Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title:	Advisory Committee on Reactor Safeguards APWR Subcommittee - Open Session
Docket Number:	(n/a)
Location:	Rockville, Maryland
Date:	Friday, April 22, 2011

Work Order No.: NRC-835 Pages 1-234

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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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APWR SUBCOMMITTEE

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FRIDAY

APRIL 22, 2011

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ROCKVILLE, MARYLAND

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OPEN SESSION

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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., John Stetkar, Chairman, presiding.

SUBCOMMITTEE MEMBERS PRESENT:

JOHN W. STETKAR, Chair

J. SAM ARMIJO

SANJOY BANERJEE

DENNIS C. BLEY

CHARLES H. BROWN, JR.

SUBCOMMITTEE MEMBERS PRESENT:

HAROLD B. RAY

JOY REMPE

MICHAEL T. RYAN

WILLIAM J. SHACK

NRC STAFF PRESENT:

ILKA BERRIOS, Designated Federal Official

JEFF CIOCCO

NGOLA OTTO

ED ROACH

RONALD LaVERA

RYAN EUL

ALSO PRESENT:

RYAN SPRENGEL

IRVING TSANG

HIROKI NISHIO

MASAKI OMURA

YVES BARLES

RICHARD BARNES

SHINJI KAWANAGO

TABLE OF CONTENTS

P-R-O-C-E-E-D-I-N-G-S

8:31 a.m.

CHAIR STETKAR: The meeting will now come to order. This is a meeting of the United States Advanced Pressurized Water Reactor Subcommittee.

I'm John Stetkar, chairman of the subcommittee meeting. ACRS members in attendance are Sanjoy Banerjee, Harold Ray, Sam Armijo, Dennis Bley, Mike Ryan, Bill Shack, Charles Brown and Joy Rempe. Good turnout for this meeting. Thank you.

(Laughter.)

CHAIR STETKAR: Ilka Berrios of the ACRS staff is the designated federal official for this meeting.

The Subcommittee will review Chapter 11, Radioactive Waste Management, and Chapter 12, Radiation Protection of the Draft Safety Evaluation Report Associated with the US-APWR Design Certification.

Subcommittee will also review technical reports related to the gas turbine generator system for the US-APWR design certification.

We will hear presentations from the NRC staff and Mitsubishi Heavy Industries. We have received no written comments or request for time to make oral statements from members of the public regarding today's meeting.

Portions of this meeting may be closed if necessary to discuss proprietary information in technical or topical reports that support the topics of our discussions.

The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions as appropriate for deliberation by the full committee.

The rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in the Federal Register.

A transcript of the meeting is being kept, and will be made available as stated in the Federal Register notice. Therefore, we request that participants in this meeting use the microphones located throughout the meeting room when addressing the Subcommittee.

The participants should first identify themselves and speak with sufficient clarity and volume so that they may be readily heard.

Before we present the presentations, I'd like to convey the Subcommittee members' heartfelt support for our MHI colleagues during these really tragic times in Japan. We sincerely hope that your families, your friends and your professional associates have been spared from the earthquake and tsunami destruction. And we hope the life in Japan can return to some form of normalcy in the near future. So, we're with you.

And with that, we will now proceed with the meeting. And I call upon Jeff Ciocco.

MR. CIOCCO: Yes, thank you and good morning. My name is Jeff Ciocco. I'm the lead project manager for the US-APWR design certification. I've been so since about 2007.

Thanks for having us back. We're certainly glad to be back presenting our Phase 3 Safety Evaluation Report with open items for Chapters 11 and Chapter 12.

Chapter 11, Ed Roach is going to be our presenter this morning. And Chapter 12, Ron LaVera is going to be presenting.

And MHI is back to give its second informational briefing on the gas turbine generator. The first briefing was back in May 21st of 2009. And staff -- Ryan Eul is going to be presenting the Interim Staff Guidance 21 on the gas turbine generator.

Just to give you a brief status since we haven't been here since November of last year, of where we are in our design certification licensing review, we currently have four chapters that are in Phase 4. We're closing the open items. Those are chapters that we had briefed you prior in June of 2010; Chapters 2 and 16.

And Chapters 8 and 13 we were here back in November. So, we're in the process of closing those open items and will be coming back in Phase 5.

Two chapters today, 11 and 12, and that leaves us with 13 chapters remaining as we're currently completing our licensing review and scheduling those presentations to you, as well as seven topical reports.

Of note, we just received on March 31st, Revision 3 of Mitsubishi's Design Control Document. And not to confuse you, but - and Chapters 11 and 12 are written to Revision 2.

Staff is currently in the process of docketing Revision 3 during our SUNCI review and soon to be making public the public version of Revision 3.

And we plan on having a public meeting around May 10th where MHI is going to explain all the changes in Rev 3 of the DCD.

With that, that's all that I have. And we'll do the individual introductions as well as we go through our chapters. And I'll see if - Hossein is the branch chief of our US-APWR branch, if he wants to say anything.

MR. HAMZEHEE: Nothing more. Just I would like to thank the subcommittee members. And hopefully by noon today we'll be done with Chapters 11 and 12.

(Laughter.)

CHAIR STETKAR: Hopefully. With that, I'll turn it over to MHI.

MR. SPRENGEL: Good morning, everyone. This is Ryan Sprengel with MNES on DC licensing. I'd like to go and just say good morning and thank you, everyone, as well.

We've got a good team here representing us. As in the past with other meetings, we'll capture any questions and we'll get those to you after the meeting similar with our previous interactions that we've had.

And like Jeff said, we'll look at Chapters 11 and 12. And then later today we'll go through the GTG testing that we've done.

CHAIR STETKAR: By the way, Ryan, as I

mentioned in the introduction, I don't know how much detail we'll get into in the discussions, and I know some of the technical reports and the topical reports have proprietary information, so I'll look to you if we get into detail.

MR. SPRENGEL: Right.

CHAIR STETKAR: If we need to close the meeting, that's no problem at all. We just need to make sure that the appropriate people are here.

But if you get a sense that we're getting into areas where the information is proprietary, just alert us and we'll figure out -

MR. SPRENGEL: Okay. We'll definitely stay aware of it. And I know there will be one portion in the GTG that we'll need to close out.

CHAIR STETKAR: We will already, okay.

MR. SPRENGEL: Yes, we've got some -

CHAIR STETKAR: Well, since we know that we'll need to close something, that helps us also to perhaps organize some of the discussion without going closed and open at different times.

MR. SPRENGEL: Okay.

CHAIR STETKAR: Thanks.

MR. SPRENGEL: Okay. Thank you all, and we have our first presentation set up here for Chapter

11. So, Irving, do you want to go through - or do we want to introduce everyone, or just the presenters?

CHAIR STETKAR: It's your presentation.

MR. SPRENGEL: Okay. Irving, do you want to go through and introduce everyone, and then we'll go ahead and get started?

MR. TSANG: Thank you, Ryan, and good morning, Dr. Stetkar. Thank you for your well wishes. On behalf of MHI, I thank you.

Good morning, members of the ACRS. And with your permission and without further delay, I'm going to start the presentation on -

CHAIR STETKAR: Irving, just be careful. Pull the microphone a little bit closer to yourself or speak up a bit.

Our transcripts are done from the oral presentation. So, we want to make sure that we have everything on the record here.

MR. TSANG: Is that clear?

CHAIR STETKAR: Yes, I mean, it's mostly for the reporter over there.

MR. TSANG: Okay.

CHAIR STETKAR: Thank you.

MR. TSANG: Very good. Thank you for reminding me that.

I'm going to start the Chapter 11, Radioactive Waste Management Systems. My objective here today is to discuss the key design features on the radwaste systems; the liquid waste management system, the gaseous, the solid, and also a little bit on the process effluent radiation monitoring system, with the focus to discuss how the design on the radwaste effluent is being controlled, and take into consideration the protection of the worker, the public, the environment and the plant.

And we also like to discuss a little bit of statuses on the response to RAI open items, the remaining five or six open items on Chapter 11, and six on Chapter 12 later on. As I go along, I welcome any questions.

Let me introduce the APWR team. I'm Irving Tsang. And sitting in my right is Nishio-san. And he's also cognizant of Chapter 11. Sitting on my right is Yves Barles on Chapter 12. And Konno-san, Chapter 12.

Next, please. As we all know, Chapter 11 has five subparts. The first part talk about the source term. Today, we're going to talk about the basis for the source term, and also the application of the source term to develop the design.

And we will talk a little bit about the key design features on the liquid system, the gaseous system and the solid system. Last, but not least, we will discuss the process effluent radiation monitoring as well.

Next, please. We have two source term models used to develop the design. One is the design basis source term which focuses on one percent failed fuel. The development of the model and equations that we use are presented in Chapter 11.1.

We also have a realistic-based source term which follows ANSI-18.1 and NUREG-0017. We use the same formulation following ANSI-18.1. The adjustment factors and everything are also presented in the chapter for your reference.

We use the GALE Code to forecast the liquid effluent, and also the gaseous effluent with MHI, and we have done a little bit of modification to the program.

Next, please. How we use the source terms, we have two source terms. On the design basis, we use - based on the one percent failed fuel, we use it to do the non-fuel accident analysis like a steam generator blowdown, a leakage analysis. And we also use it for shielding. All of the shielding around the reactor building and the auxiliary building are based on the design basis source term.

For the realistic basis source term, first we use it to forecast the effluents using the GALE Code. From there, we also develop flow streams and end up using that to perform the cost-benefit analysis for the liquid system and for the gaseous system.

We also use it for the off-site dose assessment. And lastly, we follow Reg Guide 1.143 and using the realistic source term to determine the component hazard classification.

As we know, the nuclear power plant will have some liquid waste at the end. And the liquid waste management system is designed to collect, store, process this fluid and make sure it meets the discharge classification. And we have four different subsystems designed to segregate different type of waste.

Equipment and floor drains subsystem primarily handles any liquid that's draining from the equipment during an outage, and also floor drain where we see any leakage onto the floor collected in the system, and we forward that to the waste holdup tank for processing.

The detergent waste subsystem, receive

waste from the hand washers and showers and we process it through. And it will be tied up to the discharge header or through the equipment and floor drain subsystem for further processing before we release it.

The chemical drains are receiving from labs and from other analysis. We collect it in the chemical drain system and forward it to the equipment and floor drain system for further processing before release.

We also have a reactor coolant drain tank within the containment. And that collects any reactor coolant pump seal leakages, and we forward that to the liquid waste management system for further processing before release.

Overall, the system is classified non-safety with the exception of the containment isolation valves. We have three isolation valves relating to forwarding the reactor coolant drain subsystem to the liquid radwaste subsystem in the auxiliary building.

The auxiliary building is seismic Class II, and we have two portions of the building. The bottom one is seismic Class I, and the top portion is seismic Class II in pursuing a two-over-one design.

As I said earlier, we follow Reg Guide 1.143 to do the hazard classification, calculating the

A1, A2, A3 concentrations, and using the realistic source term. And except for the liquid filter which is Class IIa, the other components are IIc.

Location of the liquid radwaste system, the reactor coolant drain subsystem is inside the containment. And the reactor building sump is in the reactor building outside the containment. All the other subsystem components are located in the auxiliary building.

Any questions so far?

MEMBER BANERJEE: What is the buffer you are using?

MR. TSANG: I'm sorry.

MEMBER BANERJEE: The buffer.

MR. TSANG: Buffer?

MEMBER BANERJEE: In your pH. If you go back to the chemical -

MR. TSANG: Chemical drain subsystem?

MEMBER BANERJEE: Yes. What is the buffer you are using?

MR. TSANG: We normally use caustic soda to neutralize -

MEMBER BANERJEE: So, you use sodium hydroxide?

MR. TSANG: Yes.

MEMBER BANERJEE: You have no aluminum in the containment space?

MR. TSANG: No.

MEMBER BANERJEE: Okay. But normally, I mean, that's what your buffer is, correct? It's not sodium tetraborate or anything like that?

MR. TSANG: No, we primarily use a sodium hydroxide solution.

MEMBER BANERJEE: Okay.

(Off-record comments.)

CHAIR STETKAR: Are you two communicating about the same thing?

You're talking about the buffer in the containment. He's talking about waste neutralization tank for chemical drains.

So, I think -

MEMBER BANERJEE: Actually, I saw what he was doing there.

CHAIR STETKAR: Okay.

MEMBER BANERJEE: Okay.

MR. TSANG: I would like to take your question for inside the -

MEMBER BANERJEE: Yes, different question.

MR. TSANG: Sorry for my misunderstanding.

Next, please. I'd like to take a moment

to highlight the key features on the liquid waste management system, the subsystem for equipment and floor drain system.

I apologize for not clearly indicating the wording on this slide, but on the top portion is the equipment drain subsystem. And on the bottom portion is the floor drain subsystem.

So, we segregate the two types of drains before we forward it into the waste collection tank, oil collection, waste collection tank.

Please note that we have a common header, but we have an isolation valve in between the four tanks. The intent there is to segregate floor drain which may be contaminated with some organic or oil or solvent.

And the equipment drains are primarily fairly clean at this point, so we intentionally will separate the two type of drains.

Also, we have two filters. Right now we are using - we intend to use the cartridge-type filter. And this has been proven in the industry many, many times. And lately they have improved the technology using the Ultipleat from one particular manufacturer. I believe it has very good loading capacity, and also do a fine job of filtration removing those expended parts.

We have an organic remover, the charcoal absorber, designed to remove organics from the floor drain system. Most of the time we would not need to use that for the equipment drains. It could be bypassed.

We have four ion exchange columns with mixed beds in ion -- in an ion bed. The four columns are arranged in two trains. And each train can be in the lead position or the lag position. And normally they are running in series. It could be arranged to run in parallel.

MEMBER RYAN: These are the four units right at the bottom?

MR. TSANG: Yes, sir.

MEMBER RYAN: Okay. Thank you.

MR. TSANG: And we also have two waste monitoring tanks receiving the treated waste. We put in sampling lines in circulation to mix it, and sampling lines to take samples before we discharge.

Most importantly, we have a radiation monitor at the end of the discharge line within the auxiliary building. And it continuously monitor the radionuclide contents when we discharge.

And if there is - for whatever reason if the nuclide concentration exceeds a predetermined set point, it will close the two valves following it. And at that point, we could recycle the content back to the waste holdup tank for further processing.

MEMBER RYAN: Just a way around that point if you do get a radiation reading or some other indication that says that you're over spec, what kind of storage capacity or surge capacity do you have back in the system to handle it?

Do you have days, weeks, hours?

MR. TSANG: That's a very good question. I'm going to hold off on that question until the next slide.

MEMBER RYAN: No problem.

MR. TSANG: The next slide, I will get to that.

MEMBER RYAN: Thank you.

MR. TSANG: Thank you.

Next slide, please. This is the chemical drain subsystem. And I apologize. I misunderstood your question.

The sodium hydroxide line is shown on the chemical addition - as a chemical addition line to the chemical tank showing on the top of the slide. And it is - we use that to neutralize any acid content within the tank and forward it to either the discharge header or the waste collection tank for further processing.

And on the bottom we show the detergent drain subsystem. We have one collection tank going through a filter. Collect it, sample it. And then we can either discharge it through the discharge header and - or go through the waste holdup tank for further processing.

Let me clarify one thing is that for the liquid system, there is only one discharge line going out the building. There's no other line for that.

Any questions?

(No response.)

MR. TSANG: Next, please.

This process flow diagram depicts the reactor coolant drain tank which takes the pump's seal leakage into the tank and forward it to several places. Primarily, to the waste holdup tank. It could also send to the CVCS holdup tank, or the refueling water storage auxiliary tank. And as I mentioned earlier, we have three penetrations as depicted on the process flow diagram.

Next, please. On this slide, I'd like to take this opportunity to answer your question. Number 1 is that the technology presented here are all industry-proven with updated technology as well.

In terms of the resin, I think we have made a long way and increases selectivities on particular resin for season removal-type thing. So, I think the intent is to use the improved - industry-proven technology for that.

We have four very large waste holdup tanks. Combined capacity, storage capacity is over 90,000 gallons. Each tank is sizing for about 31,000 gallons with a net processing capacity of 24,000 gallons with flow tank arranging segregating in two separate trains.

And for additional capacity, we could also utilize the holdup tanks in the CVCS system, which is tied to this system closely, but only in an emergency case. We do not intend to send it there.

MEMBER RYAN: Does the 90,000 gallons include those additional tanks, or no?

MR. TSANG: No, no.

MEMBER RYAN: Okay. So, that's in addition to the 90,000?

MR. TSANG: That's in addition to that.

CHAIR STETKAR: Irving, you said that this basic system, the configuration is fairly straightforward. But in terms of storage capacity and, as Mike mentioned, whether you want to call it surge capacity or buffer capacity in case you have problems, is comparable to that installed in currently operating plants?

MR. TSANG: I believe we have more.

CHAIR STETKAR: You do?

MR. TSANG: More than the current operating plant in most -

CHAIR STETKAR: Because I was curious about the actual operating experience. Many years ago I worked in a plant that was either under-designed or under-sized or whatever the problem was. We had a habitual problem with water management because of our -- our throughput processing capability in actuality, was not nearly what the designers had planned for.

So, that's my curiosity about real operating experience with these volumes.

MR. TSANG: I'd like to add a couple of comments to further explain what we have done.

Before we start the design, we talk to several utilities. And they all indicate they want extra storage capacity.

(Laughter.)

MR. TSANG: So, we adopted that philosophy to start with. And then we also go back to ANSI-55.6, look at what the normal - what will be the normal flow coming into the system, and what will be the maximum flow into the system.

MEMBER RYAN: What did you assume for the range of normal to maximum?

MR. TSANG: ANSI-55.6 Table 7 indicated the normal roughly is in between 2,000 to 4,000 gallons a day. And in the - during the anticipated operational occurrences, the flow could surge to 90,000 gallons per event.

And we know that the refueling is not just a day activity expanding several weeks. And, therefore, for the design that we have, we assume that all 90,000 gallons come in one particular time.

And we make sure we have enough capacity. And we make sure that we have enough time to process before we receive additional waste.

MEMBER RYAN: So, 90,000 gallons per event. An event would be what? A week? Two weeks? What do you assume?

MR. TSANG: I would assume that it is about three week's time.

MEMBER RYAN: Three week's time.

MR. TSANG: A typical refueling outage.

MEMBER RYAN: Over that three weeks, you

can stay ahead of the 90,000-gallon capacity limit exclusive of the extra surge capacity that you have. So, you're holding that extra tankage as almost an emergency reserve.

MR. TSANG: Yes.

MEMBER RYAN: Okay.

MR. TSANG: And a little bit later on I'll talk about the processing rate -

MEMBER RYAN: Yes, please.

MR. TSANG: -- but I will take that opportunity to answer that now.

MEMBER RYAN: Okay.

MR. TSANG: The design that we have has a processing rate, net processing rate capacity between 90 to a hundred gallons. For design purpose, we set it at 90 gpm processing rate.

With that rate, we could finish processing one tank, just the processing portion, within four-and-a-half, less than five hours.

And of course we need to allocate time for mixings, for sampling, all these activities and confirmation sampling after this treatment. And all these we anticipate with the current design and technology and equipment available at the plant, probably in a day and a half we could finish one tank.

So, we do -- combining the processing capacity and the storage capacity that we have, I am confident there is plenty of capacity for the system.

MEMBER RYAN: So, in current processing terms, basically you have designed and feel comfortable with the design that you can stay ahead of - you can stay ahead with processing of any input rate of liquid waste.

MR. TSANG: Yes, sir.

CHAIR STETKAR: And that's based on actual operating - or feedback from actual operating experience.

MR. TSANG: Yes.

CHAIR STETKAR: That's the important point.

MR. TSANG: Yes.

CHAIR STETKAR: Because in my particular situation, this is a very, very old story 35 years ago, but our problem was the designers under-sized the system by about a factor of five based on our actual operating experience, and it was terrible.

MR. TSANG: And I would say I don't have a factor of five compared to the existing plant, but a factor of two can easily be achieved.

CHAIR STETKAR: Well, I also know you don't use evaporators, which helps.

MR. TSANG: No.

CHAIR STETKAR: Because the evaporators are not particularly reliable so that at the back-end of the processing process, we always had problems. Filters and demineralizers as long as they don't saturate very quickly, are much better.

MR. TSANG: Again, the feedback is that we discuss this closely with the utilities. And in the current state of the operating plants, they would like to do without radwaste evaporators or incinerators because of the good neighbor policy.

So, in our current design, we do without.

CHAIR STETKAR: Good.

MR. TSANG: These are important feedbacks from the industry. We utilize that in the design.

CHAIR STETKAR: Okay.

MR. TSANG: In the current design, I like to emphasize that each tank, each of the four, waste holdup tank, plus the CVCS holdup tank, and any tank that is containing potential radioactive fluid, we put them in individual cubicles.

And those cubicles are for -

MEMBER BROWN: I'm the uninitiated. I'm an electrical guy, not a waste guy. So, you've got 90,000 gallons of storage capacity in terms of your normal operations, anticipated operations of the plant.

How much of that would you expect to be full or utilized? I mean, what part of that? 50 percent of it? 20 percent?

I'm just trying to get a feel for what does the 90,000 gallons mean? I mean, that's a lot of waste, but, you know, we do process a lot of waste, liquid waste.

So, I'm just trying to get a feel for what that means in terms of real, everyday operations.

MR. TSANG: Thank you for reminding me. I do want to go into that a little bit.

As I said earlier, the expected during normal operating condition, not during the refueling, is about three to 4,000 gallons. And it takes about eight days to fill a tank, roughly a week, and it only take a day to process it.

And in the meantime, we have three other tanks to take care of receiving the waste. So, I think normally we would expect that we would use 25 percent or less of the processing capacity and the storage capacity.

MEMBER BROWN: Okay. Do you process continuously or do you fill a certain amount and process it? Is it a continuous process or -

MR. TSANG: No, this is a batch-operating radwaste system.

MEMBER BROWN: Batch-operating. Okay. Probably everybody else knows that. I just didn't. Thank you.

CHAIR STETKAR: Irving, thinking about throughput, I'm not a chemical engineer. So, I know nothing about resin beds or anything like that, but do you have any operating experience for how quickly - I don't know the size of your demineralizers, but how quickly the resins saturate.

In other words, how frequently will you need to take a demineralizer string down for either resin regeneration or if you're just going to remove the resin and replace it. I don't know, you know, how you're going to manage the resins because that can contribute to downtime, you know, on your throughput.

MR. TSANG: We have talked to a lot of utilities for the removal of cesium-137 in particular, and all the other nuclides.

Our experience indicated most the ion exchange column, the resin come to a certain pressure drop first before it exceeds the activity removal of the nuclides.

The reason being that the - as we process it through, the resin bed tends to compress a little bit and also develop fines as it goes through the system.

So, when we perform design of the system, we allocate a certain pressure drop maximum to go through each bed. And we have differential pressure set points selected on that. And most of the time the set point would reach before it exhaust its nuclide-removal capability.

CHAIR STETKAR: So, design based on just replacing the resin then or do you -

MR. TSANG: Yes.

CHAIR STETKAR: Okay. So, you just use it and replace it.

MR. TSANG: Yes.

CHAIR STETKAR: Okay.

MR. TSANG: Later on in the solid waste system, I'll talk about the spent resin.

CHAIR STETKAR: Okay. Thanks.

MR. TSANG: Let me go back and -

MEMBER RYAN: Before we leave the liquid part, do you have any - you're not going to regenerate resin at all? Just onetime use.

MR. TSANG: No, the current designs do not have that.

MEMBER RYAN: Okay.

MR. TSANG: One thing I would like to point out through this slide is that the tanks are stored in individual cubicle. The intent there is two-fold.

Number one is to prevent any cross-contamination in an open-flow situation. Number two is that those cubicles, the floor is sloped and epoxy-coated to make sure it drains fast to a drain collection header inside that cubicle. And we have a leak detection instrument associated with it.

So, Reg Guide 4.21 asks us to design a system to detect a few gallons in a week's time of leakage.

The design that we have here greatly improved that. We could detect leakage probably the size of maybe two cups of coffee. So, that's a step ahead of the providing early leak detection system.

CHAIR STETKAR: Are you going to talk about the lining of those cubicles? I know there was quite a bit of discussion in the SER about whether the tank cubicles would be stainless steel-lined or your decision was to epoxy coat them.

MR. TSANG: Yes.

CHAIR STETKAR: Are you going to mention

much of that in your presentation or not?

MR. TSANG: I'd like to discuss it here now.

CHAIR STETKAR: Okay.

MR. TSANG: We use epoxy coating because it's industry proven. We have plenty of - practically all the nuclear power plant that I associated with in my past, existing operating plant, we use epoxy coating in the system. And, therefore, I feel comfortable using it.

And we do have in situ epoxy maintenance programs as a requirement to the COL applicant that we need to go in inspection, testing of the coating periodically.

That's the design that we have, and I feel comfortable that is a split design.

MEMBER RYAN: If I understand right, and correct me if I'm wrong, some of these epoxy coatings are amenable to repair. It's not hard to repair or it would be hard to repair an entire cell with stainless steel liners, for example.

Did you agree? I mean, these are -

MR. TSANG: Yes, I agree.

MEMBER RYAN: -- fairly repairable coatings?

MR. TSANG: The design life of the epoxy coating is roughly 20 years. So, for 60 years design life you probably need to replace it twice.

MEMBER RYAN: Yes. But some, you know, I recall some older coatings would be susceptible to heavy equipment rolling over them and cracking them and those kind of things.

These are more durable or -

MR. TSANG: We have made some improvement in that area. The industry has come a long way to develop the epoxy coating.

And the epoxy coating are generally applied throughout the plant, but within the cubicle itself we make sure there's no heavy equipment going over it. And we will apply the coating after the installation of the tank.

MEMBER RYAN: Thank you.

MEMBER BROWN: I had one other question.

These tanks, they're in the auxiliary building; is that correct?

MR. TSANG: Yes, in the basement level.

MEMBER BROWN: So, those are - these tanks, the radwaste tanks, are in a non-seismic building. Is that fairly standard or -

MR. TSANG: Yes.

MEMBER BROWN: I guess my inexperience on that is showing.

MR. TSANG: My experience is that all radwaste system are seismic Category II, which is non-seismic.

MEMBER BROWN: Well, that's kind of - that's uniform. That's a standard approach to doing stuff.

Are the tanks seismically qualified or anything or -

MR. TSANG: The tank does not need to be seismic qualified. The anchor bolts will be designed to the Reg Guide 1.143 OBE half SSE, safe-shutdown earthquake criteria.

MEMBER BROWN: Okay.

MR. TSANG: And that's the Reg Guide guiding us to do the design.

MEMBER BROWN: Well, the foundation hold-down system is designed to the safe-shutdown earthquake standard?

MR. TSANG: Half of that value.

MEMBER BROWN: Half of that value.

MR. TSANG: The building, MHI's design for the auxiliary building as I mentioned earlier, is a two-over-one design. So, the bottom portion of the building is seismically qualified from a structure standpoint.

The tank itself is not required to be designed to a full seismic load.

MEMBER BROWN: Okay. So, this auxiliary building, I think you said this earlier and I just missed - I didn't connect the dots.

You talked about an upper and a lower level. The tanks are in the lower level?

MR. TSANG: Yes. The tank at the basement level, which is from the reference grade standpoint, grade is set at zero. That's the reference grade elevation. The tanks are two levels below. Minus 26 the elevation.

We have another half of the building on top and that's designed for seismic Class II, but the bottom portion is a seismic Class I.

MEMBER BROWN: So, the tanks are in a seismically-qualified space.

MR. TSANG: Yes, sir.

MEMBER BROWN: It's just that the whole building is not - the part above that is not - all right. I got it now. Thank you. I did not understand that. Appreciate it.

MR. TSANG: You're welcome.

All right. And one more characteristic of this - or design feature of this design is that we have provisions for a future mobile treatment unit. If the technology improves in the next 20 years or 40 years, we are design ready for that.

So, we have provisions for all the hookup. We have the utility hookup, as well as the connecting piping that we anticipated. It's all hookup providing in the space there.

CHAIR STETKAR: But the certified design itself is a full, hard pipe -

MR. TSANG: Yes.

CHAIR STETKAR: -- system as it's presented here.

MR. TSANG: Yes.

CHAIR STETKAR: Okay.

MR. TSANG: Next, please. Like I mentioned, processing rate is set at 90 gpm, the net processing rate.

I'd like to clarify that this is the design point of processing rate. And as we process this through, the pressure drops within the filter, within the ion exchanger, increases a little bit.

So, at the beginning when we process it through, it probably at a higher rate. And at the end, it will be - but 90 is the minimum that we design for.

And of course the effluent, we comply to 10 CFR 20 Appendix B Table 2. And as I mentioned in the discussion of the process flow diagram, we have radiation monitors to ensure that the effluent is not exceeding the effluent specification.

MEMBER RYAN: What is the effluent specification relative to the Appendix B Table 2 value? Is it 90 percent? 50 percent?

I'm sure it has a range for different radionuclides.

MR. TSANG: Yes. For the most stringent requirement, the cesium-137 is one of the key points that we measure performance of the system.

As of now, it's roughly in the 0.3 range meaning that the spec is one, and we are around there.

MEMBER RYAN: 0.3 plus or minus what kind of uncertainty, would you guess?

MR. TSANG: 0.3 is determined by the GALE Code. If I may say that, the GALE Code has very conservative assumptions built into in terms of the contamination factor.

I would say in the normal day-to-day operation, that value is going to be much, much below.

MEMBER RYAN: Order of magnitude. I'm always uncertain when we rely on a code to determine the uncertainty.

MR. TSANG: I agree with you, sir.

We have several layers of margin in there, as I said, the contamination factor that we use in forecasting the performance using the GALE Code. And with the industry improving in the performance of resin, we do a lot better. That's one layer of margin.

And another layer of margin is that we use ANSI-18.1, which give a formulation to come up with what we expect as the maximum nuclide in the solution as it coming in.

So, in the normal operation in the plant, I would expect that the leakage rate is much less. The contamination level is much less.

When I talk about leakage rate, I'm talking about the primary to secondary leakage rate.

MEMBER RYAN: Sure. I understand.

So, somewhere in that range of values you have to really set - and I think the key to me is the action points. When are you going to stop and do something else or at least do further evaluation to see if things are steady state or they're getting higher values or are they, you know, well within your operating range, that kind of thing.

Do you cover that by procedures or do you have a plan like that?

MR. TSANG: We do require tank-to-tank sampling to determine the contamination level before we process. And that's part of the procedure that we will ask for. Take samples, analyze it, determine the contamination level before we process the tank.

MEMBER ARMIJO: If you don't regenerate your resins, how much solid waste do you produce? I know you're going to get to the solid waste management system, but at this point I'd like to know how much resin solid waste do you produce?

MR. TSANG: Certainly.

MEMBER ARMIJO: Annually, life of the plant, give me some sort of feel for it.

MR. TSANG: Yes, I'll answer that question.

Before we start the design, we have a survey to the industry of how much waste. In particular, how much resin. How many cubic feet that we expect to generate.

Normally, the industry indicate that generate no more than two containers of different types of resin in the plant. And that includes the steam generator blowdown if they are contaminated, and other resin. CVCS, demineralizer resin, everything included.

The industry maximum is four containers. And I'll define what the container mean. The four containers are waste total that has high enough nuclide contamination that we classify as a Class B or Class C waste.

And each container is a high integrity container about 120 cubic feet of capacity. The actual loading capacity, the amount of resin that we put into the container is, we assume, is only 90 cubic feet. So, we have a margin in there.

MEMBER ARMIJO: You'd have four of these containers, and that's for over the life of the plant, some period of time or -

MR. TSANG: Each year.

MEMBER ARMIJO: Each what?

MR. TSANG: Each year.

MEMBER ARMIJO: Each year. And that would go to some Barnwell-type place or something?

MEMBER RYAN: Well, it depends.

(Off-record discussion.)

MEMBER RYAN: Not so much Barnwell anymore.

MR. TSANG: We will discuss that when we

talk about the solid system.

CHAIR STETKAR: Irving, those volumes that you just mentioned, you mentioned experience from steam generator blowdown and CVCS demins. And you said the maximum, though, was four containers.

A lot of plants still do have radwaste evaporators. So, is the maximum experience from plants that use a full demineralize-based liquid waste processing system?

In other words, your plant doesn't have demineralizers to concentrate things. So, if you -

MR. TSANG: You mean evaporator?

CHAIR STETKAR: I'm sorry. Your plant does not have evaporators.

Does the four containers per year experience come from plants that do not have evaporators that use pure demineralized liquid waste processing system for all liquid waste drains?

MR. TSANG: I need to take that question back. The database that we have talking to utilities covers about 25, 30 plants. And I do not remember whether each plant would have a radwaste -

CHAIR STETKAR: Yes, that would be a little bit relevant, you know. If the four containers per year comes from plants that have a pure demineralize-based system for all of the waste, you know, blowdown, CVCS and liquid waste, that would be relevant experience in terms of the expected volume.

MR. TSANG: I will take that question and provide a response later.

CHAIR STETKAR: Thanks.

MEMBER RYAN: And I'm sure it's not just the plant issues that drive the question. I'm going to guess that it's also the waste disposal outlet requirements that also drive the decision making.

It's not just what's the best way to process the water. It's what end products can I actually get rid of?

So, I think that's, you know, if you want to integrate that thought into the question, that would be helpful, too, to understand how those things balance.

MR. TSANG: Thank you. I will.

We work with two utilities very closely. They do not use a radwaste evaporator. They don't like evaporators.

(Laughter.)

(Off-record comments.)

CHAIR STETKAR: I would have had a lot more questions if I had seen an evaporator.

MR. TSANG: And the amount of resin that they generate is flowing to the lower range of the forecast, but that's only the two plants I worked with very closely.

CHAIR STETKAR: Yes, but at least that anecdotal evidence tends to support the volumes that you were talking about.

MR. TSANG: Okay. Next, please. The next slide, on this slide, I just want to give an indication of how we utilize the codes and standards to guide us to develop the design.

We use 10 CFR 50, 10 CFR 20 to the form the effluent specification design. All the components that we use in the radwaste system follows - adhere to Reg Guide 1.143. The equipment code and the design requirements follows that.

And the system that we have in there also adhere to Reg Guide 4.21. As we all know, 4.21 asks us to do three things. Minimize waste generation. And if it's not possible, we have an early detection system to detect any leakage overflow. The third is that we need to - in the design, we need to provide easy access to get to the source of the problem and provide rapid fixes, remediation.

And in the current design, we cannot

prevent waste generation, no liquid leakage. We cannot do that. So, we have the leak detection system built in. And we also provide accessway, labyrinth to make sure the workers are protected with an access to fix the problem if it exists.

Okay. Any other questions on that?

(No response.)

MR. TSANG: Next, please. This completed the liquid waste system. And before I go into the gaseous waste system, I'd like to ask whether there's any more questions.

MEMBER RYAN: No.

MR. TSANG: Thank you.

The gaseous waste system, we do have some gases generating from the primary coolant system that would go into the radwaste system, primarily the gaseous system.

So, the objective for the gaseous system is designed to collect those gases, go through the necessary treatment and decay before we release that to the environment.

The gaseous system is one integrated system. And, again, it is non-safety and seismic Category II. We follow Reg Guide 1.143 for the hazard classification.

The gas surge tanks and the charcoal beds are Class IIa. Decompressors and the other equipment, the analyzers are Class IIc.

Most of the components in the gaseous waste management system are located in the auxiliary building. Some are at the lower level. Primarily at the lower level, and not in the higher level.

But the release plant vent is mounted on the outside of the containment. We tie into the auxiliary building vent header is inside the auxiliary building, but the vent stack is outside alongside the containment.

MEMBER ARMIJO: Is that the only place you release to the environment is through that stack or are there other places?

MR. TSANG: The answer is yes, but I need to clarify what -

MEMBER ARMIJO: Maybe when you get to your sketch, you can explain that.

MR. TSANG: Okay. Yes.

There are some other regulations that drive the gaseous waste management system design. And I'd just like to point out that we use Reg Guide 1.189, the second from the top, to make sure we analyze the concentration of hydrogen and concentration of oxygen to prevent it to coming to a lower vulnerability limit and the explosion limit. Also use Reg Guide 1.110 to do the cost benefit analysis, as I mentioned earlier.

We have gaseous flow diagrams for the gaseous waste system. We indicate in there two waste gas compressors. And only one is being used normally, and the other one is in a standby mode.

We have four surge tanks. Four very large surge tanks compared to the average industry volume. And one is in the receiving mode. The second one is in the recycle mode. And the third one is in the standby mode. The fourth one being a backup in case anything happens.

So these tanks are, I would say, larger than the normal plants. And we have, as I said, we have standby, we have backup, we have plenty of capacity there.

Next, please.

MEMBER RYAN: Hang on. It looks like that all the sources that go into the tanks can either all go into A or B; is that correct?

MR. TSANG: Yes.

MEMBER RYAN: You can pipe it so that one of the compressor tanks is operating for all.

MR. TSANG: Yes.

MEMBER RYAN: Okay.

MR. TSANG: It takes all the input.

MEMBER RYAN: Right. Okay. Thanks.

MR. TSANG: Next, please. In this portion of process flow diagram, which is still part of the system, we have a set of waste gas dryer to protect the charcoal absorber.

And we also have a continuous oxygen gas analyzer to make sure the hydrogen content and oxygen content are maintained in balance before we go into the charcoal absorber.

And as I depict on this - excuse me. I also need to point out that there are two intermittent waste gas analyzer. Both has capability to measure hydrogen concentration and oxygen concentration. They are used intermittently.

And at the bottom left of the screen, I show the radioactive waste gas going into the vent header, the auxiliary building vent header, the HVAC header, before it go into the plant stack.

I'd like to point out two things. One, we have two sets of radiation monitors. One right here. And another one right there.

And one of the condition that the

discharge is to make sure we have ventilation flow. So, therefore, the control is that we tie to the flow. If we have flow, we can discharge.

We do not have flow, the valve will close and we recycle the gas back to the surge tank.

MEMBER ARMIJO: Is that forced flow or natural circulation? What kind of - is it like a fan or blowers or something that assure that you have flow?

MR. TSANG: We have the HVAC system. We have blowers for that.

MEMBER ARMIJO: Okay.

CHAIR STETKAR: Yes, the tie, you can't hardly see it on this. Right at the bottom, that's the discharge from the auxiliary building ventilation system.

MEMBER ARMIJO: That little -

CHAIR STETKAR: Yes, the little arrow coming in -

MEMBER ARMIJO: Got it. Yes.

CHAIR STETKAR: -- above the U.

MEMBER RYAN: That would be HVAC down there.

MEMBER ARMIJO: Yes. Good eyesight.

CHAIR STETKAR: And the plant, also, from the left.

MEMBER RYAN: It's certainly a forced flow.

MR. TSANG: And now I'm going to answer your earlier question.

MEMBER BROWN: Wait. Can I ask -

MR. TSANG: Sure.

MEMBER BROWN: Excuse me just a minute. Correct me if I'm wrong. It seems all these, the vent stack is common for all the standard HVAC, as well as the gaseous waste discharge as well? And they all come together in one point like that.

Is that a fairly standard approach?

MR. TSANG: Yes.

MEMBER BROWN: Educational point for me. Thank you.

CHAIR STETKAR: It helps monitoring.

(Simultaneous speaking.)

MEMBER RYAN: I think that's fair because if you go back and look up in the systems we've just touched on some of the details, there's an awful lot of processing for that air stream before it gets to that point.

MEMBER BROWN: I'm not questioning that if I look at the system diagram. It's just that it's just kind of a common event for potentially contaminated, as well as all your standard HVAC exits.

CHAIR STETKAR: I mean, there's some - typically in a plant, there are some areas that are not ever exposed to radioactive stuff. And those have direct vent releases, you know. An office building, for example, doesn't exactly -

(Simultaneous speaking.)

CHAIR STETKAR: Anything potentially radioactive comes into this place.

MEMBER BLEY: Which includes the air in the plant.

CHAIR STETKAR: Which includes the air in certainly the reactor building, the aux building.

(Off-record comments.)

MR. TSANG: So, the answer to your question is a yes, but I need to qualify that.

MEMBER ARMIJO: You know, the other thing I'm interested in, obviously, because of the Fukushima events, is the hydrogen. This system is sized for handling radiolysis types, hydrogen loads, but is it sized for handling accident loads or anything like that? Generation of large amounts of hydrogen and releasing it in a way that it's harmless, hopefully.

MR. TSANG: I'm searching for where we

could generate a huge amount of -

MEMBER ARMIJO: Well -

MR. TSANG: Nishio-san, would you like to take that?

MR. NISHIO: For hydrogen, gaseous waste management input comes from only volume control tank only. So, this system doesn't use in the event of the accident.

MEMBER ARMIJO: Okay. So, it's strictly normal process -

MR. NISHIO: Normal, yes, yes.

MEMBER ARMIJO: Normal processing.

MR. NISHIO: Yes.

MEMBER ARMIJO: Okay. And the hydrogen is - what do you do to - do you have some sort of recombiner or is it in the charcoal beds where everything gets neutralized?

MR. TSANG: The gaseous system does not have a combiner system within the system itself. Other system, we have igniters to control the amount of hydrogen in the plant.

MEMBER ARMIJO: But within this process stream, is it when you have your - you try to maintain your hydrogen and oxygen ratios at some level, and at what point does that hydrogen and oxygen become water?

MR. TSANG: No, we do not have that in the design.

MEMBER ARMIJO: Okay.

CHAIR STETKAR: Is that okay, Sam?

MEMBER ARMIJO: Sure. Yes. He answered my question.

CHAIR STETKAR: There was an RAI about system responses in the event of a potential hydrogen explosion.

And I know in a pressurized water reactor, it's not nearly the same type of issue as it is in a boiling water reactor, so - but it's still possible because you are venting VCT and things like that.

And it was mentioned that if for some reason an explosion did occur, if you had a leak and for some reason monitors didn't detect the right concentrations before you had the leak and something did happen, then you rely on operator actions to isolate the flow path. In other words, isolate the feed stream.

The question I had is are those operator actions - where is this system controlled from? Is it from a local operator station in the auxiliary building or is it from the main control room?

MR. TSANG: The control of the gaseous

system is in two places. Primarily from the radwaste control room.

We also tie with the current technology nowadays, everything is tied to the main control room. So, the main control room would have knowledge of whether the system is operating or not.

CHAIR STETKAR: Can they actually operate equipment from the main control room? In other words, the isolation valves, can they be operated from the main control room or do you rely on the local operator at the radwaste panels?

MR. TSANG: Nishio-san.

MR. NISHIO: No, in the control room - in the main control room, operator can know.

CHAIR STETKAR: It's only local. Okay.

The reason I ask the question is if you're relying on operator actions to mitigate the consequences of what might be a hydrogen explosion and a fire, I would hope that the operator is in a location that's protected from those possible consequences.

Have you thought about location of that operator space relative to a potential fire that might occur?

MR. TSANG: Yes, I think we need to take

this question back and we analyze the design and get back to you.

CHAIR STETKAR: Okay. Thank you.

As long as we're talking about waste, and I'm rambling a bit here, I looked ahead in your slides and I think there's only one or two more - or one more on gaseous waste.

So, as part of the analyses that you perform, at least in my experience for gaseous waste processing, an important evolution in the plant was degassing the reactor coolant system as you're going down into an outage. We had the worst problems in processing, you know, volumes of gaseous waste at that time.

I looked at your input flow streams, but I didn't have a chance to look at the whole plant.

Where do the vent lines from the pressurizer and the reactor vessel head - do they come into this gaseous waste processing stream? And if so, where?

The reason I ask that, at the plant that I was mentioning, it didn't. I don't need to go into details of how we did it, but they were not directly processed through anything that you show on this slide. So, I was curious where those lines actually connect to systems.

MR. TSANG: I have not looked into the -

CHAIR STETKAR: That line on the top of the pressurizer that you'd use for that, and also the head vent lines that you'd use during the degassing operations.

MR. TSANG: I'd like to take that question back.

CHAIR STETKAR: Because there were questions about, you know, the presumed amount of noble gases versus the time after shutdown that you'd be doing the gaseous - the gassing operation as a basis for the amount of releases from a tank failure in the gaseous waste processing system.

That's sort of what prompted my question about how the thing was actually piped together.

MR. TSANG: That's a very good question.

CHAIR STETKAR: Okay.

MR. TSANG: I'm a little bit - I'm not that familiar with the pressurizer itself in the mode of operation that you're discussing.

CHAIR STETKAR: I understand.

MR. TSANG: I need to take that question -

CHAIR STETKAR: It's worthwhile only because the designers of our plant didn't actually have the foresight to pipe those connections into the gaseous waste processing system. Let me just put it that way.

MR. TSANG: Very good, sir. We will answer that.

CHAIR STETKAR: Okay. Thanks.

MR. TSANG: Next slide, please.

We have this gas -- we -- the technology is industry-proven. And we have four very large waste gas surge tanks. Four charcoal beds. We have hydrogen, oxygen monitoring. We have redundant systems in the design.

Certainly the design, we use the GALE Code, a modified version of the GALE Code to forecast release specification.

That concludes the presentation on the gaseous system. Any more questions on that piece?

(No response.)

MR. TSANG: Next, please. The solid waste system. As we all know, there are broken pieces of equipment, contaminated maintenance parts or broken tools and things as a result of normal operation. So, the solid waste system is designed to handle that to put it into proper disposal categories.

For the solid waste system, you primarily have three different subsystems; the dry solid waste which are all the wooden planks, you know, maintenance and the broken tools and broken instruments and things like that - valves; wet solid waste we're talking about the spent resin, spent charcoal in the system that we have in the current design; and we also have a packaging, storage and shipping subsystem and we design to package each of the waste, put it in storage until they accumulate to a certain volume that can be shipped out.

Then we arrange for shipment for offsite disposal. They'll bring a truck in, handle it and ship it out.

MEMBER RYAN: We're not using vendor services for packaging and all that or just transport?

MR. TSANG: Current design has two portions. One is the dewatering of the resin and dewatering of the spent carbon as the COL applicant's responsibility. And they could utilize vendors or they could utilize their own equipment.

The equipment are very simple. It just have a fill head header and a dewatering pump. So, it could be both in that.

Other than that, we do collect contaminated laundry. We put it in a SEAVAN container, and we ship them out for offsite processing. So, that's a vendor activity.

Okay. The system is primarily non-safety and a seismic Category II. And other than the spent resin storage tank and the breakpot that we have which are Category IIa, the others are all Class IIc.

That's the equipment. I'm not talking about the waste. All these equipment are located in the auxiliary building.

These are some of the regulations that we use to guide our design. I'd like to point out the ANSI-40.37, the mobile system.

We can see the mobile dewatering system. We need to follow that standard. That's why we mentioned it here separately. Does not tie into the liquid waste system or any - the gaseous system. We do not use mobile system other than the dewatering.

MEMBER RYAN: I know this is a bigger question, but with regard to the radwaste systems there's been a lot of interest lately in underground piping, and contamination developing in underground piping over many years.

How have you addressed that question with regard to the radwaste systems?

MR. TSANG: We address that question more plant-wide than just the radwaste system. Radwaste by itself do not have underground piping.

MEMBER RYAN: None, okay.

CHAIR STETKAR: None? There's none of the through input lines from - I was thinking the reactor coolant drain tank or any of the sumps in the auxiliary building are all - they're not buried under structures?

MR. TSANG: They are not.

CHAIR STETKAR: Okay.

MR. TSANG: Running is through the building through pipe chases.

CHAIR STETKAR: Okay. Good. Good.

MR. TSANG: For radwaste, absolutely no underground piping. No buried piping within the plant itself.

CHAIR STETKAR: That's all within the scope of the certified design. For example, on the discharge line, that also applies out to the end of your scope of supply which are the isolation valves; is that true?

MR. TSANG: Yes.

CHAIR STETKAR: Okay.

MR. TSANG: That follows Reg Guide 1.143.

CHAIR STETKAR: And then the COL applicant could decide to bury, for example, the ultimate discharge line?

MR. TSANG: That's correct, sir.

CHAIR STETKAR: Okay.

MEMBER RYAN: Thank you.

MR. TSANG: Next, please. This process flow diagram depicts the different ways of handling the solids, solid waste coming in.

The first line is the spent filters. We do use remote-handling technologies to extract spent filters from the filter vessel, put it into a shielded handling cask and then put it in drums.

Then we put the drums into storage until the volume accumulates for a course of active shipping offsite.

And the second line depicts the different ways of handling other type of solid waste for broken equipment, instruments and valves-type thing. We put them into drums, which is the middle line. And for larger pieces, we put it on through containers, which is the top line.

And then for contaminated protective clothing, we put them in SEAVAN containers until they are full, and we ship it out for offsite processing.

MEMBER RYAN: Well, I guess it's very

typical that most of the solid waste, not all, but most of the solids waste would be Class A. And the resins, as you mentioned, would be the B and C.

MR. TSANG: Yes, correct.

Next, please. Let's spend a moment on the spent resin handling system. From the spent resin tank as we depict it here, we use pneumatic transfer which is typical industry practice. We have two ways of getting spent resin into the disposal container.

One is a slurry by a pump, and the other one is pneumatic using pressurized air or nitrogen to convey the material from here to the container over here. That's the dewatering package that we discussed a little bit earlier.

MEMBER RYAN: Have you made a decision that you want to use air or slurry, or do you have the option for both?

MR. TSANG: We have the option for both right now.

MEMBER RYAN: Okay.

MR. TSANG: One of the key features that we have since this is a pneumatic system, we need to protect the HVAC and to minimize cross-contamination from the spent resin tank. That's why we provided the breakpot.

In case anything goes wrong, the tank is pressurized. The flow is separate. The air or the nitrogen was separate from the slurry before it gets to the HVAC system. That's the protection that we built into the design.

(Off-record comments.)

MR. TSANG: And in this, we talk about collecting any oil and sludge resulting from the plant from - one of the design that we have, and it is a clever design on the MHI part, the floor drain system, as I mentioned, it could be contaminated with lubricant, oil and other organics.

And in the floor drain sump, it's designed to separate heavy sludges and also oil before it get into the system.

So, the top line here is that we extract any sludge or extract any oil from there and we put it into containers. And then we ship both wastes out for offsite vendor for processing.

MEMBER ARMIJO: How do you separate it from water or other -

MR. TSANG: The sludge will tend to be heavier than water. So, it will sink to the bottom and we - there is a design that has weirs. And the input comes from here. It reduces the velocity and the solid tends to settle, but the oily organic matter would be a lighter density than -

MEMBER ARMIJO: Skim that off the top?

MR. TSANG: Skim off the top and put it in another - so, that's the design.

MEMBER RYAN: And your thought is that the water portion would have most of the radioactive contamination in it or -

MR. TSANG: There will be some, yes.

MEMBER RYAN: Yes, and the oil will too.

MEMBER ARMIJO: Everything will.

MEMBER RYAN: The oil will definitely have tritium, that's for sure, and a few other things I can think of.

So, both will end up being radwaste.

MR. TSANG: Yes.

MEMBER RYAN: And I guess the water portion you could solidify in concrete or something of that sort or -

MR. TSANG: The water portion -

MEMBER RYAN: -- what's the plan for the two-waste stream's treatment?

MR. TSANG: Yes, the water portion would go to the liquid and floor drain system for processing.

MEMBER RYAN: Gotcha.

MR. TSANG: It's just that we do not have an incinerator in the plant. The oil cannot be disposed readily within the plant. So, we ship the oil out for offsite disposal.

This is a typical industry practice.

MEMBER RYAN: Sure.

MR. TSANG: Okay. Any questions?

(No response.)

MR. TSANG: Again, I believe that before we start the system design for the solid waste system, we also talk to the utilities, what they want to use, how they want to design the solid waste system then.

And their conclusion, the result of the conclusion are all incorporated in the design that we have. They don't want incinerators. So, we don't put in an incinerator.

They don't want solidification system. So, we don't put in a solidification system. They would prefer - it's more cost effective for the utility to ship them offsite for disposal. So, the design philosophy that we have reflects the discussion.

As you can see, we're using industry-proven technology. We have two spent resin storage tanks segregating high-activity resin with low-activity resin. We could blend the resin if you want to, but that's the design that we have.

From a storage standpoint, we have two vaults in the design. The storage area that could store up to 16 containers, this goes back to your comment on -

MEMBER ARMIJO: Is that the 120 cubic foot-type containers?

MR. TSANG: Yes.

MEMBER ARMIJO: Okay.

MR. TSANG: And that's the design point for the illustration purpose. And of course we have space for other type of containers in there. And if you put drums in there, it will reduce the number of containers, and in its place will be drums.

I also want to emphasize that this is - the vaults have advanced design in it and it's a totally remote operation. And it has a cover to shield radiation streaming for worker protection.

And we also have leak detection in the design.

MEMBER RYAN: Is this an overhead operation where you take a lid off and then you place the containers and put the lid back? Is that the -

MR. TSANG: Yes, exactly as you have

described.

MEMBER RYAN: Okay.

MR. TSANG: And a very high level -

MEMBER RYAN: Yes.

MR. TSANG: The storage capacity that we have would accommodate - we made a commitment to a minimum storage of 30 days. But as you could see, it's a lot more than what it is.

But one of your comment earlier is currently Barnwell is already closed and we don't have a good place to send the Class B and C waste for offsite disposal. So, additional Class B/C waste storage is a site requirement on that.

The NRC has given us guidance that utility will need to plan ahead to have a facility store additional waste, Class B/C waste.

And this is what we classify it as an interim storage, and that storage capacity is by the COL applicant. Typical industry practice is store ten years of that, but this is the COL applicant's responsibility to take care of that.

We have a very large Class A waste storage area by comparison. I think that's a good part of the space within the storage area.

You could expand that. The vaults, the

wall, are designed to be movable. If we need additional, we could move the wall to accommodate more storage in there.

And we have an overhead crane in the system to handle the waste. We have an indoor truck bay. The truck could back in all the way and we handle it inside before - we have shield doors to protect the worker around the solid waste area.

MEMBER ARMIJO: Do you have any compactors to reduce volumes, or would that be sort of a vendor-supplied service, let's say, compaction of solid waste in drums and things like that?

MR. TSANG: Again, to answer your question directly, no, we do not have compactors or super-compactors.

When we talk to the utility, they prefer to handle that by a vendor.

MEMBER ARMIJO: Contractor, okay.

MR. TSANG: Okay. Any questions?

(No response.)

MR. TSANG: All right. These are some - I think we went through that already. We've captured it in the discussion on that.

The process effluent radiation monitoring and sampling system, when I anticipate the presentation, we focus on the radwaste discussion. So, the process effluent radiation monitoring system has over 30 sets of instruments to monitor the operating condition of the plant.

And some of the sets has multiple instruments located and I'm not - I don't think we have time to go into the discussion on each of the monitoring system.

I just want to point out that in the discussion of the liquid and the gaseous, we point out how they are monitored in the discharge for that.

And we do have - we do have sampling stations distributed around the plant to take local samples and send it into the lab for analysis.

From the radwaste standpoint, we have online monitor, we have samples, we have confirmatory samples taken. So, I think it's enough protection to make sure the plant operates safely.

MEMBER RYAN: Do you have a process control program kind of approach to integrating all those measurements and sample analysis?

Sometimes you can be overpowered by the number of sample results that you have. So, how do you make sense out of all the samples and how do you trend the plant's behavior based on all the sampling?

MR. TSANG: Let me take the question back and answer it in writing, because I'm not familiar with how the main control room is designed to keep a continuous log of the operating data.

MEMBER RYAN: And my thought is that some is actually online operating data that you'll make decisions about all throughout an operating day.

Some other of the sampling data from actual waste samples is static at a given amount of time, but somewhere you bring all that together -

MR. TSANG: Yes.

MEMBER RYAN: -- to make decisions on, you know, what's okay and what needs attention. So, I'd be curious how you integrate all that.

MR. TSANG: It's a procedural thing and I haven't come to that portion of that.

MEMBER RYAN: I just want to make sure my question is clear.

MR. TSANG: I will answer that in writing.

MEMBER RYAN: Thank you.

MR. TSANG: Okay. We have a summary of the open RAI that currently we have. RAI 624-4972, we are providing the liquid effluent/dose calculation package. We send in the package at the end of March. So, it's under NRC review right now.

And RAI 711, same thing. We already send that in. And I'm sure later on NRC will discuss that a little bit.

629 already sent in at the end of March. So, we're waiting for their review and then we'll contact NRC to seek closure on the RAIs.

Next, please. Two more open items we are working on right now, and that's RAI 712 and 629. And we will provide a response by next month on that.

I think in this discussion, I discussed the key design features on the radwaste systems and talk about the design for normal operation, we talked about discussion for anticipated operational occurrences during startup, shutdown and how the system capacity take that into consideration.

We talk about how we monitor the system, especially on the effluent discharge side. And we discuss a little bit on the discharge limit as the way it is designed at this time.

I think that concludes my presentation. Are there any additional questions?

CHAIR STETKAR: Questions from any of the members?

MEMBER REMPE: Just to clarify, you mentioned with the gaseous effluents, that you have the capability to monitor not only in the radwaste control room, but also in the main control room.

That's true for not only gaseous, but liquid and any alarms for the solid, all three systems?

MR. TSANG: That's a good point.

MEMBER REMPE: Is that true?

MR. TSANG: Yes. Yes, we do.

MEMBER REMPE: Okay.

CHAIR STETKAR: Anything else?

If not, thank you very much. It was an excellent presentation. Very clear and covered all the materials.

And we're about 15 minutes late, but we're not too bad. So, let's recess for 15 minutes until - 14 minutes until 10:15.

(Whereupon, the proceedings went off the record at 10:01 a.m. and resumed at 10:13 a.m.)

CHAIR STETKAR: Let's come back in session and we'll hear from the staff on Chapter 11.

Ngola.

MR. OTTO: First of all, I just want to say good morning to the ACRS staff and MHI staff and those who are in attendance this morning for the Chapter 11 status review.

To my right is Ed Roach. He's going to be doing the staff's presentation on the review of Chapter 11. And I'm Ngola Otto. I'm the project manager for the Chapter 11 review of the design cert.

The team who started the review for Chapter 11.1, Michelle Hart; 11.1 through 5, Rich Clement; 11.2 through 11.4, Josh Wilson; and Royce Beacom, 11.5 for those sections.

As a quick overview, we were issued a total of 94 questions. And currently we have five open items which we're working to resolve in Phase 4 of the review.

And I'll go ahead and turn it over to Ed who's going to be doing the presentation.

MR. ROACH: Good morning to the Committee. My name is Ed Roach. I'm the branch chief for the Health Physics Branch of the New Reactors Office, Division of Construction Inspection Programs.

The technical reviewer who performed this review, works for me. His name is Rich Clement. And he's very disappointed that he couldn't be here today.

(Laughter.)

MR. ROACH: He had a prior commitment to take his daughter to Disney World during spring break week.

CHAIR STETKAR: Instead of seeing us?

MR. ROACH: So, I offered to stand in for him such that he wouldn't have to back out on her.

CHAIR STETKAR: Good for you.

MR. ROACH: Rich was disappointed in another means also, because he spent about the last two and a half years working on this project and would have liked the opportunity to speak to the Committee and Mitsubishi on -

CHAIR STETKAR: I'm really disappointed. Had we known that, I'm sure that we could have rescheduled the meeting and had it at Disney World.

MR. ROACH: Our project managers were happy with the scheduling. So, we'll leave it at that.

I'm also going to present the information related to SER Section 11.1, the results. That review was performed by Michelle Hart of the RSAC unit, which is the accident analysis group within our office.

Josh Wilson who is a member of the Balance of Plant team is not here today, but he has provided his phone number. So, if there are questions on the specifics of the details of the systems that I can't answer, then I'll be glad to call him and get back to you sometime today with the resolve to that issue.

So, if there are any questions - my

experience, I have been with the NRC approximately five years. I'm a qualified technical reviewer.

About a year and a half ago I moved to a position as a branch chief. I've worked on the AP-1000 design certification and several of the COL applications under the AP-1000.

I've worked with Rich as a peer reviewer and interacted with him now as a branch chief for the last year and a half.

So, I am very familiar, but I cannot go to the depths Rich could provide you on any of the computer codes, which is his specialty, I will assure you.

All right. First of all, under SER Section 11.1, which is the source terms as discussed by Mitsubishi earlier, this uses the ANSI/ANS-18.1-1999 basis for the source terms.

The core isotopic inventory was developed using ORIGEN-2.1. And the applicant followed the SRP Section 11.1 and Reg Guide 1.12.

There were no COL information items in this section, and we ended up with no open items for this section.

Any questions on that?

(No response.)

MR. ROACH: Okay. For Sections 11.2 through 11.5 when you ask questions, I have many tabs in the Safety Evaluation Report I can refer to, to hopefully answer the questions. So, there may be a slight delay as I get that information. So, I'll apologize in advance.

SER Section 11.2 is the liquid waste management system. As we heard from Mitsubishi and discussed their design, there's key standard review plan interfaces with other chapters. Chapter 2, hydrology; Chapter 9, auxiliary systems; 10, steam systems; Chapter 11, which we're in; Chapter 13, which includes ITAAC operational programs and procedures and training; and then Chapter 14 and Chapter 16. Chapter 16 being tech specs.

The liquid waste management system design basis is, as we said, industry-proven. We did a quick template to compare the various designs and basically using filters and ion exchangers, gas surge tanks and charcoal beds. And then for processing solid waste, resins and charcoal. Pretty standard design with the current fleet that's out there and the tried and true.

The additional item to note is that in the course of this, they made provisions for future use of mobile monitoring systems, which are also used by a variety of the current plants, to tie in and say do selective processing either using reverse osmosis, specialized resins, things like that that can be used to eliminate certain isotopic issues.

The basis and development of the liquid waste process systems and the estimated inputs to the liquid waste management system and treatment process performance, decontamination factors, were provided by the applicant and found to be in agreement with the typical designs we've seen.

As we discussed earlier under Chapter 11 with the Mitsubishi presentation, our safety evaluation went into a level of detail on the various systems that there's four waste holdup tanks of about 30,000 gallons apiece.

The estimate was that 80 percent of the tank would be full when it was started the process, and that's where the five hours came form as part of that. So, that would give you a feel for the total capacity versus time of processing.

I also worked at a power plant that had numerous challenges with water management in the course of either an operational occurrence or a, you know, say, a saltwater egress event which cause resin beds to fail or which then left you with a combination of liquid waste and solid waste.

So, I believe they've done a good job of assessing that and incorporating enough features to address that.

MHI proprietary version of the PWR-GALE Code, which as we discussed in previous meetings the GALE Code is in the process of being updated, the NRC GALE Code, MHI provided a technical report which is proprietary and developed some methodologies to incorporate realistic source terms in the course of that.

And I believe our open items are mostly related to making sure we have the detailed output and input files to verify that information is good.

Okay. Next slide, please. Section 11.2 again provides the methodology and basis and assumptions used to comply with the effluent concentration levels of 10 CFR Part 20, Appendix B, Table 2, Column 2, which is basically what are the activity levels in the water and the dose that the public gets from the liquid effluents. And they do meet the design objectives of Appendix I by their certified design.

Earlier, Mitsubishi discussed - or one of the members discussed the transition from a stainless steel lining in the cubicles used for the waste - liquid waste management system tanks. And that transitioned from stainless steel in an early version of the DCD, to the epoxy coating.

My understanding is, is that the stainless steel liners were designed mostly for the mitigation of the liquid waste tank failure. And you could take that as a - used as a mitigating factor, whereas the epoxy coating really goes to the heart of the Reg Guide 4.21, 10 CFR 20.1406, which is the minimization of contamination license-termination rule where what you're trying to do is minimize contamination to the site, the facility and the environment by using design features early on.

Methodology, basis and assumptions using the RATAF code to assess the actual impacts, radiological impacts due to postulated failure of a liquid waste management tank, and that came out favorable.

I had to look up what RATAF stood for, and I couldn't tell you today. I have a tab, so RATAF is another code that fits into our set of codes. It's available on the Oak Ridge site available to be used, and we're actually looking at updating that as well with more current factors.

10 CFR 20.1406, Tier 1 and ITAAC information, tech specs and pre-operational testing were all reviewed as part of the safety evaluation in this.

We decided to list the COL information items because there are quite a few that go to the actual facility where they build the site and will be expected to weigh in on. And they are important, and many of them were discussed in the earlier section here.

So, the mobile and temporary radwaste processing equipment and the interconnections that impact, that provides each license applicant the ability to determine what type of system they want to have and provide that with their COL application.

We talked about site-specific information for release points, effluent temperature, shape of the flow, where the body of water the release -- liquid waste system release goes to, and also the hydrological data and groundwater or surface water analysis to comply with the effluent concentration limits of Part 20 for the tank failure.

We also looked at the applicant also has to provide offsite liquid effluent doses demonstrating their compliance with Part 20, 40 CFR 190 under 13 -

10 CFR Part 20.1301(e) and Part 50 Appendix I.

They have to provide implementation milestones for their epoxy coatings program. If they're taking credit for that, which falls under that, we would expect to see that as part of probably maintenance rule and operational programs.

CBA, cost benefit analysis, they have to look at that from the perspective of if they added additional processing, the dollar return and whether that additional system implementation would return a lower dose to the population.

And then they have to provide plant drawings to show exactly where the systems tie in as part of the COL.

CHAIR STETKAR: Ed, this is a question Mike asked earlier, the applicant question regarding buried or underground piping. And it's clear that that's not an issue as far as the DCD is concerned.

Where in the licensing process or in hooks to the COL, are issues related to buried and underground piping, for example, and in particular, in liquid waste that would -- in this design, it would be the discharge line, cautions about either protecting that or monitoring that system for leak detection, because it's downstream from the official monitoring point now. And effectively from that point to wherever the ultimate environmental discharge point is, it's unmonitored unless you have some sort of leakage collection and detection system.

Is that typically put into COL information items or where does that sort of thought process appear in the integrated licensing of -

MR. ROACH: I'll take a step back.

CHAIR STETKAR: Yes, it's obviously a COL item.

MR. ROACH: Right.

CHAIR STETKAR: It's just whether is it typically a hook in the COL information from the DCD or is it strictly a - when you evaluate the site-specific parts of the design?

MR. ROACH: Typically it's been captured as part of the site-specific design.

CHAIR STETKAR: Okay.

MR. ROACH: It's usually addressed under the Chapter 12 review, radiation protection program.

CHAIR STETKAR: Okay.

MR. ROACH: During the development of the guidance documents, the guidance documents for compliance with 10 CFR 20.1406, Reg Guide 4.21, that subprogram kind of fell under radiation protection from the contamination minimization. That's the name of the role.

And although you think it would tie just to liquid waste, it addresses a lot of site-specific features to minimize contamination. And there are solid waste issues with it. There can be operational programs.

Generally, most of the applicants in applications we've reviewed so far have committed to a template document developed in conjunction with the Nuclear Energy Institute described as NEI 08-08A, which is the life cycle management of minimization contamination.

And so within that program sets parameters for risk assessment not in the classic CDF risk realm, but risk assessment of the systems likely to have a problem, what you would do to mitigate that, how often you would evaluate it and what would you do to monitor for those systems that have radioactive material likely to be present.

And then as part of our Chapter 12 review and Chapter 11 review and the COL, we oftentimes look at where is the specific, you know, discharge point, how are they getting it there, what are they doing to monitor it?

Because ultimately it's conceivable that in other plants they've exhibited per an operating -

CHAIR STETKAR: It's not only conceivable. It happens.

MR. ROACH: Yes, yes. There's operating experience to support that a slow leak not detected could result in detectable contamination off the facility site that, you know, isn't recognized for perhaps years.

CHAIR STETKAR: Yes.

MR. ROACH: And the license-termination rule was actually aimed at trying to minimize the effects and costs of decommissioning of a site with lessons learned from Maine Yankee. And those have been taken by the industry to heart in some cases, and used as a springboard to actually implement controls and processes to monitor that ongoing in the reactors.

MEMBER RAY: We've had this discussion just like you and John have had just now, before.

MR. ROACH: Yes, sir.

MEMBER RAY: But to me, it's not as specific as saying is there any potential for an unmonitored release path?

Forget about decommissioning for a minute -

MR. ROACH: All right.

MEMBER RAY: -- and the cost of decommissioning and whatnot. It's really you got, you know, a two-mile discharge line that goes down the road where there's a possibility of an unmonitored release path there is, I think, the way I think about it. And I don't hear it expressed quite that way, and that's why I made the comment.

MR. ROACH: All right. Thank you, Dr. Ray.

I would say that there's always the possibility of an unmonitored release. You put adequate controls in place, you put an operational program in place to monitor it, adequate design features in place, but there's always the human performance aspect of it that can cause something to happen.

MEMBER RYAN: And, you know, we're talking 20, 40, 60 years out now.

MR. ROACH: Yes.

MEMBER RYAN: I mean, I just think it's so simple and cheap to monitor. Why not? You know, it avoids hundreds of thousands of cubic feet of headaches or debt.

MEMBER RAY: You're preaching to the choir.

CHAIR STETKAR: I was going to say we're a little bit behind and it's just important that from our perspective, the original question that I asked was where do you, you know, where do we address this?

It's strictly COL.

MR. ROACH: And when we bring in the applicant's presentations for Comanche Peak and for North Anna, we'll address the features, call them out to the Committee, because the Committee is interested.

CHAIR STETKAR: Yes, good.

MEMBER RYAN: The other conundrum on the - probably as a COL item, Ed, and I probably don't have a real good answer, but I appreciate your thoughts is, you know, were the lead times for licensing and lead times plus for construction, you know, the actual profile of what low-level waste disposal capability in the country will look like is probably murky, if not unclear completely at this point.

So, how are you going to address the fact that the actual storage capacity a plant might need, might be a lot bigger than maybe they're thinking now?

MR. ROACH: I guess -

MEMBER RYAN: I know that's a tough question to answer. Is there a radon screen? Can you talk a little bit about that?

MR. ROACH: I can. At this point, we have actually worked with OGC in reviewing what the current guidance is and what the expectation is. For current plants, they can develop additional storage under doing a 10 CFR 50.59 evaluation.

There's a generic letter - I got to go back to it, but there's a generic letter that told you what you needed to do to provide for interim storage and what to evaluate in consideration. So, any of those current plants have that capability to do that.

So, what we're doing is there's a recent RIS that came out, I believe 2008, on that same topic. And we're using that as part of our features to see what have they done, how are they going to do it and are they going to use volume reduction techniques, do they look at the possibility of a facility in Texas being available for either storage, waste minimization or burial, and what other - I would expect - my own thought is that I expect to see probably a reawakening of the compact system that started in about 1994-1995 and - because economics will drive them to essentially take some action along those lines.

CHAIR STETKAR: Okay.

MEMBER RYAN: Thanks.

CHAIR STETKAR: Thanks.

MEMBER RYAN: I think the important part

from a regulatory standpoint, is 50.59 is the option that a developing plant would have to use at that time to address something different than their radwaste plan -

MR. ROACH: That's correct.

MEMBER RYAN: -- in their application that they - the COL.

MR. ROACH: That's correct.

MEMBER RYAN: Okay. Just wanted to be clear on that. Thanks.

MR. ROACH: All right. There are two open items. and Mitsubishi personnel did talk about these open items.

And as I alluded to, they really provide calculation packages so we can confirm and validate that these are a proprietary PWR-GALE code developed by Mitsubishi. And so, we want to make sure that there's not a default in the code that takes it outside of the regulatory realm.

At this point, it appears to be very - it's conservative, but it's not as conservative as the current PWR-GALE code that we use under - the other open item is we have requested an updated code files for RATAF on the new approach for the liquid tank failure analysis described in their report. And the proprietary report is now Rev 1. So, we have that in also.

Okay. Gaseous waste management -

CHAIR STETKAR: Just be a little bit careful when you pull your paper over there. These mics are really, really sensitive and -

MR. ROACH: Sorry. I couldn't hear that. I apologize.

CHAIR STETKAR: We're trying to maintain his hearing as long as possible. He's a good guy.

MR. ROACH: Gaseous waste management system, Section 11.3 open items, the interfaces are very similar with the exception of hydrology.

We looked at among one of the discussions, we talked earlier was hydrogen and oxygen monitoring, ALARA design features and the release point.

We looked at the basis for development of the gaseous process waste stream, estimated inputs, treatment process performance, removal efficiencies and holdup time. And then the ventilation, making sure the ventilation systems tie into the appropriate place.

Next slide, please. Okay. Basically, we were able to determine that the methodology, basis and assumptions used to comply with the ECLs in Part 20,

Appendix B, public does limits, and Appendix I were met.

The methodology, basis and assumptions to assess the radiological impacts due to postulated failure of a waste gas surge tank and a charcoal bed leak.

No mobile or temporary equipment or connections to permanently installed equipment considered in this design.

Next slide. And then the COL information related to 11.3 is onsite vent stack design parameters, release point characteristics, release points, temperature, making sure, again, they comply with the regulations.

And then the COL will also have to do a cost benefit analysis and provide the actual P&IDs for this gaseous waste system.

I'm familiar with gaseous waste systems that do use surge tanks. And they generally will end up with just releasing krypton in many cases, because the iodine decays away in a relatively good time. So, they're usually effective for treating gaseous waste.

The open items for this are, again, Open Item 11.03-1, which is provide calculation packages. This is for gaseous waste.

And then Open Item 11.03-2 was provide ITAAC to address the explosive monitoring in the gaseous waste monitoring system. And as Mitsubishi described earlier, we are working to resolve those issues.

Solid waste management system, again, this interfaces with Chapter 9, 11, 13, 14 and 16. Solid waste management system, again, describes those capabilities.

One of the things that's key in solid waste management is the ALARA design because you end up with high-integrity containers with about 90 cubic foot of resin which could be CVCS resin which could be anywhere between maybe a hundred rem per hour on contact with them. It's not unusual.

And so you have to move those about and store them in a shielded area and use ALARA practices in the course of that.

There is a discussion in the SER that talks about the anticipated volume of waste generated. And it references several tables from the DCD that address how many high-integrity containers would be used, how many B-25 containers would be generated in the course of a refueling outage.

So, there's estimates in there that we've taken and looked at the applicant's estimates and seemed reasonable given this.

There are no direct liquid or gaseous effluent releases from the solid waste system. So, therefore, the real issues tend to be ALARA issues in the storage and handling.

And then if there's 10 CFR 20.1406 issues, where it's stored and making sure you don't get leakage into the ground.

And the basis for the design storage capacity of Class A, B and C, radioactive wastes, are described in their application and covered in our SER or Chapter 11.4.

There's a couple other items. The process control program, this is another COL item that we expect the applicant to pick up.

In this case, the DCD applicant described the program for the Process Control Program to ensure that it's radwaste would meet the criteria for processing and burial - shallow-land burial under 10 CFR 61.55 and 10 CFR 61.56.

The DCD adopted the NEI template 07-10A until a plant-specific PCP is developed to support the plant operation. It provides the - basically, the overall program necessary to provide a PCP to meet the

NRC's guidance.

The last thing there is the epoxy coating system was also used to line the spent resin storage tank rooms. And is, again, used to comply with 20.1406 and Reg Guide 4.21.

SER Section 11.4 has no open items. But the COL information items as we discussed earlier, include onsite radioactive waste storage, PCP, and that program's implementation milestones, mobile and portable solid waste management system connections or programs, offsite laundry services or mobile compaction unit system if you bring that in, cost benefit analysis, and then any other contract services or compaction equipment for solid waste for processing.

P&IDs are also part of the COL applicant's responsibility. And then mobile and temporary waste processing interconnection to make sure they comply with 20.1406. There's been instances where that connection has been the weak point in current plants.

Okay. The last section we cover is DCD Section 11.5, process effluent radiation monitoring and sampling systems. PERMS is the design basis and the system descriptions for all the radiological monitoring and monitors, including features such as checking operability, calibrations for the systems, alarms and provisions for automatic isolation and termination of releases during the course of the process, for instance, in a gaseous release or a liquid release.

We looked at the plant process systems, effluent flow paths and made sure which ones were monitored by radiation monitoring and sampling equipment.

The next one, please. The applicant adopted - or the DCD adopts the NEI template for offsite dose calculation manual, which plants are required to have a program for under the current regulations. So, that shows how they will meet Appendix I, 10 CFR 50, Appendix I. And they've committed to the NEI template 07-09A, which describes the full program for the ODCM.

The RCS leakage detection conforms to Reg Guide 1.45, Revision 1, and ANSI Standard N42.18, and the ability to detect that leakage conforms to those standards. And primary to secondary leakage, to the NEI guidance under 97-06 for the tech spec basis for being able to detect steam generator.

Next slide. Under 11.5, there's numerous - these are very similar to the - the COL will have to provide information items that address the ODCM, with description of their methods and parameters and set points, a REMP program that follows NUREG-1301, NUREG-0133 and the NEI ODCM template 07-09, describe their analytical procedures and sensitivity analysis, procedures related to radiation monitoring instruments and basically sampling procedures. Also, they will provide a cost benefit analysis addressed in Section 11.2 and 11.3.

We are slightly out of synch with Mitsubishi here. We have this open item identified under 11.05-1 as opposed to 11.03, but we'll resolve that.

This basically as we've asked them, provides supporting information to describe provisions for unmonitored releases and uncontrolled radioactive releases for the environment as a general what are their other features, design features to do this.

MEMBER RYAN: So, that may be something that they address now, and then the COL address their part of it?

MR. ROACH: Yes, the site-specific portion.

MEMBER RYAN: Yes.

MR. ROACH: COL information items are offsite liquid and gaseous offsite doses, the calculations related to those, and liquid tank failure analysis. If there's any differences between the DCD, they'll have to address those.

Maintenance to the epoxy coating system, cost benefit analysis, PCP and ODCM are the key ones there, significant ones.

And if there are any other questions - there's also a slide at the back with all the acronyms related to this.

Any questions?

MEMBER BLEY: I just have a general licensing question.

It seems to me that two or three years ago when we were going through another one of these, we were told that staff had decided COL information items and COL items shouldn't be flagged as such in a DCD.

Is that true or is that something that was just being tossed around once upon a time?

It was apparently that the vendor shouldn't be deciding what the COL applicant would have to do, and I'm just a little confused. It doesn't seem that they've gone away.

MR. ROACH: I would probably defer to the project management leadership over there, but my understanding is - I will give you my perspective in dealing with the licensing, is that in the various designs; AP-1000, ESBWR, COL information items have been called out that the applicant needs to do a certain -

MEMBER BLEY: Yes.

MR. ROACH: In our current ABWR design that South Texas is working on, there are several that we deal with as part of Chapter 11 or 12.

MEMBER BLEY: Yes, I know.

MR. ROACH: So, they have not gone away. And, in fact, we look to the -

MEMBER BLEY: So, perhaps they were being renamed or something.

MR. HAMZEHEE: I think you are right, Dennis. We - that was the discussion we had a few years ago. That's why we change "action item" to "information item."

MEMBER BLEY: That's the difference.

CHAIR STETKAR: It's called a COL action item.

MEMBER BLEY: In substance, they're still there. We just didn't identify them as actions.

MR. HAMZEHEE: Yes.

MEMBER BLEY: Okay. Thank you. That's enough. I was just a little confused.

MR. ROACH: And if I deferred and said "action items," then I apologize. That's bad behavior.

MEMBER BLEY: I don't think you did. I think you were precise and correct.

CHAIR STETKAR: Are there any other questions from any of the members?

MR. HAMZEHEE: It looks like we're catching up with the schedule.

CHAIR STETKAR: If not, Ed, you did a great job.

MR. ROACH: Thank you.

CHAIR STETKAR: Thank you very much and -

MR. ROACH: And I'll be glad to send Rich in here any time you would like.

CHAIR STETKAR: No, no, no. I want to go to Disney World.

(Laughter.)

(Off-record discussion.)

CHAIR STETKAR: Are you ready?

MR. TSANG: Yes, sir.

(Off-record discussion.)

MR. TSANG: Next topic that I have is the Chapter 12 on the DCD on radiation protection. I'd like to introduce the technical members of my team here.

On my left-hand side is Omura-san. And Yves and Konno-san you met earlier. And I'm Irving Tsang. I'll be the primary speaker on this topic.

I want to give an overview of Chapter 12, and then talk a little bit about the subsections. And I'd like to focus a little bit more on the discussion of the design features, and also how we comply to Reg Guide 4.21.

I heard some of the discussion earlier, and I'd like to come back here and tell you what we have done in this area.

We'll give a summary on the confirmatory item, and also briefly talk about the statuses on the open items.

Chapter 12 primarily talk about the ALARA that we build into the design, the radiation sources, the radiation protection design features, dose assessments and the -- as we mentioned earlier, the operational radiation protection program, how we use that to support/complement on the design activities that we have.

Next, please. 12.1, ensuring the occupational radiation exposures are ALARA. And we adopted the design policy that the design shall incorporate compliance to all the regulations and reduce the doses to plant personnel, the public and the environment, and also protect the plant equipment.

The design utilized shall also utilize the updated technology and the lessons learned from the industry and experience.

And some of the examples that we have included in the design consideration is provision to drains, flush and decontaminate before maintenance activities are performed. Try and also incorporate the water chemistry to reduce the amount of waste by using pH assessment, zinc injection. These are the latest chemistry method that we use to control it.

The design is equipped with permanent shielding, but we do encourage using portable shielding blankets and shielding blocks to reduce additional dose for the maintenance work.

The HVAC zones are separated and we make sure the workers breathe in as much clean air as possible. So, the flow of the air in the HVAC system will be from the low to high potential contamination.

As I mentioned earlier, we intentionally segregate as much as possible the radioactive systems and piping versus non-radioactive piping. And if it is not possible to separate them, like for example we need to bring in demineralized water to clean out the lines and things like that, we make sure we have double isolation. And that's to prevent cross-contamination going into the demin water system or air system and so on.

MEMBER SHACK: Have you taken any measures to minimize the use of Stellite hard facings?

MR. TSANG: Yes, and I believe we will have that discussion a little bit earlier, but I will assure you that the answer is yes.

MEMBER RYAN: Irving, it might be good to ask this question early even though you might not answer it right now, you know, we are currently at a dose limit of five - or 50 millisieverts as opposed to 20, which is the other standard that applies mostly around the country. That's two versus five rem.

Have you taken that into account - I'm not saying there is or have any insight that there might be, but, you know, at some point the question is will the US switch to the international units, one, and will it kind of adopt a worker annual limit that's closer to what the rest of the world has already done?

Have you taken that into account? And if you can point that out as you go along, that would be helpful.

MR. TSANG: Omura-san, would you like to take on that question?

(Off-record discussion.)

MR. OMURA: Our target is for US - our design policy is for US regulation. In MHI, we are designing for Europe plant, for European site. That regulation is different from US.

MEMBER RYAN: Yes.

MR. OMURA: The target is different from Europe and USA.

MR. BARLES: And I can add that the design should be able to comply with UK regulation and this was result in design modification.

MEMBER RYAN: Okay. I just wanted to make sure I understood that you're saying that there is flexibility so that if the US changed to be consistent more with European or Japanese or other international formulations for work protection at 20 millisieverts, that the design could accommodate that. Thank you very much.

MR. TSANG: I also will take this question and provide written response to you.

MEMBER RYAN: Thank you very much. That would be very helpful.

MR. TSANG: And in the whole plan, we

adopted welding through for the - especially for the process piping. And in addition, we required the welding to be butt-welded to minimize the crud traps on the piping.

And we also pipe all the vents, the high-point vents and the low-point drains directly to the local drain system by either stand pipe or drain hop. So, to minimize -

MEMBER BANERJEE: But does the plant minimize the cobalt in the system?

MR. TSANG: The answer is yes.

MEMBER BANERJEE: You have Stellite though, right?

MR. TSANG: We do, but we evaluate - we use the material if there's no other choice. And we do put in the specification that we minimize the use of such material.

But sometimes in a reactor system due to the high-temperature environment, we may not have a choice. Depends on the reliability that we have.

MEMBER BANERJEE: You do have experience with - in Japan or with this type of the radiation fields?

MR. OMURA: Yes, in Japan we also limit the cobalt content. We have experience.

MEMBER BANERJEE: And what does that show in terms of personnel doses and maintenance?

MR. TSANG: There is a reduction in dose. We reduce the cobalt content.

MEMBER BANERJEE: Do you see a reduced dose compared to other plants?

MR. TSANG: I'd like to table this question and I'll get back to you on that.

MEMBER BANERJEE: We are interested to understand the experience you have had.

MR. TSANG: We will share that experience with you. We will respond to that question.

MEMBER SHACK: So, just to follow up on that one, is there any specific cobalt limit on the stainless steel also?

I mean, you know, Stellite is the obvious source, but do you actually put additional requirements on stainless to get low cobalt?

MR. TSANG: Yes. On the material specification, we do clearly state the maximum amount of cobalt for the primary component.

MEMBER BANERJEE: A lot of it has to do with crud control as well, right?

MR. TSANG: Yes, and that's why we inject zinc is to provide smoothness and minimize corrosion on some of -

MEMBER BANERJEE: Do you have a protocol for the zinc injection?

MR. TSANG: Yes.

MEMBER BANERJEE: And what experience have you had with that? That would be interesting to know.

MR. TSANG: Okay. And I will ask that question when -

MEMBER BANERJEE: The core is very sensitive -

MR. TSANG: Yes.

MEMBER BANERJEE: -- when you pull the fuel out and then you -

MR. TSANG: Very good question. I agree with you, and I will respond to the protocol for adding zinc injection.

MEMBER BANERJEE: So, you have some protocol that you're going to advise the plant operators on things like this based on your experience?

MR. TSANG: Yes.

MEMBER ARMIJO: Getting to that point, do you have a zinc injection system as part of your design or is that something that would be added by the - in the COLA?

(Off-record discussion.)

MR. TSANG: I'd like to table this question and I will get back to you.

MEMBER SHACK: Well, the discussion certainly seems to credit zinc.

MEMBER ARMIJO: Yes. So, is it there? Is it going to be added later?

MEMBER SHACK: It somehow seems that it ought to be there.

MR. TSANG: Next slide, please. We talk about the radiation protection program. And this is a COL item, but we put it in the DCD.

Next, please. We evaluated the radiation sources in Chapter 12, and primarily it consists of a contained source and an airborne source.

For the contained source, we used the one percent failed fuel. And we take into consideration the nitrogen-16 activity, but we also take credit for the short half-life.

For the airborne source assuming the leakage, we base on the one percent failed fuel. And especially in the reactor coolant system, the spent fuel pit area and the refueling cavity water area, we assume there's a constant leakage and evaporation rate, the flow of the room, and is part of the HVAC system.

The leakage rate and the evaporation rate and the flow rate are all in the DCD and presented in the table in the DCD Chapter 12.

Sources for the shutdown, we are being a little bit more conservative. So, we assume that the maximum activity at the shutdown period based on the reactor core power level, the spent fuel and the in-core flux thimble, including the Cobalt-60 isotope.

We follow Reg Guide 1.183 for the release of fission products into the containment. And we have also three COL items.

We ask the COL applicant to identify additional sources like the test source or a calibration source for the instruments.

And as we discussed earlier, the site may have additional radioactive waste storage area like an interim radwaste storage facility. So if they do, we ask the COL applicant to identify additional sources.

For the refueling water storage auxiliary tank and the primary makeup water tank, the design provides treatment. When it comes out from the spent fuel pit, it goes through the cleanup system before it gets to be RWSAT.

We also want the COL applicant to provide continuous operating monitoring on that tank to minimize the contamination of - at the site.

So in case that happen, we could re-circulate back the water into the spent fuel pit cleanup system for further processing. This is just a precautionary measure.

We talk about the radiation facility design, design features. And again as we mentioned earlier, the primary components are designed with remote inspection, easy replacement components.

For example, the reactor coolant pump seals are in one, integrated package. So, we could extract it quickly and replace quickly. This is to reduce the stay time for the maintenance activities.

And as the question raises earlier, we do have a tight material specification for the NSSS components in terms of the amount of cobalt and other things in there in the material. We do control that.

Radioactive components are in cubicles with sufficient wall thicknesses to reduce radiation level in the surrounding area. And as I mentioned earlier, that's based on one percent failed fuel in the design in both the reactor building and the auxiliary building.

We have developed radiation zone maps to establish the control access and work. And, again, as Mr. Roach discussed earlier, the 4.21 compliance features are built into Chapter 12 and I'll discuss that later on in this area.

Shielding design for radiation protection, the reactor systems include the primary and the secondary shields and has extensive labyrinths to minimize neutron streaming.

In the shielding design, we assumed the maximum postulated radiation level. In the reactor, we provide enough shield wall such that even in the reactor building corridors we shield it to a Zone III access.

And also, the design considers the use of removable sections of shield walls when we're performing maintenance activity on equipment.

The ventilation flow, we partition different zones and the air flows from the low to high contamination area.

The containment ventilation will flow through a high-efficiency particulate air filter to remove any particulates, contaminant.

We could isolate systems in certain areas. The control room is designed to minimize uncontrolled in-leakage in the event of an accident. We do have radiation monitors on the air intakes. These monitors are safety-related items to protect the operators.

In conjunction with the process monitor, we also have area radiation monitors to take into -- to monitor the airborne activities.

These monitors are provided to make sure the worker exposure is ALARA. And this design comply with the Reg Guides, and also ANSI HPSSC which tell us where to locate the monitoring instruments.

The COL item topics, we would ask the COL applicant to identify portable instruments for airborne activities during and after an accident.

Also, we have zone maps developed for the plant. But in the surrounding area, this is the COL applicant's responsibility to add in additional zoning, if they do.

For example, if they build in an ISF, an interim storage facility, we would like the COL applicant to add that into the zone maps.

And if they want to use a mobile liquid waste management system in the near future, they are required to go through the process and do that.

The boric acid evaporator room control, we will ask the applicant to make sure that evaporator does not exceed the radiation level changing into a very high radiation area. That's very important as part of the activity.

And of course any additional Reg Guide 4.21 operating programs, maintenance programs are also part of their responsibility.

Next. And these are the ten radiation zones that we have. As I mentioned, Zone III area we provide enough shielding for limited occupancy.

(Off-record discussion.)

MR. TSANG: Dose assessment, and we look at all the maintenance activity and provide an estimate dose requirement for performing some of the routine maintenance, including special maintenance activities. These are the numbers that calculated from the analysis.

The inputs, the assumptions, the number of maintenance workers, the stay time, all these are in the table that we referenced for the corresponding activity.

MEMBER RYAN: I'm sorry. Which table is that?

MR. TSANG: For example, if you look at refueling, that would be Table 12.4-5.

MEMBER RYAN: Oh, okay. I see. All right.

MR. TSANG: Provide the assumption, the

parameters.

MEMBER RYAN: Great.

MR. TSANG: In summary, we projected the activity to be around 70 person-rem per year, which is lower than the guideline, the industry goal or target of a hundred.

MEMBER RYAN: And the 71.3, whatever you want to - just call it 70, how many people are involved in the total? Just a round number.

Is it a hundred? 200?

MR. TSANG: Do you have the tables?

MEMBER RYAN: I don't have them right at my fingertips.

MR. TSANG: And I apologize. I don't remember the exact -

MEMBER RYAN: That's okay. No problem. I'm just trying to get an individual, as well as a collective dose understanding.

MR. TSANG: Let's go to -

MEMBER RYAN: Just the total is really all I'm looking for.

CHAIR STETKAR: You'd have to -

MEMBER RYAN: Oh, we got to add them all up.

CHAIR STETKAR: You'd have to go back

through all of the tables and proportion them among the -

MEMBER RYAN: That's fine. If you want to take that as -

CHAIR STETKAR: -- individuals.

MEMBER RYAN: -- a take-away question, that would be helpful.

MR. TSANG: Okay. I will do that. But just to give you a sense of those tables here, Table 12.4-5, the number of - we have three activities listed. And reactor pressure vessel head and internal removal and installation, we have number of workers is eight.

MEMBER RYAN: Eight.

MR. TSANG: Okay. And the exposure time is 20 hours.

MEMBER RYAN: Okay.

MR. TSANG: Fuel preparation, number of workers would be two. And the exposure time will be 24 hours.

MEMBER RYAN: Okay.

CHAIR STETKAR: Irving, are those necessarily mutually exclusive? Are they to be treated as mutually-exclusive people?

In other words, you're assuming that

different people will be preparing/doing the fuel preparation versus fuel handling activities?

MR. TSANG: I cannot answer that question directly because I think this is operational -

CHAIR STETKAR: I mean, you know, we had a fuel handling crew and they - other than doing the head removal stuff, they were -

MEMBER RYAN: I would kind of treat that as a separate question because -

CHAIR STETKAR: Okay.

MEMBER RYAN: -- you know, these are work activity planning numbers -

CHAIR STETKAR: Yes.

MEMBER RYAN: -- as opposed to individuals who are doing -

CHAIR STETKAR: Well, but, I mean, if you were trying to average over a population, that is a question that is relevant.

MEMBER RYAN: Well, they're going to meet their individual and ALARA goals, but the collective dose is kind of a different metric.

MR. TSANG: I will answer that question in writing.

MEMBER RYAN: Okay. Thank you.

MR. TSANG: Next, please. Again, the

radiation protection program has been a COL applicant responsibility.

Next, please. I'd like to point out that in Chapter 12 we added a new section for Reg Guide 4.21 compliance.

And we list that the waste minimization design goal and operating goal, this is to provide objective and training for the operators to be conscious about Reg Guide 4.21 protection.

We also include a summary table, Table 12.3-8, that summarize all the design features at the system level.

And through this presentation, I confirm Mr. Roach's - that Reg Guide 4.21 is part of Chapter 12.

The Key design features, minimize waste - there are three goals, as I said earlier. Minimize waste generation and contamination, we have achieved that through providing as early leak detection system as possible for quick operator actions to minimize the waste volume generated.

If there are overflows in the tank, we would like to have that announcement right away so operator could terminate the transfer operation.

Segregate, so segregate waste so that we don't cross-contaminate and generate more waste. In the standard design, we do recycle boric acid concentrate and condensate flows to the primary makeup water tank.

The radioactive components are located inside the walls. And we have cubicle design to segregate so that in case something happen on one component, is not cross-contaminating the other components.

As I mentioned earlier, low-contaminated piping - non-contaminated piping is segregated as much as possible. And if we cannot avoid it, make sure we have double isolation devices provided.

Next, please. Minimizing unintended leakage, I heard the discussion earlier and these are the method that would go into the design.

From the radwaste standpoint, we do not have buried piping. The whole plant design, including the reactor building, the auxiliary building, we do not have buried piping.

For the outside, the yard piping, we do. Like is mentioned earlier if the discharge point is couple of miles away depending on the site condition, you may consider use buried piping. But in that case, we would consider the environment, soil chemistry and use appropriate material for the piping.

For one site which is a high-salt content, we evaluate to use - are using steel piping versus using high-density polyethylene piping, which is more corrosion resistant. So, we do adopt the use of that HDPE piping. And we do have double-wall piping. And we do have leak detection system built into alongside the piping.

MEMBER ARMIJO: In between the inner and outer wall of the pipe? If you have double wall, you have an annulus.

Do you have your leak detection in that annulus or do you have it outside the entire piping?

MR. TSANG: Is not built into the annulus. The piping are sloped and we do have collection points every few hundred feet. And we have a manhole built in, which is a six-foot diameter. And we do have level switches.

If the fluid goes in there and collect at the bottom of the manhole, it would provide a signal to one of the operator that this section of the pipe may have leaks or groundwater infiltration in any case.

CHAIR STETKAR: Irving, I'm a bit confused. Maybe you can help me on this particular discussion.

You mentioned earlier that there's no underground or buried piping in the certified design for the radioactive systems.

Does the certified design specify the use of double-wall piping for the COL applicant or is your discussion here simply an example of what could be done?

MR. TSANG: The description that I have is part of the COL FSAR description and is not in the DCD.

CHAIR STETKAR: It's the COLA?

MR. TSANG: Yes.

CHAIR STETKAR: So I, as a COLA, need to make that decision, but the DCD does not prescribe the use of double-walled piping or the design features you were just discussing; is that correct?

MR. TSANG: I'm trying to remember what we have in the DCD. And at this moment, I don't know the wording that we use.

CHAIR STETKAR: What I'm getting to is some of the discussion we had before.

Is this a - I won't use the term "COL action item." I'll use "COL information item," but it's something that the DCD specifies that the COL applicant should consider or -

MR. TSANG: Yes.

CHAIR STETKAR: Is it simply just a practice that's shown here for illustration, but the - but there's a recommendation coming from the designer versus the designer being silent and just saying it's the COL applicant's responsibility.

MR. TSANG: We have several -

CHAIR STETKAR: And I want to make sure that we understand it clearly of whether this is coming from the DCD as a - in the sense of a COL information item as a recommendation or -

MR. TSANG: Yes.

CHAIR STETKAR: -- just a simple discussion of one way that it could be accomplished.

MR. TSANG: No, is not a simple discussion, simply just discussion. We have COL action items for the COL applicant to meet Reg Guide 4.21 in general providing the design, as well as operating programs to support the design.

We do have that. I just do not remember the exact wording.

CHAIR STETKAR: Yes, I was going to say, you know, but to meet that requirement, you could do it a number of different ways.

MEMBER RYAN: Your example of the double

piping with manholes every so many hundreds of feet or whatever it might be is an interesting one, because that creates problems on its own.

Very often rain infiltration into a manhole has been blamed for the accumulation of water in a lot of these test points, when in fact it's not rain. It's groundwater coming up or leakage from the pipe.

So, in any one of these systems I think it clearly has to be tailored to the specific geohydrology of the site and meteorological conditions of the site as well.

MEMBER SHACK: But I think his switch was in the annulus. So, it's either coming through or coming out.

MEMBER RYAN: And that's where I was going is you really have to be very specific that your monitoring reflects -

CHAIR STETKAR: And that's one of the reasons why I was asking, you know. How specific is MHI, you know, what's the intention, essentially, of that second -

MEMBER RYAN: Well, the intention is pretty straightforward.

CHAIR STETKAR: Well, the intention I

understand. But the -

MEMBER RYAN: You should be able to detect leakage from inside the pipe.

CHAIR STETKAR: But how you accomplish it on a site-specific basis could be very different.

MEMBER RYAN: On a very site-specific basis, yes. And I think sometimes there is some confusion about what might be a better way to do that than others.

MR. TSANG: We certainly are open to suggestions, but this is we have developed a design in conjunction with the utilities in some cases and looking at their local site conditions.

I will make sure that we respond to that question and -

MEMBER ARMIJO: Well, it just seems if you go through the expense and difficulty of installing double-wall, high-density polyethylene piping, you take advantage of the annulus as a best location to sample for leakage whether radiation monitors or tritium or just water, because that's your best hope of catching it before it gets out.

MR. TSANG: Yes, I agree. We will look into putting in the annulus versus putting in a manhole. We will perform that evaluation and get back to you.

MEMBER BLEY: Just a question. You've told us a number of times this morning of how you've consulted with several utilities to help you decide how you want to do some aspects of the design.

Did you also refer to the EPRI utilities requirements document as well?

MR. TSANG: Yes, we do -

MEMBER BLEY: Okay.

MR. TSANG: -- evaluate how the design meets most of their requirements. I would not say that we need a hundred percent of the URD, but there are specific areas. We evaluate a design, we consider design is adequate from the URD standpoint and I will give you an example how we treat it.

As I mentioned earlier, we do have a truck bay in the design for the solid waste management system. URD would ask us to put three truck bays in, and I believe this is from the - among the waste that we generate, it may not be required to have three different truck bays.

So, we adopted one truck bay and we explained that taking exceptions to that area.

MEMBER BLEY: I'm personally pleased that you've actually gone to some utilities, too, to get their opinions beyond what's in the compendium. Go ahead.

MR. TSANG: All right. The plan also adopt the use of low-porosity concrete as the basemat. This would minimize the liquid infiltrating the concrete and leaking to the ground.

We do have - earlier I talked about epoxy coating, but low-porosity concrete is another barrier that we built in to make sure to minimize any unintended leakage.

Talk about tank cubicles are sloped and coated. Talk about the early leak detection system. And in between buildings, they may not be joined tightly.

In that case, we will provide piping sleeves, a sloped piping sleeve so any leaks would go into the building, and not outside. So, that's an added protection.

Prompt response, this is the third goal -- third principle of Reg Guide 4.21. We do have early warning and we do provide access to mitigate any incidents.

We have isolation valves and all the pipings are in - most of the piping are interconnected. So, we could do in-tank transfer if we need to. We have four holdup tanks, as I - if one tank leaks, we could quickly transfer to another tank and go in and fix the issue. To have clean water provided to flush out to clean out the piping after each transfer.

Next, that concludes my discussion on the radiation protections and now I'm talking about the summary of the confirmatory items that we have.

We have several confirmatory items in the SER. And because the timing of things, NRC have not reviewed Revision 3 of the DCD. And, therefore, these are listed as confirmatory items and we will discuss with NRC once they review Revision 3 of the DCD, to seek closure of these confirmatory items.

Next, please. We have several open items. And some of them we are responding to, some of them we are still in the review cycle.

And the first one is asking during the shutdown condition, how the CVCS process provide the necessary capacity to clean up the letdown flow of 400 gpm. And NRC pick up that the CVCS design is only handling 180 gpm.

What we did not discuss in the DCD is that the filters and ion exchangers could be aligned in two parallel trains. And each could handle half of the flow.

And with the design margins that we have, the filters are a little bit flexible. The ion exchange columns are a little bit flexible to handle more flow. So, I believe we - that's the approach that we use to explain the design.

Next item relates to adding the design features of the tank house containing the primary makeup water tank and the refueling water storage tank. And we have two primary makeup water tank, and one bigger refueling water storage tank.

They are located in a tank house next to the auxiliary building, and we incorporate Reg Guide 4.21 design features into the tank house with early leak detection system and piping sleeves between buildings.

We have responded to and included the design features on the primary makeup water storage tank earlier and has been captured in Revision 3 of the DCD.

RWSAT, however, was later than that. So, we have not included that in the current version, but we will include the design features in the next revision.

An open item on the mission doses and the mission pathways, we have included the tables in Revision 3. Because of timing of things, again this is - we are waiting for NRC's review to close this item.

The next item is the refueling cavity drain-down issue. MHI, we have responded to this question in September, and we will discuss with NRC to close this item.

Next two items deals with Reg Guide 4.21 as a result of RAI 578. And the response to 578 is currently in the final review cycle and we have not sent it to NRC yet, but will be sending to NRC very shortly.

We have discussed what we have done in terms of radiation protection in this session. I don't know whether there's any more questions.

CHAIR STETKAR: Any questions from any of the members?

(No response.)

CHAIR STETKAR: No. Well, thank you very much, and we're now suddenly well ahead of schedule. You did very, very well.

I'm assuming, let me ask the staff, there probably is not a convenient spot in your presentation to break after about 15 or 20 minutes, is there?

(Off-record discussion.)

CHAIR STETKAR: I mean, the question is do we want to break early for lunch now or how long would you estimate your presentation?

MR. HAMZEHEE: Half an hour.

MR. LaVERA: I would say 15 to 20 minutes.

CHAIR STETKAR: Okay. Let's do that then. And if we run over, we can break at, you know, for lunch at 12:15, 12:20 or something like that.

I just didn't want to get into a situation where it was an hour and a half or something like that and we -

MS. BERRIOS: He's got 13 slides.

CHAIR STETKAR: Yes, but I mean it's - this committee can spend two hours on one slide.

(Off-record discussion.)

CHAIR STETKAR: Are we ready?

MR. OTTO: Good morning again. I'm Ngola Otto. I'm the Chapter 12 project manager. And to my right is Ron LaVera. He's our reviewer for Chapter 12 and he's going to be covering the staff's review of Chapter 12 of the design certification.

We have the five sections in Chapter 12, 12.1 though five, which Ron did his review on. And we had a total of 72 questions asked, and we have currently six open items for those questions that we asked the applicants.

MR. LaVERA: Good morning. My name is Ron LaVera. I'm a certified technical reviewer in the Health Physics Branch of the Office of New Reactors.

I am a certified health physicist. I have a Bachelor's in radiological health science, and a Master's in computer engineering from Manhattan College in New York.

Following service in the Naval Nuclear Power Program, I had served for 30 years in the commercial nuclear power arena where I completed a senior reactor operator certification program.

As the applicant has stated, Chapter 12 describes the facility and equipment design features and programs which are used to meet 10 CFR 20 and 10 CFR 19, as well as Part 50, 52 and Part 70.

During the rest of this presentation, I will highlight the most significant issues covered in my review.

MEMBER BLEY: Ronald, can I interrupt you with something that's not a technical point?

We noticed for the first time this morning that I recall, hearing people introduce themselves as certified reviewers.

Is that something new or has it been in this area for a long time? Is it happening elsewhere?

MR. HAMZEHEE: Well, they're usually in the agency in NRR for many years, and then in NRO when it was formed. For technical reviewers, we have a certification program that they have to be qualified as a technical reviewer. And that's what Ron was referring to.

MEMBER BLEY: So, this has been there a long time.

MR. HAMZEHEE: Yes.

MEMBER BLEY: Nothing new.

MR. HAMZEHEE: Correct.

MEMBER BLEY: Okay.

MR. HAMZEHEE: It is an internal program.

MEMBER BLEY: Okay.

CHAIR STETKAR: We just hadn't heard it before particularly.

MEMBER BLEY: Sorry for the interruption.

MR. LaVERA: That's all right.

In Section 12.1, the staff reviewed the ALARA considerations with the applicant provided with the design process, including training of the MHI engineers on ALARA processes, lessons learned and regulatory guidance.

The use of low-cobalt alloy 690 for steam generator U-tubes, and the use of zinc injection into the reactor coolant system are examples of how the industry operating experience has been incorporated into the US-APWR design to reduce occupational radiation exposure, ORE.

In order to comply with the requirements of 10 CFR 20 and Part 19 and to maintain dose as to plant personnel ALARA, DCD COL information items require the COL applicant to conform to the operational radiation protection and ALARA regulatory guides.

And DCD Section 12.1 specified that these programs are to be designed, developed, implemented and maintained as described in Nuclear Industry Institute, NEI templates NEI 07-03A, generic DCD template guidance for radiation protection program description, and NEI 07-08A, generic FSAR template guidance for ensuring that occupational radiation exposures are as low as reasonably achievable, ALARA.

In Section 12.2 of the application, staff reviewed the applicant's description of the contained and airborne radioactivity sources that were used as inputs for the shielding and ventilation designs.

During this review, the staff request

information on source strengths for the reactor coolant systems, spent fuel, the boron recycle system and the in-core instrument system so the staff could evaluate the US-APWR shielding design and access controls.

Using the assumptions and models provided by the applicant, the staff performed calculations to verify some of the contained source activity values provided in DCD Section 12.2 tables.

And as a result of staff questions about the potential effects of concentrating activity in the water from the reactor coolant system on component dose rates, the applicant added a COL item to require a surveillance to prevent the boric acid evaporators from becoming a very high radiation area, VHRA, near the end of core life.

Any questions?

(No response.)

MR. LaVERA: Slide 6. Section 12.2 also describes airborne sources for the US-APWR design. because the staff was not able to reproduce the values listed in Section 12.2 airborne activity concentration tables, the staff asked the applicant to describe the methods and assumptions used to derive the list of values.

The staff used information provided to perform calculations that verified some of the airborne activity values provided by the applicant.

As a result of reviewing the basis of the assumptions used for these calculations, the staff asked the applicant about assumed purification system flow rates that appear to exceed the design capacity of some of the chemical and volume control system components.

The staff is working with the applicant to clarify the appropriate flow rates for the stated purification flow paths, and is tracking this as Open Item 12.02-1.

I would like to comment on one of the comments raised by the MHI presenters. It is not just the filter media and demineralizers that are the limiting components.

In the flow diagrams, you have items such as heat exchangers that all this flow has to pass through. So, when they're looking at this, they need to look at the most limiting component in that system. So, that's part of what is driving the question and I just wanted to make sure we understood that.

Slide 7.

CHAIR STETKAR: But you're currently

communicating on that?

MR. LaVERA: We're currently communicating on that.

In Section 12.3-4, the staff reviewed the radiation protection design features provided for meeting personnel exposures ALARA.

While DCD Section 12.1 notes that the use of low-cobalt materials in the provision of features to prevent buildup of radioactive materials are effective methods for reducing personnel exposures, specifications for reliable cobalt impurities and primary plant construction materials were not provided in the DCD.

Following questions by the staff, the applicant changed some of the reliable cobalt content specifications and provided information that allowed the staff to perform calculations confirming that the expected cobalt introduction rates from major system components were consistent with current industry guidance.

Any questions?

(No response.)

MR. LaVERA: During the review of component design features provided to improve reliability and reduce occupational radiation exposure, the staff noticed that some of the stated component specifications were not consistent with current operating experience-based industry recommendations that had been adopted to improve equipment reliability, reduce leakage and reduce ORE needed to maintain the equipment.

Following questions by the staff, the applicant committed to revising DCD Section 12.3 to reflect the use of contemporary industry guidance as part of the selection criteria for pump valves and other components.

The staff calculated dose rates in various areas using the source term values provided in Section 12.2 and compared the results to the radiation zones provided by the applicant.

As a result of staff questions, the applicant revised the radiation zones around some of the resin transfer lines, provided clarifications on the access controls resulting from the updated zone maps.

Also, since the use of the mobile liquid waste processing system is optional, the applicant added a COL item requiring updated radiation zone information from those COL applicants utilizing that system.

Slide 8.

MEMBER RYAN: I think you're at Slide 9.

MR. LaVERA: Excuse me?

MEMBER RYAN: Are we on 8 or 9?

MR. LaVERA: We're on 8 now.

The applicant performed a shielding analysis using one percent fuel cladding defects as a basis to determine the radiation zones to the plant and to ensure adequate shielding.

The staff performed independent shielding calculations for various areas, including spent resin storage tank, spent fuel transfer to gate valve reach rod and the boric acid evaporators.

As a result of staff questions, the applicant confirmed that to prevent personnel exposure to irradiated fuel, remote tools used in fuel pools have flood ports, and the cask loading and spent fuel inspection pits can only be drained by using temporary pumps.

In addition, the COL applicant added a COL item to monitor and control the amount of activity contained in the boric acid evaporators. And for those applicants using the mobile liquid waste processing system, the COL item to evaluate the radiation, protection design features provide for that system.

Slide 9. Water in the refueling cavity provides shielding and cooling for fuel and irradiated components in the refueling cavity.

Because some NRC documents discuss industry operating experience involving the loss of refueling cavity water inventory due to conditions other than the failure of the steel ring located between the reactor vessel and the refueling cavity and the resultant potential for high dose rates in and around the refueling cavity, the staff asked the applicant to describe the potential sources of radiation located in the refueling cavity, safe storage locations for fuel bundles outside the reactor vessel when the refueling cavity water level is at the minimum possible level, and the resultant potential dose rates.

The staff continues to work with the applicant to clarify the assumptions about the assumed leakage rate, the makeup rate, and to ascertain the minimum depth above fuel elements that can be temporarily stores in the refueling cavity.

Slide 10. During a review of the area radiation monitoring system, the staff asked the applicant to provide additional information about some areas of the plants without installed area radiation monitors, ARMs, which are subject to potentially significant changes in dose rates due to operational, transient or maintenance activities.

The applicant did note that based on the guidance referenced by the Standard Review Plan, an installed ARM is not required for areas with positive access control features such as normally locked doors or areas where radiological hazard only exists during specific work activities.

The applicant did state that the location of one ARM would be changed, and that the use of portable ARM equipment would be required in some areas like the cask handling area and the refueling platform.

In response to staff questions, the applicant stated that the methodology described in DCD Section 7.2.2.7, set point determination would be used to establish installed radiation monitor calibration integrals and set points.

Slide 11. Staff reviewed the application for compliance with 10 CFR 20.1406 which describes the - which requires the description of the design features and program elements provided to minimize contamination of the facility environment and to facilitate eventual decommissioning.

The staff asked the applicant to provide additional information about the systems that could be reasonably expected to contain radioactive material, the design features provided to minimize contamination and the types of program elements that were required of the COL applicants.

As a result, the applicant has modified DCD Section 12.3 to provide specific facility features in the US-APWR design for minimizing contamination, change other chapters of the DCD to reflect the presence of radioactive material consistent with industry operating experience and as described in DCD Chapter 11, radioactive waste management, and specify the need for COL applicants to address the programmatic aspects of Reg Guide 4.21 and NEI 08-08 guidance for life cycle minimization of contamination.

The staff is continuing to work with the applicant to resolve open items 12.03-12.04-3 and 12.03-12.04-4 involving design features for the condensate steam, the steam generator blowdown system, as well as the auxiliary steam system, and to ensure that some of the items that they have described and some RAI response are entered into the DCD.

Slide 12. In DCD Section 12.4, the

applicant documented the results of a dose assessment that projected an annual exposure of about 71 person-rem.

This assessment was based on current reactor operating experience and the US-APWR's ALARA design considerations.

As discussed in NUREG 0713, occupational radiation exposure of commercial nuclear power reactors and other facilities, Volume 27 which contains data through 2005, average collected dose for US-PWRs was 79 person-rem. And the median collected for radiation exposure for PWRs was 64 person-rem in 2005.

The staff did note that the gross megawatt-electric output of the US-APWR is nominally 1700 megawatts-electric, while the output of the current United States PWR four-loop plant is about 1186 megawatt-electric, which results in an estimated exposure of 0.044 person-rem per megawatt-electric-year for operating in a 95 percent capacity factor compared to a higher value of 0.09 person-rem per megawatt-electric-year for a standard plant.

NUREG 0737 clarification of TMI action plan requirements Task Action Plan Item 2B2, states that the whole-body dose to operators aiding in the mitigation of or recovery from an accident, including transit to and from the area, should not exceed five rem.

In section 12.4, the applicant provided a listing of plant areas requiring access by operators following an accident, and a summary of the expected integrated doses.

Based on the information provided in DCD Section 3.11, equipment qualification, the staff asked the applicant to provide additional information about expected post-accident missions and the resultant expected doses of plant personnel.

While the applicant has added additional equipment qualification-related missions and the associated projected dose as 12.4, staff continues to work with the applicant to coordinate the responses to questions originating from the staff's review of Section 3.11 and the information provided in Section 12.4.

This is being tracked as Open Item 12.03-12.04-1.

Any questions?

(No response.)

MR. LaVERA: Finally, Section 12.5 of the application addresses the required elements of the operational -

MEMBER BROWN: I'll ask a question.

MR. LaVERA: Sure.

MEMBER BROWN: It's probably an ignorant question, but I'm going to ask it anyway.

0.7103 person-Sievert annual cumulative dose, I guess I'm trying to go back to my calibrations that I've gotten based on recent events. What is it? Ten millisieverts per rem or something like that?

MR. LaVERA: It's a factor of a hundred between the two.

MEMBER BROWN: Okay. So, if I look at this, what is that? That's 71 rem for the whole - is that what you mean by the annual cumulative dose -

MR. LaVERA: Yes.

MEMBER BROWN: -- for the whole facility on an annual basis? All the people?

MR. LaVERA: Yes.

MEMBER BROWN: All the workers. Okay. All right.

Is that a pretty standard number used? I mean, that's a fairly large number.

MR. LaVERA: If you look at the comparison that was described -

CHAIR STETKAR: You're in the same range of something like 65 to 75, let's say, right?

MEMBER BROWN: For a typical operator.

MR. LaVERA: It varies.

MEMBER RAY: He's trying to normalize it based on electrical output also.

MR. LaVERA: Let me go back and read this section that I did. I was going through this pretty quick.

Okay. There's a NUREG, NUREG 0713. And that's the annual compilation of exposures from power plants of all types across the United States. And it breaks it down as light water reactors, and then it sub-breaks it down with oily water reactors, and sub-breaks it down with pressurized water reactors, and they provide these statistics of various methods.

They give you the average. They give you the median. So, there's a lot of information in that document.

For the year that was compared, the average estimate was 79 rem from -

MEMBER BROWN: Across the fleet?

MR. LaVERA: Across a pressurized water fleet.

MEMBER BROWN: Okay.

MR. LaVERA: The estimate for the US-APWR is 71 person-rem.

MR. HAMZEHEE: Per plant.

MR. LaVERA: Per plant. Now, the discussion about the megawatt-electric-year comes into play because as you increase the electrical capacity of the plant while maintaining the plant design essentially the same, you are essentially allowing the workers to receive less exposure per unit of electricity delivered. So, that's why you go into that discussion.

And not only is the plant performing estimated performance better than what the average PWR plant for 2005 was, when you factor into account the increase in electrical generation that you get because of some changes they've made to the plant structures, that ratio is even more favorable.

MEMBER RYAN: I think the point is, you know, if you improve the efficiency of the plant, you spend less dose per unit per watt put on the grid.

MR. LaVERA: There you go.

MEMBER RYAN: It's real simple. But, you know, how many rem you get is independent of the number of watts you're putting out on a grid within a certain -

MEMBER SHACK: But you had a number for the median, too, right? 64?

MR. LaVERA: Yes, there was a 64 person-rem.

MEMBER SHACK: Well, then if 64 is the median and 79 is the average, there's some guys out there -

CHAIR STETKAR: It's not a normal distribution.

MEMBER RAY: You got some big maintenance job.

MEMBER SHACK: Yes, I was going to say, you know, the 79 skews it. And then if you're looking at some big maintenance jobs in there, you know, the 64 might be the more - the number that you - but, again, these are also projected doses and they typically tend to be kind of conservative. So, I'm not sure what I -

MEMBER RAY: It's reasonable.

MEMBER SHACK: It's reasonable, yes.

MEMBER RAY: It's comfortable, you know, there's a comfort that you're in the ballpark.

CHAIR STETKAR: It's a metric that's not all that useful, actually.

MEMBER RYAN: Yes, I mean, as you said earlier, the question is -

MEMBER SHACK: If I keep the cobalt down

and I add zinc, I'm making things better.

MR. LaVERA: That's a real big part of it, yes.

In Section 12.5, we talked about the required programs for - that the COL applicant has to do. In Section 12.5, they provided a list of program features that are going to be required of the applicant.

In Section 12.1 of the DCD, they said that they would require the use of NEI 07-03A and NEI 07-08A, the radiation protection and ALARA program templates. Those templates which are approved by the NRC, have been reviewed by the NRC, contain all those Reg Guide program elements that they're required to have.

And that concludes my presentation.

Are there any questions?

CHAIR STETKAR: Any questions among the members?

(No response.)

CHAIR STETKAR: Excellent job. This is amazing. Thank you.

Now, just one little administrative thing here before we break for lunch. For those of you who haven't sat in on these subcommittee meetings, what we've kind of gotten into a habit of doing is we're keeping a list of questions that come up.

For those of you who have sat in on other subcommittees, we're not treating these as formally as in terms of action items. This is more for me because I can't remember things from one day to the next and I want to make sure that we keep track of questions that come up that are of interest to the subcommittee.

So, first, let me go around the table because this afternoon we're going to be talking about gas-driven generators. So, I'd like to close out anything to do with the waste management systems or the radiation protection this morning so we don't have that lingering over our head.

I'll just go around the table and ask each of the members if you have any additional comments or questions on either of the topics we had this morning.

MEMBER BANERJEE: Nothing more.

CHAIR STETKAR: Okay.

MEMBER BROWN: We talked about the double-walled pipe enough. I think that's understood.

CHAIR STETKAR: Okay. Sam.

MEMBER ARMIJO: No.

CHAIR STETKAR: Dennis.

MEMBER BLEY: None from me. Thank you.

CHAIR STETKAR: Mike.

MEMBER RYAN: Nothing additional. Thank you.

CHAIR STETKAR: Bill? Charlie? Joy?

Okay. I have seven things that I jotted down here and just make sure - I don't want to be too formal about it. Just make sure that I've captured items. And if I have too many here, tell me that I can cross them off or if I miss something.

Regarding the waste processing systems, there is a question about the cited volumes of spent resin disposal in terms of number of containers per year. There was some operating experience cited and was that consistent with the plant's design for the APWR where you don't have radwaste evaporators.

A question about the piping connections from the pressurizer and reactor vessel head vent lines, how that ties into the gaseous waste system and in particular with relevance to gassing operations for shutdown.

And a question about the sampling data management program, is the way I've characterized it here in terms of how do you handle online sampling, manual grab sampling and how is that processed into kind of a decision management?

MEMBER RYAN: Yes.

CHAIR STETKAR: Did I capture that, Mike?

MEMBER RYAN: Yes, you did.

CHAIR STETKAR: Because I was writing pretty quickly here.

MEMBER RYAN: That's fine.

CHAIR STETKAR: Okay. And as far as the second area, I have four, and this is an area where I probably don't even speak the language well enough.

Do features of the design, the certified design, support possible future revisions of US dose -- standards for worker doses that would be more consistent with international standards?

In other words, is there anything that you've put into the design specifically for the US that might have to be revised if, for example, the US revised their standards?

MEMBER BLEY: Is that open? I thought they had addressed that one.

MEMBER RYAN: I think they were going to come back with some additional -

CHAIR STETKAR: If MHI wants to respond or if they want to wait -

MEMBER RYAN: I thought that was the case.

MR. TSANG: We will respond in writing.

CHAIR STETKAR: Okay.

MEMBER RYAN: I thought that was the case, yes.

CHAIR STETKAR: Okay.

MEMBER RYAN: That's good.

CHAIR STETKAR: A question about zinc injection. Number one, just a physical question. Is zinc injection part of the certified design?

And then I think there was a peripheral question about regardless of whether it's part of the certified design, what's been the operating experience with zinc injection for reducing doses?

Is that right or -

MEMBER ARMIJO: Well, in the case particularly in the PWR.

CHAIR STETKAR: For PWR it's obvious that we don't --

MEMBER ARMIJO: We have a lot of information on the Bs where it's been used a lot. I don't know how effective it is in the Ps.

CHAIR STETKAR: Okay.

MEMBER ARMIJO: That's just an information item.

CHAIR STETKAR: Yes. As I said, these are more things that come up that -- I don't want to try to make these too formal. That's the concern here.

A question about this 71 person-rem. And I'll round off to that. How is that distributed in terms of actual individual -- average individual dose?

In other words, how many people is that actually apportioned to in the plant rather just a collective plant level dose estimate as it's presented?

And then the question that did come up about the double-wall piping, and that's more of a question, the way I have it here, is what is the interface between the DCD and COL information items or however they're characterized, in terms of the specificity of any design information?

In other words, is it really as specific as requiring double-walled pipe with sloping or is it just simply the COLA - the COL applicant needs to comply with generic, you know, regulations and it's left up to them? So, it's an understanding of that handoff.

Did I miss anything?

MS. BERRIOS: I think you said something about fuel preparation versus fuel handling.

CHAIR STETKAR: That more gets into, I think, it's how you allocate the collective plant level dose among individuals.

My example was, you know, there was a line item that said - I don't remember - two people are doing X and four people are doing Y. The plant that I worked at, there were four people who did both of that, you know, four individuals who did both of that.

So, that would come out in how they've allocated the collective among the individuals.

MS. BERRIOS: And the other thing, did you include cobalt in the zinc injection? Banerjee was asking about the limitation of cobalt.

MEMBER BANERJEE: I did not.

(Off-record discussion.)

MR. KUMAKI: Excuse me. I have a question.

CHAIR STETKAR: You need to come up to a microphone and identify yourself so that we have you on the record.

MR. KUMAKI: My name is - my name is Atsushi Kumaki from Mitsubishi Heavy Industries. And I have a question - I'm sorry. I need a clarification for your question, too, regarding the venting from reactor coolant system.

You talk about the venting from pressurizer and also reactor vessel. I think that is a stage for the maintenance because if we feel the inventory of reactor coolant system by the water, the vent gas will come from the inventory.

Are you talking about that?

CHAIR STETKAR: I'm talking about the degassing operation that you typically go through prior to shutdown, you know, when you actually degas before you open the reactor vessel head.

MR. KUMAKI: I'm sorry. You mean about the scavenging operation - when we fill the inventory by water, that water include some oxygen or some -

CHAIR STETKAR: There's two parts of it. When you initially shut down, you tend to go through what we used to call a degassing operation. And that's to bring out any dissolved gases in the primary coolant.

MR. KUMAKI: In the PWR, hydrogen is included in the coolant.

CHAIR STETKAR: Yes, but we still had dissolved gas - this was to reduce the doses when you remove the head.

So, we used to go through a degassing operation where you would basically vent the primary system, remove the gases from the primary system - I don't want to be too specific.

The question is removing to where?

Because in my plant, it wasn't designed very well to do that.

But part of your analysis of the gaseous waste system tank failure says that you account for the inventory of noble gas 24 hours after reactor shutdown as a result of this degassing operation. I mean, that seems to be the limiting basis for your gaseous waste tank failure analysis.

And my question was, well, that's fine as long as you're indeed putting that vented gas into your gaseous waste system.

So, the question is, is it piped up?

Because in the plant where I worked, it wasn't, you know. It was released via a completely different pathway in kind of an ad hoc measure.

And then, you know, you go through a similar operation, but with much less dose implications, when you prepare to actually heat up again. And that's more trying to get oxygen out of the, you know, the system before you heat up, but the real key is the degassing coming down, you know, in preparation for the outage.

And the question is, is it piped into the gaseous waste system and where? I mean, it's really a -

MEMBER BLEY: Is that a design feature?

CHAIR STETKAR: It's a feature of the plant design.

MR. KUMAKI: I understand. So, we intend to answer to explain about the degassing process after plant shutdown.

And also I would like to explain about the degassing from - degassing before the plant startup.

CHAIR STETKAR: That's interesting. But from a dose perspective, I mean, if you have the capability to handle the gas slowing down, the same pipes will handle the gas coming back up.

And from a dose perspective coming back up, it's really not as much of an issue at all. It's that going into the outage where you, you know, the concerns that we're dealing with here in terms of potential releases -

MR. KUMAKI: I understand your question clearly. Thank you very much.

(Off-record discussion.)

CHAIR STETKAR: Anything else?

(No response.)

CHAIR STETKAR: Good. Well, with that we will recess for lunch and reconvene at 1:15.

(Whereupon, the proceedings went off the record at 12:11 p.m. for a lunch recess and went back on the record at 1:12 p.m.)

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

1:12 p.m.

CHAIR STETKAR: Okay. We're back in session. And in the sense of continuity with presentations of subcommittee meetings, we're going to talk this afternoon about something that's completely different than what we heard about this morning.

The reason that we're hearing about this is that because of problems with getting material distributed in a timely manner for the last subcommittee meeting that we had where this topic would have actually been somewhat more pertinent, we had to delay it.

So, this was an opportunity to pick up on it. And there's a reasonable amount of interest among the subcommittee members on the subject.

And I guess first we're going to hear from the staff on interim staff guidance regarding how you folks are thinking about reviewing gas turbine generators.

And with that, take it away.

MR. OTTO: Thank you, John.

Good afternoon. Again, I'm Ngola Otto. I'm the project manager for Chapter 8, and we've been working on reviewing the gas turbine generator as we did for our review on Chapter 8 and part of Chapter 9.

And we do have this interim staff guidance which has been published recently and that is --

Ryan Eul, he's part of the Balance of Plant Branch. He's going to do our presentation on the ISG-21 and give us kind of a history of how it came about and where we are today.

CHAIR STETKAR: Before we get started on the ISG, are there - we've noted in various areas that ISGs seem to be taking on a rather permanent life of their own.

Are regulatory guides or is a regulatory guide being developed for gas turbine generators?

MR. EUL: I can kind of address that. And in the presentation, hopefully, I'll cover that.

CHAIR STETKAR: Thank you.

MR. HAMZEHEE: Can I just add one more thing to just similar question, because you're going to have different presentations in the future and you may get similar question.

There are a number of ISGs that NRO is generating because of the immediate need. However, our plan is to hopefully soon put all these ISGs into our revised reg guide and SRPs. So, this is our long-term plan.

CHAIR STETKAR: That's good. My only question is what long term?

Because in other topic areas, you know, we've seen several revisions of ISGs come forth and have been carried through for -

MEMBER BLEY: Quite a few years.

CHAIR STETKAR: Quite a few, yes. Thanks. I was going to say at least as long as I've been on the Committee. And it's always, well, you know, eventually we'll - they'll evolve into regulatory guidance. And at some point, you know, we need to get a sense of permanence. Thank you.

MR. EUL: Okay. As Ngola said, good afternoon. My name is Ryan Eul. I work in NRO in the Balance of Plant Branch, and I'm going to talk to you a little bit about what's in the Interim Staff Guidance-21, which is on gas turbine generators, and how it kind of came about.

So, the first slide here talks about the background. And as we all know, the emergency diesel generators are most common as far as the standby emergency AC power on the existing reactors.

And as you also all know, MHI's US-APWR design incorporates gas turbine generators as the emergency AC power source.

And much of the current guidance is diesel generator-specific, but new reactor applications can use other forms of standby AC power as long as they meet the regulations.

So, the staff developed the Interim Staff Guidance for gas turbine generators in parallel with the US-APWR review.

So, to give you a little bit of a timeline, we had the RAIs when we got the review for Mitsubishi's design and noticed that they wanted to use gas turbine generators.

We developed RAIs, Requests for Additional Information, on areas that we felt needed obviously a little bit more information and clarification to meet the regulations.

And we used a lot of the diesel generator guidance to do that. And we looked at a lot of the standards used in the diesel generator guidance and kind of developed - saw which of the guidance pertained like for like, and what needed to be modified slightly based on the fact that the gas turbine is a little bit of a different type of machine.

So, we outlined the differences between

the machines, how they work and what needed to be addressed.

And as we did that, we said future reviewers could benefit from all these lessons learned as we go through this painful process of asking these RAIs. So, why don't we in parallel, generate this guidance in parallel - basically, in parallel with those RAIs. So, that's what we did.

And the reason we use the Interim Staff Guidance, I think, as Hossein said, was the fact that it is a little bit more expeditious as far as the expediency of getting it out. And we do have a larger review in process - a larger task in process to review all of the SRPs. And that is already on a technical reviewer's plate right now.

So, we're reviewing all of the current SRPs to see what needs to be updated. And that larger effort should be within, I think, in the next year or so to give you kind of a timeline, because we've all had our specific topics on that. So, this will roll in, as you'll see here in a little bit.

In addition, we talk about research, you know, the regulatory guide aspects and the updates for that for the next revision. And all this information has obviously been communicated with them so that it can be incorporated to the pertinent regulatory guides.

Next slide. So, to give you an idea of what the current guidance we looked at and which ones will be modified in the future, we have the Standard Review Plan sections here which I'll - and we'll go through the titles here on the next page, but there's basically six sections we have.

And also for the regulatory guide space, we have Regulatory Guide 1.9 which deals with the application and testing of the safety-related diesel generators in nuclear power plants.

The key that I wanted to make note of, and we had to make note of this for the Congressional Review Act that's now in place for all the ISGs, is basically that it doesn't change any existing regulatory guidance.

So, we didn't go into Reg Guide 1.9 or the NUREG-0800 series and change, line out and revise any of the diesel generator guidance currently in place.

What we did is we just supplemented the current guidance and added paragraphs and information for the gas turbine generators separately. So, it's kind of a companion document to the existing guidance.

Next slide, please. So, here's the

contents of the ISG. Kind of a big overview. It has basically a cover sheet, an introduction, and then it has these attached eight articles.

And the introduction and the first article basically discusses the differences between the diesel generators and the gas turbine generators as evaluated by the technical staff. It's only a couple pages, a few pages long. And I think it's a good overview for those who are interested in just kind of the background and what are some of the safety-significant differences that we identified.

And then Article 2 through 8 is specifically - you see in parentheses next to each section what -- the regulatory guide or the Standard Review Plan that they pertain to.

And we broke it up this way, you'll see that note at the bottom, so that in the future when we do the Regulatory Guide revision or the SRP update, it's very easy to incorporate our changes.

So, in other words, when SRP 9.5.4, which is the fuel oil storage and transfer system, gets updated next, you can go strictly to Article 4 and that information, the ISG in Article 4, is specifically the SRP language that would need to be updated for that particular chapter.

MEMBER BLEY: Let me ask you a question because -

MR. EUL: Sure.

MEMBER BLEY: -- I might have missed something I was supposed to have seen. I don't think I saw the complete ISG. Just some short introduction to it.

MS. BERRIOS: I sent it later.

MEMBER BLEY: Oh, somehow I missed it.

MR. EUL: It's about this big.

MEMBER BLEY: Yes, I don't have it. Let me ask you a question about it though.

In Article 2 or 3, does it talk through - include testing of the output breakers and load sequencing and actual loading of the diesel?

MR. EUL: The actual loading?

MEMBER BLEY: Yes.

MR. EUL: Yes, it does.

MEMBER BLEY: Including a load sequencing test?

MR. EUL: It is almost identical to the diesel generator regulatory guide. There are a lot of sections where obviously the word "diesel" is replaced with "gas turbine," that kind of thing, and then there's a few additional paragraphs.

One of the things we added would be the spurious actuation concerns.

MEMBER BLEY: Okay.

MR. EUL: There's a paragraph on that to account for that. So, we've added some of the lessons learned we've had from other committee meetings.

But for the most part, everything that's in the Reg Guide for the diesels is -

MEMBER BLEY: Is there, okay. Good. I'll try to find it and look at it before we meet again.

MR. EUL: You can go to the next slide.

I just put some examples of the standards that we used. We used ISO standards that are in ISG-21. Pretty much all the ones we're used to.

We have ASME and IEEE. And we obviously extrapolated some of the diesel generator IEEE standards to show what applied. And we went, you know, standard by standard in the ISG and clarified if there was any nuances for gas turbines on the standard that we would accept. And, again, this goes back to the RAIs we generated and the conclusions we came to on those.

So, to get into this, obviously we go into the ISG and we're doing the RAIs separately in communication with MHI as we did the RAI and the RAI responses and then writing the SERs.

We put the ISG up for public comment. Total of 30 comments were received. We incorporated most of them. And I can go through them if you'd like, but I just really want to talk more about the exceptions that we didn't incorporate.

And I have them here. And most of these were from MHI. And I'll just kind of give you a brief overview. The first one being the applicability of some of the standards that we endorsed in the ISG.

There were some that MHI felt that did not pertain to their particular design, and they wanted them either removed -- removed from the ISG.

And our position was that we rejected that because, again, this is all guidance. So, having a standard in there means that's one way to meet it. It doesn't mean you have to use that standard.

And MHI came in with some other exceptions to some standards and some other reasons for their particular design and the way they utilize their gas turbine generators, and we found that to be okay through the RAI process, but we didn't want to remove it from the ISG. And so that was the - those were the comments on that.

And then the freeze and ice protection was a similar concern. We had asked them questions about how they were going to basically on their air intakes, how they were going to prevent freezing and air flow restrictions for the gas turbine generators.

We have some specific guidance on how to do that in the ISG to meet that one way. And they were using a different design. And, again, we went back to this is just guidance, this is one way to meet it, we're not going to remove the language, we've already accepted your design on this based on the RAI responses, as you'll see as a theme.

Vibration was a similar concern. This was with the instrumentation. This dealt with a vibration mount being an acceptable means, which is the same for the diesel generator as a way to, you know, if you don't have a floor that's not susceptible to vibration, you can install vibration mount for your instrumentation and controls.

They wanted that language removed as being one way to meet the guidance. And, again, we pushed back.

Again, this dealt with their - mostly their design and some of the things/features that they have.

And the last one that was the exception

was the air receiver capacity for successive starts which requires fives, and MHI's design is three. And so, they were concerned about that.

Again, five is one way to meet the guidance and they - their design, like I said, has a capacity for three starts and they have shown why that's acceptable and okay. And we -

MEMBER BROWN: What do you mean by a capacity for three starts? A gas turbine, you should be able to start it and stop it and start it and stop it and start it and -

MR. EUL: It's the starting air receiver for the initial start to get the -

MEMBER BROWN: Like a -

CHAIR STETKAR: You don't have anything to roll it over.

MEMBER BROWN: Yes, I know. I understand that point.

MR. EUL: That's what it is. In fact, you'll see it in their testing. You'll see the air cylinders they have, but all current plant designs have -

MEMBER BROWN: Well, diesels have the same --

MR. EUL: Right.

MEMBER BROWN: Same issue, okay.

MR. EUL: And the guidance for the diesels is five, and we just - we thought that was sufficient. So, we stuck with that value in our guidance for the gas turbines.

In MHI's design, they build their capacity, and I think they'll talk about that in their presentation if you want to wait or -

MEMBER BROWN: I can wait, I guess.

MR. EUL: And that was actually - I know just to give you another big overview, the SER for Chapter 8 was presented and reviewed in like November of this year, of this past year.

And the Chapter 9 subsystems are delivered, but have not been to ACRS yet. That's correct, right?

CHAIR STETKAR: Well, but the air start system is usually lumped with the - it's usually not covered in 9, is it? I don't remember the -

MR. EUL: Well, if you look at -

CHAIR STETKAR: Doesn't make any difference.

MR. EUL: Yes, the SRP for 956 is the start system.

CHAIR STETKAR: Oh, is it really?

MR. HAMZEHEE: John, also I just want to emphasize that we are not ready to discuss the staff's review of the GTG.

CHAIR STETKAR: I absolutely understand. This is basically for our information about -

MR. HAMZEHEE: Correct.

CHAIR STETKAR: -- how the reg guides for diesels are being adapted for eventual review of the gas turbine, which is ongoing.

MR. HAMZEHEE: Yes, right.

MR. EUL: I'm sorry. Did I answer your question?

MEMBER BROWN: Yes, you answered my question.

CHAIR STETKAR: When they complete their review, we can then ask them why three is good enough or why five is required for a diesel, but that's not a fair question to ask them today.

MEMBER BROWN: Well, I guess my next question after that, if they want to anticipate what it would be, would be what's the time frame to recharge the air start system? And from where do you get it? And does it require electric power and blah, blah, blah? A few things like that.

MR. EUL: Exactly.

MEMBER BROWN: All right.

MR. EUL: And I will tell you that I know the reviewer who has reviewed the air start. And just to give you a little overview because of the four-train redundancies that they have and the five to three, that's part of the review as far as the acceptability of having the four 50 percent diesels as compared to two.

But I'll let that review process and I will feed back that question to the tech reviewer, but I have -

MEMBER BROWN: You're attributing a memory bank that is already losing locator bits to -

MR. EUL: I understand. I understand. There will be -

MEMBER BROWN: -- whichever one it is.

MR. EUL: I'm sure MHI has heard the question as well. So, they will be ready to address it.

Okay. All right. So, please go back to the - and the last thing I want to talk about that came up, it really wasn't something we took exception with. As a matter of fact, we worked with the public comment from MHI on the startup testing.

But we - the diesel generator guidance

from the IEEE standard talks about a hundred consecutive starts with, you know, a minimal number of failures. I think it's about one.

And basically we looked at that language and we talked with our PRA folks about where that number comes from. And we looked at what we have for Station Blackout Rule, which is the 95 percent confidence - 95 percent reliability with 95 percent confidence, which is kind of the language we have from Station Blackout.

We decided to use that language, which is a little bit clear, and let an applicant show us, prove to us that their design meets 95 percent reliability with 95 percent confidence level.

So, that's the guidance we used in the startup testing for the gas turbine generators. We took an opportunity to be a little bit clear from an older standard. And since, Station Blackout Rule has now been put into effect with a lot of the PRA modeling we have to use that particular language in the guidance.

MEMBER BROWN: So, you're using - I want to get this phrase right. A 95 percent confidence level relative to the ability to complete the 100 percent - or 100 starts with - whatever the number is.

MR. EUL: Well, it works out that from the PRA, that obviously to get a 95 percent confidence level for 95 percent reliability, you need a certain number of starts.

MEMBER BROWN: Okay.

MR. EUL: So, in this case it turns out to be about - but they ended up doing 150 tests and they had zero failures, but they could have actually had a failure.

MEMBER BROWN: Well, I thought it said "two" in there somewhere. So, keep going. That's irrelevant for this part.

MR. EUL: Okay. It was basically the numbers we looked at with our PRA trying to figure out where the history of that standard might have come from.

And so when it looked at it, a lot of it talked about - the diesel generator guidance talked about because diesel generators have been around for a long time and we know how they work and we have a lot of data, this is sufficient, a hundred starts.

And so we looked at that and said, well, this is a new component. I think the Station Blackout 95 percent/95 percent should be a little bit - that should be the standard we hold it to and have the applicants show that they can meet that.

And that's kind of the language we use and they obviously understood that, and that's what they showed in their testing.

And the other thing we talked about was if the ambient temperature, ambient conditions affect the components when starting, then the test should account for these temperature conditions in a most conservative way.

And that goes into the fact that the gas turbine generators don't have a keep-warm system. And we wanted to make sure that that was okay that these cold start/hot starts weren't an issue and one wasn't more conservative than another. And, again, their test results will show that.

CHAIR STETKAR: You're still reviewing that.

MR. EUL: Right.

CHAIR STETKAR: There's quite a bit of discussion there -

MR. EUL: Right. There is. Absolutely.

CHAIR STETKAR: -- in terms of temperature.

MR. EUL: But we wanted to leave it open enough so that we had the ability to review and look at how they're justifying it's going to meet these conditions.

MEMBER BROWN: So, you haven't established the final guidance yet.

MR. EUL: Well, this is the guidance. I mean, this is the guidance. The question will be when an applicant comes in and says we meet 95 percent/95 percent, we're going to have to make sure that obviously that they do.

And then whether or not they have enough proof to show that the ambient temperature conditions don't affect or don't have any affect on the -

MEMBER BROWN: Okay.

CHAIR STETKAR: They have to come in with a convincing argument showing the parameters of their test program and make sure that it, you know, satisfies the -

MR. EUL: And that's when, you know, we'll review that with our test data. And then obviously that will be presented to you in terms of our safety evaluation and how we came to those conclusions whether their test data was sufficient enough on an individual case-by-case basis and whether it was robust enough and why we thought so.

MEMBER BROWN: Well, I asked the question for one reason. I mean, I just finished going through a test on the diesels for one of the Navy projects.

MR. EUL: Okay.

MEMBER BROWN: Two reactors and reactors shut down at sea is a real station blackout because you can't restart them without the diesels. And I think we ran 500 - did an endurance run where we did 570 starts, and it wasn't allowed not to start on any of them. Otherwise, they had to repeat the whole test again. One section on the phone.

So, station blackout is kind of important on a naval vessel.

MR. EUL: Absolutely.

MEMBER BROWN: If you lose reactors, there's just no way to get started back up. So, that's my thought process. You don't want to tow the carrier back in. That's not a good idea.

MR. EUL: Yes, I was an officer on a carrier. So, I -

MEMBER BROWN: Oh, okay. So, you're familiar.

MR. EUL: Oh, yes.

MEMBER BROWN: A nuclear carrier?

MR. EUL: Yes.

MEMBER BROWN: Okay. Lot of fun.

MR. EUL: Oh, yes.

MEMBER BROWN: All right. I'm sorry.

MR. EUL: No, I'm glad you asked the question. It's something that, again, with the way we wrote the language in here, we wanted to make sure it was broad enough so we covered it.

We didn't want to put ourselves in a corner where we didn't think of everything. So, this gives us the ability to take every - as they present their test data, to give us the opportunity to look at it and make sure it's robust enough.

Okay. And the last is this conclusion slide. I just want to kind of go over the broad things again. We know that MHI, the APWR uses the gas turbine generators.

We use the RAI process in reviewing and reaching a safety evaluations from MHI design, not the ISG.

But the ISG was developed in parallel as the RAIs were developed to provide the regulatory guidance so we could use the lessons learned through the RAI process that we learned for future applications.

And, again, this is guidance. It's not a rule. So, applicants can still come in and take exceptions to the guidance as long as they show that they meet the regulations on a case-by-case basis.

CHAIR STETKAR: But in terms of, you know, recognizing the fact that you haven't completed your review yet, but there's nothing that MHI has done since this has sort of evolved in parallel. You're not at odds with anything that MHI -

MR. EUL: We're not at odds with anything. I would say that the Chapter 8 has been presented and the tests come after. So, that's still an opportunity for the electrical folks to look at this and come back with some issues.

And all the support systems, like I said, were delivered. The SERs were delivered prior to doing this testing.

I think were just a couple open items which had path to closure, which we'll see when Chapter 9 presents their safety evaluations to you.

CHAIR STETKAR: Any other questions?

MEMBER BROWN: I'm just trying to remember when you brought up the last time we were going to cover gas turbines and we didn't -

CHAIR STETKAR: Where we are in the evolution of this -

MEMBER BROWN: Well, I was in a meeting two years ago where they -

CHAIR STETKAR: Right. We had a preliminary presentation. It was an information briefing -

MEMBER BROWN: Yes.

CHAIR STETKAR: -- on the gas turbines. And what was available at that time was, I think, the initial revision - Rev 0 of the qualification test program.

MEMBER BROWN: Yes.

CHAIR STETKAR: So, we had a briefing on that. What's happened since is that the qualification test program is up to Revision 2. So, they've done a few changes on the program document.

They've done the testing. At least the start testing and some of the load testing.

MEMBER BROWN: Right.

CHAIR STETKAR: And in parallel, the staff has developed the Interim Staff Guidance that they're going to use as a basis for, you know, writing their review of the qualifications program and the testing results and things like that.

So, this is - this, again, is a briefing of sort of, you know, after almost two years -

MEMBER BROWN: Yes.

CHAIR STETKAR: -- a snapshot of where we are in gas turbine space.

MR. EUL: And I think you'll see a lot of similarities when you look at the diesel generator guidance.

CHAIR STETKAR: Yes, and a chance for us as a subcommittee, to possibly give feedback either to the staff on - if there's anything that we noticed on the ISG that seemed to be contrary to, you know, what we might have as an opinion or any feedback we might be able to give to MHI before we finally have the SER from the staff.

MEMBER BROWN: Okay. That was my other question. We really haven't seen an SER.

CHAIR STETKAR: We have not seen an SER on the gas turbines.

MEMBER BROWN: Okay.

CHAIR STETKAR: These are strictly information briefings to us. A chance for us to raise questions as this process evolves.

MR. CIOCCO: If I could add, back in November we presented Chapter 8 which is the electric power. And this was a very specific open item. So, you saw the staff, where we were as far as our review in Phase 3. We're doing a Phase 4 review looking at the results.

MEMBER BROWN: That was six months ago.

MR. CIOCCO: Yes. Then we'll be back, we'll be scheduling with Ilka the Phase 5 for Chapter 8.

MEMBER BROWN: Okay. Thank you.

CHAIR STETKAR: With that, anything more for the staff on the ISG?

MEMBER ARMIJO: I had a quick question on the fuel.

CHAIR STETKAR: Sure.

MEMBER ARMIJO: Is the only fuel that's practical or acceptable, fuel oil, not other things like natural gas and stuff like that?

Is that something you need to -

MR. EUL: Yes, we actually - as a staff, we decided that the fuel oil would only be the diesel fuel for the review for this Interim Staff Guidance, because that was what we specifically had the time to look at for the RAIs because that was what MHI presented to us.

Although, gas turbines can use a wide variety, as we all know.

CHAIR STETKAR: That's an important point.

This ISG is - maybe you should tell us, Ryan, but it does have some caveats about its limitation.

One is the fuel type.

MR. EUL: Right.

CHAIR STETKAR: And there are a couple of others that I can't remember quite well. So, perhaps you could -

MR. EUL: Well, fuel oil is the biggest one. I'm trying to -

CHAIR STETKAR: I think it's air cooled, and I'm not sure whether the starting -

MR. EUL: Yes, air cooled.

CHAIR STETKAR: So, it's not a water cooled.

MR. EUL: Air cooled, right. The start is pretty standard. So, I don't think we did anything unique there.

CHAIR STETKAR: Is it restricted to only air start or could this apply to battery start systems?

MR. EUL: I'm not -

CHAIR STETKAR: I remember the air cooled and I remember the fuel restrictions.

MR. EUL: I'd like to say I'd like to commit that the air start is the only. Air-cooled for sure, and also the diesel. And, again, we outline that in the introduction is that a fuel oil in accordance with the American Society for Testing Materials Standard specification for diesel fuels.

CHAIR STETKAR: The only message there is that with those restrictions if I come in with a gas-fired, externally, water-cooled, battery start gas turbine generator -

MEMBER ARMIJO: You've got a problem.

(Simultaneous speaking.)

MR. EUL: The way this came about was specifically because we had - we were doing the research as every RAI we wanted to generate and looking at the current standards and figuring out how to incorporate those and we said why let someone else have to do this down the road. So, that's why the limitations are there.

So, that's a good point. I'm glad that was brought up.

MEMBER BROWN: One other thing that I didn't when I plod through was that gas turbines are notoriously fuel efficient over a range of loads. I mean, their prime efficiency is at high - is a high load. And once you start reducing the load, it goes down very rapidly.

And I guess what I was looking for or

going to be looking for is from a guidance standpoint, is how do you pick the low point at which they do their fuel oil capacity for meeting endurance for, you know, whether you want it to run for 30 days or for one day or 24, whatever the times are.

Because if they pick that time - if a time is picked at a full load capability, then your capacity is one thing. If you do it at a low load, half load or quarter load, then it could turn out to be something else like you might need more.

MR. EUL: Your concern is that we're using the most limiting case for -

MEMBER BROWN: Yes, somewhere there's got to be an analysis of the casualty situation. The most limiting casualty situation where the loads are at the worst possible point - I'm just saying this from a guidance standpoint, not from a rule standpoint, a requirement - such that you ensure that you have adequate fuel oil based on the actual circumstance - worst-case circumstance under which it's supposed to run or provide power for some period of time.

I didn't - I could see - I keyworded a bunch of things through 150-page document and I couldn't find anything. So, I didn't try to read it word for word. I would have died.

MR. EUL: Okay. It would probably be, yes, in the diesel testing as far as they didn't test the fuel oil storage and transfer system, but -

MEMBER BROWN: Well, that's just whatever it is. I'm looking at how do you size the storage and what's the guidance.

MR. EUL: Right.

MEMBER BROWN: And what's ISG-21?

MR. EUL: I believe it's Article 4 to specifically go back and -

MEMBER BROWN: Anyway, that completes my -

MR. EUL: No, it's a good question.

I think also when we do that chapter, the safety evaluation coming up with that chapter, the fuel oil storage, we know the requirements for storage, but it is seven days, you know, is that seven-day capacity, again, not questioning the need, is that based on the worst seven-day -

MEMBER BROWN: Of load. Whatever the load profile is. A fuel burn. I couldn't remember the -

MR. EUL: Right.

(Off-record discussion.)

MR. EUL: Off the top of my head, I don't know.

MEMBER BROWN: All right.

MR. EUL: But I will -

MEMBER BROWN: That was the only observation I had for the ISG.

MR. EUL: Okay. Thank you.

MEMBER BROWN: I'm done, John. Thank you for letting me -

CHAIR STETKAR: No, that's fine. Anything else?

MEMBER BROWN: No, I'm done for that -

CHAIR STETKAR: Thank you very much.

MEMBER BROWN: You're welcome.

MR. EUL: Thank you.

MEMBER BLEY: I'm sorry. What's the exact status now of this ISG?

MR. EUL: The ISG went through the Federal Register in - I guess it was March 28th, I think it was.

MEMBER BLEY: So, it's out for comments?

MR. EUL: No, it's final.

MEMBER BLEY: Okay. Thanks.

CHAIR STETKAR: We'll be back in 20 years on Rev 7 of it. Sorry. I had to get that in.

(Off-record discussion.)

MR. BARNES: Good afternoon. This gentleman here is Shinji Kawanago. He's senior vice president of licensing and engineering for MNES or Mitsubishi Nuclear Energy Systems.

This is Shinji Niida. He is a principal electrical engineer for Mitsubishi Heavy Industries out of Kob.

And I'm Richard Barnes. I'm principal electrical engineer for MNES located here in Arlington.

So, glad to be here. Glad for the opportunity to explain, you know, this gas turbine - I think it's a unique field to do.

MR. KAWANAGO: I just want to express appreciation for you, and thank you very much for having us here today. And we have already finish the qualification test of the gas turbine generator in the last year time frame.

So, we would like to explain to you what is the result of the qualification of the gas turbine generator. And also in addition, we have already finished seismic test of the gas turbine. So, we also - and we can explain to you the result on the seismic test.

And we think this gas turbine generator is only the one gas turbine generator for of which actually have the qualification for the - finish the qualification for the nuclear power plant so that we agree.

And by having this gas turbine generator, we can have the high quality and the high safety nuclear power plant for the future. Thank you very much.

MEMBER ARMIJO: I have a really top-level question.

Is this particular design, a custom design made from scratch to apply to Mitsubishi or is this pretty much - I wouldn't say off the shelf, but a conventional gas turbine that's maybe been tweaked a little bit to meet your special requirements?

MR. KAWANAGO: This gas turbine generator is completely identical and typical. One industry suggest the manufacturer product by Kawasaki.

MEMBER ARMIJO: Okay.

MR. KAWANAGO: And we modified a little bit on the supporting system. For example, the typical starting system is a DC power - DC motor, but we change to the -

MEMBER ARMIJO: So, you would have a lot of operating experience with the -

MR. KAWANAGO: Sure, sure.

MEMBER ARMIJO: -- more conventional

applications.

MEMBER BANERJEE: This is not your own gas turbine you make -

MR. KAWANAGO: -- yes.

MEMBER BANERJEE: It is a Mitsubishi Heavy Industries one?

MR. KAWANAGO: No.

MEMBER BANERJEE: It's Kawasaki. Okay.

MR. KAWANAGO: They're more reliable.

(Laughter.)

(Off-record comments.)

MEMBER BANERJEE: I've been to your plant in Takasago.

MR. KAWANAGO: Actually, this Mitsubishi gas turbine generator is a big one.

MEMBER ARMIJO: Big one, yes.

MR. KAWANAGO: A bigger one.

MEMBER ARMIJO: Yes.

MR. KAWANAGO: So, on this side is a five megawatt and so on. So, basically Mitsubishi doesn't manufacture those small type. So, we need to purchase.

MEMBER ARMIJO: Okay. thank you.

MR. BARNES: Today, what we'll go through as far as contents go is we'll talk a little bit about the initial type test program. Kind of bring you guys up to a little more familiar with that.

We will show you the results that we've summarized from the initial type test, which were conducted late last year.

We'll talk some about the ISG-21 differences. They were basically highlighted a few minutes ago. That is the reliability and the cold versus hot start.

CHAIR STETKAR: By the way, Richard, and I want to make everyone aware of this, you weren't here, and several of the others weren't here this morning, this is an open meeting. Everything is on the record.

So, if we touch on anything that is specific, proprietary information that you do not want on the public record, please be aware of that. We can close the meeting and discuss proprietary information.

At the current moment, the meeting is open. So, be aware of that as we get into the discussions.

It's not a problem to close the meeting and keep that information sheltered, but I wanted to make sure you're aware of anything that you say and any technical information will indeed be public, unless we close it.

MR. BARNES: Okay. Thank you.

CHAIR STETKAR: Keep you aware of that because -

MR. BARNES: It is an important issue.

CHAIR STETKAR: I meant to mention it earlier and I just thought about it.

MR. BARNES: We do have a discussion about the reliability of the gas turbine generator sets. We have some seismic test results, including a little bit of a surprise and some vide of the actual test.

CHAIR STETKAR: Let me leave it to you then. At the point where you feel - I'd like to keep as much of it as open as possible in the interest of what we do here.

But if at a certain point in your presentation you're going to transition into the proprietary information, just we'll stop there. We'll close the meeting and make sure that you have the appropriate attendance and treat the transcript appropriately.

MR. BARNES: I really don't think we will have any proprietary information.

CHAIR STETKAR: Okay. Just to make you aware of it. Most certainly you're aware of what's on the record and aware of the fact that there's, you know, we have no problem closing the meeting -

MR. BARNES: Okay.

CHAIR STETKAR: -- because it is a subcommittee meeting, or if any questions come up -

MR. BARNES: Sure.

CHAIR STETKAR: -- where you feel we're delving into proprietary information, just - we'll treat those.

MR. BARNES: We'll raise our hand.

MR. SPRENGEL: Just a second. This is Ryan Sprengel. The video portion will be considered proprietary.

CHAIR STETKAR: It will.

MR. SPRENGEL: So, the videos and probably the discussion around it will be proprietary.

CHAIR STETKAR: Okay. The only thing is if you know there is proprietary information, if we can somehow organize the presentation so that we don't go into this kind of open, close, open, back and forth routine, it would help us administratively a bit.

MR. SPRENGEL: We can move it to the end.

CHAIR STETKAR: Okay.

MR. BARNES: These are the basic, what's called, initial type test program. They're drawn out of Reg Guide 1.9. Most of them come out of IEEE 387, which is the diesel generator standard that's been around for a long time.

The Interim Staff Guidance, you know, talks about, you know, the differences between what we need to do in some critical areas on gas turbines versus diesel-driven generators.

There is a qualification test plan that was put on file, a technical report with the NRC, which lines out how we've gone through that, what the program really is.

This is essentially the scope, the system level scope of the test. We tested the stuff that's inside the red box there.

The other support systems that are outside of the box were not really part of these initial type tests.

All of these systems will be essentially qualified by some other means either independently by themselves or through analysis, but the stuff inside the box, the turbine itself, the generator starting systems as in the motors and the valves and those kind of things are all part of the -

CHAIR STETKAR: Part of something that's going to become, I think, rather relevant when we talk about reliability data in comparisons with diesel generators, is that in particular the testing has not included the output breaker from the generator.

So, we don't know about its reliability to close; is that correct?

MR. BARNES: Not beyond what would be on the power system side. We don't - this particular design, we do not have a, quote, generator breaker. We have a breaker on the -

CHAIR STETKAR: You do have an output breaker from the generator to the bus. It's the thing called - it's that black, little arc up there at the top that's outside the scope of your red drawing.

The only reason I mention that, and we'll probably discuss it later, but just to se the stage is the diesel generator reliability data that's published in - essentially all references that I could find includes that circuit breaker.

MR. KAWANAGO: It's actually the - when we talk about the total system, the emergency power supply system, actually this output breaker itself is very important.

However, the - when we talk about actually the reliability of the gas turbine or diesel engine generator itself. Okay. And where actually we have to test in the field is outside.

Okay. If there is an area of the gas -- either diesel or the generator itself, we count up that as a failure of the diesel or generator itself.

But if there is a failure of the codes to the breaker itself, we need to count up. That is a failure of the breaker.

So that in the scope of the failure mode analysis, okay, actually the, again, total - from the point of the total -- reliability of the power supply system actually is on the inside.

CHAIR STETKAR: My point is that you've - and I understand what you're doing. You've drawn that red box around something you're defining for the purposes of your reliability testing the gas turbine generator set.

My point is that the data that are published in several references for NUREGs, for example, would draw that red line differently to also include the output breaker and the load sequencers.

MR. KAWANAGO: I'm sorry, but I don't think so because of - this is the scope of the -- and the gas turbine generator is almost identical for the scope of the diesel generator. We can see it's typically -

MR. HAMZEHEE: Can I ask you a question,

John?

CHAIR STETKAR: Yes.

MR. HAMZEHEE: If they are doing this test, let's say they come up with reliability X. And then later on to understand the overall reliability, can they now go back and add the reliability of the circuit breaker and then explain the -

CHAIR STETKAR: Absolutely they could.

MR. HAMZEHEE: Okay.

CHAIR STETKAR: They have not.

I will quote from NUREG/CR-6928 Appendix A Section 8.2.17.1 which defines the scope of the boundaries of an emergency diesel generator. And it includes diesel engine with all components in the exhaust path, electrical generator, generator exciter all within your box, output breaker, outside of your box, combustion air, lube oil systems, fuel oil systems, starting compressed air system, local instrumentation and control circuitry, and for the service water system providing cooling to the emergency diesel generator, only the devices providing control of cooling flow to the EDG heat exchangers, in other words, inside of wherever those isolation valves are.

That's a direct quote from the NUREG for which you site reliability data. It does not include the room heating and ventilation.

So, I understand where you've drawn your boundaries. But when you compare the reliability of what's inside your red line to the reliability of something else, namely an emergency diesel generator citing data in particular from this NUREG, you're not comparing the same things.

You should either add the reliability of the circuit breaker to your data, or subtract the reliability of the circuit breaker from the emergency diesel generator data.

MR. KAWANAGO: Okay. Now, we understand your point. And actually when we calculate the total reliability of the - and including that maybe we needed to close our gas turbine generator and we needed to include in our output -

CHAIR STETKAR: If you're doing this as a comparative study. I recognize when you're actually doing an evaluation of the integrated system. You're certainly going to add it in.

But if you're trying to compare those two, you really do need to do a count for that.

MR. KAWANAGO: Okay.

CHAIR STETKAR: Because it is actually -

MR. KAWANAGO: Please kindly understand, again, basically when we actually conduct the qualification test and including initial type test and if it's clearly, INI is defined in IEEE 387 there is crossover of this and it's a diesel generator.

CHAIR STETKAR: Yes, I recognize that. You've done it consistently with that guidance. Absolutely. Absolutely.

It's just when you finally compare the overall results with data that are derived from perhaps a different scope, you have to recognize and account for those differences.

MR. KAWANAGO: Sure.

CHAIR STETKAR: And in some cases the differences might not be very important. In this particular case, it might be.

MR. KAWANAGO: Okay. I understand.

CHAIR STETKAR: Okay. I'm sorry.

MR. KAWANAGO: That's okay.

CHAIR STETKAR: Since you brought up the red line, I had to say -

MR. BARNES: Red lines always -

CHAIR STETKAR: Actually, the red line is very - it's very, very important because it's very, very important to define exactly what you mean.

MR. BARNES: Okay. The machine itself is continuously ready to 4500 kW, 5625 kVA, 0.8 power factor. Its output is 6900 volts. It's three-phase, 60 hertz.

Basic requirements are for it to start and assume load in less than 100 seconds, per the accident analysis. And the load limiting case for the machine is LOOP and LOCA.

So, that's just some of the basic stats of the block of the foundation where we can get started here.

The initial type tests, they come straight out of IEEE 387.

CHAIR STETKAR: Niida-san, be careful with your paper on the microphone. It's very, very sensitive. Thank you.

MR. BARNES: Okay. These are the three initial type tests that we ran. They're straight out of IEEE 387.

There's a load capacity test, there's a start and load acceptance test. That gives you a little bit of the reason for them.

The first one is to demonstrate the capability of the machine, the packaged unit to carry its rated load.

The second one is to support reliability and also establish that capability to start and accept load within the right required amount of time.

We also did a margin test which is - the purpose of that is to demonstrate the capability of a machine to carry step loads and large load increases during sequencing.

We did do an internal test which was a transient response test. It's really not part of the IEEE testing, but it gives us data to support some of this load sequencing and the stuff that has to come in the future.

Okay. Here is the basic timeline and the test schedule. Load capability test was done on 10/29 of last year. The start and acceptance tests were initiated or began on 11/04. Took about 24 days of testing with holidays. We finished the last one on 12/04.

That test consisted of 20 starts at ambient temperature sometimes called cold starts, and 131 starts at operating temperature which is sometimes referred to as hot starts.

We did the margin test on the 4th of December. And we did - now, somewhere in all those starts we took advantage and did the load transient tests. And I think the particular one we did was on November the 8th.

So, here's a little more expanded on the load capacity test. This one is, as I said, its purpose was to demonstrate the capability to carry a continuous load and successfully reject a short time rated load without tripping.

A short time load is considered rated plus ten percent.

How the test was done is we applied rated load until the temperature of the machine stabilized. We did a two-hour run at the short time rating, following by a 22-hour run at rated load. And then did a short time rejection.

We bumped the load back up to the short time load and then isolated the machine and rejected that load.

The basic acceptance criteria was during that period of time to maintain power to the load while maintaining normal operating temperature limits on oil and generator and those kind of things.

The short time load rejection test is essentially we were - should be able to reject a short time load without having an over-speed trip or, you know, trip the machine and require it to be restarted if there is some kind of, you know, load rejection early on because of, you know, anything that could throw the - we don't want to trip the machine and have to wait for, you know, to restart it.

CHAIR STETKAR: Richard, before you leave this, how long did it typically require for the machine to reach stable operating temperature?

In other words, you know, the scope of the test, the first bullet said you ran it at rated load until temperature stabilized. And then you hit it with a ten percent load increase.

How long did it run at rated load typically?

MR. BARNES: You mean to get for the temperature to stabilize?

CHAIR STETKAR: I do.

MR. BARNES: It normally took about 15 minutes; did it no? Ten to 15 minutes?

MEMBER BROWN: Is that turbine temperatures or are you including generator temperatures as well?

MR. BARNES: Well, the temperature we used to gauge it was the oil temperature as it -

MEMBER BROWN: Of the engine.

MR. BANES: Of the engine - well, the gearbox and the engine, yes.

MEMBER BROWN: So, in other words, it's not necessarily generator temperature stabilizing in 15 minutes.

MR. BARNES: No.

CHAIR STETKAR: I was looking at - I wasn't quite - it wasn't in the part of the report that I read. I had some indication it might have been as long as an hour, but the actual times weren't in there.

The actual test protocol results were not - at least in the version of the test results report that I saw.

The only reason I ask that is that the guidance is certainly not explicit about when to apply the higher load. All it does is say you have to run it - you're aware of it. You have to run it 24 hours. Two of which have to be at an increased load.

In the real world, it strikes me that that - if an increased load is going to be applied, it will probably be at T-zero when the thing initially starts up.

Because, you know, if there are any - if there's any problems with load sequencing or if there's any problems with rotating machinery that you're trying to start up, that higher load will apply immediately, which is a little bit more of a difficult transient for the machine to handle than, you know, warming it up and then applying the ten percent increase.

Having said that, I know the other transients and I'm not really concerned about it. I was just curious about how long you actually did let the thing warm up.

You said ten or 15, 20 minutes. Something like that.

MR. KAWANAGO: Actually, I want to explain there is restriction it's a temporary stability of the on-sites the answer is no.

I mean, it's we needed to wait. We don't need to wait. And the stable condition of the oil temperature and so on. So, that just we when we start this gas turbine generator. And actually is in the second and that this one is rated speed -- immediately you can put those on.

CHAIR STETKAR: I understand that. I was just curious the protocol for doing this test though in particular, was start it, once it reaches rated speed, load it to a hundred percent, and then let, you know, oil temperature at least become reasonably stable. And then bump up the load ten percent, let it run for two hours. Drop the load back to a hundred percent, let it run, and then unload it finally.

MR. KAWANAGO: But we conducted some kind of those test, other internal test.

CHAIR STETKAR: One of the reasons why I'm not particularly concerned about that load - I was curious about the amount of time for warmup - is the other internal tests that you did with hitting it with a hundred percent load increase. And those certainly demonstrate that the machine can handle it.

MEMBER ARMIJO: I have a question. I don't know anything about gas turbines. So, if you trip this unit, is there anything special as far as time or rotational speed or something that will prevent you from restarting it very quickly while it's coasting down or how do you actually handle a trip to restart?

(Off-record discussion.)

MR. KAWANAGO: Is a no.

MEMBER ARMIJO: So, if it tripped, you would just push the Start button again and -

MR. KAWANAGO: Yes. It's the same as a jet engine.

MEMBER ARMIJO: Okay. Happy to hear that. That's what I wanted to hear.

CHAIR STETKAR: The only thing, there is

something in their general description that says normally they don't like you to start it if the oil temperature is greater than 70 degrees C, but that's a long-term wear problem. Just the oil is a little bit thin at higher temperature, but it's not a -

MEMBER ARMIJO: But if you're flying, you'd like to be able to just push the button, right?

CHAIR STETKAR: It's not like the compressor on an air conditioner -

MEMBER ARMIJO: Okay.

CHAIR STETKAR: -- where you need to wait for some sort of duty cycle.

MEMBER BROWN: Well, you do like to know that the load tripped off. You don't want to start capturing - you don't want to start catching motor loads when they're coasting down.

CHAIR STETKAR: There are typically electrical interlocks that require you to shed loads.

MEMBER BROWN: I said that as a caveat. Hopefully, they will -

CHAIR STETKAR: That's not the machine.

MEMBER BROWN: Yes.

CHAIR STETKAR: I mean, that's the -

MEMBER BROWN: That's the generator that you get concerned about based on the stresses and the windings and stuff from the extra current based on the low frequencies and the impedances are different. Then you can get a lot greater current shot when you start.

MEMBER ARMIJO: So, the limitation wouldn't be the gas turbine, it would be the generator to make sure that the whole system -

MEMBER BROWN: Yes, I mean, you still had the load on for some reason. Just think about that.

MEMBER ARMIJO: Yes.

MEMBER BROWN: And the frequency goes down to 15 hertz by 60 and it's like an across-the-line start, okay, with much larger load than what you're anticipating. And it just the forces on the windings can get pretty large.

MR. BARNES: This is basically the results of the data we captured. The engine lube oil remained stable at approximately 150 degrees F during the entire 24 hours of the test, including 110 percent at two hours.

There are some of the average temperatures. The oil temperature going into the engine is essentially what comes out of the oil coolers.

What that oil temperature plug drain, that is the temperature of the oil coming out of the machine, you know.

Each engine is, you know, there's two engines. It's a twin engine turbine. So, there's your minimum and average then for that 24-hour period.

Pretty stable. You would expect the engine oil temperature to be up a little bit when you're running at a ten percent load. Otherwise, it's down within pretty stable conditions.

One of the things that really impressed us with this machine as we were testing, is its consistency and stability, you know, through, you know, through almost everything we threw at it.

Another good indication of gas turbine, you know, for this load capacity test is the exhaust gas temperature.

Exhaust gas temperature is directly related to load. As the load goes up, that temperature goes up.

(Off-record discussion.)

MR. BARNES; These are actually degrees C, not F, you know.

MEMBER ARMIJO: They're Cs on our charts.

(Simultaneous speaking.)

CHAIR STETKAR: Actually, on our slide it does say degrees C.

(Off-record discussion.)

CHAIR STETKAR: There are a couple places also in the test report where the Cs and the Fs are -

MR. BARNES: Well, you see it directly relates - you have average at minimum. Most of that difference is due to, you know, nighttime. The air coming in is a little bit cooler. So, you know, the machine cools off a little better.

MEMBER BROWN: Look at Page 9 and se if it's - that's in degrees F. I presume that -

CHAIR STETKAR: Those are correct because -

MEMBER BROWN: Those better be degrees F, I hope, because it's oil temperature.

CHAIR STETKAR: There are a couple of cross-references that those seem, I believe, legitimate F.

MR. BARNES: Those are an F.

CHAIR STETKAR: Those are F.

There's one place in the report where they're listed as degrees F, but the units are C. So, the cold oil temperature is like 33 degrees F, which is really cold oil.

MR. BARNES: yes, that is cold oil.

The other here is the - this inlet air

restriction is actually not degrees F. It's inches of water.

The inlet air restriction, that's essentially the difference between ambient pressure and the pressure at the intake end of the turbine.

MEMBER BANERJEE: That's inches of water?

MR. BARNES: Inches of water.

(Off-record comments.)

MR. BARNES: You know, basically our conclusions that we came to was at the end of the 24-hour test, engine temperatures were stable, are normal. Did successfully reject the short-time load and not trip or stall. This, you know, came back to normal frequency and voltage pretty quickly.

So, we counted that as a successful test.

MEMBER BROWN: When you say came back pretty quickly, do you mean a couple seconds? Do you mean -

MR. BARNES: Yes, a couple seconds.

MEMBER BROWN: Okay. Okay. Normal, typical range then.

MR. BARNES: Yes. The machine responds very well to load.

MEMBER BROWN: That seemed to be from some of the other test data.

MR. BARNES: This is an outline kind of what the purpose was for a starting load acceptance test. Really, it's purpose is to establish that the unit can reliably start and accept load within a period of time necessary to satisfy the plant design requirements.

The ISG brings in the 95/95 reliability. In order to establish that, we did perform 150 consecutive starts without a failure.

We do have to justify, you know, the selection of the starting conditions. We've got some further on discussions about that to support the reliability and the confidence level based on the combination of conditions, ambient temperature and component temperature.

As I said, the acceptance criteria was to complete 150 starts without a failure. Should be ready to load within 100 seconds. That's consistent with the accident analysis. And the load has to be greater than 50 percent of the rated.

MEMBER BROWN: You mean the step load?

MR. BARNES: Step load.

MEMBER BROWN: So, it could be a hundred, that's okay?

MR. BARNES: For this test, yes.

MEMBER BROWN: This test, okay.

MR. BARNES: Just as long as it's bigger than 50.

MEMBER BROWN What's the biggest step load you anticipate in this plant based on your load sequencing.

MR. BARNES: If we could hold that -

MEMBER BROWN: That's fine. That's okay. Thank you.

CHAIR STETKAR: There are load sequencing charts, and some of the documentation will tell you the time and the amount of load that comes off.

MEMBER BROWN: Yes.

MR. BARNES: And the margin test is specifically set up to deal with that.

CHAIR STETKAR: Richard, what I wanted to ask you is - now, this is just because I've seen people do tests in many different ways, one way of doing a test is I can have a failure as long as I then run 150 consecutive tests after that with no failure. Or I can start with Test Number 1 and have no failures by the time I reach Test Number 150.

Were your acceptance criteria the first, or the second of those? In other words, were the acceptance criteria 150 consecutive starts without a failure, but you may have had some failures previous to that 150 start run, or was it zero failures starting with Test Number 1?

MR. BARNES: We essentially wanted to get 150 tests in without a failure in sequence. Now, there is - there are some maintenance starts, post-maintenance starts that we had in the mix, but -

MR. KAWANAGO: We have -

CHAIR STETKAR: Let me just to make it clear, I run this 25 times. The 26th time I push the button and I have a start failure. And it's oh, my God, I have a start failure. So, I have to go fix something and now I restart the test sequence.

So, I push the button and that's now Test Number 1. And now, I run it 150 times with no failures. That is one way of constructing a test program to demonstrate 150 starts without a failure.

Another way is the first time I push the button is Number 1, and I only push the button 150 times.

MR. BARNES: Right.

CHAIR STETKAR: And the question is, did you have any failures to start -

MR. BARNES: That made us reset -

CHAIR STETKAR: -- that made you reset

time zero?

MR. KAWANAGO: And we have - this is, I believe, is one rule on when we have this reliability and the stop/start test.

And when actually we have the 100 or 150 test without failure is okay. No problem. But in the middle of this test if we have the failure, if that the case, we needed to have a root cause analysis of the type of failure.

And for example, maybe some bug jump into the - on the control cabinet. Okay. Control cabinet. Because it will take a long time, it's one month, and we don't know what happen.

So, if those things happen, it is completely independent issue from the gas turbine itself.

Okay. So, if that the case, we fix those problem. After that, we will count up again from - examples are 75 with failure. And if that the case, we now count up to 75 and start at 75 again.

But in the case of the failure, that doesn't come from the gas turbine generator itself. Okay. We needed to go back and fix the program.

CHAIR STETKAR: Well, I guess what I was - okay. I think I understand what you're saying.

MR. KAWANAGO: That is the typical way.

CHAIR STETKAR: I guess what I'll ask then is - how do I put this? I understand that the last 150 starts that you had, had no failures.

The question is, how many times did you actually perform this test? Was it a population of 150 or was it a population of 300 or a population of 800?

MEMBER ARMIJO: How many attempts -

CHAIR STETKAR: How many total attempts and what was the resolution of any of those failures or discounted tests you might have had?

(Off-record discussion.)

MR. BARNES: I think total number altogether is 170.

MR. KAWANAGO: 170 or something.

MR. BARNES: When we started this test with Test Number 1, we ran through, you know, the 150. But now in the middle of that after every 50 starts, we have to take the fuel injectors out, clean them, put them back in.

So, after that, there was a post-maintenance restart that did not count as part of our test.

MR. KAWANAGO: Yes, that is a change of the oil.

MR. BARNES: And then, so we would run up to, say, 50. Then Test Number 51 would not count as part of our test because it was a post-maintenance test. And then 52 would be part of the mix.

MR. KAWANAGO: So, the total number is 170 or something.

CHAIR STETKAR: I guess I'd have to think about those a bit, but I was more interested in ones where you, you know, for all practical purposes you considered this a legitimate start, and for some reason you had a problem.

You then went in, did some sort of root cause analysis, either discounted the cause as something irrelevant as being outside of your box, or maybe it was relevant to inside your box, made a repair and then reset the counter back to one.

MR. BARNES: I think that was our intent if we had failures. We did not have any failures, you know.

MEMBER BLEY: Even in the post-maintenance test?

MR. BARNES: Not after we started essentially the initial type test with the load capability.

Now, when we were doing setups, I believe we did have one unplanned trip due to a load bank failure.

CHAIR STETKAR: Yes, as a matter of fact, I read that that is mentioned someplace that you had a low bank failure. I think it was running at load or something like that.

MR. BARNES: Well, there was -

CHAIR STETKAR: Okay. Whatever.

MR. BARNES: I think it was during the setup of the initial check-out of the machine. But once we actually started testing, we had no failures to start.

CHAIR STETKAR: Okay.

MR. BARNES: And I think the total number is somewhere in the 170s to 180.

CHAIR STETKAR: The only reason is I actually have seen experience where people, you know, say, well, we made a hundred consecutive successful starts, but it took them about 800 to get there.

(Laughter.)

MEMBER ARMIJO: You talk about the machine, but the chart shows two engines. So, I guess I don't understand what you actually tested.

Was it two separate gas turbines, or was it one gas turbine that had two components called Engines 1 and 2?

MR. BARNES: Well, it's a twin-turbine, you know, engine. There's two turbines on it that drive a common gearbox. And that gearbox has got a shaft output.

We treat the two turbines and the gearbox - and when we get into the pictures, we can actually show you what that is.

MEMBER ARMIJO: If you could show me the picture now and explain what you actually tested, I'd appreciate it.

CHAIR STETKAR: Well, if that's - I mean, we don't have a problem closing the meeting. It's just in the sense of the way we typically run the subcommittees, we like to keep -

MEMBER ARMIJO: There's a picture in the handout.

CHAIR STETKAR: -- as much as possible open.

MEMBER ARMIJO: There's a picture in the handout.

CHAIR STETKAR: But if it starts to get difficult to answer questions -

MEMBER BROWN: There's a picture in the

handout, John.

MR. BARNES: There's a diagram in the handout.

MEMBER BROWN: Before we leave that -

MEMBER ARMIJO: I want to make sure what this thing looks like. Your Slide 26, is that what it looks like?

CHAIR STETKAR: No, that's only one of them.

MR. BARNES: No, that's not - that is a diagram of a gas turbine. That's not particularly this one. We have two of those driving a common gearbox, but we treat them - they have to be treated as one unit, because they are mechanically connected.

CHAIR STETKAR: Essentially, Sam -

MEMBER ARMIJO: One becomes -

CHAIR STETKAR: -- they tested as - I was curious about this, but the test that they ran was if you can think of two gas turbines with a gearbox driving a generator -

MEMBER ARMIJO: Sure.

CHAIR STETKAR: -- mounted on a skid with its appropriate, you know, whatever little support stuff it needs on it -

MEMBER BLEY: They showed us pictures of

that at an earlier meeting, actually.

MEMBER ARMIJO: Okay.

CHAIR STETKAR: They tested that thing.

MR. BARNES: There are several pictures where we can show you the various parts and how they fit together, you know.

MEMBER ARMIJO: Okay. I'll just wait. I just was confused when I saw this picture and you were talking about two engines.

MEMBER BLEY: Yes, this, in their report, they just had a little section that said here's what a diesel looks like, here's what a gas turbine looks like. And that's what that's from.

MEMBER SHACK: You can sort of see on the cover picture, you know, you see the two turbines and the -

CHAIR STETKAR: Oh, on the report.

MEMBER SHACK: On the report.

MR. BARNES: We can show you exactly. We have some -

MEMBER ARMIJO: Okay. All right. I'll just wait.

MEMBER BROWN: Can I -

MR. BARNES: yes, you may.

MEMBER BROWN: Based on your description of what you did in response to John's question, you said you had to stop after 50 -

MR. BARNES: 50 starts.

MEMBER BROWN: - to do a maintenance, I guess, required maintenance in cleaning the injectors or the spark plugs or whatever you said.

Does that mean you had to do it again at a hundred?

MR. BARNES: Yes.

MEMBER BROWN: Okay. So, that tells me you can't - operationally you have to - how are you going to handle that operationally?

For operational purposes, does that mean after you've completed 40 or 45 stops, you're now going to have to go clean those so that you don't exceed your 50 and get into your then five starts or whatever it is in terms of air start in casualty situations?

What you're telling me is you can't - you're not - the manufacturer's recommendation is don't operate more than 50 starts without cleaning the injectors.

So, that means you go up to 45 before you can -

MR. BARNES: Yes, you would have to be -

MEMBER BROWN: That's going to have to be part of your maintenance or your tech specs or something like that?

MR. BARNES: Well, I don't know that it needs to be part of the tech spec so much as it needs to be part of the maintenance program to make sure that -

MEMBER BROWN: Well, if it's needed for accident - I mean, if you're there because you need it for station blackout or loss of offsite power, then it seems to me you're going to be exceeding the manufacturer's recommendations on how to operate the machine if you don't do something like that.

So, that's a little bit more than just a maintenance-type thing. There's a little bit more criticality to it.

I mean diesels, I don't remember ever doing that with the diesels. I mean, we start them four or 500 times. I mean, there were PMs we did, but it wasn't because they couldn't start.

MR. KAWANAGO: Basically, the diesel generator also have the recommendation from manufacturer for the starting time and for the maintenance. It is the same, I believe.

And also, for example, actually the

Kawasaki have the recommendation to have the maintenance every 50 times of the starting - after the starting. But we need to have monthly test. Okay. Pump is a monthly test. So, one time per month.

Okay. And even if we have two years maintenance for the gas turbine generator, it is only a 24. 24 times.

MEMBER BROWN: So, you're going to do this every two years anyway.

MR. KAWANAGO: Or -

MEMBER BROWN: Or 50 starts.

MR. KAWANAGO: Or our US-APWR plant, we have the four train - four-train system. We have the full set of the 50, a percent of the gas turbine generator. And even if we have the one single failure, but still - and also we need to have the two set of the gas turbine generator as 100 percent. 50 and times 50. Okay.

But still we have the remaining one - and one train gas turbine generator. That mean we can do unlimited maintenance with this gas turbine generator.

So, even if the operation is a continuous 100 operation or more of the nuclear power plant, we can conduct the maintenance for this one gas turbine generator.

MEMBER BROWN: Okay. Thank you.

MR. BARNES: All right. Here again, this is the difference between hot and cold starts where the number is on the various parameters.

A cold start, you know, the air intake - these are minimums and averages, right? Average. Okay.

They're in F. That's what's throwing me off.

CHAIR STETKAR: Keep going. Just keep going.

(Laughter.)

MR. BARNES: Okay. Here's the starting times. For the cold starts, the average was 26.6 seconds. Maximum was 27.5. The minimum was 26.

For the hot starts, the numbers are a little bit longer. 28, 28 for the max. And 26 for the min.

CHAIR STETKAR; This is to full speed ready to load.

MEMBER BANERJEE: This is to full load?

CHAIR STETKAR: That's ready to load.

MR. BARNES: This is a test. The load was put on -- at the 26.6 seconds point is when the load was added, and the load was greater than 50 percent.

That's when it's ready to load.

CHAIR STETKAR: The important thing to know, I believe, and correct me if I'm wrong, the safety analyses now - one of the concerns about the gas turbine is, you know, its conceivable, long start time.

The safety analyses, I believe, are done based on a 100-second --

MR. BARNES: 100 seconds, yes.

CHAIR STETKAR: -- output breaker close time.

MR. BARNES: Right.

CHAIR STETKAR: So, this is information that seems to support the fact that they could pick - they have margin within that 100 seconds -

MR. BARNES: Yes.

CHAIR STETKAR: -- but the safety analyses are based on that 100-second time delay.

MR. BARNES: So, that's what we found as part of the test results.

MEMBER BANERJEE: That was just one turbine, right?

MR. BARNES: Well, it's one gas turbine generator.

MEMBER BANERJEE: One machine, yes.

CHAIR STETKAR: Two gas turbines, a gearbox and a generator.

(Laughter.)

(Off-record discussion.)

MEMBER BANERJEE: But, I mean, if you did this to many different skids, what would be the variability in that number, do you think?

MR. BARNES: I think it would be very small if you had, you know, similar units, I mean, similar in size. The driving time is just how fast can you drive it from zero RPMs up to its operating speed and the ramp and how fast you do that, you know.

The more massive the machine, probably a little slower you would have -

MEMBER BANERJEE: But it's a predictable number?

MR. BARNES: Oh, it's a very consistent number. As I said, this has got a very, very little -

CHAIR STETKAR: Our audio-visual system here is you can't just simply plug something else into the -

MR. BARNES: Okay. The conclusion is we had 20 successful starts at ambient conditions, cold starts. We had 131 successful starts at normal operating conditions, and 151 in total.

All the starts were less than 30 seconds. And in all cases, the load that was applied was greater than 50 percent. And those were essentially successive. There was no, I mean, the cold starts were mixed in with the hot starts and -

CHAIR STETKAR: You defined a cold start as basically when you came in, in the morning, it was a cold start. You ran a number -

MR. BARNES: That's correct.

CHAIR STETKAR: Ran as many as you could during the day. The next morning, you got - but you had something like cold 20 -

MR. BARNES: Yes, we had - we made sure we did 20.

MEMBER ARMIJO: I'm just curious about that maintenance at 50 starts. Normally, manufacturers are pretty conservative on those kinds of things.

What kind of margin do you have that you said like if we didn't do that maintenance, this thing would still work for another 50 starts?

MR. BARNES: We probably would. I mean, the interval is very simple. We can talk to them and see, but basically you take the fuel nozzle off. There's one on each turbine. And you take some like 409 cleaner and a plastic brush, and put it back in.

MEMBER ARMIJO: Okay.

MEMBER BANERJEE: So, what gets on it? Soot or what?

MR. BARNES: No, it's not necessarily soot. I think it's more of a concern with cold, with the number of starts. Because when it does start, you get a lot of fuel put in and you may get some varnish or diesel oil that doesn't quite burn in that initial start.

Once the machine is up and running, you know, it cleans itself up, but that nozzle is cold. So, there may be some varnish or buildup on that nozzle.

MEMBER ARMIJO: Okay.

MR. BARNES: Not that it would probably impact performance a lot, you know.

MEMBER BANERJEE: How big is the nozzle?

MR. BARNES: I don't know how big the nozzle exactly is. Maybe a quarter inch? One inch?

MEMBER BANERJEE: Oh, one inch.

So, the buildup, is it significant in one inch?

MR. BARNES: No. The one I saw after the 50 tests, it was, you know, you look at it and you say, gee -

(Laughter.)

(Off-record comments.)

CHAIR STETKAR: Just to make sure whenever we have conversations, we're on the record, just make sure that you speak up enough so that you record over there.

MR. BARNES: So, you know, we did these 150 tests. There was no failures. The only interruption to the sequence on the numbers would have been these post-maintenance tests where we cleaned the fuel injectors.

The margin test, this is - the purpose of this test is to demonstrate the capability of the machine to accept the most severe load step, plus a ten percent margin.

How the test is conducted is you apply pre-load, a running load prior to the most severe step. And then in a single step addition, you add the margin load which is supposedly the most severe load in the duty cycle for the machine.

The acceptance criteria is really that the machine accepts the load and it recovers to normal values, you know, and doesn't stall, doesn't trip on something.

MEMBER ARMIJO: I just had a question on

the meaning of the ten percent.

If the load step was going to be - I'll give you a number - 20 percent increase in load from what - from where you're running -

MR. BARNES: Okay.

MEMBER ARMIJO: -- does the ten percent mean it's actually you're going to put 30 percent on, or are you going to put on 22 percent?

MR. KAWANAGO: It's - actually the meaning, this is a margin test which come from the - actually, the safety injection pump motor. Okay. It's the largest motor, in this US-APWR.

MEMBER ARMIJO: Okay.

MR. KAWANAGO: And we use this profile, we added the ten percent to this one as a margin.

MEMBER ARMIJO: 10 percent of what the added load was supposed to be.

MR. KAWANAGO: Yes.

MEMBER ARMIJO: So, that's uncertainty and it -

MEMBER BANERJEE: How many megawatts is that?

MEMBER ARMIJO: Okay.

MR. KAWANAGO: It's actually the - actually, the safety injection motor rate it and, I thought, rate it 1,493 kilowatt, but -

MEMBER BROWN: How much? What was that?

MR. KAWANAGO: 1400.

MEMBER BROWN: 1400 horsepower?

MR. KAWANAGO: Kilowatt.

MEMBER BROWN: Oh, kilowatts.

Do you all use a resistance load, or is this a reactive - is it like a - do you use a real motor?

MR. BARNES: We used a real motor with some resisted load.

(Simultaneous speaking.)

MEMBER BROWN: I was just curious because the reactive current affects the regulator operation. That's all. It's different with resisted loads than it is with reactive loads equipment.

(Simultaneous speaking.)

CHAIR STETKAR: Did he really answer your question, Sam?

MEMBER ARMIJO: Yes.

CHAIR STETKAR: I'm sorry. I thought you were -

MEMBER ARMIJO: I think I understand.

MR. KAWANAGO: You are simulating the actual load that would be expected.

MR. BARNES: We're simulating the worst step load that it would see.

Here's pretty much the results. Voltage dip 25 percent. Recovered to 10 percent at 850 milliseconds. And recovered to nominal in four seconds thereabouts.

Frequency, you know, dropped by three percent in both cases. And recovered in about two-and-a-half seconds.

MEMBER BROWN: Is that okay to have a 25 percent dip on the bus at that time with your other loads on it in the actual plant application?

MR. BARNES: I mean -

MEMBER BROWN: You've got other loads on there. They're going to notice that 25 percent dip.

MR. BARNES: Right. They would.

MEMBER BROWN: Quite a bit.

MR. BARNES: I mean, the Class 1E motors are all spec'd to handle the 25 percent transient -

MEMBER BROWN: What about the electronics though? It's normally not spec'd to handle 25 percent reduction in its input voltages.

And if you've got control systems for the rest of the plant, that's going to be fairly nasty under those circumstances.

MR. BARNES: Well, with this particular test we were just trying to demonstrate that we could handle the most significant load. Okay.

MEMBER BROWN: When you see it - help me out a little bit here because you've lost power. I don't know when you sequence the electronics on. I presume they come after the motors.

CHAIR STETKAR: Charlie, you don't sequence electronics on. They're off DC batteries through -

MEMBER BROWN: Oh, okay.

CHAIR STETKAR: They don't even know about this.

MEMBER BROWN: I'm sorry. I'm sorry.

(Off-record comments.)

CHAIR STETKAR: The electronics don't know about this in these plants.

It is pertinent to undervoltage and under-frequency relay set points on your bus, you know --

MR. BARNES: That's correct.

CHAIR STETKAR: -- for rotating machinery, but the electronics don't -

MEMBER BROWN: No, I totally forgot the batteries. As long as the batteries are working okay, you're golden.

MR. BARNES: So, we concluded, you know,

the voltage return to normal pretty quickly. The frequency recovered pretty quickly. Engine didn't trip, it didn't stall, it didn't run hardly, you know. It returned to stable operation pretty quickly and smoothly.

So, there you go. We successfully accepted that margin load, plus ten percent margin on top of it.

Now, these are some internal load transient tests that we did as basically just determine voltage and frequence response to load additions and rejections, you know.

We monitor voltage and frequencies to certain block loads adding them and taking them off. Really no acceptance criteria. It's more of a data gathering exercise than it was a test.

Here's pretty much what we found. We added 25 percent load. We got 3.5 voltage variation and recovered in 0.7 seconds.

When we rejected that load, we got a variation of minus four in voltage. So, the voltage went up a little bit. Recovered in about 0.8 seconds.

You can see that, you know, the rest of the numbers there. I don't know if we need to go through every one of them.

Now, when we say a 50 percent load, that is a 50 percent block load. It's not an additional 25 to the 25 previously.

So, we loaded it to 25 percent, took it back to zero. Then threw a 50 percent block load on. Took it back to zero. Then pull a 75 percent block load. Okay.

MEMBER BLEY: The hundred percent was impressive to me.

CHAIR STETKAR: Yes, the hundred percent test was an impressive test.

MR. KAWANAGO: This is significantly different from the diesel generator performance. That is very good.

MEMBER BROWN: Was that just a resistive load in this case?

MR. BARNES: It was an inductive/resistive load, but it wasn't -

MEMBER BROWN: Static. It was not a motor. It was a static -

MR. BARNES: It was not a motor.

MEMBER BROWN: Okay.

MR. BARNES: But now the margin test previously was a motor.

MEMBER BROWN: Was a motor. Yes, I got

that part.

MR. BARNES: So, we basically there again, you know, we got some good numbers. Return to normal voltage and frequency as expected, you know. We think that demonstrated the test.

We want to hold the pictures until the end?

CHAIR STETKAR: Why don't we hold the pictures. And in the interest of time management here, you're going to transition into a slightly different topic now; is that right?

Why don't we take a break since we're obviously not going to finish by three o'clock, which was my naive guess, why don't we take a break and come back at three o'clock. And we can pick up the next topic here.

So, we'll recess until three o'clock.

(Whereupon, the above-entitled matter went off the record at 2:47 p.m. and resumed at 3:02 p.m.)

CHAIR STETKAR: Okay. We're back in session. But after some discussion during the break, what I'm going to do is close the session for the public record so that we can actually see the video and have some discussion about the proprietary information.

So, what I'd like to do, we sort of have to make sure that we don't have anybody in the room that primarily Mitsubishi is concerned about.

(Off-record discussion.)

CHAIR STETKAR: With that, we will go into closed session and be off the public record for probably the remainder of the session, but we'll see how that works.

(Whereupon, the above-entitled matter went off the record at 3:03 p.m.)

Presentation to ACRS

Chapter 11: Radioactive Waste Management Systems

Mitsubishi Heavy Industries, Ltd.
April 22, 2011

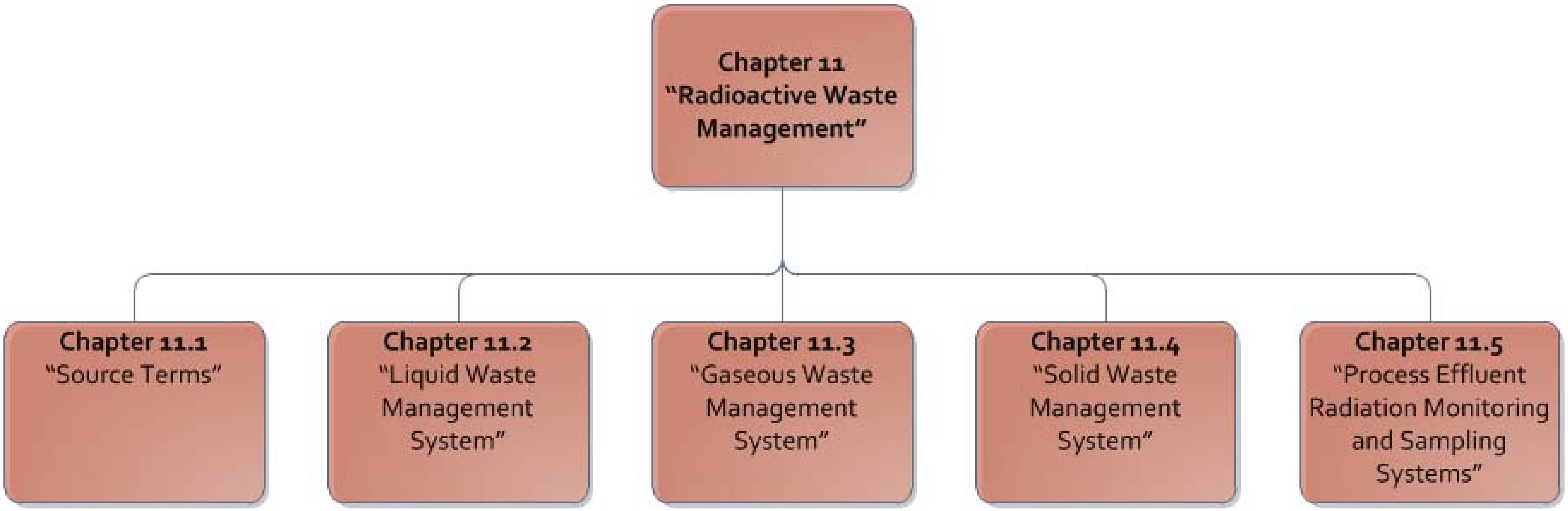
Presentation Objectives

1. Discuss key design features on Radwaste Systems (LWMS, GWMS, SWMS) and PERMS
2. Discuss status of responses to open items
3. Questions and Answers

Key APWR Presenters

- Hiroki Nishio – Acting Manager, Water Reactor System Engineering Section, MHI
- Motoki Konno – Acting Manager, Radiation Safety Engineering Section, MHI
- Yves Barles – Engineer, Radiation Safety Engineering Section, MHI
- Irving Tsang – Principal Discipline Engineer – Nuclear, URS

Radioactive Waste Management Systems



Source Terms Basis

Two source term models were utilized to calculate the radionuclide concentration in the reactor coolant and secondary coolant

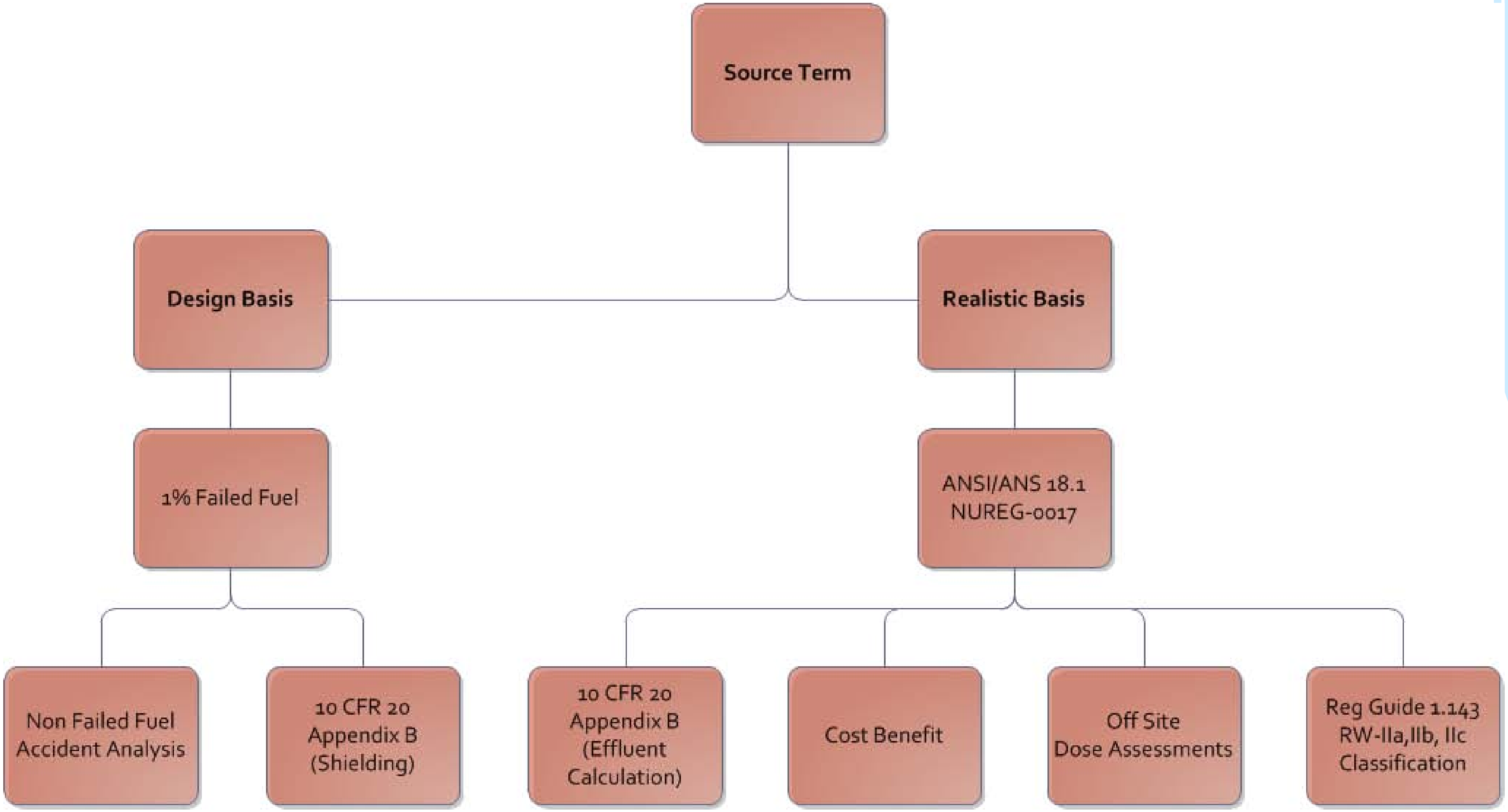
➢Design Basis Source Terms

- Fuel defect:1% based on SRP 11.2 and 11.3
- Mass balance differential equations described in DCD were used to calculate the activity of each nuclide

➢Realistic Source Terms

- Based on ANSI/ANS-18.1-1999 and NUREG-0017
- ANSI/ANS-18.1 reference plant values are adjusted for the US-APWR using the standard adjustment factors
- PWR-GALE Code was used to calculate released activity during normal operation including AOOs based on the realistic source terms

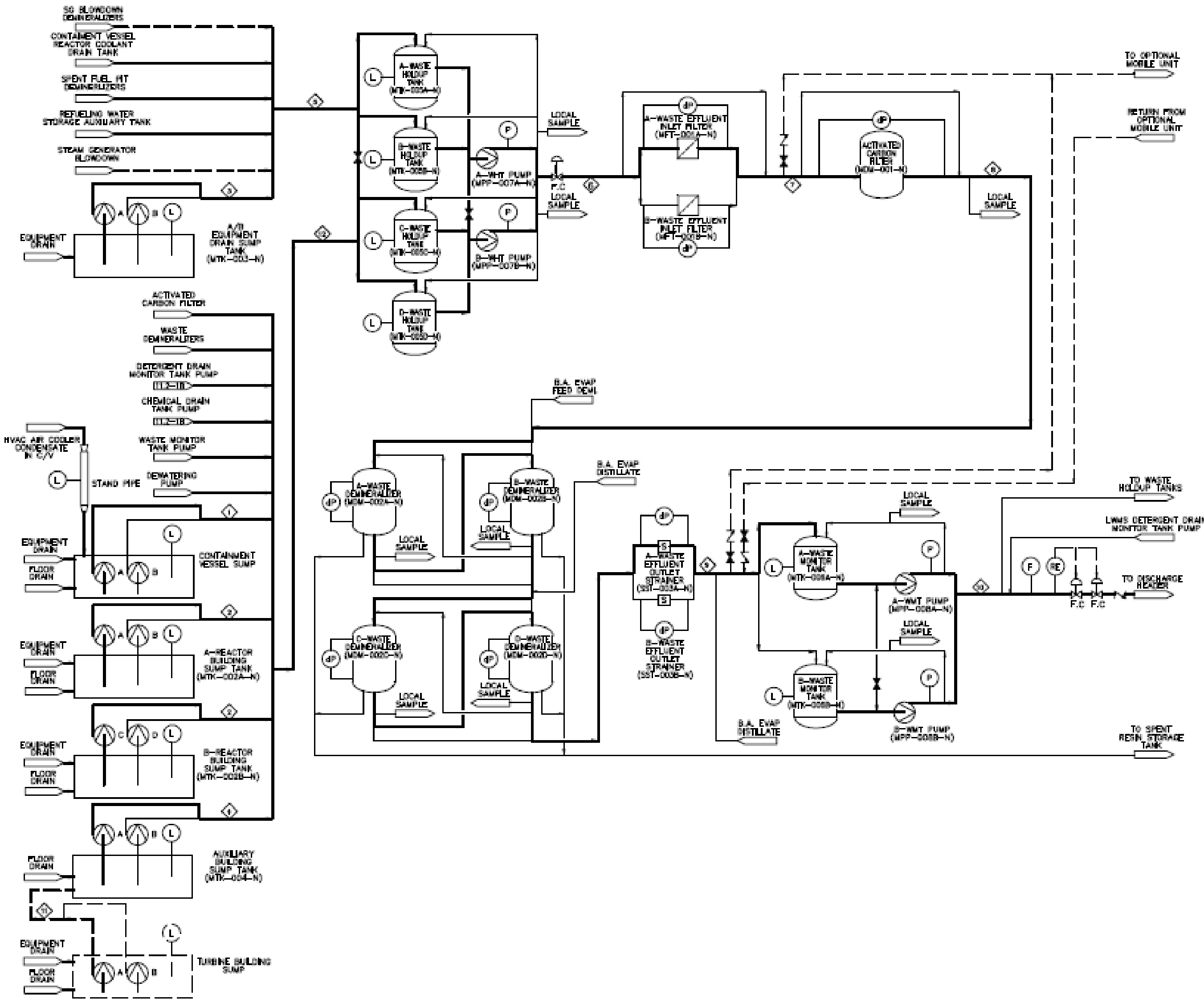
Source Terms Application



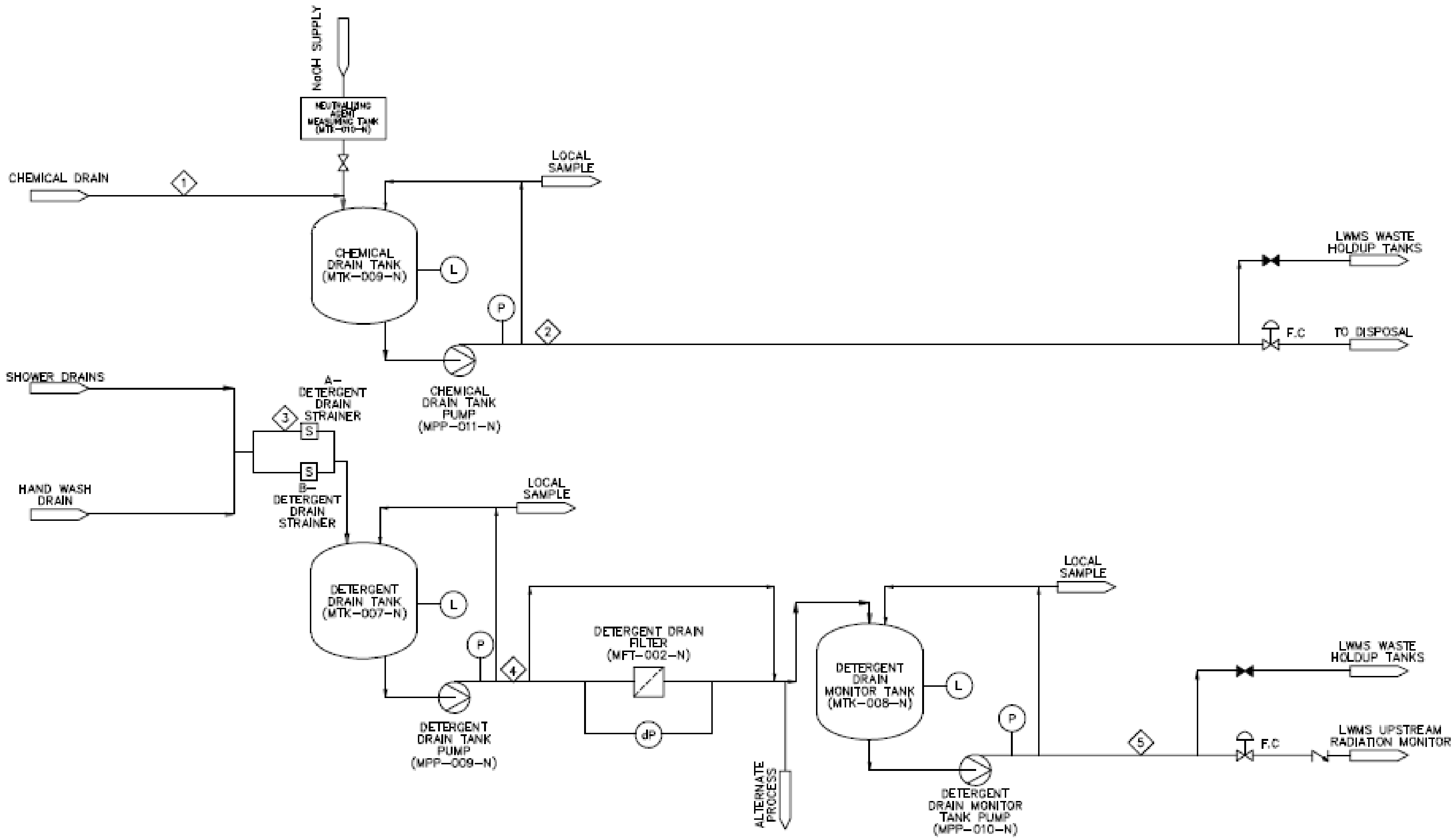
Liquid Waste Management System (LWMS)

- **Objective: Collect, store, process radioactive liquid to meet release specifications for discharge**
- **Subsystems:**
  - ✓ Equipment and Floor Drains Subsystem
  - ✓ Detergent Waste Subsystem
  - ✓ Chemical Drains Subsystem
  - ✓ Reactor Coolant Drain Subsystem
- **System Classification**
  - ✓ Non-safety related System
    - Containment penetrations are safety related
  - ✓ Auxiliary Building: seismic category II (non-seismic)
    - Components are classified according to RG 1.143 Hazard classification
  - ✓ RG 1.143 Hazard classification:
    - Liquid filters are category IIa, other components are IIc
- **Locations:**
  - ✓ Reactor Coolant Drain Subsystem is inside containment
  - ✓ Other subsystems are in Auxiliary Building

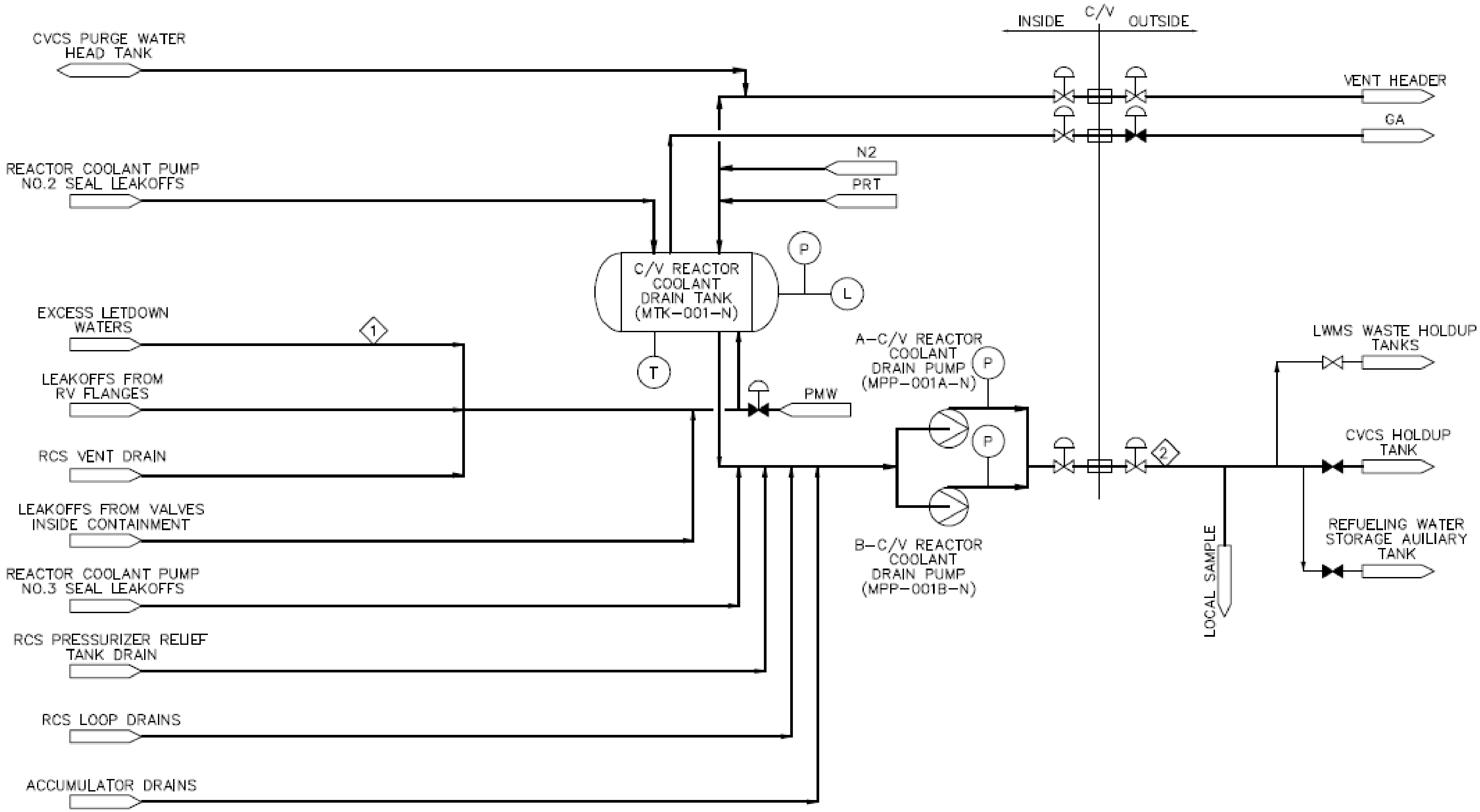
LWMS Process Flow Diagram
(Equipment and Floor Drain Subsystem)



LWMS Process Flow Diagram
(Chemical Drain and Detergent Drain Subsystems)



LWMS Process Flow Diagram
(Reactor Coolant Drainage Subsystem)



LWMS Key Design Features

System Design

- Uses nuclear industry-proven technologies
- Four Waste Holdup Tanks with segregation of floor drain and equipment drain input streams
    - Over 90,000 gallons storage capacity
    - Interconnected header with isolation valve
    - Each tank in separate cubicle
    - Cubicle floor is sloped and epoxy coated to promote drainage
    - Each cubicle has its own early leak detection instrument
- Two Waste Monitor Tanks and pumps
- Dual cartridge filters design in parallel for standby operation
- Dual trains of mixed bed ion exchange columns
    - Can be arranged in series or parallel operation
- Provision for future mobile treatment unit for updated technologies
- Separate equipment and floor drain sumps with area leak detection and local alarms

LWMS Key Design Features

System Design (Continued)

- **Process rate at 90 gpm**
  - **Complete one tank processing in less than 5 hours**
- **Effluent**
  - **Compliant with 10 CFR 20 Appendix B Table 2**
  - **Dilution flow added to minimize average concentrations**
  - **On-line radiation monitor to insure effluent specification is met**
  - **Recycle treatment if required**

LWMS Key Design Features

- Design Basis and Criteria
  - ✓ 10CFR50: effluent monitoring and dose
  - ✓ 10CFR20: effluent specifications
  - ✓ RG 1.143: SSC design and component classification, and
  - ✓ RG 4.21: waste minimization and early leak detection
  - ✓ ANSI 55.6: process and treatment design and component capacities

- Effluent releases and dose to the public (including AOO conditions and tank failure)
  - ✓ Based on RG 1.109, RG 1.112, BTP 11-6
  - ✓ Used PWR-GALE (modified version), LADTAP II, RATAF codes

Gaseous Waste Management System (GWMS)

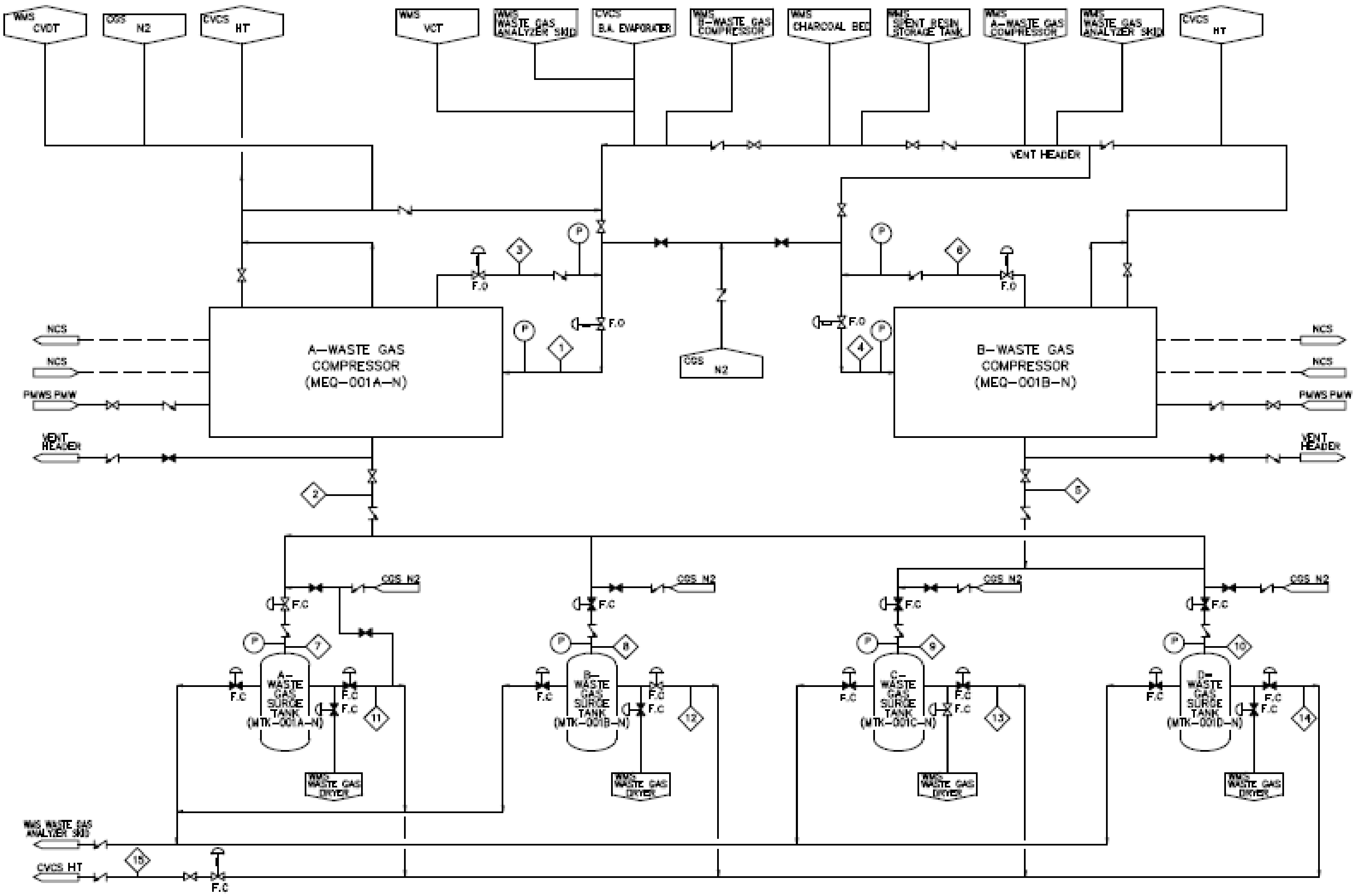
- **Objective: Monitor, control, collect, store, handle, and process gaseous radioactive waste to release specifications for discharge**
- **Subsystems:**
  - ✓ No subsystems – One system design
- **System Classification**
  - ✓ Non-safety, seismic category II (non-seismic)
  - ✓ RG 1.143 Hazard classification: Gas Surge Tanks and Charcoal Bed Adsorbers are category IIa, others are IIc
- **Locations:**
  - ✓ GWMS are located in Auxiliary Building (A/B)
    - Release stack is mounted on the outside of containment

Gaseous Waste Management System (GWMS)

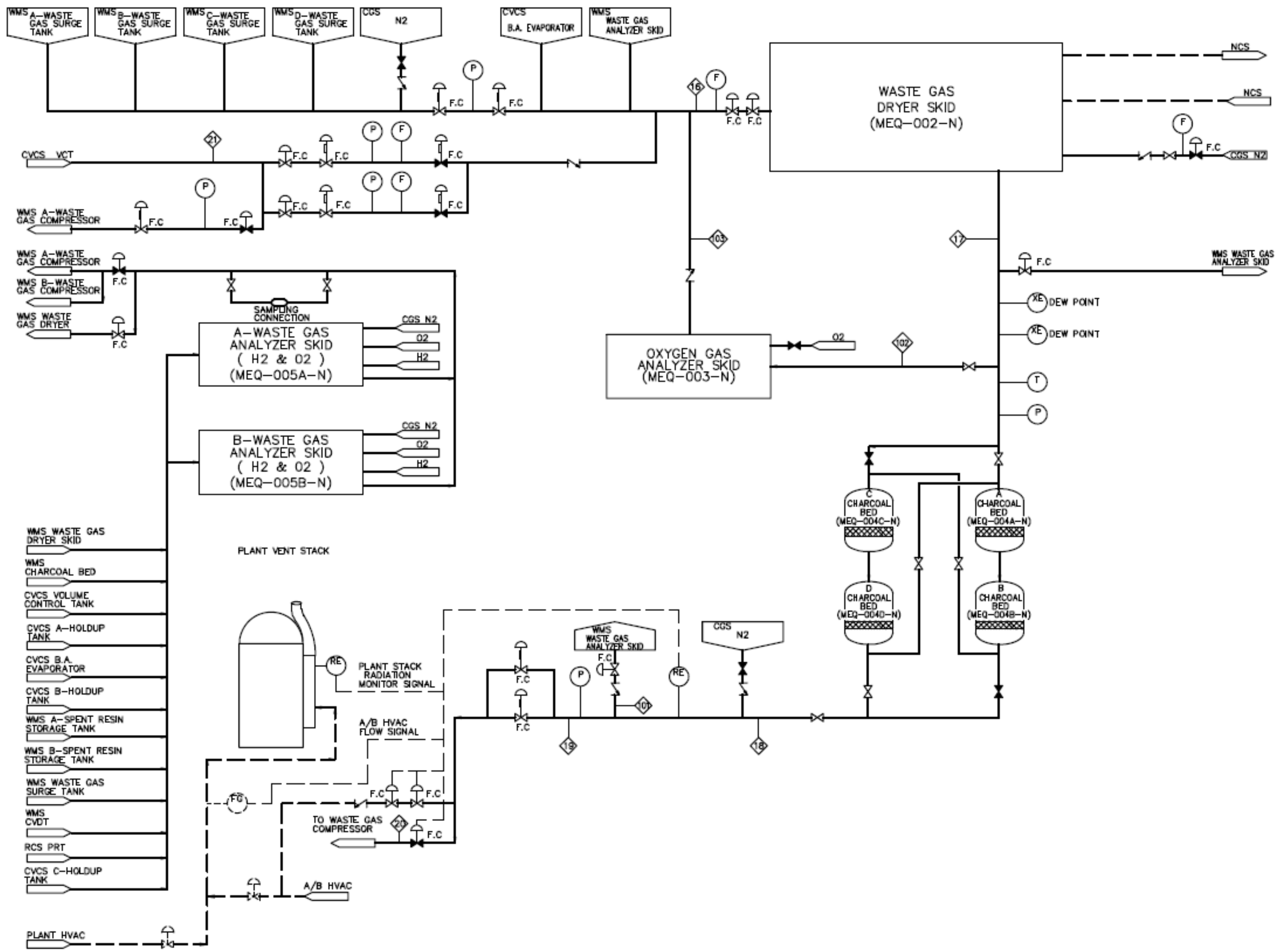
Regulations

- RG 1.143 & ANSI/ANS 55.4: System and component design
- RG 1.189: Controls explosive gases – Process control on H_2/O_2 concentrations
- RG 8.8: System design and shielding
- 10 CFR 20 Appendix B Table 2: Effluent specifications
- 10 CFR 50 Appendix I: dose limits
- 10 CFR 50 Appendix A: GDC 60, 61 and 64: Effluent control
- 10 CFR 20.1406: Waste minimization and prevention of cross-contamination
- RG 1.110: Cost Benefit analysis

GWMS Process Flow Diagram



GWMS Process Flow Diagram



GWMS Key Design Features

- **System Design**
  - ✓ Based on nuclear industry-proven technologies
  - ✓ 4 Waste Gas Surge Tanks
  - ✓ 4 Charcoal Bed Adsorbers
  - ✓ Continual dual-channel oxygen monitoring
  - ✓ Intermittent dual oxygen and hydrogen monitors

- **Design Basis**
  - ✓ Designed to 10CFR50, 10CFR20, RG 1.143, and RG 4.21
    - ✓ANSI 55.4 compliant

- **Effluent releases and dose to the public (including AOO conditions and tank failure)**
  - ✓ Based on RG 1.109, RG 1.112, BTP 11-5
  - ✓ Used PWR-GALE (modified version), GASPAR II code

Solid Waste Management System (SWMS)

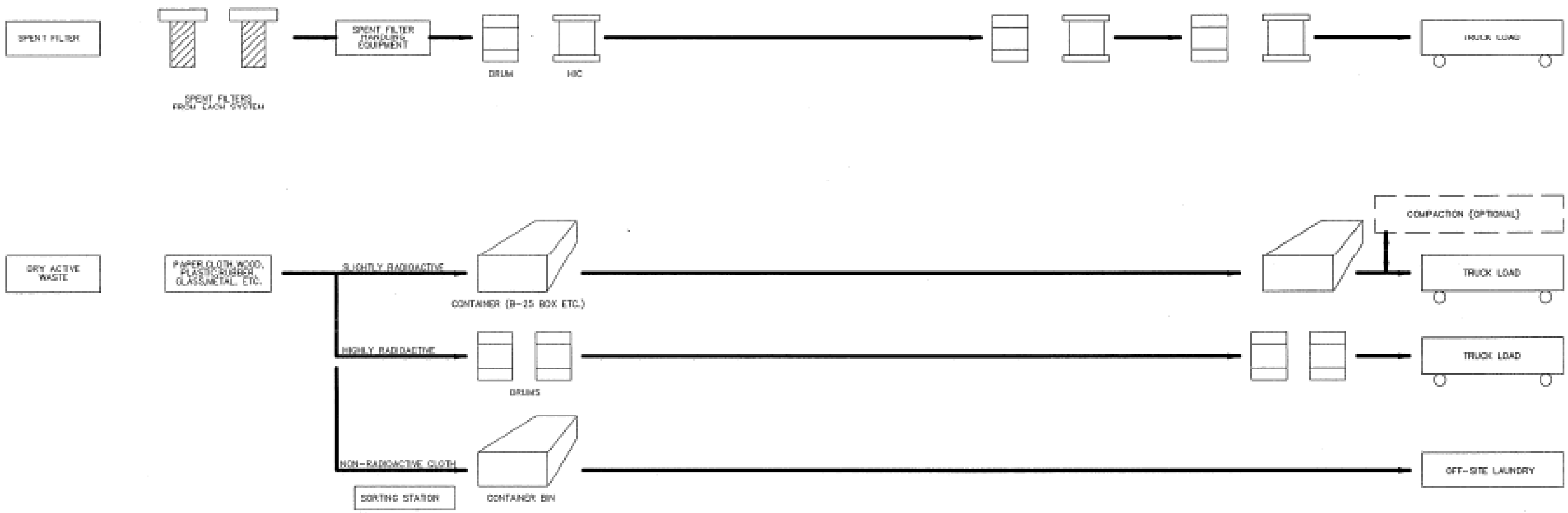
- **Objective: Collect, process, package, store, and transport solid radioactive waste for off-site disposal.**
- **Subsystems:**
  - ✓ Dry Solids Subsystem
  - ✓ Wet Solids Subsystem
  - ✓ Packaging, Storage and Shipping Subsystem
- **System Classification**
  - ✓ Non-safety, seismic category II (non-seismic)
  - ✓ RG 1.143 Hazard classification: Spent resin storage tanks and breakpot tank are category IIa, others are IIc
- **Locations:**
  - ✓ SWMS are located in Auxiliary Building (A/B)

Solid Waste Management System (SWMS)

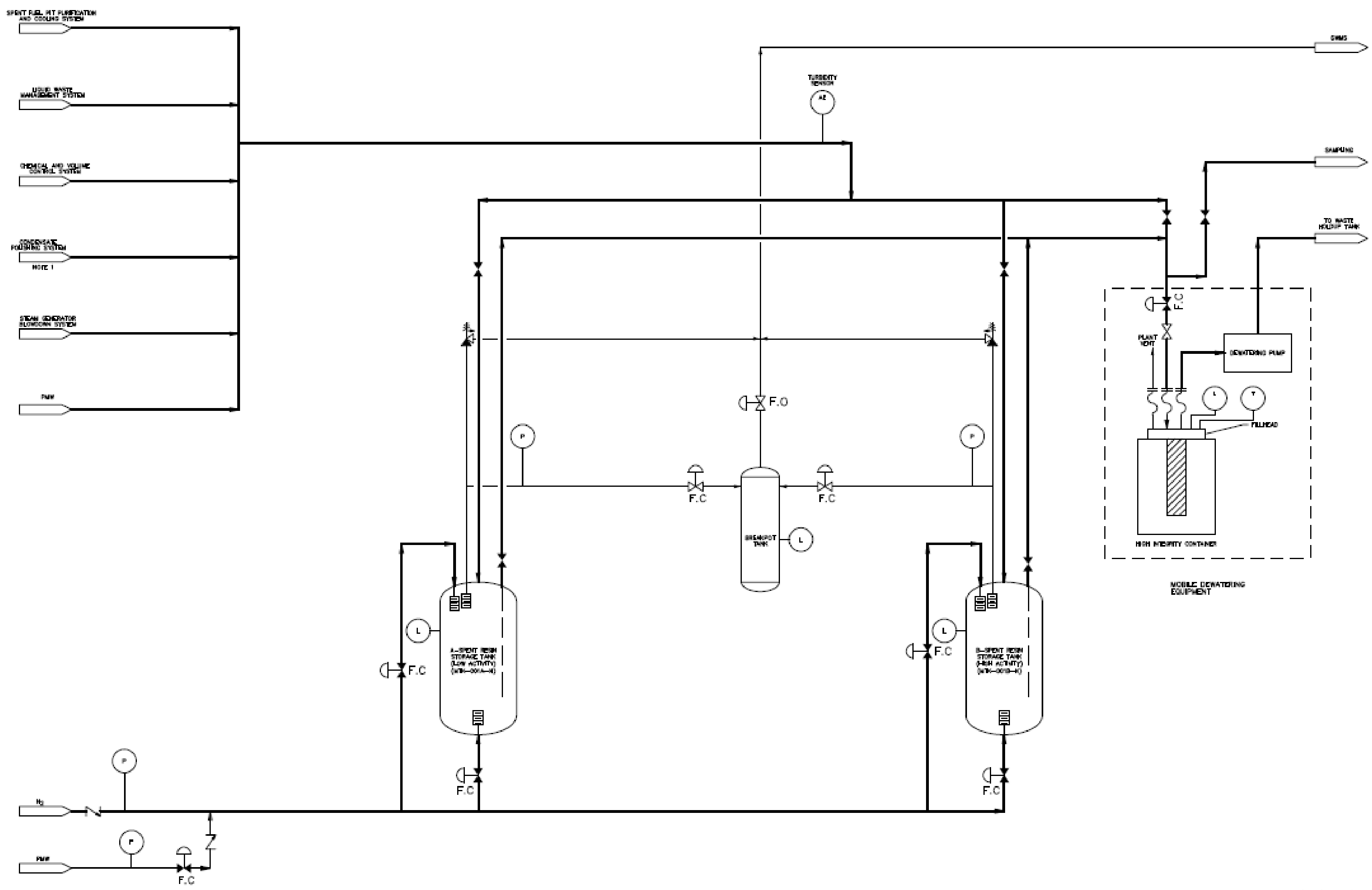
➢ Regulations

- ✓ RG 1.143 & ANSI/ANS 55.1: System and component design
- ✓ RG 8.8: System design and shielding
- ✓ 10 CFR 61 and 63: Package, handling and monitoring radioactive wastes
- ✓ 10 CFR 50 Appendix I: Dose
- ✓ ANSI/ANS – 40.37: Mobile Dewatering Systems
- ✓ 10 CFR 20.1406: Waste minimization and prevention of cross-contamination

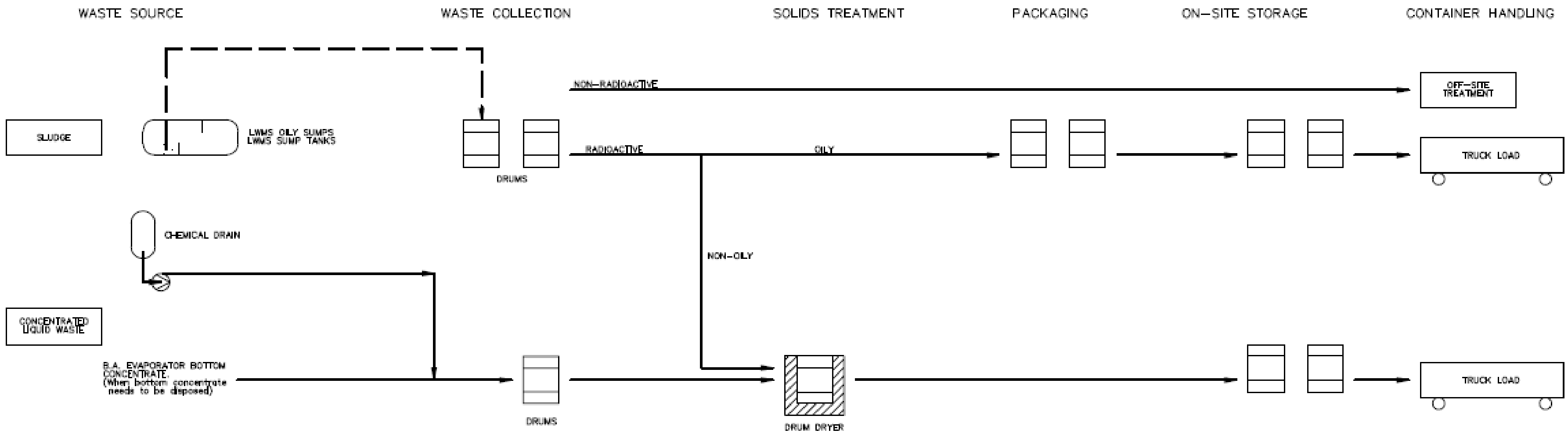
SWMS Process Flow Diagram
(Dry Active Waste and Spent Filter Handling Subsystem)



SWMS Process Flow Diagram
(Spent Resin and Charcoal Handling Subsystem)



SWMS Process Flow Diagram
(Oil and Sludge Handling Subsystem)



SWMS Key Design Features

➢ System Design

- ✓ Based on industry proven technologies
- ✓ 2 Spent Resin Storage Tanks
- ✓ Spent resin packaging and dewatering subsystem
- ✓ Solid waste storage
  - 2 vaults for Class B/C waste for up to 16 containers
    - Additional interim storage by COL Applicant
  - Storage area for Class A waste in Auxiliary Building

➢ Design Basis

- ✓ Designed to 10CFR50, 10CFR20, RG 1.143, and RG 4.21
- ✓ Full compliance with ANSI 55.1

Process Effluent Radiation Monitoring and Sampling Systems

- **Objective:** Sample, measure, control, and record the radioactivity levels of selected process streams within the plant and effluent streams released into the environment
- **System Classification:** Non-Safety
- **Locations:**
  - ✓ Monitoring Instruments are associated with the process systems, e.g. LWMS discharge monitor located in the A/B
  - ✓ Sampling stations are distributed in low radiation areas in R/B, A/B and Ac/B
- **Design Criteria:**
  - ✓ Activate alarms and control releases of radioactivity
  - ✓ Provide data to ensure doses are ALARA
  - ✓ Provide process data to support plant operation
  - ✓ ANSI 13.1, ANSI N42.18, RG 1.21, RG 1.33, NUREG-0800 BTP 7-10
- **Key Effluent Monitoring Points for Radwaste Systems:**

✓ LWMS Effluent

✓ GWMS Effluent

RAI Open Items (1/2)

RAI	Question	Description	Open Item	Open Item Status
624-4972	11.02-33, Item 2	Provide liquid effluent and dose calculation package	11.02-1	Pending NRC review (MHI submitted the calculation packages as the response of RAI#711 on March 30, 2011)
711-5533	11.02-34	1) Provide reference of MUAP-10019P/NP Rev 0, in DCD 2) Provide information on new approach to RATAF code input/output files for liquid tank failure analysis	11.02-2	Pending NRC review (MHI submitted the response of this RAI on March 30, 2011)
629-4973	11.03-18 Item 2	Submit calculation packages: 1) Gaseous effluent releases and doses 2) Waste gas tank and charcoal bed leak analyses	11.03-1	Pending NRC review (MHI submitted the calculation packages as the response of RAI#711 on March 30, 2011)

RAI Open Items (2/2)

RAI	Question	Description	Open Item	Open Item Status
712-5534	11.03-19	Revise the DCD to address charcoal bed combustion; ITAAC to address explosive monitoring	11.03-2	RAI response in preparation by MHI by middle of May, 2011.
629-4973	11.03-18 Item 4	Identify compliance with IE Bulletin 80-10 in the PERMS design; State compliance in DCD Tier 2, Section 11.5	11.05-1	Open Item resolution in preparation by MHI by end of May, 2011.

Summary

- The key design features of the US-APWR Radwaste Systems were discussed:
  - ✓ Systems are designed to operate during normal operation, including anticipated operational occurrences (startup, shutdown, and refueling)
  - ✓ System designs include instrumentation to monitor and control releases of radioactive effluents
  - ✓ Systems are designed to meet liquid and gaseous discharge limits as well as dose rate limits

- The statuses of RAI Open Items were discussed:
  - ✓ 3 responses have been submitted and are pending NRC review (11.02-1, 11.02-2, 11.03-1)
  - ✓ 2 responses are currently in preparation by MHI (11.03-2, 11.05-1)

U.S.NRC

United States Nuclear Regulatory Commission

Protecting People and the Environment

Presentation to the ACRS Subcommittee

Mitsubishi Heavy Industries, Ltd.
US-APWR Design Certification Application Review

Safety Evaluation with Open Items: Chapter 11

RADIOACTIVE WASTE MANAGEMENT

April 22, 2011

Staff Review Team

- **Technical Staff**
  - **Michelle Hart** – DCD Section 11.1
    Siting and Accident Consequences Branch
  - **Richard Clement** – DCD Sections 11.1 to 11.5
    Construction Health Physics Branch
  - **Joshua Wilson** – DCD Sections 11.2 to 11.4
    Balance of Plant Branch
  - **Royce Beacom** – DCD Section 11.5
    Instrumentation, Controls & Electrical Engineering

- **Project Managers**
  - **Jeffrey Ciocco** – Lead Project Manager
  - **Ngola Otto** – Chapter Project Manager

Overview of DCD Review

		Number of Questions	Number of Open Items
11.1	Source Terms	2	0
11.2	Liquid Waste Management System	34	2
11.3	Gaseous Waste Management System	19	2
11.4	Solid Waste Management Systems	21	0
11.5	Process and Effluent Radiological Monitoring and Sampling Systems	18	1
Totals		94	5

Technical Topics of Interest:
DCD Section 11.1 – Source Terms

SER Section 11.1 – No Open Items:

- Key SRP Interfaces: Sections 11.2, 11.3, 12.2 to 12.4, and Section 15.0.3
- Input for radwaste systems analyses and design basis accident radiological consequences analyses
- Coolant source terms based on ANSI/ANS-18.1-1999
- Core isotopic inventory developed using ORIGEN-2.1
- Applicant followed SRP Section 11.1 and RG 1.112
- No COL Information Items

Technical Topics of Interest:
DCD Section 11.2 – Liquid Waste Management System

SER Section 11.2 with Open Items:

- Key SRP interfaces: Chapters 2, 9, 10, 11, 13, 14, and 16
- LWMS design basis and features, system description, processing methods, and capacities; seismic and quality group classifications; performance characteristics; instrumentation and alarm systems; automatic termination of liquid effluent release; ALARA design features; and boundary definition
- Basis and development of liquid process waste streams, estimated inputs to LWMS, and treatment process performance (decontamination factors)
- MHI proprietary version of the PWR-GALE code used to calculate liquid effluent releases (source term) during normal operations including AOOs described in MHI Technical Report MUAP-10019P/NP (R0), "Calculation Methodology for Radiological Consequences in Normal Operation and Tank Failure Analysis"

Technical Topics of Interest
DCD Section 11.2 – Liquid Waste Management System

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<u>SER Section 11.2 with Open Items (Cont'd):</u>

- Methodology, basis, and assumptions used to comply with ECLs in 10 CFR Part 20, Appendix B, Table 2, Column 2; public dose limits in 10 CFR Part 20; and design objectives in 10 CFR Part 50, Appendix I
- Epoxy coating system used to line LWMS cells/cubicles and comply with 10 CFR 20.1406 and conform to RG 4.21 and RG 1.54 (recognizing more recent standards may be used)
- Methodology, basis, and assumptions using the RATAF code to assess radiological impacts due to postulated failure of a LWMS tank
- 10 CFR 20.1406, Tier 1 and ITAAC information, TS, and pre-operational testing

Technical Topics of Interest
DCD Section 11.2 – Liquid Waste Management System

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SER Section 11.2 with Open Items (Cont'd):

- COL Information Items:
  - Mobile and temporary radwaste processing equipment and interconnection to plant systems
  - Release points, effluent temperature, shape of flow orifice, etc.
  - Hydrological data and groundwater or surface analysis comply with ECLs in 10 CFR Part 20, Appendix B, Table 2 for liquid tank failure
  - Offsite liquid effluent doses comply with 10 CFR Part 20; 40 CFR Part 190 under 10 CFR 20.1301(e); and 10 CFR Part 50, Appendix I
  - Implementation milestones for epoxy coatings program
  - CBA
  - P&IDs

Technical Topics of Interest
DCD Section 11.2 – Liquid Waste Management System

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<u>SER Section 11.2 with Open Items (Cont'd):</u>

- **Open Item 11.02-1 (RAI 624-4972, Question 11.02-33, Item 2)**: Provide calculation packages of liquid effluent releases (both normal and maximum releases) using the MHI PWR-GALE code and comparisons to the ECLs in 10 CFR Part 20, Appendix B, Table 2, Column 1; and liquid effluent doses using the LADTAP II code.

- **Open Item 11.02-2 (RAI 711-5533, Question 11.02-34)**: Provide updated RATAF code files on the new approach for the liquid tank failure analysis described in MHI Technical Report MUAP-10019P/NP (R0).

Technical Topics of Interest
DCD Section 11.3 – Gaseous Waste Management System

SER Section 11.3 with Open Items:

- Key SRP interfaces: Chapters 6, 9, 10, 11, 13, 14, and 16
- GWMS design basis and features, system description, processing methods, and capacities; seismic and quality group classifications; performance characteristics; instrumentation and alarm systems; automatic isolation of gaseous waste process flow and effluent release; hydrogen and oxygen monitoring; ALARA design features; and release point
- Basis and development of gaseous process waste streams, estimated inputs to GWMS, treatment process performance (removal efficiencies and holdup time), and building ventilation systems

Technical Topics of Interest
DCD Section 11.3 – Gaseous Waste Management System

United States Nuclear Regulatory Commission
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<u>SER Section 11.3 with Open Items (Cont'd):</u>

- MHI proprietary version of the PWR-GALE code used to calculate gaseous effluent releases (source term) during normal operations including AOOs described in MHI Technical Report MUAP-10019P/NP (R0)

- Methodology, basis, and assumptions used to comply with ECLs in 10 CFR Part 20, Appendix B, Table 2, Column 1; public dose limits in 10 CFR Part 20; and design objectives in 10 CFR Part 50, Appendix I

- Methodology, basis, and assumptions to assess radiological impacts due to postulated failure of a waste gas surge tank and charcoal bed leak

- No mobile or temporary equipment or connections to permanently installed equipment considered in GWMS design

- 10 CFR 20.1406, Tier 1 and ITAAC information, TS, and pre-operational testing

Technical Topics of Interest
DCD Section 11.3 – Gaseous Waste Management System

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SER Section 11.3 with Open Items (Cont'd):

- COL Information Items:
  - Onsite vent stack design parameters and release point characteristics
  - Release points, effluent temperature, shape of flow orifice, etc.
  - Offsite gaseous effluent doses comply with 10 CFR Part 20; 40 CFR Part 190 under 10 CFR 20.1301(e); and 10 CFR Part 50, Appendix I
  - CBA
  - P&IDs

Technical Topics of Interest
DCD Section 11.3 – Gaseous Waste Management System

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<u>SER Section 11.3 with Open Items (Cont'd):</u>

- **Open Item 11.03-1 (RAI 629-4973, Question 11.03-18, Item 2)**: Provide calculation packages of gaseous effluent releases (normal and maximum releases) using the MHI PWR-GALE code and ECL comparisons of 10 CFR Part 20, Appendix B, Table 2, Column 1; gaseous effluent doses using the GASPAR II code; waste gas surge tank leak; and charcoal bed analysis.

- **Open Item 11.03-2 (RAI 712-5534, Question 11.03-19)**: Provide ITAAC to address explosive monitoring in the GWMS design.

Technical Topics of Interest
DCD Section 11.4 – Solid Waste Management System

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SER Section 11.4 – No Open Items:

- Key SRP interfaces: Chapters 9, 11, 13, 14, and 16
- SWMS design basis and features, system description, processing methods, and capacities; seismic and quality group classifications; performance characteristics; instrumentation and alarm systems; annual estimated waste generation rates; ALARA design features; capability to move drums and HICs; provision for mobile or temporary equipment; and boundary definition
- No direct liquid and gaseous effluent releases from SWMS (associated releases and compliance with ECLs and dose limits are addressed in DCD Sections 11.2 and 11.3)
- Basis for design storage capacity of Class A, B, and C radioactive wastes

Technical Topics of Interest
DCD Section 11.4 – Solid Waste Management System

SER Section 11.4 – No Open Items (Cont'd):

- PCP
  - Description of operational program for processing of Class A, B, and C LLRW to comply with 10 CFR 61.55 and 10 CFR 61.56
  - DCD adopts NEI PCP template 07-10A until a plant-specific PCP is developed to support plant operation
  - Approach acceptable given staff endorsement of NEI PCP template

- 10 CFR 20.1406, Tier 1 and ITAAC information, TS, and pre-operational testing

- Epoxy coating system used to line SRST rooms and comply with 10 CFR 20.1406, and conform to RG 4.21 and RG 1.54 (recognizing more recent standards may be used)

Technical Topics of Interest
DCD Section 11.4 – Solid Waste Management System

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<u>SER Section 11.4 – No Open Items (Cont'd):</u>

- COL Information Items:
  - Onsite radioactive waste storage
  - PCP and implementation milestones
  - Mobile/portable SWMS connections and other non-radioactive systems that may become contaminated and related operational procedures
  - Offsite laundry services or mobile compaction unit subsystem
  - CBA (addressed in DCD Sections 11.2 and 11.3)
  - Contract services or compaction equipment for solid waste
  - P&IDs
  - Mobile and temporary solid radioactive waste processing and interconnection to plant systems comply with 10 CFR 50.34a; 10 CFR 20.1406; and RG 1.143

Technical Topics of Interest
DCD Section 11.5 – Process Effluent Radiation Monitoring and Sampling Systems

<u>SER Section 11.5 with Open Items:</u>

- Key SRP interfaces: Chapters 5, 6, 7, 9, 10, 11, 13, 14, and 16
- PERMS design basis and features, system descriptions, types, number, and locations of PERMS monitors and samplers; seismic and quality group classifications; operational ranges, sensitivities, and alarms; system calibrations and provisions for built-in check sources; provisions for automatic isolation and termination features; and ALARA design features
- Plant process systems and effluent flow paths monitored by radiation monitoring and sampling equipment
- 10 CFR 20.1406, Tier 1 and ITAAC information, TS, and pre-operational testing

Technical Topics of Interest
DCD Section 11.5 – Process Effluent Radiation Monitoring and Sampling Systems

SER Section 11.5 with Open Items (Cont'd):

- ODCM
  - Description of the operational program for controlling and monitoring all effluent releases and assessing offsite doses in accordance with 10 CFR 20.1301; 10 CFR 20.1302; 40 CFR Part 190 as referenced in 10 CFR 20.1301(e); 10 CFR Part 20, Appendix B, Table 2 ECLs; and design objectives of 10 CFR Part 50, Appendix I
  - DCD adopts NEI ODCM template 07-09A until a plant and site-specific ODCM is developed to support plant operation
  - Approach acceptable given staff endorsement of NEI ODCM template

- RCS leakage detection conforms to RG 1.45 (Revision 1) and ANSI N42.18-2004, and primary-to-secondary leakage detection conforms to NEI 97-06 for TS basis

Technical Topics of Interest
DCD Section 11.5 – Process Effluent Radiation Monitoring and Sampling Systems

SER Section 11.5 with Open Items (Cont'd):

- COL Information Items:
  - Aspects beyond PERMS design in accordance with RG 1.12, RG 1.33, and RG 1.45; and comply with 10 CFR Part 50, Appendix I for offsite doses from liquid and gaseous effluent streams
  - ODCM with description of methods and parameters for radiation monitor setpoints and follow NEI ODCM template 07-09A
  - REMP and follow NUREG-1301, NUREG-0133, NEI ODCM template 07-09A
  - Analytical procedures and sensitivity radioanalytical methods and type of sampling media
  - Procedures related to radiation monitoring instruments
  - Analytical procedures and sensitivity radioanalytical methods and sampling media type
  - CBA (addressed in DCD Sections 11.2 and 11.3)

Technical Topics of Interest
DCD Section 11.5 – Process Effluent Radiation Monitoring and Sampling Systems

SER Section 11.5 with Open Items (Cont'd):

- **Open Item 11.05-1 (RAI 629-4973, Question 11.03-18, Item 4)**: Provide supporting information to describe the provisions to avoid unmonitored releases and uncontrolled radioactive releases to the environment.

Conclusions
DCD Chapter 11

- Resolution of open items expected in Phase 4 of DCD review

- Significant COL Information Items:
  - Offsite liquid and gaseous offsite doses
  - Liquid tank failure analysis
  - P&IDs
  - Epoxy coating system
  - Related operational, analytical, and radiation monitoring procedures
  - CBA
  - PCP
  - ODCM

Conclusions
DCD Chapter 11

Questions?

ACRONYMS

ALARA – as low as is reasonably achievable
ANSI – American National Standards Institute
AOOs – anticipated operational occurrences
CBA – cost-benefit analysis
COL – combined license
DCD – Design Control Document
ECLs – effluent concentration limits
GWMS – gaseous waste management system
HEPA – high-efficiency particulate air
HICs – high integrity containers
ITAAC – inspection, test, analysis, and acceptance criteria
LLRW – low-level radioactive waste
LWMS – liquid waste management system
NEI – Nuclear Engineering Institute
NUREG – US Nuclear Regulatory Commission Regulation
ODCM – Offsite Dose Calculation Manual
PERMS – process effluent radiation monitoring and sampling systems
P&IDs – piping and instrumentation diagrams
PCP – process control program
RAI – request for additional information
RCS – reactor coolant system
REMP – radiological environmental monitoring program
RG – Regulatory Guide
SER – safety evaluation report
SRP – Standard Review Plan
SRST – spent resin storage tank
SWMS – solid waste management system
TS – technical specifications

Presentation to ACRS

Chapter 12: Radiation Protection

Mitsubishi Heavy Industries, Ltd.
April 22, 2011

Key US-APWR Presenters

- **Masaki Omura – Acting Manager, Radiation Safety Engineering Section, MHI**
- **Motoki Konno – Acting Manager, Radiation Safety Engineering Section, MHI**
- **Irving Tsang – Principal Discipline Engineer – Nuclear, URS**

Contents

1. Overview (1/2)

- Chapter 12 : Radiation Protection

- Scope of Chapter

This chapter includes design descriptions of the following items:

- ✓ **Considerations for ALARA***
- ✓ **Radiation Sources**
- ✓ **Radiation Protection Design Features**
- ✓ **Dose Assessment**
- ✓ **Operational Radiation Protection Program**

***ALARA : As Low As Reasonably Achievable**

1. Overview (2/2)

- List of Acronyms
  - ALARA : as low as reasonably achievable
  - ARMS : area radiation monitoring system
  - BAE : boric acid evaporator
  - CLP : cask load pit
  - CVCS : chemical and volume control system
  - DAC : derived air concentration
  - FIP : fuel inspection pit
  - HVAC : heating, ventilation and air conditioning
  - ICIS : incore instrumentation system
  - ISI : inservice inspection
  - LWMS : liquid waste management system
  - PMWT : primary makeup water tank
  - PRA : probabilistic risk assessment
  - RAI : request for additional information
  - RCS : reactor coolant system
  - RG : Regulatory Guide
  - RHRS : residual heat removal system
  - RWSAT : refueling water storage auxiliary tank
  - SER : safety evaluation report
  - SFP : spent fuel pit
  - VHRA : very high radiation area

2. Outline of Subsections (1/10)

Section	Title	Description
12.1	Ensuring that Occupational Radiation Exposures are As Low As Reasonably Achievable	➢ **Policy Considerations** Design Policies: Design shall incorporate compliance with regulatory requirements, reduction of doses to plant personnel, the public, and the environment. The design shall also consider the use of updated technologies, lessons learned, and industry operational experiences. ➢ **Design Considerations** Equipment shielding and facility layout are designed with consideration of ALARA criteria to reduce radiation levels and to minimize personnel exposure Examples include: ✓ Provisions to drain, flush, & decontaminate equipment ✓ Water chemistry counter-measures ✓ Permanent and portable shielding ✓ Layout and HVAC design to minimize contamination ✓ Separation of radioactive and non-radioactive systems ✓ All welded piping system to reduce leakage ✓ Piping vents and drain directly to collection tanks

2. Outline of Subsections (2/10)

Section	Title	Description
12.1	Ensuring that Occupational Radiation Exposures are As Low As Reasonably Achievable	➢ **Operational Considerations** Operational Radiation Protection Program in accordance with applicable RGs → COL Item

2. Outline of Subsections (3/10)

Section	Title	Description
12.2	Radiation Sources	➢ **Sources for Full-Power Operation** ✓ Contained Sources: • Based on the design basis source term (1% fuel defect included). • N-16 is the predominant activity in the RCS. The very short half-life is included in the evaluation of N-16 activity in each component. ✓ Airborne Sources: • Based on the design basis source term (1% fuel defect included) • Primarily from RCS, spent fuel pit, and refueling cavity water based on assumed constant leakage/evaporation • Leak rate, evaporation rate and flow rate of HVAC system assumed for each building (RB, AB, etc) are set separately.

2. Outline of Subsections (4/10)

Section	Title	Description
12.2	Radiation Sources	➢ **Sources for Shutdown** ✓ <u>Reactor Core:</u> Specific power of 32.1 MW/MTU and two cycles operation assumed ✓ <u>Spent Fuel:</u> Specific power of 32.1 MW/MTU and burn-up of 62 GWD/MTU assumed ✓ <u>Incore Flux Thimbles:</u> Activated Cobalt-60 included ➢ **Sources for Design-Basis Accidents** ✓ Fission product release into containment based on RG 1.183 included ➢ **COL Item Topics** ✓ Identification of additional sources not already listed ✓ Radiation protection for additional radwaste storage ✓ RWSAT and PMWTs dose rates compliance and radioactivity concentration controls

2. Outline of Subsections (5/10)

Section	Title	Description
12.3	Radiation Protection Design Features	➢ **Facility Design Features** ✓ RCS components are designed with remote inspection, easy replacement components to reduce maintenance time, or through tight material specifications ✓ Radioactive components are in cubicles with sufficient wall thicknesses to reduce radiation level in surrounding areas; cubicles are designed to have access labyrinths to minimize radiation streaming and to provide easy access to reduce stay time for maintenance activities ✓ Radiation zone are established to control access and work (see zoning slide later) ✓ RG 4.21 compliance features built into the design and are supplemented by operational programs as COL Items

2. Outline of Subsections (6/10)

Section	Title	Description
12.3	Radiation Protection Design Features (Continued)	➢ **Shielding Design** ✓ Reactor system design includes primary and secondary shields; and has labyrinth design to minimize neutron streaming ✓ Shielding is designed assuming maximum postulated radiation levels ✓ Reactor Building corridors are shielded to allow Zone III access ✓ Design considers the use of removable sections of block shield walls for equipment maintenance ➢ **Ventilation Design** ✓ Air flows from low to higher contamination areas ✓ Containment ventilation flows through high-efficiency particulate air filters for contamination removal ✓ System isolation provided for affected areas in containment, fuel handling area, and AB upon contamination alarms ✓ Control Room is designed to minimize uncontrolled in-leakage in the event of an accident

2. Outline of Subsections (7/10)

Section	Title	Description
12.3	Radiation Protection Design Features	➢ **Area Radiation and Airborne Radioactivity Monitoring Instrumentation Design** ✓ Provides indication of plant radiological conditions to ensure radiation exposure is ALARA ✓ Complies with RGs 1.21, 1.97, 8.2, 8.8 ✓ ARMS conform with ANSI/ANS HPSSC-6.8.1 ➢ **COL Item Topics** ✓ Portable instrumentation for airborne iodine concentrations during accidents ✓ Site-specific radiation zones ✓ Administrative and access controls of fuel transfer tube areas ✓ Radiological considerations for mobile LWMS installation ✓ BAE room controls to prevent VHRA ✓ Site-specific RG 4.21 compliance issues

2. Outline of Subsections (8/10)

➢Radiation Zones for Shielding Design and Radiation Control

Zone	Maximum Dose Rate	Description
I	0.25 mrem/h	Controlled area, unlimited occupancy
II	1 mrem/h	Restricted area, limited occupancy
III	2.5 mrem/h	Restricted area, limited occupancy
IV	15 mrem/h	Restricted area, limited occupancy
V	100 mrem/h	Restricted area, limited occupancy
VI	1 rem/h	High radiation sources. Restricted area, limited occupancy for very short periods. Access controlled as stated in the Technical Specifications.
VII	10 rem/h	Same as Zone VI above
VIII	100 rem/h	Same as Zone VI above
IX	500 rad/h	Same as Zone VI above
X	> 500 rad/h	Very high radiation sources. Restricted area, very limited occupancy for the shortest periods. Access controlled as stated in the Technical Specifications.

2. Outline of Subsections (9/10)

12.4 Dose Assessment

- **Dose assessments are calculated based on RG 8.19**
- **Total annual station exposure is about 71 person-rem, less than the 100 person-rem value provided in NUREG-0713**
- **DCD Section 12.4 tables provide dose assessment values**

Category	Reference Tables	Estimated Annual Person-Rem Exposure
Occupational Dose Estimates During Routine Operations and Surveillance	Table 12.4-1	0.77
Occupational Dose Estimates During Nonroutine Operations and Surveillance	Table 12.4-2	8.61
Occupational Dose Estimates During Routine Maintenance	Table 12.4-3	17.93
Waste Processing	Table 12.4-4	5.63
Refueling	Table 12.4-5	8.74
Inservice Inspection	Table 12.4-6	11.6
Special Maintenance	Table 12.4-7	17.75
Total		71.03

2. Outline of Subsections (10/10)

Section	Title	Description
12.5	Operational Radiation Protection Program	✓ The operational radiation protection program for ensuring that occupational radiation exposures are ALARA → COL Item

3. RG 4.21 Compliance (1/3)

Section	Title	Description
12.3.1.3	Minimization of Contamination and Radioactive Waste Generation	➢ Added new DCD section to address 10 CFR 20.1406 and RG 4.21 requirements in DCD Chapter 12 Rev.3. ✓ Identify waste minimization design objectives ✓ Include a summary table (Table 12.3-8) to describe design features at system level ✓ Key design features: ✓ Minimize waste generation and contamination ✓ Designed with early leak detection system for quick operator actions to minimize waste generation ✓ Segregate waste collection and processing (separate equipment versus floor drains, sludge) ✓ Recycle boric acid concentrate and condensate ✓ Cubicle design segregates and minimizes cross contamination in the event of overflows and leaks ✓ Non contaminated piping is segregated as much as possible and connection to the potential contaminated piping is protected with double isolation devices

3. RG 4.21 Compliance (2/3)

Section	Title	Description
12.3.1.3	Minimization of Contamination and Radioactive Waste Generation	✓ Minimize unintended leakage ✓ Minimize buried piping within plant island ✓ Use of double-walled HDPE piping for effluent release at site specific conditions ✓ Use of low porosity concrete for basemat ✓ Tank cubicles are sloped and coated with epoxy to provide smooth surfaces for cleaning and faster drainage ✓ Provides early leak detection and warning for operator actions ✓ Provides sloped piping sleeves for penetrations between buildings

3. RG 4.21 Compliance (3/3)

Section	Title	Description
12.3.1.3	Minimization of Contamination and Radioactive Waste Generation	✓ Prompt Responses ✓ Individual leak detection alarms facilitate prompt identification of leakage source ✓ Alarm locally and in Main Control Room (representative alarm) for quick operator actions ✓ Cubicles are designed with access-ways ✓ Tanks are designed with isolation valves and inter-tank transfer capability for quick remediation ✓ Demineralized water is provided for decontamination of equipment, piping and areas

4. Confirmatory Items

- Several Ch 12 RAI responses occurred after DCD Rev. 2 was issued
- In all cases, the NRC has preliminarily accepted MHI's proposed closure of the issue identified in the RAI, subject to confirmation of inclusion in a future revision of the US-APWR DCD
- MHI has confirmed that the RAI response information has been included in DCD Rev. 3 issued at the end of March 2011
- Therefore, MHI believes that the NRC will close all of the confirmatory items after review of DCD Rev. 3

5. Open Items (1/5)

- ***<u>Open Item 12.02-1</u>: RAI 532-4019, Question 12.02-27***
  - *CVCS Letdown Flow Rate and Airborne Activity Concentration*

✓ *<u>Outstanding Issue</u>: MHI revised Section 9.3.4.1.2.3 to indicate that the CVCS can provide purification rates up to 400 gpm when using the RHRS for letdown cooling during shutdown without explaining how the 110-180 gpm design for the CVCS demineralizers can accommodate the 400 gpm flow rate.*

✓ *<u>MHI action</u>: MHI will discuss with NRC staff to close this issue.*

✓ *<u>Proposed response</u>: During shutdown purification operation, the CVCS filters and demineralizers are aligned as two parallel trains to accommodate the higher flow. The filters and demineralizers are designed with sufficient margins and are capable of handling the higher flow. It is anticipated that the higher flow condition is short term (about two days).*

5. Open Items (2/5)

- ***<u>Open Item 12.02-2</u>: RAI 532-4019, Question 12.02-29***
  - *Tank House Enclosure*
- ✓ *<u>Outstanding Issue</u>: The DCD should include the design features of the Tank House enclosure for PMWT and RWSAT, including the ventilation controls and effluent monitoring for the area.*

- ✓ *<u>MHI action</u>: MHI will discuss with NRC staff to close this issue.*
- ✓ *<u>Proposed response</u>: MHI responded to Question 12.02-29 in September, 2010, but additional information may be required in the DCD. MHI also responded to Question RAI 578-4483, Question #12.03-12.04-38 on August 09, 2010. A description of the PMWT tank house was included in DCD Revision 3. RWSAT is included in the same tank house with similar design features. The RWSAT description will be included in the next revision of the DCD. Currently this information is part of the Open Item 12.03-12.04-4, RAI 578-4483 Question 12.03-12.04-38.*

5. Open Items (3/5)

- ***<u>Open Item 12.03-12.04-1</u>: RAI 429-3178, Question 12.03-12.04-27, Part 2***
  - *Mission Doses*

✓ *<u>Outstanding Issue</u>: Insufficient data and description of mission pathways on radiation exposure associated with repair, recalibration, and replacement of qualified instruments following an accident.*

✓ *<u>MHI action</u>: MHI will discuss with NRC staff to close this issue.*

✓ *<u>Proposed response</u>: MHI provided the additional data in the response to RAI 589-4536, Question 03.11-38, including a revision to DCD Table 3D-2, Table 12.3-10 (Mission Doses for Access Areas and Access Route: 1 Week after an Accident) and Figure 12.3-11 (Post Accident Radiation Map: 1 Week after an Accident), and these revisions are included in DCD Revision 3.*

5. Open Items (4/5)

- ***<u>Open Item 12.03-12.04-2</u>: RAI 524-4020, Question 12.03-12.04-35***
    - *Rapid Refueling Cavity Drain Down*

✓ *<u>Outstanding Issue</u>: Insufficient data on doses during transferring spent fuel in the event of a postulated rapid refueling cavity drain, and the justification on continued use Fuel Drop Accident Analysis method.*

✓ *<u>MHI action</u>: MHI amended the response to Question 12.03-12.04-35 on September, 2010. MHI will discuss with NRC staff regarding the responses to RAI 507-3993 Question 09.01.04-16, and RAI 524-4020 Question 12.03-04-35, to close this issue.*

5. Open Items (5/5)

- ***<u>Open Item 12.03-12.04-3</u>: RAI 578-4483, Question 12.03-12.04-37***
- ***<u>Open Item 12.03-12.04-4</u>: RAI 578-4483, Question 12.03-12.04-38***
  - *RG 4.21 Compliance*

✓ *<u>Outstanding Issue</u>: Insufficient description on design features provided to demonstrate compliance with 10 CFR 20.1406*

✓ *<u>MHI action</u>: Amended response to RAI #578 is currently in final review cycle for submittal. The amended response includes the information outlined in this presentation earlier.*

6. Summary

- *Policy considerations, design considerations, radiation sources, and radiation protection design features described in Chapter 12 ensure that occupational exposures are ALARA.*
- *Radiation protection design complies with 10 CFR 20 and 10 CFR 50 for normal operation/shutdown and design basis post-accident actions.*
- *Dose assessment for occupational exposures and design basis post-accident actions meet NRC's general requirements and/or 10 CFR 50.34.*

Presentation to the ACRS Subcommittee

Mitsubishi Heavy Industries (MHI)

US-APWR Design Certification Application Review

Safety Evaluation with Open Items: Chapter 12

RADIATION PROTECTION

April 22, 2011

Staff Review Team

- **Technical Staff**
  - **Ronald LaVera** – DCD Sections 12.1 to 12.5
    Construction Health Physics Branch
- **Project Managers**
  - Jeff Ciocco – Lead Project Manager
  - Ngola Otto – Project Manager

Overview of Design Certification Application, Chapter 12

SRP Section/Application Section		No. of Questions	Number of OI
12.1	Ensuring that Occupational Radiation Exposures are ALARA	2	0
12.2	Radiation Sources	31	2
12.3-12.4	Radiation Protection Design Features (including Dose Assessment)	39	4
12.5	Operational Radiation Protection Program	0	0
Totals		72	6

Technical Topics

Section 12.1 - Ensuring that Occupational Exposures are As Low As is Reasonably Achievable (ALARA)

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Technical Topics Reviewed:

- ALARA considerations applied during initial design
- Equipment design considerations for ALARA
- Facility layout considerations to maintain exposures ALARA
- COL Information Items
  - Fully describe the elements of the Operational Radiation Protection program for ensuring that the occupational exposures are ALARA consistent with 10 CFR Part 20 and the applicable RGs.
    - NEI 07-03A – Radiation Protection Program
    - NEI 07-08A – ALARA Program

Technical Topics

Section 12.2 – Radiation Sources

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Technical Topics – Contained Sources:

- Types of contained sources
  - Reactor and Reactor Coolant System
  - Tanks and pools
    - **Open Item 12.02-2 (RAI 532-4019, Question 12.02-29): Tank House Enclosure**
  - Equipment concentrating activity
    - Filters and resin demineralizers
    - Boric Acid Evaporators
  - Irradiated components
- Basis for stated content

Technical Topics
Section 12.2 – Radiation Sources

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Technical Topics – Airborne Activity:

- Areas potentially containing airborne activity
  - Containment Building
  - Radiological portions of:
    - Reactor Building
    - Auxiliary Building
- Basis for stated content
  - **Open Item 12.02-1 (RAI 532-4019, Question 12.02-27): CVCS Letdown Flow Rate and Airborne Activity Concentrations**.
- Special Equipment areas (e.g. Boric Acid Evaporators)

Technical Topics

Section 12.3-12.4 – Radiation Protection Design Features (Including Dose Assessment)

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Technical Topics – Facility Design Features:

- Source control
  - Minimizing Cobalt-60
  - Controlling activity concentration in Boric Acid Evaporator fluids
- Component specifications
  - Improving reliability
  - Reducing maintenance
- Radiation Zones and Barriers
  - Separating highly radioactive pipes from other components
  - Mobile Liquid Waste Processing System

Technical Topics – Facility Design Features:

- Shielding
  - Fuel transfer tube access labyrinths barriers are specified on drawings.
  - Fuel transfer tube gate valve reach rod and fuel handling tools design features
  - Fuel Inspection Pit and Cask Load Pit design features
- Applicant added
  - COL 12.3(8) to verify shielding design for Mobile Liquid Waste Processing System
  - Applicant added COL 12.3(9) to limit activity concentration in the Boric Acid Evaporators

Technical Topics

Section 12.3-12.4 – Radiation Protection Design Features (Including Dose Assessment)

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Technical Topics – Facility Design Features:

- **Open Item 12.03-12.04-2 (RAI 524-4020, Question 12.03-12.04-35): Rapid Refueling Cavity Drain Down** Potential for very high dose rates from fuel and irradiated components in Refueling Cavity.
  - Assumed leakage rate does not reflect industry experience
  - Protection of 6 fuel bundles in two fuel racks attached to the Refueling Cavity wall is not described.
- Refueling Cavity water loss
  - US-APWR does have a permanent Cavity to Reactor Vessel seal to address GSI-137 inadvertent draining of Spent Fuel Pool.
  - NRC documents describe other potential drainage paths.
- Applicant was asked to describe expected dose rates from fuel and irradiated components and safe storage locations for in transit fuel.

Technical Topics

Section 12.3-12.4 – Radiation Protection Design Features (Including Dose Assessment)

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Technical Topics – Facility Design Features:

- Added areas to use portable Area Radiation Monitors (ARM)
  - Refueling platform
  - Residual heat removal pump and heat exchanger areas
  - Hot machine shop
  - HVAC filter area
  - Cask handling area
  - Equipment decontamination area
  - Safe shutdown panel area
- Relocated the Incore Instrument System ARM.
- Added information about calibration and set point control.

Technical Topics

Section 12.3-12.4 – Radiation Protection Design Features (Including Dose Assessment)

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Technical Topics – Facility Design Features:

- Minimization of Contamination - 10 CFR 20.1406(b)
  - Describe design features to minimize contamination
    - **Open Item 12.03-12.04-3 (RAI 578-4483, Question 12.03-12.04-37): RG 4.21 Compliance**
      - DCD does not contain all design features described in RAI responses.
    - **Open Item 12.03-12.04-4 (RAI 578-4483, Question 12.03-12.04-38): RG 4.21 Compliance**
      - Design features for some sections of Condensate, Blow down and Auxiliary Steam systems not fully described.
  - Added reference to RG 4.21 and NEI 08-08A
  - Applicant added COL Action Items

Technical Topics – Dose Assessment:

- US-APWR cumulative annual dose of 0.7103 person-Sievert
  - US-APWR estimated 0.44 person-mSv per MW-y, for a 95 percent capacity factor

- NUREG-0737 post accident mission doses
  - Some additional missions were identified and added to section 12.4
  - **Open Item 12.03-12.04-1(RAI 429-3178, Question 12.03-12.04-27, Part 2): Mission Dose**
    - Information provided in US-APWR DCD section 3.11 Equipment Qualification, indicates the need for additional post accident missions not described in section 12.4 and adjustment of projected doses.

Technical Topics

Section 12.5 - Operational Radiation Protection Program

Technical Topics – Operational Radiation Protection Program:

- No Open Items
- No Confirmatory Actions
- Required to be provided by COL applicant
- Radiation Protection and ALARA Programs as described in Nuclear Energy Institute templates:
  - NEI 07-03A Generic DCD Template Guidance for Radiation Protection Program Description
  - NEI 07-08A Generic FSAR Template Guidance for Ensuring that Occupational Radiation Exposures are as Low as is Reasonably Achievable (ALARA)

Conclusion

Questions?

ACRONYMS

10 CFR – Title 10 of the Code of Federal Regulations
ALARA – as low as is reasonably achievable
ARM – area radiation monitor
COL – combined license
FSAR – Final Safety Analysis Report
GSI – generic safety issue
HEPA – high-efficiency particulate air
HVAC – heating, ventilation, and air conditioning
ITAAC – inspection, test, analysis, and acceptance criteria
NEI – Nuclear Engineering Institute
NEI 08-08A – "Guidance for Life Cycle Minimization of Contamination"
NUREG-0737 – "Clarification of TMI Action Plan Requirements"
PMWT – primary makeup water tank
RAI – request for additional information
RG – Regulatory Guide
RWSAT – refueling water storage auxiliary tank
SER – safety evaluation report
SRP – Standard Review Plan

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Presentation to the ACRS Subcommittee

Interim Staff Guidance (ISG) 21

Gas Turbine Generators

April 22, 2011

Background

- Emergency Diesel Generators (EDG) are most common for emergency AC power on existing reactors
- Gas Turbine Generators (GTG) are provided as emergency AC power sources for U.S. APWR
- Much of current regulatory guidance is EDG-specific
- Staff developed guidance, ISG-21, for Gas Turbine Generators in parallel with U.S. APWR review

Current Guidance

United States Nuclear Regulatory Commission
Protecting People and the Environment

- NUREG-0800 Series (Standard Review Plan) sections 8.3.1, 9.5.4, 9.5.5, 9.5.6, 9.5.7, 9.5.8
- Regulatory Guide 1.9, “Application and Testing of Safety-Related Diesel Generators in Nuclear Power Plants”

ISG-21 does not change already existing regulatory guidance in these documents. It supplements the guidance in these documents to provide guidance on gas turbine generators.

ISG-21 Contents

Article 1: Introduction
Article 2: Application and Testing of GTG (RG 1.9)
Article 3: AC Power Systems (SRP 8.3.1)
Article 4: Fuel Oil Storage and Transfer (SRP 9.5.4)
Article 5: GTG Cooling Water (SRP 9.5.5)
Article 6: GTG Start System (SRP 9.5.6)
Article 7: GTG Lubrication System (SRP 9.5.7)
Article 8: GTG Air Intake and Exhaust (SRP 9.5.8)

ISG-21 is organized this way to make it easier to incorporate these changes into next RG revision and SRP update

Examples of Standards Referenced in ISG-21

- 1) International Standardization Organizational (ISO) 3977-3, "Gas Turbine Procurement Part 3 Design Requirements," August 18, 2004.

- 2) American Society of Mechanical Engineers (ASME) PTC 22-2005 "Performance Test Code on Gas Turbines," May 30, 2006

- 3) IEEE Std. 387-1995, "IEEE Standard Criteria for Diesel-Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations," IEEE, Piscataway, NJ, 1995.

Public Comments

- 30 comments, most were incorporated
- Exceptions:
  - -Applicability of some of the standards
  - -Freeze/Ice protection
  - -Vibration
  - -Air Receiver Capacity for successive starts
- Startup Testing

"A sufficient number of valid start and load tests shall be performed in order that a minimum reliability of 95% with a confidence level of at least 95% can be demonstrated. If the reliability and/or loading capability of the EGTG are significantly affected by either ambient temperature or the temperature of the GTG components when starting, the test conditions for the start and load tests should account for these temperature conditions."

Conclusion

- MHI U.S. APWR design uses GTG as emergency AC power source.
- RAIs were used in reviewing and reaching a safety evaluation on MHI's design
- ISG-21 was developed in parallel as RAIs were developed to provide regulatory guidance using lessons learned for future applications
- ISG-21 is guidance. Applicants can meet regulations using other design features as justified

US-APWR
Design Certification Application

Gas Turbine Generator Qualification

April 22, 2011

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Contents

1. Initial Type Test Program

➢ Class 1E GTG Testing Program

✓ Regulatory Guide 1.9 Rev 4

- Application and Testing of Safety-related Diesel Generators in Nuclear Power Plants

✓ IEEE 387-1995

- IEEE Standard Criteria for diesel Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations.

✓ ISG-21

- Interim Staff Guidance On the Review of Nuclear Power Plant Designs using a Gas Turbine Driven Standby Emergency Alternating Current Power System

✓ Qualification Test Plan (MUAP-07024 Rev 2)

- Qualification and Test Plan for Class 1E Gas Turbine Generator System

1. Initial Type Test Program

➢ Scope

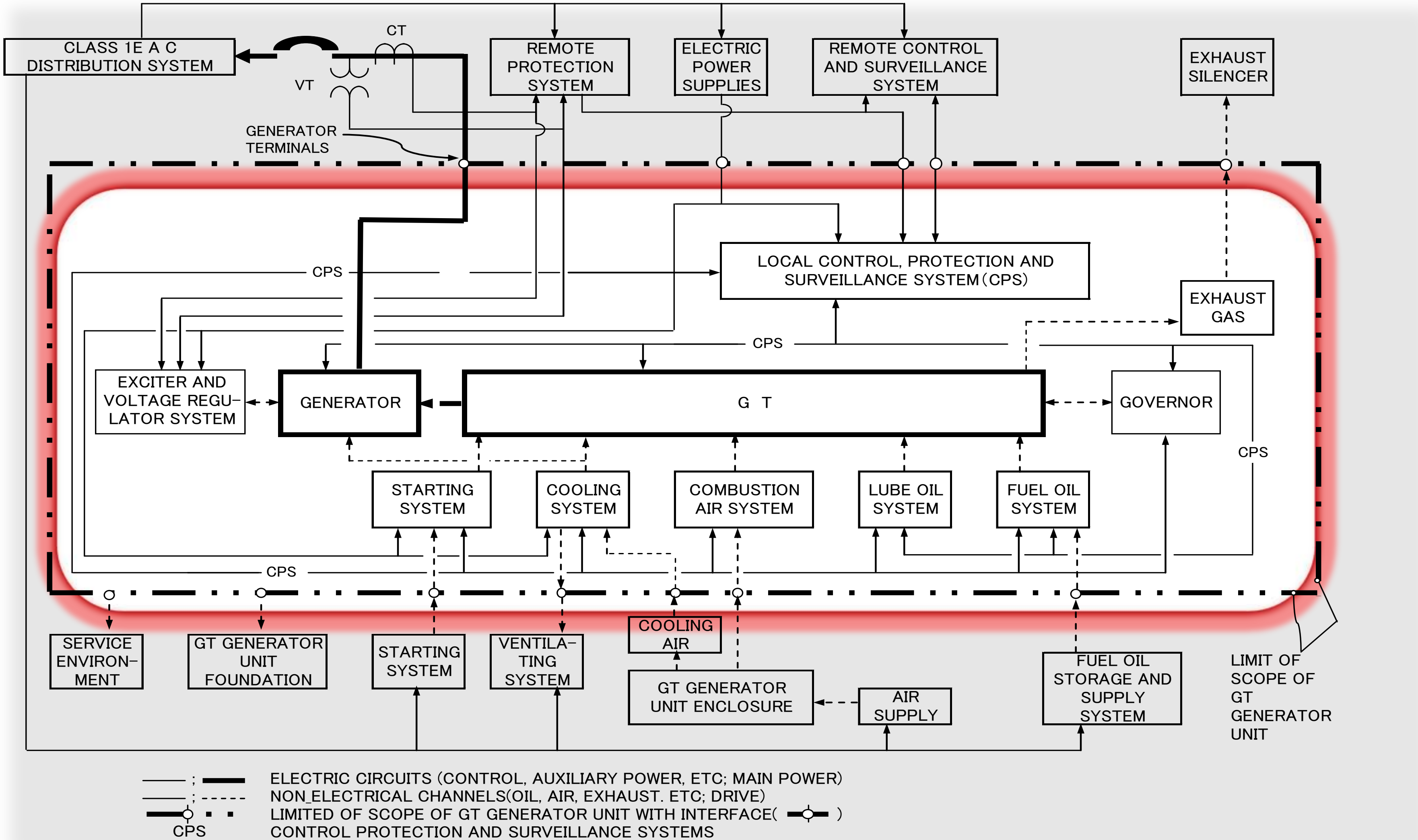


Figure 1-1: Boundary of MHI's GTG Class 1E qualification

1. Initial Type Test Program

- **Class 1E Gas Turbine Generator Specifications/Ratings**
  - ✓ Gas Turbine Generator Ratings
    - Continuous Rating: 4500 kW / 5625 kVA
    - Power Factor of 0.8
    - 6900 Volt; 3 Phase, 60 hertz
  - ✓ Start time
    - < 100 Seconds start time
  - ✓ Load
    - Limiting Case; LOOP+LOCA

1. Initial Type Test Program

➢ Class 1E GTG Initial Type Tests

- ✓ Load Capability Test
  - IEEE 387 Section 6.2.1
  - Demonstrate the capability to carry rated load
- ✓ Start and Load Acceptance Test
  - IEEE 387 Section 6.2.2
  - Establish the capability to start and accept load within the required time period.
  - Support Start Reliability Determination
- ✓ Margin Test
  - IEEE 387 Section 6.2.3
  - Demonstrate the capability to carry the most severe load step + 10%
- ✓ Internal Tests
- Load Transient test (Not part of the initial type test)

1. Initial Type Test Program

➢ Test Schedule

✓ Load Capability Tests	10/29/2010
✓ Start and Load Acceptance	11/04/2010
• 20 starts at ambient temp	~
• 131 starts at operating temp	12/04/2010 (24days)
✓ Margin Test	12/04/2010
✓ Load Transient Tests	11/08/2010

2. Initial Type Test Results

➢ Outline of Load Capability Test

✓ Purpose

- Demonstrate the capability to carry the continuous rated load and successfully reject short time rated load without tripping.

✓ Scope

- Apply Rated load until Temperatures stabilize
- 2 Hours at the short Time Rating + 22 Hours at rated
- Short Time Rejection

✓ Acceptance Criteria

- Maintain load for duration while maintain normal temperature limits.
- Short time load rejection without over-speed trip

2. Initial Type Test Results

➢ Result of Load Capability Tests

Engine lubricant oil remained stable at approx. 150 (ºF) during 24 hours including 110% operation.

Table 2-1 Engine Lubricant Oil Parameter

		Engine #1			Engine #2		
		Oil Pressure (psi)	Oil Temp Engine In (ºF)	Oil Temp Plug Drain (ºF)	Oil Pressure (psi)	Oil Temp Engine In (ºF)	Oil Temp Plug Drain (ºF)
Average during 110% operation		45	154	160	46	154	148
Average during 100% 22 hour operation	Minimum	44	150	144	46	150	135
	Average	46	151	155	48	151	141
	Maximum	47	155	162	50	156	145

2. Initial Type Test Results

➢ Result of Load Capability Tests

Engine exhaust temperature (EGT) depends on output power and ambient temperature. EGT has been shown expected pattern.

Table 2-2 Engine Temperature Parameter

		Ambient Temp (°F)	Engine #1			Engine #2		
			Exhaust Temp (°F)	Air Inlet Restriction (°F)	Compressor Discharge Pressure (psi)	Exhaust Temp (°F)	Air Inlet Restriction (°F)	Compressor Discharge Pressure (psi)
Average during 110% operation		78	496.1	6.4	135	512.7	6.1	140
Average during 100% 22 hour operation	Minimum	56	441.0	6.5	135	438.0	6.1	140
	Average	65	453.5	6.5	141	449.4	6.4	143
	Maximum	73	468.0	6.5	150	463.0	6.5	150

2. Initial Type Test Results

➢ Conclusion of Load Capability Tests

- ✓ GTG successfully completed 24 hour operation with stable nominal expected engine parameters.
- ✓ GTG successfully rejected the short time rated load without tripping.

2. Initial Type Test Results

➢ Outline of Start and Load Acceptance Test

- ✓ Purpose
  - Establish the capability of the unit to start and accept load within the period of time necessary to satisfy the plant design requirements.
- ✓ Scope (ISG 21)
  - 95% reliability/95% Confidence (150 tests)
  - Selection of starting conditions support minimum reliability and confidence level based on a combination of conditions
- ✓ Acceptance Criteria
  - Successful completion of 150 starts without a start failure
    - Ready to Load within 100 Sec
    - Load acceptance > 50% of rated

2. Initial Type Test Results

➢ Result of Start and Load Acceptance Tests

Table 2-3 Engine Parameter

		Cold	Hot
Intake Air (^{o}F)		59.4	64.6
Engine #1	EGT (^{o}F)	323.3	357.3
	Lube Oil temperature (^{o}F)	33.2	67.0
	Lube Oil Pressure (^{o}F)	56.5	46.4
Engine #2	EGT (^{o}F)	323.4	357.6
	Lube Oil temperature (^{o}F)	33.1	66.7
	Lube Oil Pressure (^{o}F)	57.4	46.5

2. Initial Type Test Results

➢ Result of Start and Load Acceptance Tests

Table 2-4 Starting Time

	Minimum (sec)	Average (sec)	Maximum (sec)
Cold (20 times)	26.0	26.6	27.5
Hot (131 times)	26.0	28.0	29.0

2. Initial Type Test Results

➢ Conclusion of Start and Load Acceptance Test

✓ 20 Successful starts at ambient conditions
(Cold starts)

✓ 131 Successful starts at Normal Operating Conditions
(Hot Starts)

✓ 151 Successful starts total

- All starts <30 seconds
- >50% rated load applied to each start

➢ Outline of Margin Tests

✓ Purpose

- Demonstrate the capability to accept the most severe load step +10%.

✓ Scope

- Apply preload (running load prior to most severe step).
- Single step addition of the margin load.

✓ Acceptance Criteria

- Successfully accept the margin load step and recover to nominal values.

2. Initial Type Test Results

➢ Result of Margin Tests

Transit Response Test	Margin Test #1	Margin Test #2
Voltage Deviation	-1752 Volts -25.40%	-1746 Volts -25.30%
Voltage Recovery	850 millisec (Recover to10% of nominal) 4.0 sec (Recover to Nominal)	850 millisec (Recover to10% of nominal) 4.0 sec (Recover to Nominal)
Frequency Deviation	-1.97 Hertz -3.28%	-2.01 Hertz -3.35%
Frequency Recovery	2.5 Seconds (Recover to Nominal)	3 Seconds (Recover to Nominal)

Rated 6900 Volts; 60 Hertz

2. Initial Type Test Results

➢ Conclusion of Margin Tests

- ✓ Voltage returned to normal quickly
- ✓ Frequency recovered quickly
- ✓ Engine did not trip and retuned to stable operation

Successfully accepted margin load +10%

2. Initial Type Test Results

➢ Outline of Load Transient Test (Internal Test)

✓ Purpose

- Determine GTG voltage and Frequency Response to load addition and rejection transients.

✓ Scope

- Monitor Voltage and Frequency response to block load additions.
- Monitor Voltage and Frequency response to block load rejections.

✓ Acceptance Criteria

- Not applicable. Data gathering test.

2. Initial Type Test Results

➢ Result of Load Transient Tests (Internal Test)

Load	Parameters	Load Rejection		Transient (Load addition)	
		Variation %	Recovery Time Sec	Variation %	Recovery Time Sec
25%	Voltage	3.5	0.7	-4.4	0.8
	Frequency	0.3	2.5	-0.3	2.6
50%	Voltage	7.5	0.7	-8.6	1.1
	Frequency	0.6	3.0	-0.6	3.2
75%	Voltage	12.1	0.7	-12.5	2.2
	Frequency	0.9	3.9	-0.9	2.9
100 %	Voltage	16.9	0.7	-16.6	2.4
	Frequency	1.4	3.4	-1.4	2.4

2. Initial Type Test Results

➢ Conclusion of Load Transient Test (Internal Test)

- ✓ GTG returned to nominal Voltage and Frequency within expected times.
- ✓ Voltage and Frequency responses to transients were as expected.

3. ISG 21 Significant Differences

- **There are two items to discuss regarding ISG 21 requirement and MHI assessment:**
  - ✓ 150/100 Start Test
  - ✓ Temperature of the GT components

3. ISG 21 Significant Differences

- **150/100 Start Test**
  - ✓ GTG reliability is statistically evaluated as 3.5 X 10^{-4} per demand according to domestic GTG field data.
  - ✓ US-APWR selected to 0.975 reliability with a 95% confidence as the reliability target for the initial test of GTG (R.G. 1.155).
  - ✓ GTG start and load acceptance test without failures out of 150 trials the reliability is greater than 0.975 with an approximately 98% level of confidence.

The initial type test condition to achieve the required reliability was selected to be 150 with no failures.

3. ISG 21 Significant Differences

- **Temperature of the GT components**
  - ✓ **RG 1.9/IEEE 387 Regulatory guidance on prototype qualification is written around engine driven generators (EDG).**
  - ✓ **ISG 21 Guidance clarifies test conditions.**

    Section 2.2.2 states in part:

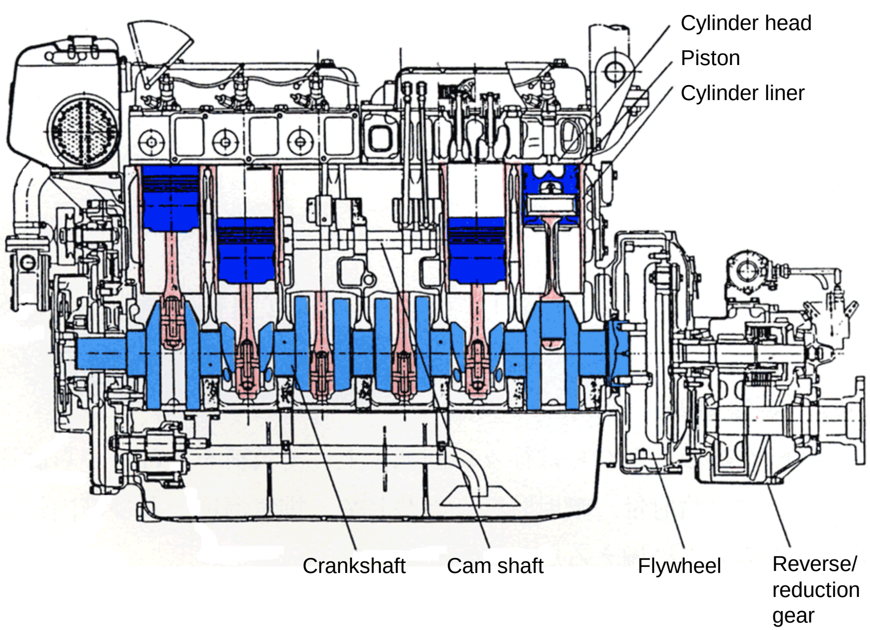
    …If the reliability and/or loading capability of the EGTG are significantly affected by either ambient temperature or the temperature of the GT components when starting, the test conditions for the start and load tests should account for these temperature conditions. The election of starting condition(s) for the tests should be justified by the applicant and shown to support the required minimum reliability and confidence level for the expected standby and operating conditions at the plant.

    ISG-21 (January 2011)

3. ISG 21 Significant Differences

➢ Temperature of the GT components

✓ Prime Mover Comparison

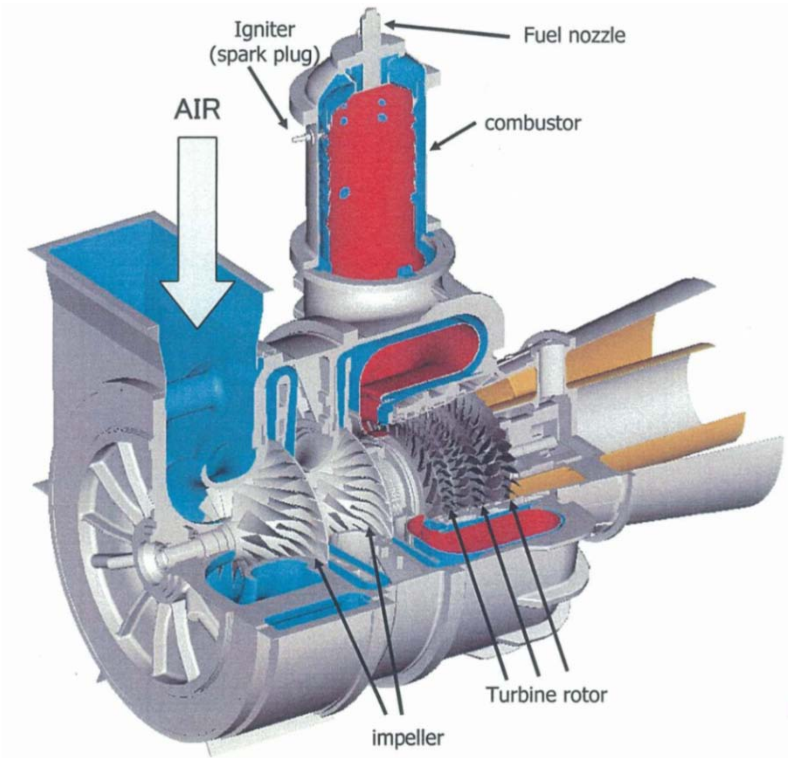


As shown in the left figure, EDGs consist of a shaft producing a rotary motion and a piston producing an up-and-down movement and are complex in structure. Therefore, the direction and amount of thermal expansion and contraction vary from element to element and that makes it difficult to include each thermal behavior of the components in the design. EDG's used in standby power application, including Nuclear power plants need to start and assume loads in a short time. The interaction and combined effects of these components negatively impact the ability of the engine to start. In order to met the start and load time requirements an EDG must be kept warm, typically 35ºC. It is important that EDGs maintain the engine coolant and lube-oil at adequate temperature by keep warm systems. This is to optimize conditions in terms of starting reliability and reduce stress on the mechanical portion of the engine during emergency starts. Additionally, keep warm systems prevent damage and improper operation of components caused by friction due to the rapid thermal expansion and contraction which occur at startup. Each manufacturer's has their own recommended temperature for warm standby conditions that are based on the dynamic characteristics, starting characteristics, and ignition characteristics of EDGs.

3. ISG 21 Significant Differences

➢ Temperature of the GT components

✓ Prime Mover Comparison



GTGs are different from EDGs in structure, characteristics/starting characteristic, and ignition characteristics. Unlike EDGs, GTGs produce a rotary motion directly, not a reciprocating motion that is converted to a rotary motion. GTGs start by rotating a rotor/blade disks mechanically using an external source and igniting fuel when they reach a specified speed that is typically around 20% of the operating speed. The number of critical components necessary to establish combustion is dramatically reduced. Additionally, since the thermal expansion and contraction is only toward the circumferential and axial direction and the components are few, it is easy to include the thermal behavior of the critical components in the design. The negative effects of thermal expansion and the interaction of the critically components and material are well known and have been eliminated or significantly reduced in the design. This significantly reduces the effect of starting temperature conditions that impact starting the unit. Therefore, the start reliability is significantly higher across a broader range of starting conditions.

In conclusion, unlike EDGs, whose starting characteristics are affected by heat expansion and contraction of components, it is not necessary for ground-based GTGs to be kept warm. This enables the GTG to consistently start under a broad range of ambient and component temperatures. None of the inherent operating principles are significantly affected by ambient or component temperatures at the time of starting.

3. ISG 21 Significant Differences

➢ Temperature of the GT components

✓ Starting Functional Comparison

Impact Evaluation of Cold/Hot Start (Starting Reliability)

Starting Basic Function	Major Component or subsystem	Function	Temperature effects: Hot Start (Normal Operating)	Temperature effects: Cold Start (Warm Standby)	Diesel Engine Differences
Ignition	Combustion Chamber	To contain the combustion and convert the energy released to mechanical energy; rotational torque and velocity. The combustion chamber is also where the air and fuel are mixed and combust to produce energy.	**Negligible**; At normal operating temperature the air entering the combustion chamber is slightly warmer; therefore fuel/air mixture is easier to ignite and ignition performance is better.	**Negligible**; At warm Standby conditions the air entering the combustion chamber is slightly cooler; therefore fuel/air mixture is slightly harder to ignite and ignition performance is reduced.	Diesel engines are significantly more sensitive to low ambient conditions. A diesel engine relies upon the heat of compression to initiate combustion. The flow of air into the cylinders is directly related to the movement of the pistons during starting.
			Basis Discussion: At ignition there is little difference in the fuel/air mixture temperature within the combustion chamber during starting. But also, any air remaining in the combustion chamber from the previous operating cycle is effectively purged during the starting sequence as the rotation of the main shaft accelerated.		
	Igniter	The function of the igniter is to initiate combustion of the fuel during starting. An igniter is similar to a spark plug in an internal combustion engine utilizing rapid burning fuels such as gasoline.	**Independent of temperature**. The spark produced contains sufficient energy to initiate combustion of the fuel independent of the temperature of the fuel air mixture.		Typical Diesel engines do not contain igniters or spark plugs within the cylinders. They rely only upon the heat of compression to ignite the fuel air mixture. Consequently are susceptible cold temperatures.
			Basis Discussion: The presence of an igniter in the combustion chamber is to initiate the combustion of the fuel. The operation of an igniter produces a highly localized area of very high temperature that will initiate combustion independent of temperature.		

3. ISG 21 Significant Differences

➢ Temperature of the GT components

✓ Starting Functional Comparison

Impact Evaluation of Cold/Hot Start (Starting Reliability)

<table>
<tr><th rowspan="2">Starting Basic Function</th><th rowspan="2">Major Component or subsystem</th><th rowspan="2">Function</th><th colspan="2">Temperature effects</th><th rowspan="2">Diesel Engine Differences</th></tr>
<tr><th>Hot Start
(Normal Operating)</th><th>Cold Start
(Warm Standby)</th></tr>
<tr><td rowspan="4"></td><td rowspan="2">Fuel properties</td><td rowspan="2">Variations of Fuel temperature affect the energy content or the amount of fuel delivered to the combustion chamber (s).</td><td>Negligible; Fuel density is less at higher temperatures.</td><td>Negligible; Fuel viscosity and density is greater.</td><td rowspan="2"></td></tr>
<tr><td colspan="2"><u>Basis Discussion</u>: Neither condition significantly affects the ability to start and assume load. The turbine is designed to use standard fuels the effects will be insignificant provided that the fuel is within specified properties set by the manufacture.</td></tr>
<tr><td rowspan="2">Rotation</td><td rowspan="2">The function of the starter motors is to bring the turbine to its starting rotational speed, typically approximately 20% of Rated.</td><td>Negligible; under high ambient or operating temperatures friction is less due to oil viscosity, the turbine may reach starting speed slightly quicker.</td><td>Negligible; under warm standby temperatures or low ambient temperatures friction is greater due to oil viscosity; the turbine may take slightly longer to reach starting speed.</td><td rowspan="2">Temperatures less the 50ºC significantly reduces the start reliability of Diesel engines. As a compensatory action “keep warm systems,” are generally required for Diesel engines utilized in standby power applications.</td></tr>
<tr><td colspan="2"><u>Basis Discussion</u>: Combustion chamber compression is established by the rotation of the main shaft; it does not depend upon seals or piston rings as in an engine driven generator. Because it does not rely upon components that are sensitive to tolerances which are impacted by temperature performance is not impacted.</td></tr>
</table>

3. ISG 21 Significant Differences

➢ Temperature of the GT components

✓ Starting Functional Comparison

Impact Evaluation of Cold/Hot Start (Starting Reliability)

Starting Basic Function	Major Component or subsystem	Function	Temperature effects: Hot Start (Normal Operating)	Temperature effects: Cold Start (Warm Standby)	Diesel Engine Differences
Fuel control	Fuel pump	The function of the fuel pump is to deliver fuel at the correct pressure and rate to the combustion chamber through a set of control and stop valves.	**Independent of temperature.**	**Independent of temperature.**	With a diesel engine the amount of fuel injected into the cylinders is controlled by the engine governor in conjunction with the fuel injectors.
			Basis Discussion: A separate DC motor driven starting fuel pump is provided to supply fuel during starting. The flow rate required during starting is less than 25% of rated load. The fuel oil pump is insulated from the high temperature turbine components; therefore independent of turbine temperature. The engine mounted fuel pump is designed to deliver the required flow rate for rated load conditions plus margin during normal operations.		
	Fuel stop valve / Fuel control valve	The function of the fuel control valves and piping are to control the amount of fuel delivered to the combustion chamber and is proportional to the load.	- **Independent of temperature.**	- **Independent of temperature.**	Diesel engines do not have fuel control valves, the amount of fuel injected into the cylinder is controlled by the fuel injectors and engine governor.
			Basis Discussion: The fuel control valves and piping are designed to deliver the required flow rate for rated load conditions plus margin. The flow rate required during starting is less than 25% of rated load. The flow rate is controlled by the engine governor and flow control valves. These valves are insulated from the high temperature turbine components; therefore independent of turbine temperature.		

3. ISG 21 Significant Differences

➢ Temperature of the GT components

✓ MHI Analysis

Based on the manufacture's experiences and technical knowledge, the reliability and/or loading capability of MHI's GTG are not significantly affected by either ambient temperature or the temperature of the GTG components.

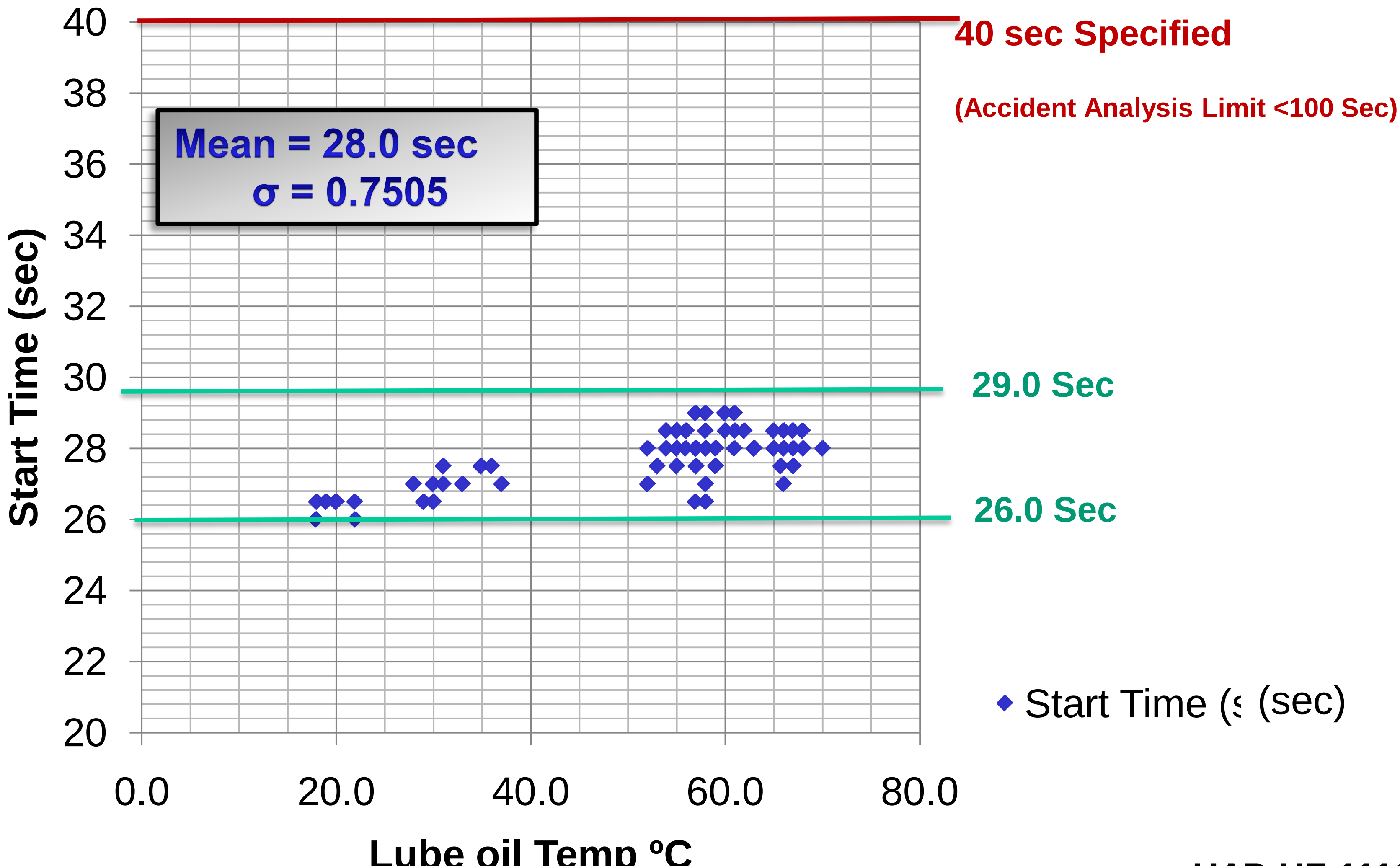
✓ Conclusion

1. There are no significant differences between hot and cold ambient or component conditions that affect GTG starting.
2. Therefore, there is no requirement to conduct a minimum number of starts at prescribed conditions. The reliability start tests may be performed at conditions close to the normal operation conditions or at ambient temperatures.

3. ISG 21 Significant Differences

➢ Temperature of the GT components

✓ Class 1E GTG Test Results



3. ISG 21 Significant Differences

➢ Conclusion Supported by Test Observation

- ✓ The 150 start tests were completed without a failure or any unexpected variation in results.
- ✓ "Ready to Load" time for all starts was less than 30 seconds.
- ✓ The rotation speed increased at the same rate on all the tests conducted.
- ✓ The starting time variation between cold and hot conditions were insignificant.
- ✓ The average starting time was shorter at the cold condition due to the governor supplying more fuel in the cold condition and starting the GTG faster. Such design properties were confirmed during this test.

4. Reliability of GTG

➢ Reliability Analysis

- ✓ GTG reliability data previously submitted was based on gas-turbine generator systems that includes support systems. The failure data extends beyond the turbine engine and includes the reliability of support systems. These support systems are critical to the starting or running of the gas turbine generator.

- ✓ The reliability analysis includes failure data for:
  - o Control cabinets and engine governor
  - o Generator excitation system
  - o Fuel Oil system pumps
  - o Starting air system

4. Reliability of GTG

➢ GTG data - Technical Report MUAP-07024

- ✓ The GPS GTG series has the same concept and manufacturing quality control.
- ✓ Reliability based on all field data of GPS series GTGs in Japan.

-Probability:

$$\Pr[x] = \frac{\text{Favorable Outcomes}}{\text{Possible Outcomes}}$$

$\Pr[x] = 2.7 \times 10^{-4}$ / demand (2/7394)

Standard Deviation (Binomial)

$$S = \sqrt{N \times p \times (1 - p)}$$

$S = 1.91 \times 10^{-4}$ / demand

95% Confidence : $\Pr[x] + 2\,S = 6.52 \times 10^{-4}$ / demand

4. Reliability of GTG

➢ US EDG Reliability

✓ US EDG reliability data evaluated from the operational experiences in NUREG/CR-6928.

✓ Failure to Start (FTS) was determined to be:

- Probability: 4.53×10^{-3} / demand
- 95% confidence: 1.32×10^{-2} / demand

4. Reliability of GTG

✓ Reliability estimation of similar GTGs based on industry operational experience

- Applicable data
  - – 1433 demands with 0 failure
  - – 2224 run hours with 0 failure
- Uncertainty of failure rate/probability
  - – Estimated using Bayesian approach applying simplified constrained non-informative prior distribution

Table 4-1

	5%	Mean	95%
Fail to start	1.4E-6	3.5E-4	1.3E-3
Fail to run	8.9E-7	2.2E-4	8.3E-4

4. Reliability of GTG

➢ Reliability Verification

✓ US-APWR GTG reliability

- Start
  - Operational experience of similar GTGs indicate a failure rate lower than the mean failure rate of EDGs (5.0E-3 /d, NUREG/CR-6928), with 95% confidence.
  - Start tests were performed as a typical “qualification starting test”, which resulted in 0 failure out of 150 starts. Results imply that the US-APWR GTGs has reliability greater than 97.5% with a greater than 95% confidence.
  - Reliability will be updated by the starting test and surveillance test results obtained during plant operation
- Run
  - Operational experience of similar GTGs indicate a failure rate lower than the mean failure rate of EDGs (8.0E-4 /hr , NUREG/CR-6928), with approximately 95% confidence
  - Run test were not performed.
  - Reliability will be confirmed and updated by surveillance test results obtained during plant operation

4. Reliability of GTG

➢ Reliability Comparison

✓ DCD Target

Failure to Start: 5.0×10^{-3}

✓ US OE Diesel Engine driven generators

Failure to Start: 4.53×10^{-3}

✓ International Gas Turbine Driven Generators

Failure to Start: 3.5×10^{-4}

✓ US APWR Prototype GTG

Failure to Start: 3.5×10^{-4}

All values are mean value

5. Seismic Test

➢ Seismic Qualification

Components of the GTG system can be seismically qualified by test or analysis (except for the engine). The gas-turbine engine is a commercial product and is not seismically evaluated. Since the gas-turbine engine is a complex component and its dynamic capability for seismic should be evaluated while it is running, MHI has performed a seismic test of the engine. The test was performed based on DCD seismic condition and in accordance with IEEE 344-2004 between March 31, 2011 and April 5, 2011.

5. Seismic Test

➢ Test Procedure

Seismic test has been performed in the following procedure with the bi-axial type shaking table.

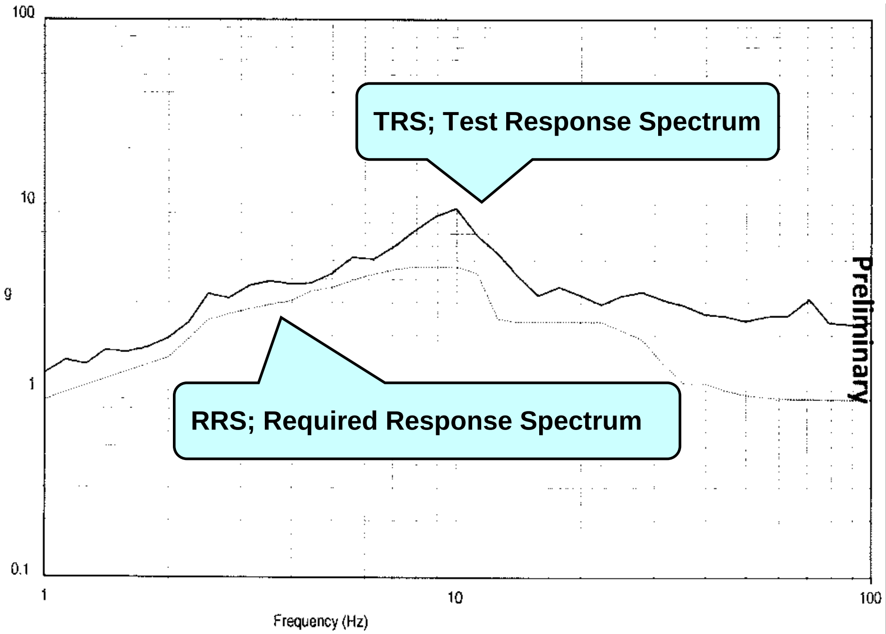
- ✓Sweep Test
- ✓OBE at standby
- ✓OBE at starting
- ✓OBE at operation
- ✓OBE at operation
- ✓OBE at operation
- ✓SSE at operation
- ✓SSE at standby

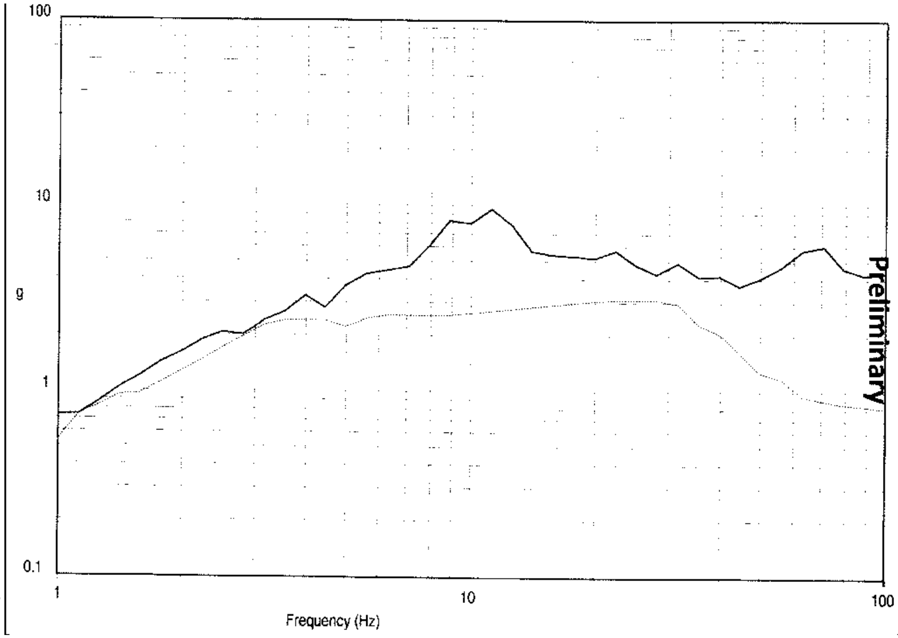
Note 1) OBE RRS were greater than ½ SSE.

Note 2) Since the table is a bi-axial type, the above set of tests was repeated after the engine is turned 90 degrees.

5. Seismic Test

➢ Result (1)



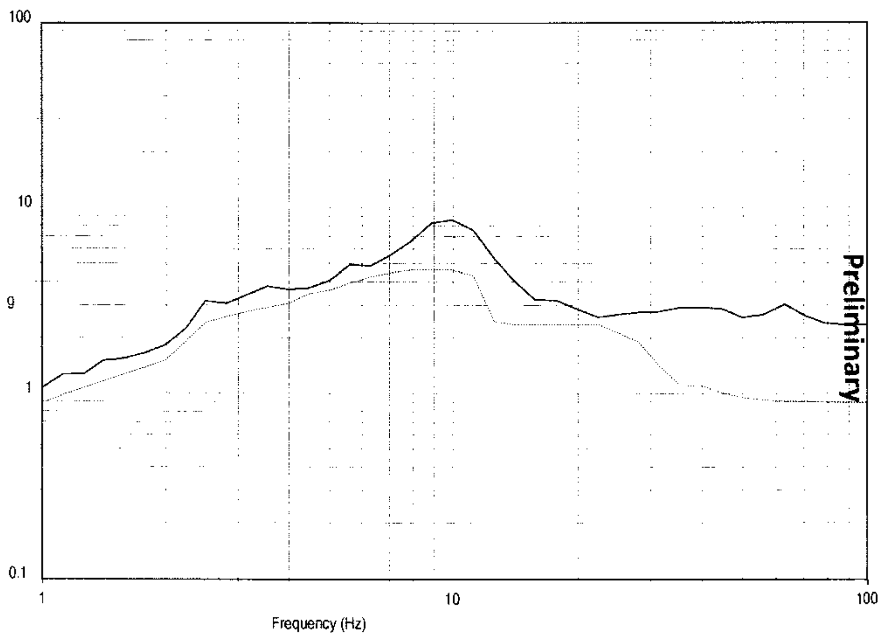


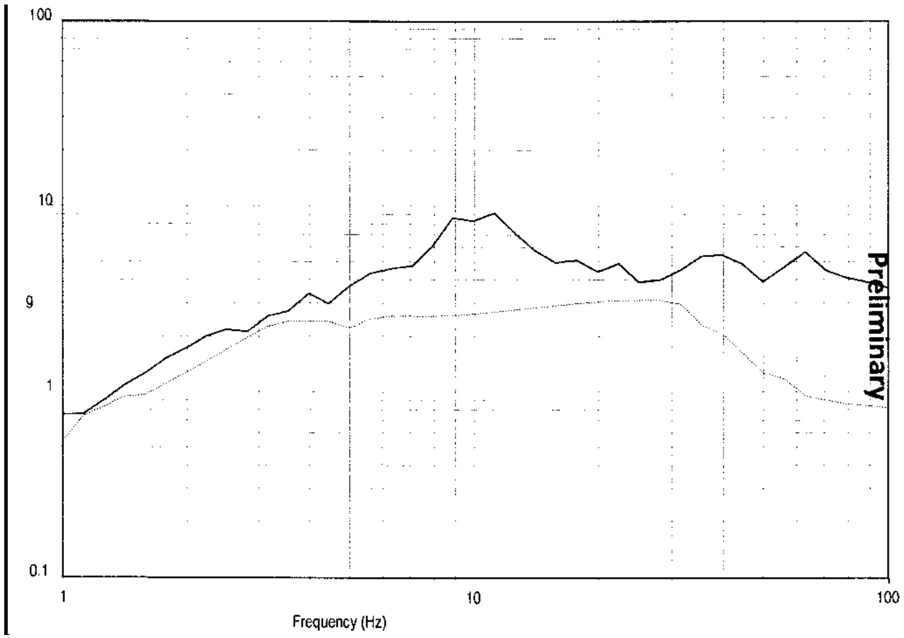
Horizontal
Axis direction
SSE at operation

Vertical
Axis direction
SSE at operation

5. Seismic Test

➢ Result (2)





Horizontal

90-degree angle to the axis direction

SSE at operation

Vertical

90-degree angle to the axis direction

SSE at operation

5. Seismic Test

➢ Conclusion of Result

- ✓ All the tests satisfied the required test spectrum.
- ✓ No mechanical damage is found on the GT during and after the test.
- ✓ Operational performance was verified by confirming normal startup and operation mode after the seismic test.
- ✓ All the seismic tests are successful.

6. Summary

- **Initial Type Test Program**
  - ✓ Complies with relevant EDG standards as modified by ISG 21 staff guidance on the application of GTG.
- **Initial Type Test Results**
  - ✓ Met or exceeded all test acceptance criteria.
- **ISG Significant Differences**
  - ✓ The 150 start tests were completed without a failure.
  - ✓ There are no significant differences between hot and cold ambient conditions that affect GTG starting.
- **Reliability of GTG**
  - ✓ Failure to Start: 3.5×10^{-4} An order of magnitude improvement over EDG
- **Seismic Test**
  - ✓ US-APWR GTG successfully completed all seismic qualification.