they are all within ten miles of the site.

And you, in the PSAR, say only one airway is within ten miles of the site. So, I'm also curious about that statement.

MS. KOLB: So, the list of the airways in the PSAR, those were based on the center line. And for the actual analysis we -- they assumed that the width of the airway was 9.2 miles. And if any part of the airway was within two miles of the SHINE site, then it was considered a part of -- in the analysis.

So, the PSAR, it is not entirely clear in that section on why that one was --

MEMBER STETKAR: Not one. Several.

MS. KOLB: No, I'm sorry. There are several.

MEMBER STETKAR: Many airways.

MS. KOLB: Yes. There are multiple airways.

MEMBER STETKAR: For example, the missing one -- my point is that you screen out all airways except the -- I think it's the high-altitude jetway J-90, because your assertion is that the boundaries from all of them are greater than five miles from the site.

I believe that's true; is that correct? I'm trying to read my notes and talk at the same time. My point is that the center lines of all of those airways, the center lines are about six miles roughly from the center point of the safety-related buildings. So, it's not clear to me how you can screen out any of them.

MS. KOLB: In the calculation that we did, the --

MEMBER STETKAR: I'm not going to talk about the calculation yet, because I have severe questions about the calculation.

MS. KOLB: Okay.

MEMBER STETKAR: I want to talk about facts, the actual geometry of the site with relationship to the actual airways.

MS. KOLB: We agree with the -- we understand the actual location of the airways. And I -- that section of the PSAR where it's just describing them is incomplete and doesn't have all of them. But when we did the --

MEMBER STETKAR: Okay. But now, and I'll ask the staff about this later, because I didn't see any staff questions about this, so we're trying to judge the acceptability of a facility on a particular site based on preliminary screening analyses that are performed in the PSR, which I don't think will ever be examined later in the final safety analysis report.

So, I'm going to try to understand the bases for the screening analyses that were done as part of this preliminary assessment. Okay.

MS. KOLB: Okay. So, the results of our calculation, which is on this slide, so we did consider airways. We did not screen out airways. We used the methodology in our DOE standard.

MEMBER STETKAR: You screened out -- okay. Here's -- I'm going to interrupt you here because -

MS. KOLB: Okay.

MEMBER STETKAR: -- you're quick to jump to results --

MS. KOLB: Okay.

MEMBER STETKAR: -- and you don't have any presentation on what you did. So, I'm going to -- I'm going to see if I understand what you did.

You used a smoothed, generic continental US aircraft in-flight crash frequency to determine the airways' contributions to this slide; is that correct?

MS. KOLB: That is correct.

MEMBER STETKAR: What is your basis for saying that the aircraft flight densities in the region around this facility can be represented by an average continental US aircraft crash rate, which, for example, includes the desert southwest, it includes the rocky -- the northern tier of the states over which there are very few flights?

If you did that, for example, if you did that, you would say that the same crash frequency applies to the entire northeast corridor of the United States, right?

So, why does it apply to this facility?

MS. KOLB: I don't --

MEMBER STETKAR: Did you look at the aircraft flight densities in these particular air traffic control corridors?

MS. KOLB: No, we did not.

MEMBER STETKAR: Okay.

MS. KOLB: We looked at the -- if there was an airway, any airway within the region of the SHINE sites, then we calculated the airway using the continental US.

We did not do any studies on the density of aircraft in those airways.

MEMBER STETKAR: You used the term "airways." You didn't pay any attention to the airways. You said there's at least one airway that meets the screening criteria. Therefore, for aircraft in-flight crash densities you will use the generic continental US aircraft in-flight flight crash rate in terms of crashes per square mile per year.

So, it didn't have anything to do with airways. Once you said there is at least one airway within the screening distance, you then applied a generic planes-fall-out-of-the-sky-per-square-mile-per-year frequency.

MS. KOLB: We did.

MEMBER STETKAR: Okay. At least I understand what you did. Thank you.

MS. KOLB: So, what we were discussing, that is represented in that Airways row on this slide, on this Slide 25. That is the average continental that we were just discussing.

The Airports row, that is also using the methodology in the DOE 3014-96 standard. And that is for the aircraft at the airport.

So, the risk of an aircraft accident, we used an acceptance criteria of 1E to the -6 per year.

The calculated crash probability for small non-military aircraft did not meet that criterion. Therefore, the safety-related structures of the SHINE facility are designed to withstand the impacts of a small non-military aircraft.

MEMBER STETKAR: Okay. I'm not going to let you off the hook yet.

MS. KOLB: Okay.

MEMBER STETKAR: In Section 2.2.5.1 -- I'm going to keep you on airways for a while, because I haven't started to talk about the airport yet.

You -- let's see. I'll let you off the

hook for that one. Let's get to the airports. You used, as best as I can tell, also generic data for aircraft crashes.

I did a little side calculation and came up with different numbers, but with the ballpark figures in this slide somewhat similar.

On the other hand, you use in your analysis, I believe, commercial air carrier crash rate data for the crash frequencies for air taxis.

In particular, in Section 2.2.5.2 it says the probability of a fatal crash per square mile per aircraft movement -- now, we're talking about aircraft, airplanes -- is provided in Table 2.2-12 where the probabilities for general aviation crashes are applied to the general aviation and local civil operations. And probabilities for air carriers are applied to air carrier and air taxi operations.

If I look at FAA or NTSB crash rate data for carriers that are regulated under 14 CFR 121 or 14 CFR 135, I note that the crash rates at airports or in the area immediately surrounding airports for what they call 14 CFR 135 on-demand carriers, which are indeed air taxis if you look up their definitions, are substantially higher than crash rates for

carriers that are regulated by 14 CFR 121 or what they call 14 CFR 135 scheduled carriers, which are, in their definition, on-demand carriers operating -- I'm sorry -- scheduled carriers of commuter aircraft and scheduled cargo flights.

So, I'm curious why you used the much lower crash rates for air carriers to air taxi operations when the vast majority of at least jet-powered aircraft from the airport are in the generic category that you call air taxis. They're either on-demand business, or -- I don't know if there are any commuter flights out of there. I couldn't find any stiff commercial commuter flights, but the small jet-powered aircraft.

So, why did you use the air carrier crash rates for those air taxis?

MS. KOLB: I don't have the details in front of me right now.

MEMBER STETKAR: Okay. Maybe you can get back to us.

MS. KOLB: I'll have to get back to you on that.

MEMBER STETKAR: Okay.

MS. KOLB: Considering that, so the air

taxis were considered to be small aircraft and they already exceeded our acceptance criteria. So, we -- designed for impact of a small non-military aircraft into the facility.

The large non-military craft, and the military craft sum of those total probabilities were below the 1E to the -6 per year acceptance criteria. So, they meet the acceptance criteria.

MEMBER STETKAR: By the way, what's the basis for the 1E to the -6 acceptance criteria?

Many other areas of the regulations we screen out external hazards based on 1E to the -7 per year screening criteria.

MS. KOLB: The 1E to the -6 per year comes out of the DOE standard that we used.

MEMBER STETKAR: Oh, okay. So, I'll ask the staff about that. Thank you.

MS. KOLB: We'll be moving on to Slide 26 for other events analyzed.

MEMBER STETKAR: No, not yet.

MS. KOLB: Okay.

MEMBER STETKAR: Not yet. I read in the SER that up until 2012 they used to have an air festival at the Janesville Airport where they had the

Thunderbirds and, I don't know, Canadian team and, you know, everything that goes on at an air festival.

And, apparently, in response to an RAI you did some evaluation of the likelihood of crashes during that air festival and concluded that it was bounded by the numbers that are shown in this table; is that correct?

MS. KOLB: That's correct.

MEMBER STETKAR: Okay. You mentioned that the analyses of the safety-related structures use as a design basis crash, a -- let me make sure I get the correct citation here.

(Pause.)

MEMBER STETKAR: This is what happens when you make too many notes. Bear with me for a second.

Used a Bombardier Challenger 605 or a Beechcraft Hawker 400 -- and I think the Hawker has a little bit bigger engine -- for your impact analysis.

Those aircraft strike me as being less massive than an FA-18 flying into the ground during an air show. So, I'm -- or other aircraft that might be participating in an air show.

So, I'm curious why you concluded that the effects of the crash of those types of aircraft doing aerobatics at an air show are bounded by the combined frequency and consequences of the small business jets.

MS. KOLB: So, we selected the Challenger 605. It was -- we contacted the airport and that was the heaviest small aircraft categorization that was based at the Janesville Airport, the Southern Wisconsin Regional Airport.

We also considered all aircraft that paid landing fees from 2008 to 2012 for a selection of that aircraft.

For the response for the potential AirFest, that was based on the number of planes -- we couldn't find any information about the Janesville AirFest because it had been cancelled. So, we used the number of flights -- that's the Rockford AirFest, which is a larger AirFest that was -- a large number of planes. So, the number -- the frequency was bounded by that.

So, they had information about the types of planes that they had on site. Military versus non-military. That's how we determined that was

bounded by the -- so, we used projection into the future based on the FAA terminal area forecast data for the number of flights.

MEMBER STETKAR: I'm sorry. The FAA terminal area forecast --

MS. KOLB: I'm sorry.

MEMBER STETKAR: -- doesn't have anything to do with an air festival.

MS. KOLB: No, it doesn't, but from the number of -- the total number of flights just -- the total number of flights that would be added by having an air show.

MEMBER STETKAR: Catherine.

MS. KOLB: Sorry.

MEMBER STETKAR: The crash frequency during AirFests is not similar to the crash frequency for routine takeoffs and landings from any airport, number one.

Number two, the aircraft that are doing aerobatics or displays during an AirFest are not similar to the aircraft that use the airport routinely.

So, if the crash frequency per operation is higher and the potential consequences of certain

types of aircraft crashes are higher, it's not clear to me how the risk from those crashes is bounded by routine operations at the Janesville Airport.

And I'm asking did you look at actual crash frequencies and damage impacts from the types of aircraft that would typically apply during an air festival.

MS. KOLB: No, we did not do --

MEMBER STETKAR: Okay.

MS. KOLB: -- any mathematical analysis.

MEMBER STETKAR: Thank you.

MS. KOLB: For, I guess, as additional information as part of another RAI response related to AirFest, we cited FAA regulations about aerobatic flights and conducting them in the vicinity of populated areas.

MEMBER STETKAR: When a pilot loses control of his or her aircraft, I suspect that they don't pay a lot of attention to the administrative limits.

So, I know you made that statement somewhere, but it doesn't have a lot to do with crash frequencies or the potential distribution around the airport of those crashes.

MS. KOLB: I would move on to other events, unless we have other aircraft --

MEMBER STETKAR: No, that's good.

MS. KOLB: Okay.

MEMBER STETKAR: Thank you.

MEMBER BLEY: Well, just a little aside.

MS. KOLB: Okay.

MEMBER BLEY: I didn't chase this the way John did, but if I just take a look online at that AirFest, I see the kinds of aircraft they were expecting to be there. And there are some pretty serious --

(Laughter.)

MEMBER STETKAR: Thank you.

MS. KOLB: SHINE also analyzed events from other sources. We analyzed explosions, flammable vapor clouds, toxic chemical releases, fires. And for these events, we also used an acceptance criteria of 1E to the -6 per year.

Next slide. For the explosion and flammable vapor cloud analysis the SHINE safety-related areas are designed to withstand a peak positive overpressure of at least one pound without a loss of function or significant damage.

And the events that were analyzed either resulted in an overpressure of less than one pound, or they met the acceptance criteria of 1E to the -6 per year.

MEMBER POWERS: You can always meet exactly that criterion that you labeled if I just take the explosion small enough or distant enough.

MS. KOLB: The first method we used for screening is that we determined that either the minimum standoff distance for impact at the site was less than the -- or a one pound impact to the site was less than the actual distance of where the chemical or the hazard was located, or we determined that the minimum amount of explosive or final chemical needed to impact the site was less than the actual amount of chemical in that site.

These are based on the Superfund Amendments and Reauthorization Act, Title III, Tier 2 reports that industrial facilities submit for their inventories of chemicals and other things on their sites.

If that deterministic type of screening didn't pass, it would have been from a deterministic point of view greater than a one pound overpressure

at the site, then we applied a probabilistic methodology where because the ones that were close enough were trucks or immobile sources near the site, all the stationary sources offsite were acceptable where they were. So, it was the mobile sources.

For that, we used the probability of a crash and a probability of a spill resulting from a crash and, you know, an explosion resulting from a spill.

All those are based on --

MEMBER POWERS: Well, it seems to me, I mean, I'm looking at your site and I said, gee, this is an agrarian site. It must have just tons of ammonium nitrate and ammonia passing by every day on this facility.

What happens if one of those -- take an ammonium nitrate shipment --

MS. KOLB: The toxic chemicals, that's actually the next slide.

MEMBER POWERS: Ammonium nitrate probably is not a good idea to take a bath in it, but I don't think it's going to kill you.

It's an interesting explosive. Let's put it that way. It's a low-presence explosion. So,

it puts a slow-moving shockwave on your wall for a long time.

MS. KOLB: I don't have the details about the explosive potential of ammonium nitrate with me right now. We'll have to get back to you.

MEMBER POWERS: Okay.

MS. KOLB: The toxic effects of ammonia --

MEMBER POWERS: But do you know anything about the rate of shipment of ammonium nitrate along the roads passing your facility?

I mean, it's an agricultural area. I would just assume that there's a lot of it. Now, I don't know anything about the agriculture of Southern Wisconsin. That's because Dr. Corradini keeps that secret from me.

He says I'm too young to know these things, but I would just assume that it's a pretty frequent transportation of ammonium nitrate.

MS. KOLB: I'll have to look into the details. I don't have that with me. I'll have to get back to you.

MEMBER STETKAR: There's a couple things that -- good lead-in -- that I wanted to follow up

on.

MEMBER POWERS: I've been helping you.

MEMBER STETKAR: You have been.

MEMBER POWERS: I'm sorry.

MEMBER STETKAR: Yeah, I knew you would be.

(Laughter.)

MEMBER STETKAR: With regards to -- a couple questions related to what Dr. Powers was discussing.

In several cases, you concluded that the standoff distance was adequate to provide assurance that the overpressure would not exceed one psi.

I looked at some of those and, for example, gasoline tanker truck explosions on US-51, you concluded that the distance for -- to the site -- by the way, are the distances to the closest safety-related structure, or to the center point of the safety-related little square on the drawing?

MS. KOLB: The closest safety-related.

MEMBER STETKAR: Closest. Okay.

So, if the distance cited is 0.22 miles and you say that the distance for the lower explosive limit is 0.214 miles, which is a 0.006-mile margin or

32 feet, my question is, what uncertainty is there in those calculations to determine that the standoff distance is adequate?

Because in several cases, those margins, to me, seemed rather small compared to the total distance.

MS. KOLB: We did not calculate an uncertainty with the various calculations like a specific calculated uncertainty.

We did use conservative assumptions where we did about -- we used the -- for the, like, flammable clouds, we used non-buoyance clouds.

I mean, I'll have to get back to you on the gasoline truck specifically about what was --

MEMBER STETKAR: I only used that as an example, the other examples that I had, because the problem of raising specific examples is people trap that.

So, onsite chemicals, propane tank, standoff distance based on your deterministic analysis is 107 feet. And the closest building location is 115 feet. That's an eight-foot margin.

The onsite chemicals liquid nitrogen BLEVE had a six-foot margin out of 200 feet. The

natural gas pipeline on the west side of US-51 there had a standoff distance, I believe, of 0.04 miles or 211 feet out of a quarter of a mile.

Those are just examples that I highlighted. So, don't just focus on the gasoline truck.

My question is broader than that is, how confident are you that indeed the calculations, the deterministic calculations that you did account for the actual uncertainties in the process?

MS. KOLB: I guess for the propane truck that you mentioned, that was actually --

MEMBER STETKAR: That's on site.

MS. KOLB: Yeah, the onsite --

MEMBER STETKAR: There's a propane storage tank and the actual forklifts, yeah.

MS. KOLB: For the forklifts. So, that was actually within the boundaries.

MEMBER STETKAR: Right.

MS. KOLB: So, the minimum was -- so, it was closer. So, we used -- for the ones that were closer, we used a probabilistic --

MEMBER STETKAR: Yes, you did.

MS. KOLB: -- analysis.

MEMBER STETKAR: You're a good straight person. So, I'll get to the -- you want to talk about forklifts. I'll talk about forklifts. Let me get to my forklift comment here.

(Pause.)

MEMBER STETKAR: When you talk about the simple probabilistic analysis for the forklifts, you said based on an expected accident rate for the forklifts, the propane tanks can be within 107 feet for an average of one hour a day, approximately 350 hours per year.

So, you have a limit on the amount of time that you can drive a forklift around in proximity to the facilities.

If I back out the frequency from that analysis, it gives me about 1E to the -7 explosive accident per year.

And let me see if I can read my notes here. Oh, which then must mean that the expected accident rate must be about 3E to the -10 accident per hour for propane tank explosions due to forklift accidents, or about one accident in every 380,000 forklift operating years.

That, to me, sounds -- I've heard about

forklifts hitting things and tanks exploding. So, I'm curious where you got the expected accident rate for forklifts from, because it wasn't -- there was no reference provided.

MS. KOLB: So, that was determined in the calculation that we did. And, I'm sorry, I have the calculation with me, but I --

MEMBER STETKAR: Okay.

MS. KOLB: I can get back to you.

MEMBER STETKAR: Okay. I hope I backed out the frequency. If I did something wrong, I hope I backed out the frequency of forklift accidents per forklift operating hour correctly.

If I did something wrong --

MS. KOLB: Okay.

MEMBER STETKAR: -- you'll need to help me there, but I couldn't find any reference for what you characterize as the expected accident rate.

All you do is say based on the expected accident rate for the forklifts, the propane tanks can be within 107 feet for an average of one hour a day. This allows some use of the propane tank forklifts at the production facility building.

And I'm basically curious how you came to

that conclusion.

MS. KOLB: Okay. We can get that.

MEMBER STETKAR: That same kind of -- so that we just kind of stay on track, you do several similar types of analyses where you just say, well, we did a probabilistic analysis. And based on that probabilistic analysis we can have up to 99 allowable shipments of ethylene oxide per year on US-51. We can have 404 allowable shipments per year of propane on US-51. And we can have 53 chlorine tanks -- tank trucks per year on I-90.

I tried. I couldn't figure out how you came up with those numbers, because there's just no -- there's not enough information.

I could infer how you might have come up with the forklift time, but the other ones are just a mystery to me.

It's also in your evaluation of the frequency of shipments on US-51 -- I'm still keying off Dr. Powers here -- US-51, I-90 and the rails, you say you did a survey of the users within five miles of the SHINE facility.

I have no idea why the users within five miles of the SHINE facility would determine the

number of shipments at least on I-90 or the railways that pass through the area.

MS. KOLB: That's correct. So, we use the users within the area for the US-51 shipments.

MEMBER STETKAR: Well --

MS. KOLB: Because that was a local road. And we assumed that if they were going to a place outside of Rock County outside of the five-mile area, they would most likely be using that interstate.

MEMBER STETKAR: Did you look at users in Beloit and in Janesville and the surrounding area further than the five-mile radius from the center of the site for possible users that might use US-51 along that stretch?

MS. KOLB: We had the Tier 2 reports from all of the Beloit and Janesville areas. We looked at those, screened them for large quantities, but we only did the detail analysis for the ones that were located within five miles of the site.

There's a chemical company just outside of five miles. And so, we considered them.

MEMBER STETKAR: I saw that you looked at that, yeah.

To remind you in Section 2.2.1.1.4

regarding highway accidents, in particular, propane, in that section it says, in addition, bounding chemicals that were not identified as being used within five miles of the SHINE facility, but are known to be significantly hazardous, such as hydrogen, were analyzed as potentially traveling on I-90. So, for hydrogen, it looks like you expanded your horizon a bit.

I have a lot of notes here, obviously, and I'm trying to combine a bunch of the notes. So, again, bear with me, if you can, a bit.

(Pause.)

MEMBER STETKAR: For chlorine, you assumed release of one chlorine cylinder from US-51, because you identified city of Janesville and city of Beloit water utilities as using chlorine cylinders of that size.

Why can't a truck crash on US-51 result in failure of more than one cylinder?

MS. KOLB: Using the guidance -- based on the guidance of Reg Guide 1.78 it has guidance to assume the failure of one tank.

MEMBER STETKAR: Do the trucks --

MS. KOLB: One container.

MEMBER STETKAR: Do the trucks and the cylinders know about that guidance?

MS. KOLB: Probably not.

MEMBER STETKAR: Okay.

MS. KOLB: That is the guidance that we used.

MEMBER STETKAR: You concluded that as long as there are less than 53 cargo tanker shipments per year on I-90, you're okay for cargo shipments of chlorine.

And you say without large producers or users of chlorine in the county, there are expected to be fewer than 53 cargo tanker shipments per year.

I-90 is a big road. How do you know if there's less than 53 per year that traverse that section of I-90?

There, you did use a qualitative discussion about users of bulk chlorine within the county to justify your assertion that there's less traffic.

MS. KOLB: For chlorine specifically, we just looked at major chlorine factories and locations in the country. And there were none -- I don't have the details of how far out we looked, but it was, you

know, further than the county.

And that -- so, it was based on an engineering judgment that we didn't have --

MEMBER BLEY: But before John goes, I wanted to back you up to the one about the one --

MEMBER STETKAR: Let me get the last chlorine one in here.

MEMBER BLEY: Oh, I was still on the tanks from before, but go ahead.

MEMBER STETKAR: Let me get the chlorine one in, the last chlorine.

You did look at chlorine releases from tanker trucks on I-90 and concluded that, at least according to your analysis, you'd be okay as long as there were fewer than 53 per year passing the site.

I couldn't find anything where you looked at chlorine releases from rail accidents. And the nearest railway is closer to the site than the highway, than the interstate. And railcars are a lot bigger than tank trucks.

MS. KOLB: For the chlorine release we looked at the stationary source, the Highway 51, a one-ton tank on Interstate 90, 22 tons on Interstate 90. And we did not look at railcars, because the

survey of the people in the area -- I guess I can get back to you. We did not look at railcars.

MEMBER STETKAR: Okay. Thank you. I'm sorry, Dennis. I'm done with chlorine.

MEMBER BLEY: That's all right. It was just the thing about you followed the guidance on the one thing.

The NRC doesn't underwrite your facility. They license it. It's your facility. Did you think is that the reasonable thing and what happens if it's more than one?

Did you consider that at all, or are we just meeting the check boxes as we go down the lessons and requirements?

MS. KOLB: We did consider that.

MEMBER BLEY: You did, did not?

MS. KOLB: We thought about that.

MEMBER BLEY: Yeah.

MS. KOLB: We did some preliminary calculations using that. But for the rates of acceptability for the regulations, we decided to use the guidance.

MEMBER BLEY: Okay. Were you, you know, when you did these calculations, were you alright if

it was more than one, or did you just think it was not likely?

I'm just thinking about the process you go through when you do this stuff.

MS. KOLB: Uh-huh. I do believe that more than one was slightly above -- it was above the -- we used the IDLH, immediately dangerous to life and health, limits for toxicity. For chlorine, that was 10 ppm. And so, more than one was slightly above that, that's correct.

MEMBER BLEY: At your site, yes.

MS. KOLB: Yes.

MEMBER BLEY: At the main control room. Okay.

MEMBER STETKAR: I'm done. I think I've got my point across. I have further comments, but so we don't --

MS. KOLB: The next slide since we're talking about releases. So, we did determine that an ammonia release could exceed the acceptance criteria of 1E to the -6 per year.

The other chemical releases either didn't meet the toxicity limits for the cases that we analyzed, as we just discussed, or they met the

acceptance criteria using the number of trips, as we were discussing previously.

For the closest ammonia release, the evaluation shows that the control room would have sufficient time to ensure the facility was in a safe condition prior to using -- or needing to use PPE.

MEMBER STETKAR: The time is two minutes and 40 seconds, according to your analysis.

MS. KOLB: Uh-huh.

MEMBER STETKAR: From the detection -- what you say is the detection of the release until the time that they reach the IDLH threshold, which is extreme discomfort.

What's your basis -- did you do a feasibility analysis and look at the uncertainties and what the operators need to do to place the -- all eight of the irradiation units in a safe shutdown condition within that two-minute-and-40-second time window?

MS. KOLB: So, the analysis that we -- for what the operators would need to do in that situation, that would be to trip the target solution vessels and that ensures that the target solution is drained to the criticality safe dump tank, that

decay heat from the target solution in that case would be passively removed by conduction through the dump tank, as well as through light water pool, and hydrogen buildup in the system would be controlled by the target solution off-gas, the vessel off-gas system.

And those specific processes will be discussed in Chapter 4, but it's a single action for each IU to trip it. So, we believe that they could be done within the two minutes.

MEMBER STETKAR: You said "we believe." I asked, did you do a feasibility assessment and look at the uncertainties about their ability to accomplish those actions given detection of an ammonia release into the main control room within two minutes and 40 seconds.

MS. KOLB: No.

MEMBER STETKAR: And how is ammonia detected? Just simply by --

MS. KOLB: Smell. Odor.

MEMBER STETKAR: Smell. Okay.

MS. KOLB: No, we haven't done a formal study. That would be part of detail design, a human factor study.

MEMBER STETKAR: Well, but, again, you've screened out ammonia. So, do you go back when you do the FSAR and look at ammonia again? Because you've just screened it out. You said it's irrelevant.

So, you said you're going to do a detailed human factors. I would be glad to see that, but are you going to revisit all of these issues that you screen out in the PSAR when you produce the FSAR?

MS. KOLB: Do you want to address that?

MR. HENNESSY: I was just prompting Catherine that we would ensure that these actions that we described can be done as we've described them in the PSAR.

MEMBER STETKAR: Okay.

MR. HENNESSY: So, if we say we can shut down the facility before the need to put on protective equipment and if we can't do that, we would have to --

MEMBER STETKAR: Okay.

MR. HENNESSY: -- take another approach.

MEMBER STETKAR: I'm glad to hear that. Thank you.

MS. KOLB: Next slide. Finally, we

analyzed fires. We analyzed limiting cases of boiling liquid expanding vapor explosions, pool fires and offsite and onsite gas line jet fires.

And the limiting fires in each case did not cause a significant temperature rise on the surface of the building concretes based on our calculations. And, therefore, they're --

MEMBER STETKAR: Yeah. Pipelines, when you looked at the -- you did a probabilistic analysis for the onsite pipelines, because, you know, obviously the standoff distances doesn't meet your criteria for that.

When you did the probabilistic analysis, you used a -- two conditional probabilities of an explosion given a leak. And the two probabilities that you used was 0.001 probability of an explosion given a one-inch equivalent diameter leak, and 0.005 for a complete rupture of a three-inch pipeline.

I couldn't find -- you didn't cite a reference for those numbers. So, where did those values come from?

MS. KOLB: I don't have the reference on the top of my head, but we can get that.

MEMBER STETKAR: Okay.

MS. KOLB: We'll get back to you.

MEMBER STETKAR: For reference, because I've looked at pipeline explosions, too, I have data from the European gas pipeline incident data group for the years 1970 through 2007 that show ignition and explosion conditional probabilities that are much higher than those values. A factor of anywhere from ten to 50 times higher.

So, that's why I was really curious about where you came up with those values from. So, I'd be happy if you can get back to me and tell me what the source is.

MS. KOLB: Next slide is on meteorology, unless there are any questions about other accidents at the site.

So, the SHINE site is located in south-central Wisconsin between Madison and Rockford, Illinois. Those are the closest first order weather stations.

The site has a humid continental climate with warm summers, snowy winters, humid conditions, large annual temperature ranges and frequent and short duration temperature changes.

The average conditions are -- range from

daily mean highs of 84 degrees Fahrenheit to daily mean lows of nine degrees Fahrenheit.

Annual snowfall ranges from 39 to 50 inches. And the annual mean wind speed ranges from 8.5 to 9.3 miles per hour.

Next slide. We looked at extreme conditions at the site. The hundred-year return period for wind speed is 96.3 miles an hour. The strongest tornado is an F5.

The probable maximum precipitation is -- in 48 hours is 34 inches. And the hundred-year return period snowpack is 30.5 pounds per square foot.

MEMBER STETKAR: A couple of these extreme conditions are incorrect. As best as I can tell for straight line wind blowing although you cite here a 100-year return period of 96.3 miles per hour, that's the extrapolated value from ASCE 7-05.

MS. KOLB: That's correct.

MEMBER STETKAR: But in Chapter 3, I believe you say that the facilities are designed for 90 mile per hour three-second peak wind gusts, which is a 50-year return period; is that correct?

MS. KOLB: No. That section in Chapter

3 is -- I know what one you're talking about. It's a little confusing the way it's written.

MEMBER STETKAR: I didn't read the whole chapter. I just looked for the most likely -- yeah, the most likely --

MS. KOLB: No, the design basis wind speed is the hundred-year return period.

MEMBER STETKAR: Is a hundred. Okay. Thank you. That helps out.

MEMBER BALLINGER: But the strongest tornado is an F5?

MS. KOLB: That's correct.

MEMBER BALLINGER: I've got a feeling that an F5 wind speed is a lot higher than a hundred miles an hour.

MS. KOLB: The wind speed we used is from -- for an F5 is from Reg Guide 1.76. And that was 230 miles per hour. That's discussed more in Chapter 3.

(Pause.)

MS. KOLB: Next slide.

MEMBER BLEY: Catherine, while this is going on, we've seen reference to an integrated assessment.

Are the fires you've described, is that part of the integrated assessment and does that already exist, or is that coming in the future? Because it -- we haven't seen it, and we've just seen reference to it in some of the chapters.

MS. KOLB: Oh, I believe you're referring to our -- so, we had an integrated safety analysis performed.

MEMBER BLEY: Okay.

MS. KOLB: That was when we thought we might be licensed under Part 70. So, we -- but you're using that and we've incorporated that into Chapter 13. So, that will be discussed in Chapter 13.

MEMBER BLEY: 13. Okay.

MS. KOLB: Yes.

MEMBER STETKAR: Before we go to the next slide, in the report when there's a table 2.3-7 that summarizes the tornado history within the area that you used for your data, there are a couple of notable omissions from that table. I couldn't find Rock County, Wisconsin in that table. That being the county where the site is located.

And also you said that you looked at the seven surrounding counties. And I found six of

those, but I didn't find Winnebago County, Illinois in that table. And I couldn't find Marquette County, Wisconsin, which is part of the general region that we used.

So, I was curious why that table in particular excluded the CAPPI that the site is located in, which was sort of curious.

MR. PRATER: Yeah, let me take a look at that. I am certain that we've looked at that.

MEMBER STETKAR: I would hope so.

MR. PRATER: Oh, yeah.

MEMBER STETKAR: I mean, I was trying to look at tornado strike frequencies and see whether there was any anomaly from the seven surrounding counties and Rock County.

MR. PRATER: Yeah.

MEMBER STETKAR: And I could find data in your table for six of the seven surrounding counties and not Rock County, which was sort of curious. So, thanks, if you can figure that out.

(Pause.)

MS. KOLB: All right. So, our slides work again. So, the next slide is extreme temperature conditions at the sites.

The hundred-year return maximum dry-bulb temperature is 104.8 degrees Fahrenheit. That's based on the Rockford station. And the hundred-year return minimum dry-bulb temperature is negative 35.1 degrees Fahrenheit.

MEMBER STETKAR: Okay. So, here again I went and there's a wonderful website that I used, www.wunderground.com, which --

MR. PRATER: Weather Underground.

MEMBER STETKAR: Weather Underground. You're familiar with it.

MR. PRATER: I am.

MEMBER STETKAR: Indeed.

MR. PRATER: It's free.

MEMBER STETKAR: It's free and it compiles historical -- the only problem is you got to download the historical data on, you know, daily or hourly or monthly or yearly. You can't -- I can't get a single thing from -- anyway, data is available there for the Janesville Airport from '73 through the current time.

MR. PRATER: Correct.

MEMBER STETKAR: As most facilities, you know, they're not necessarily all complete. You need

to look at them.

However, I found that at Janesville, there were three days in 2011, which apparently is outside of your database record for this analysis, where the temperature -- the peak temperatures at Janesville were 104, 104 and 105.

MR. PRATER: Okay.

MEMBER STETKAR: The all-time record high temperature for Wisconsin occurred on July -- there was apparently a really hot spell in July 1936.

MR. PRATER: Yes.

MEMBER STETKAR: Wisconsin Dells recorded 114, which is north of the site. And Beloit, which is just south of the site, recorded 110.

So, it's curious to me why the 100-year maximum design basis -- the 100-year maximum dry-bulb temperature is 104.8 rather than something higher.

MR. PRATER: Okay. Let's see. That -- I can address that. That hundred-year maximum dry-bulb, that was based on a time series of hourly data from Rockford.

Rockford is what we call a Class 1, Type 1 station that is manned, observed, quality checked.

You have people there checking the records. We used only those type of stations to extract the 100-year maximum dry-bulbs.

Some of the other stations that you mentioned like Beloit and others, those are co-op stations. Those -- and I am familiar with that from my days at the Weather Service.

The co-op stations take a daily high, daily low and sometimes if the observer is around, they'll take precipitation.

So, it's not the kind of series that I would want to try to construct the 100-year from. So, we use hourly data to extract these.

One reason we used hourly data, too, is we wanted to try to get a coincident wet-bulb.

MEMBER STETKAR: Right.

MR. PRATER: And so, the co-op stations do not have wet-bulbs. And also --

MEMBER BLEY: I'm a little confused. I know we've had higher temperatures than that.

MR. PRATER: Yes.

MEMBER BLEY: I mean, you get a nice mathematical analysis on something, and then you get another piece of information that says --

MR. PRATER: Right.

MEMBER BLEY: -- it's been higher than that in the last hundred years, in the last 50 years, in the last --

MR. PRATER: And also, too, that was the 2011. I believe our period --

MEMBER STETKAR: Janesville was, you know, in Weather Underground, it's only a single degree.

MR. PRATER: Right.

MEMBER STETKAR: So, it listed 105 for July 6, 2011.

MR. PRATER: Yes.

MEMBER STETKAR: Which I think your database period goes up to 2010.

MR. PRATER: Right.

MEMBER STETKAR: So, it was after.

MR. PRATER: Right. Those data would not be then in the time series.

MEMBER STETKAR: Right.

MR. PRATER: Correct.

MEMBER STETKAR: Which is -- I get that.

MR. PRATER: Right.

MEMBER STETKAR: But, again, I went back

to Beloit 110 on July 14th, 1936, and Wisconsin Dells of 114 on July 13th, 1936. And that's less than a hundred years and it's considerably higher than 104.8.

MR. PRATER: I don't --

MEMBER STETKAR: And I didn't look -- by the way, all I looked at was Janesville and I -- and found other sources for these high temperatures for Beloit and Wisconsin Dells.

I did not look at any of the other weather stations surrounding the site to -- it's too onerous for --

MR. PRATER: I understand.

MEMBER STETKAR: -- what they pay me.

MR. PRATER: The Beloit temperature there, 109, I don't have the writeup in front of me, but the 109 sticks in my mind as our actual temperature. And I think that was in 1936 also.

MEMBER STETKAR: It was. It was that same heat wave.

MR. PRATER: Right.

MEMBER STETKAR: July 13-14, 1936.

MR. PRATER: And they're showing 110 in Weather Underground?

MEMBER STETKAR: No, I didn't get that from Weather Underground.

MR. PRATER: Okay.

MEMBER STETKAR: I got that from -- what I did is I didn't want to search through all of the data in Weather Underground for all of the --

MR. PRATER: Yeah, be careful with that site.

MEMBER STETKAR: You have to be careful of every site.

MR. PRATER: Absolutely. Yeah.

MEMBER STETKAR: I know that. So, what I tried to do is very quickly pull up something that gave me the all-time record high for Janesville. I couldn't quickly find that.

MR. PRATER: Yes. That's --

MEMBER STETKAR: I could not quickly find that. So, then I tried to pull up record high temperatures for the State of Wisconsin, which is easy to find. It was Wisconsin Dells.

And at the same area that I was looking on it told me the record high temperature for Beloit. And that was listed as 110 during that same heat wave. So, that's sort of corroboration that it's, you know,

it wasn't way off as an anomaly from, you know, some weather station reporting anomaly.

I'll just --

MR. PRATER: Sure.

MEMBER STETKAR: I'm just saying that when you're characterizing something as a hundred-year maximum and, as Dennis said, when you have evidence that it might not be the hundred-year maximum, ought you not question -- I know what analysis you did. I know why you did what analysis you did, but strikes me that this temperature may not be the estimated 100-year maximum temperature.

And there might be other ways of inferring a coincident wet-bulb temperature with what the maximum is. And, in fact, you had to extrapolate to get the wet-bulb temperature anyway.

MR. PRATER: Right, because co-op stations don't --

MEMBER STETKAR: Right. Right. Okay.

MEMBER BLEY: At a minimum, I think, if you don't adjust the design value, one at least ought to look at what happens if you should get to such temperatures and how you protect against them.

MS. KOLB: The next slide. Slide 33 is

depiction of an annual wind rose from the Southern Wisconsin Regional Airport. As we said, it was located 0.5 miles to the west of the SHINE site.

This data is representative of the SHINE site based on the location of this monitoring station. And we also compared it to annual wind roses from five other regional stations which show overall patterns similar to the Janesville data verifying the representativeness of the wind data.

Next slide. So, as we said, the local data sources for the sites is the airport meteorological monitoring station, which is an automated weather observation station.

The atmospheric stability information was derived from this monitoring station derived from hourly wind speed, ceiling heights, sky covers using -- and the Pasquill stability class was derived using a code from the US EPA.

At the SHINE sites just for explanation, the Stability Class D, which is a neutral stability class, is most frequently encountered 54 percent of the time. Stability Class A, which is an unstable class, is the least frequent type of stability class.

So, the data from the airports, the wind

speed and the derived stability classes were used for our chi over Q and radiological dose calculations in other chapters.

Next slide.

MEMBER POWERS: Say that again, please.

MS. KOLB: Pardon?

MEMBER POWERS: Would you say that again? What stability class did you use?

MS. KOLB: So, for the calculations, the stability class that we used for offsite things affecting the facility, we used a Stability Class F, which is a stable type of stability class, and a one-meter-per-second wind speed. Those occurred like the toxic gas analysis.

That's the five percent worst case --

MEMBER POWERS: Okay.

MS. KOLB: -- five percent annual exceedance probability type of weather at the sites.

For like the radiological dose calculations and for chemical calculations leaving the sites, we used a median. So, that was Stability Class D, which is the most frequent that was up there. And the median wind speed has a typical release. Those are in Chapter -- they'll be at our future ACRS

meeting about releases and populations.

MEMBER BLEY: So, I haven't looked at this in a while, but is the stability class correlated with a particular site with wind direction at all, or is it --

MS. KOLB: No, it's not associated with wind direction. It's based on wind speeds. It's a turbulence kind of measurement.

MEMBER BLEY: Well, I know what it is.

MS. KOLB: Okay.

MEMBER BLEY: But I'm asking if one looks at the wind rose and then looks at the stability classes, is there any actual correlation one sees even though it's not built into the model?

MR. PRATER: It's not something that we've looked at explicitly here.

MEMBER BLEY: I've never looked at it, but I just started wondering about it.

MR. PRATER: Yeah, I'm going to kind of get off on a tangent here not related to Janesville because we're in the Midwest, but if you get to some places, say, near the ocean --

MEMBER BLEY: Yes.

MR. PRATER: -- or something where

there's a land-sea -- and I know I see it in Chicago when the wind comes from the lake and you can see that.

And there, you get -- what you're getting there is essentially a different regime, if you will. Stable air moving in, unstable air moving out.

MEMBER BLEY: Moving out. Okay.

MR. PRATER: But I'm just going to state an opinion here. I think for the Janesville site you probably wouldn't see that, because it's an agricultural area, the Midwest away from --

MEMBER BLEY: Right.

MR. PRATER: -- lakes and --

MEMBER BLEY: Thanks.

MR. PRATER: But you do see that at some sites.

MS. KOLB: Next slide. This talks about the hydrology at the site. For the surface water, the general setting, Rock County is drained entirely by the Rock River and its tributaries.

Rock River is approximately two miles south and southwest of the sites. This is a photo of the NRC during their environmental site audits in August of 2013. They are at the -- it's an unnamed

tributary approximately one mile southeast of the sites.

The ground elevation at the sites currently is 819 to 826 feet per pound water. The topsoil at the site is drained by fine to course-grained sand with occasional gravel layers that extends to depths of 180 to 185 feet below ground.

Groundwater is encountered approximately 60 to 65 feet below ground and it's expected to fluctuate depending on seasonal variations and precipitation.

Withdrawals. The SHINE facility design does not include groundwater withdrawals or injections, and none are planned.

The groundwater flow at the sites, Slide 36, is in the direction of the SHINE -- for the SHINE sites towards the Rock River year round. North-northeast to south-southwest.

Hydraulic conductivity of the sandy layers at the sites were determined by testing four monitoring wells that we drilled at the sites. And we found an average hydraulic conductivity of 0.0045 feet per second.

The next slide is the Rock River flows.

So, the peak historic flow was 16,700 cubic feet per second. And that was in June of 2008.

That particular flooding event had a corresponding flood level of 755, approximately, feet. That corresponds to the predicted hundred-year recurrence interval flow rates with a predicted water surface elevation of 755 to 761 feet.

Even the 500-year recurrence interval is up to 756 to 762 feet, which is all well below the actual site ground elevation of 819 to 826 feet.

Next slide. For -- we also analyzed local intense precipitation. There's the drainage system and the site elevation. The grading on the sites and the elevation determine that -- ensure that the facility is not affected by the probable maximum precipitation runoff from the offsite drainage areas. Other flooding scenarios were analyzed and determined not to be applicable to the sites.

A probable maximum flood was estimated using guidance in Reg Guide 3.40 and 1.59. That would be a river flow of the Rock River of 133,000 cubic feet per second, which would correspond to a Rock River elevation of 774 feet, which is still about 45 feet below the current site elevation.

MEMBER STETKAR: Quick question, Catherine.

MS. KOLB: Go ahead.

MEMBER STETKAR: Those reg guides that you site there, Rev 2 of Reg Guide 1.59 was published in August of 1977, and Rev 1 of Reg Guide 3.40 was published in December '77. So, they're pretty old.

I'm sure you're aware of the flood and hazard reassessments that are being performed for all of the sites in the United States --

MS. KOLB: Yes.

MEMBER STETKAR: -- using up-to-date methods and data. Do you have any plans to revise your external flooding hazard assessment using those methods and data?

Just push your button so that you're on the record there. Thank you.

MR. COSTEDIO: No, we used the regulatory guidance that's been provided.

MEMBER STETKAR: Okay. Thank you. Then I'll ask the staff that.

Regarding the flooding analysis, I noticed that you, I think, did not account for failures of the -- again, bear with me.

The Indian Ford Dam that's upstream from this site, it's called a "dam." It's pretty low profile. I didn't look at -- I looked at pictures of it. It looks like to be five, six, eight feet tall. Something like that. On the other hand, it impounds a fairly sizeable lake.

Do you have any notion of what the peak elevation change would be if that dam went away? Because you assumed that the spillways were operating -- or spillway, singular, is operating, but you didn't look at overtopping or failure of the dam.

MR. KRZEWINSKI: We did consider the dam.

MEMBER STETKAR: Push your microphone.

MR. KRZEWINSKI: I'm sorry.

MEMBER STETKAR: It helps, because we're on the record here and the transcription is based on all the information.

MR. KRZEWINSKI: Yeah. We did consider the Indian River Dam -- the Indian Dam failure. And I don't know is Bill Dershowitz still on the line? He's actually the one that did the calculations.

MR. DERSHOWITZ: I am on the phone. And we did consider dam failure in the calculation.

MEMBER STETKAR: Oh, okay. I must have

missed that, because a few of my notes here seem to indicate that at least what's documented in the PSAR says that you did not look at failure of that dam.

MR. DERSHOWITZ: Well --

MEMBER STETKAR: In combination with, for example, the probable maximum precipitation. So, overtopping or failure as a result of precipitation.

I know you've looked at sunny day failures of dams.

MR. DERSHOWITZ: Yeah, we looked at dam failure at the capacity of the dam.

MEMBER STETKAR: At the capacity. Okay. Okay. That in conjunction with excessive rain flow.

MR. DERSHOWITZ: We looked at single events.

MEMBER STETKAR: Okay. Thank you.

My sense, by the way, because of the relative elevations here, is that flooding of the Rock River, this is my own opinion, is not an issue. It's just for the record of whatever is published in the Safety Analysis Report I'm trying to probe of how much confidence I have in the values that are published in that report and what depth of analysis went in to provide confidence in those values.

MR. KRZEWINSKI: Yeah, it is a very high site with the water tables.

MEMBER STETKAR: Yeah, that's true.

MEMBER SCHULTZ: Catherine, your first bullet under "local intense precipitation" suggests that your site is located high relative to the surrounding area. And that the building locations onsite, because you've got a reasonably large site, are such that the drainage system can be designed to prevent any flood from local intense precipitation.

Is that -- am I assuming that's what you've concluded?

MS. KOLB: That's correct.

MR. PRATER: That's correct.

MEMBER SCHULTZ: Thank you.

MEMBER SKILLMAN: Let me ask this, please: Looking at Slides 37 and 38 as a couple, the 500-year recurrence interval shows a peak discharge of about 19,000 cubic feet a second at an elevation of approximately 762.

Yet in Slide 38, you identify a PMF of almost six times that amount at 133,000 cubic feet a second. Is that product of use of the Reg Guide?

MS. KOLB: Yes.

MEMBER SKILLMAN: Understand. Thank you.

MS. KOLB: The next slide. The hydrogeological characteristics of the sites were evaluated to support the safety analysis.

Any potential releases would migrate along the pathway downward through an unsaturated zone, through the saturated zone and discharge at the Rock River and its tributaries.

This was done, but the site has no plan -- there is, as has been discussed this morning, there is no connection from the RCA to the sanitary sewer. So, it's evaluated.

Next slide will be discussing regional geology. The SHINE region is defined as the area within a 200-mile radius of the site for the purpose of geology.

The capable faults are considered capable of being the source of moderate to large earthquakes in the future.

Only the unidentified faults associated with the Wabash Valley liquefaction features are considered essentially capable faults. They appear to have originated from earthquakes centered in

southern Indiana and Illinois more than 200 miles from the SHINE site.

And the best available science shows that faults mapped within the basement and bedrock within 200 miles of the sites are not capable faults.

And next slide.

MEMBER POWERS: You did not survey the site for sand blows and things like that?

MS. KOLB: For what?

MEMBER POWERS: Sand blows and things like that.

MS. KOLB: Sinkholes?

MEMBER POWERS: Sand blows.

MS. KOLB: I --

MEMBER STETKAR: Sand blows.

MS. KOLB: Can you take that, Tom?

MR. KRZEWINSKI: The site is agricultural. So, it's --

MEMBER POWERS: Well, they might be revealed by the agriculture, but probably destroyed, yeah.

MR. KRZEWINSKI: The water table is 60 to 65 foot down.

MEMBER STETKAR: This is, I think, if I

look at your -- no, keep going. I'll ask it later. Thanks.

MS. KOLB: Okay. The bedrock at the site is greater than 221 feet below ground surface. That was the determination of the geotechnical drilling investigations we did.

And bedrock was not encountered based on geological surveys of Wisconsin. May be as deep as 300 feet below ground surface.

Little or no net deformation beneath the sites over the last 500 million years, as seen based on surveys in general.

The soil at the sites is 10 to 40 inches topsoil of Warsaw and Lorenzo loam. Followed by 180 to 185 feet of fine-to course-grained sand with occasional gravel layers. As followed by 10 to 18 feet of clayey silts. And then sand or silty sand is the remaining down until at least 221 feet below ground.

No other hazards were found on the sites. there's no evidence of karst features. Sinkholes are unlikely due to several hundred feet of sediment. And there's no highly-plastic of swelling clays that were identified.

Next slide. So, for seismology SHINE developed a catalog of historic earthquakes based on the Central Eastern United States - Seismic Source Characterization for Nuclear Facilities.

The largest earthquake identified was a May 1909 expected moment magnitude as units used, and that's characterization 5.15. That was approximately 85 miles southeast of the SHINE sites.

The region has a historic record of relatively infrequent small to moderate earthquakes typical of much of the country.

MEMBER POWERS: You could probably say that of every place.

MS. KOLB: Regional earthquakes have developed Modified Mercalli Intensity values ranging from III to VII within approximately 200 miles.

Maximum felt intensity experienced at the sites in historic times was Intensity V where V is felt by nearly everyone, many awaken, some dishes may break. And a VII is negligible damage in buildings of good design, but considerable damage in poorly built or badly designed structures.

Next slide. As I said, the maximum earthquake in the last 200 years within 200 miles of

the site was the 5.15 event.

The longer term earthquake shaking potential was estimated using the USGS 2008 National Seismic Hazard Model.

And that determined that a 5.8 earthquake is the estimated maximum potential earthquake at the SHINE site.

For vibratory ground motion, that's based on interpolation of the USGS 2008 hazard model. And for seismic design parameters, we use the 2009 International Building Code which for the State of Wisconsin supersedes the Wisconsin Uniform Building Code.

MEMBER STETKAR: Okay. A couple questions on the seismic hazard.

MS. KOLB: Uh-huh.

MEMBER STETKAR: I'll ask the same question I asked about the flooding hazard. I'm sure you're aware that all of the sites in the US are, in fact, have updated their seismic hazard based on the central and eastern US source data, which you indeed did use, but the methodology in particular that's described in NUREG-2115, and you did not use that methodology.

So, are you planning to update the seismic hazard at the site based on the methodology that's currently being used for all other power reactor-licensed facilities?

MS. KOLB: Jim, Tom.

MR. KRZEWINSKI: What was used for the analysis was the applicable codes in Wisconsin.

MEMBER STETKAR: No, I'm not asking about the building codes. I'm asking about the actual seismic hazard where you do the process of characterizing both local sources and regional sources and looking at the ground motion response -- or the transmission from the sources to that particular site according to the methods that are being used for all of the other power reactor sites in the US right now.

MR. COSTEDIO: What are the methods used by all the power reactors?

MEMBER STETKAR: It's NUREG-2115. I'm surprised the staff didn't ask you about this, but --

MR. COSTEDIO: We'll have to look at the NUREG and the --

MS. KOLB: We'll have to get back to you

on that.

(Simultaneous speaking.)

MEMBER STETKAR: The NUREG provides the methodology. They use essentially the same sources in that -- in the 2012 compilation of the sources that was agreed on by USGS and NRC and a variety of other players.

But how you get the ground motion from each of those sources, both point estimate sources and regional sources to the site is, I believe, a different methodology than what you probably used.

MR. KRZEWINSKI: We have Alan Hull who is on the line. He is our seismologist or earthquake expert.

Alan, do you have anything you want to add?

MR. HULL: This is Alan Hull here.

Yes, I am familiar with the --

MEMBER STETKAR: Alan, you dropped off. If you're speaking, undo what you did.

MR. HULL: Okay. Sorry. Can you hear me alright?

MEMBER STETKAR: Right now, yes.

MR. HULL: Okay.

MEMBER BLEY: If you're on speakerphone, maybe you can shift to a regular one.

MR. HULL: Is this any better?

MEMBER STETKAR: So far.

MR. HULL: Yes. Good. Okay.

What you're describing is what we normally describe as a site-specific probabilistic hazard assessment.

MEMBER STETKAR: Yes.

MR. HULL: As you are familiar. And that is routinely done for power reactors, LNG facilities and other mission-critical facilities.

Now, the request from SHINE was to use available data because of the nature of the structures here. It was considered at the time that because of the relatively modest structures then, that they could be designed to use the 2009 International Building Code. So, we at this stage, have provided only 2009 Building Code parameters.

I have reviewed the 2014 USGS upgrade model. And the values for the site interpolated from their map are almost identical to what was in the 2008 model.

MEMBER STETKAR: But I'm not talking

about the USGS 2008 or the 2014 seismic hazard maps, because USGS uses a slightly different methodology.

In particular because this is a facility that will be licensed by the Nuclear Regulatory Commission under 10 CFR Part 50, I am talking about the methods described in NUREG-2115, which are used for evaluating the seismic hazards of all other power reactors in the country, at least the central and eastern United States -- I have to be careful there -- that are licensed under 10 CFR Part 50.

MR. COSTEDIO: That is not our plan to use NUREG-2115.

MEMBER STETKAR: It was not. Okay.

MEMBER BALLINGER: But in your documents you say that you will upgrade and use the current codes and standards in place on the date the construction permit is issued.

MR. COSTEDIO: That's the 2009 International Building Code.

MEMBER BALLINGER: We haven't --

MR. COSTEDIO: If that gets upgraded, then we'll look at it.

MEMBER BALLINGER: Okay. So, you're going to use that building code, not -- okay.

MEMBER STETKAR: But in particular, I mean, we heard that -- I've been interpreting the seismic hazard as a site-specific seismic hazard. Perhaps I'm misinterpreting it. So, I need some clarification on exactly what the seismic hazard should be interpreted as.

When I look at the seismic hazard as it's presented in Table 2.5-5, I notice that the peak ground acceleration at bedrock with an exceedance frequency of 1E to the -4 event per year is about 0.12g.

And if I actually plot the values from that table, I get a straight-line plot on a log-log scale of the seismic hazard, which is kind of similar to what you see from USGS.

Is that seismic hazard that you're presenting in Table 2.5-5 a median? Is it a mean? And what's the uncertainty about the acceleration as a function of return period or however you want to characterize those different phrases?

MR. HULL: They're all mean values.

MEMBER STETKAR: They are means. Okay.

MR. HULL: Yes, because they're all derived from the USGS -- interpolation of the USGS

2008 model.

MEMBER STETKAR: Okay.

MR. HULL: So, the uncertainties associated with each value will be the uncertainties associated with the logic tree developed by the USGS.

MEMBER STETKAR: Right. Right. And they don't publish those uncertainties.

MR. HULL: No, they don't.

MEMBER STETKAR: I'm just making notes here.

(Pause.)

MEMBER STETKAR: Okay. and now we get to the design -- the design basis earthquake for the SHINE site and tell me if I'm going to get into proprietary data here if I say a value. Am I?

MS. KOLB: For the design basis earthquake?

MEMBER STETKAR: For the design basis earthquake in terms of PGA.

MS. KOLB: No, that's not proprietary.

MEMBER STETKAR: Okay. Is 0.05g PGA at bedrock, and then you do a -- the soil extrapolation to get the actual acceleration of the buildings, which determines the structural analysis of the

buildings, that 0.05g PGA bedrock is based on an estimated return period of 2,475 years or a frequency of about 4E to the -4 event per year.

What's the basis for using that return period for the design basis for your site?

MR. HULL: It's based on the maximum considered earthquake included in the 2009 IBC, which uses a 2475-year return period as a maximum considered earthquake, but PGA values are not used.

Actually, the 0.2 second spectral acceleration and one-second spectral acceleration are the values that are interpolated for 2475 years return period and being scaled according to those soil factors. It's not peak ground acceleration.

MEMBER STETKAR: Yeah, I understand, because I didn't try to do the actual ground motion response spectrum analysis. I'm just trying to understand what's the basis for the frequency that you're using.

You said that it comes from the International Building Code design criteria that it's asserted that a frequency of one event in 2,475 years is -- what did you use -- maximum expected?

MR. HULL: Maximum considered.

MEMBER STETKAR: Maximum considered. Okay. Thank you.

MS. KOLB: The last slide in this section is Slide 44. Surface faulting associated with future earthquakes is not expected to affect the SHINE site.

And liquefaction potential was also evaluated qualitatively and quantitatively. Analysis demonstrates that there is no potential for liquefaction to occur within the soils underlying the SHINE site.

And that is the end of the Chapter 2 presentation, unless there are other questions.

CHAIRMAN RYAN: We're going to break for lunch now. Thank you very much. We'll come back at one o'clock.

(Whereupon, the proceedings went off the record at 12:03 p.m. for a lunch recess and went back on the record at 1:03 p.m.)

A-F-T-E-R-N-O-O-N S-E-S-S-I-O-N

1:03 p.m.

CHAIRMAN RYAN: Ladies and gentleman, can we come back in session, please?

MR. LYNCH: All right. So we're going to have our response with Chapter 2 site characteristics. These first couple sites, I am just going to clip through real quick because I don't want to repeat what SHINE was saying, but, you know, this chapter, the general topics were geography, demography, industrial, transportation, military facilities, meteorology, hydrology, geology, seismology, and geotechnical engineering.

SHINE talked about their application, but what I want to start off with is a quick discussion on the regulatory requirements for this chapter.

As I had mentioned in the introduction, the normal siting requirements that we apply to nuclear power reactors in Part 100 of 10 CFR do not apply to this facility, so our siting review is based on, you know, any meteorological events, seismic events, you know, aircraft impact events. We're looking to see that if any of these events occurred, will the facility still be able to meet the

requirements of Part 20?

So the philosophy of our review is a little bit different in that respect, and also in absence of having Part 100 siting criteria to use. For the most part, we're using local building codes for our evaluation of facilities like SHINE, and this is consistent with how we have evaluated all of our existing research reactors.

And Al is going to add a little bit more on that.

MR. ADAMS: I just wanted to add something, and to get a data point, I went back and I looked at the NIST license, you know, application, which was an application that the Committee looked at, and indeed, the major structures at NIST were built to a version of the building code.

Some specific components were built to ASME code, but in general, the facility was built to building code requirements, which is consistent with NUREG-1537, so just, you know, again, I was just looking for a data point.

MR. LYNCH: So with that, I will turn it over to our technical reviewers to discuss the results of their review of SHINE's Chapter 2.

MR. MARSCHKE: My name is Steve Marschke. I work with Sanford Cohen & Associates, a subcontractor --

CHAIRMAN RYAN: Oh, get that microphone.

MR. MARSCHKE: My name is Steve Marschke, and I am with Sanford Cohen & Associates, and we're a subcontractor to ISL as augmenting the NRC staff, and we looked at Chapter 2.

The main thing that we did with Chapter 2 was -- well, these are the five areas: geography and demography, nearby industrial transportation and military facilities, meteorology, geology, seismology, and geotechnical engineering.

I am going to be doing the first three of these topics, and Dave Back to my left over here is going to be doing the last two.

Geography and geology, we -- Catherine discussed this morning and gave a pretty good picture of what's at the site. We verified it primarily by going on Google, something like Google Maps, to look and make sure that we could identify all the waterways, railways, roads, nearest residences, et cetera.

We followed the guidance and made sure

that the section contained all the information required by NUREG-1537 Part 2. We did have a couple RAIs that we asked concerning distances, distances to the site boundary in each direction, we asked for that. We asked for distances to the nearest residence in each direction of the 16 cardinal wind directions just so that we could check out that the nearest resident was also the most critical resident from a dose perspective.

And that's -- that's what we did for Section 2.1. Next slide.

Section 2.2 was the nearby industrial, transportation, and military facilities, and again, we confirmed that with Google Maps, make sure that everything was there. We identified a couple of manufacturers that were not identified in the PSAR. I think it was Simmons Manufacturing was the name of one, and I think there was a second one, but they were in the SER on the map that's in there.

We asked for toxic chemical analysis of the control room habitability was one of the RAIs that we requested, and because the original PSAR did not analyze the access from -- the offsite access impact on control room operators, and so we requested

that they perform that analysis, and they did, and we reviewed the results of their analysis and determined it was satisfactory.

MEMBER STETKAR: Steve or Stephen, either one?

MR. MARSCHKE: Either one is fine by me.

MEMBER STETKAR: In the SER Section 2.1.1.4, and it's mentioned at least one other place that I have here, it says that NUREG-1537 recommends a visit to the site to obtain a better understanding of the physical characteristics of the site and its relationship to the surrounding area.

This site was not visited for this purpose. Did anybody actually go there and kind of wander around the area to confirm things? Because sometimes Google Maps is a little out of date by a few years.

MR. LYNCH: Yeah, actually, I have personally been there. So has Al. We wandered through the corn maze.

MEMBER STETKAR: That's what I wanted to hear, thank you.

MR. LYNCH: Yes.

MEMBER STETKAR: That's good enough.

MEMBER SKILLMAN: Let me build on John's question. What other maps or charts did you use besides Google Maps?

MR. MARSCHKE: We used basically the charts -- well, whenever the PSAR referred us to a chart or a map, we went there, but I did -- top of my head, I cannot recall any additional ones.

MEMBER SKILLMAN: Then I'd like to reinforce John's challenge. I live on a street that doesn't show up on a lot of maps, so for a lot of people, the street is not there, but I can guarantee you mail comes to our mailbox, it's there.

It seems that for an undertaking of this magnitude and this value, there needs to be certification of cartography beyond Google Maps.

MR. MARSCHKE: Okay, noted.

MEMBER SCHULTZ: Stephen, before we move to the next slide, the comment that you have with regard to control room habitability, are you still anticipating additional information from the applicant related to that? There was a comment earlier about what the control room operators would be able to sense before -- and then they would be able to shut down the facility with ample time.

Do you think that issue has been investigated thoroughly enough?

MR. MARSCHKE: Based upon the questions that were asked this morning, I probably will be -- we probably will be getting more information on that subject. That would be my view. But as of the information that we have available at this time, we're not expecting anything -- I wasn't expecting anything when I came in here -- anything more when I came in here this morning --

MEMBER SCHULTZ: Understood, okay. You're going to look further, though.

MR. LYNCH: And part of that is we will investigate further, and we will have to make a determination, is that information necessary to issue a construction permit? You know, we'll re-evaluate the information we have and see if we do need more --

MEMBER SCHULTZ: Thank you.

MR. LYNCH: -- for construction.

MR. MARSCHKE: Okay, if there's no more questions, we can go on to the next slide.

Meteorology is --

MEMBER STETKAR: I'm not really sure who

to ask, but with most things, it seems that the applicant used a screening criterion for hazards of a frequency of 10^-6 per year, and a couple of places, they seem to allude to 10^-7 per year. What's the basis for that 10^-6 per year screening criterion?

MR. MARSCHKE: The basis was the review that the NRC did for the independent storage facility that they were proposed out there. I'm trying to look through here.

The Private Fuel Storage LLC, there was a memorandum and order back on September 9th of 2005 when the Commission determined that 10^-6 was the appropriate threshold probability for aircraft accident crash hazards for the Private Fuel Storage proposed spent fuel storage installation, so that's -- we asked -- we looked at that, and then there is also, as was mentioned this morning, the DOE standard also uses 10^-6 as -- as the cutoff probability.

MEMBER STETKAR: Again, that's DOE, that's not licensed by the NRC, so it's not --

MR. ADAMS: I'll have to go and confirm it, but I believe when we licensed the U.S. Air Force at McClellan Air Force Base that that was the --

MEMBER STETKAR: Okay.

MR. ADAMS: -- that was the criteria we used for their craft there.

MEMBER STETKAR: Okay.

MR. LYNCH: I did check that, it is 10^-6.

MR. ADAMS: Yeah, so that's a research reactor when you -- and now it belongs to the University of California-Davis, but when you jump the back fence, you're literally on what used to be the Air Force Base, which is now a private airport.

So there is a history using NUREG-1537 and -- and this number that has been found acceptable, again, you know, given our graded approach that we used for research reactors, you know, as we step down from power reactors to research reactors, given source terms, given potential releases.

MEMBER REMPE: So I'm not familiar with DOE's standard, but was it a standard meant for DOE facilities on DOE sites?

MR. MARSCHKE: It's meant -- well, the name of the standard is Accident Analysis for Aircraft Crashes Into Hazardous Facilities, and they look at -- and they define hazardous facilities to include not just nuclear-type facilities but also

chemical facilities --

MEMBER REMPE: Facilities on DOE-owned land?

MR. MARSCHKE: DOE-owned, yes, it's a DOE standard, so it would be for DOE sites.

MEMBER REMPE: It's a bit of a difference.

MEMBER POWERS: Well, when you compare it against Idaho.

MEMBER REMPE: Well I was thinking more of Albuquerque area, but yeah.

MEMBER POWERS: Well, you see Albuquerque is very near a metropolitan area, it uses the same one. Brookhaven uses the same one. So I don't know there is a big difference between that and the reactor at UC-Davis.

MR. ADAMS: And that was the NRC's criterion, Davis, and that was also the criteria that the Air Force used when they designed and, you know, sited this facility next to the active runway at McClellan, and what we found is that the -- the nature of the aircraft using the base had, you know, changed when it went from an active Air Force base to a, you know, private airport.

MEMBER STETKAR: What was -- they mentioned the memo that apparently cites that 10^-6, that value?

MR. LYNCH: The memo is CLI-05-19, dated September 9th, 2005, and it's just the memorandum and order in the matter of Private Fuel Storage, LLC.

MEMBER STETKAR: Okay, thank you.

MR. MARSCHKE: We're moving on to meteorology if we can.

Again, we used the same website that was talked about this morning, Weather whatever it was.

PARTICIPANT: Underground.

MR. MARSCHKE: weatherunderground.com, and we did go through the exercise of downloading a year's worth of meteorological data, and we compared that to the data which was presented in the PSAR, and we found it to be consistent, and so that -- that was a major look at the meteorology.

We also checked, there is a snow load -- one of the RAIs that we asked was there was a discrepancy between the snow load that was given in Section 2.3 and that which was used in 3.2. We asked for an explanation as to what the discrepancy was, and the explanation came back that the -- in Section

3.2.2, or 3.2.3, they used the standard methodology for calculating the snow load, and it was conservative relative to the values that were provided in Section 2.3, so --

MEMBER STETKAR: Steve, you said you all downloaded one year's worth of data from Weather --

MR. MARSCHKE: Weather Underground, yes.

MEMBER STETKAR: Only one year?

MR. MARSCHKE: Only one year's, because like you said this morning, you have to do it day-by-day or --

MEMBER STETKAR: Well, you can get one year's worth of data on a -- one year's -- I'm rambling on, you know what you can get.

My point is you didn't download 30 years' worth of data?

MR. MARSCHKE: That's correct.

MEMBER STETKAR: Okay. And why? One year's worth of data, did you use that data primarily to confirm wind rows and stability calculations, but not temperatures and rainfall?

MR. MARSCHKE: That's correct.

MEMBER STETKAR: Okay, thank you. One year's worth of data for that is probably okay, but

for looking for extremes and --

MR. MARSCHKE: Looking for extremes, no, I didn't.

(Pause.)

MEMBER STETKAR: The general rule is five seconds of silence is interpreted as move as fast as you can.

(Laughter.)

MR. BACK: I am David Back with Sanford Cohen & Associates, and I'm a hydrogeologist, and for the hydrology section, our goal, the review criteria were to make sure there was enough information to where what was presented could be independently verified, was one of the key criteria, and then also, there's a criteria to look to make sure that the transport, solid transport risk, could be evaluated if there were release, and we've heard how this is a no-liquid-release facility, so it's very unlikely that that -- that that -- those calculations will ever be needed, but we felt to be complete, they should be included.

Go ahead to the next slide.

And so the RAIs that we submitted focused on making sure that the transport through the

unsaturated zone was properly accounted for, that the groundwater travel times to the nearest surface water body, there were some -- I don't want to say discrepancies, but we did question a few parameter ranges that were used and how they were distributed.

So those were recalculated. We also had a concern that the nearby irrigation wells, they are large-capacity wells, could actually shift the groundwater gradients, and so we asked them to take a closer look at that to make sure that that -- that would not be a concern in terms of knowing where things were going if they were released.

Then we also had an RAI dealing with -- they have four test wells on the facility, and we wanted to know -- get a little more justification on how these wells were located, whether they were optimally placed to detect the leak, and if there were leaks, whether -- I mean, in the back of my mind, I'm thinking, well, they could be used as recovery wells also.

So -- so that -- those were the -- the bases of our RAIs. I felt that they were adequately responded to, and they did a sensitivity analysis on the flow through the unsaturated zone and explained

what the other -- what the other concerns were that we had.

MEMBER STETKAR: Okay, Dave?

MR. BACK: Sure.

MEMBER STETKAR: I know, or I guess I've learned today, that the facility is not connected to the sanitary sewer system or to the storm drains from the City of Janesville, but something highlighted in Section 2.4.4 of the PSAR, it says all water for facility operation is supplied by the City of Janesville public water supply system, so it sounds like maybe there is nothing going out, but there is something coming in.

MR. BACK: The way I understand it is that that water that comes in is connected to the sewer, but nothing within the radiological component is connected, and that's -- that's my understanding, so I mean water -- the water that comes in for sanitation, you know, would clearly be discharged to the sanitation -- sanitary sewer --

MEMBER STETKAR: Okay.

MR. BACK: -- but in the radiological rooms, there is no -- none of the drains are connected, you know, so --

MEMBER STETKAR: Okay, thank you.

MR. BACK: With that, yeah, I'll go on.

Yeah, with the geology and seismology and geotechnical engineering, I am not a seismologist. We had another individual go through the probability calculations and such. However, I am familiar with the RAIs that were presented, and they had to do with -- with -- their definition of potential capable faults and whether there really were more capable faults and how that was all -- how that was all defined in terms of their certainty that the capable faults were not being -- were not being not detected, meaning they were there, but they weren't finding them, and they provided a good explanation for that.

The seismicity was another RAI, had a few -- a few questions on why some earthquakes that were in the USGS database were not included, and that was adequately addressed.

Potential karst, I know going through some of the geological reports independently, Rock County has some karst features in it, and so we ask, you know, provide additional information on their relative certainty that we're not in a karst area and that that was adequately addressed.

And then the liquefaction potential, we didn't see enough information presented on how -- how they came to their conclusions on the liquefaction potential, and so that led to additional information provided which we felt was adequate.

MEMBER POWERS: Can you explain the rationale for non-liquefaction?

MR. BACK: There were a few different aspects to it.

One is that the saturation, the water table is 65 feet below ground, so that, it needs to be saturated before you're going to get liquefaction.

Another aspect was the type -- the soil types that they were -- that they, you know, detected on the site.

I know there were like four criteria. I --

MEMBER POWERS: I mean, they do seem to run through a range of soil types. The lower ones do seem to be liquefiable.

MR. BACK: The more sandy ones?

MEMBER POWERS: Yeah, sandier ones do seem to be liquefiable, and you have this overlying layer of -- it's a bunch of organic junk and clay is

what it is, and then you have a loamy material, and then sand, and it seems to me that the -- without knowing, it would raise questions about liquefaction in my mind.

MR. BACK: And I understand what you're saying. Keep in mind, I am not a geotechnical engineer, but I wanted to make sure, when I reviewed it, I said there is not enough here for a geotechnical engineer to take it to the next step.

MEMBER POWERS: Yeah.

MR. BACK: And so that led to the RAIs, they presented additional information that then fed in, I mean, they provided an updated -- or supplemented their geotech report, and that really, I felt, was my role, just saying we need more here, and then it goes off to a geotech.

MEMBER POWERS: So you got enough to -- I mean, that -- you hit the nail on the head, there's just not enough to assess against anything I know on the liquefaction argument.

MR. BACK: Yeah, well I only knew that there wasn't -- my background stopped at knowing there wasn't enough for geotech to assess.

MEMBER POWERS: You and I are about the

same place then.

MR. BACK: Yes.

MEMBER BLEY: Before you leave this, I have a question and kind of a request. I think Bill Hinze, our consultant on the phone line, maybe did want to contribute something here.

But when John had asked the applicant about using the updated seismicity information, if I recall right, the answer was we don't have to do that because we're using -- we're not a power reactor, and we don't have to use the more recent information.

And I guess for me, I -- that doesn't seem to have anything to do with power reactors or not. If we know more now than we did 20 years ago, and we're -- we are making the power reactors use that, but if I'm coming in with a new submittal, it just would seem to me logical that that ought to be what we use.

So I -- how did you guys look at this?

MR. BACK: Well, I looked at it to my seismologist, who actually looked at it, and I tried -- I actually tried to get a hold of him on the phone to see what the -- what the process was, but all I can say is that I did go through that NUREG, and --

and I have done the kind of preliminary work working with this gentleman as kind of making sure things are there when we do DOE NEPA work, and it -- I mean, I've seen it done a bunch of different ways, and I guess my feeling was, and he did the design work and looked at the -- at the, you know, what they did, and he's done a lot of design work up at Hanford, and that's where he spent 40 years is designing buildings in that seismic environment, and with the low probability of the seismicity, I mean, I don't know whether this is what he would say, but it looked like at that -- if you take that NUREG approach, you're into a whole order of magnitude level of effort above what was done.

And I know that SHINE --

MEMBER BLEY: And given the low seismicity, you think it's just not worth that kind of effort?

MR. BACK: Well, that's -- and you're building the building codes, and you know, it was 5.3 that they built to.

I mean, again, I am not a seismologist, and we'd have to get our seismologist to answer that, but -- .

MS. GAVRILAS: If I may interject for a second, this is Mirela Gavrilas of the staff.

In the context of JLD, the Fukushima Lessons Learned, there is now a SECY paper that's up with the Commission for review, but when we presented the RTR, the RTR was scrutinized too, so we went through an assessment of all the RTRs to see if there are any vulnerabilities that we need to revisit.

And actually, three research and test reactors we are going to have audits of, consistent with Fukushima Lessons Learned, and those are big ones, the NIST reactor, MIT.

At the time, when we talked to the JLD Steering Committee, we commented to them that we're going to look at all the applicants in that same -- through that same prism, so that scrutiny the staff is going to apply once we have a design, because right now we have bits and pieces, but that scrutiny is going to happen.

MEMBER BLEY: Okay. I need a little maybe instruction on construction permit, because we're going to start building a building that's got to meet criteria that we're going to think about sometime later? That has got me a little confused.

MR. LYNCH: I think part of this comes back to given that we have a lack of siting regulatory requirements, our fallback is to go to building codes, and that's what we've used for existing research reactors, so with this recommendation, for the construction permit, since we don't have a final design, we're going to continue using the methodology that we have used for other similar facilities.

Once we have a final design, then we'll take a closer look at it and see if other standards are appropriate.

MEMBER STETKAR: But as I understand the --

MR. HINZE: Am I on?

MEMBER STETKAR: You are, Bill.

MR. HINZE: Am I on?

MEMBER STETKAR: Yes.

MR. HINZE: I don't know whether I'm being heard or not.

MEMBER STETKAR: Yes sir.

MR. HINZE: But it's important for us to understand that the USGS 2014 report uses the -- basically the same probabilistic seismic hazard analysis that is described in NUREG-1.208, and also,

it uses for the ground motion as reported in NUREG-2117, and the --

MEMBER STETKAR: You're breaking --

MR. HINZE: -- 2014 report shows that it is essentially equivalent to the 2008 report, which the applicant has used here.

If I were in the applicant's situation, what I would do is update to the 2014 because that is the most recent, and it also uses the Central Eastern United States Source Characterization data, which is the most recent, and which is also used for the post-Fukushima studies.

MEMBER REMPE: I guess I have a question to your response back about well, we're just going to go to the building code, and then when they have a final design, we'll evaluate it more carefully.

But with the construction permit, aren't they moving forward and making -- and they're authorized to go ahead and construct, and now aren't they going to come back and say well gee, Bruce, you said it was okay?

MR. LYNCH: So this is one of the things that I mentioned earlier, with when we approve a construction permit, per the regulations, we are not

approving the safety of the facility. That comes at final design.

We are saying you have enough to get started on, and a lot of the design of the facility is at the risk of the applicant. If they give us a facility that they have to end up making design changes to later and tearing down, that's at their risk.

They can build a facility that may not be -- that we may not approve operation of, you know. Just because we give you a construction permit, we are not guaranteeing that you will be issued an operating license.

MEMBER REMPE: I mean, that's, I think, a question I'd like to --

MR. ADAMS: However, let me add, I think, we're here to, you know, hear what you have to say and get your good ideas, and this is -- I think this is, you know, this is a message that we've heard, and we will take it back and work on it. I -- you know, I don't see why we would not, so -- .

MR. LYNCH: And actually, there's a good place for us to come revisit this in Chapter 3, which we're not presenting on today, for design of

structures, systems, and components, there was a lot of questions and discussion on the seismological design, so when we come back I believe in August, Chapter 3 is slated in there, we'll make sure we have our seismic expert here, and we can revisit this.

PARTICIPANT: Okay, and I'm glad Bill made the comments he did. I mean, I agree, the amount of work to do using the NUREG is --

MEMBER STETKAR: But let me try something.

PARTICIPANT: Go ahead, John.

MEMBER STETKAR: I want to make sure that I understand what I think I learned this morning.

What I think I learned this morning was that the applicant decided that they would use the International Building Code criteria, which specifies a return period of one event in 2475 years as the quote "maximum considered earthquake." They decided we are going to build to that criterion.

Now, if you then back up, and I'll give you 2115 is perhaps a lot of effort, so I'll give them what they did.

If I then back out, looking at the soil structure -- or the soil structure, whatever

interactions they did, the transmissivity from bedrock up through the soils, if I then back out, a peak ground acceleration at bedrock, at that frequency of one event in 2475 years, that corresponds to a 0.05 g peak ground acceleration at bedrock.

Okay. I got that. I think -- that's my understanding of what I think they did.

And the frequency of that event, according to the hazard analysis, is about 4 x 10^-4 per year, according to their curve, which confirms what I just said.

If I take their curve, based on the analysis of what they did, and extrapolate it out to higher accelerations like frequencies, it's a linear curve, at least over the range that they quantified, if I look at a 10^-5 exceedance frequency, I get up to .55 g at bedrock, which would be much higher up at the site. 10^-6 per year would be well over 1 g, well, well over 1 g because this curve isn't tailing off the way they did it.

Now I come back to my initial quantification -- my initial question. If I'm designing those buildings to a 4E^-4 earthquake, but

I'm screening aircraft crashes and everything else at 10^-6, does that make sense?

Oh see, that's a rhetorical question. It has been a rhetorical question for years. Go on. It's a rhetorical -- if you want to say something, you can, but it was meant to be a rhetorical question.

MR. HINZE: This is Bill Hinze. I have another appointment, and I do have to sign off now.

This is a subject that needs further developing in the classification of the soil at the -- at the site, which is classified as Type D based upon penetrometer data rather than seismic -- shear wave velocity. This needs some revisiting.

MEMBER BLEY: Okay. Hey Bill, thanks. This is Dennis Bley.

Anything you send us of course we will appreciate, and any guidance to help us get ready for the August meeting would be appreciated.

MR. HINZE: Okay.

MR. BACK: Going to the next slide, just quickly going through the end, I mean basically, what we're saying is all those topics we found adequately described and supported that we just went through, so I don't want to -- unless anybody has a comment, I

don't want to take more time going through these.

MR. LYNCH: All right, thank you.

(Pause.)

CHAIRMAN RYAN: Next topic, Chapter 4, yes, thank you.

(Pause.)

CHAIRMAN RYAN: Ladies and gentlemen, welcome. Please proceed.

MR. VAN ABEL: Hello, my name is Eric Van Abel. I'm a nuclear engineer with SHINE Medical Technologies. I am going to be discussing Section 4A of SHINE's PSAR -- Chapter 4.

The -- first off, the blue area here is the irradiation facility, the area surrounded by the blue walls, and the green area is the radioisotope production facility, the RPF.

And the irradiation facility --

MEMBER BROWN: Is that the RPF?

MR. VAN ABEL: Yes, that's correct, and we'll refer to the irradiation facility as the IF.

MEMBER BROWN: Thank you.

MR. VAN ABEL: The A2 sections of the PSAR discuss the radiation facility components like 4A2, and the B side is the RPF systems and components

if you're looking through the PSAR. That's why the A1 sides all say this does not apply to SHINE, because they're heterogeneous reactor portions.

The -- first off, the SHINE irradiation facility consists of an irradiation unit. A single irradiation unit is a subcritical assembly, and then an accelerator, which we call a neutron driver, and then the supporting systems that support that irradiation process.

The supporting systems include the biological shielding. There's a concrete biological shield that's around each IU individually. We'll discuss that in a moment.

There's a light water pool. The subcritical assembly is contained within the light water pool underwater, similar to a trigger reactor.

There is a neutron flux detection system that monitors the power of the subcritical assembly via the flux of neutrons leaving the assembly.

MEMBER REMPE: So I have a question, and I was going to ask it at some point, so let's just do it now.

How are you monitoring the flux? Have you guys gone down to the level where you can tell us

what type of sensors you have?

MR. VAN ABEL: We have preliminarily selected a neutron flux detection system, and that's used at research reactors around the country.

MEMBER REMPE: Fission chambers --

MR. VAN ABEL: I don't remember the exact type, it's the GammaMetrics system from Thermo Fisher.

MEMBER BLEY: Earlier, you or someone else told us that these -- the eight cubicles or rooms where these units are located are separate fire zones. Are they also separate flooding zones in case you get a -- a rupture of a water pipe in there?

MR. VAN ABEL: They are -- I mean, they're filled already with a pool, and there is high-level detection on the pool that would isolate the fill line, the makeup system, should water be delivered from the --

MEMBER BLEY: Is that the only water that comes in?

MR. VAN ABEL: There would be cooling water also for the heat exchangers, so if you have a rupture there, you would have to isolate that cooling water.

MEMBER BLEY: With an automatic system, or that's something -- ?

MR. VAN ABEL: Not currently planned to be automatic.

MEMBER BLEY: They'd see a high-level alarm, and they'd have to start trying to figure out --

MR. VAN ABEL: Have to isolate the -- yeah.

MEMBER BLEY: Okay, but if they don't isolate it, is there a point where it spills over into other parts of the facility?

MR. VAN ABEL: At some point, yes.

MEMBER BLEY: So if the water can spread from one to the other, how are they separate fire zones?

MR. VAN ABEL: The -- well, the water could spread out -- I mean, there's high-level alarms, so we would not expect the water to spread out, but if the water got out of the radiation cell and spread on the floor, I think --

MEMBER BLEY: So are they open on top? I guess I had a little trouble looking at the drawings.

MR. VAN ABEL: There's a shield plug, there's a shield plug approximately five feet thick on the top --

MEMBER BLEY: Okay.

MR. VAN ABEL: -- that's sealing the cell. A lot of things would go wrong if you got the whole cell filled with water.

MEMBER STETKAR: When you say a lot of things would go wrong if you have the whole cell filled with water, what a lot of things would go wrong? And if that's proprietary, we can wait until later.

MR. VAN ABEL: Yeah, the -- you have to have a rupture --

MEMBER STETKAR: No no no, not to get the frequency, we're talking about given the fact that it's filling full of water, what happens if you fill it full of water, right up to the top?

MR. VAN ABEL: If you filled it full of water, first you'd get the level alarms in the primary system and --

MEMBER STETKAR: Right, that doesn't work, go on.

MR. VAN ABEL: Okay. Then the

accelerator certainly would stop working, so it wouldn't work when it's submerged in water --

MEMBER STETKAR: Okay.

MR. VAN ABEL: -- so that would be an indication something else was wrong.

The ventilation would stop working. You'd have problems with the flow in the ventilation system, so you'd have indication that there's --

MEMBER STETKAR: Ventilation is all connected?

MR. VAN ABEL: Yeah, that cell is ventilated, so you'd have problems with ventilation.

MEMBER STETKAR: Okay. All cells are connected through the ventilation system?

MR. VAN ABEL: Yeah, they're individually isolable, so they have isolation dampers on the inlet and outlet of each cell, but --

MEMBER STETKAR: That's PVVS or whatever it is, right?

MR. VAN ABEL: That's RVZ 1, our radiological ventilation system.

MEMBER SKILLMAN: Eric, let me ask this question please.

MR. VAN ABEL: Yes.

MEMBER SKILLMAN: The safeness of this facility seems to lie in the first two sub-bullets, your shielding and your pool. That's your shielding, that's your heat transfer, that's your shutdown mechanism. It provides most of the safety functions that we speak about around this horseshoe week after week.

Describe to us, if you can at this point, the vestment in those concrete cubicles that form the barrier for the shield. Are they just concrete? Are they concrete with a liner? What ensures that this concrete vault is virtually leak-proof?

MR. VAN ABEL: So the concrete, it's reinforced concrete that makes up the walls.

MEMBER SKILLMAN: Approximately how thick?

MR. VAN ABEL: Approximately five to six feet thick, it depends on which wall you're looking at --

MEMBER SKILLMAN: Okay.

MR. VAN ABEL: -- because they're individually designed for shielding purposes.

The pool has a stainless steel liner. Inside, it's welded stainless steel with a leak chase

system behind it to help detect and quantify leakage from the liner.

The walls of the structure are seismically designed for a design basis earthquake, including the hydrodynamic loads that occur from the pool impacting the walls during the event, so there's a lot of rebar in those walls. I don't have the exact numbers off the top of my head, but you know -- .

MEMBER SKILLMAN: Thank you.

MR. VAN ABEL: The TSV off-gas system then connects to this subcritical assembly, and that's the system that manages hydrogen and oxygen production in the assembly, so that's the system that sweeps gas over the top of the assembly, recombines hydrogen and oxygen, and returns it to the vessel, and we'll have a couple slides on that later on. We'll discuss it in a little more detail.

The primary closed loop cooling system is the cooling loop that --

MEMBER POWERS: Swept gas is the -- the swept gas is what?

MR. VAN ABEL: Air.

MEMBER POWERS: Just air.

MR. VAN ABEL: Yes.

The primary closed loop cooling system is providing water flow over the external surfaces of the TSV, so that's cooling the walls of the TSV, and we'll discuss that more in Chapter 5, which is later on today.

And the tritium purification system is supplying tritium to the accelerators, and the accelerators are deuterium-tritium-based accelerators, and so the tritium purification system is supplying the clean tritium to those accelerators, and that system we'll discuss in Chapter 9, which will be at a future meeting.

There's also RPF systems, the radioisotope production facility, there's RPF systems that support the irradiation process such as the ventilation, as we touched on. The cooling water, it's a common cooling system that supplies cooling to the irradiation unit primary system, so there's primary systems, as we'll discuss in Chapter 5, and there's one common secondary system. We'll discuss that.

The electrical system is common between the RPF and IF, and the noble gas removal system takes

the off-gas from that TOGS system, the TSV off-gas system, and at the end of an irradiation cycle, takes it, stores the noble gases for decay prior to release, and that will be discussed in Chapter 9 as well.

MEMBER POWERS: You have 129-iodine in your off-gas?

MR. VAN ABEL: Sorry?

MEMBER POWERS: You've got 129-iodine in your off-gas?

MR. VAN ABEL: Yeah, there will be some 129, 131 obviously with hazard as well, but --

MEMBER POWERS: You take 131 away, the 129 is the gift that keeps on giving.

MR. VAN ABEL: Yes.

The TOGS system has a silver-coated zeolite bed in it to capture iodine. The quantities obviously are very small due to the low power level of the system, gram quantities.

All right. This is a 3-D rendering of the subcritical assembly. I wish it was as easy to build these things as it is to make 3-D renderings these days. They look pretty nice.

But in the center there, I'll point to --

MEMBER STETKAR: Use a mouse because you have to stay close to a microphone so that we pick you up on the transcript.

MR. VAN ABEL: Okay.

MEMBER BLEY: And if you just look down on your screen, it will be the same for us.

MR. VAN ABEL: Okay.

So the central vessel here is the subcritical assembly support structure that we refer to as the SASS. That's the vessel that holds the TSV, which is that target solution vessel, that's the primary vessel holding the solution during irradiation, and the neutron multiplier, those are both internal to this structure.

And if we want to discuss materials of the neutron multiplier, that's proprietary, so we can discuss that maybe at the closed section, if you have any comments on that.

The dump and overflow lines connect directly to the TSV inside of this vessel, so there's two dump lines and two overflow lines, and those directly connect the TSV to the dump tank, and the TSV dump tank is submerged in the light water pool. It's subcritical by geometry for the most reactive

uranium concentration, and it is passively cooled just by the pool.

MEMBER BLEY: Most reactive by design?

MR. VAN ABEL: Most reactive --

MEMBER BLEY: That you expect to have if you operate the way you expect to operate.

MR. VAN ABEL: No no, the most reactive just based on if you look at k-effective versus concentration, you'll find there's a maximum point, and it's at that maximum point which is --

MEMBER BLEY: Ah, okay.

MR. VAN ABEL: -- many times above where we will actually operate, the concentration.

CHAIRMAN RYAN: Back to I-129 for a second --

MR. VAN ABEL: Yeah.

CHAIRMAN RYAN: -- how much material are you talking about in terms of I-129? How much total activity is in the system, or any hints on that?

MR. VAN ABEL: I don't -- I would be guessing at the quantity. We have all the numbers, I would be guessing at the quantities right now.

I mean, gram-wise, it's a very small amount. Activity-wise, it's -- I would have to look

it up. I'd be guessing --

CHAIRMAN RYAN: Don't guess, that's fine, later would be great, but I'm just curious because as you all know, the long half-life of it means that accumulation can become an attention-getter at some point --

MR. VAN ABEL: Yes.

CHAIRMAN RYAN: -- but I'm just curious where you are on that scale.

MR. VAN ABEL: Yeah, we plan -- those zeolite beds were collected over time. We plan to replace those periodically.

CHAIRMAN RYAN: Ah, okay, so just changing the zeolite beds is the way you're going to control it, then I guess you're just going to disposal outlet for the zeolite?

MR. VAN ABEL: Yeah.

CHAIRMAN RYAN: Okay.

MR. VAN ABEL: Yeah.

CHAIRMAN RYAN: Thank you.

MEMBER POWERS: Works great as long as the zeolite doesn't get hot.

CHAIRMAN RYAN: Yes, then it comes right back out again.

MEMBER POWERS: Right.

MEMBER SKILLMAN: I see on this image a valve in the dump and overflow line.

MR. VAN ABEL: Right.

MEMBER SKILLMAN: And that valve is some number of meters underwater.

MR. VAN ABEL: Correct.

MEMBER SKILLMAN: How do you maintain that valve operable?

MR. VAN ABEL: So we haven't done the details on the maintenance operation of that valve yet. We started looking at selecting, you know, what would be ideal valves there, and we're looking primarily at solenoid-operated valves for the purposes of very high pliability.

And, you know, we'll have valve position indicators on them to help us assist in testing them, cycling them, we'll make sure that they're performing their intended function, and we can also monitor the solution drain rate during the draining to ensure that the valve is fully opening, to make sure that its drain rate is the same as we saw at the initial commissioning when we started the facility.

MEMBER SKILLMAN: So if I'm hearing you

accurately, you're saying it's a design detail, we haven't quite worked it out yet, but we're aware of that --

MR. VAN ABEL: Yeah.

MEMBER SKILLMAN: -- requirement for the function?

MR. VAN ABEL: Yes, yes, that will be part of technical specification to ensure that those valves perform the safety function, the opening -- draining the target solution of the design flow rate.

MEMBER SKILLMAN: Okay, thank you.

MEMBER STETKAR: Eric, can you help me on this one -- on this page here, and this one still probably doesn't show it, but maybe you can help me.

As I understand it, the -- I get mixed up with all of the acronyms here, so the -- the LWPS, the pool cooling water system, I think, but I'm not sure, that this charge from that system is somehow into the bottom of the support structure, and it flows up through the central annulus of that support structure and comes out of the top into the pool, is that correct?

MR. VAN ABEL: That's correct, yes, that's correct.

MEMBER STETKAR: Can you show me sort of roughly -- does it come -- does it come in right --

MR. VAN ABEL: It comes in --

MEMBER STETKAR: There's a penetration in the bottom or something?

MR. VAN ABEL: There's a penetration in the bottom.

MEMBER STETKAR: Okay.

MR. VAN ABEL: So there's a central annulus for the PCLS, and it passes through that annulus --

MEMBER STETKAR: Right.

MR. VAN ABEL: -- and into the very center of the --

MEMBER STETKAR: Into the very -- and it flows up through there, comes out through the top?

MR. VAN ABEL: Comes up to the top and disperses into the pool.

MEMBER STETKAR: Into the pool, okay.

MR. VAN ABEL: Correct.

MEMBER STETKAR: Okay. That's sort of what I figured out somehow, but --

MR. VAN ABEL: Yeah. And we didn't show the section view here because it's proprietary, which

is why --

MEMBER STETKAR: Yeah, right, well even the -- but the section view that was in the report didn't quite help me on that flow path.

Okay, thanks.

MR. VAN ABEL: Yes.

All right, next slide.

So some specifics on the TSV and SASS. We plan for the TSV to be an annular vessel, it's structure of Zircaloy-4, so Zircaloy-4, as I'm sure you all know, it's widely used in the nuclear industry as fuel cladding. It has excellent corrosion characteristics under a lot of conditions.

This vessel, this target solution vessel, holds the target solution in a proper geometry during the radiation. It's specifically designed to mate with this neutron source we have from the accelerator to capture as many neutrons as possible from that source.

There's a headspace above the target solution during irradiation, and that headspace allows the radiolytic gases to be released from the solution from bubbling, and then the headspace is swept by the TSV off-gas system during irradiation.

During irradiation, there is no mechanical mixing, so the target solution is inside that vessel. There's no mechanical mixing inside the vessel. The primary water outside the vessel is being forced through forced convection, but the target solution inside the vessel is just undergoing natural circulation, and the bubbles being produced also aid in circulation of the solution.

MEMBER REMPE: So this is where I was curious about how much margin was in the design, because it just seems that there would be a lot of uncertainty in relying on natural convection, and how can you conservatively guarantee you've got some margin in your analysis with all the uncertainties?

Can you give us some insights? Or maybe you have more details later in your presentation, because I didn't look at it in advance, but when I was looking at this Chapter 4 documentation and the staff's review, it seemed like that there would be a lot of uncertainty in --

MR. VAN ABEL: Yeah, and there is a little more in here, we can touch on that a little later.

The natural convection -- well, first of

all, the safety analysis we plan to do for the FSAR is planned to be done with correlation-based heat transfer, so --

MEMBER REMPE: And you have experiments that will give you confidence in your assumptions?

MR. VAN ABEL: Yeah, there's -- there's historical experiments, people have done all sorts of interesting experiments in the thermal-hydraulic realm, and quite a few with cooled walls and internal heating. Some people have even tried more exotic things such as joule heating of the solution, and that would be -- we looked at a historical data set, and then we worked with the University of Wisconsin-Madison, and they built an experimental setup with the same aspect ratio as a section of the TSV with the cold walls, and they injected gas into it, and we measured that heat transfer coefficient there and have correlation data from that.

And then we modeled these experiments, historical experiments, and the UW experiment as well, with CFD codes and confirmed that you can very accurately reproduce --

MEMBER POWERS: It is, of course, that we discount totally the UW stuff.

MEMBER REMPE: I'm sorry, I couldn't hear you Dana?

MEMBER POWERS: We discount totally the UW stuff.

MR. VAN ABEL: Yeah.

MEMBER REMPE: That's true, but even if we gave the UW experiments some credit, they have to assume something for their gas injection rates, and what's the -- how do I know -- I mean, if they've done a bunch of different possibilities with gas injection rates and they got something that you could come up with a bounding value and then you use that, I'd believe it, but I haven't seen the details.

And I realize you're only at, you know, the PSAR stage, but when you go to the final design, I'd really want to know that you had a good basis for a lot of these injection rates, that you've bounded all possible considerations. If you had some precipitation, I mean I am not sure I believe it's well-mixed, and what happens if it's not so well-mixed? Those are the kind of questions I'd be wanting to ask.

MEMBER POWERS: I'm willing to bet that this is pretty well-mixed.

MEMBER REMPE: I'd want to know for sure, and I just want to know how well the --

MEMBER POWERS: I think you can count on it.

MR. VAN ABEL: In terms of the generation rate, the amount of radiolytic gas produced, there were a number of experiments done in the '50s and '60s that were very well-documented that captured the generation rates of hydrogen and oxygen under fissioning uranium uranyl sulfate solutions, and we've looked at that data and bounded that with some uncertainty of the value on top of the data.

MEMBER REMPE: And so when you say "some uncertainty," 10 percent, 15 percent?

MR. VAN ABEL: I think it's 15 percent was --

MEMBER REMPE: 15.

MR. VAN ABEL: Yeah, based on the scattering of the data, and then we're also looking -- it's a function of uranium concentration as well, so the uranium concentration affects the generation rates.

MEMBER REMPE: And so then if it's not uniformly mixed, then that concentration gradient, is

there some issues that one needs to think about, localized effects?

I don't know. I mean, maybe you have looked at it all Dana, but I am not sure. I didn't have --

MEMBER POWERS: Well, it's curious, he was mentioning there were a lot of experiments done up at Los Alamos on these systems, and they're -- I mean, they weren't looking at exactly this system, but they have the advantage of it's a homogeneous solution, so concentration gradients are really small on this, especially the size scale that they've got here.

I mean, it's not like they're trying to irradiate a swimming pool.

MEMBER REMPE: Okay.

MEMBER POWERS: And so those kinds of things, I don't think I'd worry too much about.

I did have one question. You're generating 14 MeV neutrons as your source. What's the energy by the time it hits that solution?

MR. VAN ABEL: So there's a -- I'm not sure if I can talk about this. Could we -- there's a gradient there, and --

MEMBER POWERS: Yeah, we can -- we can definitely defer that to a better time to talk about it.

MR. VAN ABEL: Yeah, if we could do that during the closed session --

MEMBER POWERS: It may not even be pertinent to talk about it now, but eventually. It's just an item of curiosity, it's not terribly important.

And do -- and of course, this gets some reactivity transience in this system, especially at startup, right?

MR. VAN ABEL: Yeah, yeah. And we'll talk about those a little bit in this presentation, and we'll also talk about startup accidents in Chapter 13.

All right. Next slide.

Okay. So the target solution is drained from the TSV via gravity. It's drained into a dump tank, I mentioned before. The dump tank's criticality-safe by geometry and passively cooled.

There's two redundant dump lines. Either one functioning can dump the solution at the full required flow rate, and they are both fail open

dump valves, so either one losing power would also cause it to open and dump the solution.

MEMBER SKILLMAN: Eric, would you describe this feature of the TSV, your scram system?

MR. VAN ABEL: Yeah, it's the equivalent of a trip for a scram system.

MEMBER SKILLMAN: So let me pull the thread just a little bit further. So the scram system really depends on two valves whose design is not yet chosen, and they're underwater, and at this point one might say to you, how do you maintain those operable? So I'm just observing. As our Chairman had said, we are individual members in the subcommittee. If this is your scram system, you're depending upon valves that are not accessible to perform a safety function, and so the burden is on you to ensure that those valves are mighty good for that important function.

You're also on the hook to make sure that those lines are clear and there's no impediment to getting that solution into that criticality safe tank which is a hoop. Okay, thank you.

MR. VAN ABEL: The SASS surrounds the TSV then. That's the outer vessel that we saw in the

picture before. That's to be constructed of 316L stainless steel. That's a pressure vessel similar to the TSV. And both the TSV and SASS are designed for the maximum

(Simultaneous speaking.)

MEMBER POWERS: How much activation do you get in the stainless steel?

MR. VAN ABEL: I'm sorry?

MEMBER POWERS: How much activation do you get in the stainless steel?

MR. VAN ABEL: I don't have numbers. It will be quite activated.

MEMBER POWERS: It ought to be real toasty.

MR. VAN ABEL: It'll be real reactor components, you know, in the core, and I've seen those -

(Simultaneous speaking)

MEMBER POWERS: It ought to be real toasty and it's nasty, nasty isotopes too.

MR. VAN ABEL: So I think there was a request before to define credible, you know, how it's credibly used if we discuss it at all. So this maximum credible deflagration pressure was not used

as a quantitative evaluation, it was based on engineering judgment. We performed an integrated safety analysis of the systems, and evaluated what potential failures there could be of the system.

MEMBER BLEY: But it must mean something to you as an engineer. Does it mean it can't happen? Does it mean it's, you know, one point in a thousand times it wouldn't happen? Does it mean it's sort of unlikely? Does it mean?

MR. VAN ABEL: Do you want my personal opinion or -

MEMBER BLEY: Well -

MR. VAN ABEL: As used in this design.

MEMBER BLEY: As used in this design, what the heck's it mean?

MR. VAN ABEL: It means -

MEMBER BLEY: If it means it can't happen, that's fine and dandy. If it means something else, it would be good to tell what it means.

MR. VAN ABEL: Based on the laws of physics and the knowledge of the system, it's not going to happen is what it was intended -

MEMBER REMPE: So sometimes in the DOE world we'll say you don't have to assume more than

two failures. Did you - I mean, you didn't do any sort of reliability evaluation, so did you assume one failure, two failures in a system, or -

MR. VAN ABEL: So, the system is built on single failure methodology of active components. So the safety-related components have to function in an event, and one of them is assumed to have a random failure at the same time. No non-safety components are required to function in an accident scenario.

MEMBER POWERS: You, in your criticality safety is not single failure, is it? I mean, don't you have - have to have two independent -

MR. VAN ABEL: Double contingency -

MEMBER POWERS: Double contingencies.

MR. VAN ABEL: - for criticality safety.

MEMBER POWERS: For criticality you used double contingency?

MR. VAN ABEL: For the radioisotope production facility. All right, the primary system then and the primary system for us is the TSV, the TSV off-gas system and the dump tank, which are all of the systems that are interconnected during irradiation. Those - that system operates subatmospheric during operation during

operation to minimize any leakage of gases should there be any.

MEMBER POWERS: Well, there's always leakage in any system. What do you test this thing for? You fabricate it, you install it, and then you test it for some sort of leak, radon? What do you test it for?

MR. VAN ABEL: Yeah, we don't have specific numbers.

MEMBER POWERS: You've done them.

MR. VAN ABEL: Yeah, for -

MEMBER POWERS: But something can get into the minus-6 cubic centimeters per second or something like that?

MR. VAN ABEL: Yeah, we don't have those specific criteria. So right above -

MEMBER POWERS: So now after having spent a year using this facility irradiating like that, what kind of degradation and natural leakage rate do you expect in the system?

MR. VAN ABEL: Essentially very little to none. They're all metal components, metal sealed components, welded joints wherever possible, very few non-welded joints connecting this primary system,

just where we need them for such things as to inspect the port. We have inspection capabilities to go in the vessel and see inside the vessel.

Right above the subcritical assembly, which is the area in red that we discussed before, is the accelerator which we call the neutron driver. There's one accelerator per IU cell. It's all contained within this concrete vault. So there's eight accelerators and eight subcritical assemblies.

It's an electrostatic accelerator with a gas target chamber, so it accelerates deuterons. It creates deuterium ions and accelerates those into a tritium or deuterium gas target. The deuterium gas target produces much lower neutron output than the tritium gas targets.

DD reaction cross-sections are smaller and the DT reaction generates 14 MeV neutrons that then radiate outward in all directions from that target chamber which is in the center of the SASS. They go through the neutron multiplier. They're multiplied there and they go into the subcritical assembly and multiply further there through subcritical multiplication.

MEMBER STETKAR: Eric, if I had a

question about restart duty cycles on the neutron driver, is that proprietary or not?

MR. VAN ABEL: I don't think so.

MEMBER STETKAR: Okay, because I didn't - I excerpted a quote from the PSAR, but I don't know whether it was bracketed or not. Table 4a 231 says that the neutron driver adequately recovers and restarts from any NDAS interrupt lasting less than ten seconds.

If the interrupt is longer than ten seconds, it's automatically shut down. Ten seconds is kind of a - and again, if this gets proprietary, just stop and we'll, you know. Ten seconds is kind of a - it's a time, and I was wondering what the basis for that was? Why did you pick ten seconds?

And have you thought about what happens if the thing restarts in the middle of some transient going on that you haven't thought about and so it sends, you know, a lot more reactivity into the system?

MR. VAN ABEL: So I think there are a couple questions there. The ten seconds, so that's based on the cool down rate for the TSV. So when the accelerator is off, if we're sitting there running at

a steady state at high temperatures, we have a very depressed reactivity from where we started.

And if the accelerator shuts off, the TSV starts to cool down, which will half the activity through the system. And the ten seconds is based off the thermal time constant of the TSV. It's very conservative right now, and the design parameter that we've given Phoenix Nuclear Labs, who is the manufacturer of the accelerator, to have that automatic restart capability in there.

The actual temperature change in the TSV in that time period is very small. It wouldn't add a significant amount of activity, but it was our conservative design parameter to get -

MEMBER STETKAR: But you looked only at cool down rate on the TSV -

MR. VAN ABEL: That's the basis of it.

MEMBER STETKAR: That was the criterion? Okay, that's what I was looking for. I'm not sure what I'm going to do with that, but thanks.

MR. VAN ABEL: There was a second question which is escaping me now.

MEMBER STETKAR: I don't remember. He told me what the basis was, so I need to think about

what was the next one.

MR. VAN ABEL: All right, the neutron driver during operation it's accelerating deuterium, deuteron ions, into the tritium target chamber, so it's constantly mixing those two gases together. The flow rate is very low obviously as you can imagine.

An ion beam doesn't deliver much mass per unit of time, but it does mix those gases together. And if we just let it continue to operate like that, the pipe chamber gases would become mixed and the output of the accelerator would slowly decrease.

So we have a tritium purification system in the facility that takes off that mixed gas, separates it out using the TCAP technology from Savannah River, and returns purified tritium back to the accelerators.

So the actual output of the accelerator is then controlled by adjusting the tritium flow rate into the target chamber, so you can vary it between a deuterium target chamber and tritium to slowly ramp up the system at startup, so you don't turn on the accelerator at full rate when you just startup, so you can ramp it up.

And the neutron driver itself performs no

safety function. There's no safety function required of the driver. We isolate power. We have safety-related breakers upstream of the neutron driver.

But when we need to shut it off, we open those breakers and cut off its high voltage power supply so it can't physically accelerate ions anymore. That's our safety control of it. Next slide.

The biological shielding surrounds then the IU cell as we discussed a little bit before. It also surrounds the TSV off-gas system shield itself which we'll touch on in a moment.

But there is significant shielding around those components. As you can imagine, those components have radioactive fission product gases in them so there is significant shielding around them as well.

The design is to - for any normally occupied areas of the facility is to have the dose rates less than a quarter millirem per hour for those areas, which over an eight-hour day, you know, 250 work days a year, results in one-tenth of the NRC's dose limit to workers at five millirem which results in 500 milli, so that's the basis of that number.

Throughout around the whole IU cell, our current calculated dose rates are less than one millirem. There are some areas that are not normally accessible to personnel. When people wouldn't normally be present there, it's slightly higher.

The lower portion of the IU cell, the actual structural wall, the walls are the structural walls of the light water pool. And the IU cell and the TOGS shielded cell are also part of the confinement boundary that isolates, as we'll discuss in chapter six tomorrow, that isolates and contains radioactive materials should they be released. Next slide.

All right, the subcritical assembly then is an aqueous fissile solution system. It's a homogeneous uranyl sulfate solution inside the TSV. This is different than a traditional reactor.

A tradition reactor, as you all know, they load excess reactivity into the core and the suppress it with some means, either control rods or boron, suppress the core to hold it at critical when they want to run.

We never compiled enough fissile material to get up there. We keep the system subcritical at

all times, so we don't load excess reactivity into the system.

We load the reactivity that we do load in mode one, which is our startup mode. Mode two is the irradiation mode when we turn the neutron driver on, and mode three is the post irradiation mode where we open up the dump valves and let the solution decay in the dump tank in the pool before we transfer it over to the RPF.

MEMBER POWERS: You've designed this solution chamber so that you're always - you have like a five percent margin for criticality.

MR. VAN ABEL: Five percent by volume.

MEMBER POWERS: Okay, so your flaw or your potential failure in this system is if in fact you were to coat the inner walls with hexavalent uranium. That would put you over the - potentially put you over the criticality limit on it.

So the trick to running to this thing in a subcritical fashion is to make sure you never accumulate any coating of hexavalent or tetravalent uranium. Do I understand that correctly?

MR. VAN ABEL: So when we startup each time, and I'll talk about that a little bit in the

next slide, but when we startup each time we're going through a 1 over M startup process. It's very similar to what a reactor would go through in its startup process.

And reactivity changes due to the presence of other fissile material that we wouldn't expect to be visible very clearly in that 1 over M curve if it's a significant amount that had coated the walls. Uranium concentration errors would also be visible. The shape of that 1 over M curve would be very different and you wouldn't - your target multiplication factor wouldn't fall in the volume range that you would expect, the long range that it will have as an acceptable fill height for the TSV.

MEMBER POWERS: So your neutron flux detection system is really quite crucial here.

MR. VAN ABEL: Yes, it's important for that. All right, and in the next slide we'll go through each of these modes individually.

MEMBER BLEY: Is that process that you just talked through with Dana, is that automated or is this all under manual operator control?

MR. VAN ABEL: So the startup process

itself is being done with operators present.

MEMBER BLEY: Present? Do they push a button that says "go" and they monitor it or are they actually controlling flows and all of that?

MR. VAN ABEL: We don't have the details of how much individual control they have, you know, how much - do they dial in exactly three liters or do they dial in three liters and the computer translates that to volume and then they push go.

I mean, they'll be present and initiating each of the deliveries of fissile material any time you would increase your activity.

MEMBER BLEY: Are they the control that prevents you from going too far, or is that automated?

MR. VAN ABEL: So they - the control - the operators will be there to shut it down should something they see be out of line, but the protection to stop from going critical is based on high neutron flux in the source range.

MEMBER BLEY: Okay.

MR. VAN ABEL: So if you get to a too high multiplication factor, you'll hit your high flux trip set points and shut it down, and then you can drain the solution much faster than you can fill it. The

fill rates are very slow and limited in this design. It's one of the safety features.

MEMBER BLEY: And you're on scale, as soon as you start up the neutron generator you're on scale reading?

MR. VAN ABEL: Yeah, that will transition to the high range in the flux detectors.

MEMBER BLEY: Okay.

MR. VAN ABEL: So in the soft range it will be a - maybe I should clarify that. During the startup, during the 1 over M process, we're not using the neutron driver -

MEMBER BLEY: Okay.

MR. VAN ABEL: - as the neutron source. We have a built-in -

MEMBER BLEY: So you're just watching the subcritical multiplication from where it's built-in?

MR. VAN ABEL: Built-in neutron source as well.

MEMBER BLEY: Built-in neutron source, yeah, okay.

MEMBER REMPE: You mentioned or the documentation mentioned that there's some sort of level detector. Do you know what type of

instrumentation it will use for level detection?

MR. VAN ABEL: We're planning on using differential pressure right now across the TSV. So we have multiple locations that tap into differential pressure information there. We have the dump lines going out. We have the TSV off-gas lines coming in, so we can tap into differential pressure.

MEMBER STETKAR: What the operators dial in though depends on the uranium concentration in the feed solution and the temperature of the feed solution for that particular batch, right?

MR. VAN ABEL: Yes, the temperature does affect the 1 over M curve certainly, and the temperature will be within some allowable range, and the uranium concentration will be within some allowable range as well. They're not going to start it up with a grossly different uranium concentration than we expect them to.

MEMBER STETKAR: They're not supposed to start it up -

MR. VAN ABEL: Yeah.

MEMBER STETKAR: - is my point. They're not supposed to do a lot of things, but occasionally people do things that they're not supposed to do. So

what we're trying to do is probe on how much this five percent by volume margin depends on human, either directly controlled, or human input parameters to an automatic controls system.

MR. VAN ABEL: The five percent is the nominal level that we start at for normal startup, and there will be some trip criteria above that that's set based on the high flux trip set point, and that will -

MEMBER STETKAR: But ultimately it does come back to the high flux trip set point regardless of what the operators dial in?

MR. VAN ABEL: Yeah, it will trip it before it reaches critical.

MEMBER STETKAR: Okay.

MEMBER BLEY: Let me ask you something completely different for a sec. You were talking sometime earlier about where you get high activation. I've been to some facilities, processing facilities, that when they know they're going to have things that because of activation would be difficult to maintain, have gone to essentially almost maintenance free kinds of equipment like bubblers to measure level, like abductor kind of pumps to pump fluid so that you don't have moving parts that you'll eventually have

to replace and have to try to do maintenance in high fields.

Are there going to be substantial activation fields where people are going to have to do maintenance on this thing? It kinds of sounds like there will be. And how much thought have you given to how you do maintenance once you get this thing running?

MR. VAN ABEL: There will be some maintenance of the high rad shields. The goal is to keep as much out of that system as possible, keep as many - you know, keep the minimum number of essentials and equipment necessary in that system.

You know, like the pressure detection for level, we can transmit that pressure information outside. We can use sensing lines and such.

MEMBER BLEY: So you'll just have the taps inside?

MR. VAN ABEL: Yeah, just have the taps. So there will be a very minimum number of components that actually would need service in that high rad field. The light water pool is there obviously to help perform maintenance so you can do some maintenance with long-handled tools through the pool.

But there's not much in the TSV. The TSV is -

MEMBER BLEY: I'm sorry, I'm grinning because I'm just thinking long-handled tools, boy, the designers ought to have to do something with that maintenance, but go ahead.

MR. VAN ABEL: Yeah, there's not much actually in the subcritical assembly. There's very little there. But there will be some minimal amount of maintenance and inspections will need to occur on the TSV.

So the beginning of the startup mode, we have the target solution. One batch of target solution stays in the target solution hold tank. So there's an individual target solution hold tank for each irradiation unit. So we have eight unique target solution hold tanks all matched up with their respective irradiation unit.

That hold tank is at a lower elevation than the TSV to preclude gravity-driven filling should there be any valve leakage. And the uranium concentration and other parameters, such as PH, are measured in that hold tank prior to being - prior to that solution being delivered to the TSV.

MEMBER REMPE: So is the uranium

concentration uniform in the hold tank, and how do you know it is uniform there?

MR. VAN ABEL: It will be - so it will be in solution form by the time it gets there. We don't do any dissolution or anything in that tank. It's delivered as a solution.

It's floated from our target solution prep area or from our recirc area, delivered in a solution form. And we'll have a means to make sure our sample is taken uniformly of the concentration as well.

MEMBER REMPE: So it's just guaranteed it's always going to be - I'm not familiar with this type of solution, but you know that there's no concentration gradient in the tank somehow or another. You don't stir it or anything like that? You just know it is always uniform?

MR. BYNUM: There's no driver to make it not be -- we have the precipitation, and we've modeled the precipitation, and we're doing experiments at Argonne and we don't see precipitation which confirms the model. So I'm not sure what would drive you to -

MEMBER REMPE: Temperature? I don't

know. Sometimes things are not always so uniform, and I'm just wondering what the basis is. And again, I will admit that I'm not familiar with this type of solution.

MEMBER POWERS: Mr. Boltzmann probably takes care of this here.

MEMBER REMPE: Say it again, sir?

MEMBER POWERS: Mr. Boltzmann probably takes care of this here.

MEMBER REMPE: Okay, I just am wondering. Walls are cooler sometimes.

MEMBER POWERS: Yeah, the more entry - say that again.

MEMBER REMPE: Sometimes walls are cool. Wisconsin can get cold in the winter sometimes. I don't know. I'm just curious.

MEMBER POWERS: The really interesting thing about the hold tank of course is precipitation there. And the driving force for precipitation - the only ones that come immediately to mind is contamination of the hold tank. That's precipitation. The other one that we've run across in the past is actually bacteria.

Are your solutions hot enough or acidic

enough to ensure that you don't have anything like sulfate reducing bacteria or things like that that would cause a transition from hexavalent to tetravalent in the uranium?

MR. VAN ABEL: I know what our solution pH is. I'm not sure if it's correct or -

MR. BYNUM: I'll say it without the microphone on, then that way I won't get in any trouble.

(Laughter.)

MEMBER STETKAR: You'd be surprised how much we can pick up.

MR. BYNUM: The pH of the solution is one or less.

MEMBER POWERS: One or less.

MR. BYNUM: Yeah, about one, yeah.

MEMBER POWERS: Below one, so not particular acid, interesting.

MR. BYNUM: But it's a good point and that's something we haven't considered, and we'll go looking into that.

MEMBER POWERS: Yeah, we run across it in waste fields that you get the - I mean, there seems to be a bug that does anything that you want to in

this world.

And what happens is that you kill off all the bugs that kill that particular bug and it thrives, and so you have to worry about it a little bit, but I don't know enough. I've now exhausted my knowledge on the subject, so I'll shut up at this point.

MEMBER BALLINGER: I've avoided asking materials questions because I think those are economic issues versus safety issues, but when you say PH 1 and you say 316L stainless steel, do you know something about hexavalent chromium ions?

I mean, if you sensitize this material in welding and you stuff PH 1 in there, then you're going to have some exciting moments after maybe 10,000 hours if it's a half-inch thick, if you've got a heat-affected zone that's sensitized.

I'm just assuming that materials questions or corrosion and those kinds of things are being -

MR. VAN ABEL: Yeah, we're working with Oak Ridge National Lab on the materials issues on specifically corrosion in Zircaloy -

MEMBER BALLINGER: Delayed hydride cracking for example?

MR. VAN ABEL: They're doing - well, they're doing hydrogen uptake. They're doing stress tests. They're doing welded samples. They're exposing them to uranyl sulfate, PH 1. They're irradiating samples.

MEMBER BALLINGER: So I keep - delayed hydride cracking, if that's not in your mix, it's a fabrications issue. Call up the people at the ANTSO reactor in Australia and then weep.

MR. VAN ABEL: So then is the setup mode as we begin moving target solution into the TSV, we are using this 1 over M startup process I mentioned earlier. We're filling the TSV in discreet increments.

So we put in drops of target solution in. We allow the reactivity to stabilize, take a neutron flux measurement, and then plot the 1 over M curve. The target nominal fill level is five percent by volume below critical.

There are automatic safety systems present that ensures that the system remains subcritical should there be an operator error, should the operator inadvertently continuously add solution to the TSV, the high flux trip set points will be

designed through transient analysis to ensure the system still trips before reaching critical.

MEMBER SKILLMAN: Let me go back to Dr. Power's question. What insurance do you have that each time you fill the part solution vessel that you are beginning with a squeaky clean vessel and that you do not have a residual buildup of fissile material from a prior filling cycle such that you are getting an inaccurate reactivity reading relating to your solution?

You're still subcritical, but what you're looking at perhaps is a nanolayer on the inside of your TSV of the prior solution's fissile material in addition to the fresh material that you loaded. In any case, the batch that you're loading isn't what you think it is, and that same question applies to your dump valves, your dump lines, and your criticality safe ring header in the back of your cell.

MR. VAN ABEL: Well, I don't think a very small micron-sized layer would affect the reactivity in this system the way it's designed. It wouldn't affect -

MEMBER SKILLMAN: Is there fissile material in that layer?

MR. VAN ABEL: Yes, there would be, well, I mean, based on what you were saying, but it wouldn't significantly affect the reactivity. That small quantity if, you know, we're talking about a micron thick layer, it's not going to affect the way this system operates.

This system is ready or bust in the fact that it acts as a target for the accelerator. You know, it sits there subcritical through neutron multiplication, and then a very large range of subcritical multiplication factors can operate.

MEMBER SKILLMAN: Does the TSV flush itself when you dump it? Does it flush clean?

MR. VAN ABEL: The target solution, the plan right now is the target solution would dump to the dump tank. So that flushing would occur from the motion of that solution, but not a spray down every time or something like that.

MEMBER SKILLMAN: And what's the end condition of the TSV? Is it squeaky clean on the inside or is there a continuing layer that is building?

MR. VAN ABEL: There would be the remainder solution. And we've talked about doing

periodic flushes in that to the TSV which we could use to mess with the concentration of the uranium in the flush.

You can flush with acid, a clean acid solution, and look for residual products and measure the concentration of uranium in that flush to see if there is any - if that is becoming a concern during the initial few cycles of the TSV operation.

MEMBER SKILLMAN: But I think a greater concern is after the 50th or 200th cycle when you've really got some wear and tear on this machine and you're beginning to realize, golly, there's material that's beginning to be like the calcium on the inside of your pipes in your home water system.

MR. VAN ABEL: If there was significant amounts, then you'd also get into MC&A concerns. When you do accountability on the solution, you detect where uranium has gone. Some uranium would not be present in your solution and you'd have to account for that, and we'd go through a process to find that uranium.

MEMBER SKILLMAN: Well, I understand your answer, but I'm not convinced that you've got a practical way to address this. I'll just stop right

there.

MR. VAN ABEL: Next slide, please. Once you transition into the radiation mode, mode two in our system, we close the solution fill valves. So there's two redundant fill valves on the fill line. Those are closed to isolate the system from any further introduction of fissile material.

Then the interim driver is energized. We begin with that deuterium gas target, and then we slowly begin supplying tritium to the gas target, and the output of the system is gradually increased as the tritium is delivered.

MEMBER STETKAR: Once you achieve whatever conditions you're trying to achieve, do you then - is the tritium flow then just fixed or do you vary tritium flow?

MR. VAN ABEL: Once we get to steady state, the tritium flow is just -

MEMBER STETKAR: Is just fixed, okay.

MR. VAN ABEL: Yes.

MEMBER STETKAR: So you don't have to try to play with it.

MR. VAN ABEL: No, no, we don't try to -

MEMBER STETKAR: Okay, that's fine,

thanks.

MR. VAN ABEL: And then so once we start heating up the assembly, this fissile solution system, like aqueous reactors, has very strong negative temperature and void feedback coefficients.

So as the system heats up, the temperature increase causes a large activity decrease due to Doppler broading in the cross-sections, due to thermal expansion of the solution, and increased neutron leakage from that, and then the voiding of the solution also decreases your average uranium density and increases neutron leakage, but decreases reactivity a lot as well.

MR. VAN ABEL: Next? We continue in this irradiation mode then for approximately five-and-a-half days. The cell will continuously run at a steady state. The system operates as a target with the primary closed loop cooling system providing cooling for the TSV, and the top is recombining hydrogen oxygen.

When you're in the irradiation mode, I think it's important to note, you know, the density of this system is two orders of magnitude below a proper reactor and several times lower than a trigger

research reactor operating at the UW campus.

You know, it's a fairly low power density. The power density of these systems is quite low. So it operates and sits there at a steady state. We don't try to adjust reactivity. We keep the cooling water temperatures constant. We keep the neutron flux and tritium concentration constant, and we let it run and we monitor it for abnormal behavior.

MEMBER POWERS: What kind of boil up do you get?

MR. VAN ABEL: I'm sorry?

MEMBER POWERS: What kind of level swell do you get?

MR. VAN ABEL: In power or in physical level?

MEMBER POWERS: Yeah, the physical level.

MR. VAN ABEL: The physical level it's about five percent or so.

MEMBER POWERS: Okay, so it comes up to your flow level?

MR. VAN ABEL: Oh, yeah.

MEMBER POWERS: Okay, and the liquid droplet entrainment rates?

MR. VAN ABEL: Those are on the - we're actually doing some steps on calculations on that right now. It's on the order of milliliters per second or so, the maximum, the bounding maximum.

MEMBER POWERS: So you get quite a little bit of liquid droplet?

MR. VAN ABEL: Yeah, quite a bit of droplet entrainment, and we have a heat exchanger right at the outlet which will demist it a little, and then there's an actual demister.

MEMBER POWERS: Oh, okay, you have a demister in the system some place I would think, yeah. And your - and the droplet size range you're looking for in your demister? Most of them are designed for pretty coarse things.

MR. VAN ABEL: Yeah, I don't have the - we haven't done the final demister design yet, but, you know, droplets on the order of microns for the small ones, on the order of microns.

MEMBER POWERS: Yeah, it should be somewhere around one to two microns for the bubble burst things.

MR. VAN ABEL: Yeah, yeah, I don't have the calc on my desk.

MEMBER POWERS: Most demisters are designed for larger droplets, and I'd say you're going to have to be careful with this one.

MR. VAN ABEL: Yeah, yeah, we're looking at different designs for the droplet. What they had done was they essentially had a steel box and they put stainless steel wool inside of the fill box.

MEMBER POWERS: Yeah, I've done that kind of a design for demisters.

MR. VAN ABEL: So then the detail kinetics analysis that we're actually going to do will be performed at the FSAR. We're going to do the transient analysis of the startup process.

And we're planning to use a code that Los Alamos National Lab is working with us to develop specific to the neutron-driven subcritical assembly, neutron-driven and accelerator driver. Next slide.

The following radiation, we de-energize the neutron driver by removing its high voltage power supply that prevents it from accelerating deuterons. The dump valves are then opened and the target solution drains to the TSV dump tank which is in the bottom of the figure there in the pool.

The target solution is passively cooled

in a dump tank. There is decay hydrogen produced from decay radiation, so the TOGS system continues to operate post shutdown to recombine, you know, albeit much smaller amounts of hydrogen, but there's a small amount of produced in decay and that's recombined by TOGS.

All right, the TSV off-gas system, the off-gas system sweeps the gas over the top of the TSV and it - those gases are produced both from radiolytic decomposition and you also get the fission product gases and the wealth of fission products that are released from the target solution during irradiation.

Those are very small quantities. The major quantity in terms of volumes of gas it's handling is the radiolytic -

MEMBER POWERS: You said your zeolite was silver loaded more lite?

MR. VAN ABEL: Yeah.

MEMBER POWERS: Classic sort of thing, okay.

MEMBER STETKAR: Eric, I have kind of a fundamental engineering question. How many blowers are there in each off-gas loop, one or two?

MR. VAN ABEL: Two, there are two blowers

to a loop.

MEMBER STETKAR: Thank you, okay, because half of the things I could find seemed to indicate that there was one, and half of the things that I could find seemed to indicate that there were two, so you may want to go look at the drawings and such.

MR. VAN ABEL: Okay, yeah, sometimes what we've done on the preliminary drawings is if there's multiple copies of a unit, you'll see the letters.

MEMBER STETKAR: A/B?

MR. VAN ABEL: A/B.

MEMBER STETKAR: Yeah.

MR. VAN ABEL: But they won't show redundancy.

MEMBER STETKAR: Well, you won't find that on 4a 2.2 - 4a2.8-1. It only has a singular.

MR. VAN ABEL: Okay, I'll check that.

MEMBER STETKAR: That's okay. I was guessing there was two, but -

MR. VAN ABEL: Yeah, there's two.

MEMBER STETKAR: Okay, thanks.

MR. VAN ABEL: So the TOGS performs several functions. It contains those fission product

gases to prevent release. It removes iodine from the off-gas stream. And the primary function there is to trap iodine to prevent its release should there be a rupture of the TOGS piping, which is one of our evaluated accidents that we'll discuss in chapter 13.

But of course TOGS' function is to recombine hydrogen and oxygen to maintain hydrogen gas concentrations below the lower flammability limit, and it maintains the system at a negative pressure to correct the in leakage rather than out leakage of vent product gases.

MEMBER REMPE: So earlier you - I think at least I read that you keep it - you have an alarm that goes off if it's above 2.5 percent per volume? Where do you monitor the hydrogen and how do you know that's going to be the place where that's the maximum hydrogen concentration?

MR. VAN ABEL: The hydrogen monitor locations will be determined during detail design. They're planned to be just before the recombiner. The highest concentrations are expected to occur after the first condenser which would drop out water vapor from the - that's carried up, that's created by evaporation.

As the sweep gas goes over the TSV, you have evaporation that produces water vapor. The first condenser will knock out a significant portion of that water vapor. And then it goes to the demister, and then the blower, and the recombiners. And before that gets to the recombiners is where we would monitor hydrogen and through the - and our analysis would show that's the -

MEMBER REMPE: And you'll just have one hydrogen monitor there or -

MR. VAN ABEL: No.

MEMBER REMPE: - you'll have several sensors there?

MR. VAN ABEL: There will be two redundant hydrogen detectors. Either one activating an alarm or a trip would cause the system to alarm or trip.

MEMBER REMPE: Okay, thank you.

MEMBER STETKAR: Eric, have you decided on a design for the recombiners yet?

MR. VAN ABEL: No, not a specific design. We have a prototype that we've built at our facility in Monona, Wisconsin.

MEMBER STETKAR: Are they purely passive

or are they -

MR. VAN ABEL: We have heaters in our current design and in our prototype.

MEMBER STETKAR: You do have heaters, okay, thank you.

MEMBER SKILLMAN: Eric, let me ask this, is there any failure mode that the team can conceive of whereby organics would be introduced into any form or into any portion of your feed solution or your dump system? Is there any way organics can find their way into this system?

MR. VAN ABEL: Not that we've currently found, but if you guys have anything to add to that, we can get back to you.

MR. BYNUM: The only place that we have organics is in UREX, and it goes through a precipitation process after UREX, and the product is dried. So I'm not quite sure how we could get organics back into the IU part of the facility from there.

And there's no other organics other than the very minor quantities that are used in the purification process in the entire plant, and none of that goes - has a pathway back either.

MEMBER SKILLMAN: Thank you.

MR. VAN ABEL: All right, next slide. All right, as I mentioned following shutdown the TOGS continues to operate to recombine the residual hydrogen and oxygen that's produced. It's passed through the UPSS.

One of the things we described in our application is we plan to perform a detailed evaluation of the long-term hydrogen recombination. We have several options we're looking at. There is hydrogen produced, as you imagine, with decay heat loss, where the hydrogen is produced in smaller quantities for quite a while.

So we're looking at some options there to deal with long-term hydrogen recombination which could be a safety-related diesel generator or a passive recombiner because it's a very small amount.

MEMBER STETKAR: I was going to wait until chapter eight, but it's not clear that I'll still be awake once we get there. So if I looked at the UPSS loads in chapter eight, they list for each UPSS on the nominal five point - and be careful if I'm getting too specific, just tell me to be quiet - let me just say a nominal kilowatt load that's

associated with the off-gas blowers, and I had a couple of questions. Number one, does that account for eight blowers running? This is the running mode. It's not the start mode.

MR. VAN ABEL: The UPSS loads to account for eight -

MEMBER STETKAR: Eight, okay.

MR. VAN ABEL: - all eight blowers functioning at once.

MEMBER STETKAR: And do they account for the heaters on the -

MR. VAN ABEL: Yes.

MEMBER STETKAR: Thank you.

MR. VAN ABEL: And that's something we couldn't remove in the detail design. We found we can't operate without the heaters or something like that, but conservatively we just haven't included that.

MEMBER STETKAR: It was just a line item that said TOGS blower, singular, and it was - I couldn't figure out what the rating on each blower was because I didn't have that information, so thanks.

MR. VAN ABEL: And then at the end of the

cycle, the TSV off-gas system purges its gases, the contained gases, to the noble gas removal system. And the noble gas removal system stores those gases for decay, and following that decay period they are released, a filtered release, through HEPA and charcoal filters.

The thermohydraulics, during irradiation the PCLS and LWPS are providing cooling. The PCLS is removing heat directly from the TSV walls. The LWPS, the light water pool cooling system, is removing heat from the neutron multiplier, the tritium target chamber, and then also radiation induced heating of the pool itself.

And then during shutdown, the light water pool cooling loop is removing heat from the pool just to maintain the pool at a temperature during normal operations, but it's not required to function.

If we don't - if the cooling loop is not functioning due to reasons such as loss of off-site power, the total heat up of the pool, assuming data conditions, is about seven degrees over 90 days or so, assuming no evaporation or heat transfer to the walls, so a very small amount of decay heat that we're dealing with.

MEMBER STETKAR: Here again, just thinking about how things work perhaps, and stop me if I get too detailed, it says that TSV or the temperature of the solution is provided as an indication for the operators. But if PCLS flow decreases below acceptable levels, the TRPS shuts down the neutron driver and opens the dump valves.

So it seems to say that you infer temperature for the protection system based on PCLS flow rate rather than actual temperature.

MR. VAN ABEL: PCLS flow and temperature are both monitored for trips. I'm not sure which section that is.

MEMBER STETKAR: This is 4a2.7.8. I was just curious why didn't you just trip it on a high temperature of the solution since you're picking it off for the operators anyway?

MR. VAN ABEL: So our plan is to use the PCLS flow and temperature, and the target solution high temperature, we will have indications of the temperature.

MEMBER STETKAR: Yeah, that's what it says.

MR. VAN ABEL: But it's very hard to

quality those thermocouples in that environment for safety-related purposes.

MEMBER STETKAR: Oh, okay.

MR. VAN ABEL: So that's the primary reason.

MEMBER REMPE: The thermocouples is what you said, right? And what type are you using? What kind of sheath are you putting on them?

MR. VAN ABEL: We don't have the specific ones selected yet. And the plan for the sheets is either 316 or Zircaloy-4 for the sheets.

So the temperature in the TSV during the irradiation process is expected to increase from the nominal room temperature that it's at during filling to approximately 60 degrees during operation at our proposed licensed power limit. The power limit itself is proprietary, but we can talk about that later if we want to in a closed session.

That temperature rise is based on preliminary correlation-based heat transfer calculations that were done, and experiments that were done at the University of Wisconsin Madison, and then CFD simulations that we are doing.

MEMBER POWERS: I think I explained that

we discount those.

MR. VAN ABEL: Sorry?

MEMBER POWERS: We discount that University of Wisconsin study.

MR. VAN ABEL: Yeah, I almost mentioned at the start that I worked with Dr. Corradini and I thought then my whole presentation would be thrown out the window, so.

MEMBER POWERS: Can you give me an idea what your ionic strengths are?

MR. VAN ABEL: Sorry?

MEMBER POWERS: Can you give me an idea of what your ionic strength is for this solution?

MR. VAN ABEL: The ionic strength?

MEMBER POWERS: Is it like - I mean, if your pH is .1, it's probably about .1, but -

MR. VAN ABEL: The concentration -

MEMBER POWERS: I don't know what else you threw in there.

MR. BYNUM: We haven't done actual ionic strength, but we've got - we can tell you the concentrations once we get in closed session.

MEMBER POWERS: Okay, that would be good enough. I can handle the problem after that.

MR. BYNUM: Yeah.

MR. VAN ABEL: And then the detailed results of the thermohydraulic analysis are planned to be submitted with the OL application.

So in summary, the subcritical assembly is a target for our neutron driver or accelerator. It's brought up to a controlled subcritical multiplication level using a very discreet insertion of small amounts of target solution, monitoring the reactivity change, and then ensuring we stay below the five percent by volume through both the operators and as well as an automatic trip system that's there to protect against any operator errors.

There is large negative temperature and void coefficients in the system, and once we begin irradiating, those dry the system much more subcritical than where we started at, and we don't have any means or analyzed accent analyses to get back up to the k-effective that we started at. We always remain below that once we begin irradiation.

We don't do anything to control reactivity. Once we enter that irradiation mode, we let the system drive itself subcritical. We don't try to - we don't have control rods. We don't hold

control rods and try to hold reactivity higher or play with the cooling system temperatures to hold reactivity up. We let it depress in reactivity.

And then any time a monitor parameter exceeds an allowable level, then the system is tripped during that irradiation process. That's all I have.

MEMBER SKILLMAN: Before you go to parade rest, let me ask one or two questions here in chapter four. What prevents double batching in your TSV?

MR. VAN ABEL: Double batching in terms of concentration?

MEMBER SKILLMAN: Yes.

MR. VAN ABEL: So we have measurement of uranium concentration before it enters the TSV. We are measuring an independent verification of that concentration in the target solution hold tank.

Should there be a double batch that escapes that process, of course then the procedures failed that were used to batch this solution, the quality control steps for the batch solution failed, the independent check by the - the invented check in the target solution, the whole tank failed.

But if it did reach the TSV double batched, you would see it on the 1 over M pods. The operators would notice it. If they didn't see it, the system would still trip and prevent that batch criticality from happening.

And if you didn't trip, if you tried to operate there, you wouldn't be within the acceptable fill range of the TSV and you wouldn't be able to irradiate.

MEMBER SKILLMAN: Okay, one or two more. I'm in your paragraph four off the 226 neutron multiplier and here is the statement. "There is potential that the uranium metal would oxidize and could lead to contamination in the light water pool. Sampling the LWPS detects such a breach via the increased radioactive contamination present in the water."

My question is if you do have such a breach of any kind, how do you clean this mess up? Do you pump the pool dry? And if you do that, you've got radiological issues for the assembly. What do you envision at the conceptual stage for how you back out of a casualty like this and clean up?

MR. VAN ABEL: So for small amounts of

contaminants, we do have a cleanup system built into the cooling, sort of ion exchange beds that could remove small amounts of contaminants, and would flush those, and purge, you know, purge those and refill them several times to reduce small amounts of contaminants in the system.

One of the scenarios for a complete loss of target solution to recover from that scenario would be to transfer that contaminated water to our uranyl nitrate conversion system which treats - is the UREX process, which would treat that system, separate out the fission products and the uranium, and allow us to dispose of the waste then, the waste fission products and recover the uranium.

MEMBER SKILLMAN: Okay, thank you, one or two more. Your table four off of 222 shows the irradiated target solution activity for select radionuclides following shutdown, about six hours. And this is a classic fission product yielded table.

MR. VAN ABEL: Spectrum.

MEMBER SKILLMAN: Yeah, spectrum. My question is - and the PLCS has a cleanup system to capture these radionuclides, and some of these cesium, strontium, you're producing hundreds if not

thousands of curies, and some of those have gamma energies that are - beta and gamma energies that are significant, .667, I mean, coming off your cesium-137.

Speak to us about how your cleanup system in PLCS captures this witch's brew and why the columns that you're using to capture these isotopes are radiologically safe.

MR. VAN ABEL: So the PCLS wouldn't normally capture it because they normally separate it. Only the clean cooling water would normally go through the PCLS, so PCLS wouldn't normally be capturing those products.

The extraction columns that do capture the target solution passes there, those do capture a range of other fission products on them, and we've calculated the dose rates from those and I'm not sure we'll be discussing that the next presentation or not, but the extraction columns -

MEMBER SKILLMAN: I don't think - see, we don't get there until deeper in the review. But it seems to me that the answer to this question is fundamental to the basic design of this facility which is why I asked the question.

MR. BYNUM: We can talk about the extraction column when we get in the closed session if that will help.

MEMBER SKILLMAN: That's fine. We can talk about it then.

MR. BYNUM: I think you'll find they're very stable given these conditions, and we'll have experimental data from Argonne where they're actually running solutions similar to ours through the exact same material.

MEMBER SKILLMAN: Fair enough, I'll be happy to wait. Thank you.

MEMBER REMPE: I have a question. In designing this system, there's a lot of different limits or considerations that would drive the design, and could you speak just at a high level what - if there's one or two things that were really driving the design, and especially with respect to safety, and how that affected the design? And criticality would be one.

MR. VAN ABEL: So, obviously one of the primary design objectives is to make sure the system doesn't ever reach critical in any of the postulated accidents or abnormal conditions in the system.

So that's been an outset of how we've laid out the system to make sure that you can't add solution, you know, when you're not supposed to be able - when you're not - when you shouldn't be adding solution to the system, to make sure that the system -

CHAIRMAN RYAN: Excuse me for a second. I'm sorry to interrupt you, but we are running a little behind our calendar or the clock, so just for the compliance of that maybe pick up the pace or move along a little bit.

MEMBER REMPE: Go ahead and finish though.

MR. VAN ABEL: And, you know, for the hydride concentration, you know, our design goal is to keep that as low as possible. Our goal is to make sure that there is never a deflagration in the system, that we keep it as low as possible realizing that you are producing, you know, a significant amount of hydrogen that we have to recombine. I'm not sure if that answered your question.

MEMBER REMPE: And so did that limit then the power, the selection in the way you did some of these layouts that way?

MR. VAN ABEL: Yeah, I mean, the

reactivity staying below subcritical certainly limits the amount of power. One of the big things was not to introduce reactivity control mechanisms, things that the operators could do wrong, things that - control systems that could malfunction and drive the system to a more reactor like state where it's being controlled or reactivity is being controlled.

We wanted to stay away from that and keep it as just an accelerator driven target which led - we could have introduced systems that decreased temperature as you heat it up to try to keep power high, and you could have done this with a couple of accelerators, but the goal was to keep it as simple as possible which is what led to these eight units.

MEMBER REMPE: Okay, thank you.

CHAIRMAN RYAN: Yes, let's go ahead and take about a 12-and-a-half minute break and come back about 3:15, okay? Fair enough? We're adjourned.

(Whereupon, the above-entitled matter went off the record at 3:02 p.m. and resumed at 3:18 p.m.)

MEMBER SKILLMAN: My single comment is that for all of the water that's contained in those eight large holding tanks that are the shield and the

cooling water, need to ensure that you've got the capability to protect that water chemistry very carefully. Thank you.

CHAIRMAN RYAN: Any other comments or notes from our presenters? Any comments or observations from members or staff?

MEMBER BLEY: I think we're ready to go on to 4b.

CHAIRMAN RYAN: All right, let's do.

MS. KOLB: I'll be talking about Section 4b, as part of Chapter 4. This is the Radioisotope Production Facility section of Chapter 4. It is the area in green in this drawing. The area in blue is IF that Eric just previously talked about. Next slide. This slide describes the overall design features of the RPF, rad material processing areas and related system structures and components are in Seismic Category 1 structures.

Rad materials are contained in piping and processing systems, shielded hot cells and vaults, or shielded pipe trenches, as needed to maintain worker dose within regulations and in accordance with the facility ALARA program. Criticality-safe by geometry design is used for equipment containing

fissile material. Sumps for hot cells, vaults and pipe trenches are provided and include leak detection. Tanks include overflow lines, hard-piped to the criticality-safe collection tank in the low point of the building.

Operating areas are monitored with the continuous air monitoring system, a radiation area monitoring system, and a criticality accident alarm system. Those will be discussed more tomorrow. Hot cells are isolated from the building HVAC system upon detection of a leak to prevent the spread of contamination. Next slide. There are three main processing systems in the radioisotope production facility. These are established processes.

More details about these will be provided later in this section, in my presentation, but in summary, we have the target solution preparation system or TSPS. That's where we receive and store low enriched uranium metal, dissolve it in nitric acid and form uranyl nitrate. We also use this system to transfer the uranyl nitrates to the uranyl nitrate conversion system for thermal denitration. TSPS is also used to receive and store uranium oxide and react to that with sulfuric acid and form our

target solution. We have the molybdenum extraction and purification system. That is used to receive the irradiated target solution from the IF. This is where we extract and purify the molybdenum-99. Post extraction, this target solution is transferred to UNCS for cleanup and recycle.

The purified moly-99 is transferred to the packaging system. The uranyl nitrate conversion system is also in the RPF. That is where we convert the uranyl sulfate to uranyl nitrate. We clean up the uranyl nitrates using uranium extraction or UREX process, similar to a PUREX process that's used in fuel reprocessing plants. We also perform a thermal denitration to convert the uranyl nitrate to uranium oxide. Next slide.

There are other systems located in the RPF. These next two slides are an overview of these systems, but more details on these systems are actually in Chapter 9, which will be in a future ACRS presentation. We have the molybdenum isotope product packaging system. That's where we receive the concentrated moly-99 from MEPS and transfer it into shipping casks. We have the radioactive drain system. That's a system that routes any spilled

liquids from sumps or tank vaults to a criticality-safe by geometry collection tank in the low point of the facility. We have the noble gas removal system, which Eric mentioned previously. It's where we take the off-gas from the TOGS system and it's allowed to decay. The decayed gas is then released to the PVVS system, which is the process vessel vent system.

That system treats off-gas from the vessels that handle the main processing fluids in the RPF and from the noble gas removal system. It contains a caustic scrubbing system to remove acid gases and some iodine species. Next slide. These systems are also discussed in further detail in Chapter 9, but as an overview, we have an aqueous radioactive liquid waste storage system.

That has surge capacity for the aqueous liquid wastes to reduce fluctuations in compositions and flow rates prior to transferring it to the radioactive liquid waste evaporation and immobilization system. These storage tanks are also used to allow short-lived radioisotopes to decay prior to processing of the waste. RLWE system, that's where the aqueous liquid wastes are concentrated, and then immobilized in Portland

cement. As we said, we're a zero liquid release facility. There will be only trace quantities of special nuclear material in these two systems, since this will be after the UREX process, which is used to recover the uranium. We also have an organic liquid waste storage system. That's a small system to load, store and ship organic wastes from the radiologically controlled area. Those are primarily spent solvents from our UREX system.

Next slide. Slide 69 discusses the biological shielding in the RPF. That acronym is production facility biological shield, if you're wondering. The shielding is used to reduce the radiation exposure to facility personnel, members of the public, and to components and equipment. The design basis for normally occupied areas is .25 millirem per hour at 12 inches from the surface of the shielding.

As Eric mentioned, that's the same design basis as for normally occupied areas in the IF. The shielding is designed and constructed to remain intact during normal operations and during and following design basis accidents. There is no substantial neutron flux anticipated in the RPF,

since the irradiation --

CHAIRMAN RYAN: Can you help me understand "substantial?" Is the wall simply thick enough you'll have no neutron transport through the wall?

MR. VAN ABEL: Yes, essentially zero. You'll have a few neutron precursors. You'll have a couple atoms left --

(Simultaneous speaking.)

CHAIRMAN RYAN: The bottom line is you've got plenty of thickness to worry about any passing through, and if there is a passage through, it's a failure in the wall?

MR. VAN ABEL: Yes. The neutron flux has the light water pool to go through, and then five or six feet of concrete.

CHAIRMAN RYAN: I got you. I just wanted to probe that a bit. Thank you.

MS. KOLB: Now going into a little bit more detail about those three main processes in the RPF. For radioisotope extraction, we do one batch at a time of the irradiated target solution. That's transferred from the dump tank of the IU cell in the TSC dump tank, transferred to the MEPS system. The

extraction is performed in a hot cell. We call them supercells. We have three processes in the same hot cell, so it's a large hot cell. We just named it that.

MEMBER SKILLMAN: Let me just challenge that for a minute. What I learned is that anything that's big enough to give you everything you want is big enough to take everything you've got. Here's your supercell. It's going to give you everything you want, but if something goes belly up in there, you may have lost a key portion of your facility. Do you have just one supercell?

MS. KOLB: No, we have three.

MEMBER SKILLMAN: Thank you.

MEMBER BROWN: When you say one batch, does that mean all eight IUs go into the supercell at one time, or is it each IU individually?

MS. KOLB: Each IU individually.

MEMBER BROWN: Thank you.

MEMBER STETKAR: I think we established earlier that's roughly a batch every 18 hours if you're running full production flat out, right?

MS. KOLB: That's correct, but it'll be staggered between the three cells. The irradiated

target solution is passed --

MEMBER SKILLMAN: Let me just build on that for a second. I'm really winging it now, but just let me wing it one time, and I'll be glad to shut up. This has to do with staffing at some point. I would certainly like to hear about staffing in a future session, but as John well points out, a batch every 18 hours, three cells running somewhat in series, but perhaps also in parallel, seems to raise some very interesting staffing questions. With staffing come some human performance and some safety issues. At some point, I, for one, would really like to hear that. Thank you.

MS. KOLB: We'll make a note of that. Thank you. The irradiated target solution is passed through a column to extract the molybdenum-99. Moly-99 is then stripped off with a dilute sodium hydroxide solution.

MEMBER STETKAR: I'm assuming we're going to hear more about the columns tomorrow?

MS. KOLB: If you want to know the material of the columns, that's proprietary, but we can talk about that tomorrow.

MEMBER STETKAR: We'll bring it up

tomorrow. Thanks.

MEMBER POWERS: I've always had one question about this. I truthfully do not know the answer here. In the course of producing the moly-99, you also produce quite a number of fission products, not the least of which is tellurium. You're operating it in a city oxygenated regime, so the tellurium is probably there as telluric acid or its anions. Why doesn't it react with moly and make it just moly-telluride?

MS. KOLB: I don't know the answer to that. I can tell you that Argonne National Labs has done some studies for us. They're currently doing a mini-SHINE program, where they're doing a very small scale process of this same process and producing moly-99, but I don't know the answer to that question. We can get back to you if we figure it out.

MEMBER POWERS: Just curious.

MEMBER SCHULTZ: Catherine, when you say small scale, what are they doing, what level? Are we talking test tube or --

MS. KOLB: Five liters.

MEMBER SCHULTZ: That gives me an idea. Thank you.

MS. KOLB: The moly-99 stream is then re-acidified, since it was in the sodium hydroxide solution. There's a further processing step. We can clarify that tomorrow. That's also proprietary. Then we transfer it to be purified using the Cintichem process, which is on the next slide. That's radioisotope purification, Slide 71. This process purifies the moly-99 stream through additions of small quantities of chemicals and filtrations, solid precipitations, washes, dissolutions, columns of adsorptions. This is an established method similar to the -- it was developed by Cintichem Union Carbide in New York. It has been modified to be used with low enriched uranium, but it's the same basic overall process. Small quantities are taken to a facility lab for quality control to verify and record activity.

The final product bottle will be transferred to the packaging area of the supercell. In the radioisotope production facility we will handle special nuclear material. Shipments of special nuclear material are received in a solid form from a U.S. Department of Energy supplier. Currently plan to be the DOEs Y-12 facility. The metal will

be enriched to 19.75, plus or minus .2 percent of uranium-235. That's low enriched uranium.

The RPF contains the special nuclear material in multiple forms, uranium metal, as we receive it, uranium oxide, as a product of the thermal denitration process, uranyl sulfate, that's the main form of our target solution that we irradiate. We'll also have uranyl nitrates. We convert it into that in order to perform our cleanup process. We'll also have aqueous and cement-solidified plutonium. That's formed from the irradiation process in waste streams. Based on our product quality requirements, the target solution will be cleaned up periodically to remove the unwanted fission products. That process is we convert the uranyl sulfate to uranyl nitrates through the addition of chemicals. We can talk about that in closed session if we want to -- the specific chemicals we add. Then we transfer the uranyl nitrates through the uranium extraction process. That is using the --

CHAIRMAN RYAN: Just so I'm clear, the preparation is proprietary --

MS. KOLB: That's the name of the system, the name of the physical area. That has nothing

special. Then we have our UREX process, using centrifugal contractors and a solvents extraction process. After that, the clean uranyl nitrate is converted into uranium oxide by a thermal denitration. Next Slide.

The final type of processing we do for special nuclear material in the RPF, as I said, we receive the uranium metal in approved transport containers to be stored in criticality-safe storage racks, and we dissolve it in nitric acid as part of the target solution preparation system in that area of the facility. The uranium oxide is received from the thermal denitration area, stored in criticality-safe storage racks also, and converted to uranyl sulfates. This picture depicts a criticality-safe by geometry annular tank. This is actually the uranyl sulfate preparation tank. In summary -- go ahead.

MEMBER SKILLMAN: Catherine, in this image, is the tank the annular ring with the opening?

MS. KOLB: That's correct.

MEMBER SKILLMAN: Understand, thank you.

MS. KOLB: The opening would be connected by chutes to a glovebox where people would prepare

the metric quantities of uranium oxide and dump it into the tank. It'll be contained in a glovebox.

MEMBER SKILLMAN: Thank you.

MEMBER BLEY: I had a couple questions about this. Is your storage area criticality safe if you get flooded, or do you not have water in areas where you're storing it of any kind -- piped water systems?

MS. KOLB: Do you want to take that?

MR. VAN ABEL: I don't remember in that particular room what the criticality safety limit is on internal flooding.

MEMBER BLEY: You have cooling water that runs through there, so that you could have a pipe rupture and you could flood that area?

MS. KOLB: There will be purified water piped into this tank, specifically --

MEMBER BLEY: You need to have some kind of --

(Simultaneous speaking.)

MS. KOLB: Yes, prepare the acid.

MR. VAN ABEL: Part of the criticality safety evaluations, they look at what are the potential sources to monitor ingress into the room.

MEMBER BLEY: I don't know who they are. I thought they were you.

MR. VAN ABEL: The criticality safety engineers versus me, who is not a criticality safety engineer.

MEMBER BLEY: Where does that show up? Is that in the documentation we have? I'm not sure where it's hidden if it is.

MS. KOLB: For the construction permit, we are doing a preliminary criticality safety evaluation on this process, in particular, as an example of our methodology. The remaining criticality safety evaluations for the RPF will be prepared for the FSAR.

MEMBER BLEY: So if it later it turns out that there could be a flood in there that you hadn't thought of, you might end up having to take all the water piping out of that room or something.

MR. COSTEDIO: That was the RAI that Steve Lynch was talking about earlier.

MEMBER BLEY: We haven't seen all the RAIs yet, or at least I haven't. I'm not sure about everybody else. Did you look at the possibility of uranium metal fires when you looked at fires in this

facility?

MS. KOLB: We did a fire hazards analysis. We'll have to look that up about that specific scenario.

MEMBER BLEY: You did look at fires in the processing facilities?

MS. KOLB: That's correct.

MEMBER BLEY: You must have some kind of accountability systems or not?

(Simultaneous speaking.)

MS. KOLB: For material controls.

MEMBER BLEY: Is there a section on that?

MEMBER POWERS: Does your uranium metal come to you oil-covered?

MR. VAN ABEL: No.

MEMBER POWERS: It's just hard, dry metal?

MR. VAN ABEL: Right.

MEMBER POWERS: So it really is a fire hazard?

MR. BYNUM: It's planned to come as chunks.

(Simultaneous speaking.)

MR. BYNUM: Actually, finer pieces are

much worse. These are not finer pieces. These are --

(Simultaneous speaking.)

MEMBER POWERS: Turnings are the problem.

MR. BYNUM: Anything with lots of surface.

MEMBER POWERS: Even billets and things like that, the biggest problem is they ship it in a little water vapor, so you get hydrides all over the surface.

MS. KOLB: This is actually the last slide in my presentation.

MEMBER REMPE: I'm sure for the PSAR it's not required, but before you actually are granted an operation license, NRC will be -- you'll develop procedures and NRC will be reviewing them. They'll regularly do inspections of that. There's been some issues with some of these processes in the DOE complex over the years. I just am wondering does NRC monitor regularly, inspectors will be coming in this way, too?

MR. BYNUM: I think we should let NRC answer that question. Should we move on to NRC?

MEMBER BLEY: While you guys are coming up and getting settled, and before you start, I have kind of a general question. A lot of areas have come up where we've had preliminary analysis that they and you are saying is fine for the construction permit area. Some of those were kind of screening analyses. Some are things that they just haven't done yet.

As you go through this -- this is as good a place as any to ask you this -- what kind of tracking do you have in place? We were led to believe, or at least told on one issue, that the screenings that have been done with sometimes kind of cursory analysis or not fully validated analyses will be revisited. When the request for an operating license comes in, if it says we already screened these out and we don't have to look at them anymore, what are the checks you have in place to make sure these open areas or incomplete areas are going to get picked up?

MR. LYNCH: How we've addressed that is with our reviewers, for the most part, if we have good questions, I like them to be asked. If SHINE has come back to us and given us justification for why they believe that the information can be provided

later and we agree with that, that's okay. Why I want the question asked in the first place is just for that. I want SHINE to acknowledge this is a review area that we need to do additional research on.

They provide commitments to us in their responses to RAIs that they will provide that information in the FSAR for further analysis. Then we take that information and I keep a list of it, as well, so that when we do get to the operating license stage, I'm going to be able to hold up and say, "This is everything that SHINE said they're going to do, in addition to everything else that we've already decided that they need to do extra," but make sure that all the things that they said that they're going to come back and revisit, that they actually did. So we do have documentation of all those commitments they made in their RAI responses.

MEMBER BLEY: I haven't read the RAIs and the RAI responses yet. I hope to get to that soon. We heard a number of -- I'll call them external event analyses for fires, floods, seismic events, aircraft crash and things like that, where this morning, the factual data wasn't all in place, and there were

pieces. Of those things that we talked about this morning, are there RAIs and RAI responses that make it clear they're going to go back and look at those events?

MR. LYNCH: Yes. We've asked a lot of RAIs on aircraft analysis, a lot of RAIs on seismic analysis and its impact on the facility.

MEMBER BLEY: Red oil?

MR. LYNCH: I don't think, Mary -- I don't think we've asked about red oils specifically.

MEMBER BLEY: I thought Mary said you were asking about red oil from the beginning, not to put you on the spot.

MS. ADAMS: This is Mary Adams from NMSS. From the beginning of the -- when SHINE first came to us about three or four years ago -- it's been a while now -- when I first heard the term UREX, I thought immediately of red oil. Any time you've got organics and nitric acid and temperature and decay products and so forth.

Our guidance document, NUREG-1520 and the interim staff guidance to NUREG-1537 doesn't have the words red oil in there anywhere. Our objective is to do a chemical safety analysis and a criticality

safety analysis and fire safety and rad safety and evaluating any accident sequences that could have intermediate consequences or high consequences. If those are red oil and they are determined to be not credible, then we may or may not look any closer.

MEMBER BLEY: I hope you look at that one kind of closely because that's one, at least as far as I know, we were doing some work with another organization that was chasing that pretty hard because they're concerned with it a lot. They were telling us they'd had some research done, and they were going to pin down what the red oil reaction is, and that they'll have it -- it never happened.

They don't have it. Nobody really knows what happened. They know kind of the conditions that were around before it happened, and that it happened, and that it was very energetic. They know that the stuff left over is red and slick. The details just aren't known, so make sure you dig into that some.

MEMBER POWERS: I believe there's a rather famous paper that says red oil is not an oil, and it may not even be red.

MS. ADAMS: The same team that reviewed the MOX application quite a few years ago, those who

haven't already retired, are around. We're able to pick their brains about that. We've described to them, if they're not already on the team, what we know about the SHINE UREX process and what do they think? In fact, the guy who left Savannah River site is now at NRC.

We picked his brains, also, to ask him whether he thinks that given the conditions that we know about the SHINE UREX process, should we worry about a lot about -- should we press really hard on red oil? So far, the answer has been not necessarily.

MR. ADAMS: I want to add a few things to what Steve said. The application for an operating license, it's just that. It's a separate application for an operating license that will get a full review from the staff. We're keeping track of issues we're finding as the reviewers go through it.

We're keeping track of RAIs that say we'll tell you more later. Obviously, we're going to go back and mine through the transcripts of this meeting to make sure that there aren't additional questions or areas we need to chase on this. We will look at everything we can to make sure that when we

come with the operating license application that we have looked forward and backwards to make sure we're where we need to be. There's a question about inspectors and that. There's a couple things that are going on at this point. One is that NRO is developing for us the construction inspection program, so there will be a construction program for this that will be carried out by Region II.

We're making sure that the program matches what's important for this type of facility. We're also developing, based on our existing non-power reactor inspection program, the operational inspection programs for this, both for the radiation facilities and based on inspections that occur at material facilities for the RFP. That's additional work that's going on as we speak to be prepared to move forward when the time comes.

MEMBER BLEY: That sounds good. It struck me -- I think I heard this, but also looking through the SER -- not all of these things that were apparently asked in the RAIs and documented there made it into the SER. I think that's true, right?

MR. LYNCH: Yes, and that's one thing I've been going back through and updating, making

sure more of that's added in.

MEMBER SCHULTZ: That's your intent? That would be the way to capture it, then, Steve?

MR. LYNCH: Yes.

MEMBER SCHULTZ: It seemed that as part of the issuance of the construction permit and the SER association with it would be a good place to capture items that must be addressed in the application for the operating license.

MR. LYNCH: Yes, indeed. What I've been doing is I've been going back through and reworking some of the SER sections. I've been adding in those discussions of those areas that require additional analysis at the operating license stage, providing justification of why it's good enough for now and what we're going to look at later.

MEMBER SCHULTZ: Thank you.

MR. ADAMS: All that is good information. On top of that, the operating license will be reviewed against NUREG-1537. The fact that we're keeping track of open items is just one aspect of what we're going to do. That's not going to prevent us from getting out the standard review plan and doing a review against that.

MEMBER SCHULTZ: Understood, thank you.

MEMBER BROWN: For those of us who are chemically challenged, what is red oil, and why is it a problem?

MEMBER BLEY: Maybe we could save that for an offline discussion. It's a longer story. We can tell you a lot about it, Charlie.

MEMBER BROWN: I just want to know what it is. Obviously, it's a product of a reaction of some kind.

MEMBER POWERS: We don't know what it is.

MEMBER BROWN: That's a good answer. Okay.

MEMBER BLEY: The reactions --

MEMBER BROWN: No idea what it is, but you want to know what the effect is, right?

MEMBER BLEY: The reactions where it's happened have been very severe. Some of them have been extremely severe.

MEMBER BROWN: All right. I'll quit.

MEMBER POWERS: Usually where it's happened is called a hole in the ground.

MEMBER STETKAR: It's an energetic reaction.

MEMBER BROWN: But yet, we don't have any answers.

MEMBER BLEY: We know it ain't good.

MEMBER BROWN: Except we're not talking about it, and there's been no analysis of it, and it wasn't presented? It's just a minor detail? Okay. Thank you.

MEMBER SKILLMAN: I'd like to ask Al a question. You mentioned a construction inspection program. I've got to ask you why hasn't this project simply adopted Appendix B to 10 CFR 50 and a common construction program that inspectors in Region II would be very inclined to easily inspect? There's construction going on down in the Southeast. The inspectors are up to speed. They're trained. They know what to look for. They know how to spot problems early. I say that from the perspective of -- for the benefit of the licensee.

MR. ADAMS: The construction inspection program that you will see will parallel what's used for the power plants, but again, applying a graded approach, the detail focus areas will probably be different for this. It's the overall construction program, the same inspectors out of Region II that

inspect construction inspection will be the inspectors that we use. The individual inspection procedures that they use will be the catalog of inspection procedures. They will pick out the ones they need, but what we're writing is the overall program that tells them how to inspect these facilities. Last new construction we had in this area was in the '80s, so we have never documented it.

We're documenting, but after talking to NRO, just taking the power reactor inspection program and saying, "Use this," is like putting a square peg in a round hole, given the safety significance of this facility and the fact that at the end of the day, it's not a reactor. It's not a power reactor. We're trying to get the program to match up with the facility and the risks that the facility poses.

MEMBER SKILLMAN: Thanks, Al. Thank you.

MR. LYNCH: I think right now, I'll turn it over to Tom. He can talk to you about Chapter 4 from the staff's perspective. Just let me know when you want me to change slides.

I can quickly click through some of this because SHINE's covered most of it. We're looking

at principal features, ideas of operating characteristics and parameters for both the irradiation units and the RPF. One thing I had in here, we don't have cladding. The primary fission product barrier is the target solution vessel and the various piping in the RPF are the fission product barriers there.

MR. BOYLE: I'm Tom Boyle from research, in charge of Section 4a. Why don't you take me to Slide 8? A lot of stuff is redundant from what you heard before. These are the regulatory basis. This is probably just important to show for a minute -- 50.34 and 35, and the ISG. Let's go to Slide 10 now. These are the topics that we're about to cover. Let's just start now with the next slide. The target solution is a uranyl sulfate solution contained in the target vessel. SHINE provided its target solution qualification program through RAI 482.2-9.

In it, SHINE describes historical target solution data, such as Lane's and Wilson's 1958 works on aqueous homogeneous reactors, and the 2008 IAEA Tech Doc 1601 on aqueous homogeneous reactors. It also describes physical parameters, means of production, references to experiments done and being

done at Oak Ridge, Argonne and Los Alamos, in addition to the testing requirements. The irradiation unit operates subcritically and does not use control rods. Reactivity is controlled via these seven -- I think we're looking for Slide 12. Yes, that one -- via these seven variables. Systems that control system reactivity are discussed in Chapter 7. Again, for abnormal conditions, such as high flux, abnormal coolant temperature, loss of forced convection in the cooling system, the process control system or reactivity control system can shut the system down. Next slide.

MEMBER STETKAR: Tom?

MR. BOYLE: Yes?

MEMBER STETKAR: Those variables you listed, it didn't say anything about tritium fluoride, just saying.

MR. BOYLE: You're correct, it doesn't. I looked at the Number 7 out of the PSAR. I should've thought about that and put it there. That's absolutely correct. Let's go back to Slide 13. These are other things of note. The primary system boundary components will be compatible with the chemical environment of the target solution.

Plutonium poison buildup will be discussed in more detail in the FSAR. Additional components that aren't described completely, such as the ones I've listed here on the slide, will also be discussed completely in the FSAR. Next slide. The neutron driver is an accelerator-driven system that produces high-energy neutrons via deuterium-tritium fusion reactions. These neutrons enter the neutron multiplier, which moderates and multiplies fast neutrons from the neutron driver. Failure of any components in the neutron driver result in a decrease in fission rate.

Next slide. The TSV is made using Zircaloy. It is designed and fabricated following the intent of ASME Boiler and Pressure Vessel Code, Section 3. Research staff requested a clarification on this point in an RAI. In its response, SHINE stated that while these components cannot be certified, due to their construction material, the intent of the code is to verify if the stress intensity encountered by the TSV under design load during the design lifetime does not exceed the allowable stresses of the TSV material.

This work is currently underway at Oak

Ridge, and those results will inform the final design of the TSV and the FSAR. All fabrication, installation and pre-service inspection requirements will be followed for the TSV. The TSV can be dumped to the criticality-safe TSV dump tank, via the TSV dump valves. There are two independent flow paths to the dump tank, each consisting of a dump line and a dump valve. The dump valves can be activated by both the TRPS and the TPCS, and failure of either of those systems will cause the valve to open. The light water pool is a safety-related feature that provides cooling to the TSV and provides an additional layer of protection against radiation damage for local SSCs. Its thermal mass is sufficient to cool the TSV while the neutron driver assembly is shut down.

MEMBER BROWN: You said the TRSV system, that would shut it down. If it failed, it would automatically open the valves to dump. Those are all digital control systems, and there are multiple modes of failure, at least based on the Chapter 7 discussion. If I sit here and think about the multiple modes of failure, not all modes of failure are going to open either one or both of -- both the

valves are in series.

I just had a big question mark relative to that. If at some point, not necessarily in this presentation, but later, since the Chapter 7 is so general that there's not much technical information in it, that point ought to be addressed fully. I'll provide more discussion on that tomorrow, but since you made the statement, I thought I'd leap into the fray here, okay?

MR. BOYLE: Okay. Is it fair enough to leave that for the Chapter 7 discussion?

MEMBER BROWN: Yes, it is. I just wanted to give you a heads up, that's all. If there's not enough detail right now, that's fine. All you've got to do is tell us that. Based on looking at Chapter 7, nobody has any idea what the systems look like yet.

MR. BOYLE: I'm sure we'll see more information about that coming up in the FSAR.

MEMBER BROWN: Thank you.

MR. BOYLE: Let's see Slide 16, please. Preliminary design of the biological shield is designed to meet the goals described in Chapter 11 of the PSAR and the requirements of 10 CFR Part 20.

Proposed materials and configuration are consistent with staff-endorsed guidance. The final result of the shielding calculations will be provided in the FSAR. Next slide. The proposed design describes the reactivity and reactivity changes of the system during all modes of operation, including reactivity for of the IU components for each mode of operation, the wroth of the water held up outside the TSV, and the effects of removing that water, and expected changes in reactivity that would occur due to voiding of the cooling system. Minor power oscillations during operation are expected, but should be small and self-limiting due to the low power density and negative temperature coefficients. In the case of an off-gas system failure, the resulting void collapse will cause a small reactivity increase, but not large enough to result in a criticality.

A complete analysis of TSV kinetics will be provided in the FSAR. SHINE has described its preliminary calculations of target solution physics parameters, including which codes it intends to use and benchmark data describing its target solution qualification program. SHINE will continue its validation efforts as it develops the final design.

Staff has also reviewed SHINE's uncertainty analysis for the calculations using these codes, which was submitted in its responses to the staff's RAIs.

The validation plan for this analysis will be included in the SHINE operating license application. SHINE's preliminary calculations show that the target solution void, temperature and power coefficients will generally be negative for all modes of operation. SHINE's analyses shows that the combined reactivity coefficients should be negative over the anticipated range of operating conditions.

MEMBER STETKAR: Tom, I always feel uneasy when people carefully choose words like will generally be negative. Is there some operating regime where you'll have a positive coefficient?

MR. BOYLE: Yeah, I included a sentence in here in case you asked that question. There seems to be a wiggle word included. They say depending on final design and estimated uncertainties. The goal is to keep the negative, but I think right now --

(Simultaneous speaking.)

MEMBER STETKAR: Obviously the goal is --

MR. BOYLE: Maybe the uncertainty might

overlap in spaces, so we'll take a much closer look at that once the FSAR comes in.

MEMBER STETKAR: Thank you.

MR. BOYLE: Slide 19. SHINE described its thermal hydraulic methodology for safety calculations in the FSAR. They're calculations involving fluid flow and convective heat transfer. Details of the methodologies, including validation of the methods and calculations results will be provided in the FSAR. Void formation should enhance the heat transfer in the TSV due to increased natural circulation flows due to buoyance effects. Natural circulation should also help prevent large non-uniformities in temperature and solution concentration.

MEMBER BLEY: Do you expect these to be new correlation-based thermal hydraulic methodologies, or is this relying on things we already know? Is there something peculiar about the physics here in thermal hydraulics that they need to do more experiments on to define a methodology?

MR. BOYLE: I'm going to be real honest with you. This is not -- this thermal hydraulic stuff, I'm not going to try to pretend I know exactly

what Joe was talking about, but he did not express any concerns about this to me, so I'm going to say that --

MEMBER BLEY: It doesn't matter for construction permit, but we'd certainly want to hear more about that later on.

MR. BOYLE: I'm sure we'll take a closer look at that in the FSAR. I think the idea was, like you said, it's not critical for the construction purposes.

MR. LYNCH: I've made a note of it, so we'll follow up.

MR. BOYLE: Let's see Slide 20. Staff concludes that the shine facility has considered all significant heat loads and has provided adequate heat removal capacity and heat transfer area to remove the heat loads and maintain the TSV fluid conditions under normal and abnormal conditions. Adequate heat removal is also provided for decay heat generation in the TSV dump tank. Fluid temperatures and heat fluxes eliminate concerns about critical heat fluxes in all cases. Off-gas has a recombination and condensation capacity to control the cover gas operating conditions and maintain them within normal

operating parameters. Let's see 21.

MEMBER BLEY: When or where are we going to talk about hydrogen --

MR. BOYLE: The next slide.

MEMBER BLEY: -- and your comfort with the way they told us they're going to be running at 2 percent normally and getting real darn close to the 4 percent in some cases?

MR. BOYLE: Let me give you my bit here, and then I'm going to talk about -- I've got sort of a response to that, if not a good answer. We asked about that in an RAI. We asked them what are the pressures expected during critical deflagration? They came back and they gave -- this is not marked proprietary. Is any of this proprietary for this RAI about the critical deflagration? They came back and said that the maximum pressure they expect during a deflagration is about 50 psi. They gave a description about the worst-case scenario they think that could lead to the deflagration including a complete blockage of the TOGS lines, or the TOGS is no longer available to control hydrogen concentration. Following the blockage, hydrogen concentration rise prior to the trip of the TSV, one

of the dump valves fails.

They ultimately said that they will ensure the design pressure of each component of the pressure boundary will be greater than the credible deflagration pressure determined in the final calculations, which will be performed during detailed design. Does that help?

MEMBER BLEY: It has me thinking we're going to want to learn a lot more about this.

MEMBER STETKAR: I don't know what a critical deflagration pressure is. Is that, by definition, less than a detonation pressure?

MR. BOYLE: They say that a detonation is not credible.

MEMBER POWERS: Detonations are dynamic loads. Deflagrations can produce quasistatic pressurization. Typically for this kind of an assembly, you can actually just calculate the deflagration pressure peak adiabatically. If roughly 4 percent of the peak temperature is 900 degrees Centigrade, and the pressure ratio is two or something like that, and it increases with concentration as you go up, until you hit stoichiometric, and then it’s stoichiometric beyond

that, then the pressure peak and the temperature peak come down. The point being is they're fairly well-defined quantities.

MEMBER BALLINGER: What you don't want to do is transition to a detonation --

MEMBER POWERS: It depends on whether you can tolerate the quasistatic load or not.

MEMBER BALLINGER: The detonation's going to be factors of ten or a hundred --

MEMBER POWERS: No, they're higher, but they don't load the structure very long, so it depends on the resonance of your structure. In fact, a lot of detonations you'd rather have that than the quasistatic load.

MEMBER STETKAR: Some of this -- I don't know anything about hydrogen. I literally don't know anything about hydrogen. I do know that in the PSAR, they specifically mention that they have a pressure safety valve connected to the off-gas system that ostensibly vents somewhere to passively prevent an overpressurization, which may cause structural damage to the IU. Now if I start thinking about what's going on with hydrogen and overpressure, I don't know what goes on.

MEMBER BLEY: It's got me thinking back four years ago. It wasn't a safety issue so much, but the original boiler off-gas -- PWR off-gas system used to have pops. The hydrogen would go up high enough and it turned out the static electricity generated by the flow would lead to pops. Those pops sometimes meant you had to replace a whole bunch of that system. If I were building this thing, I'd make real sure that even if it weren't a safety issue, it wasn't going to be a terrible operational burden.

MEMBER STETKAR: Or you didn't have to climb to the top of your turbine building because some of that stuff lit a fire on the top of the turbine building, for example.

MEMBER REMPE: At the very beginning, we were talking about it today. It looked like -- I guess it's 3.9 versus 4 for an accident evaluation. Again, I heard we've got a lot of conservatisms in there. I would think that we'd want to have a real good handle on where those conservatisms are so that, again, without some sort of best estimate and uncertainty evaluation that you felt comfortable that it was sufficiently conservative and how much margin there is in the design.

I realize we're kind of in Chapter 13 instead of Chapter 4, but it affects, I think, what some of the design parameter selections were in Chapter 4. I'm guessing that's what drove the 2 2 percent and all these other things. I don't have enough details to know right now.

MEMBER BLEY: It's worth telegraphing a little bit that we're going to be really interested in that. Often, we have people tell us this is very conservative. We took this parameter high, and we took this parameter high. All of a sudden, you say what about these other three? It turns out they were optimistic, so you don't really know where you sit. We'll be interested in that.

MEMBER POWERS: In these kinds of systems, the challenge you run into with hydrogen control is that you're measuring hydrogen in a mixture of water vapor and hydrogen and air and whatnot. Then it flows from where you're measuring it, which is warm, nominally 60 degrees, to somewhere it's cold, presumably somewhere around the cooling water temperature which, in Wisconsin in the wintertime, is fairly low. Water vapor condenses out, and your hydrogen concentration screams way up

on you. Then you get into the flammability region.

Whether we can ever get into a detonation region, the problem you have with detonations is they depend both on concentration and geometry. I don't know that we have big enough geometries that I would worry about detonations. Deflagrations you worry about and whether your safety relief valves protect you or not there depends on how fast the detonation wave velocity is. That, in turn, depends on turbulence in the flow and everything else.

MR. BOYLE: To address what you were saying, I'm comfortable with 3 percent during operation as a set point where things trip. The 3.9, if I remember correctly, is when it trips and the blower doesn't work.

MEMBER REMPE: It becomes an accident, yes.

MR. BOYLE: Now you're definitely in Chapter 13 territory, but for a normal operation, I'm comfortable with those limits of 3 percent --

MEMBER REMPE: Again, I think that 3 percent was because they were thinking about the accident. I'm guessing that's how they decided to set that. Again, it's pretty close when you think

about if that's the accident load how close you are to where you’re limits. I don't have enough information to evaluate it. We'd like to see more at some time.

MEMBER BLEY: Remember the stuff Dana talked about because that's under one particular condition, but if you're moving through different temperature regimes and the like, things can change.

MR. LYNCH: We'll make sure to address this in our accident analysis discussion.

MEMBER BLEY: Is that going to be in our next session?

MR. LYNCH: I'll have to check my notes.

MEMBER BLEY: It'll be good if we could do it then because that's where a lot of issues that might be important will come in.

MR. LYNCH: I can work with Maitri on the order of discussions.

MR. BOYLE: One last bit about the off-gas system is like we discussed before for the TSV and the support assembly, they have a Table 4A2.8-1 that describes the codes and standards to which the components of the TOGS will be designed to. We were comfortable with that. We'll have it in that last

slide here. The irradiation facility systems have been described, including the architectural and engineering criteria for the design.

Details that SHINE has chosen to defer to the FSAR are reasonable. Those areas that will require further research have been adequately identified. The staff concludes that the proposed facility can be constructed without undue risk to the health and safety of the public.

MS. ADAMS: For the radioisotope production facility, Section 4b of the PSAR described the RPF in greater detail than it did in Chapter 1. NMSS staff review addressed a general RPF and process description. The processing facility biological shield, which is different from the irradiation facility biological shield, the moly-99 extraction system, and SNM processing and storage, including both irradiated and unirradiated SNM. The summary included the names, amounts and chemical and physical forms of the SNM that will be in process in each one of the areas. We didn't get an exactly quantified flow chart of how much uranium will be here, and then how much will be there, but what we did were capacities of each one of the processes, which we

find to be satisfactory and conservative for a safety analysis. The PSAR included a list of byproduct materials in the RPF process solutions, finished products, and waste from the process.

NMSS staff used this information to perform an independent evaluation of the design features for radiation protection, criticality, safety, chemical safety and fire protection. As we reviewed this chapter, we thought about what hazards could be presented by the chemical and physical forms of the SNM and by-product materials and how we expect SHINE to protect against these hazards. That's where we're thinking red oil.

The PSAR also included a detailed description of the design and construction of the equipment that will be used while processing SNM outside the irradiation facility. The PSAR contains a general description of the design basis and implementation of any criticality safety features of the RPF for establishing and maintaining a nuclear criticality safety program. NRC staff evaluation of the criticality safety program is discussed in more detail in Section 6b, which the subcommittee will see in September. The PSAR contains a description of the

design basis and implementation of any hazardous chemical safety features of the RPF for establishing and maintaining a hazardous chemical safety program. NRC staff evaluation of the chemical safety program is discussed in more detail in Section 13b, which you'll also see in September.

MEMBER BLEY: When you look at the safety and the processing system, where everything is supposedly protected geometrically, you need, though, to look back at the irradiation facility to understand what could be the maximum concentrations you might be seeing in the processing facility. Have you been able to do that yet, or is that something you're going to look at?

MS. ADAMS: We had a whole lot of criticality RAIs. We've received responses to all but one of the comments, which I think we're supposed to get an RAI reply this week or early next week. Our quick safety reviewers are having a grand old time. Among our questions were that whole thing about homogeneity and concentration gradients. We were particularly concerned about the number of experiments at around the 20 percent enrichment. There are experiments on uranyl nitrate and uranyl

sulfate and the various chemical forms that we have. There are experiments that go from 3 percent all the way up to 90 percent. In one of the RAI comments, we strongly encouraged SHINE to focus the code validation on just those concentrations right around 20 percent that are way more relevant to us.

Section 4B2 of the PSAR, this is biological shield. I don't know what flag I'm on. I didn't write it down. Section 4B2 of the PSAR presents a design basis and a detailed description of the RPF biological shields, which are the hot cell walls for the supercell and for the UREX cell and for the waste treatment cells and the transfer piping shields. Those are different cells.

All materials used for biological shielding meet or exceed the requirements of ANSI/ANS 6.4.2, which Tom said is good enough for them, so it's certainly good enough for the production facility. The design and construction of the concrete portions of the RPF biological shield conforms to NRC Reg Guide 1.69, Rev. 1, concrete radiation shields and generic shield testing for nuclear power plants. The biological shield requires a number of penetrations, inserts, and other features

where the bulk shielding materials are reduced in thickness, or where the materials used in the penetration are less dense than the surrounding bulk material. Each such penetration will be designed with well-demonstrated techniques for non-linear paths supplemental shielding, location in areas of low incident radiation and other methods to reduce draining and leakage to ensure the 10 CFR 20 limits are met.

Supports and structures ensure biological shield integrity and quality control methods will ensure that fabrication and construction of the shield meet the design criteria. Essential physical and operational features of the biological shield were identified PSAR Section 4B2 and will be included in the tech specs that will be provided in the FSAR, Chapter 14 in the tech specs.

Limited conditions for operation and surveillance requirements for the shield will also be included in the tech specs. For the radioisotope extraction system, Section 4b3 of the PSAR provides a design and detailed description of the MEPS. The process vessels within the MEPS will be safe by geometry, and the batch sizes are pretty small.

That's in proprietary information, the size of the batch sizes, but we'll never get a whole -- there won't ever be a whole TSV dump tank volume in the MEPS cells. Those are very small quantities in the MEPS supercells. For SNM processing and storage, PSAR Section 4B4 describes the processing components and procedures involved in handling, processing and storing SNM.

The processing and storage of SNM is conducted in the production facility building, and the waste storage and staging and shipping building, which is a little building outside the processing building. SNM is used throughout their radiologically controlled area, in both unirridiated and irradiated forms. As the table in Section 4B -- it's Table 4B4-1 -- estimated RPF SNM inventory of the non-public version of the Chapter 4 -- yes, non-public version -- that specifies the chemical form, physical form and inventory in pounds and kilograms of SNM that'll be in each one of the processes.

This information is not public because it's security related. Six tables in that chapter list the physical and chemical properties of the recycled target solution, the spent target solution,

the UREX feed, the thermal denitration feed, UREX raffinate and thermal denitration product. NMSS staff used this information to determine potential hazards of the various forms and quantities of SNM and what protections are necessary. Section 4B41 of the PSAR presents a summary description of the process of irradiated special nuclear material. Three of the figures present process flow diagrams of the uranyl nitrate preparation, uranium extraction and thermal denitration processes, respectively.

This information includes data on expected levels of radioactivity, broken down by radionuclide. The description identifies points in the process where major separations are performed and describes the pathways of the separated radionuclides and other constituents. The processing vessel materials will be compatible with the process material contained to withstand the effects of corrosion and radiation.

The processing system will be designed to manage fission product and radiolysis gasses that evolve in the process. Hydrogen is not the only one. Section 4B also states that the uranyl nitrate conversion system prevents inadvertent criticality

through inherently safe design of equipment that handles the irradiated SNM. A detailed description of the criticality safety program will be provided in PSAR Section 6B3. NMSS, late last week, received responses to what we hope are the last RAI comments related to criticality safety. One RAI reply remains. Section 4B4122, and a table in that section, uranyl nitrate conversion system hazardous chemicals inventory in the PSAR identify hazardous chemicals that are used in the uranyl nitrate conversion system process. SHINE will have chemical inventory controls, including separation of chemicals based on the potential for exothermic reactions.

These chemical safety controls, in addition to procedures controlling the processing of irradiated SNM, will include measures to prevent accidents. These procedures and controls will be described in the final safety analysis report, under procedures. Those would be in Chapter 12, Conduct of Operations, which you'll see some of later.

Essential physical features of the irradiated SNM processing systems that are required to prevent the release of radioactive material and to maintain radiation levels below applicable radiation

exposure limits have been identified in Chapter 4B, and will be identified in way more detail in Chapter 11, the radiation protection chapter. Any other physical features identified during design completion and operational features will be identified and included in the tech specs in FSAR Chapter 14. NRC staff has determined that the process descriptions in Section 4B of the PSAR, together with the included tables and figures, provide a detailed account of the SNM in process, along with fission product radioactivity. The process descriptions for the uranyl nitrate preparation system, UREX and thermal denitration processes are sufficient to provide a clear understanding that these operations can be conducted safely in the RPF.

NRC staff is still in the process of determining whether the criticality control measures provided are in accordance with double contingency principle, and the uranyl nitrate conversion system processing facility provides suitable defense and depth for the contained processes. When NMSS staff complete review of the remaining criticality safety RAI replies, we'll know for sure.

Unirradiated SNM -- I just had a note to

myself. It seems funny to talk about the target solution preparation system at the end of the discussion, when it gets performed at the beginning, but here we go. Unirradiated SNM will be received in the form of uranium metal, those chunks that we were talking about, and stored criticality-safe in transport containers. Yes, the size of the particles is something that we thought of, too. Is this dust? It's not. Then it'll be stored in uranium metal storage in criticality-safe configuration within the uranium metal storage rack. Fuel Cycle has a lot of experience with uranium storage racks. All of our Fuel Cycle facilities store pallets and powder and things like that in criticality-safe storage configurations.

NMSS staff intends to confirm this criticality-safe configuration as part of the Chapter 6B review. The uranium metal will be dissolved in nitric acid, transferred to the recycle uranyl nitrate hold tank and converted to uranium oxide by the thermal denitrator. The uranium oxide will be stored for future production of uranyl sulfate target solution. Target solution preparation system components will be criticality-safe by design.

As with other areas where SNM will be used, NMSS staff intends to confirm this criticality-safe configuration as part of the Chapter 6B review. The target solution hold tank, glovebox, uranium receipt ventilation hood and thermal denitration interface glovebox will be designed and fabricated in accordance with American Glovebox Society guideline for gloveboxes. Nominal sizes and specifications of tanks, uranium metal storage racks, uranium oxide storage racks, uranium metal storage cans, and uranium oxide storage cans are provided in a proprietary version of PSAR Chapter 4. Essential physical features of the unirradiated SNM processing system that are required to prevent the release of radioactive material and to maintain radiation levels below applicable radiation exposure limits would be identified and included in the tech specs in FSAR Chapter 14 when we get that.

NMSS staff reviewed Chapter 4B in view of the acceptance criteria NUREG-1537 and the medical isotopes ISG and concluded that 4B is reasonably complete, with the understanding that more detailed information is provided in other PSAR chapters.

CHAIRMAN RYAN: Day's getting late.

Chapter 5.

MEMBER BLEY: Mr. Chairman, can I ask a question? If we go past -- we were scheduled until 3:00 tomorrow. If we go past that, is that a problem for you folks at all?

MR. BYNUM: We'll stay as long as you want.

MR. VAN ABEL: My name's Eric Van Abel, again. I'm going to discuss Chapter 5 of the SHINE preliminary safety analysis report, which is cooling systems. It may be a little less technical than the last presentation. Primary cooling systems in the SHINE facility are the primary closed loop cooling system, the PCLS, and the light water pool cooling system, the LWPS, which we mentioned both in the Chapter 4 discussion. The secondary cooling systems is the radioisotope facility process cooling system, the RPCS. The RPCS absorbs the heat from the primary cooling systems and other processes in the facility and discharges that heat, then, to the facility chilled water supply and distribution system, FCHS. FCHS is just a chilled water source for the plant that discharges its heat to the environment through standard refrigeration cycle

condensation coils -- condenser coils.

The primary closed loop cooling system, the PCLS connects directly to the subcritical assembly support structure, as we saw in the figures earlier in the Chapter 4 presentation, on the supply and return connections on that SASS. The SASS directs the cooling water flow over the TSV external surfaces, and the PCLS itself consists of a circulation pump, a heat exchanger, cleanup equipment -- there's a small cleanup side stream -- a cooling water tank, which provides head protection and expansion volume for the loop and associated piping components. Pressure, flow, level, conductivity, and temperature indication are provided on the loop. There's eight PCLS systems, one unique PCLS for each of the irradiation units. They're independent of failure. Any single PCLS would not affect the others PCLSs from functioning.

Next slide. The light water pool system contains the pool itself and a small cooling loop attached to the pool. That light water pool cooling loop removes heat from the neutron multiplier, the tritium target chamber that the accelerator's directing it's deuteron beam into, and the pool

itself. The pool receives some heat from radiation transport from the subcritical assembly.

The light water pool system draws in water from the pool, passed it through a heat exchanger, and discharges it to the bottom of the subcritical assembly support structure. Accident scenarios and normal shutdown operations, then the light water pool removes the decay heat from the target solution.

MEMBER STETKAR: Eric?

MR. VAN ABEL: Yes?

MEMBER STETKAR: Question. In the PSAR, there are a couple of descriptions of the pool, but when you talk about the LWPS in Section 5A2.1.1, it says the pump suction is from the base of the light water pool and discharges to the SASS after passing through the LWPS heat exchanger. Where's the actual suction piping connection to the pool?

MR. VAN ABEL: The plan, when we wrote the PSAR, was the suction at the bottom of the pool. The idea --

MEMBER STETKAR: Bottom of the pool, so I can drain the pool through that pipe?

MR. VAN ABEL: If you had a rupture there

-- one of the things we want to do, we want to look at the proper location for the suction in detailed design.

MEMBER STETKAR: That would probably be a good idea, not just a rupture of the pipe, but a leak in a valve or a leak in a pump packing or a leak in a heat exchanger.

MR. VAN ABEL: Yeah, a leak in a heat exchanger would direct water in because of the pressure gradient.

MEMBER STETKAR: It ought to.

MR. VAN ABEL: It ought to normally.

MEMBER SKILLMAN: Eric, let me build on John's question. In Section 5A2, about the fourth paragraph, the PSAR reads as follows: "There is positive pressure differential at each thermal petition, such that a breach in a heat exchanger would result in uncontaminated water at a higher pressure flowing into the potentially radioactive water at lower pressure." This is describing the thermal petitions between the LWPS, the PCLS, and the RPCS. Would you explain that to us, please?

MR. VAN ABEL: That is trying to, probably in too many words, say that the pressure of

the secondary system's higher than the pressure of the primary systems. So if the heat exchangers leak, water flow is from the secondary system into the primary system. Does that make sense?

MEMBER SKILLMAN: That makes sense, but what does that do for contamination?

MR. VAN ABEL: Both the PCLS and LWPS will normally have some small amount of contamination because they're passing water past the neutron field, so they're going to have activation in them, corrosion product activation, so they will have a small amount of contamination in them. The RPCS is normally not passing through a neutron field, so it wouldn't have radioactive products normally in it.

MEMBER SKILLMAN: If there is that flow, can there be a change in neutron multiplication?

MR. VAN ABEL: If there is a leakage through the heat exchanger?

MEMBER SKILLMAN: Mm-hm.

MR. VAN ABEL: No, that wouldn't affect the neutron multiplication.

MEMBER SKILLMAN: You seemed to hesitate.

MR. VAN ABEL: I'm trying to think. You

would detect the increase in the pool level either through your level detection on the pool, if it's the pool, or if the leak was on the primary closed loop cooling system, the PCLS, then you would detect the change in the level in the head tank. Both of those would be your primary indicators of a leak.

MEMBER SKILLMAN: Thank you.

MEMBER BLEY: They both use demin water?

MR. VAN ABEL: Yes.

MEMBER BLEY: With any kind of water treatment?

MR. VAN ABEL: There's a facility demineralized water system that supplies the demin water. The design for that is to design that to evaluate EA standards for research reactor primary coolant.

MEMBER BLEY: I'm sorry. What I meant was after you get the demin, do you add any chemical treatment to it, or is it pure demin?

MR. VAN ABEL: No, it's pure demin, and there's a cleanup loop on the primary system.

MEMBER STETKAR: Where is that system described in the PSAR?

MR. VAN ABEL: Which system is that?

MEMBER STETKAR: The FTWS, and I'll combine it with MEPS because as I understand it, MEPS is sort of a line off of it or something.

MR. VAN ABEL: I don't know off the top of my head.

MEMBER STETKAR: I couldn't find it.

MR. VAN ABEL: I don't think there's much description.

MEMBER STETKAR: I think there's zero description.

MS. KOLB: I think it's to be determined.

MEMBER STETKAR: I looked for it in Chapter 9, which is sort of where I decided I needed to go if I couldn't find anything, and I couldn't find it there.

MR. VAN ABEL: There's a table in Chapter 3 that lists the system.

MEMBER STETKAR: Yes, it shows interfaces and stuff -- Chapter 3, the --

MR. VAN ABEL: The cross-reference table in Chapter 3, that's kind of helpful, too.

MEMBER STETKAR: Actually, I didn't go look for it there. Thanks.

MEMBER SCHULTZ: Eric, you just happened

to mention the fact that you don't do chemical conditioning of the water. You have a demin system, and you've got a cleanup system, but what led to the conclusion that a chemical addition was not the right way to go to provide longevity with regard to corrosion?

MR. VAN ABEL: I don't have an answer to that at the moment.

MEMBER SKILLMAN: Let me build on Dr. Schultz.

MEMBER BLEY: I'm sorry, you just said you don't know?

MR. VAN ABEL: Yes, I'm not sure.

MEMBER BLEY: Nobody else up there remembers where that came from? Okay, sorry, go ahead.

MEMBER SKILLMAN: Let me build on Steve's question. Seems to me that there's a body of operating experience that goes back many years on how to operate and protect the spin fuel pool. That does include a chemical addition and demineralization, cleanup. We know how to do that, and we know how to do it real well. Has that been factored into this design?

MR. VAN ABEL: As I mentioned before, IAEA has guidelines on good water quality for research reactors. We're basing our system off of that guidance.

MEMBER SKILLMAN: Does that mean you have capability to adjust chemistry, or does that mean you don't?

MR. VAN ABEL: We ensure that we have the right chemistry going in, and we have a cleanup system to maintain the chemistry that we plan on.

MEMBER SKILLMAN: Thank you.

MEMBER STETKAR: Eric, are the -- I'm lost in acronyms -- the PCLS and LWPS heat exchanger ratings proprietary information?

MR. VAN ABEL: Yes.

MEMBER STETKAR: They are? Okay, I'll wait. Thank you.

MR. VAN ABEL: The LWPS cooling loop includes -- very similar to PCLS, includes a circulation pump, heat exchanger, a sidestream cleanup loop and associated piping components. There's no head tank, obviously, in the LWPS system, since the pool is there to provide expansion volume. The cooling loop itself, the active function in the

cooling loop is not credited in accident conditions. Pressure, flow, level, conductivity, and temperature indication are provided on the LWPS system.

There are eight of these systems. Again, they're independent for each IU cell, so it has a separate cooling loop for each of the separate systems, and the failure of one of those loops does not affect the other loops' functionality.

MEMBER SKILLMAN: Let me ask is there a common makeup system to all eight?

MR. VAN ABEL: Yes, the makeup system is common.

MEMBER SKILLMAN: They're really not fully and completely independent from each other?

MR. VAN ABEL: Yes, they have a common electrical power supply, and they're discharging their heat to a common secondary system, as well. But the actual units, themselves -- the pump fails, it doesn't cause the other units to have to shut down because that pump fails, but there are commonalities that are shared between the systems.

MEMBER SKILLMAN: I realize you're in the conceptual stage and you're considering how to construct this thing, I think it would be prudent for

the designers to recognize the elevation of any commonly attached plumbing needs to be at a level, that you cannot have a thermal siphon that'll take out all your systems without your knowing it. Thank you.

MEMBER STETKAR: Eric, before you get to -- I'm trying to intercept you before you get to -- I'll let you go. Just before you get to RPCS -- I'll let you get through the next slide, and I have a couple of questions.

MR. VAN ABEL: Great. Next slide. The general design features of the primary cooling system. The pool itself is safety-related, so the structure of the pool and the integrity of the pool is safety-related, but the active function of the PCLS loops and the LWPS loops are not safety-related. The pool itself is just a rectangular concrete structure with a welded stainless steel liner with a leak trace system behind it. The PCLS and LWPS are located in a primary cooling room. That room sits directly adjacent to the IU cells. That room has N-16 biological shielding around it, too, because there's some dose rate off the equipment due to N-16 and corrosion product activation. Makeup water is

supplied, then, from the primary cooling makeup water system. As we highlighted, this system is not much more than the piping runs and the flow controllers and flow control valves that connect the facility demineralized water system from the non-radiological area to the radiological primary cooling systems.

MEMBER SCHULTZ: Eric, for N-16, it's mentioned in a few places, which is why it seems so prominent, but that you're going to shield with regard to N-16. Was there other considerations associated for removal or to reduce --

MR. VAN ABEL: We've looked at putting a delay tank in as another possible option, locating a delay tank in the pool. The dose rates are fairly low. It's around 100 millirem for the worst-case dose rate inside the cell with the systems operating full power. Shielding is around that. It doesn't take much shielding to shield that.

MEMBER SCHULTZ: In order to prevent the complication, you determined that the shielding would be adequate?

MR. VAN ABEL: Yes, at this stage.

MEMBER SCHULTZ: That portion of the statement wasn't included in what I saw, so that's

good.

MEMBER STETKAR: Before you switch, let me get a couple of questions in that I had that I think you can address. If I look at the table of interfaces from the PCLS, LWPS, and we'll get to RPCS, I notice that they all have interfaces with the facility instrument air system for pneumatic control mechanisms. The process flow diagrams don't show me any valves, so I don't know what these pneumatic control systems are, but I'm kind of guessing they're air-operated valves. Is that correct?

MR. VAN ABEL: Yes.

MEMBER STETKAR: Have you looked at the effects of the failure positions of the air-operated valves on loss of air and what the consequences are? For example, if I think of PCLS, too much PCLS makes things too cold, which increases your activity. That's not so good. Too little PCS doesn't remove enough heat, which makes things heat up, which might be okay for reactivity, but might be bad for other things. Do you know what directions those valves are going to fail in each of those systems, and what are the consequences if I lose instrument air to the whole facility?

MR. VAN ABEL: Not yet. We plan to look at the valve locations and failure positions in detailed design.

MEMBER STETKAR: I just didn't know whether you'd looked at them.

MEMBER BLEY: When you look at that, although there won't be a regulatory requirement for this, experience in a lot of different facilities is that a great many losses of air aren't sudden, complete losses of air, for which you'll probably be well designed. They're gradual, and things start to drift here and there. It's worth thinking about what that could do to you, too.

MR. VAN ABEL: Understood.

MEMBER STETKAR: One more -- I'll let you make a note on that, then I have a pure curiosity question. This is not trying to set you up. I just never heard one. What is an air gap backflow preventing device?

MR. VAN ABEL: Essentially, it's two check valves, essentially, with a drain area in the middle so you can drain out the --

MEMBER STETKAR: I know exactly what that is. I have one on my sprinkler system at my house.

(Simultaneous speaking.)

MEMBER STETKAR: It just didn't call it -- thank you.

MR. VAN ABEL: Is it safety related?

MEMBER STETKAR: No. I don't want to get into it. It's inspected every year, as a matter of fact.

MEMBER SKILLMAN: Let me just ask this. Is there any connection between your air system and any water system?

MR. VAN ABEL: Direct connection?

MEMBER SKILLMAN: Yes.

MR. VAN ABEL: Not that I can think of at the moment, but we could get back to you on that.

MEMBER SKILLMAN: Get back to yourself on that one. Sometimes the construction will hook up the water system, and the next thing you know, what you thought was your nice clean air system has become a conduit, in this case, for a moderator, and you find that your air components do not function, or by the time you realize that they're not functioning, they've rusted so badly that you have to replace the whole system.

MEMBER BLEY: Even if they don't rust,

you'll never clean them out.

MEMBER SKILLMAN: Thank you.

MEMBER BLEY: Are you using oil free compressors for your compressor system?

MR. VAN ABEL: Not determined yet.

MEMBER BLEY: If you don't, you can get oil into the system. If you do that, you'll have all sorts of drift problems.

MEMBER SKILLMAN: Check out the Davis-Besse incident. The name of the game is minus-70 Fahrenheit dry air.

MR. VAN ABEL: So the RCPS absorbs the heat from the primary cooling loops. The primary cooling loops absorb the fusion and fission generated heat by the target chamber and the subcritical assembly. Then the RPCS also absorbs heat from other processes, such as the moly extraction systems that Catherine discussed earlier, uranyl nitrate conversion system, the tritium purification system, the heat exchangers on the TSV off-gas system.

The RPCS is a single system that services the entirety of the RCA and provides cooling to the primary heat exchangers. It consists of a heat exchanger, a head tank, redundant circulation pumps

and associated piping components.

MEMBER STETKAR: This system has one, and only one, heat exchanger for the entire facility, correct?

MR. VAN ABEL: Correct.

MEMBER STETKAR: If that heat exchanger develops a leak, or you have to do maintenance on it, you have to shut the entire facility down?

MR. VAN ABEL: You would have to shut down any processes that require heat removal, and that would be the radiation unit, cells.

MEMBER STETKAR: I said the entire facility because everything's cooled by this.

MR. VAN ABEL: Yes. There's a few things that don't require cooling.

MEMBER STETKAR: Anything that you can make money from.

MR. VAN ABEL: Yes. There's pressure, flow, temperature, conductivity and radiation detection instrumentation provided on the loop. The RPCS is maintained at higher pressures than the primary cooling system to reduce contamination potential from the primary system, should the leak in heat exchanges develop. The temperature of the

primary cooling systems is held constant by varying the flow rate of RPCS water to those primary heat exchangers. We have a temperature control setpoint, and then we vary the amount of RPCS water delivered to those heat exchangers to keep the primary cooling systems at a constant delivery temperature to the TSV.

Heat removal by the RPCS does not have a safety function. If we lose RPCS functionality, the systems have to be shut down. There's no significant amount of decay heat to other heat removal. That's a safety function.

MEMBER BLEY: You have a bypass or something - you'll bypass the heat exchanger to balance your temperature for temperature control?

MR. VAN ABEL: You would close the RPCS loop - close the RPCS water flowing to that heat exchanger.

MEMBER BLEY: Okay.

MR. VAN ABEL: And sampling and analysis is performed periodically for radiological contaminants in RPCS to detect for potential leakage and to ensure proper water quality. That's all for the cooling systems.

MEMBER SCHULTZ: Eric, a couple questions. In the - in the last presentation the staff talked about heat transfer with voids in the system. Does that have anything to do with Chapter 5 or are they talking about Chapter 13? Have you in fact done any work or reporting with -

MR. VAN ABEL: Can you refresh me on what the - the context of the discussion?

MEMBER SCHULTZ: Just in the previous presentation there was some discussion about how if you had voids you'd have better heat transfer than without them. But I didn't see anything in your discussion associated with this.

MR. VAN ABEL: In the target solution - those are the bubbles, the voids of the - of the bubbles increase the heat transfer -

MEMBER SCHULTZ: Okay.

MR. VAN ABEL: - from the target solution to the target solution. That's the wall.

MEMBER SCHULTZ: Okay.

MR. VAN ABEL: But we plan any voids in primary -

MEMBER SCHULTZ: On Chapter 5. Okay. I just wanted to double check. The other question I

had was on leak detection. Could you describe them in some more detail?

Where you come with respect to a leak detection system because it's descried as a level system but I'm trying to understand what type of leak - what degree of leakage you would be able to see in a level detection system within the facility.

MR. VAN ABEL: So for the - for the light water pool there's level detection, which would obviously detect gross leakage and there's also a leak chase system behind the stainless steel line there.

MEMBER SCHULTZ: Okay.

MR. VAN ABEL: To collect to a common drain point and it will be sectionalized so you can see what part of the liner that would be leaking should there be leakage.

MEMBER SCHULTZ: Okay.

MR. VAN ABEL: People at spent fuel pools know it is not uncommon there is some amount of leakage from the liners. Our water doesn't have boric acid in it, which is nicer. But there would be a leak detection system that would detect leakage from the pool liner.

And then the primary closed loop cooling system the level - the head tank is much smaller. So the level detection on that will provide much more clear indication of small changes.

MEMBER SCHULTZ: You mentioned earlier the leak detection system that you have in mind. I mean, the level detection system is what type of system?

MR. VAN ABEL: For - what I had discussed before, I believe, was for the target solution vessel and that was a differential pressure monitoring system. Here the exact level detected is not determined yet.

MEMBER SCHULTZ: Okay. Thank you. Any questions?

MEMBER STETKAR: Target solution pressure - I'm trying to remember - target solution pressure is less than PCLS pressure.

MR. VAN ABEL: Yes.

MEMBER STETKAR: So you get water into whatever -

MR. VAN ABEL: Whatever would go into the TSC -

MEMBER STETKAR: Into the target

solution. Is there an automatic makeup to the PCLS surge tank?

MR. VAN ABEL: No.

MEMBER STETKAR: There's not a - on that? Okay.

MEMBER SCHULTZ: Eric, in a couple places you've got descriptions of the system where you provide ranges for flow or ranges for cleanup monitoring and so forth in the cleanup system.

Does that mean that you got variable - you have a system that has variable flow that will meet the range that you've described or that the flow rates have not yet been set?

MR. VAN ABEL: The flow rates for the primary systems will be constant fixed flow rates. They won't be - we won't try to vary the -

MEMBER BLEY: I'm sorry. I couldn't hear all that. Could you say it again?

MR. VAN ABEL: The flow rates for the primary coolant systems of PCLS and the LWPS will not be variables that we control with the flow control valve.

They'll be constant flow rates once the final design is determined on what those flow rates

are.

The RPCS flow rate to the secondary side of that heat exchanger then that flow rate is a variable. That is controlled to reduce heat removal as needed.

MEMBER SCHULTZ: And then there was also a range provided for the flow associated with the cleanup system and it seemed like it was a fairly large range. Can you describe what is the flow capability of the cleanup system or -

MR. VAN ABEL: The design of the cleanup system will be that there will be some amount of liquid - some volume of water that needs to be added to the primary cooling systems and the operators will dial that in, whether it's through a known flow rate they want to set or it's predefined by the system and there's a totalizer that goes to that flow rate.

But there's a flow rate given in the PSAR to give an idea of the flow rates that we're looking at. But it's not - it's a small flow rate for makeup purposes, not to fill the pool.

MEMBER SCHULTZ: You describe in some detail the way in which the cleanup system will function. Is that derived from some model system

that one could - have you got a reference for that that you could provide?

MEMBER STETKAR: Steve, are you talking about UNCS or the cleanup bypass loops on the -

MEMBER SCHULTZ: The bypass loop cleanup system.

MEMBER STETKAR: Okay. I just wanted to make sure you're talking about the same - the same things.

MR. VAN ABEL: That cleanup loop is based off the IAEA good practices guidance.

MEMBER SCHULTZ: Okay. I haven't gotten to that document yet but I will. Thank you.

MR. VAN ABEL: Anything else?

MEMBER STETKAR: The same thing applies to you guys. I mean, you even have more lives. For example, you nominally live in this area. We don't.

MR. ADAMS: I do have one comment. There was a question about, I think, chemical additions in primary systems. And at least within the existing fleet of research reactors you don't see that at all.

Water quality is maintained by basically to mix bed the mineralizers. Conductivity is very

low and in most cases that limits PH to a very narrow range.

So that's basically how we maintain water quality and maintain low levels of corrosion in our systems.

MEMBER SKILLMAN: And Al, that's dandy and most of those demineralizers are organic. And they're great until they break through. In a system like this if you get the organics where they shouldn't be and you get the radiation levels we're talking about in addition to hydrogen - you got methane, ethane, propane and butane - and so caution. Hence, we ask the questions.

MR. WEITZBERG: I am Abe Weitzberg. I've been doing miscellaneous things in the nuclear field since 1958 and this is one of them.

Before I start, I'd like to express my envy of the committee's freedom to ask questions. It's not that as a review I haven't thought of some of those questions but we've been constrained to focus on factors of preliminary design and we're looking for a construction permit. So I thoroughly - I have appreciated all the questions you've been asking.

I'll try to make up some time. The principal purpose of the cooling system is safely remove fission and decay heat just about from everything - should remove and transfer the heat environment from all the significant sources.

The design of the cooling system is based on interdependent parameters. I could introduce here the fact that we don't have the benefit of the accident analysis and we're sort of focusing on normal expected operation. But for the construction permit we have sufficient information. Next page.

And we prefer - performed a very thorough - complete section by section we went through the entire report relevant to this. But as I said, we're limited to preliminary design information.

We looked at design criteria, design bases, the design information. We included the radiation unit, secondary cooling, cleanup and the makeup water systems and was noted by SHINE they don't have the nitrogen 16 control system and no aux systems - used a primary coolant.

The summary of the application - you've just gotten a more detailed summary so there's no reason to repeat it here.

The PSAR described the pressure flow temperature, conductivity, radiation detection instrumentation and raised the same question about pressure being an apparent measurement used to identify system leaks.

However, the staff determined that additional information was needed to evaluate the adequacy of the pressure measurement to identify system leaks and instrumentation for the cooling system functions.

Therefore, we issued a REI and asked about the ability of those pressure measurements. Next.

In response, SHINE stated that there were no plans to use pressure measurements to detect the presence of small leaks in the reactor cooling system, the - in the primary cooling system.

The pressure in the primary is greater than the pressure in the secondary and therefore prevents the transfer of contaminated liquid that comes back from the secondary into the primary.

It says small leaks will be also detected by a rise in the level of the expansion tank, periodic sampling and lock downs.

They also mentioned today that the level indication was going to be determined by pressure and this then gets into what we'll be discussing tomorrow but there is some question about the ability of these measurements to give you sensitive information to determine small leaks.

But for the construction permit we found that their response was adequate.

In REI 5a2.2-2, we requested additional detail on the instrumentation for the cooling systems to ensure that the intended functions are performed. SHINE committed to install adequate instrumentation to identify and quantify leakage rates including very small leaks.

The instrumentation would have the ability to identify leak locations as they relate to allowable leakage limits and the safety functions of the systems.

MEMBER SKILLMAN: Abraham, would you explain very small leaks, just from a practical perspective, please?

MR. WEITZBERG: Well, I don't know. That's why I asked the question just because I personally would like to be aware of leaks as soon as

possible and I would want them to reach a point where you have contamination collecting and other problems.

So it's enough, I guess, to be significant then I would defer to the applicant for him to tell me when would one would have to know when leakage was occurring.

MEMBER SKILLMAN: So what's - in your judgment, what's very small? For me maybe it's a half a CC a minute or a CC a minute. Is that the kind of rate you're thinking about?

MR. WEITZBERG: I would think so.

MEMBER SKILLMAN: Yeah. Okay.

MR. WEITZBERG: Yes, I'm used to having, you know, systems with tapes and electric indicators that it is moisturing in a place that should be dry. You get some electrical indicator. So -

MEMBER SKILLMAN: Thank you.

MR. WEITZBERG: In the section on the primary closed loop cooling system process function indicates that the water quality will be maintained to reduce corrosion and scaling and I believe you guys mentioned that before.

I come from a BWR background. I'm intimately familiar with crud and so I know there's

contamination - things build up over time and eventually gives you a problem.

Therefore, staff determined that additional information was needed to evaluate the impact of potentially toxic additives used to maintain water quality under corrosion and scaling.

In REI 5a2.2-3 staff requested a list of all potentially toxic chemicals expected to be on the SHINE side for water quality control.

And SHINE's response stated that they won't be used, and as they stated before today they'll be using filters and ion exchange resins to remove contaminants and maintain water quality parameters.

They said in the secondary system they may use nonphosphate buffers but the quantities would be very small, less than five pounds, and that they'll be stored in appropriate chemical storage areas and segregated from incompatible chemicals.

As far as our findings and conclusions, the staff finds that the level of detail provided on SHINE's cooling systems is suitable to determine that both the irradiation unit and processing facility have very low heat loads during normal operation.

The IU shutdown promptly drops that heat

load by an order of magnitude or more and there is no buildup of long-lived fission products.

SHINE has stated that there is no way for a major accident to happen that cannot be handled by this system.

While this statement must be substantiated by accident analysis, in the final design the design of the cooling system that's documented in PSAR is sufficient for the approval of a construction permit.

And based on engineering judgment, it is concluded that this level of review is adequate for the issuance of that construction permit because there is such a low heat load and therefore there is little or no safety risk.

And as far as how this relates to the requirements, the bottom line is the facility can be constructed without undue risk to the health and safety of the public. Operation is another question.

MEMBER STETKAR: This is - I'm thinking on the fly here so might not be completely - it might be less coherent than on - than I usually am. I'll just put it that way.

Our PCS cools everything. So if I lose

RPCS, it goes away, I will heat up - start to heat up the PCLS.

I will start to heat up the LWPS and I'll start to heat up but I'll lose cooling to the off-gas system condensers in all eight irradiation units.

Now, we've learned that if, I think, high temperature and PCLS actuates a trip function that dumps all of the TSVs into their dump tanks, okay, so I'm not critical anymore.

But I'm still evolving hydrogen. What happens if I lose cooling to all of the off-gas condensers and hydrogen recombiner condensers in all of the off-gas systems? Do we know? Do I know? I don't know.

MR. WEITZBERG: Well, I think you raise a couple of interesting questions which I haven't heard addressed, like, if you have a loss of one system for an incident you don't shut the others down but there will be some by which if you lose the secondary cooling everything should shut down as fast as possible.

MEMBER STETKAR: Everything should shut down but some systems it's - they make a point of saying that the off-gas system remains running

because you're still generating hydrogen that you need to take care of.

And I don't know enough about hydrogen - the gentleman - I'll lose the term loosely - sitting on my left here knows a lot more about it than I do. If I - if I lose -

MEMBER POWERS: I know the chemical symbol.

MEMBER STETKAR: If I lose - if I lose cooling and I don't care whether it's one or eight because I'm assuming they're all going to behave the same way, do I have a problem?

And I don't know because I don't know enough about - but what I'm trying to probe is how much - when you say this facility has enough information as designed, is that single RPCS cooling loop that's a fundamental part of the design and its loads are fundamental part of the design, have you thought about what happens if it goes away?

Not from a criticality perspective but from everything else that happens in the whole facility.

MR. WEITZBERG: Well, backwards to the radiation units there is a fair amount of V capacity

in the water in the pool -

MEMBER STETKAR: In the pool. I'm not worried about cooling right now. I'm just -

MR. WEITZBERG: The question is can the off-gas system be cooled -

MEMBER STETKAR: That's one thing that I could think about. I preface this by saying I'm thinking on the fly. I haven't thought about this.

But I would take it out also into the other - the rest of the process systems that are out there that are also cooled by RPCS - the same system, on the recovery part of the plan - the process part of the plan.

MR. WEITZBERG: Yeah, and I would wonder, depending on how - which functions are lost, if it's like loss of transmission to the - if the heat exchanger to the environment is lost can you continue to dump heat back into the pool.

I mean - I mean, there's all sorts of possibilities of replumbing or reconnecting if the capability is built in. I don't know. And the thing is I haven't seen the accident analysis and what the consequences would be of specific failures.

MEMBER STETKAR: Okay. Thank you.

MEMBER BALLINGER: If you lost the, like you say, lost - dumped everything then you lost a major source of radiolysis. Hydrogen.

MEMBER STETKAR: You're thinking about one particular function. That's what I'm trying to get people away from.

I'm trying to think about if I lose RPCS what happens throughout the entire facility? What happens throughout the entire facility?

All of what - everything that's going on, not radiologist, not anything. Everything that's going on, because it is a common system that cools everything - everything with the exception of, in fairness, a few other little things that aren't cooled by it, but everything that handles TSV - you know, the solution that handles, you know, the stuff I'm processing out in the recovery stream that's everything.

I'm just asking whether, you know, people have thought about that because it is a fundamental part of the plant design. I certainly don't have the answer. I mean, you know, I -

MR. LYNCH: We'll follow up.

MEMBER STETKAR: Okay.

MR. LYNCH: It is noted.

CHAIRMAN RYAN: Are there any questions from members of the public or those that might be here who want to make a comment?

Okay. Thank you very much. Appreciate it. Back to you, Mr. Chairman.

MEMBER BLEY: Mr. Chairman, we haven't heard on the phone yet.

CHAIRMAN RYAN: Okay.

MEMBER BLEY: She'll be right back.

MEMBER STETKAR: And I can say this because it's embarrassing to me. If there's anyone out there the only way that we have confirmation that the line is actually open can someone just say hello?

CHAIRMAN RYAN: Anybody on the bridge line, please?

PARTICIPANT: It's still open. We're here.

CHAIRMAN RYAN: Thank you. Is there anybody that wishes to make a comment at this point on the bridge line? We've not had anybody that's interested in making a comment so I think - is there any in the audience that wishes to make a comment?

I think we offered the opportunity online

and in the room and with that I'll turn it back. Is there a motion to adjourn? Okay, no.

MS. BANERJEE: No, wait a second. We have responses to your questions that require closing - I mean, in a proprietary session.

CHAIRMAN RYAN: I'm good. I'm done. Thanks for asking though.

MEMBER STETKAR: We can do that tomorrow. Last thing. They've taken notes.

CHAIRMAN RYAN: Is there any other business before the committee today?

MEMBER STETKAR: No, let's - no, we'll wait until the end of the meeting tomorrow to do that. We're just recessing today's session.

CHAIRMAN RYAN: With that, we'll recess until tomorrow morning.

(Whereupon, the above-entitled matter was adjourned at 5:14 p.m.)

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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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RADIATION PROTECTION AND NUCLEAR MATERIALS

SUBCOMMITTEE

+ + + + +

WEDNESDAY

JUNE 24, 2015

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ROCKVILLE, MARYLAND

+ + + + +

The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, at 8:30 a.m., Michael T. Ryan, Subcommittee Chairman, presiding.

COMMITTEE MEMBERS:

MICHAEL T. RYAN, Subcommittee Chairman

JOHN W. STETKAR, ACRS Chairman

RONALD G. BALLINGER, Member

DENNIS C. BLEY, Member-at-Large

CHARLES H. BROWN, JR., Member

DANA A. POWERS, Member

JOY REMPE, Member

STEPHEN P. SCHULTZ, Member

GORDON R. SKILLMAN, Member*

DESIGNATED FEDERAL OFFICIAL:

MAITRI BANERJEE

ALSO PRESENT:

AL ADAMS, NRR

MARY ADAMS, NMSS

STEPHEN ALEXANDER, Information Systems Laboratories

VANN BYNUM, SHINE

JIM COSTEDIO, SHINE

MIRELA GAVRILAS, NRR

BILL HENNESSY, SHINE

CHRISTOPHER HEYSEL, McMaster University

CATHERINE KOLB, SHINE

STEVE LYNCH, NRR

IRWIN PRATER, Sargent & Lundy

ERIC VAN ABEL, SHINE

ABRAHAM WEITZBERG, Information Systems Laboratories

STEVEN ZANDER, Sargent & Lundy*

*Present via telephone

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P R O C E E D I N G S

8:33 a.m.

CHAIRMAN RYAN: Can we come to order, please? It's the second day of the meeting on the SHINE Medical Technologies Incorporated presentation to the ACRS and with that short introduction I would like to - I'm sorry.

MS. BANERJEE: Yes, I guess it's SHINE.

MEMBER STETKAR: I think Mirela wanted to make a couple of remarks going in.

CHAIRMAN RYAN: I'm sorry, Mirela. It's fine. No problem.

MS. GAVRILAS: This is Mirela Gavrilas of the staff. Just last night we basically finished with the staff's discussion and Abe made the remark that - Abe Weitzberg, for the record - made a remark regarding constraints on the questions that we would ask.

So I apologize to Dennis for stealing Al but Al, Steve and I went back and discussed that and we wanted to make sure that we present to you the philosophy and asking questions and since Steve is the PM and he has been the filter and the conduit for the question I'm going to ask him to discuss it. Steve, please.

MR. LYNCH: Just real quickly, just as our philosophy of asking RAIs, you know, I don't want to - pretty much every RAI that I was given for the most part we asked the applicant and Frank can attest to this - they weren't always happy with all the RAIs we asked.

But part of my philosophy with this is if someone had a good question maybe it was or was not appropriate for construction.

For the most part, I wanted it asked because if someone has a good idea I don't want it getting forgotten, you know, two years from now when we're considering the operating license application and I want to make sure that SHINE understands what our expectations are for final design when they get there.

They may not be there now but this is what we're looking for. That being said, as the RAIs were being developed I did ask our reviewers to be conscientious of, you know, if there's a question that you - is not going to help you come to a conclusion that this facility can be constructed safely, consider holding it off.

Write down your question. You can share it with me and I - we can keep a document of it. But

maybe we might not ask it until operations.

And some of that is, you know, we're trying to be sensitive to the time of the licensee as well and, you know, what is the safety significance of what we're asking. If it's not going to help us with the licensing action in front of us, we did want to try waiting.

But that being said, you know, if someone has an idea of what we need to be looking forward to, you know, we want to capture that as well.

CHAIRMAN RYAN: All right. Thanks very much. Are there any other comments from yesterday?

MS. GAVRILAS: And not to be putting too fine a point on it, but there's awareness too that we are charging SHINE for a construction product review.

So therefore crafting questions at this stage has to be connected to the - to the construction permit.

CHAIRMAN RYAN: Thank you.

MS. GAVRILAS: It's a balancing act. Thank you.

CHAIRMAN RYAN: Any other opening remarks or questions? If not, I'll turn to the presenters from SHINE today. Gentlemen, please proceed.

MR. VAN ABEL: All right. My name is Eric Van Abel. I'm going to discuss Section 6a of the SHINE PSAR, which is the radiation safety features - engineered safety features - sorry.

For the irradiation facility, which is covered in 6a, that's the blue area again on the figure on slide 83. The discussion on the radioisotope production facility inherent safety features - the green area - will be discussed at a future meeting.

All right. Next slide. Engineering safety features are those systems that are designed to mitigate the consequences of accidents to keep radiological exposures acceptable and for SHINE that means to ensure radiological exposures are within 10 CFR Part 20.

We performed an accident analysis as described in Chapter 13 and that accident analysis came up with accidents that were required to be mitigated by ESFs and there were three categories of those accidents, which are listed on the bottom of slide 84 - the mishandling or malfunction of target solutions, the mishandling or malfunction of equipment affecting the primary system boundary and the tritium purification system design basis

accident.

So those are the three accidents mitigated by ESFs. It's important to note that SHINE's design does not require a containment like a traditional PAR reactor.

SHINE's power level and therefore its fission product inventory is approximately 10,000 times less than a power reactor. There's not much stored energy - very little stored energy as it - it's a low temperature system, low pressure system and there are low powers involved.

So SHINE does not have a containment. We have a confinement that confines radioactive materials should there be a release from the systems.

But there's not an energetic source of release like a power reactor that has a high pressure system that is at high temperatures as well.

So the ESFs performed the confinement functions should releases occur and the confinement is just a low leakage boundary that surrounds radioactive material to ensure that the leak rates are less than that assumed in the accident analysis.

The ESFs in the IF include the IU cell - IU cells themselves, the TOGS-shielded cells and the penetration seals on those cells.

They are low leakage seals on the penetrations of those cells and the zone one duct work as well connects to those cells and there are bubble tight isolation dampers on the duct work.

There are isolation valves on piping systems that enter and leave the IU cells and the actuation system, ESFAS, for the IF is a safety-related part of the ESFs.

And finally, the TPS confinement system which includes the glove boxes themselves if confine or release should occur the double wall piping that the tritium piping is contained within an isolation valve that limit the release. Yes?

MEMBER BROWN: Could you back up a slide? Could you back up a slide, please, to 84?

MR. VAN ABEL: Yes.

MEMBER BROWN: Just want to understand. The - trying to understand a little bit of difference between confinement and containment.

I read the words that you all had both in the ESF and the other ones and I guess I stumbled over what's meant by a low leakage boundary.

I mean, there's got to be a criteria in some form that defines what I guess low leakage is. Is that - but I didn't see it, couldn't find anything

that references the value you would be designing to. I understand the little bubble damper valves.

I mean, I read all that stuff but why confinement is better than containment. I mean, it's harder to do for containment.

MR. VAN ABEL: The confinement leakage rate for most of these cells that we're targeting is 10 percent. So over the course of an accident 10 percent of the material within the cell would be released beyond those penetration seals.

MEMBER BROWN: That would be translated into some amount that you know you have in the cell and is that in terms of curies or is it in terms of -

MR. VAN ABEL: Yeah. In the accident analysis we disbursed the material in the cell using the accident analysis methodologies and then we have some leakage out of the cell and that leaked material from the atmosphere in the cell to out of the cell is then exposed to workers and workers receive a dose from that material.

MEMBER BROWN: Okay. Does that just mean particulate - air particulate or does it also include liquid if there's something?

MR. VAN ABEL: It depends on the

accident. Generally it's going to be gasses and particulates for the accidents we're looking at.

MEMBER SCHULTZ: Eric, what's the technical basis for selecting 10 percent? Is it an assumption? Is it something melting or -

MR. VAN ABEL: Currently, it's an assumption. It's assumption based on engineering judgment that we're going to perform detailed analysis with the operating license using a code such as GOTHIC or some code to quantify the potential leakage rates from cells.

MEMBER SCHULTZ: So a design assumption -

MR. VAN ABEL: Yes.

MEMBER SCHULTZ: - in order to move forward with the evaluation?

MR. VAN ABEL: Yes. To set the boundary of where our design needs to be - a design requirement for the cells.

MEMBER STETKAR: Eric, have you done enough - easy to say no if you haven't but if - have you done any analyses to have any sense of what kind of margins you have from that 10 percent?

MR. VAN ABEL: Not yet. Not yet.

MEMBER STETKAR: Okay. It's as I

suspected. I just wanted to check.

MEMBER BROWN: You didn't give me - I know the accident. You've got an analysis. I guess it's in Chapter 13 is where the consequences are determined?

MR. VAN ABEL: Yes. Are described.

MEMBER BROWN: Do you have an idea how many curies you have in an IU at any one time? I'm trying to get my hands around what 10 percent means just on a ballpark.

I mean, is it one curie, two curies, a half a curie when you've got all the - everything going on?

MR. VAN ABEL: Thousands of curies are in the cell.

MEMBER BROWN: So 10 percent of a thousand is 200 curies and you can have that leak out?

MR. VAN ABEL: It's not leaking out of the SHINE facility. That's contained within the second layer of the SHINE boundaries. So the IU cells are the innermost layer of the HVAC design philosophy.

So that material escapes from that cell. It's also then contained within the second zone of

our HVAC system.

MEMBER BROWN: That would be the IF - the overall facility?

MR. VAN ABEL: Overall, and then isolation dampers close on the IF as well.

MEMBER BROWN: A lot of stuff. Okay.

MR. VAN ABEL: I think we're done with 86. Go to slide 87.

So the confinement boundary is comprised both of passive components and active components - the isolation valves and dampers.

Any components that are required for safety, required to perform this confinement function are safety related and safety related active components are designed with sufficient redundancy that they can sustain a single failure and not lose capability to perform their safety function.

So for the isolation valves that usually means having two valves in a series of redundant valves. Isolation valves and dampers take the position of greater safety.

Upon loss of action power which in all identified cases currently is to fail to close - to shut.

CHAIRMAN RYAN: Eric, could you share a

little insight on what is sufficient redundancy?

MR. VAN ABEL: In this case for the valves sufficient redundancy would be two valves in a series of - if you assume one valve fails for the single failure criteria.

CHAIRMAN RYAN: Okay. Thank you.

MR. VAN ABEL: Next slide. ESF actuation - so during normal operation the inside of the zone - inside of the IU cells and TOGS-shielded cells is zone one and if maintained at a lower pressure then the surrounding environment which encourages in-leakages of that cell to minimize contamination outside of those cells.

In the event that there is a release detected from the equipment in those cells, the TOGS-shielded cell, the IU cell or the TPS glove boxes, the materials confined initially by the walls of the cell or glove box and the high radiation detection in the exhaust lines detect the increased radiation and initiate confinement.

Confined isolation signals generated by ESFAS which we'll discuss in Chapter 7 as an analog relay-based system and the confinement isolation signal closes the isolation valves and the confinement area is isolated and held up.

The ESFs are periodically tested to ensure components can perform their intended safety functions.

The penetration seals that will be required to ensure the leakage rate meets the assumptions as specified in this preliminary analysis will be tested for leak rate.

Isolation valves, bubble tight isolation dampers will be tested for leak rate and the glove boxes and other components that are required to maintain confinement will be tested as part of the technical specification requirement and the testing - the actual required testing and the testing intervals are to be provided with the operating license application in the technical specifications.

CHAIRMAN RYAN: Just so I can get a handle on it, how many barriers are there between the radioactive material and outside the cell?

MR. VAN ABEL: For - it depends on location of the release. So the primary system boundary is the - what we discussed yesterday, the TSV - the TSV off-gas system, the dump tank.

If the release occurs outside of that SASS then your release would go into the TOGS cell atmosphere or the pool if it's in the IU cell to be

released into the pool.

And then that IU cell or TOGS cell is the secondary boundary that would close and isolate and if it leaks out of that cell it's then contained within our radiation facility boundary and that would be the barrier to release from the - to the environment.

CHAIRMAN RYAN: Okay. Thank you.

MR. VAN ABEL: Next slide. The section in the NUREG is to describe emergency pooling in NUREG 1537 and the emergency cooling for the SHINE facility is accomplished by the systems we described earlier.

There's no separate emergency cooling system because the decay heat removal requirements are minimal for the system.

So there's no dedicated emergency cooling system. All emergency cooling is performed by the light water pool for the target solution.

MEMBER STETKAR: Eric, how long - I haven't looked at Chapter 13 so it might be in there. I can't read everything.

How long can the light water pool remove heat? In other words, just have the accident walk away, don't need any other make up forever?

MR. VAN ABEL: You know, we've analyzed

it for three months and it's 7 degrees over three months.

MEMBER STETKAR: That's good enough. Thank you. I'll give you 90 days. Thank you.

MR. ADAMS: I'd like to start by just saying a word or two about containment versus confinement. It's discussed in NUREG 1537 and also ANS standard 15.1 discusses it.

It's normally based on the accident scenarios. Normally containments can handle accidents that create positive pressure. Containments normally have specific tech specs about a measurable leak rate. Confinements do not.

Containments normally show up where you need a large amount of shielding because of some accident that creates an internal radiation field and it's - interesting enough it's not power related.

For example, I work at a two megawatt research reactor that had a true containment NIST at 20 megawatts has a confinement. So it's driven by the accident scenarios and what's needed to contain the radioactive material from those accidents.

MR. HEYSEL: Good morning. My name is Chris Heysel, for the record. I've been working in operations of research reactors and nuclear

facilities for over 28 years and I'm here today to talk about Chapter 6.

The first six slides are repeats of what you've seen and what SHINE has presented. So we can proceed to slide seven.

To discuss the preliminary design and performance of SHINE's IF ESFs in support of the issuance of construction permits, staff conducted a thorough and complete section by section evaluation of the technical information presented in Section 6a2. A follow-up assessment considering SHINE's response to RAIs raised during the initial evaluation was -

MEMBER STETKAR: Chris, pull your microphone a little closer to you just to make sure we get you on the record.

MR. HEYSEL: Okay. A follow-up assessment considering SHINE's responses to RAIs raised during the initial evaluation was included in our assessment.

The three topics reviewed - summary description, detailed descriptions and emergency cooling systems - the summary descriptions SHINE provided Section 6a2 forms the basis for the evaluation performed in Chapter 13 accident analysis.

Table 6a2.1-1 described the ESFs required to maintain the confinement function during three design basis accidents analyzed in the PSR.

Following its review the staff initially determined that 6a2.1 of the SHINE PSAR did not contain enough information for an overall understanding of the functions of the ESFs.

In an RAI 6a2.1-1 staff requested that SHINE provide a description of the conditions under which the ESFs must function, dot diagrams and drawings to clarify that the location basic function or relationship of each ESF to the facility and additional clarifying information.

In response, SHINE provided the additional details on conditions under which ESFs were required to operate, specific ESFs credited in the PSAR and the other topics requiring clarification including appropriate references to the other sections of the PSAR.

Additionally, the applicant provided a new block diagram showing the basic functions and relations of the SSCs providing the confinement ESFs in the IF and the relationship between each ESF SSC and the confinement.

With the response - with this response

staff concluded that sufficient information was provided in the summary description.

MEMBER BROWN: Were those drawings tested? Were those figures given to us? I didn't have any drawings for the ESF stuff. I did for Chapter 7 but not Chapter 6.

MR. HEYSEL: The drawings for -

MEMBER BROWN: I'm talking about the block diagrams you're talking about.

MR. HEYSEL: I'm not sure.

MEMBER BROWN: So they would ask for a clarification.

MR. LYNCH: I can make sure that - they were provided in the RAIs that I think maybe you were just given links to. But I can make a point of sending those specifically to you.

MEMBER SCHULTZ: We didn't get them.

MR. LYNCH: I'll make a point of sending them to Maitri so you can look at them.

MEMBER BROWN: Okay. I'd appreciate that. Are they along the lines of 78211 that was given to us for Chapter 7?

MR. HEYSEL: There were tables and charts. So -

MEMBER BROWN: Tables - okay. I'll wait

until we see them.

MR. HEYSEL: Section 6a2-2 identified a list of initiating events which did and did not require - did and did not have radiological consequences and required mitigation by the ESFs but did not explain the basis for this determination.

An RAI was raised to request that SHINE provide the basis for the determination and in the response SHINE provided a table referencing the specific radiological consequence analysis for each initiating event and committed to concluding a stable and final safety analysis report.

It its review of confinement systems and components, staff determined that additional information was needed to evaluate the adequacy of the design of the SHINE TPS confinement system.

Three RAIs were issued requesting information on the design and function of the TPS confinement system, isolation valves and automatic and manual circuits, bypasses, interlocks and special I&C systems.

In response, SHINE provided the requested information including references to other PSAR chapters as applicable, details on confinement system boundaries and isolation points, committed to

providing additional isolation valve details during detail design and updating the FSAR with a list, details or locations of these isolation points and providing clarification on the ESFs and duct work confinement - duct work in the confinement volume in response to RAI 6a2.2-2.

While reviewing the functional requirements of the confinement system, staff determined that additional information was needed to evaluate the adequacy of the SHINE confinement system to withstand and mitigate adverse environments and to understand the basis for the system design to meet the single failure criteria. Two RAIs were issued requesting SHINE provide the necessary information.

In response, SHINE provided the requested information. Additionally, SHINE identified an administrative error in its discussion of single failures and committed to correcting this error in the FSAR.

The staff found that responses to these RAIs acceptable and supported the issuance of the construction permit.

In review of confinement components, staff determined that additional information was needed to evaluate the secondary confinement barrier

of the IU cells, determined the adequacy of waiting to provide details on the TPS confinement system to be provided in the FSAR and to determine the systems open to the IU cells TOGS-shielded cell atmosphere in the TPS glove box. As a result, three RAIs were raised.

In response, SHINE stated that the facility does not have a secondary confinement barrier and committed to updating the FSAR.

MEMBER BROWN: But I thought they just said there were multiple barriers in the last conversation. Like the IU and the IF and then the RP - then the remainder of the total RPF or whatever. That seems to be inconsistent with the -

MR. HEYSEL: I realized that after the comments earlier this morning. I'll leave it to SHINE to answer that question.

MEMBER BROWN: Just which one is it? That's -

MR. HEYSEL: That's correct.

MR. VAN ABEL: Is this on? Can you hear me? So the - this is a wording issue. We have one confinement system that's actually called a confinement system and that provides a confinement barrier.

There are multiple barriers for fission products to give to the outside environment which is what I was describing in the previous session.

But there's one single confinement systems and we have some words in the PSAR that describe it as secondary. It was confusing wording and that's what we had corrected in this RAI.

It was not meant to imply that we had any fewer barriers to release fission products. It was a wording issue.

MEMBER BLEY: I guess that was less clearer than I was hoping. When you rewrite all this will the whole ventilation system set of barriers be part of what you call confinement or will that not? Will it just be the inner system?

MR. VAN ABEL: Yes. The ventilation barriers are part of confinements.

MEMBER BLEY: Okay. That's more clear. Thanks.

MR. LYNCH: I think - so I think really - so everything SHINE said in the previous presentation was correct. We - there was just some confusing wording when we were reviewing it and understanding what was meant by that.

MR. ADAMS: We normally don't consider,

for example, the fuel cladding or in this case the TSV tank to be part of the confinement system even though that is a barrier to fission product release. It's - the confinement system is the - were the contaminated areas.

MR. HEYSEL: SHINE also provided the rationale for not completing the detailed design of the TPS and committed to provide additional isolation valves during detail design and the FSAR staff found these responses acceptable in support of the issuing construction license permit.

In its review of engineering safety features and test requirements, staff found that the plans for testing of the ESF functionality and operability and preoperational and post-commissioning testing were not fully described.

An RAI requested the additional information. SHINE provided in its response the distinction between the terms functional and operable and also provided a list of planned and preoperational and post commissioning testing for the ESFs. Staff found their response acceptable.

In conclusion, staff found that SHINE had met the appropriate regulatory requirements in acceptance criteria specifically if the IF ESFs have

been described including the principal architectural engineering criteria for the design, further technical or design information may be reasonably left for later consideration in the FSAR and the proposed facility can be constructed without undue risk to the health and safety of the public.

CHAIRMAN RYAN: Any other questions or comments for -

MEMBER BLEY: Yeah, I've got one. Maitri and I had a little discussion. Should the more detailed work on hydrogen turn out to be that - some accident involving hydrogen turns out to be a significant event that maybe ought to - that needs to be mitigated, would there be any - would it - would there need to be some addition to the engineered safeguard features to deal with protecting for hydrogen?

MR. ADAMS: I would - I'll comment. I think it's sort of an iterative approach. You do your analysis. You identify those initiating events that require mitigation and you put in engineering safety features as required to provide mitigation.

So you're correct. If further and detailed analysis comes through the final safety analysis report then the proponent would be required

to adjust their engineering safety features to meet it.

MEMBER BLEY: Okay. Thanks.

MEMBER SCHULTZ: I just had a comment in general. Here we've seen a number of areas where the staff had provided a request for additional information to the applicant and the applicant has responded, and I reviewed the original information that was provided to the staff as well as the changes of the documentation - current documentation as a result of the RAI interactions.

I think the staff did a very good job in interacting with the applicant here because there were important things that needed to be documented in this section which were not and now they are.

Therefore, the applicant responded in a very appropriate way in terms of that document and it's done two things.

It's really augmented the importance of this particular section of the documentation and it's also provided some key links between what ought to have been in here in terms of consequence evaluation which will tie it to the accident evaluation in section 13. So I really wanted to compliment the applicant as well as the staff in this interaction.

MEMBER BLEY: I had just one follow-up and not for answering today, not wanting to sound like a one-trick pony.

But hydrogen - right now, and I don't know when we're going to review Chapter 9 with you folks but for both of you when we get to Chapter 9 there's kind of a throw aside little piece that says should it be necessary there are some things that we can consider such as recombiners and deflagration flame arresters and some other things.

I'll be interested in how you think about that, especially given what the applicant says is a real need to keep a fairly high concentration of hydrogen in the process.

So, you know, recombiners would seem an odd choice given that. So I'll be interested in that. But I'll say that before we get to Chapter 9.

CHAIRMAN RYAN: Any other comments? Questions? Hearing none, we'll proceed on. Yes, Chapter 7 is coming up. We just have to make sure - Steve Zander, are you on the line?

MEMBER STETKAR: Jim, make sure your mike is on.

CHAIRMAN RYAN: It's helpful too if you talk when it's on but if you're not going to talk

shut it off.

MR. COSTEDIO: Steve Zander, are you on the line?

MEMBER BLEY: It's so quiet I think nobody's allowed to talk yet.

MR. COSTEDIO: I know he's connected but I just don't know.

MS. BANERJEE: We are checking the line.

MR. COSTEDIO: Steve Zander, are you on the line?

MR. ZANDER: Yes.

MR. COSTEDIO: Okay. Thank you.

MR. VAN ABEL: All right. My name is Eric Van Abel with SHINE Medical Technologies. Unfortunately, our IT expert, Steve Zander, took ill and was unable to travel to the meeting today so I'm going to go through the meeting and he's available to answer questions as we go.

All right. So the incident and control systems are comprised of sensors, electronic circuitry and displays and actuating devices throughout the SHINE facility.

The I&C provides information and means to safely control the SHINE irradiation facility and radioisotope production facility to avoid or mitigate

accidents.

There are numerous parameters throughout the facility including neutron flux density, target solution temperature, coolant flow in temperature and radiation intensities throughout the plant and we'll discuss those systems in a moment.

The I&C systems have the capability to terminate the irradiation process when the safety parameters exceed the trip set points.

And then the irradiation facility and RPF facility, I&C initiate engineered safety features as well, which we'll discuss.

The primary - next slide, please - the primary I&C systems in the radiation facility are the radioactivity protection system which is the TSV reactivity protection system known as TRPS.

That's a digital protection system that's function is to protect the primary system boundary and ensure that the subcritical assembly remains subcritical.

The reactivity control system that's a digital controller as well. That's known as the TSV process control system - the TPCS - and that's for use for normal operations, the mode changes and shut down and start up of the assembly.

And then the engineered safety features actuation situation, ESFAS, which is a system that's diverse from the reactivity protection system, it monitors for radiation releases and uses an analog relay train to initiate confinement should the need arise.

MEMBER BROWN: Does the - this system have its own sensor systems feeding into this relay actuation function?

MR. VAN ABEL: It's getting information from the radiation area monitoring systems - from the RAMS.

MEMBER BROWN: So it's strictly a response on a radiation basis?

MR. VAN ABEL: Yes. So the radiation monitors will provide a radiation level information to -

MEMBER BROWN: An analog signal to these things?

MR. VAN ABEL: Steve, can you talk to that? I think it'll be - the signal itself will be evaluated at the RAMS.

MR. ZANDER: What was the question?

MEMBER BROWN: The sensing - the radiation sensors for the ESFAS - analog relay

trends. Is there - I mean, I presume if you're monitoring radiation you go to have an output and there's got to be a trip set point.

MR. ZANDER: Right.

MEMBER BROWN: Are those radiation monitors are they digital systems or are they the analog style systems?

MR. ZANDER: Well, we really haven't got too far along in the design to determine what we're going to use but they may be a digital system but they'll have an analog output available.

MEMBER BROWN: Okay. Do you know how many or is that show in the figures that I didn't have?

MR. ZANDER: No, it's not shown in the figures and I don't know yet. We have to see how many we need.

MEMBER BROWN: Okay. Is it a voting type system or is it a nonvoting type system? Single output? One out of one?

MR. ZANDER: It would be one out of one.

MEMBER BROWN: Okay. So I guess I presume the consequences of having an actuation are just isolation? That's what I got from the previous discussions. Is that - is that correct?

MR. VAN ABEL: Yes.

MEMBER BROWN: And that can be - that's not catastrophic anyway. If you isolate do you also shut down the -

MR. VAN ABEL: Yes.

MEMBER BROWN: There's an input from this to the other system.

MR. VAN ABEL: Yes, there is.

MEMBER BROWN: So consequently you get a shutdown via the TRPS and I guess the - whatever the TPCS. Is there any input to that? Is the process control being affected by an output from the ESFAS relay logic or -

MR. VAN ABEL: The ESFAS relay logic would initiate a trip via TRPS. TRPS would -

MEMBER BROWN: If there's no TPCS involvement then in the - from the ESFAS. It just stays where it is?

MR. VAN ABEL: I don't know if we know that at this point -

MEMBER BROWN: Okay.

MR. VAN ABEL: - what the - how the mode would change or -

MEMBER BROWN: So you don't know whether the rate - the actual sensing part of this is going

to be digital or - I presume it would be. So there will be more definition of that and when the FSAR is prepared, I presume?

MR. VAN ABEL: Yes.

MEMBER BROWN: Okay. So one out of one though you all have determined that and I guess what I'm asking there's - I presume there is more - is there more than one radiation monitor? Is this on a per cell basis - IU basis?

MR. VAN ABEL: Yeah. This is per cell and there would be two detectors minimum to detect a release from a single cell.

CHAIRMAN RYAN: Eric, I'm guessing those are two independent - those are two independent radiation monitors, correct?

MR. VAN ABEL: Yes.

CHAIRMAN RYAN: All right. Thank you.

MEMBER BROWN: Okay. So it's not - that's not two sensors feeding one -

MR. VAN ABEL: No.

MEMBER BROWN: - measuring set. It's two -

MR. VAN ABEL: Two independent.

MEMBER BROWN: - two independent tracks and an output from either one of them -

MR. VAN ABEL: Would cause a trip. Cause an ESFAS actuation which would cause a trip of the IU cell.

CHAIRMAN RYAN: Is there any circumstance where if they're both going off at once you'd have a different and maybe higher level response or not?

MR. VAN ABEL: Not in the current --

CHAIRMAN RYAN: Okay. Just sometimes it's set up that way, sometimes not. Thank you.

MEMBER BROWN: Okay. Thank you.

MR. VAN ABEL: Next slide. All right. This is slide 95. The TRPS and the ESFAS have the capability to trip any single IU cell or multiple IU cells independently and the TSV off-gas shielded cells are also isolated as well.

The TRPS is the safety related protection system that protects the primary system boundary and, again, the -

MEMBER BROWN: Excuse me. I guess I - when I first read this - first read this I got the impression that there was a TRPS for each IU.

MR. VAN ABEL: No.

MEMBER BROWN: And then when I saw the figure I figured - but there was no definition in

some of the other wording. So there was only one TRPS monitoring all eight IUs.

MR. VAN ABEL: That's correct. The TRPS is protecting the primary system boundary. The primary system boundary is the TSV - TSV dump tank and the TSV off-gas system and the connecting pipings as described earlier.

The ESFAS functions as the mitigation system that actuates the confinement boundaries as we discussed with the previous chapter.

MEMBER BROWN: So the common TRPS is a single channel protection even though it monitored, you know, with - but it can control any one IU or shut them all down based on your statement here. Is that -

MR. VAN ABEL: It doesn't - well, the TRPS protects and actuates a trip but it doesn't control.

MEMBER BROWN: I understand it doesn't control the trips, whatever's the dump levels to dump your target solution.

MR. VAN ABEL: Yeah.

MEMBER BROWN: They block them and stuff. But here you're saying the TRPS has the capability to trip either one or all. So I presume if you've got

a potential problem in one, in those independent sensors of some sort in each IU, correct?

MR. VAN ABEL: Yeah. If they were low PCLS flow, for example, in two units for some reason it would trip both of those units.

MEMBER BROWN: But it's still a single system.

MR. VAN ABEL: Still a single system.

MEMBER BROWN: Nonredundant.

MR. VAN ABEL: Well, there's internal redundancy which Steve Zander can discuss. Do you want to speak to that at all, Steve?

MR. ZANDER: Yeah. There would be redundancy in the system but it would be - and we don't know the exact design but it could be a multiple controller or a single controller. But it would - but it's one system. Let me put it that way.

MEMBER BROWN: I understand that. You're one system. But I'm just asking if there were multiple -are there more than one independent sets of some - if you read some of these it talks about two out of three functions for tripping stuff and if you've only got one set of processing for all the neutron detectors in all eight units feeding one monitoring platform of some kind that's not defined

yet? You don't - or you haven't laid that out yet or what?

MR. ZANDER: We haven't laid that out yet.

MEMBER BROWN: So that's still to come in the FSAR?

MR. ZANDER: Yes.

MEMBER BROWN: Hold on a minute. I'm looking at my notes. All right. I guess I'm having a little hard time getting my hands around that.

I don't quite see - there's only one system doing all of this stuff and it doesn't - I guess the redundancy issue comes to play in here somewhere. It's just a matter of how. So I'll go ahead and I'll keep my brain moving here somehow.

MR. VAN ABEL: Okay. So we'll go through the trip signals in that in a moment too here, which may help. The TRPS and ESFAS are evaluated for a postulated single failure to ensure that single failure would not prevent an IU trip or ESFAS actuation. The control system - the TPCS - is a separate PLC-based control system that's independent of the protection system.

MEMBER STETKAR: That second to the last bullet there, since you know nothing about the design

yet, is a commitment, not a statement of truth at the moment, right?

MR. VAN ABEL: Steve, can you talk to that a little? I mean, you guys have looked at safety-related PLCs and have gone over that in Chapter 7.

MR. ZANDER: Yeah. You're talking about the single failure?

MR. VAN ABEL: Yes.

MR. ZANDER: Yeah. That would - that's a commitment -

MEMBER STETKAR: Yeah.

MR. ZANDER: - because we just don't know enough about the specific design yet.

MEMBER STETKAR: Right. Thanks. Thanks, Steve. I just wanted to make sure I understood that.

MR. VAN ABEL: Next slide. The process control system - so I'll go through the process control system, the TRPS and ESFAS individually here.

Process control system is the process controller with self-diagnostic functionality internally to ensure that it can detect internal errors.

In radioactivity control, keep in mind

that the system is from a control standpoint is fairly straightforward. The radioactivity is added. You initiate solution transfers.

You add solution to the system and that's the only time you're increasing radioactivity through a control system is when you're adding that solution in discrete batches.

MEMBER BROWN: You've got a five and a half day period in which the reaction is going on. Is there feed being sent in during that? It's just one feed - close off and that's it?

MR. VAN ABEL: Yeah. It's a batch -

MEMBER BROWN: I understood the word batch, yeah.

MR. VAN ABEL: - that's delivered to the TSV and then it's isolated and that single batch is isolated in the system. The water that's removed from the TOG system is condensed and returned back to the - to the radiation unit.

MEMBER BROWN: So there's no - what I'm trying to make sure of is that - so whatever you initially introduce in there effectively sets the reactivity k-effective, whatever, the goal is to keep yourself in a subcritical mode. So it's strictly a function of your control of the initial load.

MEMBER BLEY: Let me ask Charlie's question a little differently. Once you set up the batch are there interlocks that prevent somebody from adding more? Or is it just administrative controls and operating procedures that control that?

MR. VAN ABEL: No, it's interlocks. Once we enter - mode one is where we do the filling and once we entered the second mode the fill valves are interlocked to prevent -

MEMBER BLEY: Okay. Thanks.

MR. VAN ABEL: - solution addition.

MEMBER BROWN: Okay. But those right now you're being - those are being interlocked. The functionality is being controlled by a digital control system - the TPCS is a digital control system.

MR. VAN ABEL: Those would be safety related interlocks so they'd be controlled through the TRPS. But yeah, it's digital.

MEMBER BROWN: They're controlled by -

MR. VAN ABEL: Digital control.

MEMBER BROWN: - a digital system.

MR. VAN ABEL: Yes. Correct.

MEMBER BROWN: And I guess one of the things I missed in looking at the diagrams and other stuff is, because it wasn't shown anywhere, is how -

what's the right way to phrase this - control signals are being sent to the TPCS by operators to control this to make the batch - I mean, to make the fill - the add? Somebody does that manually?

MR. VAN ABEL: Through TPCS and -

MEMBER BROWN: Through TPCS. Is there any information sent to other locations of the function - what's going on with the TPCS? In other words, data sent out to some other remote station?

MR. VAN ABEL: There is data communicated with the RPF controller, the RICS - the digital controller because there has to be a solution transfer between those. So they have to have the proper valve line ups.

MEMBER BROWN: What I'm trying to get to is you've got these digital control systems for both the TRPS and the TPCS. Are there networks that these things operate via or has that been defined yet?

In other words, how is the data transmitted throughout the facility and into the IF?

MR. VAN ABEL: Steve, do you want to discuss that?

MR. ZANDER: Well, I guess what we would say is that there is a network because they're digital control systems because we have to transfer

data from, you know, from the TRPS to RICS. But the exact architecture is not known right now.

MEMBER BROWN: Okay. Is there ability to admire or have information from that network outside of the RPS to management or corporate - a local office or whatever it is? Is this connected externally to the Internet, the networks -

MR. VAN ABEL: No, not the Internet, no.

MEMBER BROWN: - in any way, shape or form?

MR. BYNUM: No. The only reason we hesitate is we do have a - we have to have a monitoring capability for emergency response. But it's our intent that this network will be air-gapped from the Internet.

MEMBER BROWN: In other words, it will not communicate to the Internet even one way via data diodes or -

MR. VAN ABEL: It would be - it would be hardwired to our monitoring location for emergency response's purposes.

MEMBER BROWN: Okay. And that'll be specified in the FSAR when you prepare that?

MR. VAN ABEL: Yes. Uh-huh.

MEMBER BROWN: Okay.

MEMBER BALLINGER: So to make it very clear, there's no way that you on your iPhone out in the - at the McDonald's down the street is going to be able to monitor what's going on at the facility?

MR. VAN ABEL: Right. Correct.

MEMBER BROWN: Was there any intent to use wireless signals within the facility? I understand that but -

MR. VAN ABEL: Not for these control -

MEMBER BROWN: I'm being more explicit.

MR. VAN ABEL: No, not for any of these control systems. Not for TPS - TPRPS, ESFAS, RICS.

MEMBER BROWN: I know some people like to use wireless. That way they don't have to have wires penetrating boundaries.

MR. BYNUM: That would be very difficult, given the design of this facility. The massive concrete walls and rebar - wireless. I mean, we will have a wireless repeater within the facility for outside emergency response for first responders but not for anything such as regular -

MEMBER BROWN: That's not for data.

MR. BYNUM: No.

MEMBER BROWN: It's for voice communication.

MR. BYNUM: For fire departments or the radio's report because they have to respond.

MEMBER BROWN: Okay. Okay.

MR. VAN ABEL: All right. So the rate of reactivity increase is also limited by the fill system design - by the physical design of the fill system by the selection of piping and piping components and the pumping capability of the fill pump.

So there's a limited rate of reactivity increase and then the dump valves can only decrease reactivity upon opening. The TPCS controls four modes of the irradiation unit.

The three modes we discussed previously for the TSV, which are the actual TSV modes where the TSV is performing at function, and that's filling the TSV where we're loading fissile material into the TSV, the irradiation mode where the neutron driver is active.

The post-irradiation mode where we open the dump valves and the solution is either actively draining to the dump tank or is drained into - and is decaying in the dump tanks.

And then the fourth mode is the interaction between the RPF control system and the IF

control systems when we transfer a solution to the RPF.

The TRPS performs trip functions for each of the eight IU cells. So it will - there are four functions that are performed for a trip. Not all of them occur every trip because some of them have already occurred.

The whole thing of the TSV dump valves, the de-energizing of the high-voltage power supply for the neutron driver, closing TSP fill valves which would normally be closed during an irradiation process and closing the TSV dump tank outlet isolation valves.

So closing these valves moves the solution to the dump tank in the light water pool and isolates it from being moved out of that light water pool.

MEMBER BALLINGER: So in the case of loss of power, the fail - loss of power position for these valves and things are such that you maintain safety, right?

MR. VAN ABEL: Yeah. The dump valves open and the isolation valves close and the solution is moved to the dump tank and loss of power. The variables monitored -

MEMBER BROWN: Let me go back. You don't have to go back in slides because you've talked about the single failure and fail safe and all this other type stuff. Yesterday you made the comment that all failures of the control systems would result in opening the dump valves.

MR. VAN ABEL: Yeah, I think that might have been staff that made that comment.

MEMBER BROWN: I don't think so.

MR. VAN ABEL: Okay.

MEMBER BROWN: Because I asked - we don't need the - however it came up but I'm pretty sure it was you all.

MR. VAN ABEL: Okay.

MEMBER BROWN: And I may have phrased it improperly but the implication and then I went on to state that there were a lot of modes of failure that you could never analyze in a digital control system.

MR. VAN ABEL: Mm-hmm.

MEMBER BROWN: So would just - just to get on the record that somehow you're going to - in the FSAR you're going to have to provide some discussion as to how any potential failures modes in these digital control systems, particularly the TRPS, would result in opening the dump valves as opposed to

just not doing anything.

MEMBER STETKAR: Closing the dump valves, to be clear.

MEMBER BROWN: I thought you had to open the valves to get the stuff dumped into the -

MEMBER STETKAR: You're looking for spurious dump? That's not -

MEMBER BROWN: I'm looking for -

MEMBER STETKAR: Prevention of dump?

MEMBER BROWN: Loss of safety function dump which we talked about.

MEMBER STETKAR: Prevent the dump valves from opening or spuriously close the dump valves.

MEMBER BROWN: Maybe I'm wrong but I - you're going to have to explain this to me easier or again. You talked about failure modes would ensure that the target solution would be dumped.

MEMBER STETKAR: That's opening the dump valves.

MEMBER BROWN: Opening the dump valves, and that failures of the system would automatically open the dump valves, and my comment was there are a lot of failure modes that would not do - potentially not do that and that when we get the final FSAR it would be very important to clearly identify certain

computer system failures that could - like your computer locks up and decides to send no commands to anybody because it's a system - single platform right now - like you have the little pointer not move on your screen on the computer.

So that - I'm just - you made the comment. I just would be interested in making sure for the record that we make sure how that's - how that's accomplished and I'll probably expand on that in a few minutes.

MR. VAN ABEL: Okay.

MR. VAN ABEL: Okay.

MEMBER STETKAR: One of the messages that I think you may be hearing from us, which is kind of an undercurrent of a few things that I think you've heard yesterday and today is that when you do your failure modes and effects analyses or however you confirm that you don't have single failures in the design, many people fall into a trap of looking at what I call clean failures. It does not do what it's supposed to do.

I don't have power or I don't have cooling water flow or I don't have what I think I need.

You also need to look at failure modes

that can give you not that or too much this, too cool, for example, could give you negative consequences.

Spurious signals from a system that's not well designed could prevent safety functions from being performed, which is what Charlie's talking about here.

And, you need in your failure modes an effects analyses to also examine those types of conditions to give you some confidence that you have at least enough redundancy or you've thought about those conditions.

MR. VAN ABEL: Okay. The variables monitored for IU trip based on their preliminary design are as listed on the bottom slide 97 there. We're going to go through them individually, so I'll just go to the next slide.

And the hydrogen detection in TOGS in the TSV off gas system and the two detectors for hydrogen in the TOGS system located at the expected location of high hydrogen concentration. And those are voted one out of two for trip. Should either detector sense high hydrogen, the system will trip.

There are neutron flux detectors surrounding the subcritical assembly. The detector systems monitor the power and flux of the subcritical

assembly and there's an individual neutron flux detection system for each radiation unit. And so that --

MEMBER REMPE: Could you clarify, so there's three detectors and there's three for each irradiation unit, right? And there are 120 degrees apart on the same axial plane? Are they going to be --

MR. VAN ABEL: The same axial plane as the plan.

MEMBER REMPE: Center of the --

MR. VAN ABEL: To be evaluated. What's the most effective for the -- the position of the detector will change the 1 over M flux shape, you know, the position of the source location and as you fill up with uranium and the detector location will change how that 1 over M curve is of flux because the detector sees the different radiation field, a different neutron field, depending on where it is relative to the --

MEMBER REMPE: Right. So, if you fill it, it seems like at the bottom, you might want something or other because that's where it would go at first. Right?

And I'm just am wondering why three --

and then where you're going to pick and why three is enough? What was -- I mean is that adequate?

MR. VAN ABEL: Yes.

MEMBER REMPE: We heard yesterday that this is going to be during operations, I mean totally homogeneous. So the detectors are just during the filling is when it's of concern, not during the operation?

MR. VAN ABEL: During operation, the detectors are also monitoring the power to the assembly. So, they're ensuring that we don't reach high flux, trips that point high health limits in the TSV. So, they're monitoring the system during operation, too.

MEMBER REMPE: And, the three detectors, are they all going to be capable of doing source range and high range or is it when the source range and when a high range or --

MR. VAN ABEL: All three can do the entire plane.

MEMBER REMPE: The whole spectrum?

MR. VAN ABEL: From the source to the higher range.

MEMBER REMPE: Okay.

MR. VAN ABEL: This is a -- the intent

is this a commercial system that's used in research reactors.

MEMBER REMPE: And so, if you don't put them at the same axial plane, I'm just wondering, is there any experience to say that's adequate and what the basis of citing that as an adequate number of detectors?

MR. VAN ABEL: I think that's -- we have to comment to locate the detectors of the same plane. We'll do analyses during detail design to ensure that that will detect the different events that can occur, the different transients and events that can occur in the subcritical assembly.

MEMBER BROWN: How big is the TSV?

MR. VAN ABEL: That is proprietary information but we can discuss it later.

MEMBER BROWN: Big or small?

MR. VAN ABEL: It's bigger than it's small.

MEMBER REMPE: Bigger than a breadbox?

MEMBER BROWN: I was only asking it relative to the positioning of the detectors, you know, axial location.

MR. VAN ABEL: It's a fairly small assembly on the neutron flux distribution. It's well

coupled throughout the whole assembly.

MEMBER BROWN: So I'm not denigrating the question just trying to have an understanding of how it relates, that's all. Thank you.

MR. VAN ABEL: The neutron flux detectors at source and high ranges we discussed already and they're voted triad of the three detectors, that's two out of three logic for those detectors.

There are thermocouples in the primary cooling system. As we discussed earlier, three thermocouples with over- and under-temperature trips. The under-temperature trips preventing against access for activity insertion by overcooling and over-temperature trips preventing against loss of cooling functionality. And those are voted triad, two out of three.

Next slide?

There are flow meters in the PCLS, two flow meters and those flow meters guard against loss of flow in the primary cooling system which would be a loss of cooling accident. And there is one out of two logic, so either flow detector detecting loss of flow would cause a trip of the assembly.

There are inputs from the Engineer Safety Features Actuation System, so the ESFAS trip. If

either train of ESFAS, ESFAS has two independent trains, if either ESFAS train trips, the IU cell would trip as well.

And there are manual trip push buttons in the control room as well.

MEMBER BROWN: Excuse me, by IU trip, you mean the TRS?

MR. VAN ABEL: The TRPS trip.

MEMBER BROWN: the TRPS trip. Okay, thank you.

MR. VAN ABEL: There are two push buttons in the control room for each IU cell. So, each IU cell has two push buttons. Either push button being depressed would cause a trip of the IU cell of the TRPS trip.

And the following --

MEMBER BLEY: I'm just curious, when you do that, are they side by side and just there for redundancy or are they in different locations to let the operator reach them regardless of what he's up to?

MR. VAN ABEL: Not determined yet. They're there for redundancy.

MEMBER BLEY: Okay.

MEMBER BROWN: Relative to the manual

trip switches, I only brought this up once years and years ago and that's so, you've got two switches there on the panel and they're tied together and one wire goes out. That's not necessarily independent.

So, I don't know how you explain that but somewhere in the -- for these diverse backups, it has to be pretty clear when you're writing it that that's what you end up with, separately wired all the way out. It's a detail, but it's a critical detail if you're talking about manual backups.

MEMBER STETKAR: Well, and also, that they bypass all of the intermediate processing logic because I've seen many designs, especially older ones, where they were just a redundant input to the system that had already failed.

MEMBER BROWN: Yes, exactly. Thank you, John.

MR. VAN ABEL: The next slide please?

The Engineering Safety Features Actuation System mitigates consequences of the accidents as described previously. It's an analog relay based system.

There's really not much to do in terms of Engineering Safety Features Actuation for our system. It's fairly easy to accomplish with the relay based

system.

The ESFAS configuration allows any IU cell to be isolated independently. So, one or two or eight cells could be isolated, depending on the incoming actuation.

MEMBER BALLINGER: So, activated is really isolated?

MR. VAN ABEL: Yes. Yes, that's actuation.

And there are two independent trains, either train actuating with cost isolation of the cell.

MEMBER BROWN: Again, I presume that the FSAR would have some type of description and block figure and not a detailed wiring diagram, but a block diagram to show that literally there is no coupling between the two in any way, shape or form in terms of getting to the final actuation point?

MR. VAN ABEL: Yes.

MEMBER BROWN: Okay. For the record.

MR. VAN ABEL: All right. The ESFAS is designed to fail safe upon loss of power. So, should the ESFAS itself lose power, the IU cells would trip which is the isolation of the IU cells which, in turn, causes at TRPS trip.

The monitor parameters for ESFAS actuation are high radiation in the RVZ1 ventilation. So, this is detecting a potential release from the cell in the exhaust ventilation from the cells.

There are two independent radiation detectors with a predetermined trip value that actuates a relay that initiates isolation. It's one out of two logic, either detector actuating would cause the trip.

And there are manual trip switches as well for ESFAS actuation. There's two control switches, one dedicated to each train. Depressing either push button would cause a trip in the ESFAS actuation.

And that actuates ESFAS without any interaction from the visual control systems. And it needs to be manually reset following a trip.

All right. The RPF control systems, the RPF contains the extraction purification processes for the target solution where we extract the medical isotopes and purify the product, the target solution preparation and clean up processes and the waste treatment systems.

The off-gas I&C systems consist of primarily of the RICS and FICS which are digital

control systems. RICS is the Radiological Integrated Control System and the FICS is the Facility Integrated Control System that does a lot of the balance of plant controlling.

The radiation monitors between the two are -- the radiation monitoring systems which I'll describe at the end are shared between the IF and RPF.

The RICS is a safety related digital control system. When monitor safety parameters exceed normal conditions, RICS actuates the Engineered Safety Features to isolate the cells.

So, the ESF and the RPF, very similar to the IF provide isolation of confinement areas. So, the closed bubble-tight dampers and pipe isolation valves to close the -- to isolate a cell.

MEMBER BROWN: We just finished discussing how you isolate via ESFAS. This is different than ESFAS?

MR. VAN ABEL: Yes. On the RPF side, it's through a digital control system. It's the design.

MEMBER BROWN: It's the same damper? It's the same ventilation system actuating? I got confused when I was reading this.

MR. VAN ABEL: There are local isolation valves for the ventilation system on each isolable area. So, on, for instance, a supercell, the two isolation dampers on the inlet ventilation for that supercell and two isolation dampers on the outlet ventilation.

MEMBER BROWN: Okay, let me -- so, in the IU then, the ESFAS only affects the IF isolation?

MR. VAN ABEL: Yes.

MEMBER BROWN: And this system is for the outside the IF, the RPF part and the supercell area or is there another system for the supercell area?

MR. VAN ABEL: The supercell area is within the RPF area.

MEMBER BROWN: And both are digital controls because the document also then -- all right.

MR. VAN ABEL: All right. So, the ESFs in the RPF provide isolation functions and notify the operators of potential contamination should the ESF function be actuated.

Each of those isolable hot cells, you know, an individual supercell can be isolated and the ventilation Zone 1 and Zone 2 dampers at the outlet of the facility can be isolated as well.

RICS is sectionalized into two parts.

There's a part dedicated -- next slide, please, Jim.

It's sectionalized into two parts. One part's dedicated to safety related measurement and control and the second part of the system is dedicated to nonsafety related RPF functions.

The RICS is independent and isolated from other RCA systems. And again, the FICS is the digital controller that just controls balance of plant system such as our compressed air systems, our water systems and power distribution systems.

RICS initiates isolation for three items from preliminary design from our accident analysis. The first two items are nonsafety functions. With the hot cell fire detection and suppression system, actuation would cause an isolation of that cell.

The facility fire protection system actuation would cause isolation and the radiation levels on the exhaust from an individual cell would cause actuation.

And that third one is the safety related function that's credited in the safety analysis for maintaining doses below 10 CFR Part 20.

MEMBER BROWN: Is RICS -- you've got two trains of ESFAS for the IFs. Is it the same apply for the RICS, you have two trains or it just one?

MR. VAN ABEL: It's a -- Steve, do you want to talk to that?

MR. ZANDER: Yes, it's -- well, I don't think we've exactly determined how the design looks but it should be -- it's two trains.

MEMBER BROWN: Okay.

MR. ZANDER: I mean, yes.

MEMBER BROWN: Two independent trains?

MR. ZANDER: Two independent trains.

MEMBER BROWN: The -- okay. The radiation -- let me backtrack just a second since I said -- we talked about the radiation monitoring, the CAMS, RAMS and CAAS. You haven't talked about those yet, are they coming up?

MR. VAN ABEL: Yes, they are a few slides ahead.

MEMBER BROWN: All right, I'll wait. Just going.

MR. VAN ABEL: All right. And isolation of an individual cell initiates closure of the bubble-tight isolation dampers on the inlet and outlet of those cells and closing of the piping isolation valves.

And the isolation dampers and valves are fail safe and loss of power as well.

Next slide?

There are manual trip switches also planned to be located at each hot cell or other confinement area. So, a local operator can actuate confinement of that hot cell should the need arise.

RICS provides alarms to alert the operator when other monitored parameters throughout the plant exceed predetermined limits such as temperatures in the hot cells, differential pressures across the hot cell boundary as the hot cells are normally maintained below the negative pressure relative to the surrounding environment.

RICS also controls the normal process flow in the RPF. So, RICS is the system that's directing the movement of those target solution batches through the plant. It's controlling the valve line-ups to ensure you have proper valve line-ups and the pumping of the solution between the tanks the facility.

It monitors valve positions and checks those valve positions against predefined logic tables to ensure the proper valve line-ups are made.

Next slide?

The CAAS system, the Criticality Accident Alarm System --

MEMBER BROWN: One more question. I'm just being repetitive in a way, but just to make sure, the RICS similar to the TRPS is a standalone internal to the RPF system with no X outside influence so that --

MR. VAN ABEL: Same -- yes, same as the --

MEMBER BROWN: Program it and lay out your logic tables. There's no capability for an outside influence to change, interfere with or anything else, correct?

MR. VAN ABEL: Yes, same as TRPS, same design philosophy for that.

MEMBER BROWN: The other thing was, this only controls the flow of the target solution within the preparation mode and the -- when you want to put it into the IUs, that's done by the TPCS?

MR. VAN ABEL: The TPCS controls the filling of the IU cells.

MEMBER BROWN: Okay. So, there's a boundary condition as to what this influences and like you control the other stuff? Okay. Thank you.

MR. VAN ABEL: So, the CAAS is provided -- the Criticality Accident Alarm System, the CAAS, is provided for continuous monitoring indication and

recording of neutrons and gamma radiation levels to detect for an accident of criticality in the facility.

There are two detectors monitoring each area requiring coverage to ensure that an accident of criticality is detected. And local and remote alarms are provided to initiate personnel evacuation should a criticality accident occur.

MEMBER BROWN: Are there redundant systems for this or is it just one system?

MR. VAN ABEL: It's a single system with internal redundancy of the detectors.

MEMBER BROWN: Just the detectors? But the measurement and generation of the alarms is a single -- done by one unit? There's not two independent units? There's no redundancy within the entire process other than two detectors?

MR. VAN ABEL: I don't think I can -- I don't think we have that level of design to determine that for that.

MEMBER BROWN: This seems kind of important to detect a potential criticality. Am I wrong even though you have a very controlled design in terms of preventing it physically from happening?

MR. VAN ABEL: It isn't wrong at all.

MEMBER BROWN: It just seems to not have some redundancies such that if something fails, then you then failed -- so the detector detects something if it can't process it, it doesn't do you much good.

MR. VAN ABEL: Do you have anything you want to add, Steve?

MR. ZANDER: Not right now. I would think that there would be redundancy but I don't know that we have that level of detail right now.

MEMBER BROWN: Okay. So, I don't beat this thing to death, all of these digital control systems that do things like this, I guess we would expect to see, at least as a committee, we would expect to see sufficient description and either little figures or what have you to ensure we understand the nature of these beasts and whether they are independent and whether they are redundant or not. And if no redundancy is there, why it's not required.

MR. VAN ABEL: Yes.

MEMBER BROWN: At least I can't speak for the committee, I can only speak for myself. That's what I will be looking for.

MR. VAN ABEL: Yes. And the CAAS itself is a safety related system. By definition it has to

be protected against single active failures of the system.

MEMBER BLEY: That's like we're used to some event happens and then there's a single failure following the event?

MR. VAN ABEL: Yes, yes, and we designed it with the same philosophy.

Now, I'll discuss --

MEMBER BLEY: And you searched for the single worst failure?

MR. VAN ABEL: Yes.

The common systems between the IF and --

MEMBER BLEY: Sorry, this usually doesn't come up in our reactors, but eventually it does. Do you consider human actions as possible failures?

MR. VAN ABEL: Do you have anything, Bill? Can you talk about that?

MR. BYNUM: I'll comment on it.

MEMBER BLEY: I kind of think that's a no.

MR. BYNUM: No, I'll comment on it. We don't consider malicious acts as failures. But we do have to look at what happens if a person double batches, for example.

MEMBER BLEY: Okay, that's the kind of thing, something people do either intentionally because they think it's right or accidentally.

MR. COSTEDIO: But that would be the single failure. It wouldn't --

MEMBER BLEY: You would count that as a single failure?

MR. COSTEDIO: We would count that as a single failure.

MEMBER BLEY: Fair enough.

MEMBER BALLINGER: So, you don't consider malicious acts?

MR. BYNUM: We do not.

MEMBER STETKAR: But, we don't consider malicious acts for power reactors either, so we should not infer in this meeting that they should be held more accountable than the power reactors in that sense.

MEMBER BROWN: The only thing we do do is try to provide administrative controls to ensure malicious, you know, configuration control management and stuff like that to ensure malicious acts can't be done surreptitiously in some manner, particularly in these software based systems where if you changed a line of code or changed a, you know, something that

deals with the quantity that's going to get fed into something, you've got to be pretty sure you've got the right software.

MEMBER STETKAR: Eric, before you continue, let me just make sure I got the sort of really high level concept here.

If I lose cooling from RPCS, RPCS goes away. The TRPS should then respond to dump the TSVs in all eight irradiation units.

The ESFAS should then also isolate all of the irradiation units and the RICS should probably get a signal somehow to isolate -- irradiate the RPF.

Is that the likely --

MR. VAN ABEL: The TRPS would trip the IU cells, all eight IU cells to cover the loss of cooling. I'm not sure that the ESFAS and the RICS would isolate cells, though.

MEMBER STETKAR: Okay.

MR. VAN ABEL: There wouldn't be a reason to do that. None of the actuating -- the actuating signals are based on high radiation.

MEMBER STETKAR: Yes, okay. Okay. Okay.

MR. VAN ABEL: There wouldn't be a release concurrent with that.

MEMBER STETKAR: And RICS wouldn't -- what does RICS do if you get -- well, I don't know enough about the process. But RICS is initiated only by high radiation?

MR. VAN ABEL: Through isolation functions.

MEMBER STETKAR: Okay.

MR. VAN ABEL: Currently that's all it's identified in the preliminary design.

MEMBER STETKAR: Thanks. That's, like I said, pretty high level. So, thank you, that helps.

MR. VAN ABEL: All right, next slide?

The RAMS, Radiation Area Monitors, and CAMS, Continuous Air Monitors, throughout the facility and those record radiation levels to ensure safety of the personnel and public.

The radiation monitors, specifically the RAMS, provide input to ESFAS and RICS for confinement actuation functions. And the radiation monitors are present in personnel where radiation levels may become significant to ensure that those areas are monitored adequately.

And the specific layout of the radiation monitors is to be determined in detailed design based on locations of where piping and material may be moved

in the facility to ensure it's adequately monitored.

CAMS are also located where we have the potential for airborne radioactivity. Obviously, CAMS are much more sensitive to low levels of airborne radioactivity.

And beta monitors are present around the tritium purification system gloveboxes to detect and alarm for tritium rates.

Next slide?

CAMS monitors for personnel safety when monitoring for airborne contamination. RAMS detect releases in accident conditions and initiate confinement functions. And also there are alarms in the control room and locally with visual and audible indication to ensure that if there's a high contamination alarm it is visible to the operators and the local personnel.

Next slide?

The control room and instrument displays, so the IF and the RPF are both monitored from a central control room. There are two independent and redundant operator consoles for the irradiation facility.

On each of these consoles, there are displays for the TRPS and the TPCS and there's also

duplicated on these consoles are the RICS controls.

The TRPS and TPCS displays have annunciation alarm and operator interface displays.

And then there's a separate third console provided for the RICS functionality and that RICS console has the RICS and FICS, Facility Integrated Control System, displays on them. And the radiological monitoring information provided in the control room as well.

On the next slide, there's --

MEMBER STETKAR: Eric?

MR. VAN ABEL: Yes?

MEMBER STETKAR: Oh, okay. Never mind.

I guess I've got to ask why two redundant sets of consoles in the control room? It's rather unusual I think from our experience.

MR. VAN ABEL: It allows the operators to monitor any - either operator station to monitor multiple irradiation unit cells so that if one console's being used for a startup operation, for instance, and we find that two operators present for a startup operation and that would be the focus of those operators.

MEMBER STETKAR: And they're both live? They're both active at all times?

MR. VAN ABEL: That's the intent, yes.

MEMBER STETKAR: Does it double likelihood of getting spurious signals?

MR. VAN ABEL: Not that -- can you clarify that for me?

MEMBER STETKAR: Yes. If I push the wrong button on my computer, the screen just cleared. I have one button that does that, now I have two buttons that could do that. And they're both live and operating at all times.

Now, I don't know how likely that is, but it's just we're not used to seeing these doubly live -- we see designs that have alternate control and shutdown consoles but that are normally de-energized, you know, for diversity redundancy, things like that.

MEMBER BLEY: That's power reactors.

MEMBER STETKAR: That's power reactors.

MEMBER BLEY: You see it quite frequently in chemical processing facilities, especially when you have multiple tasks to do.

MEMBER STETKAR: Okay.

MEMBER BLEY: And you have multiple operators. The ones I've seen typically, they won't all be aligned to the same actual area.

MEMBER STETKAR: That's why -- I was

going to say, that's why they are live and functional.

MEMBER BLEY: It would be to different -- like to different cells and that sort of thing. But it is pretty common there.

MEMBER STETKAR: Is it? Okay. I'm not familiar with chemical facilities. Thanks.

MEMBER REMPE: But just to clarify what you're saying that they would prioritize and one group over in front of one monitor would have certain tasks on certain units and others would have a different something?

MR. COSTEDIO: That's correct.

MEMBER BALLINGER: And is there any chance that both of them could be operating on the same unit and doing things that might be counter?

MEMBER BLEY: That's what John raised.

(Simultaneous speaking.)

MEMBER BALLINGER: Is there some kind of unique means unique means other than looking over your shoulder and finding out that Joe is doing the same thing that you're trying to do?

MEMBER BROWN: Let me amplify that right now, okay? Just to make it clear.

MEMBER BALLINGER: That's a med alert.

MEMBER BROWN: I'm just -- I'm going to

use your comment.

I mean there's possibilities you've got two operator consoles that if one operator has selected IU-3 that that then locks out the other console from taking any positive action to do anything. You can do that.

For example, if I tried to log on to my particular A-12 from two different computers, I can't do it. I can only do it from one.

MEMBER BALLINGER: How do you know that?

MEMBER BROWN: How do I know it? Because it won't let me do it, that's why. So, that's how I found it out. Yes, it tripped, you're exactly right. It drops -- one of them goes away.

So, it's very possible, so it is possible to do that if you incorporate that thought process just to ensure there's no accidental attempt by two operators to perform different functions at the same time on the same IU.

MEMBER BLEY: This is something we'll really want to look at at the more refined design. But I think all these things, and I sort of agree. You need some protections to make sure you don't get yourself in a bind in this.

But, you're going to need them for doing

multiple operations which you're going to have.

MR. VAN ABEL: All right. So, on the diagram there the IF workstations are there and the RPF workstation is there with the radiation monitoring detection information in the center there.

Each of the boxes on the top and the bottom here are the neutron flux detection system racks and the ESFAS manual operator's panel is sitting here in the preliminary layout.

Next slide?

So, in the control room, the operator's direct visualization of essential values and has the ability to control and monitor processes throughout -- from the control room.

There are static annunciator displays planned to be available on each of those TRPS, TCPS and RICS panels which gives the operator quick, easy visualization of the status of each of the IU cells.

The functionality of the actual displays, the HMIs for the operators does not affect how the TRPS functions. The TRPS would still perform its safety functions if safety limits were exceeded even if the operator interface display was not functioning.

And there are also planned to be operator

interface terminals located at each hot cell that needs local access. And those operator interface terminals take values, take data from RICS and display it locally and allow some limited control of components in that hot cell for the local operator.

So, those operator interface terminals are really just extensions of the RICS system.

And that's all I have in Chapter 8.

MEMBER BLEY: I have one --

MR. VAN ABEL: And Chapter 7.

MEMBER BLEY: -- question. We talked about red oil a few times yesterday and you have no controls kind of directly aimed at that like monitoring where organics are and maybe you always know where they are and monitoring especially the temperature of areas that would have the organics.

But, as we say, I guess you'll want to come back to that. But, I don't know what your consultants told you, but if there are places where, in fact, temperatures could start rising under some accident conditions, I think you need to be thinking about that and thinking about ways you can make sure you don't get into a problem.

MR. BYNUM: Just to clarify one thing. We only have those organics in one location in the

facility, that's in the UREX hot cell. So, we do know where they are.

MEMBER BLEY: Sometimes what's happened is contaminates move from one area to another. I don't know if that's possible in your process. I haven't studied the process part well enough to understand that. Perhaps you have.

Both kinds of facilities I've seen where they have them localized in one part eventually some of those fluke steams go to other processing after they've been separated. But they have special monitoring to make sure that they don't get things carried into places they don't expect them to get.

CHAIRMAN RYAN: If I may, folks, I'd like to suggest we take a short break at this point. I'm sorry, I didn't know you want to ask a lot of questions.

MEMBER BROWN: Yes, well, I was waiting for Dennis to finish.

CHAIRMAN RYAN: Let me just finish then. After Charlie's finished with his comment, maybe we can take a short break and give everybody a breather for a few minutes. What do you say?

MEMBER BROWN: That's right. Well, this is a five minute comment. No, I'm just kidding.

MEMBER STETKAR: If you can hold it to five minutes, I'd be amazed.

MEMBER BROWN: I just wanted to make a couple of observations of some expectations for me, anyway, when we finally get to the end when it comes to a digital control systems for protection and/or control purposes.

In reading your alls, I guess, design criteria tables and verification matrix design basis descriptions, et cetera, et cetera, you make the observation that you selected a platform for the ECSs that have been previously approved by the NRC for use in safety systems, triple-redundant, modular, blah, blah, blah, whatever your magic words are for the processors.

The observation is that this does not mean that it is -- and you use that in the context of here, we're talking about independence that was one of the design criteria, protection system independence criteria, I think GDC 22.

But selecting that platform does not necessarily mean you have an independent architecture. That's just a platform, it's a box.

And, fundamentally, when we look at these systems, we look at them -- I look at them and

recommend to the committee that, for our purposes in the review, we look at redundancy, how you achieve redundancy, independence, deterministic processing, in other words, non-interrupt driven type processing in the platform, diversity of defense in depth, control of access which was the point I was trying to make on the networks as well as the simplistic -- a design that has some simplicity to it.

So, figures and discussion relative to that is what I look for to try to do an assessment of these features.

One example that we seem to get hung up on frequently is, when you've got voting level systems and the signals from a trip processor are sent to a voting processor, they're done with serial data. But one processor for generating a trip has to send a signal to two or three different voting units.

You can -- corrupt data can lock up all three and you never get a trip even though the others ones may be generating a trip.

People argue about that. We quit arguing about that six or seven years ago. When we brought this up, people may or may not agree with me, but that's the way you guard against that in the voting

units, if you're using a processor like your triple-redundant whatever platform for a voting unit, you have a watchdog timer. It's a hardware based watchdog timer that's independent of all the software. All it does is get triggered, you know, with a bi-stable type signal that says, hey, I've completed my sampling. I've completed all the processes. Go back and start over again. And I don't reinitialize everything, it just says I'm running.

And if it doesn't get it, then it goes out and says here's a trip. That trip can be a shutdown trip if you want to dump stuff or it can be an alarm, depending on what the function is.

But we look for that type of assessment to ensure that the computer based systems don't lock up and prevent anything from happening when you least desire that to happen.

The control of access, we talked about. So, if somebody comes up with the great idea that, gee, we've got all this data on the network, we can pump it out somewhere and all of a sudden, you're opening an air gap, Internet connection disappears, you want to make sure that's a hardware base, not an output.

There's nothing wrong with doing that if you want to do it as long as it's a hardware based digital diode as opposed to a software based firewall type system which can be compromised.

So, I just used a couple of examples to look at it from that standpoint. If you go back and look at some of our other letters if you can ever find them, you'll find copious discussion on these types of subjects, particularly the independence, deterministic behavior and control of access.

So, that's -- I just wanted to get that on the record so that you have at least some idea of expectations, how I look at things in order to try to make recommendations to the committee whether I think something is satisfactory or not.

Okay?

MR. COSTEDIO: Okay, thank you.

MEMBER BROWN: Did I miss anything? John? Dennis?

MS. BANERJEE: Could I just remind everybody That yesterday, I was trying to email you SHINE's electronic copy. I couldn't get them to size so I gave you CDs.

CHAIRMAN RYAN: Thank you, Maitri.

MEMBER STETKAR: By the way, Charlie, I

always have been a Bayesian and I continue to be a Bayesian. You spent five and a half minutes doing that. Thank you.

CHAIRMAN RYAN: With that, we'll take a 15 minute break. Please reconvene at 10:30.

(Whereupon, the above-entitled matter went off the record at 10:16 a.m. and resumed at 10:32 a.m.)

CHAIRMAN RYAN: Yes, we're going to start the record, please. And we'll come to order.

Our next speaker up is? Mr. Lynch?

MR. LYNCH: We're going to talk about instrumentation and control. But, right before we get into that, I just wanted to close the loop on our last discussion on Chapter 6.

We had a question from Charlie on getting the block diagrams and I provided that RAI that included those to all of you, so you should have a copy of that now to look at.

And also, I don't think we explicitly mentioned it, but we only covered the irradiation facility, ESFs today. We're still working -- MNSS is still working with SHINE on completing its review of the RPF engineered safety features and we'll be presenting on that half of the chapter later summer.

But with that --

MEMBER SCHULTZ: Steve, can we expect we'll get a revision to that half of chapter? In other words, we have that material.

MR. LYNCH: I don't think I gave you 6b. Yes, I didn't give it to you.

MEMBER SCHULTZ: We don't have 6b? I don't think we have 6b officially of the ACR.

MR. LYNCH: I thought I did not give it to you because it was not ready.

MEMBER SCHULTZ: We have the CSAR.

MR. LYNCH: Yes, yes, the SHINE -- you have not seen the staff's evaluation of 6b.

MEMBER SCHULTZ: Well, that's what I wanted to know --

ME. LYNCH: Yes, you will get that.

MEMBER SCHULTZ: -- if the SHINE information was going to change as a result of your interactions?

MR. LYNCH: We will work with SHINE on updating their FSAR --

MEMBER SCHULTZ: Okay, that's fine.

MR. LYNCH: All right.

MEMBER BLEY: We probably won't see that by August I would imagine.

MR. LYNCH: Right now, we're aiming for the September meeting for that.

MEMBER STETKAR: Right now, just for clarity, 6b --

MR. LYNCH: Yes?

MEMBER STETKAR: -- is scheduled for our September subcommittee meeting?

MR. LYNCH: Correct. Yes.

MR. WEITZBERG: Okay, I'm Abe Weitzberg. I was introduced yesterday.

Next, please?

I&C systems, you've been told what they have, the sensors, the circuitry, displays, actuating devices and the purposes to the safety control the irradiation facility and to avoid or mitigate accidents.

Just went through a thorough discussion of what instruments they were and that the I&C systems shutdown automatically the IU radiation units when they have to. And they're also designed to actuate the engineering safety functions.

Next?

As stated before, we've done a thorough review section by section of the information that was provided to us and supplemented by several RAIs.

We considered design criteria, the design bases and whatever relevant design information was provided to us. And we including reviewing the control system, the process control, reactivity protection system, engineered safety features, actuation control console, display information and radiation monitoring.

The application you've just been taken through, so I won't go over that again.

Our review of the design basis requirements, we determined that we needed additional information just to make sure that the postulating reactivity accidents would not result in damage to the primary system boundary or would sufficient disturb the targeting solution vessel and support the structures and the internals to impair significantly the capability to drain the vessel.

MEMBER STETKAR: Abe, on the slide you skipped, number 6, what's your and the staff's interpretation of the word independent?

MR. WEITZBERG: Independent?

MEMBER STETKAR: Independent. You said, you know, this is now the staff's conclusion or some application SHINE utilizes independent I&C systems to protect.

Oh, this is independent for protection and control?

MR. WEITZBERG: Yes.

MEMBER STETKAR: Okay. Thank you. I'm sorry.

MR. WEITZBERG: Yes, the systems are independent, yes.

MEMBER STETKAR: And protects the full systems are independent. I was reading the bullet in a way that I --

MR. WEITZBERG: Otherwise -- the PVOCs --

MEMBER STETKAR: Okay, I got it. I got it. I'm sorry. Thank you.

MR. WEITZBERG: Okay.

We submitted the RAI 7a2.2-1 want the details on the accuracy of the reactivity control and criteria to determine that draining the TSV is not impaired.

In response, the SHINE provided us the range and accuracies of the monitored variables. The response further stated that the nominal margin to critical volume in the TSVs, for example, is five percent. I note that that's an example, not a commitment.

With the five percent margin, there's -- I'll show you a little bit later, the TSV would be substantially more subcritical than the Applicant's target effective multiplication factor which is proprietary.

And the staff finds that this response is acceptable for the preliminary design.

In the review of the TSV process control description in the startup mode, states That the startup process calculates, not measures, but calculates a subcritical multiplication factor M from the neutron flux level and plus 1 over M versus the fill volume, which, in this case, translates to the high.

However, it's not clear how the bias and the uncertainties associated with the benchmarking of the criticality calculations, together with the expected variability and the process parameters and instrumentation readings, were being considered.

So, in RAI 7a2.3-1, staff requested additional information regarding the uncertainties including quantitative estimate of the overall uncertainty in their subcritical reactivity values during startup.

In response, SHINE stated the plans to

use a volume margin to critical approach and cited an example of overall uncertainty on those measurements at 30 percent.

And the staff found that that 30 percent number we looked at all the independent uncertainties and we figured 30 percent is a good estimate of what the overall uncertainty might be in each measurement.

MEMBER BLEY: What are the implications of that on the actual -- that's 30 percent on every instrument reading you're saying?

MR. WEITZBERG: No, 30 percent total. There's a one percent here, a two percent uncertainty in the enrichment.

MEMBER BLEY: So, what does that translate into in uncertainty on K-effective calculation?

MR. WEITZBERG: That is the bottom line question. I'd be happy to explore it with you. It's significant and it's a question that has to be addressed by SHINE when we get into the details.

MEMBER BLEY: It might mean you might not be subcritical?

MR. WEITZBERG: Yes, that's on the next slide --

MEMBER BLEY: Based on the reading?

MR. WEITZBERG: Yes, that was a good straight question. The next slide sort of --

MEMBER BLEY: You're welcome.

MR. WEITZBERG: Thank you.

MEMBER SCHULTZ: Abraham, I have another question.

MR. WEITZBERG: Sure.

MEMBER SCHULTZ: I didn't review that RAI response. Was it a detailed description of an example? The example was a detailed description that arrived at that conclusion of 30 percent uncertainty?

MR. WEITZBERG: Yes, you looked --

MEMBER SCHULTZ: Or was it --

MR. WEITZBERG: -- at all the different, you know, two percent here, three percent there, five percent there. The enrichment can be 19.75 plus or minus two percent.

So, you take a look and you say, you know, to say at any given point, if you did it a priori based on nominals, any given measurements, you could be off by 30 percent. And one by extrapolation, we'll get in to it here, you know, is something.

So, the reason I went to this chart is two separate reasons. First is, I think, this in Mode 1, the process of subcriticality which is the

only time you really deliberately add any reactivity is the key challenge to the I&C. I mean all the others are real challenges but this is a fundamental that you have to do physically.

Second is a nostalgia trip for me. I did my first real critical experiment Labor Day weekend, Brookhaven in 1958 with Herb Kouts, Joe Henry and Rudy Sher. I learned from people who sort of knew what they were doing.

I did SNAP critical experiments at Atomics International. I did C-4 criticals at CPR3 in Idaho. I did BWR criticals at GE Vallecitos. And after that, I developed all the nuclear methods that GE used for designing all their BWRs and I benchmarked them.

So, this is what I grew up on. Everything I've done after has not been as much fun as this.

But, in a nutshell, this SHINE reference sort of shows you what it's like. And, you know, this is a very accurate portrayal. You can't read the fine print down here, but it says if the extrapolation is concaved downward, it's risky. If it's concaved upward, it is conservative and, therefore, more safe.

SHINE says That they're going to try to make it concave upward.

The question was asked before about the location of the neutron detectors, that has, as you can see here from this chart which is real data, they're depending on the location of the detectors in relation to the source. You get three separate extrapolation data plots from three supposedly identical, you know, detectors.

And, to the question about actual location and stuff like that, even if two of them are in the same place, you see that those measurements differ.

So, I read in some of the documentation, you know, there are three detectors and some averaging, but when you plot them, I think you plot them each detector separately. I don't know how you auction That, how you decide where your critical point truly is.

And, in my experience, and I know it's a long time ago, the only time I knew I was subcritical was when I first found out where criticality was and backed away with it in known increments.

Without ever getting there, there's some uncertainty in criticality and I'm just stating the

problem and look forward to seeing the answer when SHINE gets into more detail.

And, even the location of the source is deferred to the FSAR so, we have to wait until we get more detail to say.

I mean, it's not an insoluble problem and there's always margin to deal with the uncertainty but then there is the increased margin which is in conflict with the desire for a higher k-effective to increase productivity.

And so, in a nutshell, I mean that's the challenge that we'll see down the road.

MEMBER REMPE: So, let me ask you what I asked them earlier about is three enough and what do you recommend?

MR. WEITZBERG: My guess is, for this purpose, three is plenty. In fact, the more you have, the more confusing the information will be.

MEMBER REMPE: But, if you only have one, I mean, do you really have a good handle on it?

MR. WEITZBERG: If you're going critical, yes. A lot of the old ones, you only had one. Because, I mean, if you have three, you've got to apply three, you've got to extrapolate three, you get three answers. Which one do you choose? The

most conservative.

And, basically, in these things, you add your increments are half of what will you think, based on your last extrapolation will take you to critical.

MEMBER REMPE: What about your plan to at least put them 120 degrees apart? Is there any benefit from doing that?

MR. WEITZBERG: Well, if you read the fine print down there, it says, if you're on the same size as the source, you're more closely coupled, you get a more immediate answer and it's better.

If you are on the other side, you're decoupled and you get the wrong kind of answer.

Conversely, this is a homogeneous solution. In SHINE's configuration, you actually have the neutron multiplier which, for the purposes of this, is an absorber which would affect the decouple the source from the detector which is bad.

So, there's no easy answer as far as what does the way to get the most concave upward curve and be, therefore, more safe when you're making the critical approach.

MEMBER REMPE: What about experience from other homogeneous reactors in the past?

MR. WEITZBERG: I have not researched

that. But none of them, I think, had a neutron multiplier in the middle.

MEMBER REMPE: Okay.

MR. WEITZBERG: And that -- later on, we'll get into more detail on related things. This is a new, unique configuration and somebody should be doing some research to determine where the best place to give you the best critical approach.

MEMBER REMPE: Okay. Thank you.

MR. WEITZBERG: It's an open item, I would think.

Next?

During the review of our approved reactivity protection system states that the only nuclear trips are on high neutron flux both in the source range and in the high range.

And, it's obvious that there are no anticipatory trips provided for high startup rates or short periods which are usually needed to adequately limit efficient reaction during high reactivity transients.

So, in RAI 7a2.2-1, staff requested analyses supporting the adequacy of the trips to avoid a possibly unacceptably high reactivity transient considering the uncertainties and possible

reactivity insertion events.

In response, SHINE stated that the trips would be supported by transient system modeling which is still under development and the results would be provided in the FSAR.

Before I say it's acceptable, my comment is, experience has shown that both on static and transient modeling, they are not any better, the modeling is no better than the experiments that are used to benchmark them.

So, modeling is good but the concern is that, yes, how good are they? So but, for the PSAR, the staff finds this response is acceptable both for preliminary design.

MEMBER BLEY: For Steve, primarily, is this a place where you've got something anchored in the RAI and RAI response --

MR. LYNCH: Yes.

MEMBER BLEY: -- to items related?

MR. LYNCH: Yes.

MR. WEITZBERG: Continuing the -- okay, there we go.

In evaluation findings and conclusions, the staff, we decided it meets the regulatory requirements and acceptance criteria for the issuance

of the construction permit, acknowledging that additional research and development activities are required to resolve some of the issues, that they're primarily associated with the avoidance of inadvertent criticality.

And, based on engineering judgment, it's concluded the level of review, it's satisfactory for this time because any modifications to the system design, this is I&C, or even in the source arrangement and operating procedures which are also important.

Here, I would mention the operating procedures have to do with the amount of time the operator takes to let his system reach steady state after he's added reactivity.

The closer you get to critical, the longer it takes. And the operator can say, oh, it looks like it's flat, I'm going to the next step. But prudent operations might include taking successive separate counts and seeing that they don't change.

I mean, and so, you get into operating procedures as well as hardware, but they can be implemented after the facility construction activities have yet been completed.

And again, you know, we feel it's -- the

information is sufficient for the issuance of the construction permit. And the bottom line is the facility can be constructed without undue risk to the health and safety of the public.

Now, we get into the radioisotope production facility, and same. You heard that RPF houses the different extraction purification packaging target solutions. And their systems are enclosed predominantly in hot cells and gloveboxes. Criticality safety is controlled through the use of geometrically safe designs and control the process variables.

I would digress here a second just to say the question was raised a couple of times by the committee about double-batching. If you're double-batching an increasing your concentration by a factor of two, does criticality-safe geometry allow for the fact that you have twice the concentration of uranium?

And so, there are a whole bunch of interacting factors that will have to go in. At the top level, you know, it's a conceptual design and that's what we're acting on.

And you've heard about RICS and the best safety function actuation as well as monitoring the

process control through the rest of the facility.

Next?

Again, we performed a thorough, complete review and we considered all the design bases and you just went through the application.

And during the review, staff concluded that there was insufficient information to determine that the RPF instrumentation was adequate to detect excessive deviations from the critical process variables.

And staff issued RAI 7b.3-1 asking SHINE, again, to provide additional information regarding the adequacy of the instrumentation to detect the deviations from nominal concentrations and quantities of fissile materials should they occur.

And in response, SHINE stated that the tanks containing fissile materials are designed to be criticality-safe and any excess liquid, in the event of an overfill, is contained in criticality-safe geometry configurations.

Liquid is also checked to verify absence of appreciable quantities of fissile material before transfers to the waste storage tank. And that they're going to be appropriate instrumentation that will monitor the tank level and the flow indications.

I'm sure there's more level of detail that will eventually come out, but at this point, again, the staff finds that the response is appropriate for the preliminary design.

When we looked at the engineered safety features and alarming, again, we requested Applicant provide additional information to justify how the location of the temperature sensors at the outlet, which is what the document said, of the uranyl nitrate conversion system is representative of the process.

In response, Applicant explained temperature sensors would be located at appropriate points to make sure that they're representative of the process and be sufficient to ensure safe and reliable operation of the system.

Specifics in temperature sensor locations will be determined during the detail design. And the staff, again, found this to be appropriate.

The findings and conclusions are basically, again, that the information contained in the PSAR supplemented by RAIs meet the regulatory requirements and acceptance criteria for the issuance of a construction permit with the acknowledgment that additional research and development activities are

required to resolve some of the issues.

And, based on our engineering judgment, it's concluded that this level of review is appropriate at this stage in the process.

And the bottom line of the findings and conclusions is that the facility can be constructed without undue risk to the health and safety of the public.

CHAIRMAN RYAN: Thank you.

MEMBER STETKAR: I think we're going to break for lunch because we have a long lunch hour. So, we will reconvene at 1:00 with Chapter 8.

CHAIRMAN RYAN: Sounds great.

(Whereupon, the above-entitled matter went off the record at 10:54 a.m. and resumed at 1:01 p.m.)

CHAIRMAN RYAN: Okay. Without further ado, I think, Bill Hennessy, you're up to take us through Chapter 8, Electrical Power Systems.

MR. HENNESSY: Good afternoon, everyone. My name is Bill Hennessy. I'm the engineering manager at SHINE. I want to talk about the final chapter for this session, the electrical power systems.

The SHINE facility electrical power

systems are common to both the irradiation facility and the radioisotope production facility.

And we have two systems. A normal electrical power system, which I'll discuss first, and an emergency electrical power system.

Slide 117. The offsite -- the normal electrical power system begins with offsite power which comes in through a single offsite circuit from the electrical transmission network.

It goes to two outdoor transformers, 12 kV transformers rated at 2,000 kVA each. Our connected loads are about 1500 kVA for each transformer. Those transformers are connected to our main 40-volt switchgear buses.

MEMBER STETKAR: Bill, before you get inside the plant, why is your fire pump powered from something outside of the owner controlled area?

On your one-line diagram for the offsite power connections, the fire pump is powered from the offsite power feed to switchgear bus A outside of the little dotted line that segregates SHINE from the utility, which, to me, says that you don't have control over the power supply to that pump. The utility does.

MR. COSTEDIO: What diagram are you on?

MR. HENNESSY: I think it's in the PSAR.

MEMBER STETKAR: It's in the PSAR. I'm looking at figure, in particular, 8a2.1-1. One-line diagram. Normal electric power supply system.

If you look at the left of that diagram and you see a little dotted line that says "utility interface" and above that comes off the supply to your fire pump.

It's located outside facility, but --

MR. HENNESSY: Yeah, I think that's probably not right. We'll have to check that.

MEMBER STETKAR: Okay.

MR. HENNESSY: The utility owns the transformers and the --

MEMBER STETKAR: Oh, the utility -- yeah, the utility owns the transformers.

MR. HENNESSY: Yeah. Right. And we're downstream of that. The metering point which is shown there would be the point at which our actual ownership would start.

MEMBER STETKAR: So, your little dash line is just --

MR. HENNESSY: I think the dash line is in the wrong place.

MEMBER STETKAR: Okay.

MEMBER SKILLMAN: Bill, this is Dick Skillman. May I ask a question, please?

MR. HENNESSY: Certainly.

MEMBER SKILLMAN: The transform from 12 kV down to 480 is not a common transforming ratio.

Why was that voltage chosen?

MR. HENNESSY: I don't know the answer to that. I'll have to look that up. I imagine that we're getting 12 kV from the utility and we needed 480 volt for our loads. And so, that's what was chosen.

MEMBER SKILLMAN: Okay. Are you getting it from a co-op, or from a large operator?

MR. HENNESSY: It's Alliant Energy. They're a large operator.

MEMBER SKILLMAN: Okay. Thank you. I'll go back on silent. Thank you.

MR. HENNESSY: Okay. So, we feed two switchgear from our two transformers where large loads are fed, the HVAC loads, feeds to two motor control centers per switchgear and some distribution panels. And the motor control centers then feed smaller loads such as motor loads and cranes and lighting and that sort of thing.

Next slide, please. The normal

electrical power systems also include the standby diesel generator. Standby power is from an onsite diesel generator system that supplies power to selected loads in the event of a loss of offsite power.

The availability of the standby diesel generator is not required for any safety function at the SHINE facility.

The diesel generator is sized to provide power to certain asset protection loads such as our battery chargers, some HVAC equipment, instrument air, freeze protection, fire systems, emergency lighting and that sort of thing.

Standby generator automatically connects to its standby diesel generator switchgear upon loss of power to that switchgear, either or both. And the operators can add additional loads to the switchgear based on the need and the availability, capacity available.

MEMBER BLEY: The argument for that not being a Class 1E diesel is that the UPSS running in takes care of you.

MR. HENNESSY: That's correct.

MEMBER BLEY: Where do you show why the UPSS, the time that will be available is good enough,

you know? Why don't you need the diesel in the slightly longer term?

Your battery is -- somewhere it says a couple or three or four hours is what they're good for.

MR. HENNESSY: Two.

MEMBER BLEY: Two hours?

MR. HENNESSY: Two hours. I believe it says two hours in the PSAR.

MEMBER BLEY: Yeah.

MR. HENNESSY: And that's -- we need to continue to reevaluate that. The preliminary design indicated two hours. And so, that's what they're sized for right now, but that's --

MEMBER BLEY: The preliminary design indicated that if you had power for two hours, then you were all okay? Nothing ever mattered after that?

MR. HENNESSY: Yes, but we'll need to, as we define the design and go forward, we'll need to continue to evaluate that. And if we need more battery power or safety-related diesel generators, then we'll provide that capability. So, that's to be determined.

MEMBER BLEY: Okay.

MR. HENNESSY: The preliminary design is

the way it is right now.

MEMBER BLEY: Yeah, I didn't see any justification of the two hours or even the mention of the two hours in the area where it talks about the UPS.

(Comments off mic.)

MEMBER BROWN: When I read this, I had the same question, obviously, but I thought when I read it that it said with zero power from anyplace you can attain a shutdown condition.

MR. HENNESSY: That's correct.

MEMBER BROWN: Okay. Then it said to maintain it you had to have the battery systems or some other power. Either the diesel or something else, but you had to have power to maintain it.

It never said that you only needed to maintain it for two hours or less or any other period. It just said you needed power to maintain the shutdown condition.

MEMBER BLEY: But it also said the UPS was all you needed.

MEMBER BROWN: No, that's right. It did say that, but I never found the two hours, but I was --

MEMBER STETKAR: It exists kind of hidden

in a table in Chapter 8. I found it elsewhere. I don't remember which chapter. It specifically says two hours. But did -- we've heard your response you're continuing to look at it. So, that's fine.

Did you -- but how did you come up with the two hours initially? Did you look at what functions needed to be supported for a particular time period and say, well, two hours seems to be what we need based on this preliminary, or did you just say, well, other people have licensed facilities with two-hour batteries, so that's good enough for us?

MR. HENNESSY: No, it would be the first.

MEMBER STETKAR: Okay. What was the most limiting function that you needed to support such that after two hours you didn't need power for it?

MR. HENNESSY: The function that -- the most limiting function, I believe, is probably the TOGS blowers and the PVVS fans to keep hydrogen removal going on.

MR. COSTEDIO: No, it's the hydrogen analysis that we need to --

MR. HENNESSY: Yeah. And so, you need to complete that analysis and get some real --

MEMBER STETKAR: Yeah. I was just

curious what, you know, which of the various functions --

MR. HENNESSY: Right.

MEMBER STETKAR: Hydrogen and TOGS basically.

MR. HENNESSY: Yeah.

MEMBER STETKAR: And PVVS, I guess.

MR. HENNESSY: Next slide.

MEMBER STETKAR: Hold on a second.

Your diesels are designed to start and connect to the bus in 60 seconds, as I -- as described in the PSAR anyway.

And as you mentioned, the load list, the rating of the diesel is based on a subset of the loads that are connected to the buses.

Is the diesel going to have -- or each bus, I guess -- an automatic load shedding and load sequencing system?

MR. HENNESSY: There is no plan for that right now.

MEMBER STETKAR: How do you not overload the diesel then when it connects onto stuff that's larger than its capacity?

MR. HENNESSY: Well, we have no large loads that are --

MEMBER STETKAR: I'm sorry. You've got big loads.

MR. HENNESSY: But on -- but the asset loads that are on the standby diesel bus --

MEMBER STETKAR: The standby diesel bus is connected to the normal 480-volt bus, which has big loads on it.

MR. HENNESSY: Right. It wouldn't be during -- those loads would not be powered from the diesel bus.

MEMBER STETKAR: What prevents them from being powered from the diesel bus?

MR. HENNESSY: I don't know the answer to that.

MEMBER STETKAR: Okay.

MR. HENNESSY: We'll have to do that in design, but it's not the intention for the standby diesel to power the normal buses, just the asset loads that are listed.

MEMBER STETKAR: Okay.

MR. HENNESSY: So, it would put a disconnect there.

MEMBER STETKAR: So, there's at least a disconnect on the feed to the diesel --

MR. HENNESSY: Exactly. There would be

some type of automatic function, which would disconnect the main bus. It's not the intention of the standby diesel to power the whole plant.

MEMBER STETKAR: Okay.

MEMBER SKILLMAN: Bill, let me pile onto John's question. I'm in the -- in your table 8a2.1-1 in the PSAR and you've got 800 horsepower chillers.

That would lead me to the question, how important are those chillers such that they would be required to be powered by your emergency generator?

MR. HENNESSY: Those chillers are important for normal processes, but they are not required for shutdown.

So, we would not be able to continue to process, to run our normal processes and to operate the plant as it's normally operated, because those chillers would not be functioning.

MEMBER SKILLMAN: Okay.

MR. HENNESSY: But safeguard systems and those things required to keep the plant safe would be powered.

MEMBER SKILLMAN: Okay. So, that would leave, actually, 500 horsepower of exhaust fans and I would suspect that those are required.

MR. HENNESSY: Well, anything on the

normal buses would not be powered. We are not going to power the normal switchgear buses from the diesel generator. So, just the loads listed for the standby diesel generator switchgear buses.

MEMBER SKILLMAN: Okay. I see that now. That's Table 8a2.1-2. Thanks.

MEMBER STETKAR: And teeing off what Dick asked about, I asked about this yesterday if I -- and I know this is a preliminary safety analysis, but if I look at the loads that -- well, I'll let you get to the UPS.

MEMBER BLEY: Before that, John, I would point out that I thought I noticed that and I had to go back that on the drawing you brought up there's a breaker up here that automatically trips on loss of power to the bus.

Now, that depends on which bus it's referring to. One would hope it's the loss of power to the -- oh, I missed that -- I have to put my magnifiers on -- the other night and again today. It's there in the notes. It's Note 1.

(Simultaneous speaking.)

MEMBER STETKAR: But the SDG is sized to power one, and only one, of those two SDG buses.

MR. HENNESSY: No, either one or both.

MEMBER STETKAR: Both.

MR. HENNESSY: Yes.

MEMBER STETKAR: Okay.

MR. HENNESSY: If one loses power, it will power that one. If they both do, it will --

MEMBER STETKAR: It will pick up all the loads --

MR. HENNESSY: Yes.

MEMBER STETKAR: -- on both buses. Okay.

MR. HENNESSY: That's the intention.

MEMBER STETKAR: Thank you. Thank you. Thank you.

MR. SPEAKER: But only to dead buses.

MEMBER STETKAR: Yes.

MR. HENNESSY: Okay.

MEMBER STETKAR: Go ahead.

MR. HENNESSY: Okay. Finishing up normal electrical power systems, other systems we have would include facility grounding, lightning protection, cathodic protection and freeze protection.

The equipment is distributed in cables and raceways that meet separation for important functions such as fire protection and that sort of

thing.

MEMBER BLEY: Not that it matters a whole lot, sounds like all your connections for the grounding system must all be Y connections.

Is there a particular reason for that, or you just wanted to have the ground as neutral or something else?

MR. HENNESSY: I do not know the answer. I have to find that out.

This is a simplified diagram, Slide 121, of our normal electrical power systems showing normal incoming power through the two transformers. It's much more simplified than the one you guys have been looking at.

The normal switchgear, which do power the standby diesel generator switchgear, the standby diesel generator switchgear would be separated from the normal switchgear in a loss of power so that the standby diesel generator could pick up the loads.

The safeguard loads, which we'll look at next, are downstream of the standby diesel generator switchgear. And we do have a plug-in connection for additional diesel power if we need to.

MEMBER BALLINGER: Where is the cathodic protection needed?

MR. HENNESSY: Pardon?

MEMBER BALLINGER: I see here other systems, cathodic protection. It must be -- I'm just curious as to where -- I don't see that written anywhere.

MR. HENNESSY: It's -- the PSAR section is 8a2.1.8. There's metallic tanks, pumps, structures provided with cathodic protection system in accordance with --

MEMBER BALLINGER: Thank you.

MEMBER SKILLMAN: Bill, I would offer that this is a question we'll probably need to discuss in some detail as you get towards the operating permit stage, but this is the system that can protect this facility for many, many years as long as it's installed properly and operated with the proper voltage at the proper polarity.

We've seen applications where people have had cathodic protection systems installed and either did not power them, or powered them backwards, which was actually deteriorating the plant.

So, this happens to be a particularly important feature even though it's buried down here in just one sentence in your PSAR.

MEMBER STETKAR: But on the other hand

for the purposes of this meeting and powering these loads, the cathodic protection system only has to be available 85 percent of the entire time to achieve its -- at least under the Reg Guides or ISG to achieve its function.

So, you know, I don't think we're planning on powering this facility from a standby diesel 60 percent of the time.

MR. HENNESSY: I hope not.

MEMBER STETKAR: Before we get away from the standby diesel, I had one more question.

In the PSAR you say when offsite power is available to be restored to either of the SDG switchgear buses, it's reconnected to its respective main switchgear bus via manually initiated dead bus load transfer.

Why do you do it that way rather than paralleling the diesel, you know, putting the diesel in a parallel operation mode and closing the breaker so you never de-energize that bus?

MR. HENNESSY: I know it's in there as well and I've read that.

MEMBER STETKAR: I mean, I looked at it and I said there must be a reason that you were doing that.

MR. HENNESSY: I think just to keep it simple.

MEMBER STETKAR: It may be less reliable, though.

MEMBER BLEY: Well, but they don't have any immediate --

MEMBER STETKAR: True.

MEMBER BLEY: -- instantaneous demands. And parallel means another place where you can load stuff up.

MR. HENNESSY: That's true.

MEMBER STETKAR: Okay.

MR. HENNESSY: Additional complications and I think just to keep it simple we disconnect the bus and then turn off the diesel and reconnect the bus. It should just be a matter of a few minutes.

Okay. Any other questions on normal electrical power?

MEMBER BLEY: Yeah, one. And I don't know the answer to this. That's why I'm asking. When you talk about your design bases and separation requirements, you cite the IEEE stuff. Aren't there -- I don't know if there are NFPA requirements for separation, too.

Are there?

MR. COSTEDIO: Chapter 9, you know, for fire protection --

MEMBER BLEY: Yes.

MR. COSTEDIO: -- would design the systems as like 48 NFPA codes that we've committed to following.

MEMBER BLEY: So, in Chapter 9 you have to think back to Chapter 8 to make sure you --

MR. COSTEDIO: Well, you got to implement the code.

MEMBER BLEY: Okay.

MR. COSTEDIO: So, it will go across the systems and --

MEMBER BLEY: Fair enough. That's where we'll see it is in Chapter 9. Okay.

MR. HENNESSY: Thanks, Jim.

Okay. Next slide. Emergency electrical power systems. Our emergency electrical power system is our safety-related uninterruptable power supply which consists of two independent safety-related trains of 208Y/120-volt AC emergency power buses and associated 250-volt DC battery subsystem, inverters, battery chargers, voltage regulating transformers and the panels and the bus system itself.

Next slide. The battery subsystem under

normal operation, the battery charger provides power to the required operational loads and the battery floats on a bus.

When we lose AC power, the battery subsystem continues to provide uninterrupted emergency electrical power required for safe shutdown loads.

The AC input breakers on the battery chargers and voltage regulating transformers are the isolation devices between the nonsafety-related normal system and the safety-related emergency system.

The uninterruptable power supply loads include the TSV reactivity protection system, the off-gas system as we've discussed, our neutron flux detection system, the process vessel vent system blower and our radiation monitoring systems, the radiological integrated control system on the RPF and the SFAS system in the IF.

MEMBER STETKAR: In the PSAR, I mean, you have -- you've added up the demand loads on -- and the normal operating loads for everything you have listed here and you come up with, to me, a very precise 61.44 kilowatt nominal demand load so that you know out to one, two, three, four significant

figures the amount of load. 13.92 kilowatt for the blower.

The question I have about that is; A, they're very precise and; B, I noted that the process vessel vent system blower, PVVS blower, has precisely the same load as the TSV off-gas system recirculating blower, singular as it's listed in this table.

Yesterday I asked the question about does the TSV off-gas system also include power to the heaters for the recombiners, which I think I need to recombine the hydrogen and the oxygen.

And the answer to that was yes. So, it's really curious to me out to four significant figures why a blower in the vent system has precisely the same load as eight blowers and eight sets of heaters for the off-gas system.

So, are these -- am I to just discount and say it's going to be somewhere around 60 or so kilowatts? Are these placeholders, or how do I interpret this data?

MR. HENNESSY: That's how I would interpret it. Obviously the equipment hasn't been selected yet.

MEMBER STETKAR: Yes.

MR. HENNESSY: We're still in

preliminary design. So, these are nominal numbers based on certain, you know, selected types of equipment. And when we actually do the detail design --

MEMBER STETKAR: But, see, that's what initiated -- originally I had a question that, okay, if I have a or perhaps two PVVS blowers powered from this thing, I get how I can add that up.

It's really curious to me if I then added up eight off-gas system loads, plus the heaters, that it would come out to be something precisely the same. If I had only one of each, I get it.

MR. VAN ABEL: The basis for the PVVS blower load is that the blower was not sized at the time.

MEMBER STETKAR: Yeah.

MR. VAN ABEL: The engineers knew that that blower would be smaller than the combined load of all the TOGS.

MEMBER STETKAR: Thank you.

(Simultaneous speaking.)

MEMBER STETKAR: Okay. Got it. Thank you. Thank you. That's -- I got it.

MR. VAN ABEL: This number is big enough.

MEMBER STETKAR: That it wouldn't be any

more than the combined loads of the TOGS.

MR. VAN ABEL: Yes, that's correct.

MEMBER STETKAR: Got it. Okay.

MR. HENNESSY: I agree it is a lot of precision. Thank you, Eric, for that.

MEMBER STETKAR: It's a lot of precision, but now I understand why the two numbers are the same. Thank you.

MEMBER BLEY: I probably read it and don't remember it. Do you only need one of the emergency buses to survive?

MR. HENNESSY: That's correct. Yes.

MEMBER BLEY: Okay.

MR. HENNESSY: This is a simplified diagram of the uninterruptable power supply system. It shows you that we have the standby generator switchgear at the top normally feeding through the battery charger to the DC bus normally going through the inverter to the emergency AC bus and the associated loads.

Upon a loss of power to the switchgear, the battery, which is normally floating, will pick up the loads through the inverter and continue to supply power to the bus.

In the event that there's a problem with

any of this equipment and we need to go straight off the bus, we can bypass it using the regulating transformer to the bus.

The safe shutdown of the SHINE facility is accomplished in a loss of power when the irradiation process stops and the neutron driver loses power.

As we've previously discussed the filled -- any filled TSVs will dump their contents upon loss of power.

And the dump tank is located below the TSV. So, the fluid will flow into the critical safe dump tank.

The light water pool passively absorbs the residual heat from the target solution. Confinement dampers will close on loss of power.

And the UPSS powers the TOGS and the safety-related blowers and the vent system to maintain the safe shutdown.

MEMBER BLEY: I know we're designed to single failure. And I'll also note that way back when the first PRA was done there was nuclear plants WASH-1400.

The aerospace guys who came over to help were astounded by how reliable our systems were and

power reactors that were designed to the single failure criterion and that was good, but they also found some things that were surprises.

One of the things we found is sometimes double failures are more likely than some single failures.

Should you have two valves fail, I know it's not required, but have you thought about what happens if you can't dump?

Does something really serious happen, or does it just sit there and kind of spin for a while?

MR. VAN ABEL: The system could continue operating with driver. You could shut it down and let it cool down in the TSV, increase, but it would still --

(Simultaneous speaking.)

MR. VAN ABEL: In the worst case, you could keep the driver running if you want to keep it hot, or you could keep the primary cooling system warm. You remove cooling from the primary cooling system to keep the TSV warm if that was an emergency situation.

MEMBER BLEY: Okay. Thanks.

MR. HENNESSY: Okay. And I think that concludes my discussions on electrical power.

CHAIRMAN RYAN: Thank you.

(Pause.)

(Comments off record.)

CHAIRMAN RYAN: We're ready when you are. Turn your mic on if it's --

MR. ALEXANDER: Can you hear me?

Okay. So, good afternoon ladies and gentlemen of the Committee. My name is Steve Alexander formally with NRC for 24 years. Then I worked for ISL for a while, and now I'm consulting to them.

And I provided the principal input to the SER chapter on this preliminary design on electrical power systems. And some of that input was also provided by members of the staff.

You've seen how the facility is put together as explained by the applicant. And a couple concepts that were not -- those of us from power reactor backgrounds are not used to is that having this -- both facilities having a common single power system, and also the idea that all of the safety-related loads are protected by or supported by the UPS and that the diesel generator is not an emergency diesel generator. It's just a standby diesel generator.

MEMBER STETKAR: That, by the way, for the record, is not unique to this facility. It's also a feature of the passive new reactor design. So, I don't want to make it, you know, for the record of our meeting to say that this is some anomaly that --

MR. ALEXANDER: Well, it's not an anomaly. All I meant to say was it's not something that we're used to seeing except in some of the new -- some of the reactor designs.

MEMBER STETKAR: Yes.

MR. ALEXANDER: So, as we've said before, the single system serves both the irradiation facility, including its irradiation units -- or the irradiation unit and the eight cells, and of course also the radioisotope production facility.

Provides normal service, emergency service. And the functions are to shut down the facility and maintain it in a safe shutdown condition. In other words, any electrical power that's required to perform those functions. And sometimes electrical power is not required when things can failsafe upon loss of power.

And of course prevent/minimize the offsite radioactivity release so that power would be

required or the design will be set to failsafe on loss of power to isolate the facility to prevent offsite release.

So, what we took a look at was the normal and emergency systems and the sufficiency of principle design criteria not that there was enough of them, but that they covered adequately the things that we thought were needed to keep the facility safe.

Looked at the design bases that came from those, bases, and what information was available at this preliminary design level on the types of equipment, functional requirements, general arrangement so that we could get a reasonable assurance that the final design will conform to the design basis and, again, for the purpose of issuing a construction permit.

MR. LYNCH: And I think we'll have Mary talk about her slide here for on the production facility. And then we'll turn it back over.

MR. ALEXANDER: Okay.

MEMBER BLEY: Well, if this would be a point -- something we knew about for a hundred years and paid a lot of attention to and then kind of forgot about until some recent incidents in electrical system design is, what happens if you get an open

phase condition and you get some pretty interesting stuff happen inside the facility, or you can.

Have you thought about that at all? Did you look at their design from the point of view of does anything significant happen if we get such a condition?

MR. ALEXANDER: This was something that was not specifically looked at during the review of the preliminary design, but we realized that, of course, that those kinds of things can happen.

And I think the intent was to address that during the review of the more detailed design when they'll know more about the physical configuration of it.

MEMBER BLEY: Okay.

MR. ALEXANDER: So, it was not looked at initially.

MEMBER BLEY: I'm glad to hear that you are going to look at it. It turns out they are more frequent than we probably thought a couple years ago --

MR. ALEXANDER: Yes.

MEMBER BLEY: -- now that we started looking. And --

MR. ALEXANDER: And now that we've had

one happen.

MEMBER BLEY: We've had more than one happen.

MR. ALEXANDER: I mean very recently, yeah.

MEMBER BLEY: That got people looking and there have been a dozen of them over the last ten years.

That's okay. Go ahead.

MS. ADAMS: Okay. The Office of NMSS also looked at the electrical power system for the radioisotope production facility that we're generally licensing under something that looks sort of like Part 70. I think we've already had the discussion about where Part 70 fits.

We looked at the common normal and emergency electrical power systems that we shared with the irradiation facility.

We were particularly interested in the accident analysis on how dependent are the accident sequences on the performance of any electrical components.

And according to the application, according to the PSAR, any electrically controlled safety-related structure systems and components will

be designed such that they failsafe.

Now, we don't have all 56 of the accident sequence descriptions or anything. So, we're not absolutely sure yet that every single of the safety-related SSCs will indeed failsafe, but that's something that we'll definitely be looking at when we get to the operating license stage.

MEMBER BLEY: Well, let me stop you there for a second. Usually when people design failsafe they say, well, if the power disappears, are we okay?

Sometimes if you can get intermediate conditions, and I don't know if it's possible, funny things happen that you don't get right to that failsafe and you get to some spot in between that can be troublesome.

Are you thinking about that or will you be when it comes around to the final design?

MS. ADAMS: I don't know how to answer that.

MR. ALEXANDER: The answer is that we would be looking at -- and, again, with a bit more rigor based on recent experience, things like open phase and ground conditions that can cause all kinds of stuff like power showing up where you don't expect it to be.

MEMBER BLEY: Yeah, and at different voltages than you expect.

MR. ALEXANDER: Indeed.

MEMBER STETKAR: Well, but it goes, I mean, there are some accidents that are worse if you have some combinations of power gone and power available.

Accident analyses typically look at the most limiting condition of no power available, or, in some cases, power available is more limiting.

MEMBER BLEY: But particularly in the case of electrical faults where part of the design is going to be looking at the available short circuit current --

MEMBER STETKAR: This is not, though, from an electrical perspective.

MEMBER BLEY: Okay.

MEMBER STETKAR: It's from a plant physics thermal hydraulic accident analysis perspective that, for example, if I have combinations of power failures and power availability that get me into a cool-down transient, that might not be a good condition on this plant, whereas with no power available I don't have a cool-down transient because, by definition, all of my cooling systems go away.

MS. ADAMS: We definitely are looking at could the operating when there isn't a failure of or loss of offsite power, can the electrical system actually initiate an event? Can it start a fire? Can it lead to overheating of any of the processes containing SNM in any of its many chemical forms? Or can it cause an inadvertent electrical -- electromagnetic interference between the electrical power systems and any other safety-related features?

So, we'll definitely be looking at that.

MEMBER STETKAR: Somebody has to help me here, because you're still talking about electrical transients rather than plant transients.

MEMBER SCHULTZ: This is a little different. If you will, it's a partial loss of power so that some equipment is going to be operational that you thought would fail, and others will not be available.

So, you could have a circumstance, and the one described as a good example, where you thought you were going to lose cooling, but you didn't. You have cooling, but other equipment that should be available is not. And, therefore, the upset condition is different than what you anticipated.

MEMBER STETKAR: And it's not electrical

system. It's a combination of what is energized, what is not energized and can you get into a situation where combinations of things that are energized and de-energized make a condition worse than if everything was de-energized, which is the traditional, you know, no AC power.

MR. ALEXANDER: If I may suggest what we would be looking for is in terms of the design of the electrical power system, that's a question more for could such adverse abnormal conditions be sensed by any of the sensors that are designed to desense those kinds of conditions happening, and then taking action to shut the facility down to prevent an accident or uncontrolled release based on that?

So, if you had a system where you lost power to things that would reduce the ability to control a reactivity addition kind of an accident and the cooling system was still running, so you're still cooling down the TSV, then I think at that point we would expect the design to be able to have that sensed -- the results of that condition be sensed and the TSV protection system to shut it down.

And we didn't look at that kind of thing in terms of the design of the electrical system.

MEMBER BLEY: No, it's not there. It's

when you're thinking safety analysis --

MR. ALEXANDER: Right.

MEMBER BLEY: -- and you say, I have to take a single failure. For example, I don't -- I haven't studied the system well enough to think of all the ones that could happen, but the one we just mentioned if the single failure should be an open phase condition, some pumps might trip because of that. Other ones might keep running.

MR. ALEXANDER: Might keep running.

MEMBER BLEY: Some chillers might keep running. So, half the equipment might work, and half of it might trip.

MR. ALEXANDER: Or if there was some mechanical --

MEMBER BLEY: That single failure could create some unusual conditions that might get us into trouble. I don't know if they can or not.

MR. ALEXANDER: Well, if you have some kind of a calamity that causes physical damage to the structures or fire or something like that, then you can end up having grounds that would put --

MEMBER BLEY: Some stuff out.

MR. ALEXANDER: -- some stuff out and some stuff not, yes.

MS. ADAMS: Or the thermal denitration system, for example, that's operating at less than its optimum temperature and something strange happens.

MEMBER STETKAR: Mary, you brought it up in the context of your side of the plant, but you mentioned, you know, you haven't looked at the combinations of power failures in the context of the analyses of that and it's kind of an opportunity to raise it through the whole facility.

MR. LYNCH: Yeah, and I think as far as the accident analysis goes that Mary has performed, what we've asked SHINE to do right now is to provide a representative example of the different mean categories of accidents that they might expect at the RPF and so we can make sure that their methodology of accident analysis is consistent with what we hope to see in the FSAR.

So, we looked at those first few types of accidents that they've given us and we've been satisfied with those.

And I think also what Mary is getting at is when we see, you know, our analysis will continue when we actually see the full list of accidents.

MEMBER SCHULTZ: I think you're getting

it, but let me try one more piece and that is what we want to see is a multi-disciplinary approach to examining what could happen at the facility in determining the overall accident evaluation so that the electrical folks are not saying, well, I knew this would happen, but I didn't know it would have an impact on that safety analysis portion of the facility operation if there were -- if this were to happen. I thought somebody else would look at that --

MR. LYNCH: Absolutely.

MEMBER SCHULTZ: -- multi-disciplinary approach that we're looking for.

MS. ADAMS: Degraded part of integrated safety analysis.

MR. ALEXANDER: In an integrated approach so that the multi-disciplinary people are talking to each other, yes, sir. We understand.

MEMBER STETKAR: Well, and in principle the integrated safety analysis should address this provided that the integrated safety analysis is not done under some presumptions of what failures must be examined. In other words, that no AC power is always worse than AC power available.

So, in principle, that integrated safety

analysis ought to identify these things if the people performing that analysis are not focused only on one set of presumed bad conditions.

MS. ADAMS: The best addition to an ISA is a box of donuts to get the reviewers together in the same room.

MEMBER SCHULTZ: Now, you have it.

MEMBER BROWN: Did I hear donuts?

(Laughter.)

MEMBER SKILLMAN: Only Charlie could pull that off.

MEMBER BROWN: Thank you, Dick.

MR. ALEXANDER: Did you have any other comments, Mary?

(No comments.)

MR. ALEXANDER: All right. So, to continue then, I just want to go back to that irradiation facility. Let's go back to this one here.

Okay. So, then to the next one, if we could, please. All right. So, we looked at both normal emergency systems and again the thrust was to look at failures of the electrical power supply system and how that would impact the plant.

And those failures were admittedly

concentrating on loss of power as opposed to things like open phase and how the plant would react to that. So, that's something that we definitely want to look at.

And sufficiency of principle design criteria and design bases, okay, I think we're beyond this now.

Back one. There we go. Okay. So, to go back to the idea that if you have a simple failure of some electrical component, that it's not going to either prevent the -- it's neither going to cause a problem or prevent the mitigation of a problem.

And so, electrical equipment that needs to be de-energized when it performs its safety functions have to be able to fail in that condition. And so, we took a look at that.

So, to summarize here then the response to interruptions of normal electrical service, ability of the facility to be maintained in a safe condition with and without normal service -- and, again, maintained here is important -- monitoring and control of routine releases, prevention of uncontrolled releases of radioactive material in the event that normal electrical power is interrupted.

So, and by that, by normal electrical

power being interrupted we mean no AC power on site other than from the UPS. No diesel. No offsite. Still have to be able to meet these design criteria.

Okay. We already know we have one common system for both facilities. The normal electrical power supply is 480-volt. Now, it says 480-volt offsite service from Alliant Energy. It's transformed down, obviously, but the onsite nominal bus voltage is 480-volt AC and either comes from offsite or from a commercial-grade standby diesel generator. And it has -- which power both the safety-related and nonsafety-related loads normally.

On loss of offsite power -- and we've kind of assumed that you'd know what that meant. Figured we were safe in that assumption.

Safety-related loads are the only ones that really continue to be powered. The diesel generator will power some loads, including emergency loads. And if you lose that, then that comes from the battery, the inverters.

And in terms of how long that system, we also kind of question the two-hour emergency electrical power system capability.

And our thought on that was that with the known amount of -- which is very small of decay heat,

that the main thing was keeping things like the PVVS blowers running for as long as they need to.

And so, following that path, pulling that string we found out, well, we don't know how much we're going to need yet. So, we said, okay, we'll wait to ask that question. It would have been an RAI, but I didn't see the point at that point other than that people should be thinking about it.

Okay. Next slide, please. Regulatory requirements. These regulatory requirements here are the ones really applicable to the application. What needs to be in an application and what do you have to have to issue a construction permit. So, these were our guiding principles.

There are some other regulations, obviously, that are going to be involved in the design. Shielding and radiation protection, radiological controls all have to conform for occupational exposure to 10 CFR Part 20.

And obviously to prevent offsite releases we have 10 CFR Part 100 guidelines and a couple of other regulations.

MR. LYNCH: Part 100 doesn't apply to this.

MR. ALEXANDER: Doesn't apply to this.

MR. LYNCH: Yeah.

MR. ALEXANDER: But, anyway, we -- those are going to govern things like offsite release. So, it's kind of something to give thought about here in addition.

Acceptance criteria. During the review, the official acceptance criteria comes from the ISG and Part 2 of NUREG-1537. We took a look at Part 1 also just to make sure that the application conformed to the form and content requirements for an application.

It's just kind of a -- just did kind of an idiot check to make sure that all the dots were -- Is were dotted and Ts were crossed.

The other acceptance criteria are some referenced or invoked codes and standards. And one of the ones that comes up here later will be IEEE 384. And so, those are codes and standards that were referenced in NUREG, and in the PSAR.

Okay. So, we took a look in taking a look at doing the review, section-by-section evaluation of the information in 8a2 and 8b of the PSAR.

Plus, and this was the input provided by one of the other NRR staff members, review of other

chapters with regard to electrical power requirements of or interfaces with the IF and RPF systems and equipment.

And supplemented by the response to the RAI. And finally we looked at assessed the sufficiency of the preliminary design, expected performance of the electrical power systems in support of the CP issuance.

So, we had to kind of stifle ourselves a little bit to keep in mind that we're looking at the CP and there are important questions that need to be answered, but the answers are just not available now.

Okay. In looking at the schematic of the electrical power system, I was also at first puzzled by the dotted line. And so I'm wondering, okay, depending on where that is, how do we do Class 1E isolation?

In other words, how do we make sure that there are devices that will isolate operable, not in a tech spec sense, but in a general sense operable Class 1E or safety-related circuits from the faulted circuits whether they are nonsafety-related or other safety-related circuits that have a fault. Anything can develop a fault. And so, what are we going to do for Class 1E isolation?

So, we wanted to take a look at their design approach to that, because it appeared that there were quite a number of breakers that could be considered Class 1E isolation devices depending on where power gets interrupted on loss of offsite power or on a fault. That would determine then what you have to have later to isolate the safety-related circuits. And once you get into the details, you see that some of that is covered by the notes.

Designate which circuit breakers or other devices to serve as Class 1E isolation devices, which they have done right now.

Bases for those designations and the reasonable assurance that the isolation devices will meet 384-2008. I have to check again. I believe that is the latest edition of that standard.

The NRC may not have endorsed that one yet, but as far as I know it's a bit more restrictive than some of the previous editions.

Their response was to point out that the SDG breakers, circuit bus breakers are not considered Class 1E isolation devices.

And that the isolation devices are -- the Class 1E battery chargers, or more specifically the circuit breakers that supply those battery chargers

from the diesel bus.

MEMBER STETKAR: The Class 1E isolation device battery charge breakers -- if they were only manual -- of course we don't know that yet until they've specified the equipment, but if they were only manual they couldn't be credited to be Class 1E isolation devices.

MR. ALEXANDER: If presumably on a fault, even a manually operated circuit breaker is not a circuit breaker unless it is able to open on a fault. If it's just -- there's a disconnect in series with those. Let's take a look at that diagram.

MEMBER STETKAR: No, continue the presentation. I was somehow interpreting what I read -- perhaps I was misinterpreting what I read, because I thought that they were arguing that somehow the inherent features of the battery charger and the voltage regulating transformer functionally provided isolation, but you're saying that you're interpreting the circuit breaker, the input circuit breaker as providing that isolation.

MR. ALEXANDER: Well, and, in fact, it says that in the applicant's presentation. You have to also read the notes, but in the applicant's presentation --

MEMBER STETKAR: Well, but the notes are inside the box that surrounds both the circuit breaker and the device.

MR. ALEXANDER: These are different notes that I'm talking about.

MEMBER BROWN: It's on the second figure that only shows the battery charger.

MEMBER STETKAR: Yeah, and there's a star inside the box that says, non-Class 1E to Class 1E isolator.

MEMBER BROWN: Yeah.

MEMBER STETKAR: Okay. The star is inside the box that includes both the circuit breaker and the rest of the device.

MR. ALEXANDER: Okay. Good question. And my understanding was that not the Class 1E battery charger itself, but its supply circuit breaker isolates it form the bus. And that statement was made in the applicant's presentation earlier.

MEMBER STETKAR: I missed it in their presentation. So, this is the circuit breaker the applicant --

MR. ALEXANDER: It's the circuit breakers for the battery chargers and the voltage regulating transformers. Is that right? Yes. But

we should have put circuit breakers, and not the devices themselves here on this slide.

MEMBER STETKAR: Well, and I don't recall where I read it, but someplace over the last week I read it and I had interpreted that it was the device. That for some reason you're accounting for the inherent features of a battery charger and the inherent features of a voltage regulating transformer, the physics of those devices.

MR. ALEXANDER: Yes, sir. And, in fact, I had that same impression when we got the response to the RAI.

MEMBER STETKAR: Okay.

MR. ALEXANDER: And upon reading further, found out that they're taking -- okay. A voltage regulating transformer theoretically could act as a choke.

MEMBER STETKAR: And that's what I'm trying to make it do in my mind.

MR. ALEXANDER: But a battery charger would probably have to release all of its stored up smoke to do that.

So, I didn't think they were really, really relying on the battery chargers and the voltage regulating transformers.

And then reading into the information further realized that it's the breakers supplying those two devices that actually should open on a fault and isolate them from the non -- from the nonsafety-related circuits.

MEMBER STETKAR: Okay. Thank you.

MR. ALEXANDER: The only problem that, again, looking at the detailed design --

MEMBER STETKAR: I mean, obviously you need to know what the protection trips on those breakers are.

MR. ALEXANDER: Right. And of course you need to know the interrupted capacity, which is probably even more important ultimately for faults, but that's something that we're going to look at in great detail for the -- in the final design.

And once I realized that it wasn't just the battery chargers and the transformers themselves that are the isolation, it's the supply breakers to those.

MEMBER STETKAR: Well, that certainly makes it a lot easier for me to understand how you're opening the circuit.

MR. ALEXANDER: Yes, sir. Because at first I thought, wow, these voltage regulating

transformers are going to be designed as a choke so that if you get a fault current, it's going to slow it down, but that's only -- yeah.

MEMBER STETKAR: Thank you.

MR. ALEXANDER: That would only take care of the inverse transient anyway. If you had a sustained overload, it wouldn't help you.

Detailed design will address how Class 1E battery chargers and voltage regulating transformers will include electrical isolation requirements, i.e., their input circuit breakers to meet 384.

Okay. So, one of the things obviously we want to makes sure of is the system will support all the required loads and that the facility can be safely shut down and maintained again in a safe shutdown condition in case of loss of normal power supplies. And we talked about that earlier.

So, based on that information and realizing what information that we wouldn't normally have to see for a construction permit, we looked at functional characteristics and felt that they were commensurate with the design basis of supported systems and equipment.

We figured that the -- we felt that the system design maintains safe facility shutdown to the

extent that the requirement for that is known, I would add, to prevent uncontrolled releases of radioactive material.

And that the sources of emergency electrical power are capable of supplying power for the duration required by -- and, again, that should be probably FSAR analysis, because under the PSAR they don't know the answer to that one yet.

System designed for either automatic or manual trip and manual startup and switchover. Anything requiring manual trips and startups and so on, we also would be mindful that those are, in fact, manual things and not simply inputs to a digital system that may have failed or locked up.

We know the expectation. As a consultant to the staff, we know that the expectation certainly of the staff and obviously of the Committee is that if an operator has to press a button to make something -- a safety-related function happen, that that signal is going to go directly bypassing digital equipment directly to make something happen. Open a breaker, shut a valve, whatever it -- or open a valve in this case. Whatever it has to do.

So, emergency electrical power should not interfere with or prevent safe facility shutdown.

It's a general guideline and it didn't see anything other than equipment arrangements and open phase conditions which weren't specifically looked at, as we mentioned. But in normal types of failures, we wouldn't -- there is what you call "clean failures." The emergency electrical power system should not interfere with or prevent safe facility shutdown.

Malfunctions of emergency electrical power system during operation with normal electrical power should not interfere with normal operation or prevent safe facility shutdown.

In other words, if you still have normal power and you had a criticality event that needed to be squashed quickly, then a malfunction of the emergency system would not interfere with that.

Nonsafety-related uses of the emergency electrical power system should not interfere with performance of its safety-related functions. Well, the way the system is designed, there really aren't any nonsafety-related uses of the emergency electrical power system. So, it kind of meets that criterion.

Is that a fair statement there, people from SHINE? Okay.

PSAR identifies design requirements,

equipment required and power and duration of operation required. Again, I have to qualify that by saying to the extent that it is known at this time. We can't say that for sure.

But as far as enough information for a construction permit and to permit the final design to proceed, we think that that was -- is adequate.

So, finally in accordance with the governing regulation for the issuance of a construction permit, 10 CFR 50.35, the applicant has described the systems and including the principal architectural engineering criteria.

Not detailed physical design, but conceptual design, functional performance requirements, that sort of stuff is there.

Further technical or design information may be reasonably left for later consideration in the FSAR.

Safety features or components requiring research and development have been identified. And more may still be identified as they go further.

The proposed facility, we think, can at least be initially constructed without undue risk to the health and safety of the public.

Any further questions?

MEMBER BLEY: I think we've discussed everything.

MR. ALEXANDER: Thank you very much.

MR. LYNCH: I think that wraps up all of our scheduled presentations for today.

MS. BANERJEE: We have two things on the agenda. One is response to the previous questions that required the meeting to be closed to the public. And the other one was opportunity for public comments.

I'm wondering which one do you want to take first?

MEMBER STETKAR: We want to take public comments first, because that way we don't have to reopen it after the closed session.

MS. BANERJEE: Okay. Let me go and ask Theron to open up the line so that we can hear the public.

(Pause.)

(Discussion off record.)

CHAIRMAN RYAN: I might ask while we're waiting, are there any comments from our participants in the room?

(No comments.)

CHAIRMAN RYAN: Going once. Going

twice.

(No comments.)

CHAIRMAN RYAN: Okay. Thank you. No comments.

MR. LYNCH: I think as far as response to questions from the members here, I could probably do this in five seconds for right now.

You have a lot of questions and there are a lot of good questions. I've made a summary list of what we're going to come back to you with for the construction permit. And we're going to go back through the transcript afterwards and make sure that we didn't miss anything, but a lot of these issues, you know, when I look forward at the presentations we have coming up in the next couple months, we're going to relook at our aircraft impact analysis.

You had some questions on quality assurance that we've got a whole presentation we'll come back with and talk more about that.

Hydrogen treatment is going to be addressed and that really goes into more details on the accident analysis, which is coming up, hydrogen treatment, you know.

Also partial loss of power, you know, we'll make sure we'll address when we come back and

talk about accidents.

We'll make sure that red oil is looked at further. External hazards came up. You'll see that and we'll talk about structure systems and components.

We'll look at extreme weather conditions and how those were determined. Again, make sure that we're set on our analysis there.

We had some questions on cooling systems and water quality from you as well and we've got all those notes. We're going to keep going through them, make sure we've got them and incorporate them into the presentations you'll be seeing in the coming months.

MEMBER BLEY: The phone line is supposed to be open now, Mike. You can invite comments from --

CHAIRMAN RYAN: Are there any comments from participants on the phone line?

MEMBER SKILLMAN: None from Dick Skillman. Thank you, Mike.

CHAIRMAN RYAN: Thank you, Dick.

Are there any other participants on the phone line that would like to make a comment?

(No comments.)

CHAIRMAN RYAN: We're done. Let's close the phone line back up, please.

MEMBER STETKAR: Steve, are you saying that there's no -- I was trying to listen between the lines. That there's no really need to go into a closed session because there were --

MR. LYNCH: Not unless there are things you'd like to discuss with us. But as far as the questions that you had, I think it's best served we put them into the context of our future presentations that are coming in the next couple of months.

So, as far as the staff is concerned, unless you have specific issues you'd like to discuss with us, that's where I think we're best served to give you more information.

MEMBER BLEY: I think that's fine, but SHINE might have had something.

MS. BANERJEE: Well, there were like three or four questions that those were proprietary.

MS. GAVRILAS: I remember, for example, the dimension of the vessel. That was a question. We can close for a little bit and we can get some answers like that.

MEMBER STETKAR: It depends on what SHINE prefers to do, I think.

MR. BYNUM: SHINE prefers to do whatever makes you guys happy.

(Laughter.)

MR. COSTEDIO: There were ten factual items that we can get back to you folks on from questions from yesterday.

MEMBER STETKAR: Okay.

MR. COSTEDIO: Two of them involved proprietary information.

MEMBER STETKAR: Okay.

MR. COSTEDIO: Okay. And then whatever other proprietary information the ACRS would like to know.

I know of two items that would be proprietary. So, we could cover the public items first and --

MEMBER BLEY: Sure. That sounds great, yeah.

MEMBER SCHULTZ: Steve, before you go, you mentioned quality assurance as something you were going to get back to us.

Could you describe what you feel our question is there? Because I'm not sure if I was going to expand on it or --

MR. LYNCH: Well, what I want to do is

you were wanting to know our philosophy for using our ANSI standard versus Appendix B.

And I want to -- what I'm going to do is I'm going to sit down a little bit more closely with NRO and look at our requirements and do a better analysis crosswalk between the two and highlight differences and why what we're doing is adequate.

MEMBER SCHULTZ: Okay.

MR. LYNCH: So, I want to come back with a more full response to that. And that will take a little bit of time for me to go back through and have a better answer for you.

MEMBER SCHULTZ: Yeah, that will be helpful. My question is not so much aimed at the construction permit, but the operational license and what ought to be required, I believe, in terms of quality assurance.

We've talked about a number of calculations that the licensee is going to do in order to provide support for the operating license and --

MR. LYNCH: Yeah. Absolutely.

MEMBER SCHULTZ: Very fine. I would like to know the quality assurance program that that's under. Maybe the type of, or the program itself.

MR. LYNCH: Absolutely.

MEMBER SKILLMAN: Steve, I believe I'm the one who pushed on that subject. Others may have also without my knowing about it, but I certainly led at least a piece of that discussion.

And I'd be very interested in how you would look at the ANIS standard and Appendix B and provide an explanation of either graded approach, or perhaps a change in thinking that the collage of the 18 points in Appendix B really will give SHINE, in my view, a product perhaps better than they might have considered if they use the ANSI standard.

And I'm certainly not carving out territory, but I've become convinced that when Appendix B is used properly and used with prudence, the final product can be a very excellent product. Thank you.

(Comments off the record.)

MEMBER STETKAR: As I understand it, you have questions that you wanted to address that are public information and then we can close it.

We've already established yesterday that we don't care.

(Laughter.)

MR. COSTEDIO: Let's see. The first

item was what fire protection standards we used in the design of the facility.

And the design testing and surveillance of the fire protection system is based on the guidance from codes and standards provided in Subsection 982.3.2 of the PSAR.

CHAIRMAN RYAN: 982.3.2?

MR. COSTEDIO: Yes.

The second item is how is internal flooding handled? Has a time analysis been performed? How is stoppage ensured? Provide reference to where this is addressed in the documentation.

Section 3.3 of the PSAR describes water damage from internal flooding sources. In accordance with NFPA 801 Section 5.10, the volume of discharge from a failure of fire protection piping is size plus suppression system operating for a duration of 30 minutes.

CHAIRMAN RYAN: Could you just give me the number on that NFPA again, please?

MR. COSTEDIO: NFPA 801 Section 5.10.

CHAIRMAN RYAN: Section 5.1?

MR. COSTEDIO: Yes.

CHAIRMAN RYAN: Thank you.

MR. COSTEDIO: 5.10.

CHAIRMAN RYAN: Oh, 5.10. I'm sorry.

MR. COSTEDIO: Yes.

Cathy, want to go over Chapter 2?

MS. KOLB: There were a couple of questions from Chapter 2. We were asked if the comprehensive plans from the cities of Janesville and Beloit went all the way out to 2050.

The comprehensive plan for the city of Janesville is out to 2030. And then we assumed that same rate out to 2050. SHINE did.

For the comprehensive plan for Beloit, that also went out to 2030. They staggered it every five years. They had a different rate. So, we used the last rate and extended that out to 2050.

For the Wisconsin Department of Administration for the areas outside the city limits, that was projected out to 2035. And we extended that out to 2050 ourselves.

Bill.

MR. HENNESSY: For the questions surrounding and related to the aircraft impact analysis, including the figure that was provided in the handouts, we had recognized that there was a problem with that figure during our preparations for

this presentation and we had entered that into our corrective action program already to look at and to be fixed in the FSAR.

And regarding the interest in general on the aircraft impact analysis, we're going to take another look at that, a fresh look and, you know, using the questions that were asked and make sure that we've got the right analysis and that it's done well.

MEMBER STETKAR: Thank you.

MS. KOLB: All right. We also had questions about the source of our accident rates for the chemical hazards, for the forklift and the pipeline.

All of the accident rates are from the Handbook of Chemical Hazards Analysis Procedures. It's a 1989 document from FEMA, the Department of Transportation and the EPA.

MEMBER STETKAR: And they all came from that?

MS. KOLB: The --

MEMBER STETKAR: Because some of the things actually refer to that document. Other places just use the generic term "a report." And other places don't say anything. They just say here's the

number.

MS. KOLB: So, the forklift in particular was assumed to be -- we used the accident probability for a truck. So, that's where that came from.

For all of the ones involving --

MEMBER BLEY: For, I'm sorry, for a truck on the road or --

MS. KOLB: Yeah, for a truck on the road assuming that that would be conservative that there would be a higher --

MEMBER STETKAR: How do you know that's conservative?

MEMBER BLEY: That doesn't even sound related to me.

MS. KOLB: We can look back into the reasons why that was chosen, but to just tell you where that came from, that's where it came from.

MEMBER BLEY: I would just throw out the chemical processing industry has published a lot of this kind of data, too. You might get something more thorough.

MS. KOLB: Thank you.

CHAIRMAN RYAN: Could you tell me that handbook name again? Handbook of Chemical Analysis?

MS. KOLB: Handbook of Chemical Hazards

Analysis Procedures.

CHAIRMAN RYAN: Chemical Hazard Analysis. Thank you.

MS. KOLB: That document also contains the accident rates for pipelines. We were asked about the rates for the pipelines.

MEMBER STETKAR: Maitri, I have it if you want it. I downloaded it.

(Comments off the record.)

MEMBER STETKAR: It's -- for the record, let me look it up in my -- I have to go to a different place here.

It is O-S-W-E-R-H-C-H-A-P. That's the document identifier. Handbook of Chemical Hazard Analysis Procedures. And it's issued jointly by the Federal Emergency Management Agency, US Department of Transportation, US Environmental Protection Agency. And it was 1981, I think, is the -- it doesn't have a date on it.

MEMBER BLEY: She had said '89.

MS. KOLB: 1989.

MEMBER STETKAR: '89?

MEMBER SCHULTZ: Catherine said '89.

MS. KOLB: Our reference in the -- or in our calculation is --

MEMBER STETKAR: Yeah, I couldn't find it in -- I'm sorry. It is '89. I found it in the introduction here.

It doesn't have a date on the cover of it and I had to -- I remember the -- just remembered the date. 1989. So, I'm looking at the same document you used.

MS. KOLB: Great.

MEMBER STETKAR: And we have it, Maitri, so I can -- just ask me for it.

MEMBER BLEY: Just an aside, another aside, something that -- I'm not familiar with this document, but NTSB tracks accidents, pipelines, and they've got some -- they might have modified some of that from some of the cases they've looked at in the last 15 years.

MS. KOLB: Thank you.

(Comments off the record.)

MS. KOLB: We also had a question that Table 2.3-7 in the PSAR does not contain information on tornadoes or waterspouts for Rock County, Wisconsin or Winnebago County, Illinois.

SHINE recognizes that Rock County, Wisconsin and Winnebago County, Illinois were not included in Table 2.3-7 of the PSAR.

SHINE will initiate an IMR for a corrective action program to add Rock County, Wisconsin and Winnebago County, Illinois to that table in the FSAR.

MEMBER STETKAR: There was one -- I think there was one more that was missing, Catherine.

(Comments off the record.)

MEMBER STETKAR: Hold on a second. Let me find my -- look for it in the transcript. My recollection was three. Rock County, Winnebago and one more, but it's in the transcript from yesterday.

MS. KOLB: We will check the transcript and ensure those are added, but I would also like to add that Table 2.3-8 of the PSAR does provide details on the strongest tornadoes in Rock County.

MEMBER STETKAR: Yeah.

MS. KOLB: So, you can --

(Simultaneous speaking.)

MEMBER STETKAR: Absolutely.

MS. KOLB: Okay.

MEMBER STETKAR: It does.

MS. KOLB: And then --

MEMBER STETKAR: I just couldn't calculate a strike frequency for the county.

MS. KOLB: Yeah. So, they're included

in the analysis, but they weren't included in that particular table. So, we recognize the error and we will correct it.

MR. PRATER: And just to follow up, Table 2.3-9 of the PSAR provides details of the strongest tornadoes in the surrounding counties.

So, between Table 2.3-8 and 2.3-9 basically we have it covered to look at the strongest tornado within Rock County itself and then go out within the climate area.

And while I'm on the subject of weather, I'll make a couple comments on the temperatures. Just to reiterate what we have already written in the PSAR, the 100-year temperatures were computed using hourly data from the closest first order, that is manned with observer stations, that's at Rockford at Madison, using a technique that was described in ASHRAE fundamentals.

These stations have wet-bulb information that is needed to derive the coincident wet-bulb info that's presented in Table 2.3-15.

And just to comment further on the methodology, this methodology and approach has been used by other licensees in presenting previous ACRS meetings.

In fact, I think I was sitting in this very same seat last September when we went through this very same discussion on the 100-year --

MEMBER STETKAR: I was going to say we've had the same questions with those other --

MR. PRATER: Yes, we have. We've talked about this, but I just want it entered into the record that this has gone on before.

And one other item on the temperatures and I was thinking about this last night, I'll throw this out, is regarding temperatures from nearby stations that exceed the 100-year value computed, perhaps those temperatures correspond to some other lower frequency values.

Again, I'm just going to throw this out for consideration. Perhaps it's a 150-year value. Maybe a 200-year value you're looking at.

So, the 100-year value is not necessarily the all-time high value we're trying to define for a region. I just wanted to throw that idea out.

MEMBER STETKAR: And since you wanted to reopen it, I'll grind it in a little more.

MR. PRATER: All right.

MEMBER STETKAR: Table 2.3-16 --

MR. PRATER: We've had this discussion

before.

MEMBER STETKAR: Right. So, it says dry-bulb temperature extremes at local and regional NOAA co-op meteorological monitoring stations within the slight climate region. That's the title of --

MR. PRATER: Which table is that again, please?

MEMBER STETKAR: 2.3-16.

MR. PRATER: Uh-huh.

MEMBER STETKAR: It lists a temperature of 102 degrees for Beloit. It lists a temperature of 102 degrees for Wisconsin Dells.

MR. PRATER: Uh-huh.

MEMBER STETKAR: And as I said yesterday, I found temperatures substantially higher than that for both Beloit and Wisconsin Dells in 1936, which is less than a hundred years ago.

MR. PRATER: And the source you used for that information was Weather Underground something.

MEMBER STETKAR: No, I didn't get it from Weather Underground. Actually, I checked -- I didn't poll those two stations, because I didn't want to go into an exercise of screening all of the temperatures from each station in the surrounding area. That's a lot of work.

MR. PRATER: That's a lot of work, yeah.

MEMBER STETKAR: So, I looked at Janesville and did a little bit of screening on Janesville to look at the anomalies. And, okay, I couldn't find anything that was as high as other estimates.

And I said, well, gee, what's the record high temperature for the state of Wisconsin? 114 degrees --

MR. PRATER: And where is that located?

MEMBER STETKAR: I don't know. I googled record high temperature for the state of Wisconsin.

MR. PRATER: Yeah.

MEMBER STETKAR: And I found it -- no, but I found it at multiple sources.

MR. PRATER: Okay.

MEMBER STETKAR: And one of them was linked to NOAA.

MR. PRATER: Okay.

MEMBER STETKAR: And I did the same thing. I said, well, what about Beloit? That's the next closest place that I would look for. And I found -- I think it was 113 degrees. Was it 110? It's on the transcript. The correct numbers are in yesterday's transcript. I can't find them quickly.

MR. PRATER: Okay. I'll just --

MEMBER STETKAR: But then again the same process was not to look at the Beloit station and go back through however many, you know, 40, 50 years, because none of those records go back to 1936.

MR. PRATER: And just one other item I'd put on there as far as the -- remember this whole discussion is we started with a climate area.

So, depending on where those state extremes are measured, and I have to admit I haven't looked at that parameter recently, that may not even be in our climate area.

MEMBER STETKAR: Beloit is certainly within your climate area --

MR. PRATER: It certainly is.

MEMBER STETKAR: -- because it's a few miles south of the site.

MR. PRATER: Yes.

MEMBER STETKAR: Wisconsin Dells is in the center of your climate area just not far north of the site.

MR. PRATER: Yes, there are --

MEMBER STETKAR: And for the record, it was 114 degrees at Wisconsin Dells on July 13th, 1936. And 110 degrees -- Dr. Bley has an excellent memory

-- at Beloit on July 14th, the next day.

MR. PRATER: Yeah, 1936 was a big drought year throughout the US.

MEMBER STETKAR: And, in fact, in your PSAR there's a statement in Section 2.3.1.2.11 -- I just love the numbering scheme -- says the overall extreme dry-bulb temperatures for the climate region are a maximum of 109 degrees Fahrenheit recorded on 14 July 1936 at Marengo in Boone County, Illinois, and a minimum of 45 degrees Fahrenheit recorded on 30 January 1951 at Baraboo in Sauk County, Wisconsin.

MR. PRATER: You have two watches now and you're trying to figure out what time it is. It depends partially on the data quality that you put in the sources.

MEMBER STETKAR: Right.

MR. PRATER: That's all we have.

MEMBER STETKAR: Okay.

MR. PRATER: Thank you.

MEMBER STETKAR: But it's notable that the 109 degrees that you cite is from that same heat wave.

MR. PRATER: Yes.

MEMBER STETKAR: I mean, it's a different location, Marengo weather station, but it's that same

two-three-day, you know, week-long heat wave.

MR. PRATER: Yes. And we see that -- I guess I'll enter back into it -- in many stations here in this part of the country. That was part of the great heat wave in the mid-'30s. Drives a lot of statistics.

(Comments off the record.)

MEMBER BLEY: Do we have some more things you wanted to --

MR. COSTEDIO: Oh, yes. Yes. I mean, the other ones was discussed, the flux gradient and discuss uranium concentration. Those are the --

MEMBER STETKAR: I have a couple others. If we're going into a closed session, I have a couple other questions that I asked would it be proprietary information, and you said yes. So, I didn't raise the question because it's pointless.

MR. COSTEDIO: Okay.

MS. BANERJEE: Now, the people that you have on the private line, are we okay with --

MR. COSTEDIO: I don't know if there's anybody on there anymore.

MS. BANERJEE: Okay.

MR. COSTEDIO: I think Steve Zander was the only one. And I think --

MEMBER STETKAR: We should close all lines except Dick Skillman.

MS. BANERJEE: That's the private line. That's the other line.

MEMBER BLEY: Mr. Stetkar and Chairman Ryan, I would think we want to go around the members while we're still in public session, wouldn't you?

(Comments off the record.)

CHAIRMAN RYAN: Yes. Comments from the Committee?

Steve.

MEMBER SCHULTZ: I'd like to thank the Applicant and the staff for the presentations that were made. I thought the discussion was very helpful for the starting point of the evaluation of the application for the construction permit and look forward to additional meetings.

I appreciate the responses that have been made to the staff from the Applicant to the RAIs and the quality of the documentation that has been produced as a result.

And, again, I expect further discussions as we go into the other chapters of the application.

MEMBER BLEY: Steve.

CHAIRMAN RYAN: He had a follow-up

question.

MEMBER BLEY: Well, I think for all the members, Mike and I were talking, give your thoughts about whether we need a letter or a full committee meeting at this time.

MEMBER SCHULTZ: Well, I -- my view is that I think it could be helpful for the staff and for the applicant for us to write a letter to describe the interaction we had over the last two days.

And the other option is to wait for September, which is not too far away. So, the fact that we have additional meetings that are upcoming soon --

CHAIRMAN RYAN: Steve, how would you feel about just exactly that of maybe delaying that a little bit and then a subcommittee meeting if some other --

MEMBER SCHULTZ: I see advantages to both. Clearly, you know, the activity associated with doing a letter soon leaves a potential gap, because we don't have all of the information that we'll have in September. So, I have no problem waiting.

I just would suggest that there's certainly a value in us presenting a letter sometime

soon.

(Comments off the record.)

MEMBER POWERS: I have no additional comments that I want to make. I don't think it's useful expenditure of our time or the applicant's time to have a full committee meeting in the near term since we're on a pathway that's fairly aggressive here.

As we've described here, they have a sense of what we're looking for and they can act on that. I mean, they seem to be responsible and interested and looking at the transcript and things like that.

I think that covers everything and I think it would be premature to present the material as it stands now to the rest of the committee.

CHAIRMAN RYAN: Thank you. Other comments?

John.

MEMBER STETKAR: No more comments. Thanks a lot. I really enjoyed the exchange. You probably didn't, but that's okay.

I appreciate, I mean, join the crowd. Honestly, I do appreciate the information and I'm torn regarding a presentation to the full committee.

I think that the sense that I have is both the staff and the Applicant were taking copious notes and I'm sure you're going to study the transcripts.

In my opinion, the only reason to bring the issue to the full committee at this time is if we sense that there is a particular issue or a pervasive issue that could affect a conclusion regarding the construction permit where the ACRS feels that it's useful to weigh in at this stage of the process.

Dana mentioned the fact that we are on a fairly compressed schedule for the staff's review gives some sense of not bothering you with ACRS input. On the other hand, there could be benefit of getting early ACRS input in an interim stage if we feel that there's something worthy of the Committee's mentioning.

I'll just leave it at that, because I'm not going to speculate about what the Committee is --

MEMBER BLEY: I bet it hurts to come down with one foot on each side of the fence.

(Laughter.)

MEMBER STETKAR: It really does.

MEMBER BLEY: I came in here thinking I

probably would want to have a meeting. But after all the discussions and I see where you're headed, I don't have anything I would see rising to the occasion of really needing to get a letter out early. So, I'd be against having one now.

You answered lots of questions. There are lots of on-the-table questions that come up especially at the time of the final safety analysis and we'll look forward to seeing those.

And that's all I have. Thank you very much. And the staff, too.

CHAIRMAN RYAN: Joy.

(Comments off the record.)

MEMBER BALLINGER: I don't think we need to write a letter right now.

CHAIRMAN RYAN: Charlie.

MEMBER BROWN: I don't consider -- I have no more comments at this time. I made my points when I needed to make my points. And I personally do not see the need for a letter at this particular time. That's my personal opinion.

I don't know what we're going to bring to it, what recommendations and conclusions we'd throw out on the table. I tried to formulate those as we were talking. So, I don't see any need for it right

now.

MEMBER REMPE: I'd like to also offer my appreciation for the presentations from the applicant, as well as the staff.

I think Stephen's comments about how he'd like to address some questions at our next meeting and with respect to the hydrogen are helpful and encouraging. And I hope that we see a good discussion on what he's mentioned.

In addition, I'd like to add a request of evaluations of the margin as we go through in Section 13 if that information is available or your best guess at this time.

And I think that simply the accident response will depend on what instrumentation is available to the operators and how good that is.

And so, I really liked the presentation today about the 30 percent uncertainty with the approach to criticality.

And so, things like that I'm interested in and I realize it's just a construction permit, but, again, I have to do it sooner or later and I think that those discussions earlier would be helpful from my perspective.

And I believe that's all I wanted to say

-- oh, and I don't see a reason for a letter at this time just because I don't know with the schedule there is unless we really think that we need to stop the show, and I don't personally feel that way, so I don't see a reason for a letter at this time.

CHAIRMAN RYAN: Great. Thank you.

MEMBER REMPE: Don't forget Dick.

CHAIRMAN RYAN: I'm sorry?

MEMBER REMPE: Dick, he may have some --

CHAIRMAN RYAN: Oh, Dick. Are you still on the line, please?

MEMBER SKILLMAN: I am. Can you hear me?

CHAIRMAN RYAN: Yes, we can hear you just fine.

MEMBER SKILLMAN: Thank you. These are the comments that I would offer. First of all, I think it's premature to write a letter.

I agree with Dana. We probably would not be using resources wisely to write one now and I respect the SHINE team's hearing the comments that we made and committing to get back to us on what they recognized as some key issues.

I would like to just make three or four other comments. An important feature of this

facility is that it does not have a containment. Its protection is confinement.

And the confinement is really provided by the quality of construction particularly of the concrete.

And so, I would like to reinforce this issue of assuring that the very highest quality standards are provided for two reasons.

First of all, the building itself provides that containment, but the concrete provides the IU basins that are the emergency core cooling and the shielding.

And so, the quality of the concrete and the quality of the engineering into the structure are critical.

Another point that we kind of tumbled to yesterday was Dr. Bley's question regarding flooding, whether or not there are pipes that run through areas where an undetected leak could, in fact, provide moderator.

And that's a trap so many plants have gotten into over the years. And so, I would reinforce that issue of ensuring that where the water piping is routed deserves special attention by the SHINE team.

And finally, there is so much water in this facility in the eight IU units and elsewhere in the plant, there needs to be the ability to readily maintain the quality of that water without radiological challenge.

If there is a leak, if the water becomes contaminated, there needs to be the ability to clean the basins in which the IU units sit and to do so with relative ease without creating a radiological challenge for the people that are operating the plant.

With that, I commend the SHINE staff for a very thorough and interesting presentation, and the NRC staff for some very insightful challenges. Thank you.

CHAIRMAN RYAN: Thanks, Dick.

Any other comments from the room or on the bridge line?

(No comments.)

CHAIRMAN RYAN: Hearing none, we'll close.

(Whereupon, at 2:35 o'clock p.m. the meeting was adjourned.)

Advisory Committee on Reactor Safeguards
Radiation Protection & Nuclear Materials Subcommittee
Meeting on the SHINE Construction Permit Application

June 23-24, 2015

SHINE Medical Technologies, Inc.
Advisory Committee on Reactor Safeguards
Radiation Protection & Nuclear Materials Subcommittee

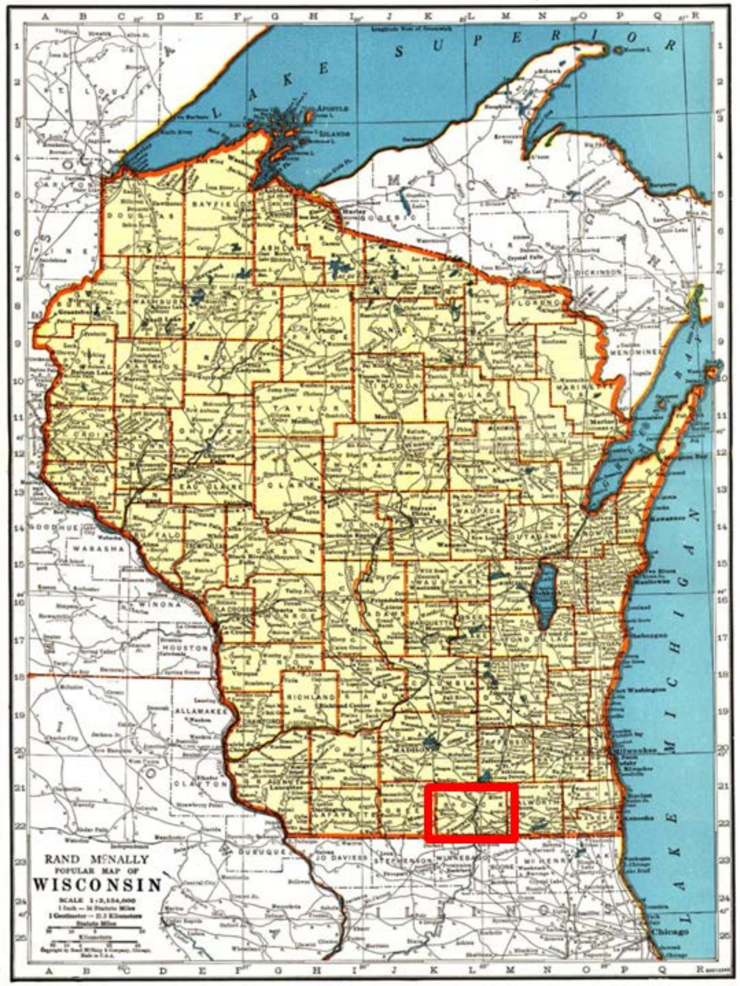
Chapter 1 – The Facility

R. Vann Bynum, Ph.D.
Chief Operating Officer
June 23, 2015

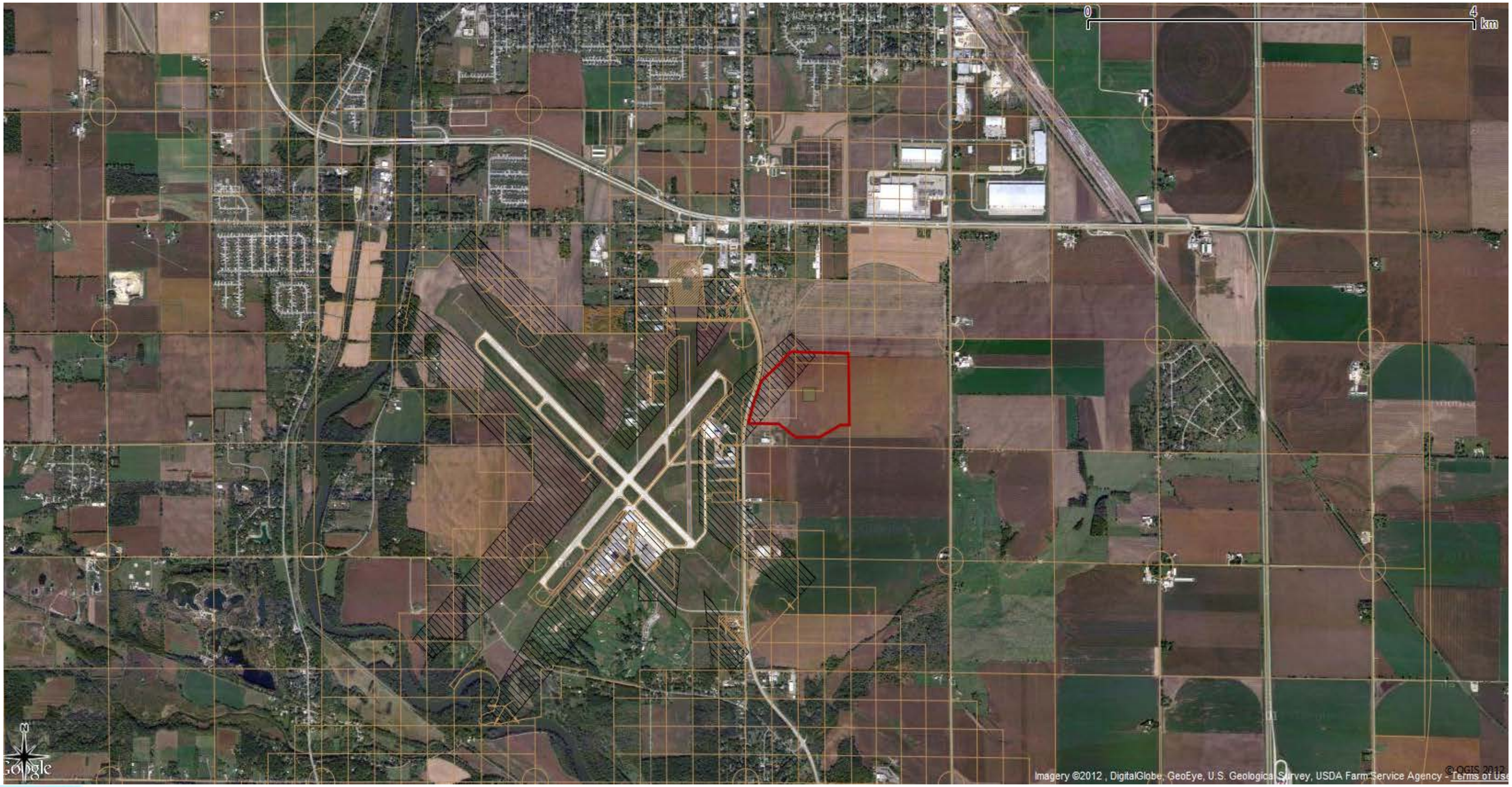
An Introduction to SHINE

- SHINE Medical Technologies
  - Private corporation, based in Monona, Wisconsin
  - Created for the purpose of designing, constructing, and operating the facility described in the PSAR
- SHINE facility
  - Purpose of the facility is to produce the medical isotope molybdenum-99 (Mo-99)
  - The SHINE production facility consists of an Irradiation Facility (IF), Radioisotope Production Facility (RPF), shipping and receiving area, and other areas that contain various support systems and equipment
  - The SHINE facility is located on a previously undeveloped 91 acre parcel in the southern boundaries of the City of Janesville in Rock County, Wisconsin

SHINE will be Constructed in Southern Wisconsin

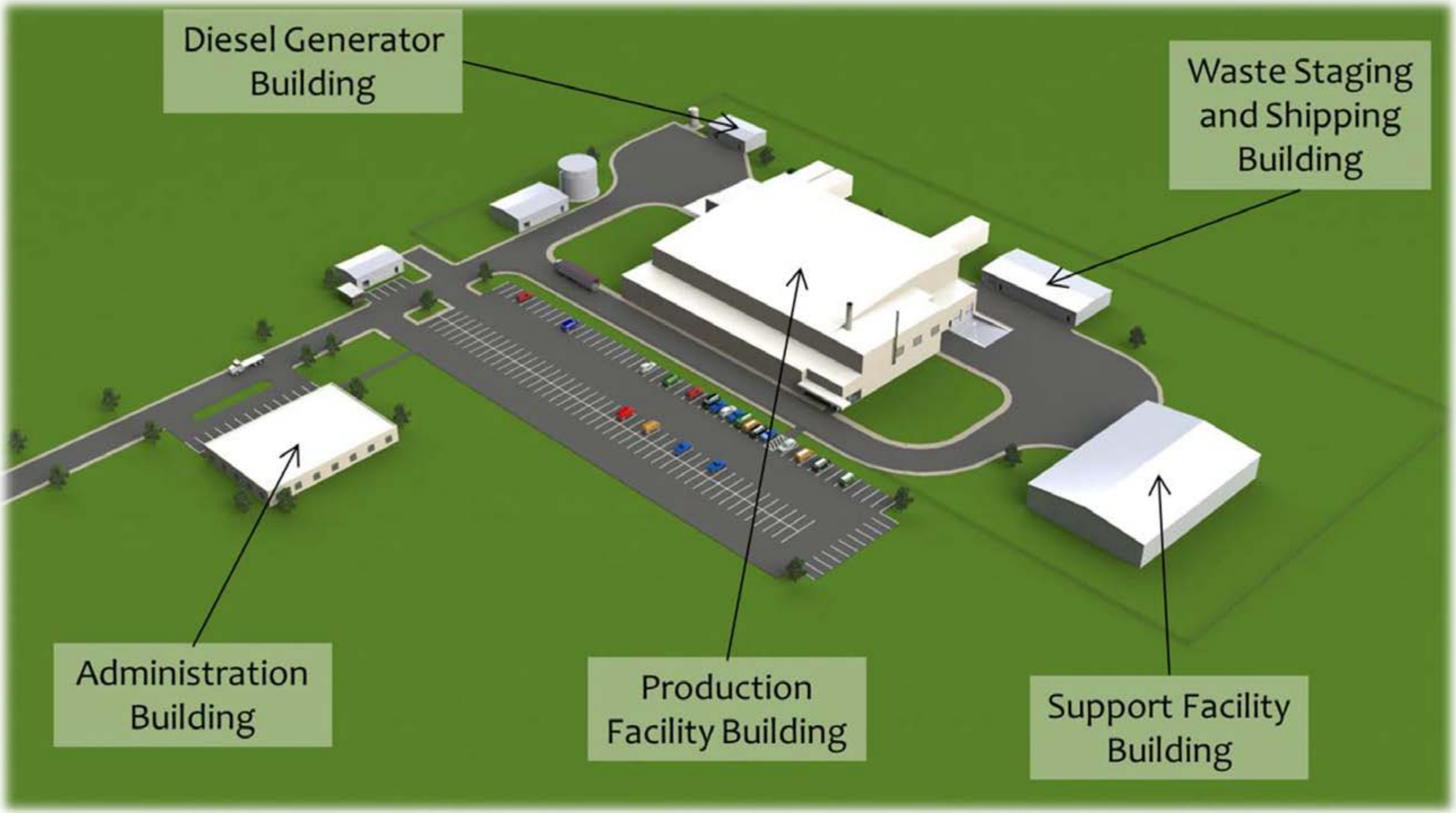


Location Provides Access to Air and Interstate Transportation Routes



Land has Historically been Farmed

Integration of Operations at a Single Site Enhances Safety and Efficiency



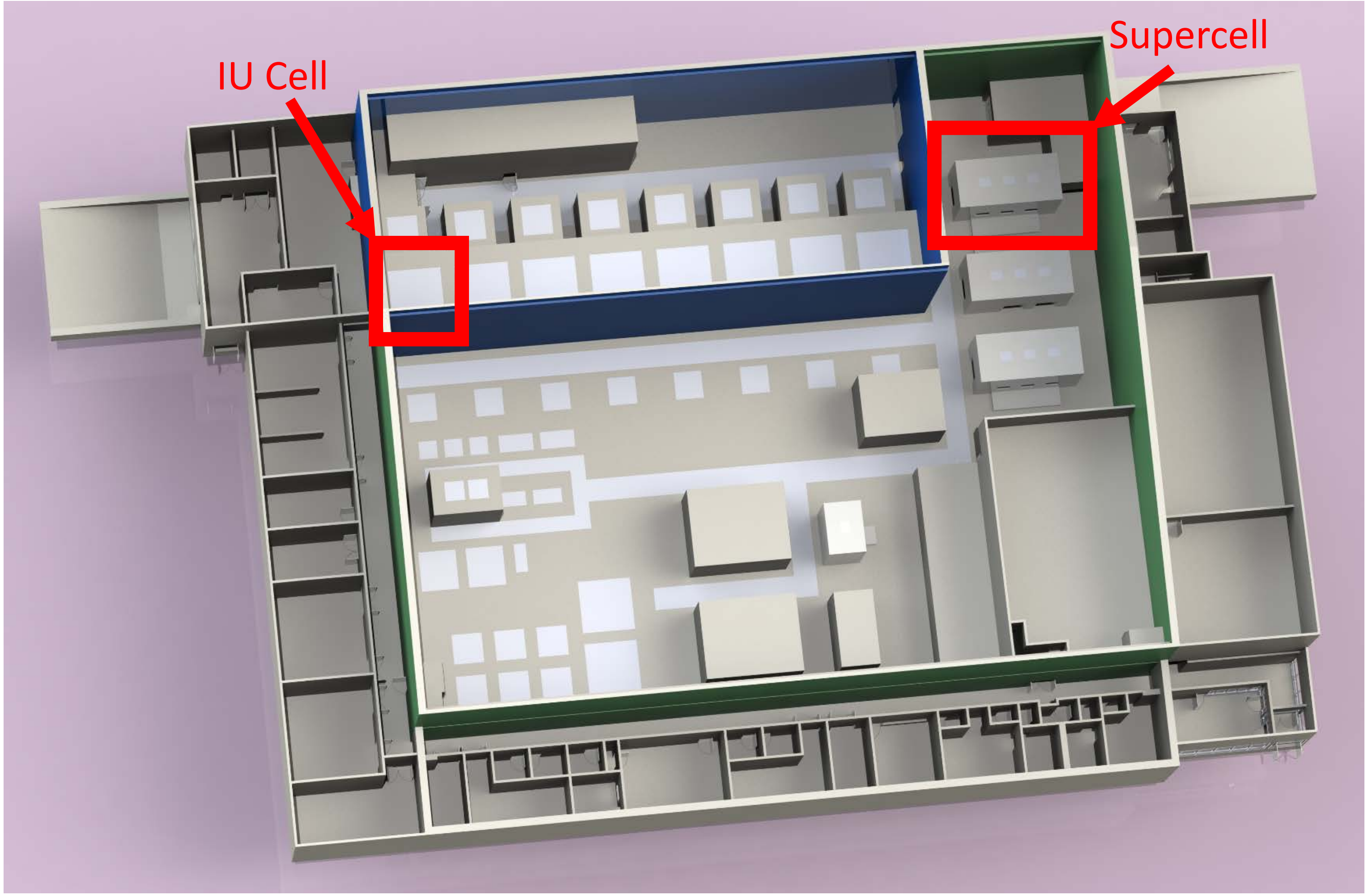
The Facility is Comprised of an Integrated Irradiation and Radioisotope Production Facility

- Irradiation Facility (IF)
  - SHINE has developed a new method for the manufacture of medical isotopes, primarily Mo-99
  - Uses a non-reactor based, subcritical fission process
  - Process includes the combination of an accelerator-based D-T neutron generator with a reusable low enriched uranium aqueous target
  - The combination of the neutron driver, subcritical assembly, light water pool, off-gas system, and other supporting systems are known as the irradiation unit (IU)
  - The IUs are utilization facilities as defined in 10 CFR 50.2
  - Eight IUs and their supporting systems comprise the IF

Radioisotope Production Facility (RPF)

- The RPF is where
  - Feed material is prepared for the IF
  - The irradiated material is processed to separate and purify medical isotopes
  - Wastes are handled and prepared for shipment
  - Products are packaged for shipment to customers
- Comprised of established chemical processes housed in hot cells, tanks, and gloveboxes

The Plant will be Housed in an Integrated, Robust Facility



Facility Operating Characteristics

- IUs are operated in a batch mode with an approximate week-long operating cycle
  - The subcritical assembly irradiates at full power for approximately 5.5 days
- The RPF also operates in a batch mode
  - Recovery and purification of an IU batch requires approximately 6 hours
  - Waste processing will occur as required
- Sequencing of the IUs and RPF processing are coordinated to meet customer needs during the week

Engineered Safety Features

- Engineered safety features are Structures, Systems, and Components (SSCs) that mitigate design basis events or accidents
  - The primary system boundary is enclosed within the confinement boundaries of the IU cell and TSV off-gas system shielded cell.
  - The RPF confinement areas include hot cell enclosures and gloveboxes for process operations and trench and vault enclosures for process tanks and piping

Instrumentation, Control, and Electrical Systems

- The TSV is protected by the safety-related TSV Reactivity Protection System (TRPS)
- IF accidents are mitigated by the safety-related Engineered Safety Feature Actuation System (ESFAS)
- Radioactive material in the RPF is protected by the safety-related Radiological Integrated Control System (RICS)
- Emergency electrical power is provided by a common safety-related Uninterruptable Electrical Power Supply System (UPSS)

Radioactive Waste Management and Radiation Protection

- SHINE has a Radiation Protection Program to protect the radiological health and safety of its workers, the public, and the environment
- Complies with the regulatory requirements
  - Program includes ALARA, radiation monitoring and surveying, exposure control, dosimetry, and contamination control
  - A respiratory protection program protects workers from airborne contamination
- SHINE's Waste Management Program provides control of gaseous, liquid, and solid radioactive wastes
  - Radioactive liquid waste storage, evaporation, and immobilization systems
  - Noble gas removal system
  - Solid radioactive waste packaging system

Research and Development

- Required by 10 CFR 50.34 and 50.35
- Testing to validate material and target solution compatibility is being performed at the Oak Ridge National Laboratory
  - Materials will be examined following irradiation at fluence levels expected in the operation of the target solution vessel for a 30 year life-time
  - Testing includes specific work on the properties of selected materials in an “as received” and “as fabricated” state to examine raw material and welded samples
- Testing to validate precipitation of uranyl peroxide will not occur is being performed at Argonne National Laboratory
  - Data shows small amounts of catalyst prevents uranyl peroxide formation
  - Ongoing work being performed to verify kinetic limits are fully characterized
- This work to be completed prior to December 31, 2016

Summary

The plant is being designed with safety as the primary criteria

- The preliminary design described in the PSAR shows the SHINE facility can be constructed such that it meets applicable regulatory requirements
- The facility is designed to be a zero radioactive liquid effluent discharge facility
- Robust engineered and administrative controls have been identified to ensure protection of the public, the environment, and our workers

Radiological consequences to workers and the public during normal operation and postulated accidents are within the limits of 10 CFR 20.1101, 20.1201, and 20.1301

Chapter 2 – Site Characteristics

Catherine Kolb
Engineering Supervisor

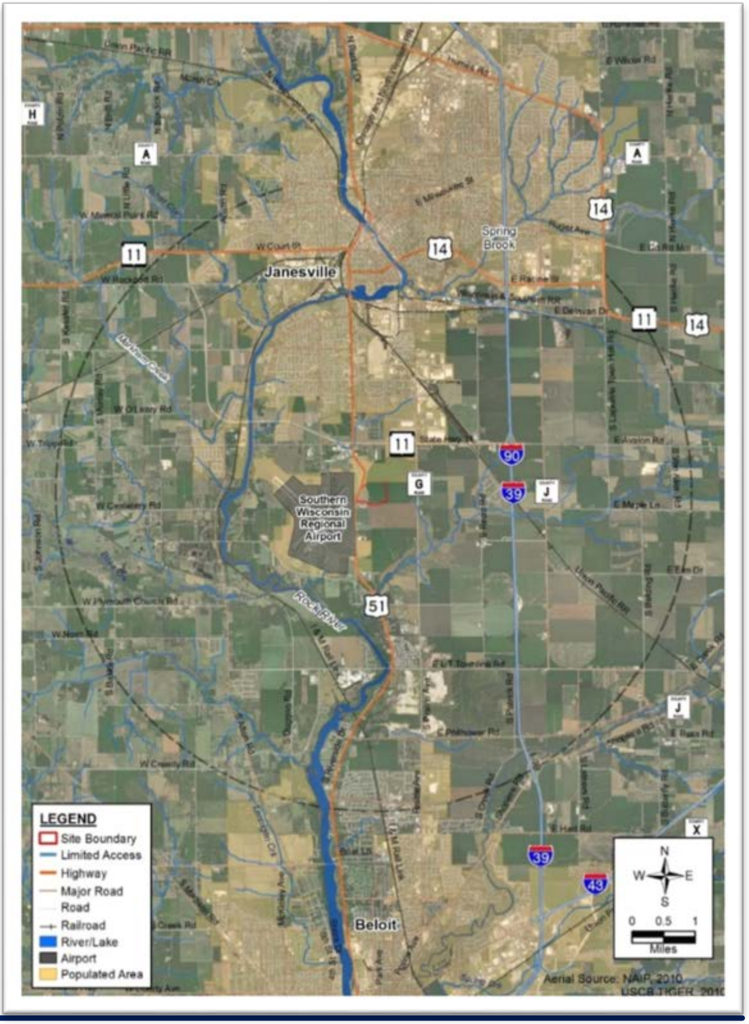
June 23, 2015

Chapter 2 – Site Characteristics

- Geography and Demography
- Nearby Industrial, Transportation and Military Facilities
- Meteorology
- Hydrology
- Geology, Seismology, and Geotechnical Engineering

Geography and Demography

City of Janesville,
Rock County, Wisconsin

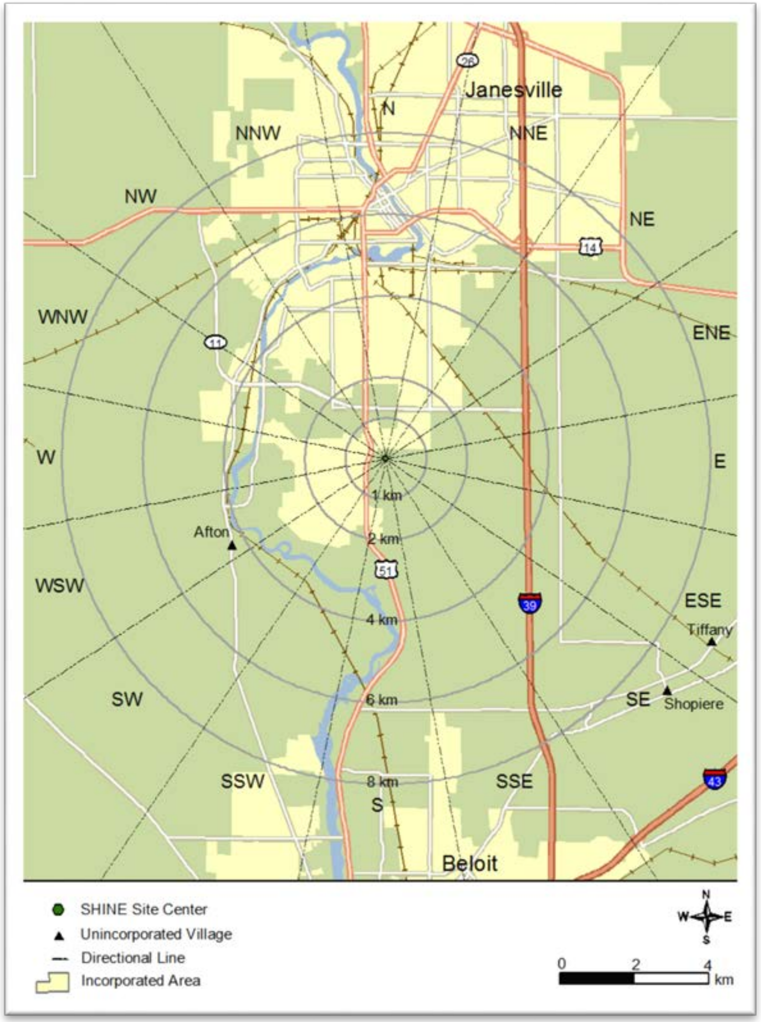


Geography and Demography

- Site boundary is
  - The property line around the perimeter of the SHINE site,
  - The area directly under the facility operating license, and
  - The owner controlled area

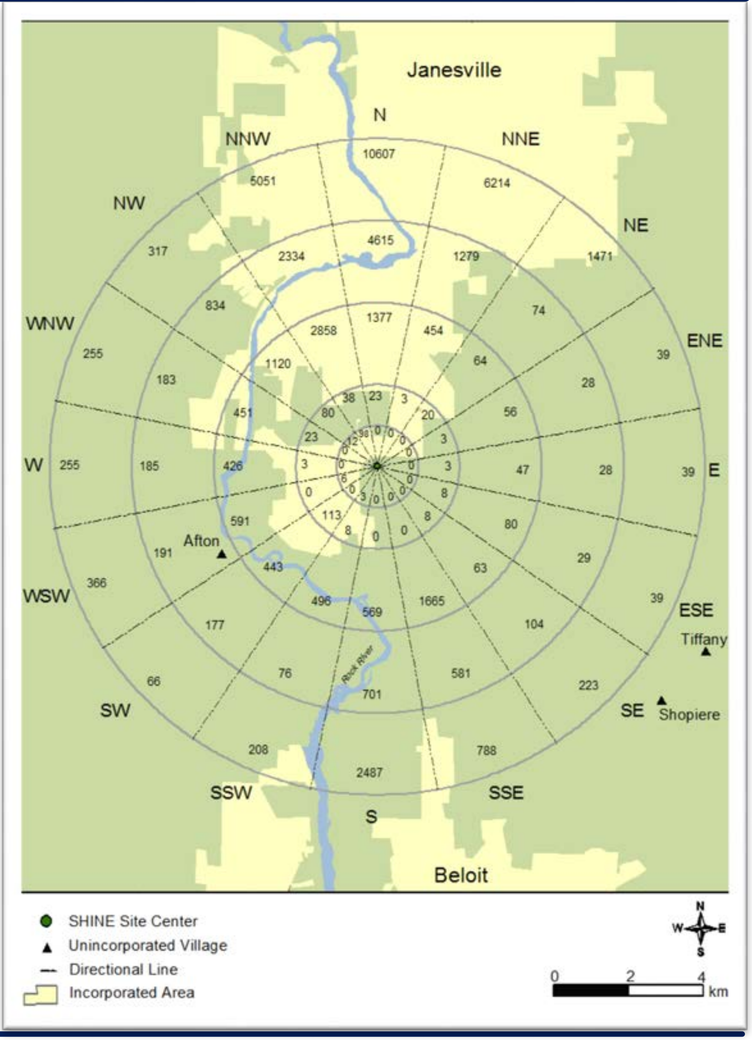
Population Distribution

- Resident and transient population estimated within 5 miles of the SHINE site
- Resident population estimated based on 2010 US Census information, field reconnaissance and aerial photographs.
- Transient populations estimated based on typical times people would be present at major employers, schools, and other facilities
- Future populations extrapolated using 2010 data



Population Distribution

- Combined resident and transient population of 51,055 within 5 mi. for 2010
- Projected to grow to 79,738 by 2050



Nearby Industrial, Transportation and Military Facilities

Locations and Routes within 5 mi. of the SHINE site

Examples of Industrial Facilities
- Abitec Corporation
- Crop Production Services
- Evonik Goldschmidt Corporation
- Janesville Jet Center
- School District of Beloit Turner
- United Parcel Service

Pipelines
- Alliant Energy Natural Gas Pipelines
- ANR Natural Gas Pipeline

Waterways
- Rock River

Highways
- Interstate I-90/39
- U.S. Highway 51
- U.S. Highway 14 (US 14)
- Wisconsin State Route 11 (SR 11)
- Wisconsin State Route 26 (SR 26)

Railroads
- Union Pacific Railroad
- Canadian Pacific Railroad
- Wisconsin & Southern Railroad

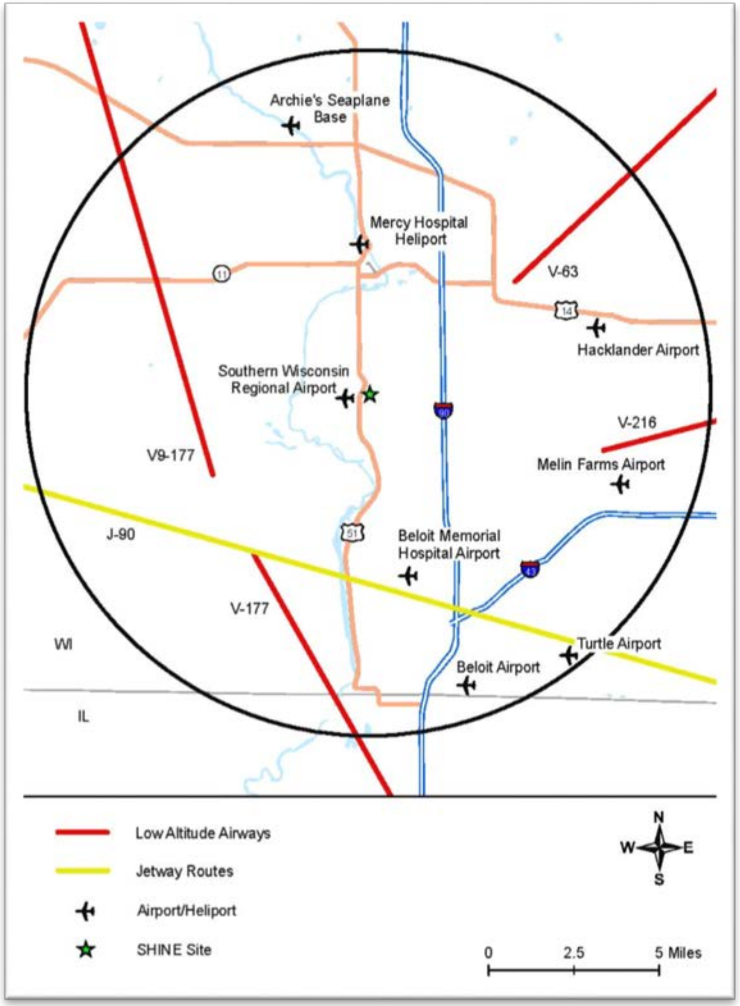
Airports
- Southern Wisconsin Regional Airport
- Mercy Hospital Heliport

Airways
- Federal Airway V9-177

Nearby Industrial, Transportation and Military Facilities

Air Traffic and Aircraft Hazard

Methodology used is from DOE-STD-3014-96



Nearby Industrial, Transportation and Military Facilities

Air Traffic and Aircraft Hazard Results

	Large Non-Military Aircraft	Small Non-Military Aircraft	Military Aircraft
Airports	2.9E-07	2.6E-04	1.5E-07
Airways	1.5E-08	1.9E-06	1.6E-07
Total	3.0E-07	2.6E-04	3.1E-07

- The risk of an aircraft accident is considered acceptable if the frequency of occurrence is less than 1E-06 per year
- The calculated crash probability for small non-military aircraft does not meet this criterion.
- The safety-related structures of the SHINE facility are therefore designed to withstand the impact of a small non-military aircraft.
- The combined probability of all other aircraft crashes meets this criterion.

Nearby Industrial, Transportation and Military Facilities

Analysis of Potential Accidents at Facilities

- Events analyzed:
  - Explosions
  - Flammable Vapor Clouds (Delayed Ignition)
  - Toxic Chemicals
  - Fires
- Acceptance criteria:
  - Rate of an event is less than 1E-06 per year

Nearby Industrial, Transportation and Military Facilities

- Explosion and Flammable Vapor Cloud (Delayed Ignition)
- SHINE safety-related areas are designed to withstand a peak positive overpressure of at least 1 psi (6.9 kPa) without loss of function/significant damage.
- Events either result in an overpressure of less than 1 psi, or meet acceptance criteria of 1E-06 per year

Nearby Industrial, Transportation and Military Facilities

Analysis of Potential Accidents at Facilities

- Toxic Chemicals
  - Only an ammonia release could exceed the 1E-06 per year acceptance criteria
  - Other chemical releases either do not exceed limits at the facility, or meet the 1E-06 per year acceptance criteria
  - For the closest ammonia release, the evaluation shows that the Control Room Operators would have sufficient time to shut down the facility

Nearby Industrial, Transportation and Military Facilities

Analysis of Potential Accidents at Facilities

- Fires
  - Analyzed limiting fires
    - Boiling liquid expanding vapor explosion (BLEVE)
    - Pool fires
    - Off-site and on-site gas line jet fires
  - Limiting fires do not cause a significant temperature rise on the surface of the building concrete

Meteorology

General and Local Climate

- Site is located in south-central Wisconsin, between Madison, WI and Rockford, IL (closest NOAA first order weather stations)
- Humid continental climate with warm summers, snowy winters, and humid conditions, featuring a large annual temperature range and frequent short duration temperature changes
- Average conditions
  - The area ranges from daily mean highs of 84°F (Rockford, July) to daily mean lows of 9°F (Madison, January)
  - Annual snowfall ranges from approximately 39 in. (Rockford) to 50 in. (Madison)
  - Annual mean wind speed is 8.5 mph (3.8 m/s) in Madison and 9.3 mph (4.2 m/s) in Rockford

Meteorology

General and Local Climate

- Extreme Conditions
  - Wind speed (100-year return period) = 96.3 mph (43.0 m/s)
  - Strongest Tornado = F5
  - Probable Maximum Precipitation (48-hour) = 34 in (176.8 lb/ft^2)
  - Snowpack (100-year return period) = 30.5 lb/ft^2

Meteorology

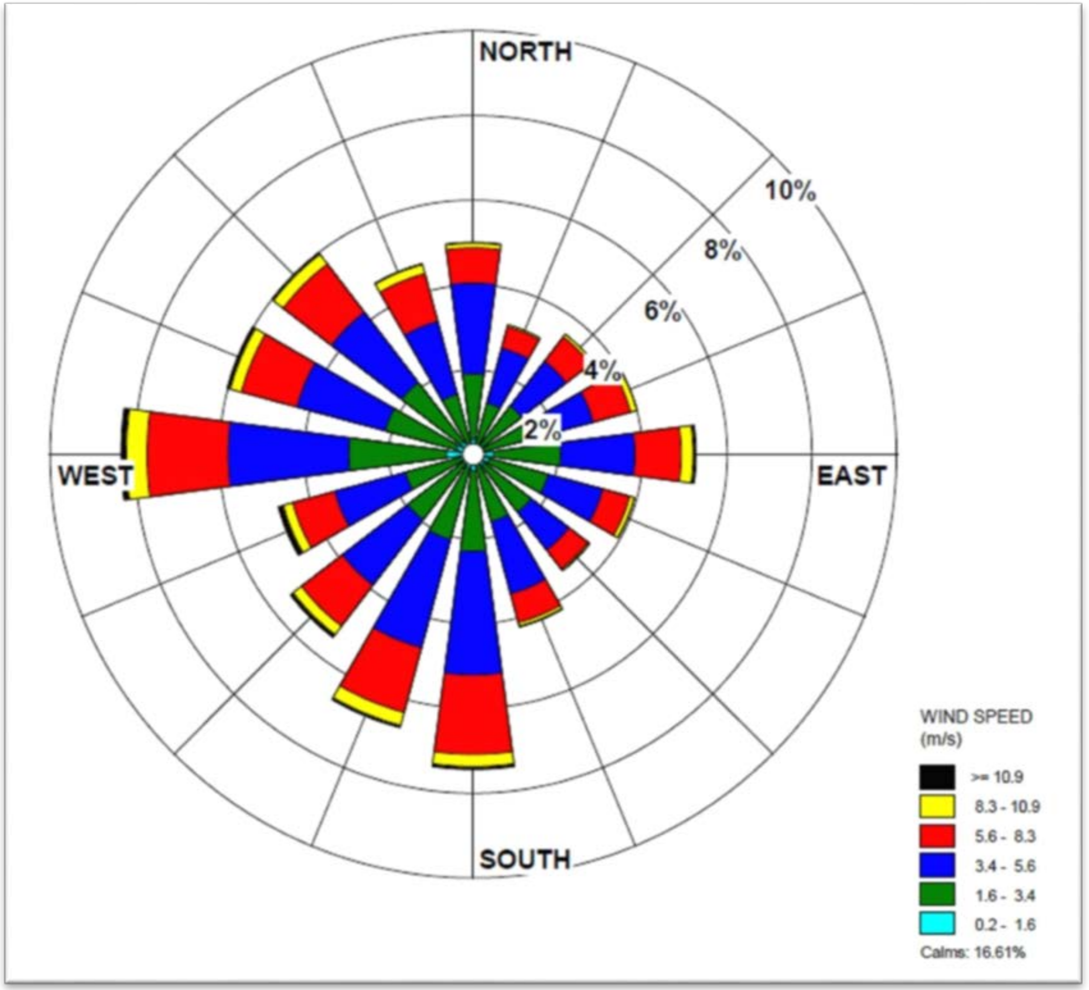
General and Local Climate

Statistic	Bounding Value (°F)
Estimated 100-yr maximum DBT	104.8 (Rockford)
MCWB coincident with 100-yr maximum DBT	80 (Rockford)
Historical maximum WBT	85.0 (Madison)
Estimated 100-yr maximum WBT	86.0 (Madison)
Estimated 100-yr minimum DBT	-35.1 (Rockford)

Meteorology

Site Meteorology

Annual wind rose from Southern Wisconsin Regional Airport, located approximately 0.4 miles west of the SHINE site



Meteorology

Site Meteorology

- Local Data Sources
  - SWRA meteorological monitoring station, an automated weather observation station (AWOS)
- Atmospheric Stability
  - Derived from hourly wind speed, ceiling height, and sky cover measurements from the AWOS at the SWRA
  - Pasquill stability class derived using computer code from US EPA
  - At the SHINE site, stability class “D” is most frequent (54%), “A” is least frequent (1%)
  - Used for χ/Q and radiological dose calculations

Hydrology

Hydrological Description

- General Setting – Surface Water
- General Setting – Groundwater
- Withdrawals

Hydrology

Hydrological Description

- Groundwater flow
  - The groundwater flow direction on the SHINE site is toward the Rock River year round (NNE to SSW)
  - Hydraulic conductivity of the sandy layers at the site was determined by in-situ hydraulic slug tests in the monitoring wells.
  - Average hydraulic conductivity of 0.0045 ft/sec

Hydrology

Floods

- Rock River flows
  - Peak historic flow was 16,700 cfs in June 2008.
  - Corresponding June 2008 flood level was 755.65 ft.
  - Site ground elevation is 819 to 826 ft.

Recurrence Interval	Peak Discharge (cfs)	Water Surface Elevation (ft)
10	10,900	758.3 to 752
50	14,500	760 to 754
100	16,000	761 to 755
500	19,000	762 to 756

Hydrology

Floods

- Local Intense Precipitation
  - The drainage system and site elevation ensures SHINE facility is not affected by PMP runoff from off-site drainage area.
- Other flooding scenarios are not applicable to the site
- Probable maximum flood
  - Estimated using Reg Guide 3.40 and 1.59
  - PMF is Rock River flow of 133,000 cfs, with a corresponding Rock River elevation of 774 ft., about 45 ft. below current site elevation
  - PMP for a 24-hour storm is approximately 14-16 in.

Hydrology

Pathways and Transport

- Hydrogeological characteristic of the site were evaluated to support the safety analysis
- Any potential releases would migrate along the following pathway:

    a. Unsaturated zone

    b. Saturated zone

    c. Discharge at Rock River and its tributaries

Geology, Seismology, and Geotechnical Engineering

Regional Geology

- SHINE region is defined as the area within a 200 mi. (322 km) radius of the site
- Capable faults are considered capable of being the source of moderate to large earthquakes in the future
- Only the unidentified faults associated with the Wabash Valley liquefaction features are considered capable faults, which appear to have originated from earthquakes centered in southern Indiana and Illinois, more than 200 miles from the SHINE site
- The best available science shows that faults mapped within the basement and bedrock within 200 miles of the SHINE site are not capable faults.

Geology, Seismology, and Geotechnical Engineering

Site Geology

- Bedrock
  - Greater than 221 ft. below ground surface (bgs) based on geotechnical drilling investigations
  - May be as far as 300 ft. bgs
- Little or no net deformation beneath the site over about the last 500 million years
- Soil
  - 10 to 40 in. of Warsaw and Lorenzo loam topsoil
  - 180 to 185 ft. of fine- to coarse-grained sand with occasional gravel layers
  - 10 to 18 ft. of clayey silt
  - Sand or silty sand to at least 221 ft. bgs
- No other hazards
  - No evidence of karst features.
  - Sinkholes unlikely due to several hundred feet of sediment overlying bedrock.
  - No highly-plastic or swelling clays identified.

Geology, Seismology, and Geotechnical Engineering

Seismicity

- SHINE developed a catalog of historic earthquakes based on Central Eastern United States – Seismic Source Characterization for Nuclear Facilities
- Largest earthquake is the May 26, 1909 expected moment magnitude (E[M]) 5.15 event located approximately 85 mi. (137 km) southeast of the SHINE site
- Region has a historic record of relatively infrequent, small to moderate earthquakes that is typical of much of the central and eastern United States.
- Regional earthquakes have developed Modified Mercalli Intensity (MMI) values ranging from III to VII within approximately 200 mi. of the SHINE site.
- The maximum felt intensity experienced at the SHINE site in historical times is MMI V.

Geology, Seismology, and Geotechnical Engineering

- Maximum Earthquake Potential
  - The maximum earthquake that has occurred during the last 200 years within 200 mi. (322 km) of the site is a E[**M**] 5.15 event in 1909 in Illinois
  - Longer term earthquake shaking potential was estimated from USGS 2008 National Seismic Hazard Model
  - An M 5.8 earthquake determined to be the estimated maximum potential earthquake for the SHINE site
- Vibratory Ground Motion
  - Based on interpolation of USGS 2008 National Seismic Hazard Model
  - 2009 International Building Code supersedes Wisconsin Uniform Building Code, used for seismic design parameters

Geology, Seismology, and Geotechnical Engineering

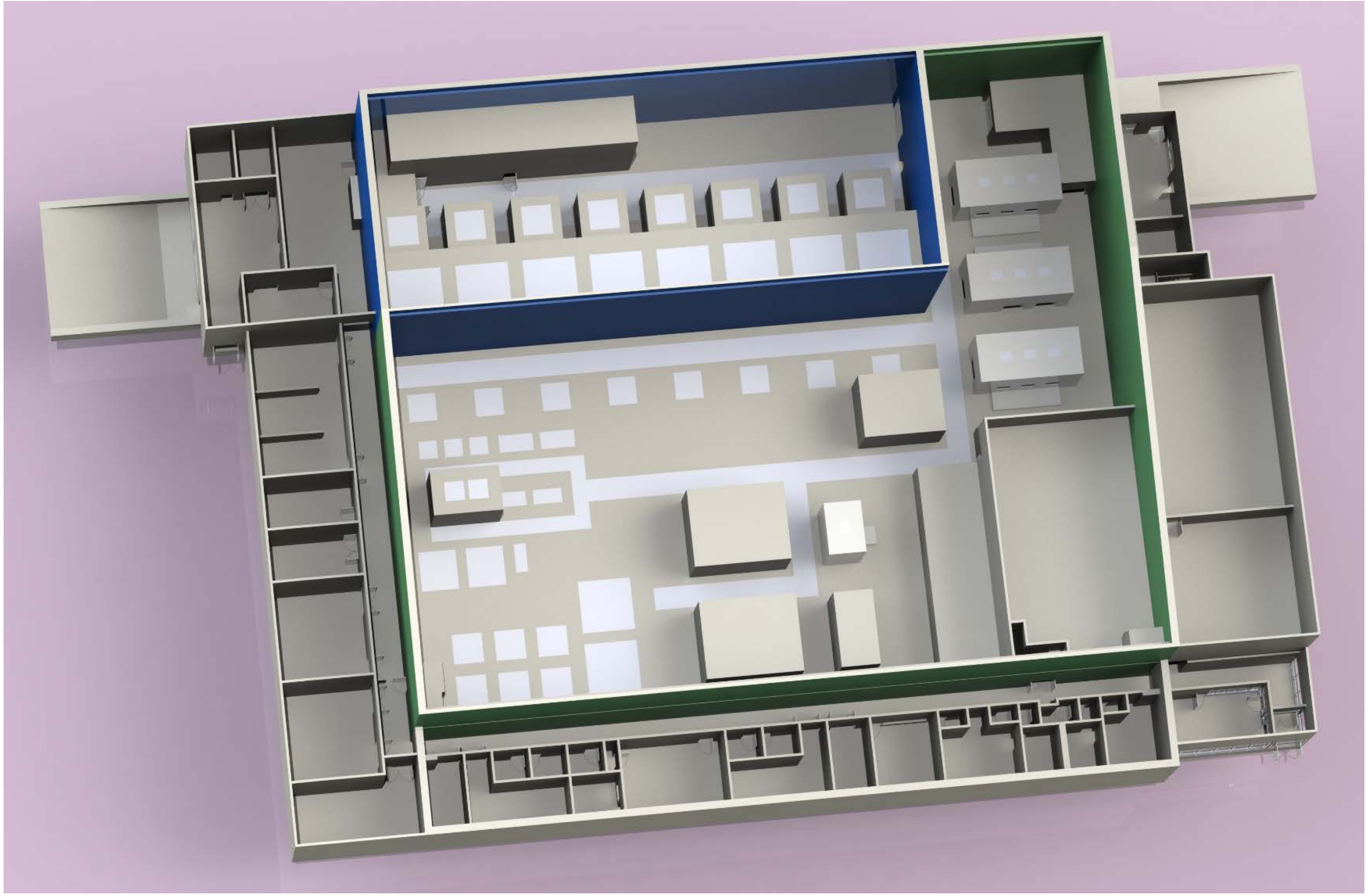
- Surface Faulting
  - Surface faulting associated with future earthquakes is not anticipated to affect the SHINE site.
- Liquefaction Potential
  - Qualitative and quantitative liquefaction analysis demonstrate that there is no potential for liquefaction to occur within the soils underlying the SHINE site

Section 4a – Irradiation Facility Description

Eric Van Abel
Engineering Supervisor

June 23, 2015

Irradiation Facility and Radioisotope Production Facility



SHINE Irradiation Facility

- An Irradiation Unit (IU) is a subcritical assembly, a neutron driver, and supporting systems
- Supporting systems include:
  - Biological shielding
  - Light water pool
  - Neutron flux detection system
  - TSV off-gas system (TOGS)
  - Primary closed loop cooling system (PCLS)
  - Tritium purification system (TPS)
- There are eight (8) IUs in the SHINE Irradiation Facility
- Some RPF systems also support the irradiation facility processes (e.g., ventilation, cooling water, electrical, noble gas removal system)

Subcritical Assembly

TSV and SASS

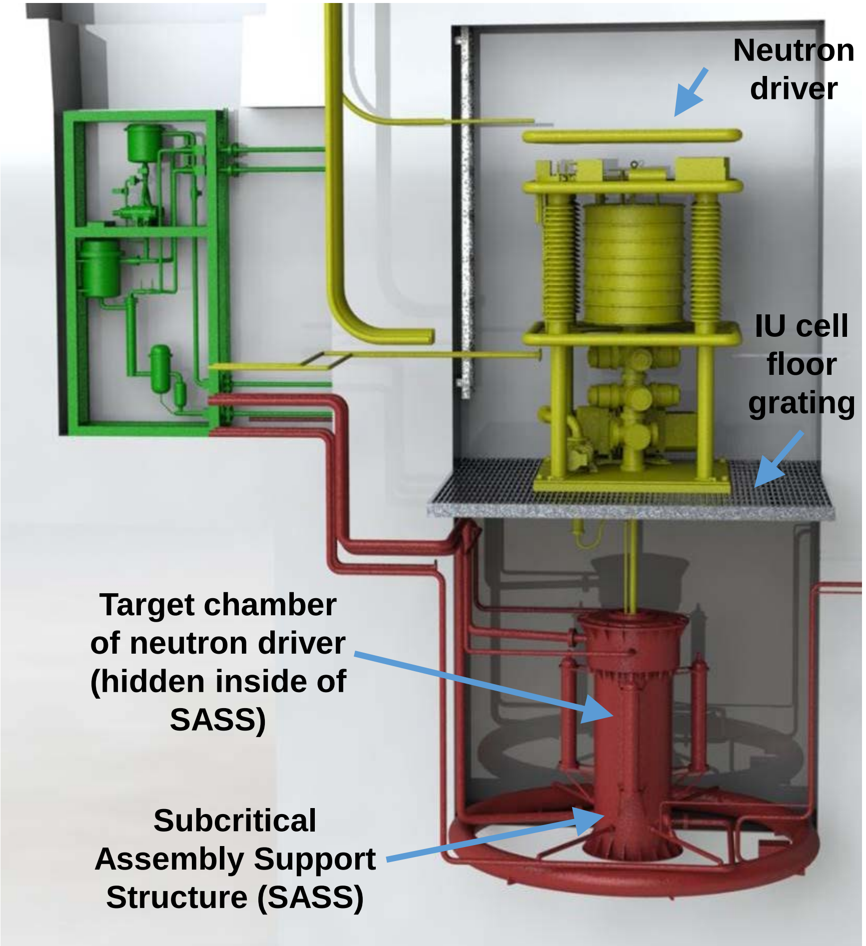
- TSV is an annular vessel to be constructed of Zircaloy-4
  - Holds target solution in proper geometry during irradiation
  - Approximately 30-50 cm of gas space above the target solution
- No mechanical mixing of the target solution; solution undergoes natural convection in the TSV and is agitated by radiolytic bubble production

TSV and SASS

- Target solution is drained from the TSV via gravity
  - TSV dump tank is criticality-safe by geometry and passively-cooled
  - Two redundant dump lines
  - Fail-open dump valves
- SASS is an annular pressure vessel to be constructed of 316L stainless steel
- Primary system normally operates slightly below atmospheric
- TSV and SASS to be designed for pressures exceeding the maximum credible deflagration pressure

Neutron Driver

- One (1) Neutron Driver per IU cell (8 total)
- Electrostatic accelerator with a gas target
  - Accelerates deuteron ion beam into a target chamber containing tritium and deuterium gases
  - D-T fusion reaction generates 14 MeV neutrons



Neutron Driver

- Accelerator operation introduces deuterium into tritium gas target chamber, resulting in mixing of gases
- Neutron driver performs no safety-related function; therefore, it is a nonsafety-related system
- Neutron yield is controlled by adjusting the tritium concentration in the target chamber
  - Flow rate of tritium controls tritium concentration, which controls neutron output

Biological Shielding

- Biological shielding protects SHINE facility personnel, members of the public, and various components and equipment from excessive radiation exposure
  - Typical exterior dose rates less than 1 mrem/hr
- The lower portion of the IU cell walls serve as the light water pool walls
- IU cell and TOGS shielded cell also serve as a portion of the confinement boundary

SCAS Nuclear Design

- Aqueous homogeneous uranyl sulfate solution in the TSV
- Three modes of operation involving the TSV:
  - Mode 1: Startup
  - Mode 2: Irradiation
  - Mode 3: Post-Irradiation
- System remains subcritical during all modes of operation

SCAS Nuclear Design – Startup Mode

- Target solution is staged in the Target Solution Hold Tank
  - Hold tank is at a lower elevation than TSV to preclude gravity-driven filling
  - Uranium concentration of solution and any other necessary parameters are measured prior to filling
- Operators use a 1/M startup methodology to monitor the reactivity increase in the TSV
  - TSV is filled in discrete increments
  - Final fill level is approximately 5% by volume below critical
- Automatic safety systems will be designed to protect the PSB and ensure the TSV remains subcritical

SCAS Nuclear Design – Irradiation Mode

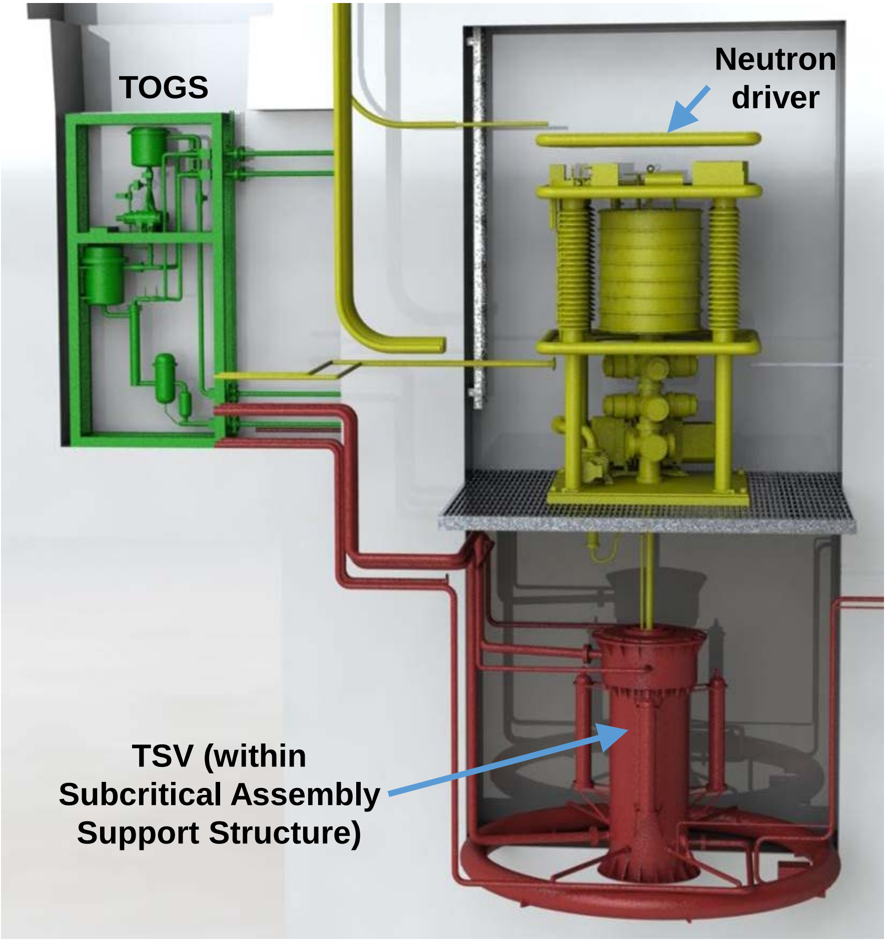
- Further solution addition is prevented by closing two redundant (series) fill valves
- Neutron driver is energized with deuterium target gas
- Tritium is supplied to the target and neutron driver output is gradually increased
  - Reactivity decreases in the assembly due to the generation of heat and radiolytic gases in solution

SCAS Nuclear Design – Irradiation Mode

- Normal irradiation mode operations are approximately 5.5 days
  - Radiolytic and fission product gases are handled and contained by the TOGS
  - Primary closed loop cooling system (PCLS) removes heat from TSV
  - Light water pool cooling loop removes heat from the pool, neutron multiplier, and tritium chamber
- Detailed kinetics analysis will be described in the FSAR

SCAS Nuclear Design – Post-Irradiation Mode

- Following irradiation:
  - Neutron driver high voltage power supply (HVPS) is de-energized
  - Dump valves are opened
  - Target solution drains to the TSV dump tank
  - Target solution is passively cooled
  - TOGS continues to operate



TSV Off-Gas System (TOGS)

- Off-gas formed during irradiation of the TSV due to:
  - Radiolytic decomposition of water
  - Generation of gaseous and volatile fission products
- TOGS performs several functions:
  - Contains the fission product gases
  - Removes iodine from the off-gas
  - Recombines hydrogen and oxygen to maintain hydrogen gas below the LFL
  - Maintain the system at a negative pressure to prevent egress of gases

TSV Off-Gas System (TOGS)

- Following shutdown, TOGS continues to operate to recombine hydrogen from decay radiation
- TOGS powered from the Uninterruptible Power Supply System (UPSS) and will have power should offsite power be lost
  - Detailed evaluation of duration of emergency power requirements for TOGS to be provided with OL application
- Gases are purged at the end of irradiation to the noble gas removal system (NGRS)
  - NGRS holds the fission product gases for sufficient decay time prior to release

SCAS Thermal Hydraulics

- PCLS and LWPS cooling loop remove heat from the subcritical assembly during normal irradiation and shut down operations
- Temperature in the TSV expected to increase from 20°C to nominally 60°C during operation at the proposed licensed power limit
  - Preliminary correlation based heat transfer calculations, experiments done at University of Wisconsin – Madison
  - CFD simulations done at University of Wisconsin – Madison and LANL
- Results of thermal-hydraulic analyses to be provided with OL application

Irradiation Facility Summary

- Subcritical assembly is irradiated by the neutron driver
- Subcritical assembly is filled in a controlled, discrete process
  - Automatic trips ensure acceptable reactivities are maintained during startup
- Large, negative temperature and void reactivity coefficients drive the system further subcritical during irradiation
- TOGS circulates sweep gas to ensure hydrogen concentrations remain acceptable
- No manual control of reactivity during irradiation required or included, system is monitored to ensure steady behavior
  - If monitored parameter exceeds acceptable values, uranium solution is automatically dumped to the criticality-safe, passively-cooled dump tank

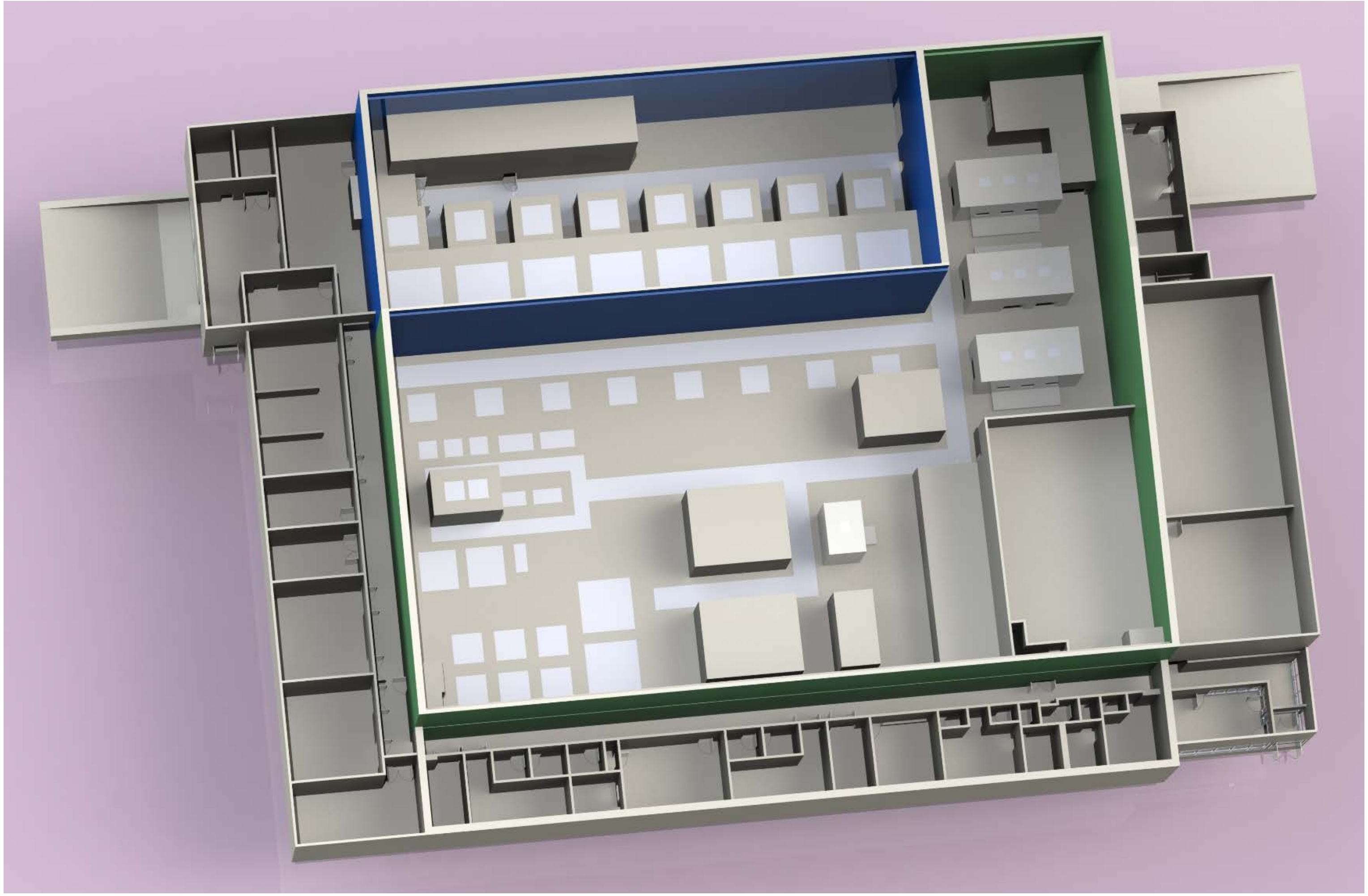
Section 4b – Radioisotope Production Facility Description

Catherine Kolb

Engineering Supervisor

June 23, 2015

Irradiation Facility and Radioisotope Production Facility



Facility and Process Description

- Rad material processing areas and related SSCs are in Seismic Category I structures
- Rad materials contained in piping and processing systems, shielded hot cells and vaults, or shielded pipe trenches as needed to maintain worker dose within regulations and in accordance with the ALARA program
- Criticality-safe by geometry design for equipment containing fissile material
- Sumps for hot cells, vaults and pipe trenches include leak detection
- Tanks include overflow lines hard-piped to the criticality-safe collection tank in the low point of the building
- Operating areas are monitored with the Continuous Air Monitoring System (CAMS), Radiation Area Monitoring System (RAMS), and Criticality Accident Alarm System (CAAS)
- Hot cells are isolated from the building HVAC system upon detection of a leak to prevent the spread of contamination

Radioisotope Production Facility

- Target Solution Preparation System (TSPS)
  - Receive and store LEU metal, and dissolve LEU metal in nitric acid to form uranyl nitrate
  - Transfer uranyl nitrate to UNCS for thermal denitration
  - Receive and store uranium oxide, and react UO_3 with sulfuric acid to form target solution (uranyl sulfate)
- Molybdenum Extraction and Purification System (MEPS)
  - Receive irradiated target solution
  - Extract and purify Mo-99
  - Transfer post-extraction target solution to UNCS for cleanup or recycle
  - Transfer purified Mo-99 to packaging system
- Uranyl Nitrate Conversion System (UNCS)
  - Uranyl nitrate conversion (uranyl sulfate to uranyl nitrate)
  - Target solution cleanup (uranium extraction, or UREX)
  - Thermal denitration (uranyl nitrate to uranium oxide)

Radioisotope Production Facility

- Molybdenum Isotope Product Packaging System (MIPS)
  - Receives concentrated Mo-99 product solution from the MEPS
  - Product containers transferred to shipping casks
- Radioactive Drain System (RDS)
  - Routes liquids from the cell sumps and tank vaults to a criticality-safe by geometry collection tank in the low point of the facility
- Noble Gas Removal System (NGRS)
  - Store TSV off-gas to allow for noble gas radioactive decay
  - Release decayed off-gas to PVVS
- Process Vessel Vent System (PVVS)
  - Treats off-gas from the vessels that handle the main process fluids
  - Caustic scrubbing removes acid gases and some iodine species

Radioisotope Production Facility

- Aqueous Radioactive Liquid Waste Storage (RLWS)
  - Surge capacity for aqueous liquid wastes to reduce fluctuations in composition and flowrates
  - Allows short-lived radioisotopes to decay
- Radioactive Liquid Waste Evaporation and Immobilization (RLWE)
  - Aqueous liquid wastes concentrated and immobilized in Portland cement
  - Only trace quantities of SNM in RLWS or RLWE
- Organic Liquid Waste Storage (OLWS)
  - Load, store, and ship organic wastes from the RCA
  - Primarily spent solvent from UREX

RPF Biological Shield (PFBS)

- Reduces radiation exposure to facility personnel, members of the public and various components and equipment
- Design basis
  - Design dose rate for normally occupied locations in the facility is 0.25 mrem/hr at 12 in. from the surface of the shielding
  - PFBS designed and constructed to remain intact during normal operations as well as during and following design basis accidents
  - No substantial neutron flux is anticipated in the RPF

Radioisotope Extraction and Purification

- Radioisotope Extraction
  - One batch of irradiated target solution is transferred from the IU cell TSV dump tank to MEPS
  - Extraction process performed in a hot cell (supercell)
  - The irradiated target solution is passed through a column to extract the Mo-99, which is then stripped with dilute sodium hydroxide
  - The Mo-99 stream is re-acidified and further processed before being purified using the Cintichem process

Radioisotope Extraction and Purification

- Radioisotope Purification
  - The purification process purifies the Mo-99 through additions of small quantities of chemicals, filtration, and other laboratory techniques
  - Cintichem involves solid precipitations, filtrations, washes, dissolutions, and column adsorptions
  - Small samples are taken to verify and record activity in a facility lab for quality control
  - Final product bottle is transferred to the packaging area of the supercell

Special Nuclear Material Processing and Storage

- Shipments of SNM are received at the facility in solid form from a U.S. Department of Energy (DOE) supplier
- Uranium metal enriched to 19.75 ± 0.2 percent U-235 (LEU)
- RPF contains SNM in multiple forms:
  - Uranium metal
  - Uranium oxide
  - Uranyl sulfate
  - Uranyl nitrate
  - Aqueous and cement-solidified plutonium
    - From irradiation processes, contained in waste streams

Special Nuclear Material Processing and Storage

- Based on product quality requirements, the target solution will be cleaned to remove unwanted fission products
- Uranyl sulfate (target solution) is converted to uranyl nitrate in uranyl nitrate preparation (UNP)
- Uranyl nitrate is cleaned using the Uranium Extraction (UREX) process
- Clean uranyl nitrate is converted to uranium oxide by thermal denitration (TDN)

Special Nuclear Material Processing and Storage

- Uranium metal
  - Received in approved transport containers
  - Stored in a criticality-safe storage rack
  - Dissolved in nitric acid in TSPS
- Uranium oxide
  - Received from TDN
  - Stored in a criticality-safe storage rack
  - Converted to uranyl sulfate by reaction with sulfuric acid in uranyl sulfate preparation tank

SHINE Medical Technologies, Inc.
Advisory Committee on Reactor Safeguards
Radiation Protection & Nuclear Materials Subcommittee

Chapter 5 – Cooling Systems

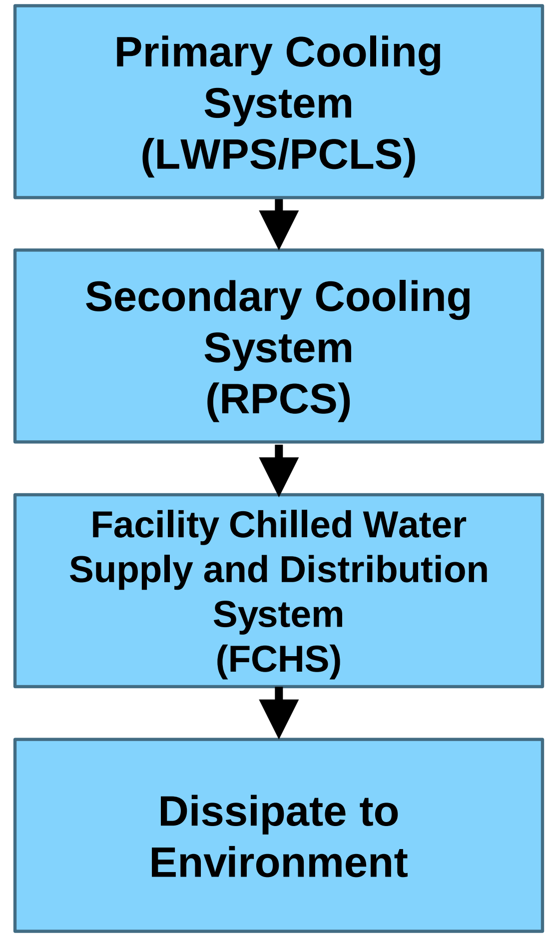
Eric Van Abel

Engineering Supervisor

June 24, 2015

Cooling Systems

- Primary cooling systems are the Primary Closed Loop Cooling System (PCLS) and the Light Water Pool System (LWPS)
- The secondary cooling system is the Radioisotope Process Facility Cooling System (RPCS)
- The Facility Chilled Water Supply and Distribution System (FCHS) provides chilled water to the radiological and non-radiological portions of the facility



Primary Closed Loop Cooling System

- The PCLS connects directly to the SASS, supply and return connections
  - SASS directs cooling water over TSV external surfaces
- PCLS consist of a circulation pump, heat exchanger, cleanup equipment, cooling water tank, and associated piping components
- Pressure, flow, level, conductivity, and temperature indication provided
- Eight (8) PCLS systems
  - Independent for each IU
  - Failure of one PCLS does not affect others PCLS systems or IUs

Light Water Pool System

- LWPS removes heat from the light water pool, neutron multiplier, and neutron driver target chamber
  - Draws water in from pool, discharges cooled water past multiplier and target chamber back into pool
  - Pool passively removes decay heat in shutdown conditions and accident scenarios
- LWPS cooling loop includes circulation pump, heat exchanger, cleanup equipment, and associate piping components
  - Cooling loop not credited in accident conditions
- Pressure, flow, level, conductivity, and temperature indication provided
- Eight (8) LWPS systems
  - Independent for each IU
  - Failure of one LWPS does not affect other LWPS systems or IUs

Primary Cooling Design Features

- Pool is safety-related, but active function of PCLS and LWPS cooling loops are not safety-related
- Light water pool is rectangular concrete structure, with stainless steel liner
- PCLS and LWPS located in primary cooling room, which is shielded due to N-16 and corrosion product activation
- Makeup water supplied from the facility demineralized water supply via the Primary Cooling Makeup Water System (MUPS)

Radioisotope Process Facility Cooling System

- Primary cooling loops absorb fusion and fission generated heat by the target chamber and subcritical assembly, transfer it to RPCS
- RPCS also absorbs heat from other process systems
- One (1) RPCS services the RCA
- RPCS consists of a heat exchanger, head tank, redundant circulation pumps, and associated piping components
- Pressure, flow, temperature, conductivity, and radiation detection instrumentation are provided

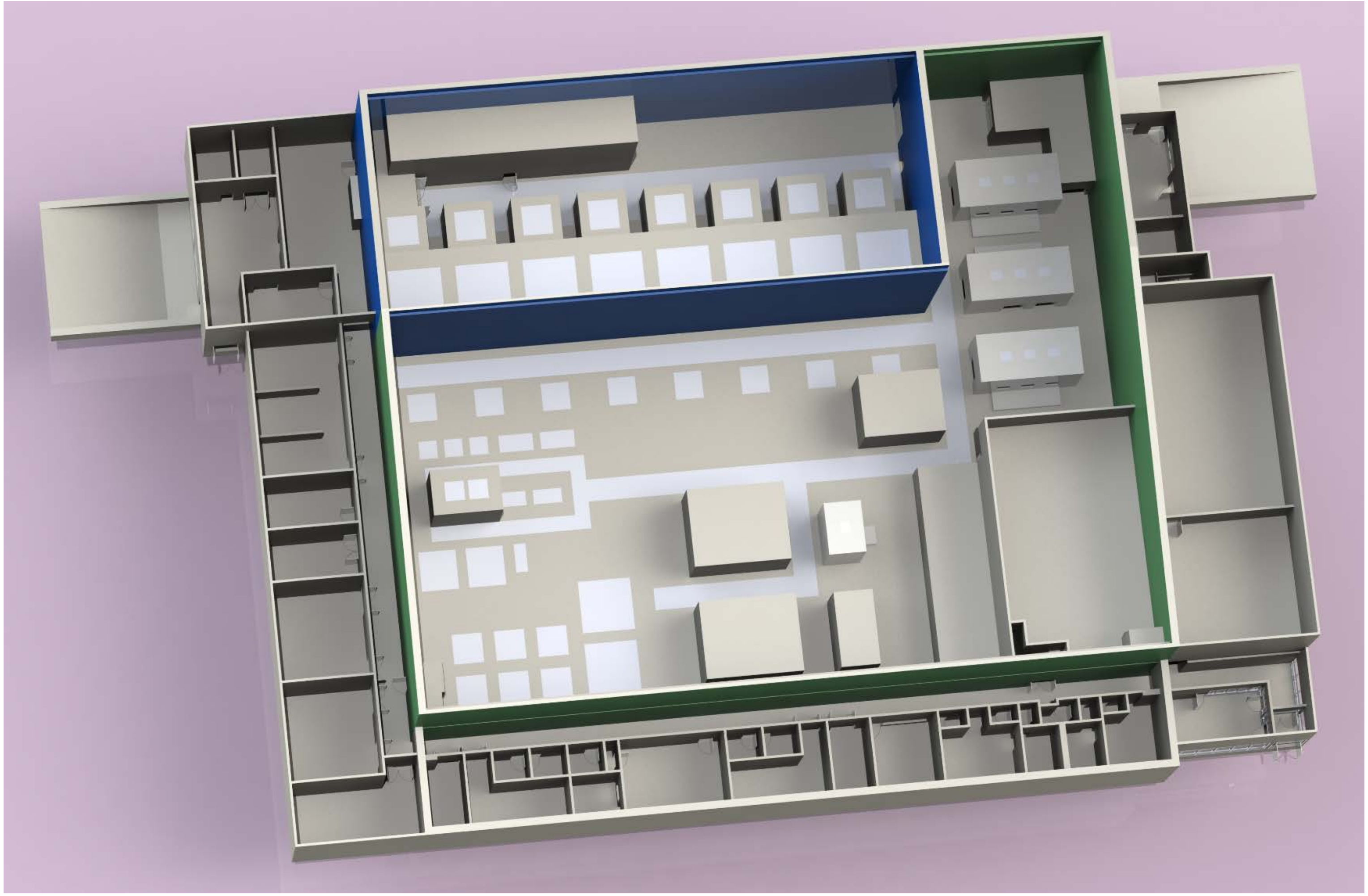
RPCS Design Features

- RPCS is maintained at higher pressures than the primary cooling systems to reduce contamination potential should a leak occur
- Temperature in primary cooling loops is maintained by flow control of RPCS water at the primary heat exchangers
- Heat removal by the RPCS does not serve a safety function; RPCS is not a safety-related system
- Sampling and analysis is performed periodically for radiological contaminants and water quality parameters

Section 6a – Irradiation Facility Engineered Safety Features

Eric Van Abel
Engineering Supervisor
June 24, 2015

Irradiation Facility and Radioisotope Production Facility



Irradiation Facility Engineered Safety Features

- Engineered safety features (ESFs) are those systems that are designed to mitigate the consequences of accidents to keep radiological exposures acceptable
- SHINE’s accident analysis determined what accidents required mitigation by ESFs
- The following design basis accidents are mitigated by Irradiation Facility ESFs:
  - Mishandling or malfunction of target solution
  - Mishandling or malfunction of equipment affecting the PSB
  - Tritium Purification System design basis accident

Irradiation Facility Engineered Safety Features

- SHINE's design does not require a containment due to the low temperatures, low pressures, and low powers involved
- ESFs in the IF perform confinement functions to minimize releases should they occur
- Confinement is a low leakage boundary surrounding radioactive materials

Irradiation Facility Engineered Safety Features

- ESFs in the IF include:
  - IU cells including penetration seals
  - RCA ventilation system Zone 1 (RVZ1) ductwork
  - Bubble-tight isolation dampers
  - Isolation valves on piping systems penetrating the IU cells
  - TOGS shielded cells including penetration seals
  - Engineered safety features actuation system (ESFAS)
  - TPS confinement system components, including gloveboxes, double-walled piping, and isolation valves

Irradiation Facility Engineered Safety Features

- Active and passive components comprise the confinement boundary
- Those components required for confinement are safety-related
- Safety-related active components are designed with sufficient redundancy and independence such that a single failure does not cause a loss of capability to perform the safety function
- Isolation valves and dampers take the position of greater safety upon loss of actuating power

ESF Actuation

- During normal operation, negative differential pressures are maintained within the confinement areas to minimize contamination
- In the event of a release of radioactive material in the IU cell, TOGS shielded cell, or TPS glovebox, radioactive material would be confined by the walls of the cell itself
- High radiation levels in the exhaust ventilation result in the generation of a confinement isolation signal by ESFAS
- Confinement isolation signal initiates confinement by:
  - Closing isolation dampers on inlet and outlet ventilation ports of the affected cell or glovebox
  - Closing isolation valves on lines penetrating the cell

ESF Testing

- ESFs are periodically tested to ensure components can perform their intended safety functions
- Penetration seals, isolation valves, bubble-tight isolation dampers, gloveboxes, and other components relied upon for confinement will be tested prior to and during operation
- Required testing, including testing intervals, will be included in the Technical Specifications with the OL application

Emergency Cooling

- Decay heat removal during accident scenarios is provided by natural convection and the safety-related light water pool
- No emergency cooling systems are required

Chapter 7 – Instrument and Control Systems

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Engineering Supervisor
June 24, 2015

Instrument and Control Systems

- Instrument and Control (I&C) systems are comprised of sensors, electronic circuitry, displays and actuating devices.
- Provide information and means to safely control the SHINE irradiation facility (IF) and radioisotope production facility (RPF) and to avoid or mitigate accidents.
- Instrument are provided to monitor, indicate, and record operating parameters, such as
  - neutron flux density
  - target solution temperature
  - coolant flow and temperature
  - radiation intensities
- Certain I&C systems will automatically shutdown the irradiation units when a safety parameter reaches a predetermined setpoint.
- Systems are designed to actuate engineered safety features.

Irradiation Facility (IF)

Irradiation Facility Instrument and Control Systems

- Reactivity Protection
  - To protect the primary system boundary (PSB) and ensure subcriticality, SHINE uses the TSV Reactivity Protection System (TRPS), a digital protection system
- Reactivity Control
  - TSV Process Control System (TPCS) is the digital control system used for normal operations, startup, and shutdown
- Engineered Safety Features Actuation System (ESFAS)
  - The ESFAS is a diverse system utilizing analog relay trains to actuate confinement isolation

Design of Irradiation Facility I&C Systems

- Irradiation facility TRPS and ESFAS has the capability to trip any or all irradiation units (IU) and isolate the affected IU cells and TSV off-gas system (TOGS) shielded cells
  - TRPS functions as the safety-related protection system for the PSB
  - ESFAS functions as the safety-related mitigation system for confinement
- A postulated single failure in the TRPS or ESFAS does not prevent IU trip or ESF actuation
- Control system (TPCS) is separate and independent of protection systems (TRPS and ESFAS)

TSV Process Control System

- High integrity process controller
  - Internal redundancy with self-diagnostic functionality ensures robust and reliable controller
- Reactivity control
  - Reactivity is only directly adjusted during the TSV fill process and dump process
  - Rate of reactivity increase during the fill process is limited through physical and control system design
  - TSV dump valves can only reduce reactivity upon opening
- TPCS controls modes of the irradiation unit:
  - Mode 1 Startup Mode: Filling the TSV
  - Mode 2 Irradiation Mode: Neutron driver active
  - Mode 3 Post-irradiation Mode: TSV dump valves open
  - Mode 4 Transfer to RPF Mode: Solution transferred out of IU cell

TSV Reactivity Protection System Design

- When an abnormal event is detected, affected IU is tripped
  - Open TSV dump valves
  - De-energize high voltage power supply to Neutron Driver
  - Close TSV fill valves
  - Close TSV dump tank outlet isolation valves
- Variables monitored for IU trip
  - Hydrogen concentration in PSB (high hydrogen)
  - Neutron flux, source and high range (high flux)
  - Primary cooling system temperature (high or low temperature)
  - Primary cooling flow (low flow)
  - Radiation in RCA ventilation system (high radiation)
  - ESFAS actuation signals
  - Manual emergency trip

TSV Reactivity Protection System

- Hydrogen detectors in TOGS
  - Two detectors
  - Voted on 1 out of 2 logic for high hydrogen
- Neutron flux detectors surround subcritical assembly
  - Measure power and flux, one system per IU cell
  - Three detectors
  - Source range during fill operations
  - High range during irradiation operations
  - Voted triad (2 out of 3)
- Thermocouples in PCLS
  - Three thermocouples
  - Under- and over-temperature trips
  - Voted triad (2 out of 3)

TSV Reactivity Protection System

- Flow meters in PCLS
  - Two flow meters
  - Low flow detection
  - Redundant detection of low flow, 1 out of 2 logic
- Inputs from ESFAS
  - Two independent inputs
  - Either ESFAS train actuation results in IU trip, 1 out of 2 logic
- Manual trip pushbuttons
  - Two pushbuttons
  - Either manual switch activates IU trip
- Manual reset required following trip

Engineered Safety Features Actuation System

- ESFAS activates the ESFs to mitigate possible consequences of postulated accidents
  - Analog, relay-based system
- ESFAS configuration allows each IU to be activated independently
- Two (2) independent trains, either has capability to mitigate consequences
- ESFAS design is fail-safe upon loss of power
  - ESFs are also fail-safe upon loss of power

Engineered Safety Features Actuation System

- Monitored parameters for trip:
  - High radiation in RVZ1 ventilation
    - Two independent radiation detectors
    - Pre-determined trip value actuates relay
    - Trip actuated by 1 out of 2 logic
  - ESFAS manual trip
    - Two control switches, one dedicated to each train
    - Actuates ESFAS with no interaction from TRPS or TPCS
- ESFAS must be manually reset following trip

Radioisotope Production Facility (RPF)

Radioisotope Production Facility Instrument and Control System

- Radioisotope production facility (RPF) contains the extraction and purification, target solution preparation and cleanup, and waste treatment systems
- RPF I&C systems include:
  - Radiological Integrated Control System (RICS)
  - Radiation monitoring systems:
    - Continuous Air Monitoring System (CAMS)
    - Radiation Area Monitoring System (RAMS)
    - Criticality Accident Alarm System (CAAS)
  - Facility Integrated Control System (FICS)

Radioisotope Production Facility Instrument and Control System

- RICS is a safety-related digital control system
- When monitored safety parameters exceed normal conditions, RICS provides mitigative action by activating the ESF for the affected area
  - ESFs in the RPF provide isolation functions and alert the operators of potential contamination
  - Isolable hot cells can be activated independently
  - RCA Ventilation Zones 1 and 2 can also be isolated by RICS by closing bubble-tight dampers

Radioisotope Production Facility Instrument and Control System

- RICS is sectionalized into two parts
  - One part dedicated to safety-related measurement and control
  - Second part for nonsafety-related RPF functions
- RICS is independent and isolated from other RCA systems
- FICS controls balance of plant, including lighting, compressed air, water systems, power distribution

Radioisotope Production Facility Instrument and Control System

- RICS initiates isolation for:
  - Hot Cell Fire Detection and Suppression System (HCFD) actuation (non-safety function)
  - Facility Fire Protection System (FFPS) actuation (non-safety function)
  - Radiation levels exceeding pre-determined thresholds in hot cells or other cells requiring isolation
- Isolation signal initiates closure of redundant bubble-tight dampers on the inlet and outlet of the isolated cell and closes piping isolation valves
  - Isolation dampers and valves are fail-safe on loss of power

Radioisotope Production Facility Instrument and Control System

- Manual trip switches also located at each hot cell or other confinement zone
- RICS provides alarms to alert the operator when monitored parameters exceed pre-determined limits
- RICS controls normal process flow in RPF, as well
  - Monitors valve positions for routing fluids, including target solution
  - Controls valve alignments, checking permissives tables to allow energizing of pumps

Radioisotope Production Facility Criticality Accident Alarm System

- CAAS provides for continuous monitoring, indication, and recording of neutron or gamma radiation levels to detect for an accidental criticality
- Two detectors cover each area needing CAAS coverage
- Local and remote alarms are provided to initiate personnel evacuation
  - Location of criticality accident alarm communicated to RICS
- CAAS is a safety-related system

Irradiation Facility (IF) and Radioisotope Production Facility (RPF)

Radiation Monitoring Systems

- RAMS and CAMS continuously record radiation levels in facility for the safety of personnel and the public
- Radiation monitors provide input to ESFAS and RICS for confinement actuation functions
- Radiation monitors provided in areas where personnel may be present and radiation levels may become significant
  - CAMS are located in work areas where there is potential for airborne radioactivity
  - Beta monitors are placed around tritium purification system gloveboxes to detect and alarm for tritium leaks

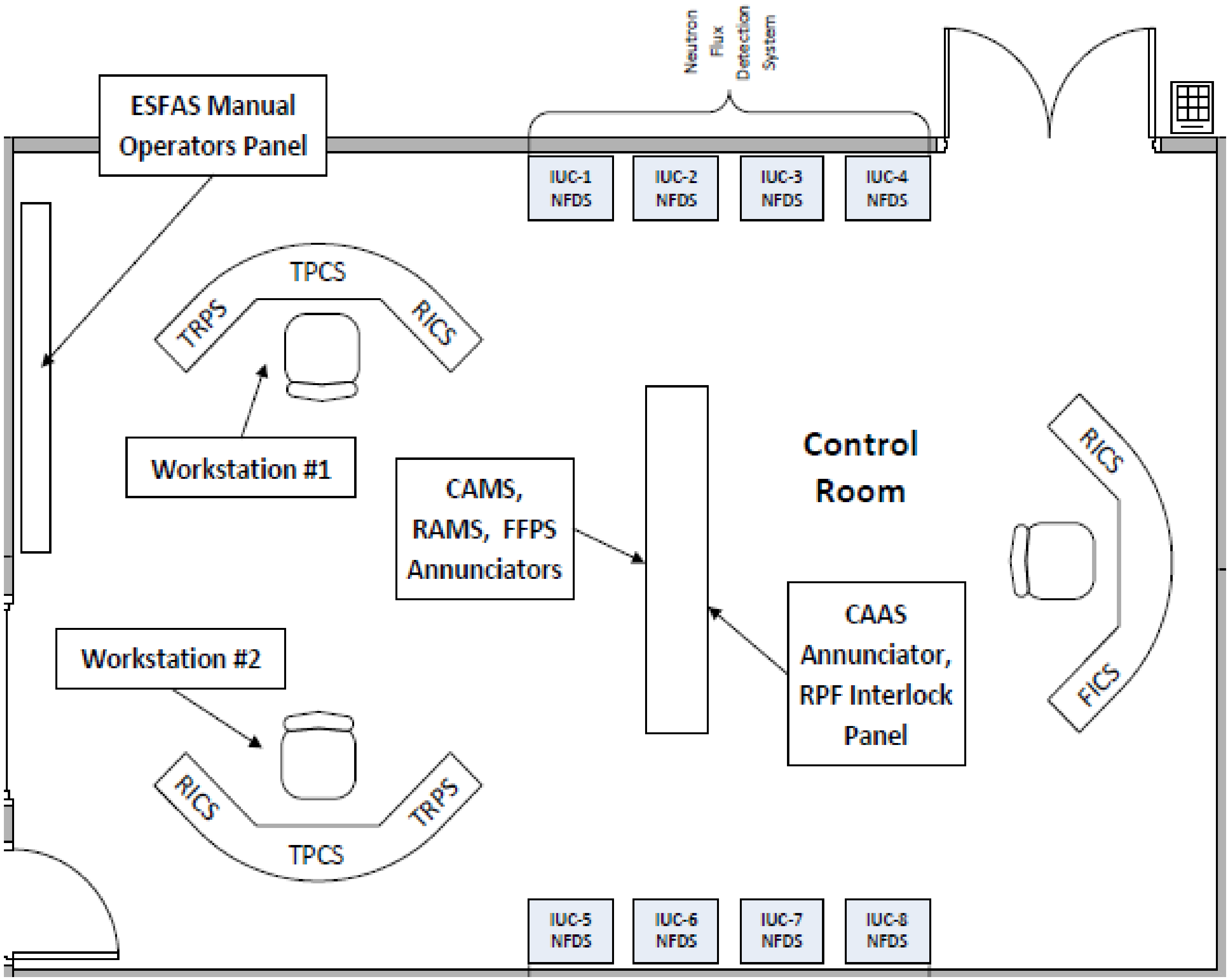
Radiation Monitoring Systems

- CAMS ensure personnel safety by monitoring for low levels of airborne contamination
- In addition to personnel safety, RAMS are also used to detect for releases from accident conditions and initiate confinement
- When radiation exceeds predetermined levels, alarms actuate locally and in the control room
  - Visual and audible indication

Control Room and Instrument Displays

- IF and RPF are monitored from a central control room
- Two independent and redundant operator consoles for irradiation facility
  - TRPS and TPCS have separate, dedicated displays at each console
  - TRPS and TPCS each have annunciation, alarm, and operator interface displays
- One additional operator console dedicated to RICS and FICS
  - RICS displays also provided at both IF consoles
- Radiological monitoring from CAMS and RAMS also displayed in control room

Control Room Layout



Control and Display Information

- Operator has direct visualization of essential values and has ability to control and monitor processes from control room
- Static annunciator/fixed status displays provide simple visual indication of status for each IU cell
- Functionality of displays or human-machine interfaces does not impair operation of TRPS or TPCS
- Operator interface terminals (OITs) are located in the plant adjacent to individual hot cells and glovebox systems
  - OIT provides local control to operators, where appropriate
  - Extension of RICS

Chapter 8 – Electrical Power Systems

Bill Hennessy

Engineering Manager

June 24, 2015

Electrical Power Systems

- The SHINE facility electrical power systems are common to both the irradiation facility (IF) and radioisotope production facility (RPF)
  - Normal electrical power system
  - Emergency electrical power system

Normal Electrical Power Systems

- Off-site power
  - Single off-site circuit from the electric transmission network
  - Feeds two 12 kV power feeds connected to two local outdoor 12kV – 480 VAC transformers at 2000 kVA each.
    - Approximate connected facility loads 1500 kVA each
  - Each transformer is connected to a main 480 VAC switchgear bus

Normal Electrical Power Systems

- Power distribution system
  - The SHINE facility power distribution voltages are 480 VAC and 208 VAC 3-phase, 60 hertz (Hz)
  - Two facility switchgear
    - Large loads such as HVAC, feeds to motor control centers (MCCs), and distribution panels
  - Two MCCs
    - Smaller loads such as motor loads, cranes, lighting

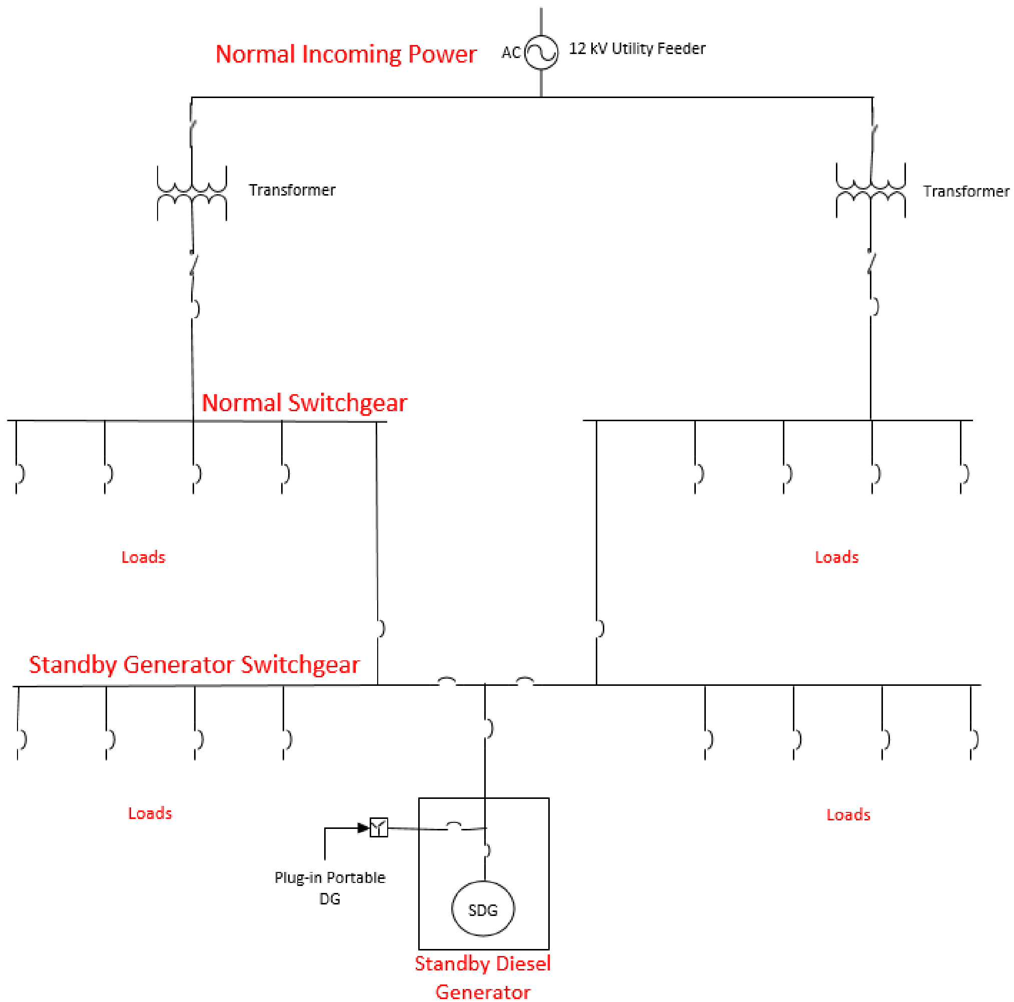
Normal Electrical Power Systems

- Standby diesel generator (SDG)
  - Standby power is from an on-site diesel generator system
    - Supplies power to selected loads in the event of loss of off-site power
  - Availability of the SDG is not required for any safety function at the SHINE facility
  - SDG is sized to provide power to the asset protection loads such as battery chargers, HVAC equipment, instrument air, freeze protection, fire systems, emergency lighting, and SDG switchgear MCCs
    - SDG is automatically connected to SDG switchgear MCCs
    - Operators can add additional loads to the SDG based on need and SDG capacity available

Normal Electrical Power Systems

- Other systems
  - Facility grounding
  - Lightning protection
  - Cathodic protection
  - Freeze protection
- Equipment
  - Power distribution equipment
  - Cable and raceway equipment and routing

Normal Electrical Power Systems



Emergency Electrical Power Systems

- Safety-Related Uninterruptable Power Supply System (UPSS)
  - Two independent, safety-related divisions of 208Y/120 VAC to emergency power buses
    - 250 VDC battery subsystem
    - inverter
    - battery charger
    - voltage regulating transformer
    - panels
    - 208Y/120 VAC bus system

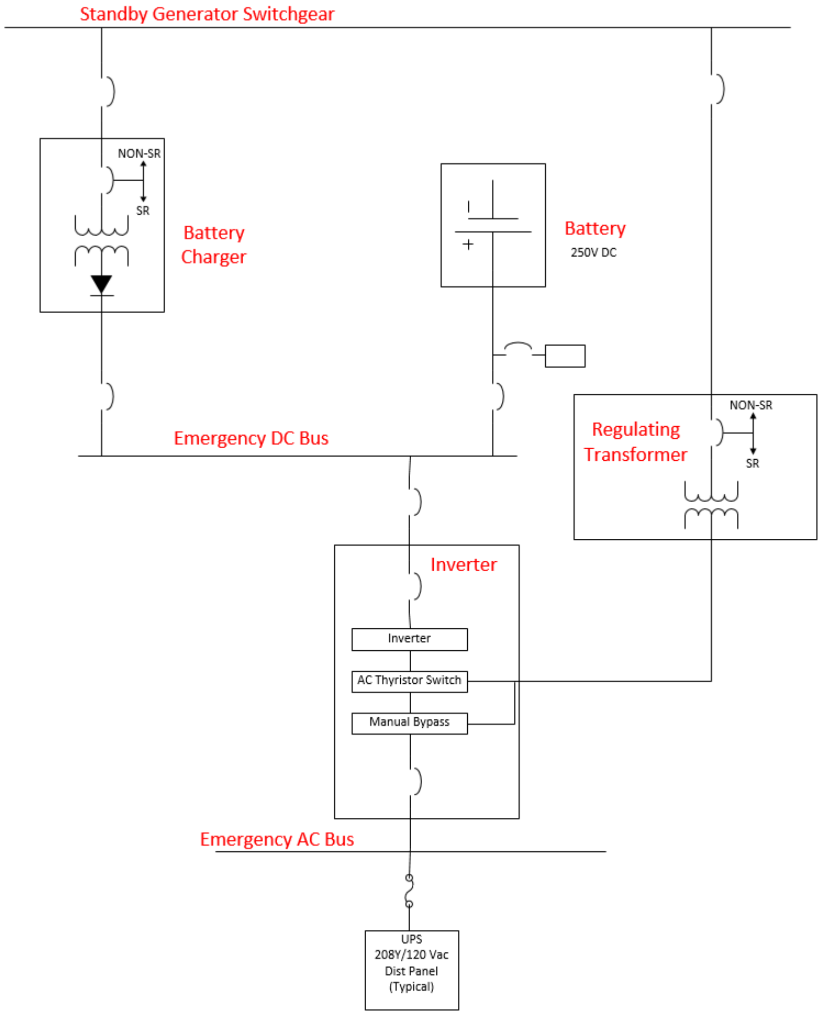
Emergency Electrical Power Systems

- 250 VDC safety-related battery subsystem
  - For normal facility operation, battery charger provides power to the required operational loads via the inverter while the battery bank is kept fully charged and maintained at float charge
  - For loss of AC power, the battery subsystem continues to provide uninterrupted emergency power to the required safe shutdown loads
- AC input breakers on the battery chargers and voltage regulating transformers are isolation devices between the nonsafety-related normal system and the safety-related emergency system

Emergency Electrical Power Systems

- UPSS loads
  - TSV Reactivity Protection System
  - TSV Off-Gas System
  - Neutron Flux Detection System
  - Process Vessel Vent System blower
  - Continuous Air Monitoring System
  - Radiation Area Monitoring System
  - Criticality Accident and Alarm System
  - Radiological Integrated Control System
  - Engineered Safety Features Actuation System

Emergency Electrical Power Systems



Emergency Electrical Power Systems

- Safe Shutdown of the Facility
  - Irradiation process stops when the neutron driver loses power
  - Any filled TSV will dump its contents upon loss of power; the TSV dump tank is below the TSV
  - The light water pool passively absorbs the residual heat from the target solution
  - Confinement dampers close on loss of power
  - UPSS powers the TOGS and PVVS safety-related blowers to maintain safe shutdown

Electrical Power Systems

- The SHINE facility has one common electrical power system for the IF and RPF
- Provides the reliability, redundancy, and defense in depth necessary to support normal and emergency operations

Advisory Committee on Reactor Safeguards
Radiation Protection & Nuclear Materials Subcommittee

Meeting on SHINE Construction Permit Application

Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
June 23-24, 2015

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Advisory Committee on Reactor Safeguards
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Chapter 1
Introduction to the Facility

Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
June 23-24, 2015

SHINE Medical Technologies, Inc.

- SHINE has requested a construction permit for a medical radioisotope production facility in Janesville, WI
- If granted, permit would allow construction of eight commercial non-power utilization facilities and one production facility
- Eight accelerator-driven subcritical operating assemblies comprise the irradiation facility (IF) and will produce ^{99}Mo through fission of uranium solution
- Three hot cell structures comprise the radioisotope production facility (RPF), which will chemically separate ^{99}Mo from uranium solution

SHINE Irradiation Facility

- Irradiation facility houses eight subcritical irradiation units, which are comparable in power level and safety considerations to existing non-power reactors licensed under 10 CFR Part 50
- However, due to subcriticality, irradiation units did not meet the existing definition of utilization facility in 10 CFR 50.2
- To align licensing process with potential hazards, issued direct final rule modifying 10 CFR definition of utilization facility to include SHINE irradiation units
  - Published October 17, 2014
  - Effective December 31, 2014

SHINE Radioisotope Production Facility

- RPF process descriptions
  - Attention to quantities and chemical forms of special nuclear material
  - Safety criteria based on dose requirements and regulatory guidance
- PSAR includes a Integrated Safety Analysis and designated safety-related structures, systems, and components
- Intermediate-consequence accidents unlikely and high-consequence accidents highly unlikely
- Nuclear processes are subcritical

Construction and Operation Licensing Process

- Construction permit application
  - Environmental report
  - Preliminary safety analysis report
- Operating license application
  - Final Safety Analysis Report, including: plans for operation, emergencies, and technical specifications
  - Update to Environmental Report, as necessary
  - Physical Security Plan
- 18 – 24-month review of each application

SHINE Licensing Process

- SHINE facility will be licensed under 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities”
  - Target irradiation performed by *utilization facilities*
  - Fission product separation in *production facility*
- Special nuclear material will be licensed under 10 CFR Part 70, “Domestic Licensing of Special Nuclear Material”
- Byproduct material will be licensed under 10 CFR Part 30, “…Domestic Licensing of Byproduct Material”
- Source material will be licensed under 10 CFR Part 40, “Domestic Licensing of Source Material”

Construction Permit Regulatory Requirements

- Regulatory considerations for evaluating construction permit:
  - 10 CFR 50.22, Commercial and industrial facility licenses
  - 10 CFR 50.34(a), Preliminary safety analysis report
  - 10 CFR 20.1201, Occupational dose requirements
  - 10 CFR 20.1301, Public and accident dose requirements
  - 10 CFR 50.35, Issuance of construction permits
- Note: 10 CFR Part 50 Appendix A, “General Design Criteria” and 10 CFR Part 100 siting and accident dose criteria (among other requirements) do not apply

Regulatory Basis for Construction Permit

- The following determinations must be made to issue a construction permit, based on 10 CFR 50.35:
  - Systems have been described, including the principal architectural and engineering criteria for the design
  - Further technical or design information may be reasonably left for later consideration in the FSAR
  - Safety features or components requiring research and development have been identified
  - The proposed facility can be constructed without undue risk to the health and safety of the public

Regulatory Guidance and Acceptance Criteria

- NUREG-1537, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors”
- Interim Staff Guidance Augmenting NUREG-1537
  - Radioisotope production facilities
  - Aqueous homogeneous reactors
  - Incorporates relevant non-reactor guidance from NUREG-1520, “Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility, Rev. 1”
- Other guidance and engineering judgement used, as appropriate, to determine what is necessary for construction permit

NUREG-1537 Review Areas

1. **The Facility/Introduction**
2. **Site Characteristics**
3. Design of Structures, Systems, and Components
4. **Facility Description**
5. **Coolant Systems**
6. **Engineered Safety Features**
7. **Instrumentation and Control**
8. **Electrical Power Systems**
9. Auxiliary Systems
10. Experimental Facilities
11. Radiation Protection and Waste Management
12. Conduct of Operations
13. Accident Analysis
14. Technical Specifications
15. Financial Qualifications
16. Other License Considerations
17. Decommissioning
18. Uranium Conversions
19. Environmental Review

Summary of Chapter 1 Review

- Applicable requirements of Atomic Energy Act and Commission regulations have been met
- SHINE facility does not share any systems or equipment with other facilities
- SHINE irradiation units are unique technology with no similar facilities in existence
- RPF processes, such as Mo purification and uranium extraction are similar to other facilities around the world
- SHINE facility will not have high-level nuclear waste or spent nuclear fuel, so Nuclear Waste Policy Act of 1982 is not applicable

Status of Safety Evaluation Report Development

- Staff is nearing completion of technical review of SHINE PSAR

- One outstanding RAI response expected by July 2015

- Presenting selected chapters that staff have determined are technically complete and have no outstanding RAIs

- Completion of Safety Evaluation Report by October 2015

Discussion

Advisory Committee on Reactor Safeguards
Radiation Protection & Nuclear Materials Subcommittee
Meeting on SHINE Construction Permit Application

Chapter 2
Site Characteristics

Steve Lynch and Mary Adams, Project Managers, U.S. NRC
Steve Marschke, Dave Back, and Milton Gorden, SC&A

June 23-24, 2015

Site Characteristics

- Site characteristics include the geographical, geological, seismological, hydrological, and meteorological characteristics of the site and vicinity in conjunction with present and projected population distributions, industrial facilities and land use, and site activities and controls.

- The SHINE irradiation facility and radioisotope production facility are collocated on a single site.

Areas of Review

Areas of review included geography and demography; nearby industrial, transportation, and military facilities; meteorology; hydrology; and geology, seismology, and geotechnical engineering.

Summary of Application

- The SHINE medical isotope production facility is located on agricultural property in the City of Janesville, Rock County, Wisconsin. The site boundaries encompass approximately 91 acres of land.

- The area within 8 km (5 mi) of the SHINE site supports a population estimated to be about 43,000 people, who mostly live north of the SHINE site in and around Janesville, Wisconsin.

Summary of Application

- Rock county is largely characterized by agricultural land, but also includes industrial facilities, pipelines, highways, railroads, and airports.

- Rock County is drained entirely by the Rock River and its tributaries. The proposed site is upstream from the mouth of the Rock River where it joins with the Mississippi River.

Regulatory Basis and Acceptance Criteria

- Regulatory Requirements:
  - 10 CFR 20.1201, “Occupational dose limits for adults.”
  - 10 CFR 20.1301, “Dose limits for individual members of the public.”
- Acceptance Criteria
  - NUREG-1537, Part 2, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors, Standard Review Plan and Acceptance Criteria.”

Review Procedures and Technical Evaluation

- The staff performed a thorough and complete section-by-section evaluation of the siting information presented in Chapter 2 of the SHINE PSAR, as supplemented by responses to RAIs, to assess the sufficiency of the preliminary design and performance of the SHINE facility in support of the issuance of a construction permit.

Review Procedures and Technical Evaluation

- Geography and Demography
- Nearby Industrial, Transportation, and Military Facilities
- Meteorology
- Hydrology
- Geology, Seismology, and Geotechnical Engineering

Geography and Demography

- PSAR distance-direction relationships to area boundaries, roads, railways, waterways, and other significant features were independently verified using a third-party-supplied map (i.e., Google Maps).

- Based on the distances provided in the SHINE response to RAI 2.1-2 and the PSAR meteorological data, the NRC confirmed that the nearest resident in the northwest direction is also the critical resident.

Nearby Industrial, Transportation and Military Facilities

- Staff confirmed that hazards posed by nearby manmade stationary facilities and transportation have been described and analyzed to the extent necessary to evaluate the potential risks.
  - Locations were confirmed using a third-party-supplied map (i.e., Google Maps).
- RAIs were asked to clarify the impact of off-site toxic chemical releases on operators, the potential for an accident during an air show at SWRA, and the aircraft accident cutoff probability.
- The RAI responses were reviewed and determined to be satisfactory.

Meteorology

- Staff verified that sufficient meteorological data has been provided to support the necessary analyses, including the predicted frequencies of recurrence and intensities of severe weather conditions.

- PSAR met data consistent with a year’s worth of data (2013) from an independent source.

- In RAI response SHINE explained that the Section 3.2.3 ASCE Standard 7-05 based loads were more conservative than the Section 2.3.1.2.9 loads.

Hydrology

- The NRC staff verified that the applicant provided sufficient information regarding the general hydrogeological characteristics of the proposed site to allow an independent review of hydrologically related design bases, performance requirements, and bases for operation of structures, systems, and components important to safety.

- NRC staff also verified the information provided would allow an assessment of hydrologic, hydrogeologic, and solute transport risks.

Hydrology (cont.)

- Hydrology RAI's requested that SHINE:
  - Predict travel times for potential contamination to migrate from the ground surface to the water table.
  - Clarify and provide additional technical justification for the parameters used to calculate groundwater travel times from the facility to the nearest surface water body.
  - Evaluate potential impacts of high capacity irrigation wells on groundwater flow directions.
  - Justify placement and screened intervals of on-site monitoring wells.
- The RAI responses were reviewed and determined to be satisfactory.

Geology, Seismology, and Geotechnical Engineering

- The NRC staff verified that the applicant provided sufficient information regarding the regional and site geology, seismicity, maximum earthquake potential, vibratory ground motion, surface faulting, liquefaction potential
- RAI's pertained to:
  - Potential capable faults
  - Seismicity
  - Potential karst
  - Liquefaction potential
- RAIs resulted in changes made to improve consistency with geotechnical report.
- Confirmed the applicant used credible sources of information and information is consistent among data sources.

Evaluation Findings and Conclusions

- The SHINE PSAR provides sufficient information to accurately describe the geography surrounding the SHINE site, and the information is sufficient to assess the impacts resulting from the location and operation of the facility.

- There is reasonable assurance that no geographic features will render the site unsuitable for the construction of the SHINE facility.

- The staff concludes that there is reasonable assurance that operation of aircraft nearby will not adversely affect SHINE facility operation.

- The staff concludes that there is reasonable assurance that operation of nearby manmade facilities and activities (i.e., industrial, transportation, and military) will not adversely affect SHINE facility operation.

Evaluation Findings and Conclusions (cont.)

- Meteorological history and projections were factored into the design of the SHINE facility, such that no weather-related event is likely to cause damage to the facility and a release of radioactive material.
- The applicant selected combinations of site characteristics and facility design bases to provide reasonable assurance that uncontrolled release of radioactive material in the event of a credible hydrologic occurrence would be bounded by accidents analyzed in Chapter 13 of the SAR.
- The SHINE PSAR and RAI responses has provided sufficient information to accurately describe the information on the regional geologic features at the proposed site to be integrated acceptably into design bases for structures, systems, and operating characteristics of the proposed facility.

Discussion

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Radiation Protection & Nuclear Materials Subcommittee
Meeting on SHINE Construction Permit Application

Chapter 4
Facility Description

Steve Lynch, Tarek Zaki, and Mary Adams, Project Managers
Tom Boyle, Joe Staudenmeier, and Ray Skarda, Technical Reviewers
U.S. Nuclear Regulatory Commission

June 23-24, 2015

Facility Descriptions

- Addresses the principal features, operating characteristics, and parameters of the SHINE irradiation units (IUs) and radioisotope production facility (RPF)

- Provides the bases for many systems, subsystems, and functions discussed elsewhere in the SER and for many Technical Specifications

Facility Descriptions

- Cladding is not used in the design of the irradiation units or radioisotope production facility
- The primary fission-product barriers of the IUs are the target solution vessel (TSV), TSV off-gas system (TOGS), and TSV dump tank
- The primary fission product barrier in the RPF consists of vessels and associated piping that contains the irradiated SNM and fission products (in solid, liquid or gaseous form) during the separation process

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Section 4a
Irradiation Facility
Description

Areas of Review

- To provide reasonable assurance that the final design will conform to the design basis, the staff evaluated the preliminary design of SHINE’s irradiation facility systems to ensure sufficiency of:
  - principle design criteria,
  - design bases, and
  - information relative to materials of construction, general arrangement, and approximate dimensions

Summary of Application

- SHINE IUs are accelerator-driven and sub-critical
  - Accelerator used to create fusion reactions
  - Fusion reactions induce multiplying reactions in neutron multiplier
  - Neutrons from multiplier then enter TSV
  - Fission process essentially terminates when accelerator is not in operation
- The subcritical assembly (SCAS) primarily comprises the TSV and the neutron multiplier, which are both supported and positioned by the subcritical assembly support structure (SASS)
- The SCAS is submerged in a light water pool and located directly beneath the neutron driver assembly

Summary of Application (cont.)

- The IU consists of:
  - The SCAS and NDAS
  - Biological shielding
  - Light water pool system
  - Neutron Flux Detection System
- There may be as many as eight IUs on the SHINE site
- Important reactivity control systems:
  - TSV Reactivity Protection System (TRPS)
  - TSV Process Control System (TPCS)
  - Each can drain the TSV target solution to the dump tanks or shut down the accelerator during abnormal conditions

Regulatory Basis and Acceptance Criteria

- Regulatory Requirements:
  - 10 CFR 50.34, “Contents of applications; technical information,” paragraph (a), “Preliminary safety analysis report”
  - 10 CFR 50.35, “Issuance of Construction Permits”
- Acceptance Criteria
  - NUREG-1537 and ISG, Part 2, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors, Standard Review Plan and Acceptance Criteria”

Review Procedures and Technical Evaluation

The staff performed a thorough and complete section-by-section evaluation of the technical information presented in Section 4a2 of the SHINE PSAR, as supplemented by responses to RAIs, to assess the sufficiency of the preliminary design and performance of SHINE's IF description in support of the issuance of a construction permit.

Review Procedures and Technical Evaluation

- Subcritical Assembly
- Neutron Driver
- Target Solution Vessel and Light Water Pool
- Irradiation Facility Biological Shield
- Nuclear Design
- Thermal-hydraulic Design
- Gas Management System

Subcritical Assembly

- Target Solution:
  - Uranyl sulfate
  - Enrichment of 19.75 percent
- SHINE's Target Solution Qualification Program describes:
  - Historical target solution data,
  - the means to produce the target solution,
  - processes that the target solution is exposed to,
  - limits to ensure safe and reliable target solution performance,
  - research to validate the target solution characteristics

Subcritical Assembly (cont.)

- Reactivity Control:
  - Sub-critical during normal operation; no control rods
  - Reactivity is determined by seven variables:
    - Generally not altered: uranium concentration in the target solution, uranium enrichment, TSV fill-volume
    - Used to manipulate reactivity: target solution temperature, target solution pressure, temperature of the light water pool, and temperature of the primary closed loop cooling system
- For abnormal conditions the accelerator is shut down, or the target solution can be drained into criticality-safe dump tanks. Both the TPCS and TRPS can perform these functions

Subcritical Assembly (cont.)

- The primary system boundary components, including the SASS and TSV, were designed to be compatible with the chemical environment of the target solution

- Plutonium and poison buildup, along with changes in pH, will not be significant. A complete analysis is expected in the FSAR

- The FSAR will contain more detailed discussions on the subcritical multiplication source, the neutron multiplier, the light water pool, behavior of the TSV during a credible deflagration, and the final description of the target solution qualification program

Neutron Driver

- The NDAS is an accelerator-driven system
- Deuterium-tritium fusion creates high-energy neutrons that enter the neutron multiplier:
  - Neutron multiplier is an aluminum clad annulus of material that moderates and multiplies fast neutrons from the neutron driver
- The NDAS is mounted to the cell wall above the subcritical assembly
- Failure of any component of the NDAS results in a decrease in fission rate

Target Solution Vessel and Light Water Pool

- Target solution vessel constructed using zircaloy:
  - chemically compatible with the target solution
  - no significant chemical damage is expected
  - testing at ORNL will inform the final design of the TSV, which is expected to be completely described in the FSAR
  - Fails to a safe, non critical geometry and is designed to withstand credible accidents and the normal operational environment
- The light water pool provides cooling to the TSV and provides an additional layer of protection against radiation damage for local SSCs

Irradiation Facility Biological Shield

- The preliminary design of the biological shield is designed to meet the goals described in Chapter 11 of the PSAR, and the requirements in 10 CFR Part 20, “Standards for Protection Against Radiation.”

- The proposed materials and configuration are consistent with staff-endorsed guidance:

  - ANSI/ANS-6.4.2-2006, “Specification for Radiation Shielding Materials”;

  - American Concrete Institute [ACI] 349-06, “Code Requirements for Nuclear Safety-Related Concrete Structures and Commentary,”

  - Regulatory Guide 1.69, Revision 1, “Concrete Radiation Shields and Generic Shield Testing for Nuclear Power Plants”

Nuclear Design

- The proposed design describes:
  - the reactivity and reactivity changes of the system during all modes of operation
  - reactivity worths of the IU components for each mode of operation
  - the worth of water outside TSV and effects of removing that water
  - expected changes in reactivity due to voiding of the cooling system
- Minor power oscillations are expected, but small and self-limiting due to the low power density and negative temperature coefficients
- In the case of a TOGS failure, the resulting void collapse will cause a small reactivity increase, but not large enough to result in a criticality. A complete analysis of TSV kinetics will be in the FSAR

Nuclear Design (cont.)

- MCNP5 used to calculate neutron flux, reactivity, dose rates, neutron lifetime, and reaction rates
- COUPLE used to calculate cross-sections and fission yields
- ORIGEN used to generate source term concentrations and activities following various irradiation and decay intervals
- The staff reviewed SHINE's uncertainty analysis for these calculations. SHINE's validation plan will be included with the FSAR
- Target solution void, temperature, and power coefficients will generally be negative. SHINE's analyses show that the combined reactivity coefficients should be sufficiently negative over the anticipated range of operating conditions

Thermal-Hydraulic Design

- The applicant will use a correlation based thermal-hydraulic methodology for safety calculations in the FSAR for calculations involving fluid flow and convective heat transfer

- The heat transfer in structures will be used to solve conduction heat transfer equations. The nuclear heat generation rates will be calculated using MCNP5

- The effects of the voids on nuclear and heat transfer performance of the system will be accounted for in the final design

- The void formation should enhance the heat transfer in the TSV due to increased natural circulation flows due to buoyancy effects. The natural circulation should also help prevent large non-uniformities in temperature and solution concentration

Thermal-Hydraulic Design (cont.)

- SHINE has considered all significant heat loads and has provided adequate heat removal capacity and heat transfer area to remove the heat loads and maintain the TSV fluid conditions under normal and abnormal conditions

- Adequate heat removal is also provided for decay heat generation in the TSV dump tank

- The fluid temperatures and heat fluxes eliminate concerns about CHF in all cases

- The TOGS has the recombination and condensation capacity to control the cover gas operating conditions and maintain them within normal operating parameters

Gas Management System

- TOGS construction materials compatible with chemical environment
- No credible scenarios should result in a loss of confinement as a consequence of corrosion
- TOGS geometry precludes criticality if filled with the target solution
- H2 recombiner capable of preventing a deflagration or detonation
  - Neutron driver shuts down at 3% H2 concentration
  - Complete analysis of hydrogen generation provided in the FSAR
- The operating condition envelope and design assumptions of the gas management system and the associated analysis are sufficient to provide reasonable assurance of safe operation and compliance with all applicable chemical and radiological release criteria

Evaluation Findings and Conclusions

- Accordingly, SHINE has met the following requirements of 10 CFR 50.35 for issuance of a construction permit:

  1) Irradiation facility systems have been described, including the principal architectural and engineering criteria

  2) Further technical or design information may be reasonably left for later consideration in the FSAR

  3) Safety features or components requiring research and development have been identified

  4) The proposed facility can be constructed without undue risk to the health and safety of the public

Section 4b

Radioisotope Production Facility Description

Areas of Review

- Processes containing SNM when material is not in IF
- Principal safety considerations factored into design
- Names, amounts, and specifications (chemical and physical forms) of SNM processes
- Byproduct materials (identity and amounts) in process solutions, finished products, and wastes
- Equipment, including materials with moderating, reflecting or other nuclear-reactive properties

Areas of Review

- Biological shield design and construction, entry and exit, radiation doses, ventilation

- Radioisotope extraction system: materials, sequence, apparatus, criticality control measures, hazardous chemicals, radiation protection

- SNM processing and storage

  - Irradiated SNM
  - Unirradiated SNM

Summary of Application

- RPF facility and process description
  - 10 processing systems located within the RCA
- Biological shield
  - Design basis: radiation safety exposure goals
  - Shield materials: ANSI/ANS 6.4.2-2006; Reg. Guide 1.69-2009
- Extraction System
  - Process description, physical properties, criticality controls, shielding and radiation protection
- SNM processing and storage
  - Irradiated SNM
  - Unirradiated SNM

Regulatory Basis and Acceptance Criteria

- Regulatory Requirements:
  - 10 CFR 50.34, “Contents of applications; technical information,” paragraph (a), “Preliminary safety analysis report.”
  - 10 CFR 50.35, “Issuance of Construction Permits.”
- Acceptance Criteria
  - NUREG-1537 and ISG, Part 2, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors, Standard Review Plan and Acceptance Criteria.”

Review Procedures and Technical Evaluation

- The staff performed a thorough and complete section-by-section evaluation of the technical information presented in Section 4b of the SHINE PSAR, as supplemented by responses to RAIs, to assess the sufficiency of the preliminary design and performance of SHINE's RPF description in support of the issuance of a construction permit.

Review Procedures and Technical Evaluation

- Biological Shield
- Extraction System
- Processing of Irradiated Special Nuclear Material
- Processing of Unirradiated Special Nuclear Material

Evaluation Findings and Conclusions

- PSAR provides general understanding of processes
- Biological shield analysis offers reasonable assurance that design will limit radiation exposures within 10 CFR Part 20 limits and ALARA considerations
- Molybdenum-99 extraction and purification system descriptions provide confidence that SNM and byproduct materials can be controlled
- Irradiated SNM processes can be operated safely
- Un-irradiated SNM processes can be operated safely

Evaluation Findings and Conclusions

- Accordingly, SHINE has met the following requirements of 10 CFR 50.35 for issuance of a construction permit:

    1) Radioisotope production facility systems have been described, including the principal architectural and engineering criteria

    2) Further technical or design information may be reasonably left for later consideration in the FSAR

    3) Safety features or components requiring research and development have been identified

    4) The proposed facility can be constructed without undue risk to the health and safety of the public

Discussion

Advisory Committee on Reactor Safeguards
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Chapter 5
Cooling Systems

Steve Lynch, Project Manager, U.S. NRC
Abraham Weitzberg, Stephen Alexander, and John Atchison
Consultants, Information Systems Laboratories

June 23-24, 2015

Regulatory Basis and Acceptance Criteria

- Regulatory Requirements:
  - 10 CFR 20.1201, "Occupational dose limits for adults."
  - 10 CFR 20.1301, "Dose limits for individual members of the public."
  - 10 CFR 50.34, "Contents of applications; technical information," paragraph (a), "Preliminary safety analysis report."
  - 10 CFR 50.35, "Issuance of Construction Permits."

Regulatory Basis and Acceptance Criteria

- Acceptance Criteria
  - NUREG-1537 and ISG, Part 2, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors, Standard Review Plan and Acceptance Criteria.”

Section 5a and 5b
Irradiation Facility and Radioisotope Production Facility Cooling Systems

Cooling Systems

- Principal purpose of the cooling systems is to safely remove fission and decay heat from the target solution and dissipate it to the environment under normal and accident conditions.

- Systems should remove and transfer heat to the environment from all significant heat sources.

- Design of the cooling systems is based on interdependent parameters.

- Primary cooling system is cooled by the secondary cooling system, a.k.a., RPCS or Radioisotope Production Facility Cooling System which, in turn, dumps heat into the chilled water system and then to the facility cooling tower.

Staff Review

- The staff performed a thorough and complete section-by-section evaluation of the technical information presented in Chapter 5 of the SHINE PSAR, as supplemented by responses to RAIs, to assess the sufficiency of the preliminary design and performance of SHINE's cooling systems in support of the issuance of a construction permit.

- Staff considered design criteria, design bases, and relevant design information to provide reasonable assurance that the final design will conform to the design basis.

- Areas of review included IU primary and secondary cooling systems, primary coolant cleanup and makeup water systems.

- SHINE's proposed design does not contain a nitrogen-16 control system and there are no auxiliary systems using primary coolant.

Summary of Application

- SHINE PSAR Section 5a provides the preliminary design of the SHINE IU cooling systems, including physical descriptions, design bases, process functions and operation, safety functions, interfaces, and probable subjects of technical specifications.

- The preliminary design of the SHINE IU cooling systems is supported by figures, which show flow paths between system components, and tables, which describe specifications, components, and interfaces of the IU cooling systems.

- As described in Sections 5b, “Radioisotope Production Facility Cooling Systems,” and 5a2.3, “Secondary Cooling System,” the radioisotope process facility cooling system (RPCS) provides cooling to the RPF. Certain areas of review, as indicated in the SHINE PSAR, are applicable to both the SHINE IF and RPF.

Review of Primary Cooling System

- In the SHINE PSAR, pressure, flow, temperature, conductivity, and radiation detection instrumentation are discussed, with pressure being the apparent measurement used to identify system leaks.

- However, the staff determined that additional information was needed to evaluate the adequacy of pressure measurement to identify system leaks and instrumentation for cooling system functions.

- Therefore, in RAI 5a2.2-1, staff asked about the ability of pressure measurements to identify the presence of small leaks and address how the location of leaks would be determined.

Review of Primary Cooling System (cont.)

- In response, SHINE stated that there were no plans to use pressure measurements to detect the presence of small leaks in the RPCS.
- The pressure in the RPCS is greater than the pressure in the PCLS and LWPS to prevent the transfer of contaminated liquid.
- Small leaks will also be detected by a rise in the level of the expansion tank, periodic sampling, and walkdowns.
- The staff finds this response adequate to support the issuance of a construction permit.

Review of Primary Cooling System (cont.)

- In RAI 5a2.2-2, the staff requested additional detail on the instrumentation for the cooling system functions to ensure the intended functions are performed.

- In response, SHINE committed to install adequate instrumentation to identify and quantify leakage rates, including very small leaks.

- Instrumentation will have the ability to identify leak locations as they relate to allowable leakage limits and the safety functions of the systems.

- The details on the type and accuracy of the instrumentation will be provided in the FSAR.

Review of Primary Cooling System (cont.)

- SHINE PSAR, Section 5a.2.2.2, “PCLS [Primary Closed Loop Cooling System] Process Functions,” indicates that water quality will be maintained to reduce corrosion and scaling, but this section does not indicate how this will be done.

- Therefore, the staff determined that additional information was needed to evaluate the impact of potentially toxic additives used to maintain water quality on corrosion and scaling.

- In RAI 5a2.2-3, the staff requested a list of all potentially toxic chemicals expected to be on the SHINE site for water quality control.

Review of Primary Cooling System (cont.)

- In response, SHINE stated that chemical additives will not be used in the primary coolant systems, the PCLS, or the LWPS.
- Filters and ion exchange resins will be used to remove contaminants and to maintain water quality parameters.
- Potentially toxic chemicals used to maintain water quality in the secondary water systems may include non-phosphate buffers.
- Quantities of chemicals needed for the secondary water systems are expected to be small (i.e., less than five pounds), and will be stored in appropriate chemical storage areas, segregated from incompatible chemicals.

Evaluation Findings and Conclusions

- The staff finds that the level of detail provided on SHINE's cooling systems is suitable to determine that:
  1) Both the IU and RPF have a very low heat load during normal operation. IU shut down promptly drops that heat load by an order of magnitude or more, and there is no buildup of long-lived fission products
  2) SHINE has stated that there is no way for a major accident to happen that cannot be handled by this system. While this statement must be substantiated by accident analyses in the final design, the design of the cooling system as documented in the PSAR is sufficient for the purposes of approval of a construction permit.

Evaluation Findings and Conclusions (cont.)

3) Based on engineering judgment, it is concluded that this level of review of the cooling system is adequate for the issuance of a construction permit because there is such a low heat load, and therefore there is little or no safety risk.

Evaluation Findings and Conclusions (cont.)

- Accordingly, SHINE has met the following requirements of 10 CFR 50.35 for issuance of a construction permit:
  1) Cooling systems have been described, including the principal architectural and engineering criteria for the design
  2) Further technical or design information may be reasonably left for later consideration in the FSAR
  3) Safety features or components requiring research and development have been identified
  4) The proposed facility can be constructed without undue risk to the health and safety of the public

Discussion

Advisory Committee on Reactor Safeguards
Radiation Protection & Nuclear Materials Subcommittee
Meeting on SHINE Construction Permit Application

Chapter 6
Engineered Safety Features

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Areas of Review (Irradiation Facility)

- Engineered safety features (ESFs) are active or passive features designed to:
  - mitigate the consequences of accidents and
  - to keep radiological exposures to the public, the facility staff, and the environment within acceptable limits
- The concept of ESFs evolved from the defense-in-depth philosophy.
- The need for ESFs is determined by SHINE's accident analysis.

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Section 6a
Irradiation Facility
Engineered Safety Features

Areas of Review

Staff evaluated PSAR design of SHINE's IF ESFs to ensure:

- sufficiency of principle design criteria and design bases;
- information regarding materials of construction,
- general arrangement, and approximate dimensions,
- reasonable assurance that the final design will conform to the design basis.

Summary of Application

Section 6a2 of the SHINE PSAR provides:

- a description of the preliminary design (including a list of structures, systems, and components (SSCs) that provide confinement),

- A description of initiation, and operation of the IF ESFs, including an overview of the design basis accidents (DBAs) considered for the development of ESFs.

Regulatory Basis and Acceptance Criteria

- Regulatory Requirements:
  - 10 CFR 50.34, “Contents of applications; technical information,” paragraph (a), “Preliminary safety analysis report.”
  - 10 CFR 50.35, “Issuance of Construction Permits.”
- Acceptance Criteria
  - NUREG-1537 and ISG, Part 2, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors, Standard Review Plan and Acceptance Criteria.”

Review Procedures and Technical Evaluation

To assess the preliminary design and performance of SHINE's IF ESFs in support of the issuance of a construction permit staff conducted:

- a thorough and complete section-by-section evaluation of the technical information presented in Section 6a2

- a follow-up assessment considering SHINE's responses to RAIs raised during the initial evaluation.

Review Procedures and Technical Evaluation

- Summary Description
- Detailed Descriptions
- Emergency Cooling System

Summary Description

- SHINE PSAR Section 6a2 forms the basis for evaluations performed in PSAR Chapter 13, "Accident Analysis."
- PSAR Table 6a2.1-1 describes the ESFs required to maintain the confinement function during three DBAs analyzed the PSAR.
- Following its review, the staff initially determined that:
  - Section 6a2.1 of the SHINE PSAR did not contain enough information for an overall understanding of the functions of the ESFs.

Summary Description (cont.)

In RAI 6a2.1-1, staff requested that SHINE provide:

- a description of the conditions under which ESFs must function;
- block diagrams and drawings to clarify the location, basic function, and the relationship of each ESF to the facility; and
- additional clarifying information.

Summary Description (cont.)

In response to RAI 6a2.1-1, SHINE provided:

- additional details on the conditions under which the ESFs were required to operate,
- the specific ESFs credited in the PSAR, and
- other topics requiring clarification, including appropriate references to other sections of the PSAR.

Summary Description (cont.)

- Additionally, the applicant provided a new block diagram showing the basic function and relationship of the SSCs providing the confinement ESF in the IF and

- the relationship between each ESF SSC in the confinement.

- With this response to RAI 6a2.1-1, staff concluded that sufficient information was provided in the Summary Description.

Confinement

- PSAR Section 6a2.2 identified a list of IEs, which did and did not have radiological consequences and require mitigation by ESFs but did not explain the basis for the determination.
- RAI 6a2.2-10 requested that SHINE provide the basis for making this determination.
- SHINE provided a table referencing the specific radiological consequence analysis for each IE, committing to include this table in the FSAR.

Confinement Systems and Components

- Staff determined that additional information was needed to evaluate the adequacy of the design of the SHINE TPS confinement system.

- Three RAIs were issued requesting information on the design and function of the TPS confinement system, isolation valves, and automatic and manual circuits, bypasses, interlocks, and special I&C systems.

Confinement Systems and Components (cont.)

In response, SHINE provided the requested information, including:

- references to other PSAR chapters, as applicable
- details on confinement system boundaries and isolation points
- committed to providing additional isolation valve details during detailed design, and to updating the FSAR with a list, details, or locations of these isolation valves
- provided clarification on the ESFs and ductwork in the confinement volume in response to RAI 6a2.2-2.

Functional Requirements

- Staff determined that additional information was needed:
  - to evaluate the adequacy of the SHINE confinement system to withstand and mitigate adverse environments and
  - to understand the basis for the system design to meet the single-failure criterion
- Two RAIs were issued requesting SHINE to provide the necessary information.

Functional Requirements (cont.)

- In response SHINE provided the requested information. Additionally SHINE identified an administrative error in its discussion of single failures and committed to correcting this error in its FSAR.

- The staff found the responses to these RAIs acceptable in support of the issuance of a construction permit.

Confinement Components

- Staff determined that additional information was needed to:
  - evaluate the secondary confinement barrier of the IU cells,
  - determine the adequacy of waiting to provide details of the TPS confinement system in the FSAR, and
  - determine the systems open to the IU cell, TOGS shielded cell atmosphere, and the TPS glovebox.
- Three RAIs were issued requesting information on the secondary confinement barrier and the delaying aspects of TPS confinement design.

Confinement Components (cont.)

- In response to these RAIs:
  - SHINE stated that the facility does not have a “secondary confinement barrier.”
  - provided rationale for not completing detailed design of the TPS and committed to provide additional isolation valve details during detailed design and the FSAR.
- These responses were found acceptable in support of issuing a construction permit.

Engineered Safety Feature Test Requirements

- In its review, staff found that plans for testing ESF functionality and operability and the preoperational as well as post-commissioning testing were not fully described.
- An RAI requested this additional information.
- SHINE provided the distinction between the terms “functional” and “operable” and provided a list of planned pre-operational and post-commissioning tests for ESFs.
- The staff found this response acceptable

Evaluation Findings and Conclusions

- Accordingly, SHINE has met the appropriate regulatory requirements and acceptance criteria.

- Specifically, SHINE meets 10 CFR 50.35 requirements for issuance of a construction permit:

  1) IF ESFs have been described, including the principal architectural and engineering criteria for the design

  2) Further technical or design information may be reasonably left for later consideration in the FSAR

  3) Safety features or components requiring research and development have been identified

  4) The proposed facility can be constructed without undue risk to the health and safety of the public

Discussion

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Chapter 7
Instrumentation and Control Systems

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June 23-24, 2015

Regulatory Basis and Acceptance Criteria

- Regulatory Requirements:
  - 10 CFR 50.34, “Contents of applications; technical information,” paragraph (a), “Preliminary safety analysis report.”
  - 10 CFR 50.35, “Issuance of Construction Permits.”
- Acceptance Criteria
  - NUREG-1537 and ISG, Part 2, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors, Standard Review Plan and Acceptance Criteria.”

Section 7a

Irradiation Facility

Instrumentation and Control Systems

Instrumentation and Control Systems

- Instrument and control (I&C) systems comprise the sensors, electronic circuitry, displays, and actuating devices that provide the information and means to safely control the irradiation facility and to avoid or mitigate accidents.

- Instruments are provided to monitor, indicate, and record such operating parameters as neutron flux density, target solution temperature, coolant flow and temperature, and radiation intensities in selected areas.

- Certain I&C systems will automatically shut down the irradiation units when a safety parameter reaches a predetermined set point.

- I&C subsystems may also be designed to actuate engineered safety features (ESFs) upon the detection of abnormal conditions.

Staff Review

- The staff performed a thorough and complete section-by-section evaluation of the technical information presented in Section 7a2 of the SHINE PSAR, as supplemented by responses to RAIs, to assess the sufficiency of the preliminary design and performance of SHINE's IF I&C systems in support of the issuance of a construction permit.

- Staff considered design criteria, design bases, and relevant design information to provide reasonable assurance that the final design will conform to the design basis.

- Areas of review included control systems, process control descriptions, reactivity protection system, engineered safety features actuation system, control console and display information, and radiation monitoring systems.

Summary of Application

- SHINE utilizes independent I&C systems to protect and control the neutron driver and target solution vessel (TSV).
- PSAR Section 7a provides the preliminary design of the I&C systems, and includes physical descriptions and design criteria, together with tables describing the intent of the design to comply with requirements.
- System functions include TSV process control and reactivity protection, engineered safety features actuation, and radiation monitoring.
- Figures are provided showing the safety approach, system block diagram, typical circuitry, operator panel, and workstation and control room layouts.

Review of Design Basis Requirements

- In the evaluation of SHINE’s design basis requirements, staff determined additional information was needed to determine that the effects of postulated reactivity accidents can neither:

    1) result in damage to the primary system boundary greater than limited local yielding, nor,

    2) sufficiently disturb the target solution vessel, its support structures or other target solution vessel internals to impair significantly the capability to drain the target solution vessel.

Review of Design Basis Requirements (cont.)

- RAI 7a2.2-1 requested details on the accuracy of reactivity control and criteria to determine that draining of the TSV is not impaired

- In response, SHINE provided the range and accuracies of the monitored variables. The response further stated that the nominal margin to critical volume in the TSV is, for example, five 5 percent. With this margin, the TSV would be substantially more subcritical than the applicant’s target effective multiplication factor (k_{eff}).

- The staff finds this response acceptable for preliminary design.

Review of TSV Process Control Description

- In its review, the staff noted that PSAR Section 7a2.3.2.1, “Mode 1 - Startup Mode,” states that the startup process calculates the subcritical multiplication factor M from the neutron flux level and plots 1/M versus the fill volume (height).

- However, it was not clear how bias and uncertainties associated with the benchmarking of criticality calculations, together with the expected variability in process parameters and instrumentation readings were being considered.

Review of TSV Process Control Description (cont.)

- In RAI 7a2.3-1, the staff requested additional information regarding the uncertainties, including a quantitative estimate of the expected overall uncertainty in their subcritical reactivity values during startup.

- In response, SHINE stated it plans to use a volume margin to critical approach, citing an example of overall uncertainty of 30 percent.

- The staff finds this response acceptable for a preliminary design.

Figure taken from SHINE response to RAI

Clayton

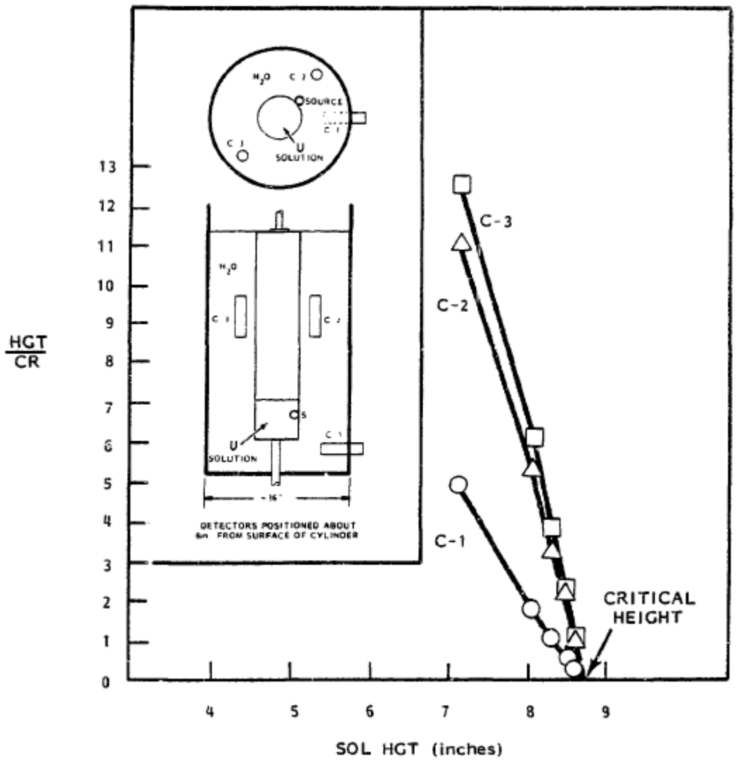

FIGURE 7. Inverse Multiplication for 9 1/2 Inch Diameter Water Reflected Cylinder of High-Enriched Uranyl Nitrate

In the event an internal source is not practicable, the shape of the inverse multiplication curves will depend markedly on the source counter relationships. Extreme convex shapes are to be expected if the source and the detector are on the same side of the assembly and concave curves if the source and detector are on opposite sides. The latter is to be preferred from safe operations standpoint, since conservative estimates will be obtained for the critical mass, i.e., the actual value will be larger than predicted during the approach-to-criticality.

Validity of 1/M method depends in part on locations of source and detectors. SHINE has deferred definition of source and its location to FSAR.

Review of TSV Reactivity Protection System

- During its review, the staff noted that SHINE PSAR Section 7a2.4.1, “TRPS Description,” states that the only nuclear trips are on high neutron flux, source range, and high range.

- However, there are no apparent anticipatory trip(s) provided for high startup rates or short periods, which are usually needed to adequately limit the fission reaction during high-reactivity transients.

Review of TSV Reactivity Protection System (cont.)

- In RAI 7a2.4-1, the staff requested analyses supporting the adequacy of the trips to avoid a possibly unacceptable high reactivity transient, considering uncertainties and possible reactivity insertion events.

- In response, SHINE stated that trips would be supported by transient system modeling, which is still under development. Results will be provided in the FSAR.

- The staff finds this response acceptable for preliminary design.

Evaluation Findings and Conclusions

- The preliminary Irradiation Facility I&C system described in the SHINE PSAR meets the regulatory requirements and acceptance criteria for the issuance of a construction permit, with the acknowledgement that additional research and development activities are required to resolve some issues primarily associated with the avoidance of inadvertent criticality.

- Based on engineering judgment, it is concluded that this level of review of the Irradiation Facility I&C system is adequate because any required modifications to the system design and operating procedures can be readily implemented after the major facility construction activities have been completed.

Evaluation Findings and Conclusions (cont.)

- Accordingly, SHINE has met the following requirements of 10 CFR 50.35 for issuance of a construction permit:
  1) Irradiation Facility I&C systems have been described, including the principal architectural and engineering criteria for the design
  2) Further technical or design information may be reasonably left for later consideration in the FSAR
  3) Safety features or components requiring research and development have been identified
  4) The proposed facility can be constructed without undue risk to the health and safety of the public

Section 7b

Radioisotope Production Facility

Instrumentation and Control Systems

Instrumentation and Control Systems

- Instrument and control systems comprise the sensors, electronic circuitry, displays, and actuating devices that provide the information and means to safely control the radioisotope production facility (RPF), and to avoid or mitigate accidents.
- The RPF houses the extraction, purification, packaging, target solution preparation and cleanup, and waste treatment systems.
- The systems are enclosed predominately by hot cells and glove boxes and criticality safety is controlled through the use of geometrically safe designs and control of process variables.
- The Radiological Integrated Control System (RICS) provides for monitoring and control of Engineered Safety Features within the RPF.
- The RICS also provides process monitoring and control of the nonsafety-related systems within the RPF.

Staff Review

- The staff performed a thorough and complete section-by-section evaluation of the technical information presented in Section 7b of the SHINE PSAR, as supplemented by responses to RAIs, to assess the sufficiency of the preliminary design and performance of SHINE's RPF I&C systems in support of the issuance of a construction permit.

- Staff considered design criteria, design bases, and relevant design information to provide reasonable assurance that the final design will conform to the design basis.

- Areas of review included control systems, process control descriptions, engineered safety features and alarming, control console and display information, and radiation monitoring systems.

Summary of Application

- PSAR Section 7b provides the preliminary design of the RPF I&C systems, and includes physical descriptions and design criteria, together with tables describing the intent of the design to comply with requirements.

- I&C System functions within the RPF include:
  - Engineered Safety Functions (ESF),
  - Process Control, and
  - Radiation Monitoring

Production Facility Process Control Systems

- During its review, the staff concluded that there was insufficient information to determine that the RPF instrumentation was adequate to detect excessive deviations from critical process variables.

- The staff issued RAI 7b.3-1, asking SHINE to provide additional information regarding the adequacy of the facility's instrumentation to detect deviations from nominal concentrations and quantities of fissile materials, should they occur.

Production Facility Process Control Systems (cont.)

- In response to this RAI, SHINE stated that RPF tanks containing fissile materials are designed to be criticality safe and any excess liquid, in the event of an over-fill condition, is contained in criticality-safe geometry configurations.

- Liquid is also checked to verify the absence of appreciable quantities of fissile material before transfer to the waste storage tank.

- Appropriate instrumentation will monitor tank level and flow indications, as well as detect leaks and prevent overfills.

- The staff finds this response appropriate for preliminary design.

Review of Engineered Safety Features and Alarming

- In RAI 7b.4-1, the staff requested that the applicant provide additional information to justify how the location of temperature sensors at the outlet of the uranyl nitrate conversion system (UNCS) is representative of the process.
- In response, the applicant explained that temperature sensors will be located at appropriate points representative of the UNCS process, sufficient to ensure safe and reliable operation of the system.
- Specific temperature sensor locations will be determined during the detailed design.
- The staff finds this response appropriate.

Evaluation Findings and Conclusions

- The preliminary RPF I&C system described in the SHINE PSAR meets the regulatory requirements and acceptance criteria for the issuance of a construction permit, with the acknowledgement that additional research and development activities are required to resolve some issues primarily associated with the avoidance of inadvertent criticality.

- Based on engineering judgment, it is concluded that this level of review of the RPF I&C system is adequate because any required modifications to the system design and operating procedures can be readily implemented after the major facility construction activities have been completed.

Evaluation Findings and Conclusions (cont.)

- Accordingly, SHINE has met the following requirements of 10 CFR 50.35 for issuance of a construction permit:
  1) RPF I&C systems have been described, including the principal architectural and engineering criteria for the design
  2) Further technical or design information may be reasonably left for later consideration in the FSAR
  3) Safety features or components requiring research and development have been identified
  4) The proposed facility can be constructed without undue risk to the health and safety of the public

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Chapter 8
Electrical Power Systems

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Sections 8a and 8b

Irradiation Facility and Radioisotope Production Facility

Electrical Power Systems

Electrical Power System

- Single system serves:
  - Irradiation facility (IF), including irradiation units (IUs)
  - Radioisotope production facility (RPF)
- Provides:
  - Normal Service
  - Emergency Service
    1) Shut down facility, maintain in safe shutdown condition
    2) Prevent/minimize offsite radioactivity release

Areas of Review (Irradiation Facility)

- Normal and Emergency Systems
- Sufficiency of principle design criteria
- Design bases
- Information on types of equipment, functional requirements, and general arrangement, sufficient to provide reasonable assurance that final design will conform design basis

Areas of Review (Production Facility)

- Common normal and emergency electrical power systems shared with irradiation facility
- Safe operation and shutdown of RPF
  - Response to interruptions of normal electrical service
  - Ability of the facility to be maintained in a safe condition with and without normal electrical service
  - Monitoring and control of routine releases
  - Prevention of uncontrolled releases of radioactive material in the event that normal electrical power is interrupted

Summary of Application

- One common normal electrical power system and one common emergency power system to serve both the IF and RPF.
- Normal electrical power supply
  - 480-VAC off-site power service from Alliant Energy
  - On-site commercial-grade standby diesel generator (SDG)
  - Safety-related and non-safety loads normally
- Emergency electrical system-upon LOOP
  - Safety-related loads only
  - Station battery, chargers, inverters, VRTs (UPS)

Regulatory Basis and Acceptance Criteria

- Regulatory Requirements:
  - 10 CFR 50.34, “Contents of applications; technical information,” paragraph (a), “Preliminary safety analysis report.”
  - 10 CFR 50.35, “Issuance of Construction Permits.”
- Acceptance Criteria
  - NUREG-1537 and ISG, Part 2, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors, Standard Review Plan and Acceptance Criteria.”
  - Referenced/invoked codes and standards

Review Procedures and Technical Evaluation

- Section-by-section evaluation of the technical information presented in Sections 8a2 (IU) and 8b (RPF) of the SHINE PSAR
- Review of other chapters with regard to electrical power requirements of/interfaces with IF and RPF systems and equipment
- Supplemented by response to RAI
- Assessed sufficiency of preliminary design and expected performance of IF and RPF electrical power systems in support of CP issuance

Emergency Electrical Power Systems

- RAI 8a2.2-1
  - Design approach to Class 1E isolation
  - Designate which circuit breakers or other devices to serve as Class 1E isolation devices
  - Bases for those designations
  - Reasonable assurance of Class 1E isolation devices of meeting IEEE Std. 384-2008, “IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits.”

Emergency Electrical Power Systems

- SHINE Response
  - 480-VAC SDG bus circuit breakers not considered Class 1E isolation devices
  - Class 1E isolation devices comprise
    - Class 1E Battery Chargers
    - Class 1E Voltage-regulating transformers
  - Detailed design will address how Class 1E battery chargers and voltage regulating transformers will include electrical isolation requirements and meet IEEE 384-2008 (Section 6.1.2.3 in particular)

Evaluation Findings and Conclusions

The design bases and functional characteristics of the normal electrical power systems will provide reasonable assurance that:

- Systems will support all required loads
- Facility can be safely shut down and maintained in a safe shutdown condition in case of loss of normal power supplies

Evaluation Findings and Conclusions

Level of detail provided on SHINE’s emergency electrical power systems is suitable to determine that:

1) Functional characteristics commensurate with design bases of supported systems and equipment

2) System design ensures and maintains safe facility shutdown and prevents uncontrolled release of radioactive material;

3) Sources of emergency electrical power are capable of supplying power for the duration required by the PSAR analysis

4) System designed for either automatic or manual startup and switchover

Evaluation Findings and Conclusions

5) Emergency electrical power system should not interfere with or prevent safe facility shutdown;

6) Malfunctions of emergency electrical power system during operation with normal electrical power should not interfere with normal operation or prevent safe facility shutdown;

7) Non-safety-related uses of the emergency electrical power system should not interfere with performance of its safety-related functions; and

8) PSAR identifies design requirements, equipment required, and power and duration of operation required.

Evaluation Findings and Conclusions

- PSAR Sections 8a2 and 8b meet the following requirements of 10 CFR 50.35 for issuance of a construction permit:

  1) Electrical power systems have been described, including the principal architectural and engineering criteria

  2) Further technical or design information may be reasonably left for later consideration in the FSAR

  3) Safety features or components requiring research and development have been identified

  4) The proposed facility can be constructed without undue risk to the health and safety of the public

Discussion