Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title:	Advisory Committee on Reactor Safeguards Future Plant Designs Subcommittee
Docket Number:	(n/a)
Location:	teleconference
Date:	Tuesday, September 22, 2020

Work Order No.: NRC-1104 Pages 1-81

NEAL R. GROSS AND CO., INC.
Court Reporters and Transcribers
1323 Rhode Island Avenue, N.W.
Washington, D.C. 20005
(202) 234-4433

DISCLAIMER

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

The contents of this transcript of the proceeding of the United States Nuclear Regulatory Commission Advisory Committee on Reactor Safeguards, as reported herein, is a record of the discussions recorded at the meeting.

This transcript has not been reviewed, corrected, and edited, and it may contain inaccuracies.

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

+ + + + +

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

+ + + + +

FUTURE PLANT DESIGNS SUBCOMMITTEE

+ + + + +

TUESDAY

SEPTEMBER 22, 2020

+ + + + +

The Subcommittee met via Video-Teleconference, at 9:30 a.m. EDT, Joy Rempe, Chair, presiding.

COMMITTEE MEMBERS:

JOY L. REMPE, Chairman

WALTER L. KIRCHNER, Member-at-large

RONALD G. BALLINGER, Member

CHARLES H. BROWN, JR. Member

VESNA B. DIMITRIJEVIC, Member

JOSE MARCH-LEUBA, Member

DAVID A. PETTI, Member

MATTHEW W. SUNSERI, Member

ACRS CONSULTANT:

MICHAEL CORRADINI

DESIGNATED FEDERAL OFFICIAL:

DEREK A. WIDMAYER

ALSO PRESENT:

TAMARA BLOOMER, RES

JOHN TOMON, RES

KIM WEBBER, RES

AGENDA

P R O C E E D I N G S

9:30 a.m.

MEMBER REMPE: Good morning. This meeting will now come to order. This is the meeting of the Advisory Committee on Reactor Safeguards, Subcommittee on Future Plant Designs.

I'm Joy Rempe and I'm chairing the Future Plant Designs Subcommittee today. ACRS members in attendance include Charlie Brown, Walt Kirchner, David Petti, Jose March-Leuba, Ron Ballinger, Vesna Dimitrijevic, Matt Sunseri, and we expect to be joined by Pete Ricardella later in the meeting.

We also have our consultant, Mike Corradini, in attendance. Derek Widmayer, of the ACRS staff, is the designated federal official for this meeting.

The purpose of today's meeting is to review the draft report, NRC non-LWR Vision and Strategy, Volume 4 -- help me out with -- the Licensing and Siting Dose Assessment Codes.

The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed decisions and actions as appropriate.

This matter, along with a draft Volumes 1 through 3 in this report series, is scheduled to be addressed at the October full Committee meeting.

The ACRS was established by statute and is governed by the Federal Advisory Committee Act, FACA. The NRC implements FACA in accordance with its regulations, found in Title 10 of the Code of Federal Regulations, Part 7.

The Committee can only speak through its published reports. We hold meetings to gather information and perform preparatory work that will support our deliberations at a full Committee meeting.

The rules for participating in all ACRS meetings, including today's, were announced in the Federal Register.

The ACRS section of the U.S. NRC public website provides our charter, bylaws, agenda, letter reports, and full transcripts of all full and subcommittee meetings, including slides presented therein. The meeting notice and agenda for this meeting were posted there.

As stated in the Federal Register, notice and the public meeting notice is posted on this website, members of the public who desire to provide written or oral input to the Subcommittee may do so, and should contact the designated federal official five days prior to the meeting, as practicable.

Today's meeting is open to public attendance and we've received no written statements, or requests to make an oral statement.

We've also set aside ten minutes in the agenda for spontaneous comments from members of the public attending or listening to our meetings.

Today's meeting is being held with a telephone bridge line, allowing participation of the public over the phone, and a transcript of today's meeting is being kept. Therefore, we request that meeting participants on the bridge line will identify themselves when they speak, and to speak with sufficient clarity and volume so they can be readily heard.

Participants in the meeting room should use the microphones -- excuse me. That's left over from an old write-up and I forgot to cross that out. But at this time, I do ask that all meeting participants place themselves on mute, unless talking, so that their cell phones or other devices that make noise in the homes, such as clock bells, won't disrupt this meeting.

And I will now proceed with the meeting and call on Kim Webber, Deputy Director of the Division of Systems Analysis, of the Office of

Research, to make introductory remarks. Kim?

MS. WEBBER: Yes, thank you, Joy. And good morning to you and the other members.

Thank you for taking the time to review our latest volume of the Code Development Activities, Volume 4, Licensing and Siting Dose Assessment Codes. I'm going to skip to the next slide, since you introduced me already.

By way of an agenda, I have with me today John Tomon. He's the Chief of the Radiation Protection Branch in my division. And he and his staff have been working very hard with staff in NRR and NMSS over the last several months to develop a strategy that we believe is the most resource-effective approach for the codes covered by Volume 4, and will ensure the safety as we conduct our licensing review of non-light water reactors.

I'll provide high-level overview of the status of the whole non-light water reactor code development project, and a short introduction to Volume 4. Then I'll turn the presentation over to John, who's going to discuss the details of Volume 4, including the topics shown on this slide and in the agenda.

With non-light water advanced reactor

applications on our doorstep, including the March submission of the Oklo application, our Office of Research mission, now more than ever, is to enable the regulatory offices to be ready to conduct their licensing activities.

With our be-ready attitude, we are doing research differently, by embarking on more be-ready strategies, and transforming to become a more modern risk-informed regulator.

To improve mission value, we are working hard to deliver the tools, expertise, and information, in a cost-effective and efficient manner, so that licensing can be completed on time and within the allotted resources.

A key element of this strategy is developing the codes and analytical tools, like the ones you see here, and having them ready to go for use and safety analysis.

Through our code development activities and collaborations with many organizations you see on this slide, our staff has been acquiring a lot of new knowledge about advanced reactor designs and phenomena important to safety, thus growing staff expertise and analytical capabilities, in addition to capturing knowledge not only in the codes, but also in code documentation.

To facilitate the agency's readiness, the NRC's near-term implementation action plan was developed in the summer of 2017. The IAP is the vehicle to execute the NRC's vision to safely achieve effective and efficient non-light water reactor mission readiness.

As you know, the IAP includes six strategies, which are shown here, and Strategy 2 focuses on computer codes and knowledge to perform regulatory reviews. On the next slide I'll discuss high-level progress made for Strategy 2.

As you know, earlier this year we completed the Introduction, and Volumes 1 through 3. We thank you for conducting an in-depth and thorough review of our plans. Your views and perspectives resulted in changes in those plans in support of the realization of IAP Strategy 2.

Each report identifies the computer codes that we may use for our independent safety analysis, gaps in code development capabilities and data, verification and validation needs, along with specific code development tasks.

Volumes 1 through 3 focus on systems analysis, fuel performance, neutronics, source term, severe accident progression, and accident consequence codes.

If you'd like to follow the status of our code development activities, you can go to the NRC's advance reactor public webpage, which is shown on the slide.

If you scroll down the page, and then click on the summary of integrated schedule and regulatory activities image, you'll see the status of the near-term code development tasks for each volume.

Although not the subject for this meeting, the status of code development activities for Volumes 1 through 3 is provided for your reference in the background slides, as Slide 34. At a later meeting, we'll provide more information on these activities.

As you know, we're developing two additional volumes, Volume 4, which is the subject of this meeting, and Volume 5, which focuses on code development activities related to criticality and shielding considerations for the front and back end of the fuel cycle.

We had a meeting scheduled with the Subcommittee on December 1st to talk with you about Volume 5. We value your feedback and recommendations.

As we requested a letter from you on Volumes 1 through 3, we are also requesting a letter from you on Volumes 4 and 5. I believe a full Committee meeting with a summary of Volumes 4 and 5 is being scheduled for February.

Volume 4 provides an overview of the radiation protection related to technical areas that warrant code development modifications in our literature reviews.

The codes that John will describe shortly provide radiation dose assessment capabilities that encompass nuclear power plant licensing, including reactor siting, design basis accidents, and normal effluent release analysis.

The codes also support dose assessment for emergency response and severe accidents, and atmosphere transport dispersion and site decommissioning regulatory actions.

MEMBER REMPE: So --

MS. WEBBER: Depending on the --

MEMBER REMPE: Oh, I'm sorry. I thought you were done. Go ahead, please finish your slide, and then I have a question.

MS. WEBBER: Yes. Depending on the analytical needs identified for these areas, the suite of 10 codes, they needed to be modified for each combination of fuel and advance reactor type, of which there are many combinations.

To modify each of the codes for each fuel reactor combination could be resource-intensive. And that's a more resource-efficient approach is to consolidate, while also modernizing, the codes. Going forward, we would maintain the consolidated set of codes.

As you know, code consolidation and modernization also make sense since these codes have been inconsistently maintained over the years based on organizational needs, and there are overlaps in models, dose coefficients, functionality, and use cases.

Code consolidation and modernization are natural progression steps in the lifecycle of computer codes, and have been demonstrated successfully by the NRC in the past.

For example, our trace thermal hydraulics codes, MELCOR source term and severe accident code, and our fast fuel performance code, have all undergone consolidation and modernization efforts. And now, we can go to your question, before I turn it over to John.

MEMBER REMPE: So, I have a couple of questions. First off, with the earlier volumes, the ongoing work with MELCOR and MACCS, because of later questions I'm going to be bringing up, I know that you're going to be giving us an update in a closed session later on today, but can you say something about the progress that's being made with applying MELCOR in the open section?

Because I know there have been public meetings about ongoing efforts with trying to apply MELCOR for the various non-LWR technologies.

MS. WEBBER: Yeah. So, this is an image from the public website. And what you can see is, in the regulatory activity column, this is a list of all of our code development activities for each of those volumes.

So, here on this line you see Code Assessment Report, Volume 1; Code Assessment Report, Volume 2; Code Assessment Report, Volume 3. And you see sub-level milestones under each of those.

And so, for Volume 3, which is focused on MELCOR scale and MACCS, you can see a number of different activities. And then over to the right, whether those activities have been completed, or what the target schedule is to complete those activities.

And so what you'll see here is that for Volumes 1 and 3, a lot of work has gone to develop reference plant models for the different types of reactors. And those reference plant models are descriptions of different advanced reactor designs based on publicly available information for the different types of reactors.

And so you can see that for Volumes 1 and 2, many of those reference plant models have been completed.

Additionally, for MELCOR and SCALE, they're working on completing reference plant models for several different advanced reactor designs. For MACCS, there are plans to do some radium nuclide screening analysis, and then the near field atmospheric transport and dispersion model assessment has been done.

So, I hope that this answers the question. And we'll talk a little bit more about that in the later session.

MEMBER REMPE: So, I appreciate this. Again, because of upcoming letters or discussions, I want to make sure what is it Camby said in the open session. So, that's why I'm asking these questions for you now.

MS. WEBBER: Sure.

MEMBER REMPE: Now, the source term for each technology -- although there may be gaps, which I assume are identified in these ongoing efforts with MELCOR -- but there is a base source term that could be used as input for all these other Volume 4 codes.

MS. WEBBER: Yes.

MEMBER REMPE: Because you do depend on MELCOR and MACCS to do the Volume 4 work.

MS. WEBBER: That's right.

(Simultaneous speaking.)

MEMBER REMPE: Right?

MS. WEBBER: Yes.

MEMBER REMPE: Okay. So, that helps a lot. And then I draw your attention -- but you can bounce this question to John Tomon -- but I guess I'm one of the ACRS members that has the common misconception mentioned in Volume 4, because actually, we even discussed this at our prior meetings, about why not have a simpler version of MACCS that can read in those source terms from MELCOR, although other work you're doing with Volume 3 codes, and really consolidate things.

I mean, read in the local weather and have something that is fast running with MACCS, instead of trying to consolidate the numerous codes we're going to be hearing about with Volume 4.

To me -- and we discussed this before -- and I thought the prior transcript from the prior meeting when I reviewed it, the staff said yeah, that's a long-term goal, but we kind of wanted to do this earlier mid-term consolidation.

And knowing -- I think even Volume 4 said we're not going to plan up and running for five years, where you have to worry about an emergency. It sounds like you have a bit of time.

So, when I reviewed Volume 4, I really had that question in my mind, and I wasn't convinced by what I read that it was really necessary to go through this intermediate step.

MS. WEBBER: So, because we recall that that was a question you had raised, I think John specifically is going to address that in his presentation.

MEMBER REMPE: Good. Thank you.

MS. WEBBER: You're welcome. Any more questions from the Committee?

MEMBER BROWN: Yeah, Charlie Brown.

MS. WEBBER: Hi, Charlie.

MEMBER BROWN: I'm not an expert in this

stuff, I'm the I&C guy. But I'm reading your approach part and you talked about modernized dose assessment.

Now, we've been doing dose assessments and stuff for over 60 years now for plants. And so I'm just kind of curious what modernize means.

MS. WEBBER: I think in this context -- and John can correct me if I'm wrong -- modernization means to go towards a code language that results in faster speeds of codes and is able to be more interoperable with multiple codes. I don't know, John, if you want to nuance that answer.

MR. TOMON: Yes. Exactly what Kim was saying is that many of the codes right now were built kind of in silos and by themselves. And so transferring input and output from one code to another code usually involves many intermediate steps.

So, we kind of viewed this as modernizing the codes so that they all work together. They use a common language both in the inputs and the outputs, so that the information can be transferred back and forth fluidly between what we're calling -- and I'm going to get to in a little bit -- the calculational engines that actually do the actual calculations for the code.

MEMBER BROWN: Are the codes that NRC uses? Or are you talking about the industry codes that are developed by various, I guess, other bodies?

MR. TOMON: These are NRC codes. These are our NRC codes that we've developed.

MEMBER BROWN: Okay, I understand that then. Thank you.

MR. TOMON: Yes.

MEMBER REMPE: Out of curiosity, are the codes in FORTRAN? And are you using just a new version of FORTRAN, or are you going to a different language?

MR. TOMON: Well, some of the codes are in an older version of FORTRAN, some are in the newer version, some are in Java. But it's really the output files themselves in the data. They're not in a common language, so usually you have to do some manipulation by the operator and the user, and intermediate steps, to either take a source term, or take an atmospheric transport values, and then put them into the dose assessment codes.

So, what we wanted to do was build a construct -- as I'll get to -- that does this all, and then it's one code that the user operates, and then the information is passed fluidly from the input to the output, and also guide the user, to ask the user, what kind of outputs are you looking for, so that the user can really drive what he wants to see in the output files.

MEMBER BALLINGER: This is Ron Ballinger. Can't you just do this with scripts?

MR. TOMON: Well, for some of the codes we could, but for most of the users it would be more, I don't know, user-friendly just to have it all in one area in the codes.

And there are some issues with the codes right now that combining them together, there's some duplication that has to be done because some of them use the same atmospheric transport models in the codes, but yet I have to maintain them in three different codes, whereas if I put them all together in one atmospheric transport engine, as it were, then I would only have to make changes to that one engine, and then that data could be passed for, say a mid-field calculation, a near-field calculation, or a far-field calculation.

MEMBER BALLINGER: Yeah, but the sort of workload to do this is definitely not linear. Once you get out of scripts, it's non-linear and it becomes an enormous task for which there are unknown unknowns, so to speak.

MS. WEBBER: So, I'm wondering if we

should transition to John's presentation, because I think he's going to talk about some of these things. Would you like me to stop sharing my screen, and at least we'll transition to John's presentation?

MEMBER REMPE: That sounds like a good idea, Kim.

MS. WEBBER: Okay.

And then if you want to continue with questions, we can do that.

MEMBER REMPE: Do any members have any other questions while we're in transition mode here?

PARTICIPANT: No, Joy. Thanks for asking.

MEMBER REMPE: Thank you.

MR. TOMON: So, does everybody see my screen now?

(Chorus of aye.)

MR. TOMON: Okay, thanks. So, good morning. As Kim said, my name is John Tomon and I'm the Chief of the Radiation Protection Branch of the Office of Research. And this morning I'm going to discuss Volume 4, the Licensing and Siting Dose Assessment Code Plan, that my staff developed in collaboration with the program offices and several of our code contractors and developers.

Volume 4, Licensing and Siting Dose Assessment Codes, this report describes the vision and strategy to achieve readiness for non-light water reactor designs for the Licensing and Siting Dose Assessment Codes, and is a living document.

It provides an overview of the technical issues related to the different non-light water reactor design technologies that warrant code development, modifications, and/or literature reviews.

The report is generally oriented towards generic activities that benefit all non-light water reactor designs, while ensuring that the codes continue applicability for the current light water reactor fleet.

MEMBER BROWN: Can I ask a question? This is Charlie Brown again.

MR. TOMON: Sure.

MEMBER BROWN: I had just backtracked to the -- you can keep this slide up -- back to the earlier one where you're talking about -- let me think, did I get this straight -- with the non-light water reactors, I'm trying to get a handle between light water reactor and non-light water reactor when we talk about atmospheric transport dispersion, all that other type of good stuff you all want to develop.

Are the characteristics of the non-light water reactors, in terms of their particulate or their fuel constituency or appearance, that change what we've done in the light water reactor world?

MR. TOMON: Well, in some -- as we're going to talk to later -- in some of the slides, some of the non-light water reactor designs are saying that if there are radionuclides that are induced into environmental source term, they could be of a different particulate size typically different than we currently use in the 1-to-10 micron range for the current atmospheric transport and dispersion codes.

They could be down in the nanometers, which could have a different result on doses. So, there is that aspect.

And then there's the other aspect, that some of the non-light water reactor water reactor designs are using different -- not as far exclusionary of boundaries and emergency planning zones as the current light water reactor fleet -- and so in that regard some of our atmospheric transfer codes, because they were built kind of rigidly for specific purposes of the near-field, the mid-field, and the far-field, there are certain attributes and correction factors in some codes that would be applicable and would want to be used by the non-light water reactor designers and reviewers for the near-field, that maybe isn't a function of the mid-field characteristics.

So, to that end, that is another reason why we kind of wanted to combine at least all of these codes, and specifically into engines and in the atmospheric transport phase, so that you could choose from, and maybe have available, those correction factors that are available in one code right now in the specific code design available to all the codes to do all the calculations.

MEMBER BALLINGER: This is Ron again. I think we're dealing with that with NuScale right now. No?

MR. TOMON: Yes, sir. Yeah, typically using, for the exclusion area boundary and the low-population zone, the PAVAN Code, it doesn't take into account building wake effects and corrections like that.

And so, they wanted to use -- with the ARCON Code, which is for control room habitability, they wanted to use corrections that were used in that, but that's not built in to the PAVAN Code.

So, as a result, they have to do additional work, or code work, to make these corrections work. So, that's where we felt combining the codes would be beneficial for all, both the licensees and the reviewers.

MEMBER REMPE: But now, we saw from Kim's slide that the near-field equations have now been put into MACCS. Right, John?

MR. TOMON: I know they evaluated it. I'm not sure. We've been working with our counterparts in the other branches, and I'm not sure if and how they've been completely implemented into MACCS.

But we are going to continue to work with them in that, so that when we combine these, any lessons learned they learn from that. We're not going to try to reproduce the wheel in that regard, but use what they've already done into our codes, in and of itself, for the reviewers that need it for this purpose.

MEMBER REMPE: Okay. I thought that they had the box that it was completed. Maybe I misread the chart for -- or I didn't remember correctly.

MS. BLOOMER: Can I answer that? Hi, this is Tammy Bloomer.

MEMBER REMPE: Yes, please do.

MS. BLOOMER: So, I'm the Branch Chief for the Accident Analysis Branch. We work through the

MACCS code with Sandia.

And the chart that you're referring to, we did an assessment of the applicability of MACCS for near-field ATD modeling, and that is what was completed.

The incorporation of the calculations into MACCS is not yet completed, and we will have those calculations identified and the models prepared by the March time frame, 2021, and incorporated into MACCS shortly thereafter.

MEMBER REMPE: Great. Thank you for the update.

MR. TOMON: Any additional questions, or shall I go on?

MEMBER BROWN: Yeah. This is Charlie Brown again. Just trying to get a better handle on -- you keep talking about consolidating codes, making them easier to use and all that type of stuff.

MR. TOMON: Yes, sir.

MEMBER BROWN: Again, in the light water world, as well as the non-light water world, fissionable material is fissionable material. They're the same, kind of. So, you know what those are.

But irradiated materials that could get dispersed in an accident condition are going to be different in many circumstances for the non-light water reactors.

I haven't heard you talk about how you come up with characterizing these materials, that we don't even know what they all are yet for the non-light water reactors, and how your codes will be amenable to incorporating those.

MR. TOMON: And as we're going to let to later on when I talk about some of the tasks in Volume 4 and some of the codes, that is one of the things we're working on.

For example, right now we have, for light water reactors to those fission products and those activation products as you were talking about, we have a code that similarly does this for, and is released for what we consider normal effluent source terms for light water reactors for both pressurized and boiling water reactors, the GALE code.

It takes into account the activation products, corrosion products, and we then use that as our source term input to the NRC dose code, combined with the LADTAP code, to do dose assessment. That is one of the issues that we have.

And we're working with our partners, our radiation protection code assessment contractor, PNNL, and their work with source terms with the National Reactor Innovation Center, to come up with what would be a good source term, or what's the best way to develop a source term to encompass all these activation products that we might see from these various non-light water reactor designs. And again, we don't have a firm direction on whether that's going to be just some generic module that just allows the user to import this, or we're going to actually -- but we are looking at operational data where we can find it, to see if we can actually hard wire maybe some of these values into the codes to begin with, so that the user can select, versus having to use user-defined inputs.

MEMBER BROWN: Okay, so if I hear you right, what you're saying, you're trying to roll all this stuff up in the source term parts of these codes.

MR. TOMON: Yes, sir. Yes, sir.

MEMBER BROWN: Okay. Thank you.

MEMBER REMPE: And say that again, because in my mind I would assume you'd take something from the MELCOR evaluations of each technology, as a base that would be put into your codes, as are the MACCS, if -- with what I'm kind of suggesting.

And then the user would say, okay, it's

only at 25 percent power when it had the release, and they would do whatever they wanted to do. And now, you're thinking you're going to get it from someplace other than MELCOR?

MR. TOMON: No. I mean, there's going to be multiple sources that we envision getting this data from. MELCOR and working with the staff over at the Accident Analysis Branch and the Severe Accident Branch, we envision getting MELCOR data typically similar to what we use right now in the RASCAL code, where that data from MELCOR is hard-wired into RASCAL, and the user does not have to select specific pressures or temperatures.

They're asked a series of questions, to come up with a rapid dose assessment characteristic based upon some other inputs that they put in.

So, again, we envision that the source term module would include inputs from both MELCOR, inputs from operational data, if there is any available, specifically because when you look at a normal effluent source term from GALE -- like the GALE code puts out for pressurized and boiling water reactors -- that's mostly operational data that it includes for the reactor cooling source term.

So, we envision multiple sources going

into developing the source term module. But we already have that in for P's and VWRs, but we have them in separate places for different things, for different codes.

So, where we envision is to combine them all together into one source term engine, that would then be used with the other engines in the code, to get the outputs that the user desired.

MEMBER REMPE: Okay, so you might say for the other operational data, you might have a circulating activity, or something that's been fine-tuned, or something like that. But from the core, basically -- of course, how old the core is and things like that, that would come from other analysis results from --

MR. TOMON: Yep.

MEMBER REMPE: -- within the NRC complex. Got it.

MR. TOMON: Yes, ma'am. Okay. Anything else, or shall I continue?

MEMBER REMPE: Please go on.

MR. TOMON: Okay. So, in the next slide, when the staff on the Radiation Protection Branch and our code developers and contractors started the process to think about making our codes ready for non-light water reactor technologies, we sought out various sources of information, including the other three volumes that Kim discuss earlier for Strategy 2, to identify the various non-light water designs that the dose assessment codes would need to be prepared for.

As we looked further into the non-light water designs, we further categorized them into further generic classes of non-light water reactor designs for Volume 4, to include molten salt reactors, high-temperature gas cool reactors, liquid metals, cool fast reactors, and several stationary and transportable micro-reactor designs.

MEMBER REMPE: So, could you stay on that price? Like -- when is the soonest that you, the NRC, would estimate you'd have a plan up and running, where you might be concerned about the need to use these codes for emergency response guidance?

MR. TOMON: Well, the emergency response guidance I would assume -- I know we have the Oklo application in-house, which came in in March, so I would need somebody to back me up on that. I would think we're looking at three to five years to actually have some sort of source term analysis that we could put into our source term module for accident scenarios.

But by the same token, we would also need from the dose assessment and licensing siting space, we would also need to look at the normal reactor effluent releases that are going to happen during normal operation.

And as far as I know right now, we've been in contact with our counterparts over in NRR, and from the initial application from Oklo, there's not a really good environmental source term they have from both an accident scenario, or from a normal source term scenario, included in their application.

So, right now I don't know a firm date that I could give you, but I would say probably three to five years.

MEMBER REMPE: So, on Page 36 out of 53 of your report, you have here, and I quote, non-LWR plants are not expected to be operational within five years at the earliest. Now, today you've said three to five years. And so, is that just an updated response since you wrote the report?

And then, I'd note that yes, you're right about the circulating activity is important for siting and licensing, but in some of these advanced reactors, but the gas reactor, the circulating activity may be important for a lot of things, because it takes a lot to get the core up to where you have accident releases.

So, I would think this is something that would be used again for other evaluations that would require like MELCOR, not just your codes.

MS. WEBBER: Joy? On the timing piece, so we're constantly adjusting our priorities, given what we know of applicants potentially making submittals. And so, the fact that the report might say three to five years and John is telling you five years, is symptomatic of that dynamic environment.

And so, I think we're trying to do the best that we can to be ready. And so that's where we are right now.

MEMBER REMPE: It's just interesting how fast it's moving up.

MS. WEBBER: Oh, I know. It's a very dynamic fast-paced environment that we're all feeling.

MEMBER PETTI: So, I have a question. John, is it fair to say that the biggest concern technically with all these codes, besides the modernization and the consolidation, is the ability to accurately calculate low EPZ results, for instance, where the site boundary is really tight, and making sure that the tool can calculate that accurately, given how so many of them are hard-wired for large light water reactor-type sites.

MR. TOMON: Yes, that's correct.

MEMBER PETTI: Is this the biggest thing?

MR. TOMON: Yes, that's one of the biggest things. I mean, some of the codes -- and I was going to speak to this a little later -- some of the codes, as written right now, are semi-flexible, in that while they're written for the large light water reactors, they will allow you to use user-defined characteristics.

For example, the SNAP/RADTRAD code, it's more labor-intensive for both the applicant and the user to come up with the source term at the release fractions and timing sequences for their reactor, than doing a typical -- what's hard-wired into the code right now, a dropdown selection of a pressurized water reactor or boiling water reactor inventory, and the release fraction and timing sequences.

So, some of the codes are that way and they're going to be used in that specific code; the SNAP/RADTRAD code is written in Java and the transfer of information is very much along the lines of what we talked about being from input and output in our code modernizations strategy. So, yes.

So, it will be more labor-intensive. Some of the codes can do it right now, but that is a big issue and concern in getting these codes ready so that both the applicants or, in our case, just the reviewers, have the tools available. They don't have to go to five different places. It's all available at one place that they can do it. And if possible, hard-wired in, and if not, at least at the minimum, be something that they could import and bring into the code as a user-defined spectrum. But the goal would ultimately be to have these as hard-wired inputs into the code, that they can select from in multiple choices, or multiple selection options.

MEMBER PETTI: All right.

MR. TOMON: Yes. Okay, so the regulatory needs for dose assessment codes. So, with the assistance of the program offices, we then identified specific dose assessment computer codes or tools that the NRC staff uses to perform independent assessments and confirmatory calculations, with respect to the various regulations in the Code of Federal Regulations, and NRC Regulatory Guides.

In Volume 4, we grouped these dose assessment codes based upon two areas. First was based upon the source terms -- severe accident, design basis accident, the normal or routine effluent releases and decommissioning -- and also based upon the types of reviews that are done for them, whether it's dose consequences, siting and environmental reviews, and decommissioning reviews.

The staff also determined that these dose assessment codes would have to be updated for the various non-light water reactor designs and phases, based upon the availability of the resources and the time frame for the various non-light water reactor applications.

Case in point, as was already brought up, we've already been in discussions with NRR about the Oklo application and trying to stay in tune to what needs to be done now ahead of time, prior to doing any other of our phase approaches.

That application is at hand right now. But as of right now, as I said, there's no environmental source term that they have in their application.

Our phase approach. We are considering in the near-term, now through the next five years, an intermediate phase, five to ten years, and a longer-term phase greater than ten years, with the ultimate long-term goal of reducing the current ten-plus license and siting dose assessment codes down to one or two codes that accomplish the same regulatory functions as all the existing ten codes currently do now.

MEMBER REMPE: John, could we stay on that prior slide? In the report I really like that you finally describe what the different tools do, and there was clearly a lot of overlap.

What I wasn't sure of after reading the report was how many other agencies use these various different tools.

MR. TOMON: Meaning federal agencies, or federal and state agencies?

MEMBER REMPE: What I'm really looking for, is there any -- like we know that MACCS, and even MELCOR actually, have a users group that helped contribute to activities related to co-development and maintenance.

Are there any codes here that have other organizations that are helping to support NRC in maintaining and developing these codes?

MR. TOMON: Well all of these codes, in one form or another, are codes under the Radiation Protection Code Analysis and Maintenance Program

(RAMP). So there are user groups for all of these codes, and RAMP not only includes these NRC dose codes -- there's about 10 listed here -- but there's also another five to six codes that are included under RAMP.

So the user group has a wide breadth of both international and state and local agencies, other federal agencies, and the codes like the RASCAL code, their user group includes the state and local officials who are decision-makers for protection of action guidelines.

Licensees are also included in the RAMP user group. And we do get contributions from them. We do solicit at our two RAMP meetings, input and feedback from the users groups. We do it not only at those meetings, but we also try to do it throughout the year.

For all these codes, we routinely have email help lines that they can ask questions and make recommendations and inputs for improvements to the code. So the RAMP is really the mechanism by which we do our outreach for most of these codes and get input and feedback on these codes.

MEMBER REMPE: So again, I'm still struggling with my question that I raised with Kim earlier, about why not just go to MACCS and have a simplified option? And I'm still not sure I've got a good answer to that question.

Aren't the answers that some of these other agencies are really pushing no, keep these codes? I'm still struggling with why we can't -- because at the earlier meeting we discussed this, it was not just ruled out that you just can't do it, which is what this report tends to imply.

MR. TOMON: Well some of the codes, like specifically the RASCAL code, as we said before in the past, and I know it's not the only answer, but the RASCAL user group is a unique group. They are typically local and state officials that are protective action decision makers, that are trying to make decisions based on real-time accidents, or real-time events in the plant, using real-time meteorology, both observational and forecast dated, to make their protective action decisions based upon the pre-existing emergency plans they have.

Usually, in most of the cases, most of these first responders are not very technically savvy in some cases in the reactor physics world and the nuclear plant world. They are really just looking at what is the environmental source term, what is that term that's leaving containment that can be transported downwind, and what do I have to do to protect my people?

Most of our state and local officials don't particularly want to just go with what the licensee says, even though the licensee is -- we do confirmatory analysis at the operations center and the incident response center, to verify what the protective action recommendations are and the decisions are.

Typically the state and local officials, those decision-makers, sit there, want to make some sort of back-up calculation, confirmatory calculation, to what they're getting from the licensees in their locality. So they will run RASCAL.

But again, RASCAL, they don't have that technical background and savvy to know what this plant pressure or this plant temperature, or this containment pressure means. They don't know that.

But what RASCAL does, it asks them very simple questions based on hard-wired MELCOR data that's already in, and scale data for the core inventories, that we ask them some specific questions, they make some very minor inputs, weather is automatically downloaded for them, and that they can run a relatively quick, scientifically defensible, calculation, that they can then look at what the licensee is telling them, and confirm it one way or another, same way as the NRC is doing that, and the same response.

MEMBER REMPE: So again, I'm still puzzled why you can't take MACCS, put a simplified option with the hard-wired data and the questions required, since it's coming from other codes, and do something like that.

Because the report says it's a common misconception. Well it seems to me still that it's an attitude of whether I want to do it this way or the other way. And I'm not seeing that it's impossible to do.

MR. TOMON: I guess I'm not saying it's impossible. But the paradigm for the user communities are totally different. And building off inputs from the MACCS code, I mean we intend as a staff to leverage work done, because resources, as everybody always knows, resources are always tight all the way around.

We don't plan to do things in a vacuum, not working with what work on MELCOR is being done, what work in scale is being done, and what work in

MACCS is being done.

But the user community typically -- I know they came up with a MACCS-lite, as it were, many years ago, a fast-running MACCS, but for whatever reason -- and one of the reasons I think I remember hearing but don't quote me on it -- was that the user community, meaning the state and local officials, found it way too difficult to use, as compared to codes like the RASCAL code, that asked very simple questions to do it.

Ultimately, I guess if you look at it -- to get to your statement, Joy -- they basically do the same things. They have the same inputs from MELCOR, the weather runs are much less because they do real-time data in RASCAL.

But the way the format that's used in RASCAL, is something that the user community kind of expects, is kind of used to, and it's not difficult for them to make the decisions and recommendations, based upon the outputs of the RASCAL code.

(Simultaneous speaking.)

MEMBER REMPE: I just think we're getting back to what we heard at the prior meeting then, that if you look at it in the long-term -- and again, you need to be very careful about the customer and what they want -- but you could have another MACCS-lite that would download the data very rapidly.

And it might be a more efficient use of resources if you looked at the long-term, which is kind of where we got to at the prior meeting. And none of that discussion actually shows up in this report.

And that's where I was confused, because I just can't see a reason that it couldn't be done. I mean the report's pretty strong. It says this is a common misconception. Well it's not a misconception. It's just an approach that you've selected. Right?

MR. TOMON: Yes. And I guess getting to your point, that is something we could look to in the long-term, maybe 10-plus years. Because originally when we talked about it -- in the later slides when I go on -- this approach for code consolidation and modernization trying to get them in, as I said earlier, we're trying to get down to one or two codes.

And ultimately, the goal would be to get down to one. And there's always been some discussion in a group with our contractors right now, that loading something like RASCAL into this one code that did everything that these 10 codes does, but just have it so that the RASCAL code would be something that just the emergency response the immediate responders would use, that might not be something we can do up front, and it might be something we can do later on down the line, to get it into one code, as it were.

So I mean we're not -- I guess the answer is I'm not saying that we are completely ruling out something like that. But for now, we see as keeping RASCAL and kind of MACCS, making them feed off each other from what they do, and even in the point, even if we get to a point later on, maybe 10 years down the road, that there's some way to combine, that's not out of the realm of possibility. But right now that's not currently in our plan.

MS. WEBBER: Yeah, can I just add something quickly? I think John characterized it pretty well. But so Joy, it's not impossible to do. We could do it. We have chosen to take this route, or the route that's represented in Volume 4.

Part of it is that we have an internal-to-the-NRC community that use these different codes at different times. And so to provide codes that the individual communities who use all these codes at the bottom, different people use them at different times, I think that's a service that we need to provide.

And so to introduce potentially a new code with a different set of dynamics plus additional costs, is something that maybe we could do in the long run, but it may not support our near-term activities with applicants coming through the door in the next few years.

MEMBER REMPE: So I get what you're doing. But I mean if you looked at the long-term and the cost of maintaining all of these different codes, or even what you end up with the consolidated version versus going to the long-term goal of having MACCS, downloading stuff from MELCOR and immediate data coming from the site, the long-term cost to the agency might be lower.

But again, how you get funding allocated from Congress on an annual basis or users, that kind of thing has to be considered. But I think the report's not accurately reflecting that this was an approach selected because of whatever. Because it implies it's a misconception, you can't do it. And I think that needs to be corrected.

MS. WEBBER: Okay. Thanks for the comment. I wonder if we should move on to the next slide.

MEMBER REMPE: Please do. I'll quit whining about it. But thank you for also being a little bit more forthright about it than what I saw in the report.

MS. WEBBER: Okay, thanks.

MR. TOMON: So continuing on, as shown in the bottom of the previous slide and in this figure from Volume 4, we are looking towards the possibility of having to make ready 10 licensing siting dose assessment codes for the various non-LWR applications.

Included in these codes are the radionuclide transport removal and dose estimation code (RADTRAD), the control room habitability code (HABIT), the atmospheric relative concentrations and support of control room habitability (ARCON), the ground level air concentrations for accidental release codes (PAVAN), the gaseous and liquid ethylene code (GALE), the normal effluent dose assessment and siting code (NRCDose), the normal relative air concentrations and relative disposition factors code (XOQDOQ), the radioactive material transport dose assessment code (RADTRAN), the radiological system for consequence analysis code (RASCAL), the decommissioning and decontamination code (DandD), and the residual radioactivity code (RESRAD).

In Volume 4, we also included discussions on other codes that either non-light water reactor designers are considered using in their applications, such as the Generation 2 code, or the GEN2 code, or codes which have inputs to the codes on this slide, such as the dose coefficient package code (DCFPAK), the SCALE code, the MELCOR code.

In the next few slides, I'll briefly discuss the purpose of each of these codes for licensing and siting purposes.

MEMBER BROWN: Can I ask another question that just popped up as you read through all that?

MR. TOMON: Mm-hmm. Yes, sir.

MEMBER BROWN: Part of your -- if you go back to that earlier slide, you talked about consolidation and modernization. So you must have listed a dozen codes or so.

MR. TOMON: 10, sir. Yes.

MEMBER BROWN: 10, okay, I was off a little bit.

MR. TOMON: No problem.

MEMBER BROWN: So I presume when you talk about consolidating, you want to bring these together --

MR. TOMON: Yes, sir.

MEMBER BROWN: -- in their operations. Isn't there a danger in that? I mean it's nice many times to have a lot of eggs, as opposed to having one big basket. If something has to be worked on or done in an overall consolidating code, it takes out of service all of them.

So I've just been thinking about that after I looked at your introduction stuff and everything else. Have you taken that into consideration?

I understand the idea of trying to not have to go piecemeal, but consolidation could also add complexity and reduce usability, if something goes wrong and you've got to go correct something in one of the modules or sub-modules or whatever. The whole code is out of service.

MR. TOMON: Well the goal was -- and one of our phases in our goal was to do the atmospheric transport consolidation, the ARCON, PAVAN and the XOQDOQ codes.

And in that, one of our goals -- and you're right, and we wanted to do it as a proof of concept to see if we developed that one engine, because they all use straight-line Gaussian plume models, that we still met the existing requirements for the different regulatory guides and the different needs of those codes, but that they were consolidated into one module, so that -- because currently right now, codes like ARCON just got updated.

But some of the codes have not been updated in years. And to do changes, or to do stuff to them, is more labor-intensive. So what we figured is if we did this proof of concept with this one engine -- we called it the atmospheric transport engine -- that would be our first to see -- and it's a natural kind of evolution of the codes, because they all use the same models underneath for calculational purposes, with different varying correction factors in there.

So we're going with the assumption that that will be our first proof of concept, and we'll learn from that as we move further on with the other codes. But we don't foresee it -- I mean I guess we didn't foresee it as a big stumbling point in taking down all the other codes and taking us out of work in that particular point in time. Because we -- go ahead.

MS. WEBBER: I was just going to say, plus you wouldn't take those old codes out of service until you got a working new version of the consolidated models.

MR. TOMON: That's correct. We would make sure that the proof of concept works and meets the needs of the program offices and before we would sunset those codes, as Kim is saying.

MEMBER BROWN: Yeah, but once you have a working model that's been blessed, you're inevitably going to want to make changes to it. And when it's taken out of service to make changes, that takes out of service everything.

MS. WEBBER: I think with code development, as I understand it from a limited perspective, they don't take out a service -- the code -- while they're working on the next version.

So as I understand it, there's a working version, regardless of what's in that code and the models and phenomena modeled in those codes. And then as they're building new functionality or making changes to the code based on bugs that have been identified, they'll redo the validation for the code before they release it, so that it ends up being a working code.

MEMBER BROWN: Okay. Thank you, Kim.

MS. WEBBER: Yeah, sure.

MR. TOMON: So my next slide depicts the safety and environmental review codes that are used for siting purposes for design basis accidents.

The RADTRAD code is used by the NRC staff and applicants to calculate doses to demonstrate compliance with the nuclear plant siting criteria at the exclusion area boundary in the low-population zone. It is also used to calculate occupational radiation doses within the control room and/or other offsite emergency facilities.

The code is joined together at the front end, with the symbolic nuclear analysis package, is commonly referred to as SNAP/RADTRAD.

The PAVAN code is used to estimate relative ground-level, short-term air concentrations resulting from releases of design basis accident at the exclusion area boundary and the outer boundary of the population zone.

PAVAN uses a straight line Gaussian plume model that assumes a release rate is constant for the entire period of the release.

The ARCON code is used to calculate short-term accident air concentrations in support of control room habitability assessments, as described in Reg Guide 1.194. The code uses a straight-line Gaussian model that assumes constant release rate.

ARCON also implements building wake, low wind speed dispersion algorithms, and ground level and elevated source release modes.

The next code I will briefly discuss is the HABIT code, which is used to examine control room habitability following a postulated release of toxic chemicals, based on regulations in Reg Guide 1.78.

The code consists of four FORTRAN codes connected through a common graphical user interface. These codes include the external transport computer code EXTRAN, which is a Gaussian puff dispersion model, the control room chemical code CHEM, the Environmental Protection Agency's dense gas dispersion code (DEGADIS), and the Department of Energy's denser-than-air release computer code SLAB.

This slide shows the relationship of dose assessment codes which are used for normal effluent releases and transportation reviews. The GALE code, as I spoke to before, which is used to estimate annual routine releases of radioactive gases and liquid effluence from pressurized and boiling water reactors, based upon the regulations in Reg Guide 1.112, the NRCDose code, which is a software suite that contains a common graphical user interface that runs three FORTRAN codes -- GASPAR, LADTAP and XOQDOQ code -- working together, these codes are used to estimate offsite doses from liquid and gaseous radioactive releases from routine nuclear power plant operations, and implement those low-as-reasonably-achievable requirements of Appendix I of 10 CFR Part 50.

The LADTAP code, which implements the liquid pathway models in Reg Guide 1.113, and when combined with the normal liquid effluent from the GALE code, will calculate the annual doses from routine releases of reactor coolant effluence per Reg Guide 1.109.

The XOQDOQ and GASPAR codes implement the atmospheric pathway models in Reg Guide 1.111, and when combined with normal gaseous effluent source term from the GALE code, GASPAR will calculate the annual doses from routine releases of gaseous effluence per Reg Guide 1.109.

Finally, the RADTRAN code is used to estimate doses from routine and accident scenarios involving the transportation of radioactive material, including spent nuclear fuel.

The code is used for environmental impact statements pursuant to the requirements of the National Environmental Policy Act and NRC and Department of Transportation regulations.

Dose consequence codes. The RASCAL code is an emergency response code, as we've already talked about, used to perform independent dose consequence projections during the initial plume phase of radiological incidence and emergency, including severe accidents.

As I spoke to before, it was designed to provide scientifically defensible dose projection, within 15 minutes of the occurrence of an event to support protective action decision-makers at the state and local level, as well as the NRC staff.

While very similar to the MACCS code, each of these codes serves a different user community, with different expectations.

For example, as I spoke to earlier, the RASCAL users typically are first responders, state and local personnel, running many different what-if scenarios during the plume phase of an event.

RASCAL uses automatically downloaded, real-time observational and forecast meteorological data from the National Weather Service, combined with a limited number of user supplied plant inputs, to provide dose projections to compare to the EPA's protective action guidelines.

MACCS users are typically emergency planners and dose-consequence analysts who use the code for facility siting purposes. Additionally, MACCS codes require a significant number of weather trials and plant inputs, and can require several hours to days to set up and run calculations. MACCS calculations also extend to the intermediate and long-term phases of an event.

Decommissioning codes. The staff decided to, before thinking when developing Volume 4, to include decommissioning codes as part of our phased approach for our non-light water reactor code readiness strategy.

Codes such as decontamination and decommissioning (DandD) and the RESRAD family of codes, are used by licensees and the staff in license termination surveys. They are briefly discussed in this volume to bring attention to the entire lifecycle of non-light water reactors, not just siting, licensing and operations.

Their need to be evaluated may become more apparent in the longer term implementation plan, i.e., greater than 10 years.

Research and other codes. Finally, the staff also looked at several other dose assessment codes that are either similar in function to many of the licensing and siting codes already discussed in the previous slides, or are codes which are used as inputs to the licensing and siting codes.

Such codes at the ones that are similar to the ones we've already talked about was the Generation 2 computer code, or the GEN2 computer code, which models atmospheric releases of radioactive materials to the environment, and had a similar dose assessment and points with several of the licensing and siting codes previously discussed.

MEMBER REMPE: John, I meant to ask you earlier, but what would you use for assessing release from a reactor that's being transported either by rail or by airplane?

MR. TOMON: Well that's where the RADTRAN code on the couple of slides back would come into effect. And right now that scenario is not in there, because we would have to add that source term to the RADTRAN code. But it would be the RADTRAN code. That's the purpose of the RADTRAN code.

MEMBER REMPE: Okay. Yeah, and that's what I thought when I read the report. I guess I couldn't hear it during this session. I might have missed it. Thank you.

MR. TOMON: Yes. The Dose Coefficient Package File, or DCFPAK, includes nuclear decay data and dose and risk coefficients for exposure for each of the 1,252 radionuclides addressed in ICRP Publication 107. Parts of DCFPAK are currently used in the RASCAL code, NRCDose, and the SNAP/RADTRAD codes.

Finally, the staff also included a discussion of the scale and MELCOR codes in Volume 4, because these outputs from both are currently hard-wired into codes such as RASCAL and SNAP/RADTRAD.

The staff plans to leverage work done on these codes for non-light water reactor technologies in our licensing and siting codes, where applicable.

Volume 4 Code Readiness Test. Working with our individual dose assessment code developers and the radiation protection computer code analysis maintenance program (RAMP contractor, Pacific Northwest National Laboratory), the staff developed the five tests listed on this slide to prepare the license and siting dose assessment codes for non-light water reactor readiness.

These tests included looking at Code Consolidation and Modernization, Task 1, code source terms, atmospheric transport and dispersion models, dose coefficients used, and environmental pathway models used in some of the codes.

Code Consolidation and Modernization,

Task 1. One of the first tasks that the staff came upon was the number of license and siting dose assessment codes, 10, and the number of different non-light water reactor designs.

The staff decided that code consolidation, where possible, was an efficient means of maintaining and writing the codes with the resources available. Code consolidation and modernization was viewed at a means to help reduce functional redundancy between codes, outdated science and technology associated with the design and development of the codes, limited ability of the current codes to assess advanced reactor designs, agency resources associated with undue analysis and co-distribution efforts, and the inefficiency of having to maintain multiple codes.

With this thought in mind, we came up with a code consolidation approach with the assistance of our RAMP contractor, Pacific Northwest National Laboratory.

We developed a three-pillar approach to code consolidation, including first create consolidated engines. This is a set of functional modules for engines that would be developed to form the regulatory calculations as those performed by the current suite of licensing and siting dose assessment codes.

The functional engine approach improves development flexibility by allowing future modifications and efficient data transfer.

Furthermore, separating these capabilities as standalone engines eliminates the code redundancy and inefficiencies that currently exist.

Second, develop a standardized data transfer schema. Using standardized data transfer schema, such as extensive markup language, or XML, for encoding data for each engine, would make data input universal and adaptable, while making it easy to pass output data between the different functional engines.

By using the extensive markup language as a data management system within the consolidated code framework, the entire system would be more robust relative to the advancements in the nuclear industry, and any improvements in data entry, such as downloading meteorological data inputs.

Finally, the last pillar is to build a single user interface. A single user interface would be developed separate from the functional engines that would interact with users and communicate with the functional engines to execute user-defined commands.

The user interface would be designed to

effortlessly guide users to the relevant code engine input screens, primarily through a series of questions about desired outputs.

The conceptual model for a consolidated code. The figure on this slide is a conceptual diagram of the proposed consolidated code paradigm showing how the models from the existing siting and licensing codes could be integrated into a new consolidated code.

The modules within the consolidated code would be grouped or characterized within this general dose assessment approach. In addition, the modules would be further broken down into scientific disciplines, to account for the unique differences of these fields.

The proposed consolidated code would have several modules or components of each, which will contain phenomenological models from the existing light water reactor codes.

The eight modules of the consolidating code include a source term including core inventories; release fractions and timing sequences; an atmospheric transport and dispersion modeling, to include near-, mid- and far-field models; aquatic pathway modeling, including ocean, river and lake dispersion;

environmental accumulation; human biota consequence modeling; non-human biota consequence modeling; dose efficients and health risk factors; and an integrated dose module.

The second task of Volume 4 was to identify the source term inputs, such as the radionuclide fuel inventories, reactor coolant inventories, plant design and operational data, for each of the non-light water reactor designs.

Source terms are one of the higher priority modules, because it's the first data needed in the dose assessment process.

For normal operations, the radionuclides of interest in the source term include fission products, capture products, activation products produced during normal operations, and the reactor cooling system.

For accident conditions, both severe accidents and design basis accidents, the primary source term information will be from the work on the SCALE and MELCOR codes described in Volume 3.

And finally the transportation source term, the various non-light water reactor fuel types, vary significantly from the current light water fuel configurations.

In addition, some of the non-light water reactor designs may adopt a battery-type approach where it's likely that the entire core containing the spent fuel will be transported as a single shipment. Therefore, the transportation source term and module will need to take these issues into account and consideration.

Some other source term considerations, the radiation protection branch staff plans to work with the program offices and the other co-development branches and research to leverage activities from Volumes 1, 2 and 3.

We are also working with your RAMP contractor, Pacific Northwest National Laboratory, to leverage their source term work and activities with the National Reactor Innovation Center. And specifically we will look to leverage the work done with SCALE and MELCOR codes, to estimate the inventories and these fractions and timing sequences, and reduction mechanisms, for the various non-light water reactor designs.

Finally, some of our current licensing and siting assessment codes, as I spoke to earlier, are flexible in their current configuration, to accept source terms outside of the current light water reactor designs.

For example, as currently constructed, the SNAP/RADTRAD code will allow users to enter user-defined source terms, release fractions, and timing sequence. However, this is a more involved thought process than selecting from current hard-wired pressurized and boiling water reactor options already in the code.

Additionally, NRCDose can allow for import of user-defined source terms. However, there is currently no code that will perform normal effluent reactor source term calculations for non-light water reactor technology, like the GALE code does for light water reactor technology.

MEMBER KIRCHNER: John?

MR. TOMON: Yes.

MEMBER KIRCHNER: This is Walt Kirchner.

MR. TOMON: Yes.

MEMBER KIRCHNER: Some of these designs will produce significant amounts of tritium. How does that fit into the overall scheme that you envision?

MR. TOMON: In some of the later tasks we do talk about that. We will have to consider both the amount for the high-temperature gas cool reactor, and the molten salt reactor, the tritium that is being produced, both with the environmental pathways and the dose coefficients that we use in the code.

So we are looking towards that. We are also looking to try to get some of the operational data from the molten salt reactor, to see what the tritium concentrations were and what they were seeing for maybe their normal tritium concentrations in the plant, so that we can take that into consideration as we move on and develop a source term for those codes.

MEMBER KIRCHNER: I'm sorry. To follow on, how do you deal with -- tritium production is not such an issue with our current fleet. It's a bigger issue, for example, for the CANDU reactors. How do we take care of it currently with the existing suite of codes that you use?

MR. TOMON: I would have to defer to -- I'm not really 100 percent sure how the exact mechanism we use in our codes -- I mean I know typically, that typical code that you would see that in the source term, or it would be included in the source term would be when performing calculations within the NRCDose code.

However, I'm not really 100 percent sure of how we take that into account for the current P and PWR, BWR fleet.

MEMBER KIRCHNER: Yeah, it just becomes -- the reason I raise it, it becomes a much larger concern with some of these advanced designs than we've had to deal with in the past. Okay, thank you.

MEMBER PETTI: So Walt, there is international work done through the IAEA on what's the state of the art tritium transport code. Because of other technologies that use tritium. And so the fusion program has spent a lot of time internationally on the code called UFOTRI, which I think is now in the IAEA database.

So there is a community that has looked into that. They've done release experiments to make sure they understand the transport and the uptake. And there's a lot of data out there.

MEMBER KIRCHNER: Yeah. Dave, I almost imagine that it would be an overlay of the existing framework that John has been sharing with us, almost like a side -- I hate to say a side calculation, but it probably would be an overlay and you would deal with it perhaps independently with other codes that have been developed, as you point to in the fusion community.

MEMBER REMPE: Could we ask for you as a follow-on to maybe send us a note through Derek, John, about what is done with tritium for the current fleet?

MR. TOMON: Sure. I can look into that. Sure, no problem.

MEMBER REMPE: Thank you.

MR. TOMON: The third module or third task we have in the report involves the atmospheric transport and dispersion model.

Most of the licensing and siting dose assessments use or have atmospheric transport and dispersion models, which are typically Gaussian plume models. For example, ARCON, PAVAN and the XOQDOQ codes use straight-line Gaussian models with different correction factors, such as building wake effects, wind direction, wind speed, atmospheric stability cost, location of the release point, stacked downwash and plume rise to adjust for the codes used.

As a proof of concept for code consolidation, the staff is looking to consolidate ARCON, PAVAN and the XOQDOQ into a single atmospheric engine and a phased approach.

Phase 1 would be an integrated atmospheric engine that would have the capability of performing near-field, mid-field, and far-field calculations, thereby the user could perform regulatory calculations relevant to any of these three distances.

Phase 2 would involve adding capabilities to the consolidated atmospheric to support non-light water reactor technology sitings, such as siting in remote areas with differing atmospheric stability, diffusion and dispersion characteristics.

MEMBER KIRCHNER: John?

MR. TOMON: Yes?

MEMBER KIRCHNER: That last statement doesn't kind of ring true. We have that same problem with the current fleet. What would be different? It might be Alaska where you haven't sited before or something like that, but I would think from a methodology standpoint, that's just a factor of importing the local meteorological conditions, right?

MR. TOMON: Well, what they're -- I guess what we're looking at here, and that's why it's a phase 2 part of the approach, is that we're looking at most of the Pasquill-Gifford calculations for dispersion and diffusion were done in the middle of the United States with relatively flat terrain and topography back in the '60s.

So, I know there have been and we have been in discussion with our meteorologists that we work with on the PAVAN code and the ARCON code in Pacific Northwest National Laboratory, that there have been other studies that have been done in some remote areas where there are those, where those dispersion and diffusion characteristics might not be, the Pasquill-Gifford ones might not be true to what is not in the remote area, say sort of like in Alaska.

So, right now, we are going to work with the meteorologists over in NRR to implement these based upon the needs and to allow that option so that we can, in this consolidated atmospheric transport module, so that we can implement those as needed based upon the siting in remote areas based upon what the reviewers at NRR deem as appropriate or acceptable then from typical ones we use right now, which are the Pasquill-Gifford ones.

MEMBER KIRCHNER: Yeah, I just, well, I guess what I'm objecting to is just that I wouldn't call Oak Ridge a remote area anymore, but, you know, we did an early site permit for Oak Ridge and they had rather interesting meteorology there. I mean, they've got -- you probably know the site, so I'm just reacting to it's not a remote siting issue.

It's just the basic physics of the models that you incorporate, but you have sites in the U.S. that have some peculiarities and Oak Ridge is certainly one that's, you know, prone to atmospheric inversions, et cetera.

MR. TOMON: Yeah, well, what we really want to do is kind of be ready for the needs of the reviewers at NRR, so to listen to their needs based upon what they need if the code as consolidated doesn't do exactly what it does.

But we're hoping since we're going to this kind of standard input/output XML data transfer, that making changes to the code and providing updates as needed with verification and validation would not be a long process.

It would be relatively quick to do what the reviewers need for different scenarios based upon whether it's remote or not remote, or just because of the environmental conditions of the site.

So, this slide is showing an example of some thoughts we had for the user inputs and features that could be incorporated into the atmospheric engine prototype along with the data flow between the interface and the engine.

After selecting a dispersion distance model, i.e., the near, mid, or far field, the user could provide source receptor inputs such as distance, intake height, and direction using 2D and 3D graphical displays.

The user would then choose a meteorological file and visualize the wind distribution. The terrain data could be imported from a public database such as the National Elevation Dataset.

And once the inputs are set up, the data shall be transferred using extensive markup language, XML schema, to the atmospheric engine where the calculations are performed.

After the calculations are completed, the atmospheric dispersion engine would allow the user to select various outputs for both reporting and plotting results depending upon the needs and the regulatory requirements.

A dose coefficient module, the fourth task involved developing a dosimetry engine that has the flexibility to use different vintage dosimetric models and dose coefficient values, and also examining the dose coefficient models with respect to aerosol particle size since most of the non-light water reactor and technologies could release particles smaller than the one to ten micron range that are currently considered for the current codes.

Current regulations such as 10 CFR 20 require that licensees use dose coefficient values from older dosimetry models and systems. Typically for the codes, the dose coefficients and dosimetry models are hardwired into the code and the user has few options to edit or change these values.

An important element of this task is to design the module with an understanding of the different dosimetry endpoints of siting, licensing, and emergency response for non-light water reactor designs.

The vision for the dose --

MEMBER REMPE: You'll have to be careful because of the folks that are your users that may not have the technical background to do too much, right?

MR. TOMON: Yes, ma'am. Yes, we'll have to be careful of that, plus they'll have to -- the goal would be to make it flexible, but also at the same time, where necessary, add how they're using or what they're using, or what they choose for different dose coefficient and dosimetry models and how that would affect or what -- you know, just make sure that there's a warning in the system somehow along those lines as well.

The vision for the dose coefficient module is it would be a flexible module that allows the user to select from Federal Guidance Reports 11 and 12 dose coefficients used by the current regulations, as well as future Federal Guidance Report dose coefficients such as FGR 15.

Another part of this module would consider options to allow the user to select aerosol particle size for radionuclides.

The dose coefficient forms may also need to be modified to account for various different forms of volatile carbons such as carbon monoxide, carbon dioxide, and other organic molecules, as well as a modification for tritium dosimetry models for the high temperature gas cool reactors and the molten salt reactors.

Currently, the SNAP/RADTRAD code allows the user to enter user-defined dose coefficients in addition to the hardwired Federal Guidance Report 11 and 12 values.

The remaining dose assessment codes as currently configured do not possess an option for the user to select user-defined coefficient values.

Codes like NRCDose and RASCAL do allow the user to choose between dose coefficient values from different hardwired dosimetric models such as ICRP 2, 26 and 30, and ICRP 6072.

The final task in Volume 5 consists of

further developing aquatic pathways, river, lake, ocean dispersion, environmental accumulation, and human and non-human bio consequences.

These tasks are in future phases because they are less dependent on the non-light water reactor design and fuel types, and we're considering that in the five to ten-year range.

The task will also look to explore the feasibility of radionuclide particle size behavior in the environment for some of the non-light water designs.

The task will also leverage models from the Generation 2 code and the decommissioning codes like RESRAD and work plan for the max mode to examine deposition models to the environment.

Some other considerations and challenges, as I stated in the beginning of my presentation, we are looking to implement these tasks in phases depending on several factors such as the timing of non-light water reactor submittal versus code readiness.

For example, as I mentioned before, the radiation protection staff is monitoring the Oklo submittal and meeting with the staff from NRR. However, there is currently no source term to the environment in the current application.

We also need to take into account code consolidation versus non-consolidation as was brought up in the meeting, which includes the availability of resources, both the staff and contract farming on a year to year basis for near, mid, and long-term code consolidation projects, and will be a continuing consideration and challenge.

And finally, the radiation protection branch staff has already reached out and has had several meetings with the various branches at NRR and NMSS to collect, to collaborate in developing a targeted and agreed upon code consolidation plan.

My final slides show some of the near and midterm planning milestones for the licensing and siting dose assessment code readiness.

We are planning for the developing and piloting of the consolidated atmospheric transport engine hopefully by the end of fiscal year '21, and we will continue to meet and collaborate with our co-developers, contractors, and counterparts in the program office in developing and coordinating implementation plans for the code consolidation, and that concludes my presentation.

MEMBER REMPE: Thank you, John. Do any

members have any additional questions at this time? So, not hearing any response, I'd like to ask that the public line be opened and we provide the public an opportunity to comment, and then we'll go around like we used to when we were meeting together and ask the members if they have any final thoughts before we end this public session, and then my plan is to have a break before we transition to the nonpublic session. Does that sound good to everybody?

MS. WEBBER: Yes, thanks.

MEMBER REMPE: Okay, so let's open up the public line.

OPERATOR: The public line is open for comment.

MEMBER REMPE: Great, if there are any members of the public who'd like to make a comment, please state your name and provide that comment at this time.

So, not hearing any comments, let's close the public line, and let's go through the member list and see if any of them would like to make some closing comments, and we'll start with you, Charlie.

MEMBER BROWN: Nothing else. I asked mine. Thanks, Joy.

MEMBER REMPE: Okay, Walt?

MEMBER KIRCHNER: Nothing further at this point. Thank you, Joy.

MEMBER REMPE: Okay, Jose?

MEMBER MARCH-LEUBA: Jose's trying to get the mouse to work. No, I have no further comment.

MEMBER REMPE: Okay, thank you. Dave?

MEMBER PETTI: Nothing further.

MEMBER REMPE: Okay, Ron?

MEMBER BALLINGER: Only that this whole process sounds like an enormous effort and rebaselining all of the codes. It just seems like a very, very large effort which I wonder whether the schedule actually reflects what will actually happen.

MEMBER REMPE: Okay, thank you for your comment. Matt?

MEMBER SUNSERI: Joy, I don't have any other comments. Thanks for the presentation.

MEMBER REMPE: Vesna, do you have any comments?

MEMBER DIMITRIJEVIC: No, nothing further. Thanks.

MEMBER REMPE: Okay, so before we close and take a break, I need to acknowledge I was given this information and Kim was correct. The letter for this will be on Volumes 4 and 5, and we have plans to work on that letter in February of next year, and so in the interim, Dennis and I will work on it together and I'll give him input from this meeting.

And so at this point, my clock says it's five after the hour, so how about a --

MEMBER BROWN: Joy?

MEMBER REMPE: Yes, sir?

MEMBER BROWN: Before you hang us up, I don't know whether I'm the only one that has the problem. I just looked at my chart and I do not see a closed meeting session, so if I hang up from this, I don't have anything to go to your closed session.

MEMBER REMPE: Okay, so --

MEMBER BALLINGER: Same goes for me. This is Ron.

MEMBER REMPE: It's the same place, right, Derek? You help me out, because again, I wasn't involved in how you were planning this with Dennis, but my understanding is that we will be using the same line and they'll monitor it, right, Derek?

MR. WIDMAYER: That's correct.

MEMBER REMPE: So, we're going to take -- and I know, Walt, you like longer first morning breaks, so should I say we're going to start up at 9:20 or are you okay at 9:15?

MS. WEBBER: Well, I think the, so the staff was preparing for noon, so I'm not sure if all of the staff are, you know, available to start earlier. I can try to see offline if they are ready to start earlier, but I'm just not sure.

MEMBER REMPE: Well, in light of that, we can't tell members to come back in 15 minutes and then tell them we don't want them, so should we just go with the plan and we're going to take a very long break unless I hear differently from our Chairman. Matt, do you have a better suggestion?

MEMBER SUNSERI: No, I don't. I guess we'll be finished in time for the next meeting this afternoon though, right?

MEMBER REMPE: Tim, could you --

MS. WEBBER: I'm sorry. What was the question? I was trying to --

MEMBER REMPE: If we wait until noon --

MS. WEBBER: Yeah.

MEMBER REMPE: -- D.C. time, will you give us adequate time for a -- we have another meeting that starts at 1:30, so this is basically going to be a tighter schedule at that point. Is that --

MS. WEBBER: Right, so what we have planned for the other session is to talk about some of the things that I already showed you on the public website, and there's a few other things that are not publicly available at this point in time that we plan to discuss with you.

So, you know, we have a lot of information to present, but because we talked about some of it, I think we could go fairly quickly unless you have a lot of questions.

MR. WIDMAYER: So, hey, Kim? Hey, Kim, this is Derek.

MS. WEBBER: Hey, Derek.

MR. WIDMAYER: Yeah, hey, in answering emails and stuff with your staff, I'd encourage them to come on early. Could you check and see --

MS. WEBBER: Right.

MR. WIDMAYER: -- if everybody is available?

MS. WEBBER: Okay, do you want to hold on? Because I see some of them. I see some of them on the call, so let me Skype them individually and I'll see if they're available, and then if you give me five minutes or so, I'll report back to you.

MEMBER REMPE: So, let's take a ten-minute break --

MS. WEBBER: Sure.

MEMBER REMPE: -- and come back at -- well, it's 9:08 right now, so let's come back at 9:20, and let's hope we're going to have a meeting, but if not, we will take a longer break and deal with it. Does that sound -- does everybody understand what we're going to do here, members?

MEMBER KIRCHNER: Yeah, it's really 11:08.

MEMBER REMPE: Oh, I'm in Idaho, so I'm looking at -- yeah, you're right. We all are having trouble with that.

MEMBER BROWN: Let me just make sure -- Joy? Joy?

(Simultaneous speaking.)

MEMBER REMPE: This weekend, they were saying good morning, good night, and good afternoon depending on where everyone was.

MEMBER BROWN: Joy? Joy, Joy, Joy?

MEMBER REMPE: Yes, sir?

MEMBER BROWN: Just to make sure, we are not hanging up. We're just going to come back?

MEMBER REMPE: Yes, you can --

MEMBER BROWN: Great.

MEMBER REMPE: You can rejoin the same session at 11:20 if you're in D.C. time.

MEMBER BROWN: Well, I'm just going to

mute.

(Simultaneous speaking.)

MEMBER KIRCHNER: Could we give --

MEMBER REMPE: Pardon?

MEMBER KIRCHNER: Could we give the staff a little more time to rally and take a break until 11:30?

PARTICIPANT: Sure.

MEMBER REMPE: That sounds good. And Kim, whoever you can get, just go out of order and let's really hope we can start at 11:30, okay?

MEMBER BROWN: Joy, Joy, my --

MEMBER REMPE: Yes, sir.

MEMBER BROWN: Yeah, my agenda showed on Eastern Standard Time this session starting at 11:30 Eastern Time.

MEMBER REMPE: This whole thing, like I have an agenda that's a final agenda, and the agenda started at 9:00 D.C. time instead of at 8:30, and so we've had a lot of, or instead of 9:30, so there's been some time issues that are confusing, Charlie.

Let's just go with what we're going to be doing. At 11:30 D.C. time, we're going to come back, okay?

MEMBER BROWN: Okay, that works. Yes,

thank you.

MEMBER REMPE: Thank you very much, everyone, for your patience with the changes that are occurring in real time. Okay, see you at 11:30 D.C. time. Thank you.

(Whereupon, the above-entitled matter went off the record at 11:09 a.m.)

Implementation Action Plan (IAP) Strategy 2 Volume 4 - Licensing and Siting Dose Assessment Codes

September 22, 2020

Kimberly A. Webber, Ph.D.
Division of Systems Analysis
Office of Nuclear Regulatory Research

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Agenda

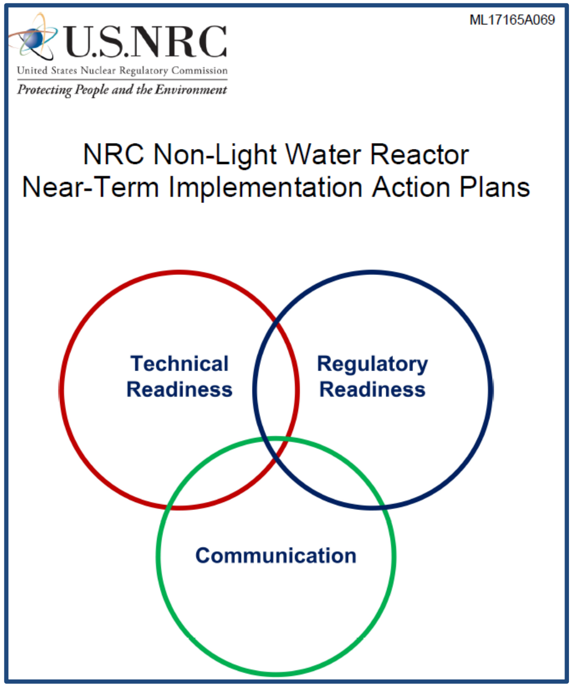
- Staff Introduction
- Overview
  - Radiation Protection Code Modernization
- Non-LWR Code Development, Volume 4, "Licensing and Siting Dose Assessment Codes"
  - Discussion of Codes
  - Discussion of Volume 4 Tasks
  - Leveraging Other Non-LWR Code Readiness Work
  - Other non-NRC Dose Assessment Codes for Non-LWR Readiness and Other Considerations

NRC's "Be Ready" Attitude

- Improve mission value while enabling safe operations
  - Deliver cost savings
  - Develop regulatory tools
  - Build staff expertise
  - Leverage collaborations

BlueCRAB

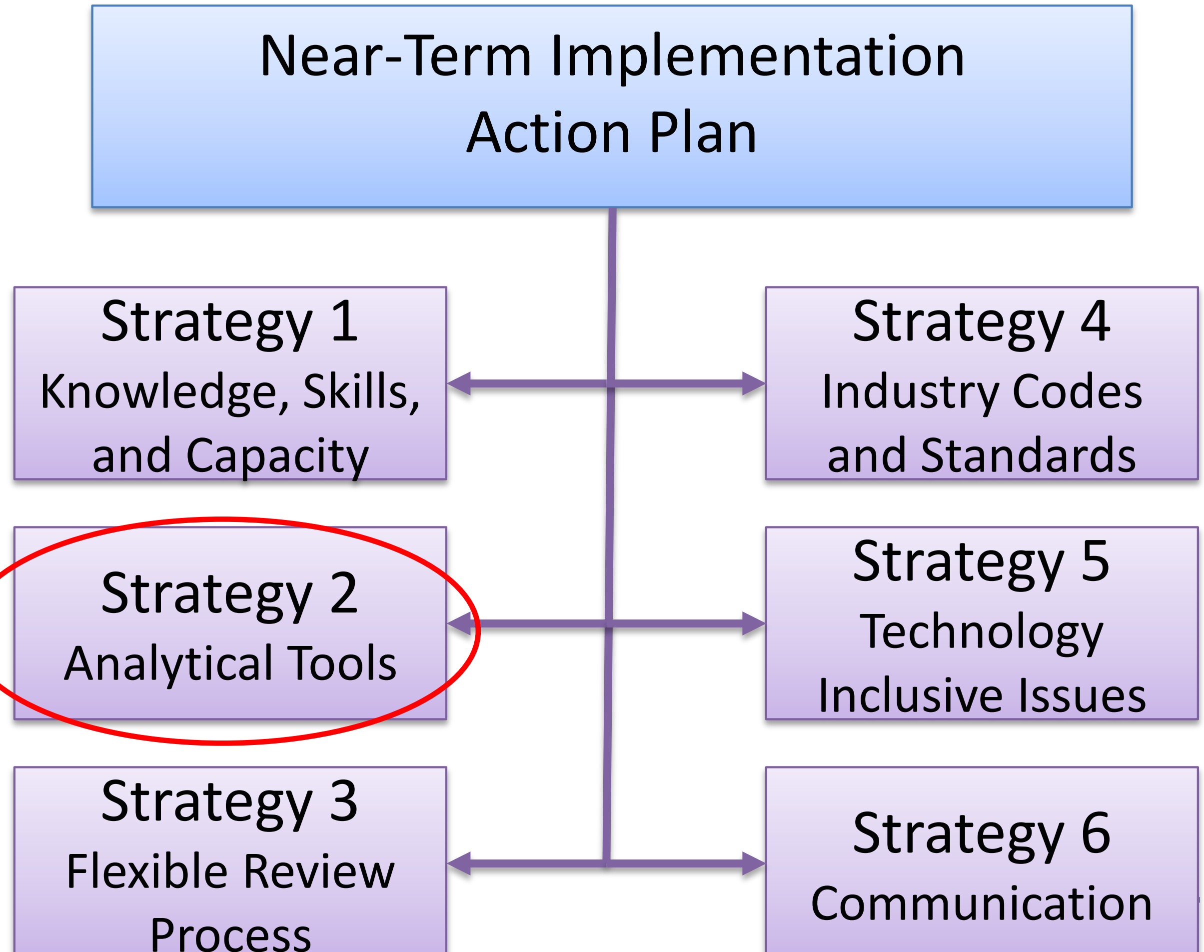
NRC's Integrated Action Plan (IAP) for Advanced Reactors


ML17165A069

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

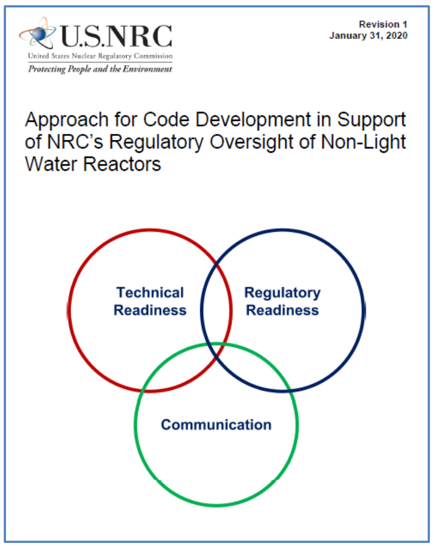
NRC Non-Light Water Reactor
Near-Term Implementation Action Plans

ML17165A069

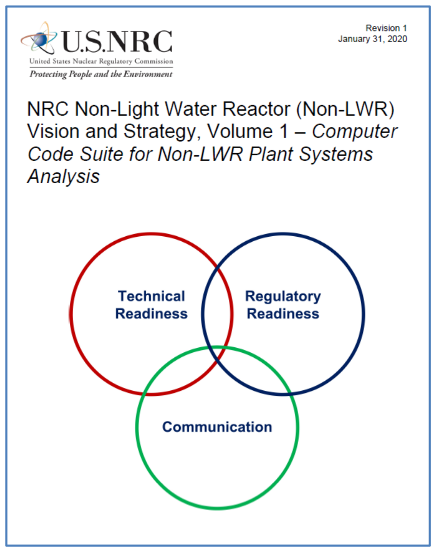


Strategy 2: Computer Code Readiness
Code Development Plans

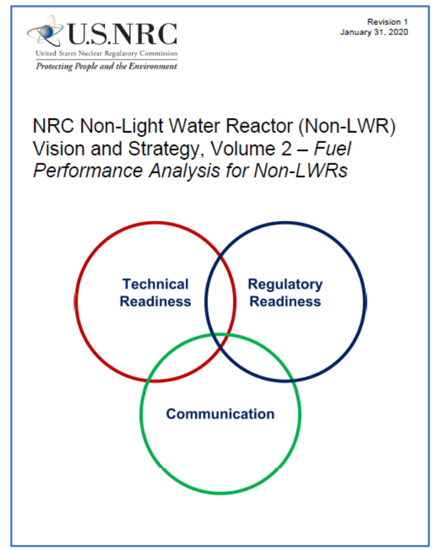
These Volumes outline the <u>specific analytical tools</u> to enable independent analysis of non-LWRs, <u>"gaps"</u> in code capabilities and data, <u>V&V needs</u> and <u>code development tasks.</u>



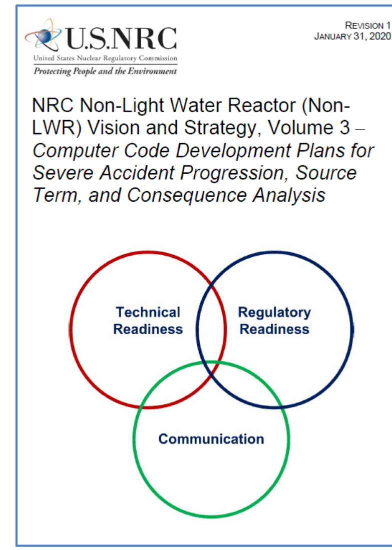
Introduction
ML20030A174



Volume 1
ML20030A176

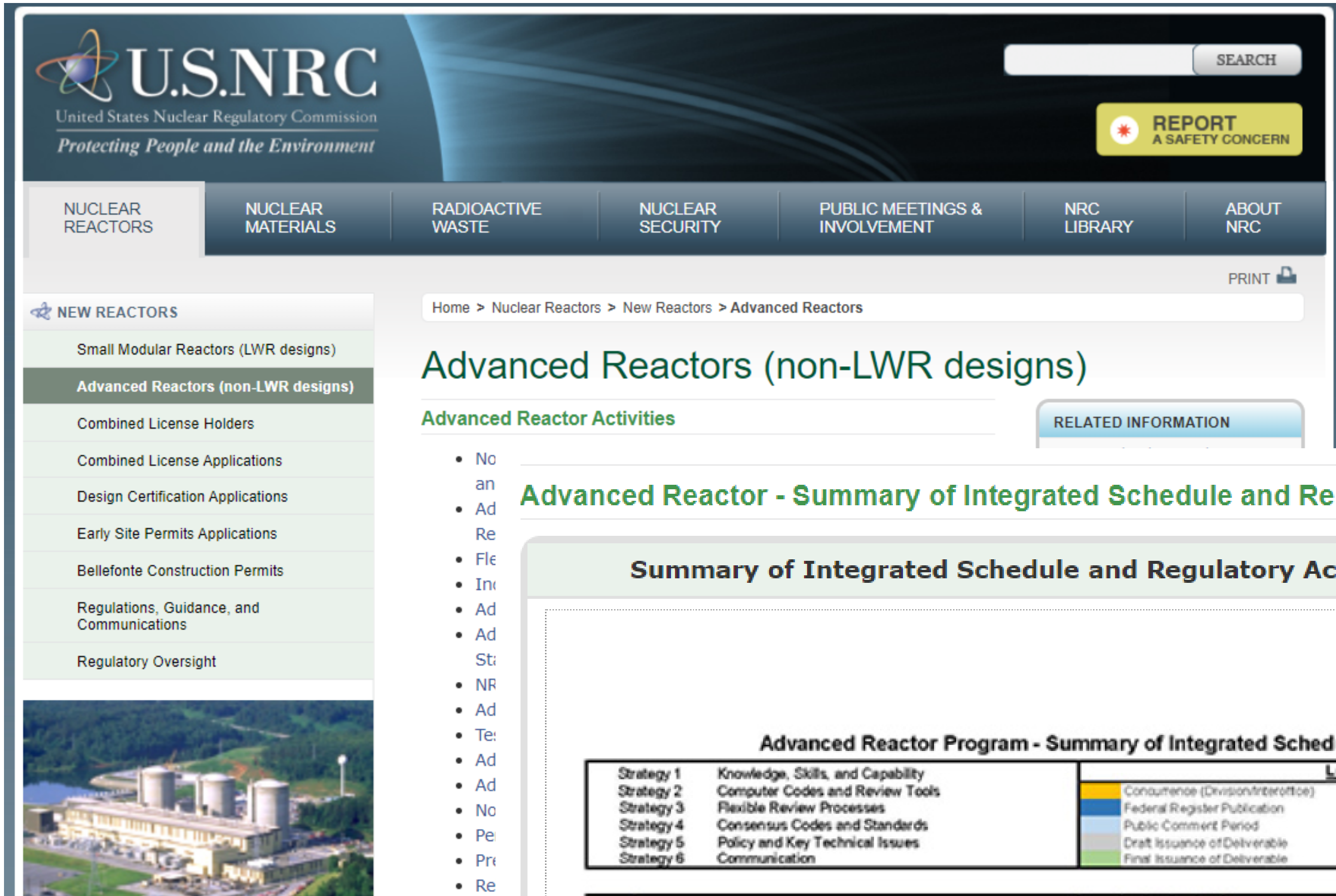


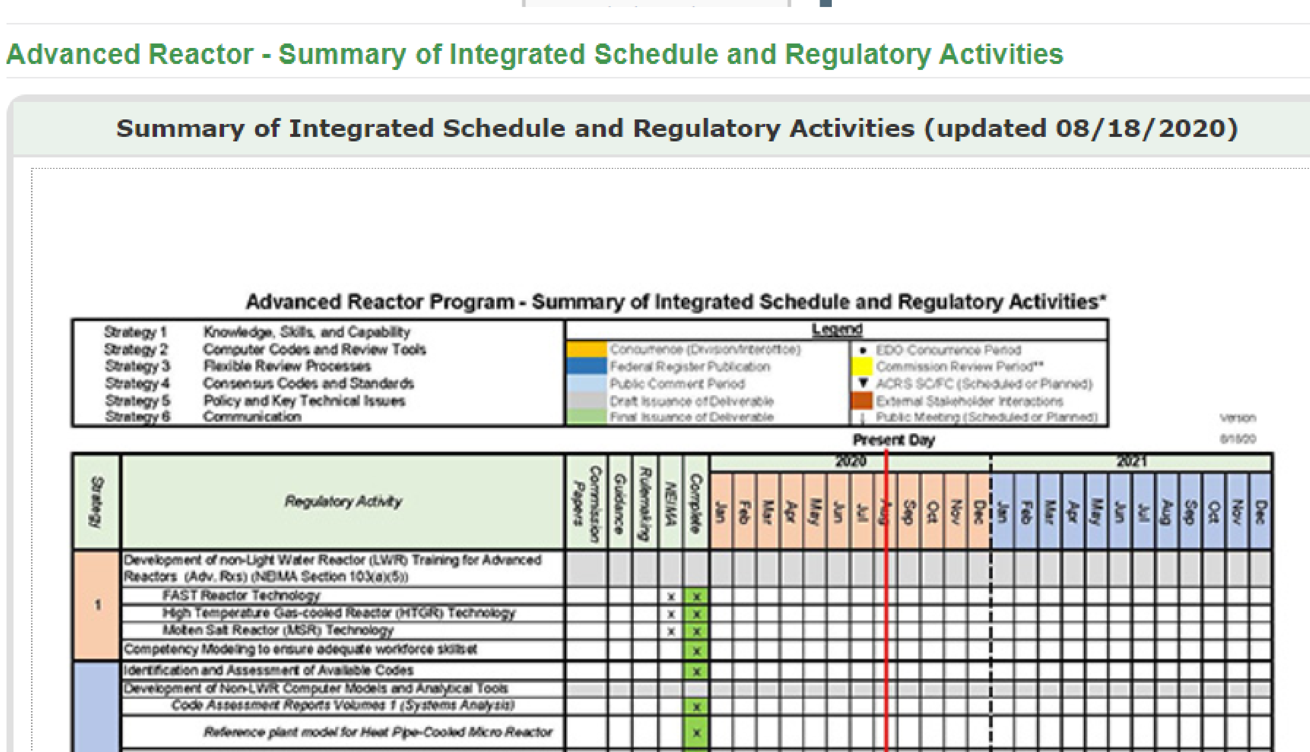
Volume 2
ML20030A177



Volume 3
ML20030A178

NRC's Integrated Action Plan (IAP) Status



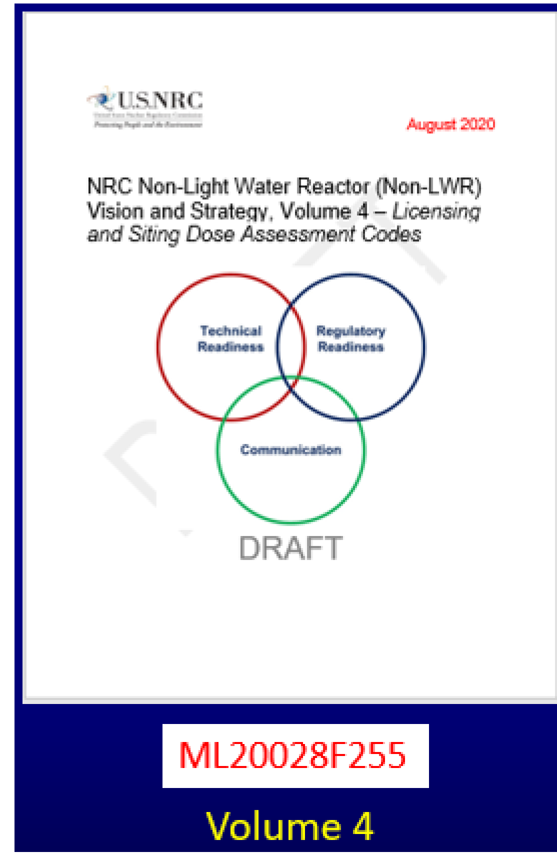


Strategy 2 – Volumes 4 & 5

- **Volume 4 — Licensing and Siting Dose Assessment Codes (ML20028F255)**
  - Development Plan (living document)
- **Volume 5 — Computer Code Development Plans for Criticality, Shielding, and Accident Analysis in the Nuclear Fuel Cycle**
  - ACRS Subcommittee meeting December 1, 2020

Volume 4: Licensing and Siting Dose Assessment Codes

- Landscape
  - Potential for a spectrum of Non-LWR and fuel designs
  - Over 10 licensing and siting dose assessment codes
  - Inconsistent code development practices, by various contractors, over decades
  - Overlap in code capabilities and need to use resources pragmatically
- Approach (Tasks)
  1. Consolidate/Modernize Dose Assessment Codes
  2. Improve characterization of Source Terms
  3. Improve Atmospheric Transport & Dispersion Models
  4. Update Dose Coefficient values
  5. Develop Environmental Pathway Models



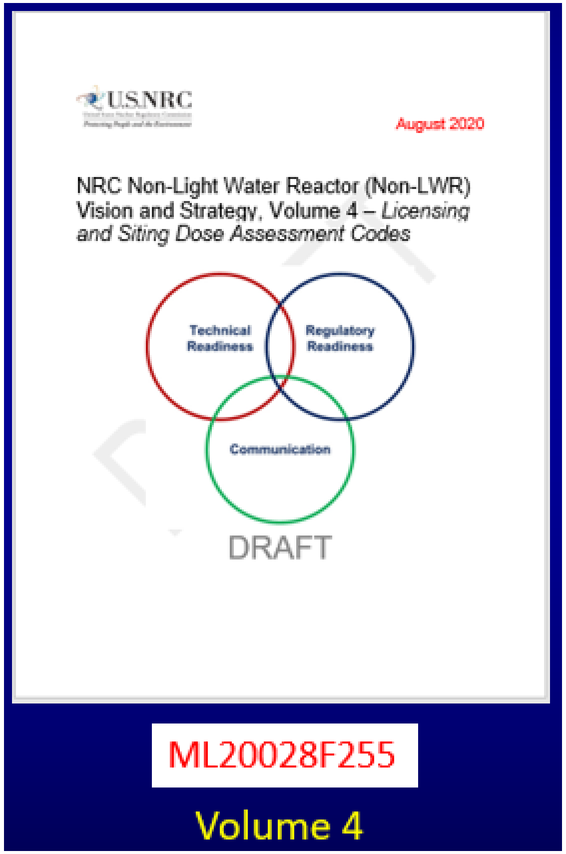
U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Volume 4 - Licensing and Siting Dose Assessment Codes

John Tomon, CHP
Chief, Radiation Protection Branch
Office of Nuclear Regulatory Research

Volume 4: Licensing and Siting Dose Assessment Codes

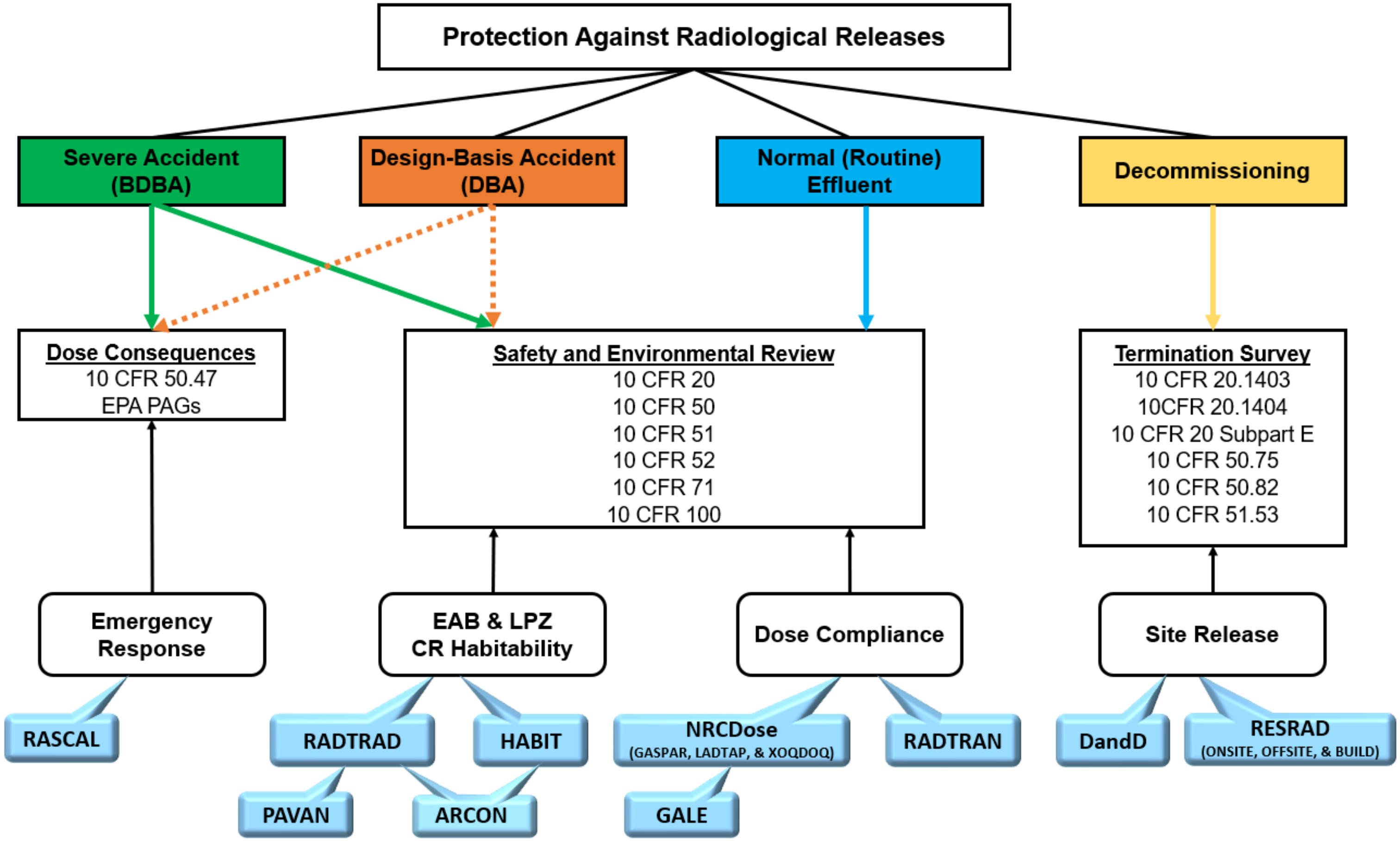
- This report describes the licensing and siting dose assessment computer codes and how they would be applied and consolidated for the non-LWR design types.
  - Section 1 — Introduces the regulatory requirements.
  - Section 2 — Describes each code and uses.
  - Section 3 — Tasks related to non-LWR designs including code consolidation.
  - Section 4 — Discusses code readiness.
  - Section 5 — Conclusions.



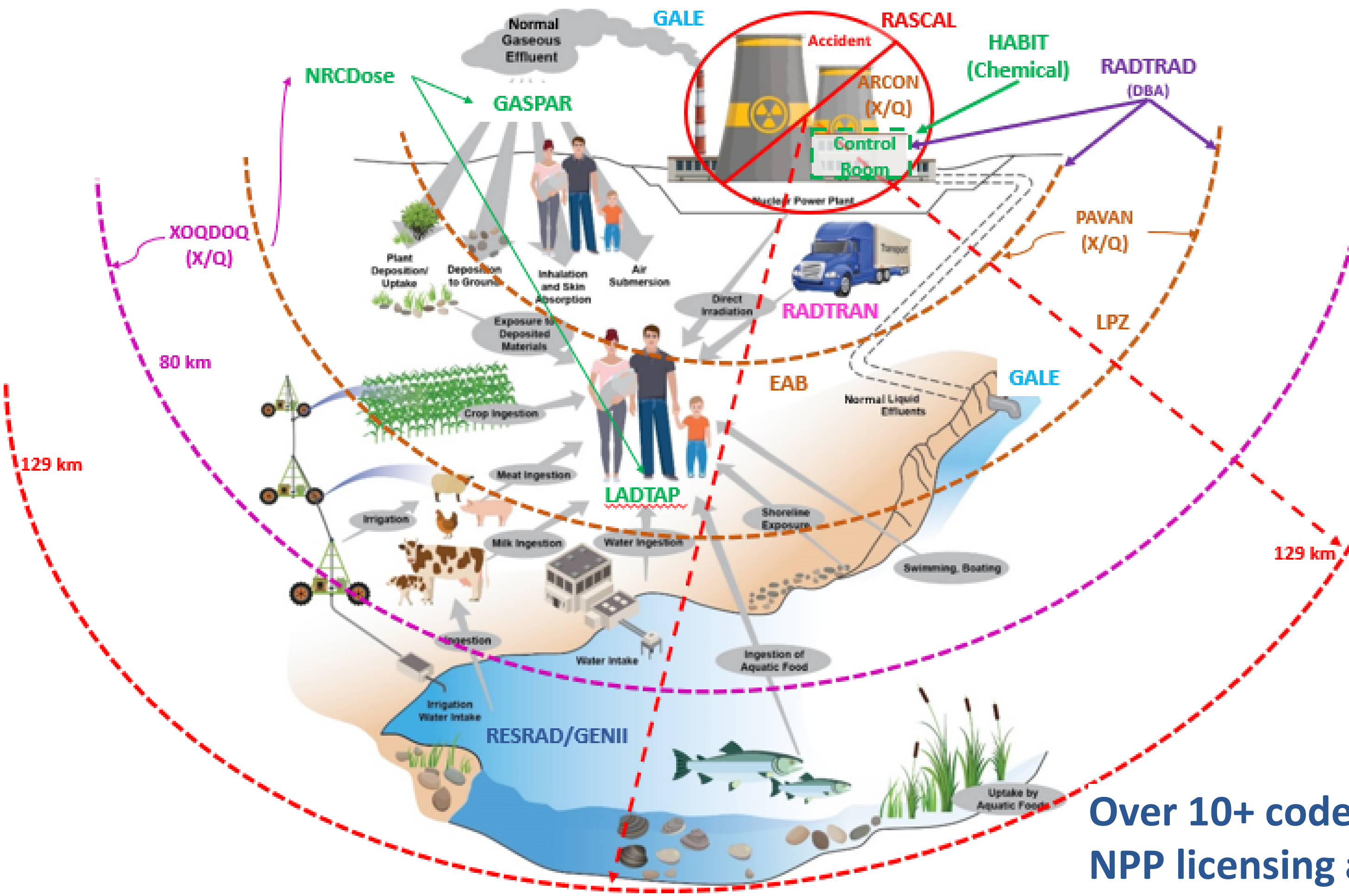
Non-LWR Technologies

	Non-LWR Plant Description	Examples	Fuel Types
1	HTGR; prismatic core, thermal spectrum	Framatome	TRISO (rods or plates)
2	PBMR; pebble bed core, thermal spectrum	X-energy, Starcore	TRISO (pebbles)
3	GCFR; prismatic core, fast spectrum	GA	SIC clad UC (plates)
4	SFR; sodium cooled, fast spectrum	PRISM, ARC, TerraPower	Metallic (U-10Zr)
5	LMR; lead cooled, fast spectrum	Westinghouse, Columbia Basin, Hydromine	(Possibly nitride fuel.)
6	HPR; heat pipe cooled, fast spectrum	Oklo, Westinghouse	Metallic (U-10Zr)
7	MSR; prismatic core, thermal spectrum	AHTR	TRISO (plates)
8	MSPR; pebble bed, thermal spectrum	Kairos	TRISO (pebbles)
9	MFSR; fluoride fuel salt, thermal/epithermal spectrum	Terrestrial Thorcon, FliBe	Fuel salt
10	MCSR; chloride fuel salt, fast spectrum	TerraPower, Elysium	Fuel salt

Regulatory Needs for Dose Assessment Codes



Licensing and Siting Dose Assessment Codes



Over 10+ codes used for NPP licensing and Siting.

Image adapted from BNWL-1754, Models and Computer Codes for Evaluating Environmental Radiation Doses.

Safety & Environmental Review Codes

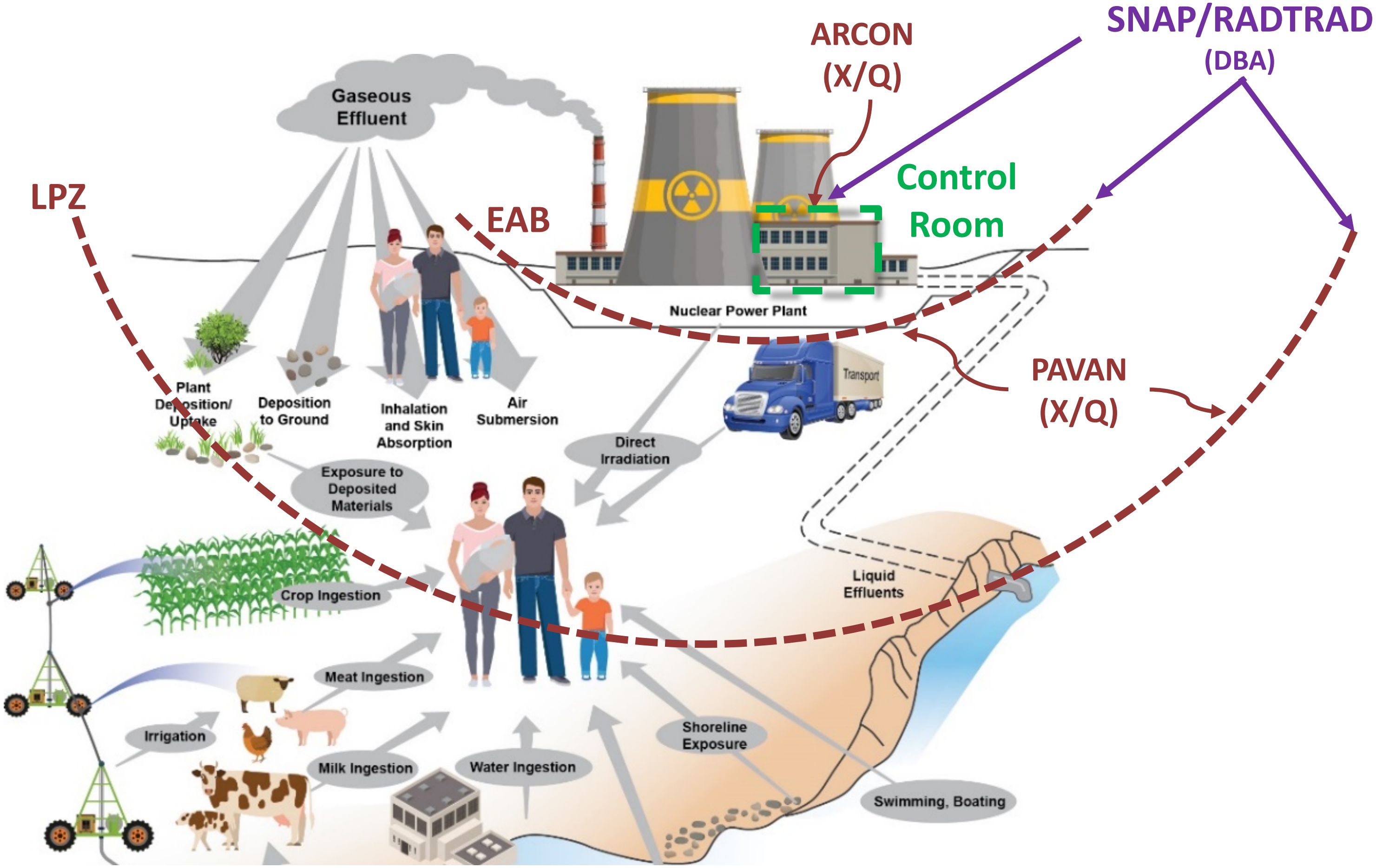


Image adapted from BNWL-1754, Models and Computer Codes for Evaluating Environmental Radiation Doses.

Safety & Environmental Review Codes

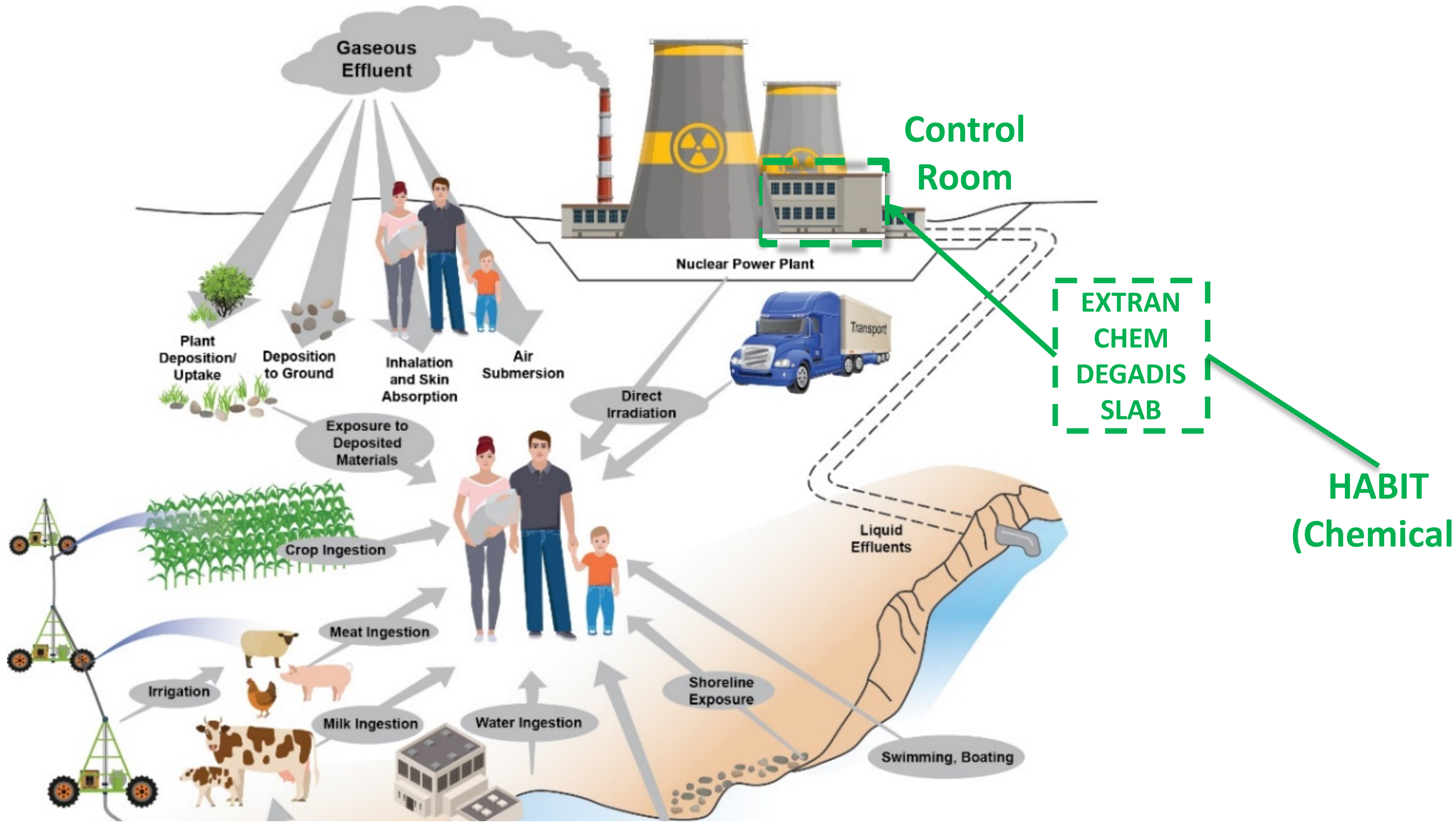


Image adapted from BNWL-1754, Models and Computer Codes for Evaluating Environmental Radiation Doses.

Safety & Environmental Review Codes

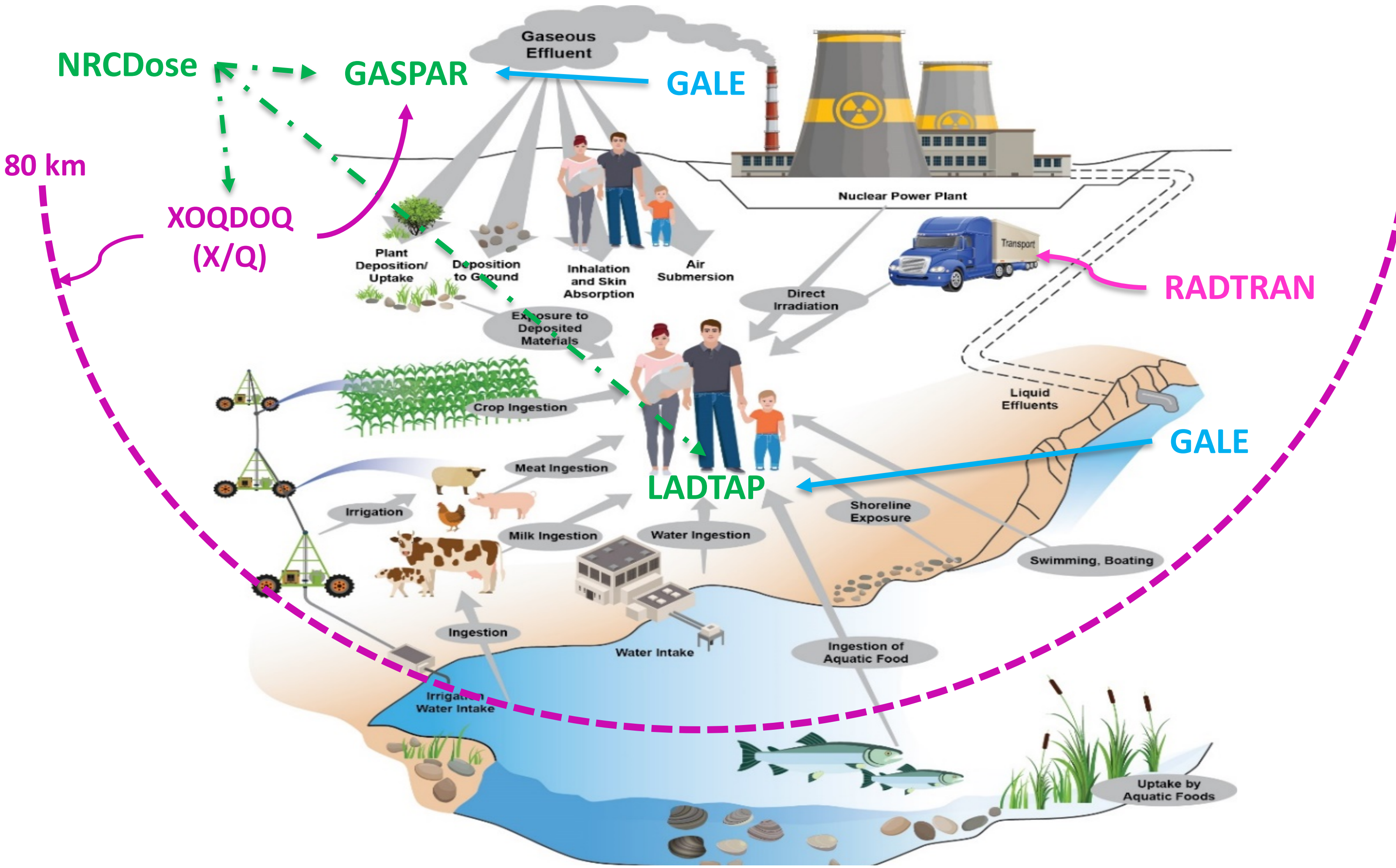


Image adapted from BNWL-1754, Models and Computer Codes for Evaluating Environmental Radiation Doses.

Dose Consequences Code

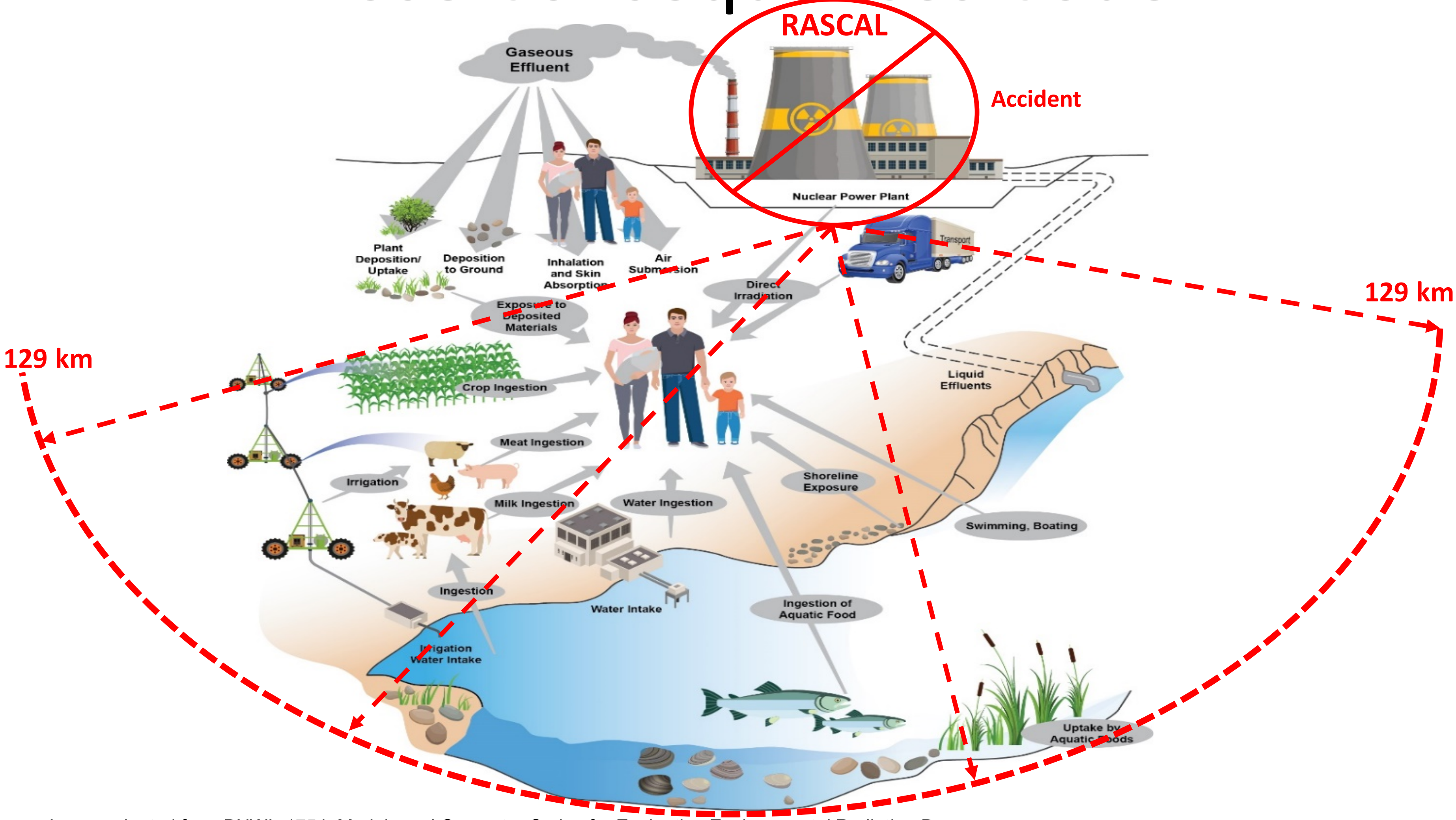
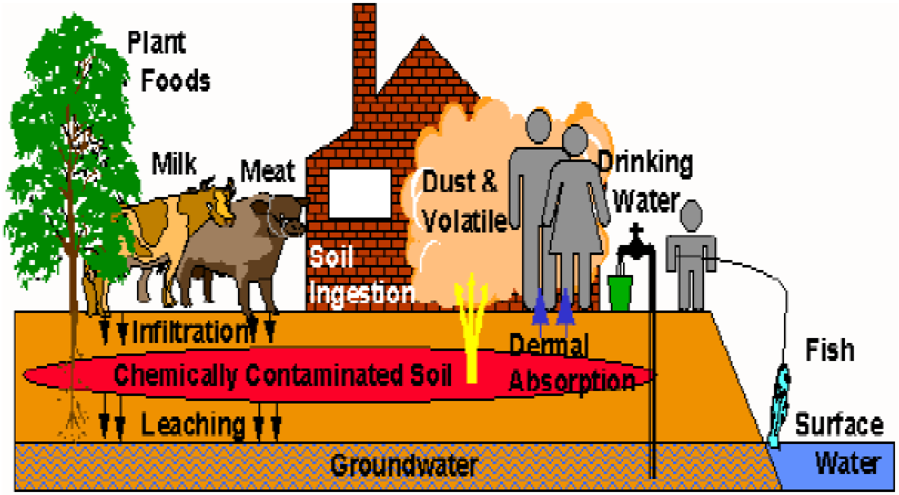


Image adapted from BNWL-1754, Models and Computer Codes for Evaluating Environmental Radiation Doses.

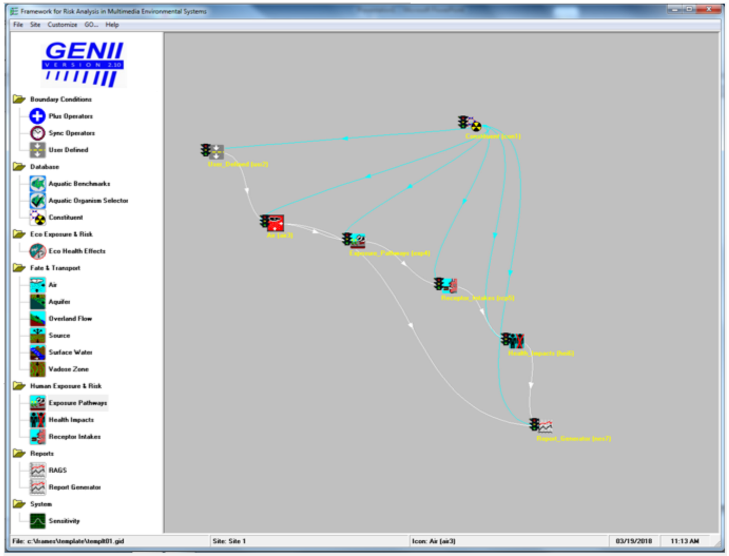
Decommissioning Codes

- **DandD (Decontamination and Decommissioning)**: compliance with the dose criteria of 10 CFR Part 20, Subpart E. Perform simple estimates of the annual dose from residual radioactivity in soils and on building surfaces.
- **RESRAD (Residual Radioactivity):** Family of codes used to analyze human and biota radiation exposures from environmental contamination of residual radioactive materials.



Research and Other Purposes

- **GENII (Generation II computer code)**: a set of programs for estimating radionuclide concentrations in the environment and dose to humans from acute or chronic exposures from radiological releases to the environment or initial contamination conditions.



- **Dose Coefficient File Package (DCFPAK):** that includes nuclear decay data and dose and risk coefficients for exposure to radionuclides.

- **SCALE** and **MELCOR** are used in development of core radionuclide inventory and severe reactor accident source terms as described in Volume 3. Plan to leverage work done for Volume 3 in the licensing and siting dose assessment codes.

Volume 4: Code Readiness Tasks

- Code Consolidation & Modernization (Task 1)
- Source Term (Task 2)
- Atmospheric Transport & Dispersion (ATD) Module (Task 3)
- Dose Coefficient Module (Task 4)
- Environmental Pathways (Task 5)

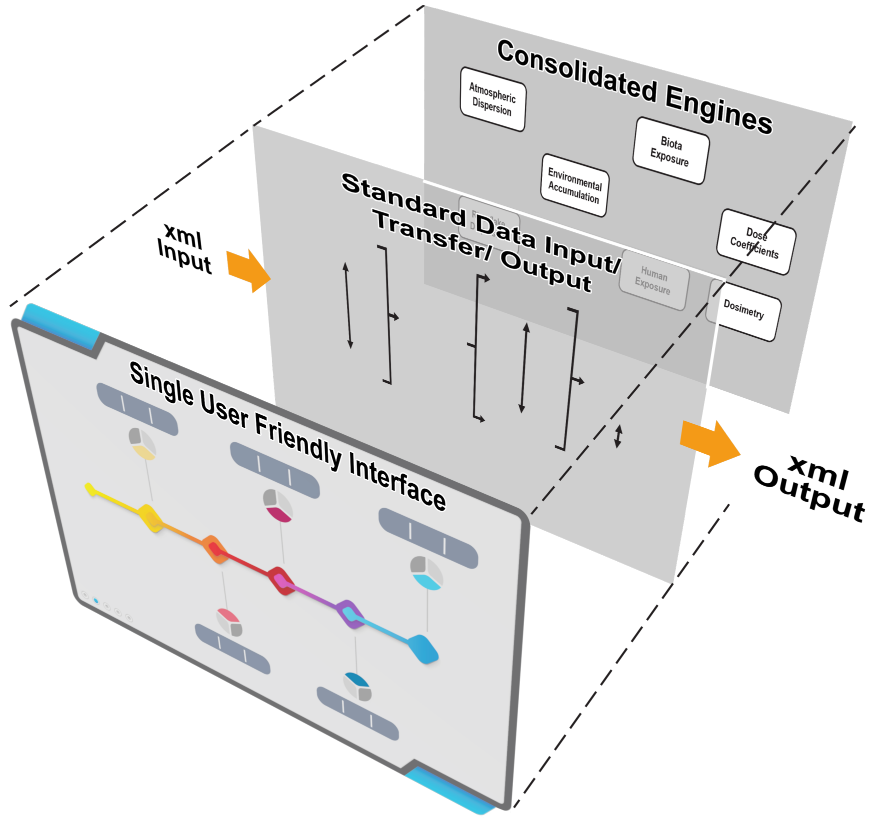
Code Consolidation and Modernization (Task 1)

- Given the large number of Non-LWR technologies being conceived and developed, it will be resource intensive to modify each of the siting, licensing, and emergency response codes for each design type.
- Therefore, the staff is proposing to consolidate and integrate them into several codes (i.e., two or three) that are modular, flexible, efficient, and user-friendly.

Code Consolidation Approach

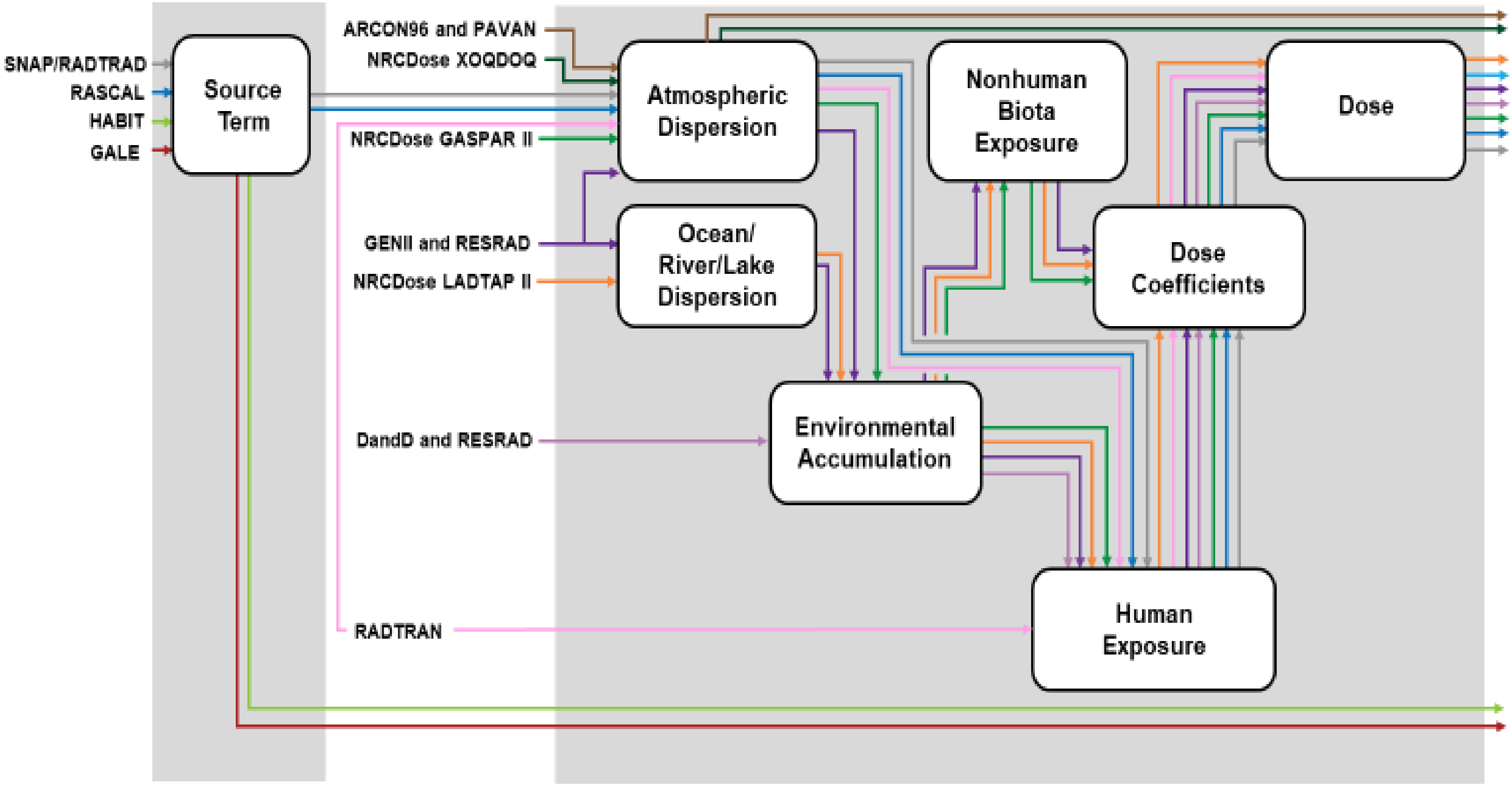
The three pillars to the dose assessment code consolidation process:

- **Create consolidated engines**
- **Develop a standardized data transfer schema**
- **Build a single user interface**



PNNL-29717, Health Physics Codes Consolidation and Modernization

Conceptual Model for the Consolidated Code



PNNL-29717, Health Physics Codes Consolidation and Modernization

Source Term (Task 2)

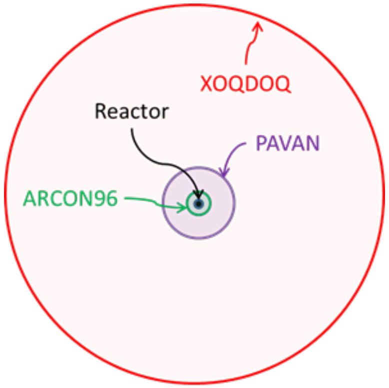
- Identify source terms inputs (i.e., radionuclide fuel inventories, reactor coolant inventories, plant design and operational data) for each of the Non-LWR designs.
  - Normal (Routine) source terms
  - Severe Accident source terms
  - Design-Basis Accident source terms
  - Transportation source terms

Source Term (Task 2)

- Source Term Considerations:
  - Source term/release rate framework database will:
    - Leverage activities from Volumes 1, 2 and 3
    - Estimate inventory in core/release from core
    - Identify dominate release pathways
    - Characterize mechanism to reduce release (e.g. filters)
    - Estimate release rates,
    - Use operational data where applicable

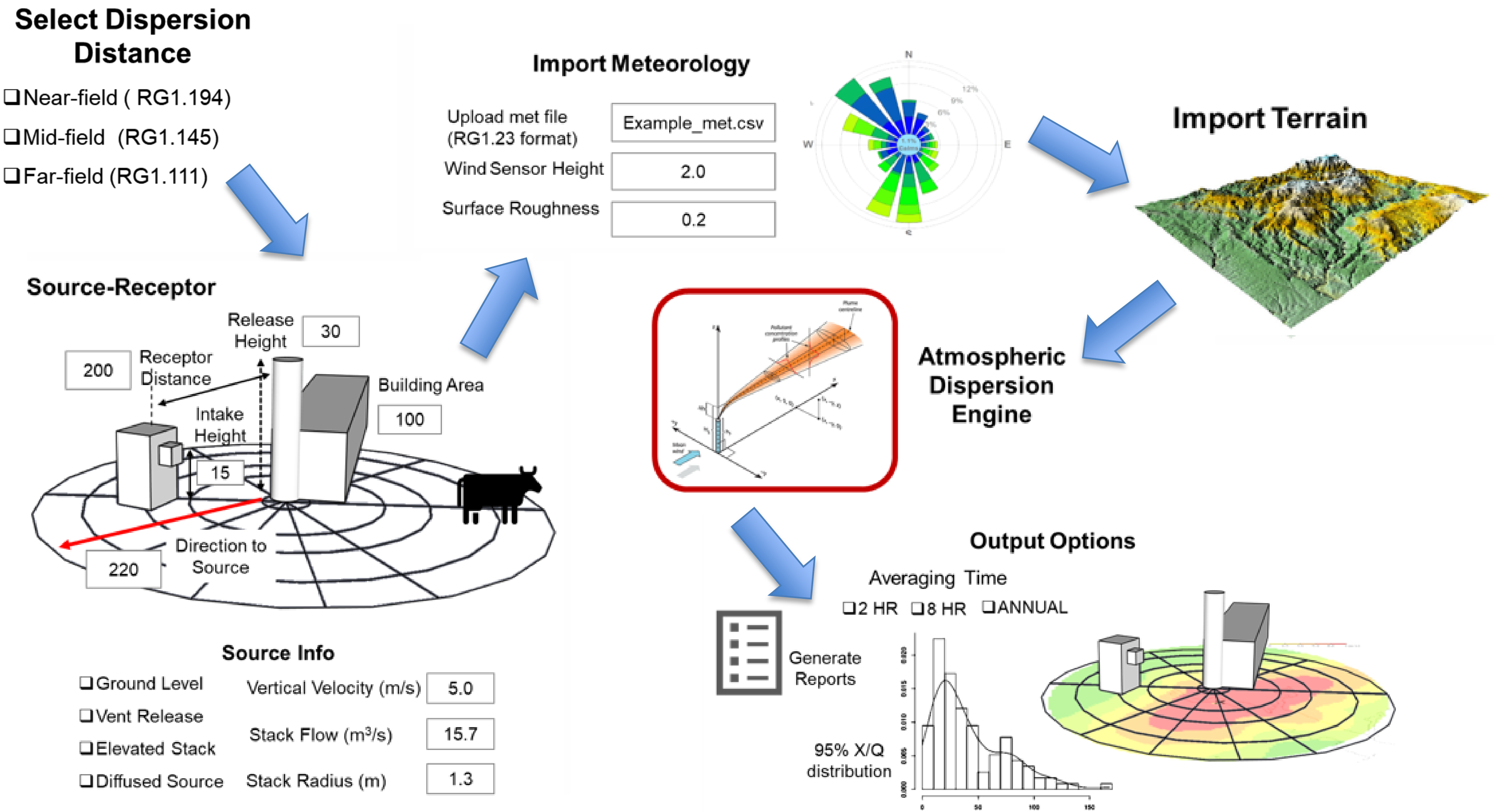
ATD Module (Task 3)

- ATD consolidation in Phases:
  - Phase 1: Consolidate ARCON, PAVAN & XOQDOQ.
  - Phase 2: Evaluate the applicability of the near-field and ATD models for Non-LWR technologies.
- These phases would leverage the experience of the meteorology staff and MACCS near-field modelling efforts from Volume 3.



Dispersion Distances

Atmospheric Engine Prototype



U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Dose Coefficient Module (Task 4)

- This task involves:
  - Developing dosimetry modules/engines that have the flexibility to use different dose models and dose coefficient values
  - Examining dose coefficient models with respect to aerosol particle size in addition to exploring the impact of tritium and carbon-14 biokinetics since these radionuclides may be in higher quantities in non-LWRs.

Dose Coefficient Considerations

- Vision for module:
  - Flexible Engines for different dose coefficient values
  - Dose Coefficient Package Code (DCFPAK)
  - Aerosol particle size relative to dose coefficients
  - H-3 and C-14 relationship to dose coefficients
- Current State
  - Some codes can choose different data sets.
  - Leveraging DCFPAK datasets with US EPA.
  - Possibly acquiring international dosimetry codes.
  - Training RPB staff on specific designs where internal dosimetry could be significant such as MSRs.

Environmental Pathways (Task 5)

- Further developing the aquatic pathways (river/lake/ocean dispersion), environmental accumulation, and human/non-human biota consequence modules for codes.
- Lower priority because they are less dependent on Non-LWR designs and fuel types.
- Explore the feasibility of radionuclide particle size behavior in the environment for some non-LWR designs.

Other Considerations/Challenges

- Timing of Non-LWR submittals vs code readiness
- Consolidation vs no consolidation
- Wide range of program office participation and input
- Managing expectations

Code Readiness

- Next Steps for Volume 4: (Near- & Mid-Term)

Activity	Date
Brief SC and Full ACRS	Sept 2020/Feb 2021
Build Consolidate Code Framework	FY 2021
Obtain Source Terms from Most Probably Designs	Ongoing
Pilot of Atmospheric Models	FY 2021
Include Non-LWR HP Operational Experience (Domestic and International)	FY 21 and beyond
Dose and Environmental Engines	FY 23 and beyond

Background Slides

Advanced Reactor Program - Summary of Integrated Schedule and Regulatory Activities*

Strategy 1	Knowledge, Skills, and Capability
Strategy 2	Computer Codes and Review Tools
Strategy 3	Flexible Review Processes
Strategy 4	Consensus Codes and Standards
Strategy 5	Policy and Key Technical Issues
Strategy 6	Communication

Legend

	Concurrence (Division/Interoffice)	•	EDO Concurrence Period
	Federal Register Publication		Commission Review Period**
	Public Comment Period	▼	ACRS SC/FC (Scheduled or Planned)
	Draft Issuance of Deliverable		External Stakeholder Interactions
	Final Issuance of Deliverable	↓	Public Meeting (Scheduled or Planned)

Version 8/18/20

Present Day

Strategy	Regulatory Activity	Commission Papers	Guidance	Rulemaking	NEIMA	Complete	2020 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2021 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2	Identification and Assessment of Available Codes					X																								
	Development of Non-LWR Computer Models and Analytical Tools																													
	Code Assessment Reports Volumes 1 (Systems Analysis)					X																								
	Reference plant model for Heat Pipe-Cooled Micro Reactor					X																								
	Reference plant model for Sodium-Cooled Fast Reactor					X																								
	Reference plant model for Fluoride-Salt-Cooled High-Temperature Reactor																													
	Reference plant model for Gas-Cooled Pebble Bed Reactor																													
	Reference plant model for Molten Salt Fueled Reactor																													
	Code Assessment Reports Volumes 2 (Fuel Perf. Anaylsis)					X																								
	FAST code assessment for metallic fuel																													
	FAST code assessment for TRISO fuel																													
	Code Assessment Reports Volumes 3 (Source Term Analysis)					X																								
	Non-LWR MELCOR (Source Term) Demonstration Project																													
	Reference SCALE/MELCOR plant model for Heat Pipe-Cooled Micro Reactor																													
	Reference SCALE/MELCOR plant model for High-Temperature Gas-Cooled Reactor																													
	Reference SCALE/MELCOR plant model for Molten Salt Cooled Pebble Bed Reactor																													
	Reference SCALE/MELCOR plant model for Molten Salt Fueled Reactor (schedule TBD)																													
	MACCS radionuclide screening analysis																													
	MACCS near-field atmospheric transport and dispersion model assessment					X																								
	MACCS near-field atmospheric transport and dispersion model improvement																													
	Code Assessment Reports Volumes 4 (Dose Analysis)														▼															
	Code Assessment Reports Volumes 5 (Fuel Cycle Analysis)																		▼											
	Non-LWR MELCOR (Source Term) Demonstration Project																													
	Research on Innovative Methods to Enhance Seismic Safety for Design and Construction of Adv. Rxs														↓															