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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON NUCLEAR WASTE & MATERIALS

November 14, 2007

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON NUCLEAR WASTE AND MATERIALS (ACNWM)

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184th MEETING

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VOLUME I

+ + + + +

WEDNESDAY,

NOVEMBER 14, 2007

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The Advisory Committee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B3, 11545 Rockville Pike, Rockville, Maryland, at 1:00 p.m., Dr. Allen G. Croff, Vice Chairman, presiding.

MEMBERS PRESENT:

ALLEN G. CROFF, Vice Chair

JAMES H. CLARKE, Member

WILLIAM J. HINZE, Member

RUTH F. WEINER, Member

NRC STAFF PRESENT:

DAVE DITTO
JOHN FLACK
ROD McCULLUM
EVERETT REDMUND II
TAE AHN
SHEENA WHALEY
ALBERT WONG
CHRIS JACOBS
TIANGING CAO
BAKR IBRAHIM
BRET LESLIE
MYSORE NATARASA
YONG KIM
MAHENDRA SHAH

ALSO PRESENT:

RAY CLARK
MAL KNAPP
NORM HENDERSON

C-O-N-T-E-N-T-S

P R O C E E D I N G S

(1:02 p.m.)

VICE-CHAIR CROFF: The meeting will come to order.

This is the second day of the 184th meeting of the Advisory Committee on Nuclear Waste and Materials.

During today's meeting the committee will consider the following: final proposed design for a geologic repository at Yucca Mountain, Nevada; discussion of ACNW&M letter reports.

The meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act. Mike Lee is the designated federal official for today's session.

We have received no written comments or requests for time to make oral statements from members of the public regarding today's sessions.

Should anyone wish to address the committee, please make your wishes known to one of the committee staff.

It is requested that speakers use one of the microphones, identify themselves, and speak with sufficient clarity and volume so that they can be readily heard.

It is also requested that if you have cell phones or pagers, kindly turn them off or place them on mute.

Feedback forms are available at the back of the room for anybody who would like to provide us with his or her comments about the meeting. Thank you.

Without any further ado, cognizant member for this is Professor Hinze. Bill, take it away.

FINAL PROPOSED DESIGN FOR A GEOLOGIC REPOSITORY AT YUCCA MOUNTAIN, NEVADA

MEMBER HINZE: Thank you very much, Allen.

As you can note by the speaker at the front of the room, Paul Harrington from the office of chief engineer of the Yucca Mountain Project Office will be, give us a discussion on the continuing saga, I think is the proper term, of the design for the geological repository at the proposed high level waste site at Yucca Mountain.

We are extremely pleased that Paul is giving of his time and effort to keep this committee and the audience apprised of the design changes.

As I believe you have learned from Mike Lee if the staff, we are particularly interested in anything you can comment on regarding the seismic events and seismic hazards associated with the design of the preclosure facility.

We have heard from you last March, and this is an update of that. So I think you can assume that we're up to speed with where you were last March.

Otherwise, it's up to you. Thank you, Paul.

MR. HARRINGTON: Okay, thank you.

I do have a number of slides that do capture the design in March. I will go through those quickly just as a reminder of what those facilities are.

But one thing you'll see this time is a set of cuts out of the actual engineering model. As we go through here you'll see a series of color graphic slides. The important thing is, those are not cartoons that a draftsman came up with. This information is loaded in the design model and these are sections taken out of the design model to give an understanding of where we are.

Another comment before I start: I noticed the agenda for this, or the Federal Notice, referred to this as the final design. It is for LA, but in DOE speak, and I know we don't generally do DOE speak here, we have a series of critical decisions to go through, and we do detail design after critical decision #2.

We have not yet done critical decision #2. We'll do that after submittal of the LA. We have to have a design, a safety analysis included in that. And we'll use the LA information as the basis for that.

But we also have to do a fairly detailed cost estimate to set the cost baseline for the project. That hasn't been done yet; that's one of the things that'll have to be done for CD2. So in our parlance, we're still in preliminary design; we'll advance to final design after the CD2, critical decision #2, operation.

MEMBER HINZE: Thank you, and welcome; we're happy to have you with us.

With that, Mike, are we ready?

Okay, we can go ahead and start. I'll skip over that part. What I was going to do was identify the various buildings.

This is a cut -- oh, actually, I'll just get up and go do it.

VICE-CHAIR CROFF: You are going to have to stay at the microphone.

MEMBER HINZE: Mike, that first building

on the left that your finger is, the shadow is on right now, that's the warehouse of nonnuclear receipt facility.

I put this up just to give a sense of perspective, probably much more than just a plan drawing, of the -- thank you.

MEMBER HINZE: Can you give us North on that, Paul?

MR. HARRINGTON: Yes, north is that way, and that is the north portal there. This is the warehouse and nonnuclear receipt facility. This is where empty waste packages, empty TADs would come in.

That's the initial handling facility, dedicated primarily to Navy spent nuclear fuel has the option of the commercial, or of the high level waste.

That is the wet handling facility. That's the first CRCF, cannister receipt and closure facility. That's the receiving facility.

And then beyond here would be the next two canister receipt and closure facilities, a series of admin buildings, warehousing, the emergency diesel generator facility. Let's see, that one was the low level waste handling facility.

So I wanted to put that up there just to give you a sense of the size of the structures, relative distance, that sort of thing.

Okay, a plan view that I don't think conveys that quite as well as that other. This is essentially as you've seen before. The aging pads are off to the north there. Up there.

MEMBER WIENER: Can you put a scale, or indicate a scale there?

MR. HARRINGTON: North to south is about 2-1/2 miles.

MEMBER WIENER: Yes.

MR. HARRINGTON: Okay. Subsurface really does not change. This is essentially what I've shown you before.

The only thing we did, and I don't remember if we had done it by last spring, is move this panel one just a little bit to the south so we wouldn't have to back up as we came from the north ramp into that first panel one group.

There are now six drifts in that panel one; used to be eight.

Waste handling functions, you may have seen this before, simply the various waste forms through the set of receiving and waste transfer facilities, to either emplacement or aging.

The functional matrix of what forms go

into which buildings. This is our assessment today of what features are important to safety and not. The preclosure safety analysis generally will conclude at the end of this month and into December. Some of the structural analyses, the fragility and the convolutions will go until early February.

But based on the work that we have done right now, that's what it looks like for those. And that's essentially as you saw before.

Now you've seen that floor plan, but this is the model cut. The main feature in this IHF, since all it's doing is receiving a transportation cask with either Navy canisters or high level waste, it'll move that transportation cask over.

This is a shielder canister transfer machine that will take that from the transportation cask, put it into a waste package; the waste package gets welded close, in an enclosure cell. Then down ended, and put onto the PEV. I'm going to go through this fairly quickly, to get them to what those components are.

This process has not changed.

Wet handling facility, as you saw before with the pool in the middle. Transportation casks that do not have canisters in them are put into the pool for unloading.

If there is a nondisposable canister that canister will be put into the pool, cut open, the fuel assemblies removed, put into a TAD, drained, dried, closed in this building, then the TAD is taken over to CRCF for insertion into a waste package.

Waste packages are not loaded in the wet handling facility.

The cut from the model showing the pool, various handling components, cranes, for that process.

The CRCF, the main production facilities, for transferring disposable canisters into waste packages, the incoming transportation casks are here.

This has two lines. We changed in the summer to an air pallette arrangement for moving the transportation cask handling device from the unloading area over to the unloading port.

That then required that we increase the size of the air systems to support those air palettes, and that caused us to increase the electrical loads to that building. So we enhanced the size of the switch gear areas and that sort of stuff.

So the output is the same. There's the down ending pallette, it's a waste package pallette. Moves it over, lays it down for insertion into the transport and emplacement vehicle.

The basic process is unchanged. But the – for a functional change from this past spring was the adoption of the air pallette handling methodology.

It's the same as the Navy is using for their system, up in Idaho.

The cut from the model showing that progression of transportation casks being unloaded, again using the shielded canister transfer machine, into waste packages, closure cell, down ending, and then out to emplacement.

The receipt facility is really as before. All it does is receive a transportation cask; takes canisters out of that; puts them into aging overpacks for transport out to the aging TADs. When those come back from the aging TADs, they'll go to a CRCF for transfer into a waste package.

The section through there. Now, getting to what are the components, I wanted to focus on those that are not common out there. There's not a precedent or an existing piece of hardware doing quite all of the things that we need to do.

But these are weldings, they're constructions. Cask handling cranes, certainly those exist. Site transporters, the spent fuel transfer machine, the closure system for the TAD canisters, the cutting system to open the nondisposable canisters, those exist.

We'll go out with procurement specs and buy available type of equipment for that. But the cask transfer trolley to take the transportation cask from its receiving area in the building to the unloading port, then the canister transfer machine itself, there are some out there now generally for smaller canisters than we'll be looking at.

The waste package transfer trolley to take the loaded waste package from where it gets loaded, translated over to where it gets closed, down ended, so that the waste package can be removed from it, put into the TEV, and then finally the transport and emplacement vehicle itself, we are coming up with preliminary designs for those.

The next series of slides will go through the progression of that design process and talk about the products that we have developed for that. But we will not do the final fabrication level detail of those components. We'll bid those out to people who do that kind of work as their core business.

But the Xs are intended to convey where those components are found. The wet handling facility and the receipt facility, since they do not package waste packages, they don't have the waste package trolley or the TEV, but all of the facilities use the trolleys and the canister transfer machines.

This is a cut from the model of the transport and emplacement vehicle. It has a tongue there that can extend and retract. It has shielding across the bottom of it, so that when a waste package is loaded in this it is completely shielded so that if there are equipment failures, if we lose a bearing, if we lose a motor, people can access it to do whatever repairs are necessary to restore that to function.

Let's see, this is a rail-based unit; that's as before.

This is the cask transfer trolley. The transportation cask is upended by a crane off the transportation conveyance, normally a rail car or possibly a truck; upended, put into this. There's a gate that closes so that it's entirely encapsulated or restrained. This has an air pallette, which is to say, it has a series of ports on the bottom of it that when you run air into it will list it so that you can translate it.

You can move heavy loads that way, and there's no risk of dropping from a crane or other sort of movement. It simplifies it versus rail-type motions. It keeps it lower. We're trying to keep the center of gravity as low as possible, and preclude any sort of drop event. So that's why we went with that sort of arrangement.

Cask transfer machine: there are actually a number of those out there. We have them down at Savannah River for doing transfer of some of those canisters. Even at Ft. St. Graham, we used a similar machine for moving canisters into our facility. But this one will have to be big enough to accommodate a full sized TAD, not restricted to an 18 or 24-inch diameter, but rather, the approximately 6-foot diameter TAD.

So we have come up with the loadings, the dimensions, the seismic analysis for that.

Here's the waste package transfer trolley. This receives the waste package in the upright orientation. It's moved into the port in the transfer cell. The canister is loaded into it from that shielded canister transfer machine on the previous slide.

This then translates, this is rail mounted because of the distances it has to go, and the precision that we want to control it to. It's translated from the loading port over to the closure port. And then the welding, the lids are installed, the welding done, the nondestructive examination, the helium backfilling, the testing, is all done in that closure cell, and then this is further moved over, and we have gone to a gear arrangement to control the upending and down ending of that, similar to some heavy industrial components that we had found that are used for fabrication of heavy weldings.

This is in the down ended position with the tongue extending from that, with the waste package sitting on its pallette. AS the waste package is moved from the transfer trolley to the TEV, there are several feet of it that are exposed as it moves across there. That will be the final inspection of that waste package prior to emplacement.

This is the mechanical equipment envelope sketch for that transfer trolley. This is to give a sense, I put in some representative drawings here. They are a little difficult, certainly, to see detailed here. But what I was trying to get to was the level of design that has been completed, that will be used as the basis for the safety case that we'll make in the license application.

So we have dimensioned it out, we have

sized components in there. We have to get a level of precision to support the fragility analysis to then support the classification.

So all of these components as well as the structures are being evaluated like this.

So this is an example of an MEE, mechanical equipment envelope. Let's see.

What are the principal design codes for the mechanical handling equipment? For the ones that are currently out there, such as cranes, transporters, transfer machine - that spent fuel transfer machine is the one that's in the pool moving individual fuel assemblies. All the reactors have them; it's nothing new.

The TAD closure equipment, that exists. DPC cutting, those are out there. So we'll simply have that designed to the current consensus codes and standards.

We use ASME NOG-1 for frames, handling equipment.

However, the transfer trolleys don't have consensus design codes and standards explicitly for them. So we will use applicable portions of the crane code, and of the ASIC Manual for Steel Construction that addresses these stresses in welding components, and given that these trolleys and other components that we're making are in essence large weldmans, fabricated steel plate, structural members, wheels, bearings, shafts.

We're going down to that piece/part level in our analysis for the LA in the absence of existing consensus codes and standards that actually address those sorts of components.

Cask transfer machine, basically a crane. We'll use NOG-1 for that. Then the TEV, we'll use the applicable portions of NOG-1 and the steel construction manual.

This is the design process, the next several slides are kind of the progression of what we've done for these components.

In the conceptual design one package from year and a half ago approximately we had identified the basic handling approach for the TAD-based repository. So it had the components in there, what it was we were relying on those components to do.

Also part of the CD1 package was the preliminary hazards analysis. It's certainly not the full blown preclosure safety analysis, but it was an assessment of the hazards associated with that. That's part of the DOE critical decision #1 set of products that are required for that decision to be made.

So that identified what it was that we were going to rely on from those components to prevent or mitigate event sequences.

We then developed the conceptual design. The CD1 was approval to go from conceptual design to preliminary design. So the DOE term for the phase that we had been in for the last year and a half or so has been preliminary design.

We did that conceptual design captured there, developed that concurrent with the ongoing preclosure safety analysis. We developed block flow diagrams to depict that. And this is an example of block flow diagrams. It basically says, what is it that this component has to do, the inputs, the outputs.

We then developed the mechanical equipment envelope drawings to, for structural design purposes, found how big these components need to be. The waste package trolley for example, large component. We're taking a canister that weighs on the order of 60 tons and putting it in a shielded overpack; the total weight is around 200 tons; and we're having to translate that and rotate that.

So these are big components. So to do facility design we needed to have some sense of just how big is this thing; what are the loads. So that we dimensionally size the structure to accommodate it, and we have the right design loads then to do the structural analysis for buildings.

So we develop process and instrumentation drawings for those components to identify what instrumentation, what controls, what interlocks they need to have; developed then logic diagrams to show how those interrelate.

And the next several series are those. This is the mechanical equipment envelope for the canister transfer machine giving dimensions. We get masses out of that also.

This is the process and instrumentation drawings showing various limits which is load sensors, all the other position sensors, all the other instrumentation we need to have on that component.

And then finally the logic diagrams for how that instrumentation controls that component and interfaces with the rest of the plant.

There is a CCCF, it's the control facility. I may digress for a moment and talk about the control logic.

One of the questions that comes up is, where does the equipment get controlled from? And the answer is, it's local control. Yes, we'll have a control room. But the enabling of an operation is not going to happen from that remote control building. It'll happen from local control stations in the various structures.

The remote control facility can interrupt an operation, but it isn't the permissive for that operation.

We then did the mechanical handling design reports on that conceptual design to provide the confirmation of functional demonstration. And we're doing now the fault trees, and fragility analyses.

I said before that that equipment doesn't exist, so I'm not able to go to existing vendors and have them either provide me information or do fragility analyses. So we're having to work it up essentially from first principles based on what we know the equipment has to perform; our preliminary design for that component; use that as the basis for the reliability analyses.

In the future, as I said at the start, we'll develop performance specs, and we'll provide those to vendors for that type of equipment for the final detailed design and procurement. We won't have our contractors try and do a detailed design for TE release for example. We'll go to people who do that sort of work as their primary business.

And they'll then do the detailed design, and provide confirmatory analyses for what we have included in the preclosure safety analysis.

Structural, principal design codes that we're using are the ASCE standard 498, the ACI 349 is the nominal power plant safety-related concrete spec; and ANSI/AISC -690 for structural steel structures.

Where are we with the structural design? We have set the facility configurations. We have identified wall and slab thicknesses.

The first pass through there was really based upon best estimate, best practice, expected case. We chose wall thicknesses for example based on our expectations as to what type of wall thickness, what range, we would need to have in order to meet the seismic loads, the other dynamic loads, provide shielding, and then we did an analysis to see if that selection worked.

And one of the things we found was that in the IHF it didn't give us as much margin as we'd wanted to have. So we actually redesigned the IHF, we beefed up the structure somewhat based on that first 2-D lump mass stick model results.

The other facilities did not require that. We had the margin that we were looking for. But in that IHF, that first analysis showed us that we needed to beef the structure up, so we've done that.

Generally we are using the lump mass multiple stick model as the first task through these just for the purpose I talked about, to make sure that we're there, and conservative.

Now the reason I say generally is, a few of the structures that are relatively simply, specifically the emergency diesel generator facility, we didn't bother with the 2-D lump mass model. We just went right to the 3-D finite element analysis model.

But the point I want to convey is that there is sufficient structural analysis to support our fragility analyses, to give us the results that we think we need for demonstrating the safety case.

So in the more complicated facilities, that'll be based upon that 2-D lump mass model. And I have some graphics to kind of show what that is.

And in the simpler facilities, it's just going right to the 3-D model.

The ITS surface facilities are not designed to a 3G value. They are designed to a 2000-year return period, and those are the peak ground accelerations. I think earlier I had used a value of about .7 with you. That was an older value. And in fact we are continuing to use the information that we've gathered from some of the recent bore hole work we've done. And that may come down a little bit more in the future from those values.

But this is what we're designing to now. If it does come down, then I simply have more margin in my building.

Question obviously is where did the 3G value come from? Let me talk a little bit more about this.

We're doing three design bases value. There's the DBGM-1 which is 1,000-year return period. That's nominally for the non-ITF buildings.

We're using the design basis ground motion two for the generally important to safety structures, those values for all of the facilities.

We're also evaluating performance to what we're referring to as the beyond ground motion design basis, beyond DBGM. And that's a 10,000-year return period. And that is around 1G.

We're - when I say evaluating performance, we're not looking for compliance with code-allowable stresses for those. We're using that value for determination of code-allowable stress compliance.

We are evaluating performance against the beyond DBGM value of around one.

For the aging system, when we were looking at how to design that, stay within a licensed basis, one of the issues was, what do we do with the tip over? There was a lot of concern about have the existing dry cask systems been designed, been analyzed for tip over? We couldn't find any evidence that they really had, and that there was any basis to have a tipped over cannister be deemed acceptable.

We looked at various components to avoid tip overs. One of them was bolting down the dry casks. That's going to get workers dose, both to initially bolt it down and then to remove it.

We looked at coming up with structures to bridge across sets of dry cask, and that also is going to involve worker dose to install and remove those.

As we were talking to the vendors, one of them, at least one of them, had indicated that they likely could design a dry cask system to resist overturning in a seismic event that would be equivalent to a 1 in 500,000 year, or 500,000 year return period.

Five hundred thousand years is the cutoff point for beyond CAT-2 event sequences for that 50-year aging facility.

So we had the choice of either coming up with components to prevent tip over for a more frequent than one in 500,000 year seismic event, and then take worker dose on that. Or look at designing a system that would not overturn in that seismic event and avoid that worker dose.

And we chose the latter. That's why that got into the performance spec. And we had at least one vendor tell us that they thought that was doable. I don't know that we have formally, or even informally, heard back from others. I understand that at your meeting a month ago that was one of the topics of discussion.

We are not looking for the TADs to be designed to code allowable stresses associated with a 3G ground motion. That's what that 500,000 year return period event translates to. But we are looking for precluding overturning of those dry casks in that event.

We had for a time looked at, if they had turned over, if they were not capable of resisting that, what would it take to upright them. We had a field of potentially 2-1/2 thousand aging casks on their sides, how long are they qualified for in that configuration? How long is it going to take to get out there and upright them, particularly when they don't have shielding on the bottom of them; maybe minimal shielding on the top. That did not seem like a very prudent task to go down.

So given that there seems to be some sense from at least some of the industry that designing these to resist overturning for that ground motion moves that event sequence out beyond CAT-2. So that's why we did what we did there.

And if we want to stop and discuss that anymore right now, I'd be glad to.

MEMBER HINZE: Let's pick it up.

MR. HARRINGTON: Okay.

So we did the lump mass model, confirmed the reinforcing steel. As I said we had to enhance the IHF then. Now we're doing additional analyses of those to develop the fragility curves that we use as the basis for convolution with the seismic hazard curve to support the license application development. That's for evaluation against the beyond design basis ground motion earthquake.

We have developed the seismic hazards curve. That's being convolved with the fragility curves to show that those IDF structures can perform their functions in those event sequences.

There is a representation of what that lump mass stick model looks like. A series of diaphragms are taken, sheer walls. The diaphragms represent the floors. This is the wall, typical wall elevation. They do acknowledge the cutouts for doors and other larger penetrations. Obviously not the small pipe or cable tray or HVAC duct or those sorts of things.

There is a form work drawing for concrete. That indicates the forming for example for the floor slabs that will have to be done. So we have progressed to this, the stands for the fairly large open spaces for form work for the slabs there.

Typical fragility curve for a structure. This happens to be for the CRCF. At limit state A, this is the high confidence of low probability of failure. That's the no more than 1 percent probability of that structure failing at that seismic acceleration.

This is a preliminary hazards curve. We

take those two curves and convolve them to find out where the structure may be fragile in an area where it's also subject to seismic ground motion that might exercise that fragility.

So following the demonstration of the adequacy of that design we'll go ahead and do additional modeling of those structures via the finite element analysis model.

In that we'll go ahead and detail the reinforcing steel around doors, for example; rebar around doors is not specifically modeled in the 2-D lump mass model.

We'll use that to do it with the SSI, the soil structure interaction, out of SASSI, and that will be a basis for the final design.

This is just a representation of a finite element analysis, model four, the CRCF.

Where are we? We had identified 1,318 products out of engineering, and preclosure safety analysis that we needed to complete to support development and submittal of the license application.

That includes structural drawings, ventilation drawings, the instrumentation control, the electrical power, all of the different products on the design side, the mechanical equipment envelope drawings, the design bases reports, and then on the preclosure safety analysis side, it's the whole sweep of hazard identification, event sequence identification, event sequence probabilities, consequences, and then classification of components, development of the Q list that comes out of that process.

We believe that that will provide a basis for compliance, for demonstration of compliance of the safety case. We've said more than 95 percent of that has been completed to date.

Our schedule really had the engineered products completing in early November, now, and PCSA completing in later November with the exception of things that are left open yet, primarily the completion of the hazards curves, the fragilities and convolution of them, and the finalization of the categorization products out of PCSA.

But the HVAC, the mechanical handling equipment, the structural, virtually all of that is complete now.

So the design will finish by next month, and then the PCSA, that's the organization that is doing the fragilities and convolutions finishes in February.

So I believe that's the end. So with that -

MEMBER HINZE: Thank you very much, Paul. You've been very busy the last six months.

MR. HARRINGTON: Yes, we have.

MEMBER HINZE: That's obvious.

What we'll do now is we'll ask the committee if they have any questions, then we'll open it up to the public and see if we can get a discussion going.

I'll turn to Dr. Wiener first.

MEMBER WIENER: Thank you. I just have one question because much of this not being a structural engineered, much of this sounds good to me. But what do I know?

Could you go to your slide #43, please? That one.

What is the basis for that curve?

MR. HARRINGTON: Frankly I would have to defer to our science folks. This is what we in engineering have received from science. They have done the characterization of the mountain. They have developed the seismic curves that we then use in our structural design.

I think you are asking the where-does-it-come-from, and I'm really not the one to answer that question.

MEMBER WIENER: And is there somebody here?

MR. HARRINGTON: No. No.

MEMBER HINZE: Buck, would you like to take a shot at that?

MEMBER WIENER: You can come right up here, and these microphones pick up.

MEMBER HINZE: State your name, your affiliation, and then go for it.

MR. IBRAHIM: Bakr Ibrahim, NRC staff. This hazard curve was developed from expected situation which was done by DOE. You have a different group in modeling. And seismic hazard analysis, and collected some data at the site, and earthquake and the faulting, and the characteristics of the site. And between this expected illustration they developed what we call the seismic hazard curve, and this is exactly what it represents from the different data they collected, and with the expert, then they developed that.

MEMBER WIENER: So it was essentially developed from expert elicitation?

MR. IBRAHIM: Exactly.

MEMBER WIENER: Thank you.

MEMBER HINZE: But it incorporates the local characteristics.

MR. IBRAHIM: Based on site characterization. The experiment, there was a ground motion experiment, and size modeling experiment. And both of them gives their - and both -- and what they come out with was a seismic hazard curve.

MR. HARRINGTON: Buck I would suggest that that doesn't fully capture the amount of physical examination of the site that we have done to use as the basis for that.

There was certainly more than just expert elicitation. All the bore holes, the trenching --

MR. IBRAHIM: Exactly. But this bore hole and trenching came out after the development, because they developed that for a hard rock site. Okay, a different spot. And after that they have to do the drilling and the core sampling and everything like that, so they are going to do the substructure interaction to see what exactly is the difference between a hard rock and a soft rock, because most of the structure may be on a soft clay. So you have to know how is a quake propagated from the hard rock to the soft rock, where is that site the building will be sitting on.

And as you know, you still collected some data. And as you said, this one may go down because the information you are collecting, it may affect what is the result. Because this information was based on 19 - or 2001 or something like that. And now we are moving also the bed. When you move the bed, you get a different location, and you have to know what is the characteristic of the soil and the structure under this site.

MEMBER HINZE: Dr. Weiner, was your question sort of to what geotechnical work did we do to develop that? Or why it's that curve instead of something that looks a little different?

MEMBER WIENER: No, the question was, how did you come up with that curve, and that's very helpful, thank you.

MEMBER HINZE: Any other questions?

VICE-CHAIR CROFF: Paul, can I take you back to your slide #18? I wish this had slide numbers on it. It's the one that of the canister receipt loading facility process.

If I understood your description of it, the transportation cask potentially containing a TAD comes in from the right, gets put on a pallette, but then the canister, the TAD, gets lifted out of the transportation cask, moved over and put into the disposal package; is that roughly -

MR. HARRINGTON: Yes.

VICE-CHAIR CROFF: How far up off the floor does the canister get lifted during that move?

MR. HARRINGTON: Well, the lift of the canister proper is done inside here, so it gets lifted, the height of the transportation cask, plus another probably four or five feet, to clear the thickness of the wall and also of the shield door on the bottom of that canister transfer machine.

And then once it is lifted up there, the shield door comes across the bottom. And then the shield barrel is translated over from the transportation cask to the waste package.

VICE-CHAIR CROFF: So we're on the order of 20 feet?

MR. HARRINGTON: Yes. Yes.

VICE-CHAIR CROFF: Okay, how does that compare to the drop test or the drop requirements put on the TAD? In the spec?

MR. HARRINGTON: The reason those drop requirements are as low as they are is that this is inside a shielded compliant area.

We had the one-foot drop, I think that's what you're referring to, because when that is taken out to the aging TAD, we don't want to have a drop that could potentially breach that canister outside of this confinement area.

If we had tried to impose a 25-foot drop requirement on TAD, we didn't think we'd have any takers. It's not a good way to word it. We didn't think that would be physically achievable for these large TADs.

We do have drop requirements on that order for the smaller waste canisters, we have some F canisters. Those are physically smaller. They have some of them have crush components on the bottom of them. They can take that kind of drop, but a TAD we didn't think practically speaking we'd be able to make that case; nor since it's in the confinement area did we need to.

But out on the aging pad, absent confinement, we wanted to have that requirement.

VICE-CHAIR CROFF: Okay, thanks.

Dr. Clarke.

MEMBER CLARKE: Could you go forward a couple of slides? Is this a new feature?

MR. HARRINGTON: This is redesigned. We

had had that function before, and this simply takes the transportation cask and is the vehicle for getting it off of the transportation conveyance, rail car or truck, over to the unloading port.

It looks different than it had before. The main feature is the change from the railway system that we had earlier to the air pallette that we have now.

MEMBER CLARKE: I was going to ask, is that older than '83, that crane transfer?

MR. HARRINGTON: Yes.

MEMBER CLARKE: So or course there's a significant number of train transfers eliminated through this?

MR. HARRINGTON: Yes, on the order of 10,000.

MEMBER CLARKE: Do you have an estimate of the maximum number of transfers, assembly might undergo --

MR. HARRINGTON: An individual assembly or a canister?

MEMBER CLARKE: You can talk about assemblies.

MR. HARRINGTON: That would be probably two.

MEMBER CLARKE: That's in the --

MR. HARRINGTON: Yes, that's in the pool. And the reason I say that is, either a transportation cask with bare assemblies, or a DPC, goes into the pool, gets opened. There is a small amount of staging ramp space in there that an assembly could be put into, if not directly into the TAD, and then taken from that rack to the TAD.

So just two moves and it's in the pool. In the previous design we had four moves; doesn't really matter what they are, we're not doing them anymore.

MEMBER CLARKE: The other area of questions I have, the basic question is, I find myself sometimes wandering around in terms container, canister, cask, waste package, I think there are probably a couple of others. Waste package is the final product; that's what goes into the systems, is that right?

MR. HARRINGTON: Yes.

MEMBER CLARKE: And the welding to close the waste passages is very important, as I understand. That will all be done, and the, all the waste packages obviously will be welded together?

MR. HARRINGTON: Yes.

MEMBER CLARKE: Now on the TADs, the TADs come in from the facility. Is the welding of the TAD done at the utility?

MR. HARRINGTON: Yes. If TADs are loaded at the utility, then they would be sealed as part of that loading process.

MEMBER CLARKE: And TADs are used for assemblies that are mixed and matched at Yucca Mountain, that welding would be done --MR. HARRINGTON: Right. Everything that goes through the pool for nondisposable transportation casks that we get, that - those assemblies get put into a TAD in the pool so the WHF, the wet handling facility, has the function of drying and closing that TAD, so nominally 10 percent of the commercial fuel will be loaded into TADs at the repository; the remaining 90 percent at the utilities.

MEMBER CLARKE: That material is in the DPCs now?

MR. HARRINGTON: Right.

MEMBER CLARKE: I think those were my questions.

MEMBER HINZE: Paul, I have a few questions. The first will be kind of a variety of topics if I might.

A couple of months ago there was a

newspaper release regarding a fault that ran underneath the aging area.

I believe, I don't know that it was really mentioned, but I believe that probably is the Bow Ridge fault. And this was announced as some great new discovery and had great impact.

Can you give us an idea of what's going on there?

MR. HARRINGTON: Yes. As a result of the additional bore holes that we've been doing, have been doing over the last six or nine months, one of those indicated that what we had thought was a splay I believe of the Ghost Dance fault was in fact the fault, and it came across part of where we had an aging pad situated.

So we simply moved the aging pad. This reflects that. Previously I think it was shifted a little bit over to this side. But we moved the aging pad just to get off of it.

MEMBER HINZE: Has that in any way been incorporated into the seismic hazard curve, the movement of that in proximity of the fault?

MR. HARRINGTON: I guess I don't know that the seismic hazard curve is dependent upon that. It may be; I just don't know. We are given the seismic hazard curve. We don't want to straddle the fault, and sort of sheer on that. But the values that we're using for the seismic design to my knowledge they are not dependent on how far off of a fault I am. They are simply the values that we use.

MEMBER HINZE: You have put in a lot of drill holes. There's also a lot of space between the drill holes.

Has there been any effort made to do - hold the hole investigations to try to get some idea of the material, the possibility of splays of that fault between the drill holes?

MR. HARRINGTON: Yes, one of the issues has been the consistency of information from holes. We find out this sort of thing. We did find the one fault there, but been believed to be elsewhere.

But I don't know of any other changes that resulted from that. I believe that had been confirmatory in nature, the kind of information that we're finding.

MEMBER HINZE: At the last meeting in March, when you were here, we had some questions about the possibility of igneous activity during the precolonial period. And what considerations were being taken into account in the design. At that time one of the questions related to the possibility of clogging the ventilation system; do you recall that we discussed that?

And at that time I believe there was a question of mine, if there was any provisions being made to accommodate ash that might fall on the repository clogging the ventilation system. Has any of that been taken into account?

MR. HARRINGTON: Yes, there are prefilters in the ventilation system.

MEMBER HINZE: And these are designed for the ash?

MR. HARRINGTON: They would accommodate the ash. I don't think they were in there specifically for the ash.

MEMBER HINZE: You discussed - well, let me ask you this question. Do you perform an accident analysis, an overall accident analysis that occurs within these structures? And if so what is incorporated?

MR. HARRINGTON: Yes. The --

MEMBER HINZE: I didn't -- as part of the presentation. And I just thought I'd ask.

MR. HARRINGTON: Well, the reason I'm saying yes is, that's part of what the preclosure safety analysis has to get to is what can happen in that building, it's likelihood, its consequences.

So we have approached that from several different perspectives. We've done energy evaluations. Is there electrical energy, is there compressed gas, flammables.

So as part of the PCSA in identifying hazards that would lead to event sequences, yes, we've had to look at accidents. We've also had to look at accidents from the perspective of reliabilities, considering frame drop as a potential accident.

We've looked at available information from industry as to history of drops of heavy loads; drops from field handling machines; and factored that in.

We've also over the last probably year focused on separating the human reliability part of that from the equipment. A lot of that information was simply the number of events that had happened without really breaking them out, human versus hardware, but to respond to a number of questions that we've gotten, we'll go ahead and address the human contribution to that also.

So to answer the question, have we evaluated accidents -

MEMBER HINZE: You're deep into this at

this time. In speaking about the wall thickness and some of the other parameters you were talking about, the necessity of evaluating the seismic hazard and the radiation standard and the radiation - and I think you mentioned some other things as well. I'm not certain that I caught those.

How did you integrate, how did you meld these various requirements for seismic hazard, for radiation, et cetera, into determining such things as the wall thickness? Did you just take the maximum of all of those? Or were they integrated in some other fashion?

MR. HARRINGTON: Well, we chose a value based on I'll use the term best practices, expected outcomes, and then evaluated that to see if it would give us the performance that we were looking for.

Back when we were first starting these building designs, we looked at two feet, three feet, four feet, six feet. And decided that based on people's experience in designing these kinds of structures, and looking at the loads, the seismic accelerations for example that we were going to have to subject that structure too; also looking at likely needs for shielding; we chose four feet for example as wall thicknesses for many of the areas. They are not all uniformly that dimension.

And then we plugged those into the structural analysis, to see did we satisfy the loads for seismic events. That really is the dominant driver. Do we satisfy the loads for shielding? And four feet, even for the design basis fuel, 80 gigawatt, 5 percent enrichment, 5-year out of core, satisfies that.

So it wasn't trying to for every facility determine the minimum thickness that might just satisfy the margin that we were looking for, but rather, for simplicity's sake, choosing a value, standardizing on a value, demonstrating that that would meet the margin that we want to have; and not trying to go to three foot eight inches, just use some standardization.

MEMBER HINZE: That's very helpful, because this question of the thickness of the walls was very prominent at our meeting last month, and I wanted to get your insight into this.

Let me ask you how do you determine what to evaluate with a convolution of a fragility curve with the hazard curve? How do you determine what's important to safety? And how quantitative is that?

MR. HARRINGTON: the determination of

what's important for safety comes out of the preclosure safety analysis, which is identifying what system structures or components were having to credit for prevention or mitigation of event sequences that otherwise would exceed the performance objectives.

That is what has determined the closed structures for the ones that are, are ITS, we're relying on them for support of the capital handling equipment, cranes, et cetera. We are relying on them, except in IHF, for confinement. So that was the determination of what was ITS.

The performance of the convolution , we simply did the structural analysis of the structure to determine the fragility of that structure, and then got the seismic hazards curve from the science folks, and we're having to do the convolution of those two.

Frankly, I have personally never done a convolution in my life, so I can't really tell you how to do that.

MEMBER HINZE: No problem. For one of these buildings, how many convolutions do you have? Ten? A thousand? Ten thousand? And I've heard different numbers here. I'm just curious; what are we talking about? How much of a problem is this?

MR. HARRINGTON: It's a problem that we're going to deal with and are dealing with. That's not a helpful answer; I'm sorry.

I said I hadn't done convolutions. Looking at that 2-D model, what I think that means is that for every element that we design, we're having to do that convolution.

So that may be a variable number of convolutions for a structure. I can't imagine how you could do it in only one or a very few numbers.

MEMBER HINZE: I understand, okay. That was stretching the point. But 100, or 1,000 or 10,000, I'm just trying to get an order of magnitude.

MR. HARRINGTON: Oh, I don't know.

MEMBER HINZE: Let me ask, one of the - you mentioned that you've used - or the role of ASCE for a 98, nuclear facilities for structures. I wonder, has there been any consideration of this new ASCE standard, 4005, which defines this fragility seismic hazard convolution? Is that being invoked here?

MR. HARRINGTON: I'm sorry, I don't know that.

MEMBER HINZE: Okay. You mentioned that the seismic hazard curve was still in a state of flux, or progress?

MR. HARRINGTON: What I said is, we have a curve. And we are using that curve for current design. And that that curve may change, may be reduced a little bit based on the work that's going on today.

If that does happen, that would simply mean that I have more margin in my design. I'm not going to go back and try to redesign this structure. There is no expectation that it's going to go up and reduce the margin that's in the structures now.

MEMBER HINZE: What's that work that is going on?

MR. HARRINGTON: Oh, it's the data reduction from the additional bore hole work that we have - that we what a month ago finished the bore holes, as many as we were able to do. The data reduction from that is going on now. And what that will potentially result in is a slight reduction in the seismic acceleration values for the DBGM-1 and 2 values.

MEMBER HINZE: Is there anything in the wind regarding looking at the accelerations associated with a 500,000-year return period, a 3G? Is that being revisited?

MR. HARRINGTON: Well, that would have, this work that we're talking about now for the DBGM-1 and 2, would potentially have an effect on the 500,000 year return period also.

MEMBER HINZE: Okay. Staff, I'm wondering whether - Mike.

MR. LEE: I just have one comment, and then a question, just to help Dr. Wiener out.

The seismic hazard curve is derived from a probabilistic seismic hazard analysis that is based on expert judgment in part, and that of course relies on data.

And the PSHA provision if you will in the review of nuclear regulatory facilities goes back to as early as 1982 based on the recommendations of the USGS. And the agency has adopted the PSHA standard for nuclear power plants, as Dr. Hinze pointed out, because that's subject to review right now at the Vogtle Nuclear Power Plant. So the expert judgment, PSHA based on expert judgment now has permeated throughout review guides and all manner of NRC requirements in the area of nuclear licensing. So this isn't something that's new or unique; this is standard practice today.

So in fact all former nuclear power plants had to go through the IPEEE process, which looked at expert judgments, probabilistic seismic hazard analyses, in light of existing designs and operations.

And I just wanted to make sure that both you and members of the public here today understand that this isn't a new requirement or anything like that.

There may be some issues between staff and DOE right now on fine tuning the geometry and things like that.

MEMBER WIENER: No, you are reading much more into this than the question. I just looked at this and thought, where does this come from? Do you have data? And that's fine, but thanks, that's very helpful, Mike.

MR. HARRINGTON: Mike, the one comment I would add to that is, yes, the other facilities are having to do this for the structures. It's not clear to me how far into mechanical components for example they're having to go. And we certainly are.

MEMBER WIENER: That's also very good to know.

MR. LEE: I just have one question, and this is kind of a problem from our working group meeting in October related to seismic event sequence. The regulation in Part 63 requires a PCSA based on seismic event sequence. Is that provision, without commenting on the acceptability of the regulation, is this a workable engineering task for DOE in the context of the preclosure facility design? I guess if you want to fine tune it, Dr. Hinze, that question.

MR. HARRINGTON: Yes, that's workable. And I'll elaborate on that a little.

MR. LEE: Please do; that's what I wanted to hear.

MR. HARRINGTON: For the structures, it's much more straightforward. Developing these fragility curves, doing the convolution, it's simply work that we have to do, and we're doing it.

For some of the components, though, particularly where those components don't exist, and we're not ourselves doing final design on that, as I talked about earlier, that presents a little more of a challenge.

So for things like the TEV, for the trolleys, we're developing those designs to the extent that we think we need to to support our performance of the fragility analysis on them.

Ultimately, though, when we do buy those, that'll be one of the things that the vendors will have to perform and defend is those analyses on their final design to show that they, as final design, satisfy those.

But there were other components out there now that will come to a repository that have not been designed under those rules, and that's probably the area that will be most challenging to us.

We talk about receiving DPCs. It's been made very clear to us that components that come to the repository need to be evaluated under the repository regulations.

So we are having to work with vendors, and we will in the future, to get sufficient information to support doing those sorts of analyses.

Potentially, we might be in a position where components that have been found to be acceptable elsewhere are not acceptable at the repository.

That would be a difficult position to be in, so we'll do everything we can to get the information, to support those sorts of things coming to the repository, but that I think is probably the biggest delta from where the rest of the industry is now to where we need to go.

MR. LEE: And I'm sure if and when any license application review takes place, the staff will help you identify what those deltas are.

MR. HARRINGTON: I'm sure.

MEMBER HINZE: Dr. Wiener, another question?

MEMBER WIENER: Yes, I did.

Could you go back to the slide that you put up for Allen Croff, please, for a moment. And I apologize for not - for taking more time. That one.

And the canister that the material comes in on the right-hand side?

MR. HARRINGTON: Yes, it does. The transportation cask comes in this side.

MEMBER WIENER: And the transportation cask is horizontal on the vehicle; isn't it?

MR. HARRINGTON: Yes, you're looking at the end of a transportation cask right now. It's in and out of the -

MEMBER WIENER: So how often do you have to turn it? Then it's turned to be vertical to take the pad out?

MR. HARRINGTON: Yes, there is a crane that will engage the lifting lugs on the transportation cask, and in fact we'll have to reinstall those lifting lugs.

And that is about the biggest dose contributor in the whole repository operation is having to manually access that transportation cask to reinstall the trunnion. So that's one of the things we'll look at in the future for enhancements with those vendors, is how can we simplify it.

But we have to reinstall lifting trunnions, and then engage that with the overhead crane, pick it up, move it sideways and then the vertical orientation, into the open side of this trolley, and then the gate will swing around and close that so it can't fall out.

This then, the air supply gets energized so that it can be translated underneath the lifting port, there, and then the canister transfer machine will go over above the transportation cask, reach down inside, grapple the canister, pull it up into that shielded canister transfer machine, and then translate over, lower it down into the empty waste package that's already been placed in the waste package trolley, and the adjacent port, then that waste package translates over to the closure area. That's where the lid installation, welding, nondestructive examination, backfilling with helium for corrosion protection and thermal heat transfer to take place.

And then finally that trolley is moved further out, lowered out into the horizontal position, and the waste package on its pallette is moved from that trolley into the transport and placement vehicle.

MEMBER WIENER: Is the mechanism that takes the TAD out of the horizontal transportation cask and realigns it vertically, is that like your other machine that turns the cask? What do you have that does that?

MR. HARRINGTON: Okay, the TAD canisters stay in the transportation cask until the transportation cask is operated.

MEMBER WIENER: Oh. So you upright the transportation cask?

MR. HARRINGTON: Right.

MEMBER WIENER: And you do that with a mechanism with a trolley that is similar to the one that goes the other way?

MR. HARRINGTON: No, that's done with that overhead crane with the hooks engaging lifting trunnion on the side of the transportation cask -

MEMBER WIENER: I see, and that turns it?

MR. HARRINGTON: Yes, it'll upright it, and then move it over to the trolley.

MEMBER WIENER: Thanks.

Have you done a probabilistic accident analysis on that first step?

MR. HARRINGTON: Yes. Yes.

All of these steps, that's what's contained in the PHA; those are the event trees, the fault trees, to determine the probabilities of accidents at each of those points.

Reasons for that potential accident, is it a equipment failure. Is it somebody put the wrong trunnion or grapple or something else on. So that really is the core of the PCSA work is understanding what can go wrong; what is the probability of it going wrong; what's the consequence of it going wrong.

MEMBER WIENER: Thank you.

MEMBER HINZE: Thank you.

With that I'll open it up to questions from the audience and staff. John Flack.

MEMBER WIENER: There's a microphone right here.

MR. FLACK: John Flack, ACW staff. My questions relates to the five-rem as being the criteria of offsite for that you are trying to meet in these category two events.

Have you been pushing up against that criteria at some point, in some scenario? And if so, and if not even, what are the limiting scenarios? I imagine it's a seismic event at some level at some return frequency that will be pushing you up against that ceiling. I was curious about what that scenario might be.

MR. HARRINGTON: A draft and breach of a TAD as currently very conservatively modeled would somewhat exceed that. And that's why we're trying very hard to make sure that we don't have any breaches of TADs. That's where the one-foot drop height for the TAD, out on the aging pad comes from. It's where the building confinement credit comes from.

Excluding that, no, we really don't have anything that comes close to that.

MR. FLACK: Okay, and that would be a drop during a seismic event?

MR. HARRINGTON: It could be, or just an equipment drop.

MR. FLACK: The frequency of that would probably be pretty much a seismic event, because that's the one you need to treat in that sequence, right? I mean that's the one that would end up being probably - or it could be again a drop. But I was just curious as to whether the seismic level or the seismic event, the G value, has an impact on that scenario, and what would it be about.

MR. HARRINGTON: Well, we're doing the

design of the components, so that in a seismic event it doesn't get dropped. It just freezes in place. So we're trying to rule out dropping in a seismic event.

MR. FLACK: Up to what G level is that?

MR. HARRINGTON: That's to the analyzed one, the design basis ground motion two.

MR. FLACK: Which is 5 X 10^-4?

MR. HARRINGTON: No, no, that's the 2,000 year return period.

MR. FLACK: Oh, okay, up to that point. Seismic events that exceed that value?

MR. HARRINGTON: Then we have to look at consequences.

MR. FLACK: You haven't done those? What I'm trying to understand is, the likelihood of the seismic event occurring during that period of time, and the consequences, and how one would then have to go back and try to identify what equipment or margins would have to be put in place to try to prevent that kind of release under those circumstances.

MR. HARRINGTON: Well, that's part of what's going into the equipment design now for that, for the seismic event and the equipment will ensure that it doesn't breach so we're not crowding those limits.

MR. FLACK: I understand that. I'm just trying to understand at what G value you're designing it to, and what margin you're putting on it to prevent that kind of leaks at those very low frequencies?

MR. HARRINGTON: Well, we're designing it to the DBGM-2 value of approximately .55, and we'll evaluate performance beyond DGBM-2 at the 10,000 year return period at around 1G.

MR. FLACK: And if that doesn't make it?

MR. HARRINGTON: Well, if it doesn't make it then we would have to redesign.

MR. FLACK: You'd have to redesign?

MR. HARRINGTON: Yes, but so far it's making it.

MR. FLACK: Okay, that was my question. So far you've looked at it, and it is making it.

MR. HARRINGTON: Yes.

MEMBER HINZE: Thanks, John.

Rod, did you have a question?

MR. McCULLUM: If the committee would let me come to a microphone.

MEMBER HINZE: Okay.

Identify yourself, Rob, if you would please.

MR. McCULLUM: Sorry, Rob McCollum, Nuclear

Energy Institute, and I appreciate the opportunity to follow up on our discussion of last month.

On the seismic hazard, because I can see where the 3G if you look up there, it does correspond to about once in every 500,000 years, correct?

MR. HARRINGTON: Yes.

MR. McCULLUM: So you're criteria was that you didn't want to exclude tip over; it had to not have a probability greater than that, correct?

MR. HARRINGTON: Yes.

MR. McCULLUM: So you were in essence convolving a fragility and a hazards curve, or at least prespecifying a fragility curve to the vendors that you could convolve with this hazard curve to assure that you would have to go below that point on the curve; is that a good way of putting it?

MR. HARRINGTON: I would have put it a little bit differently, and simply choosing a value for the seismic acceleration. That would be beyond Category 2.

I suppose you could say it your way too.

MR. McCULLUM: Right, so you're telling the vendor that they must therefore meet that. So that you are basically telling them in advance where the fragility curve has to end up on the hazard curve.

MR. HARRINGTON: I guess I'll say no. All we want to do is make sure it doesn't tip over. Now the fragility curve I think is going to be code compliant. I don't need it to stay within design basis allowable, for example. I'll treat that as the same thing we're doing with the Yvonne design basis evaluation for other structures.

But I do need to make sure it doesn't tip over.

MR. McCULLUM: Okay, so you're got to that point of tip over. Now in terms of the fragility of all these other things, whether it's 10 or 10,000 or some number in between, in those cases you are looking strictly at whether or not it's going to be within code allowances.

MR. HARRINGTON: For the DBGM-2 values, those are to the code allowables.

For the beyond DBGM evaluation, that's not within code allowable stresses. That - does this thing fracture or not.

MR. McCULLUM: Okay, so that's analogous to the does-it-tip-over?

MR. HARRINGTON: Yes.

MR. McCULLUM: So you have somewhere between 10 and 10,000 more fragilities that you have to convolve with hazard curves.

Is there any possibility that for any of those components or systems for the not-fracture, not tip over scenario, that you would also end up at 3G?

MR. HARRINGTON: I would say no.

MR. McCULLUM: So all of those are going to stay down at the DBMG-2 level?

MR. HARRINGTON: Yes. The only thing that we were trying to move here was the tip over of these dry casks. All of the structures are being evaluated against the other values.

MR. McCULLUM: Even in the case of not fracture, not fail this way, wanting to exclude an event, if you're not going to have any other event that you're going to want to exclude, then you start doing that convolution with similar probability that puts you at the same place on the curve.

MR. HARRINGTON: Not having any other event, or a magma intrusion. There's an event that is low probability also that we're excluding. So I wouldn't say blanketly that this is the only event. I mean there are lots of potential events that are beyond Cat-2. That's the only point I think I'm trying to make here is that if we can design this component so that it's tip over is beyond Cat-2, it will then reside in beyond Cat-2 space just like many other potential event sequences that have low probability.

MR. McCULLUM: And do you have to go through all of those convolutions of fragility before you know what those are in -

MR. HARRINGTON: No, no, those are done simply based on the probabilities. That's why earlier when you said, aren't I in essence providing a fragility curve to a vendor, I said no. To use another example, why isn't that known, magma intrusion during a preclosure period. That's a low probability event, which is beyond Cat-2. I'm not relying on any sort of fragility analysis. We're doing that strictly on probability.

MR. McCULLUM: You're not providing a fragility curve; you're providing a tip over curve.

MR. HARRINGTON: I need the vendors to provide a confirmation that the component won't tip over in that seismic motion.

MR. McCULLUM: And there aren't any other components out there where you're going to end up with a similar type of criteria when you go through all these analyses and convolving curves?

MR. HARRINGTON: I don't think so. None

that we've talked about, none that I know of.

MR. McCULLUM: Can I ask one more question. Could you go back to slide #38?

MR. HARRINGTON: Which one was that?

MR. McCULLUM: It was six bullets, structural design process.

The last bullet on there, if the history of this was discussed in previous meetings when DOE submitted a seismic design topical report, it was rejected by NRC, and then that led to a series of interactions that became ISG-1.

If it had not been for that series of interactions, would you still be doing the sixth bullet? Or would you have stopped up somewhere in the marginal analysis above?

MR. HARRINGTON: We had felt that the seismic margins assessment approach was sufficient. But we got a response that said it's helpful, but it doesn't demonstrate regulatory compliance, and suggested another approach. So we are doing that approach.

Irrespective of how we got there, I guess I would simply focus on where we are.

MR. McCULLUM: Very helpful, thank you.

MEMBER HINZE: Yes, sir, please.

MR. KIM: Yong Kim, structural engineer from NMSS, high level waste program.

I have two questions for Paul. First question is, in page 29, you mentioned that some mechanical handle equipment such as TEV do not have a consensus design code. Therefore they will be designed to applicable codes.

And then P36 and then you will demonstrate design by performing PCSA analysis, and such as fragility analysis, et cetera.

My question to you is whether DOE has any plan to demonstrate adequacy of design by performing actual experimental test at the appropriate site.

MR. HARRINGTON: Certainly we will be doing prototype testing. And we are currently prototype developing the waste package closure system up at Idaho, and some folks have gone up and seen that.

We have developed prototype waste packages. EM has developed prototype canisters for some of their waste forms, and has actually done testing of them.

We will in the future develop some prototype handling equipment like the TEV because of the inability to directly access that readily when it's in the emplacement. And I said that we build it shielded so that if there were a component failure, we could access it to repair it.

And that works fine right up until the point that you get into the emplacement group and start driving down that. That'll be thermally hot and radiologically hot.

So we want to make sure this equipment works with a high reliability. So yes there will be more prototype development that goes on in the future.

MR. KIM: Okay, thank you very much.

My second question is, on last slide, 46, you indicate that more than 95 percent of design and PCSA have been completed.

If I remember correctly in the last two public meetings, one meeting in Las Vegas, September, and second public meeting in October, in Rockville office here, DOE staff indicate that 30 to 40 percent design correction is done, and that will be submitted in LA.

Now today you are making about 95 percent completions. It seems to disconnect. Would you clarify?

MR. HARRINGTON: Sure. And for those that have the opportunity to hear the December NSC management meeting, you'll hear that in a lot more detail; I'll get to talk to that.

The question is, what is 100 percent? When we talk about 35 or 40 percent design complete, that is of 100 percent of the design that will ever be needed to be done to construct and start up this facility.

So it's not simply the important safety equipment. It is not simply the major design work that we need to do to support preclosure safety analysis.

It is the selection of the last nut or bolt out there. To be a little more explicit in the piping area for example, we've done piping and instrumentation diagrams. They will show all of the components on the facility. It shows the instrumentation on them to a much greater degree than has been the case in previous license applications.

We will have vents and drains in some areas. We certainly have filter bypasses and all those sorts of things that typically people wouldn't have seen.

But P&ID says what the system is and how it operates. To actually build it you then go create piping isometric drawings that take physical sections of the piping and lay it out, and that's done to the physical structure, meaning it shows the pipe chases, it roots major sections of piping, and it shows every component that goes into that piece of pipe, the Ls, the reducers, the Ts, everything about that piece of pipe that has to be built shows up on the isometric drawing.

Then the fabricator creates spool sketches where they will take an even smaller piece of pipe and detail out that showing each weld that has to be made to physically assemble that spool, shows where the field wells are. There's a little extra length there so it can be trimmed to fit.

That's the level of design that we're not doing at this point that has no bearing on identification of what the facility is, or what it's operating basis or safety case is.

Structural, for example: We have the structure laid out not just at a general arrangement drawing level, but the rebar pattern is there; the spacing; the bar sizing. But we have not detailed embed plates now. We have not detailed the rebar pattern around the HVAC penetrations. Nor do you need that at this point.

So all of the non-ITS components, the warehouses, the admin buildings, the parking lots, all of that stuff, the heavy equipment maintenance facility, we have not detailed that. But 100 percent design represents that.

Someone will have to have done every structural connection; selected the plumbing fixtures that go into it; located all of the electrical wiring terminal strips; done the drawings that the electricians are going to use to join wire A to wire B. We haven't done that yet.

That's the delta between the 40 percent design that Bob Sloga talked about a month or two ago, versus what 100 percent design really represents. This 95 percent is of those design and PSA products that we believe necessary to support the license applications.

MR. KIM: That's more than enough. Thanks.

MR. HARRINGTON: Okay.

MEMBER HINZE: Further compelling questions?

MR. KNAPP: Malcolm Knapp. I represent myself. Two quick questions.

I believe you said that a breach of the TAD might result in a dose to a member of the public greater than 5 REM. Do you have a number on that?

MR. HARRINGTON: I do, but it is very very conservative. We did not credit any retention within the TAD itself, or confinement within the transport vehicle.

We did not credit much in the way of dispersion from the point of release to the site.

So I think all I'd want to say is that it might exceed 5. But before we go public with a number, I would want to have a much more realistic number.

MR. KNAPP: Second question. You either stated or I think implied the capacity of the aging bed, in your earlier remarks.

Could you restate that please?

MR. HARRINGTON: I said 2-1/2 thousand dry cask assemblies.

MR. KNAPP: Thank you.

MR. HARRINGTON: It's 21,000 MTHM times about 8-1/2 per, about 2-1/2 thousand spots.

MR. KNAPP: Thank you very much.

MEMBER HINZE: Other questions?

MR. SHAH: Mahendra Shah, NRC staff. I just wanted to respond to the questions about ASE documents. ASE 4305 provides recommendations on selecting a safe shut down earthquake performance based, while ASE 498 provide guidelines on using that as a design basis, how to analyze a structure.

So these two documents are quite different, the scope is different. So I just wanted to make sure.

MEMBER HINZE: Thank you, that's very helpful.

MR. SHAH: That's it, thank you.

MR. VON TIESENHAUSEN: E. von Tiesenhausen, Clark Count. I just have one really quick question.

Could you go to slide six? Rats. Thank you, Paul.

While you are searching, you mentioned that you finished as many bore holes as you were able to do for the VSP data, and I believe that leaves roughly 20 percent that were not finished.

And I just wondered, was there any area that was disproportionately impacted by the lack of that data?

MR. HARRINGTON: No. We got at least one under every component, under every aging pad, under every building. So going back several years to when we had started - actually more than several - to when we had started the bore hole program, at that time we had fewer structures, in fact back at the site recommendation, it was one big building; and the bore holes were done based on that set of structures and their locations.

As we have shifted to a more modular approach, and shifted to external aging, rather than the pools that used to be in that SR design, obviously spread out more, so this latest iteration of bore holes was to go out to those new building footprints, and we were looking for at least five under each building, one at each of the corners, plus one in the middle.

We did get at least one under each building. I'm not sure where each of them were; whether or not it was centered, or one of the corners. But we did get at least one under each. And we are looking a lot for consistency and finding it, other than the fault that we found, a little bit away from where we thought it was.

But other than that, yes, there's consistency. So though each building may not have many, there's consistency enough between them across a fairly broad footprint that gives us comfort, or think it makes us acceptable.

MEMBER WIENER: Can I ask one more?

MEMBER HINZE: Half of one.

MEMBER WIENER: Okay, half of one. It's a real short one.

Did I just understand you to say that if there is a drop, a TAD drop, that a member of the public could receive a dose in excess of 5 REMs? Is that what you said? Did you hear that correct?

MR. HARRINGTON: Yes, you did. And I also qualified it by saying that that was a very conservative number that did not credit many contributors that would reduce that.

MEMBER WIENER: Well, my question is, how close is that member of the public to where the TAD is dropping?

MR. HARRINGTON: It's about five miles.

MEMBER WIENER: And you're going to get a dose of 5 REM five miles away?

MR. HARRINGTON: That's why I chose not to give that number because there are many conservatisms in there that are excessive, and I recognized that. And I don't want to convey something that is not realistic.

MEMBER WIENER: Thank you for that explanation. Because I have a little bit of a problem figuring out how that could happen.

MR. HARRINGTON: It is based on an assumption that every rod in there breaches; that they all oxidize; that there is no retention in there.

MEMBER WIENER: And no dispersion?

MR. HARRINGTON: Nope, and that's somebody just standing out there for, oh gosh, I think it's 24 hours.

So when you lay all of that together, it's kind of like standing next to it, and it's all spilled out on the parking lot.

Well, obviously that is not real.

MEMBER WIENER: Thank you.

MEMBER HINZE: If there are no compelling questions, I will thank you for all of us. It's been a very interesting, illuminating discussion and presentation. We appreciate it very much.

MR. HARRINGTON: Okay, well, thank you.

MEMBER HINZE: Come back again, please.

And with that I will close the meeting.

(Whereupon at 2:48 the proceeding in the above-entitled matter was adjourned.)

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: Advisory Committee on Nuclear Waste & Materials 184th Meeting

Docket Number: n/a

Location: Rockville, MD

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

Doug Turner
Official Reporter
Neal R. Gross & Co., Inc.

U.S. Department of Energy

OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

Status of Yucca Mountain Repository Design

Presented to:
Advisory Committee on Nuclear Waste and Materials

Presented by:
Paul Harrington
Director, Office of the Chief Engineer
Office of Civilian Radioactive Waste Management
U.S. Department of Energy

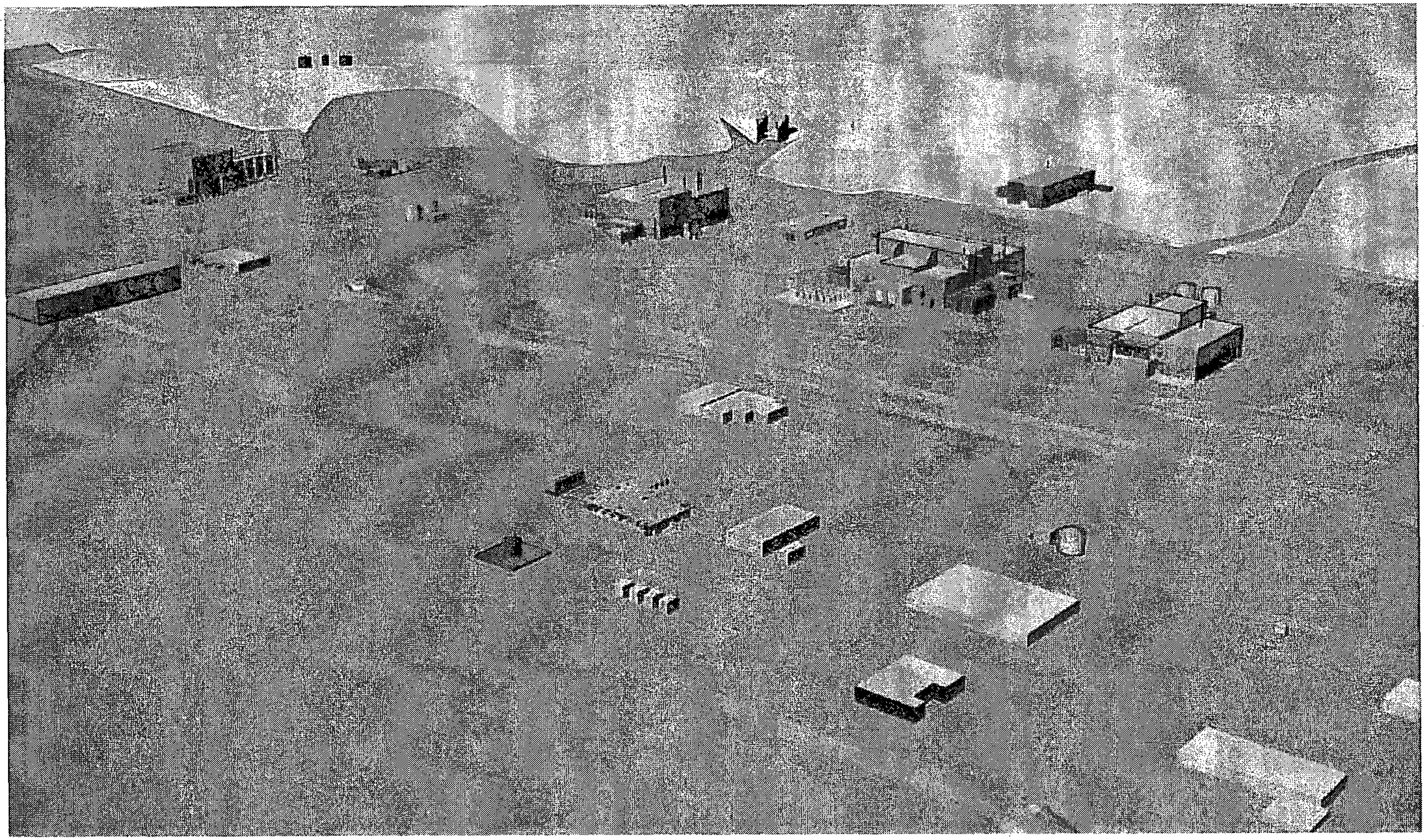
November 14, 2007
Rockville, Maryland

Acronyms

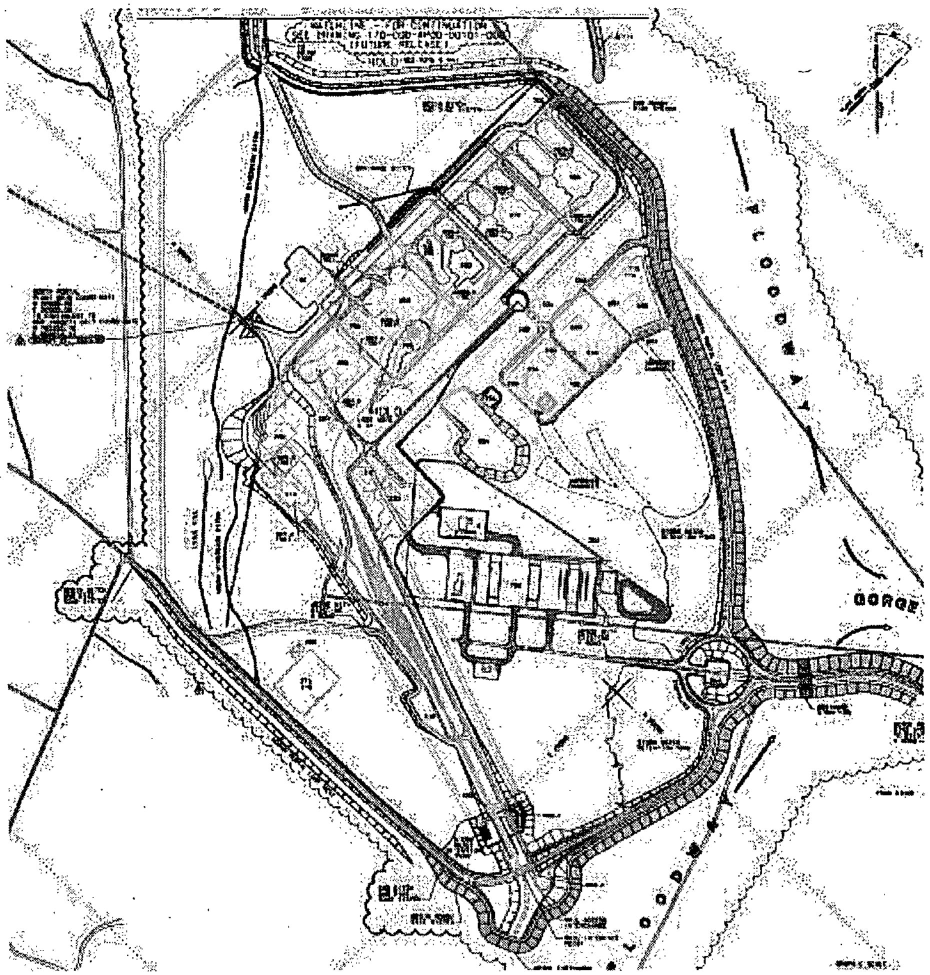
BWR	Boiling water reactor
CRCF	Canister receipt and closure facility
CSNF	Commercial spent nuclear fuel
HLW	High level radioactive waste
GROA	Geologic repository operations area
HEPA	High efficiency particulate air (filter)
IHF	Initial Handling Facility
ITS	Important to safety
MCO	Multi-canister overpack
PWR	Pressurized water reactor
RF	Receipt Facility
TAD	Transportation, aging, and disposal
WHF	Wet Handling Facility

Site Overview

3D Repository Model Looking West



Site Overview



New Facilities

IHF - Initial Handling Facility

WHF - Wet Handling Facility

CRCF 1 - Canister Receipt and Closure Facility 1

CRCF 2 - Canister Receipt and Closure Facility 2

CRCF 3 - Canister Receipt and Closure Facility 3

RF - Receipt Facility

LLWF - Low Level Waste Facility

EDGF (26D) - Emergency Diesel Generator Facility

Previous Facilities

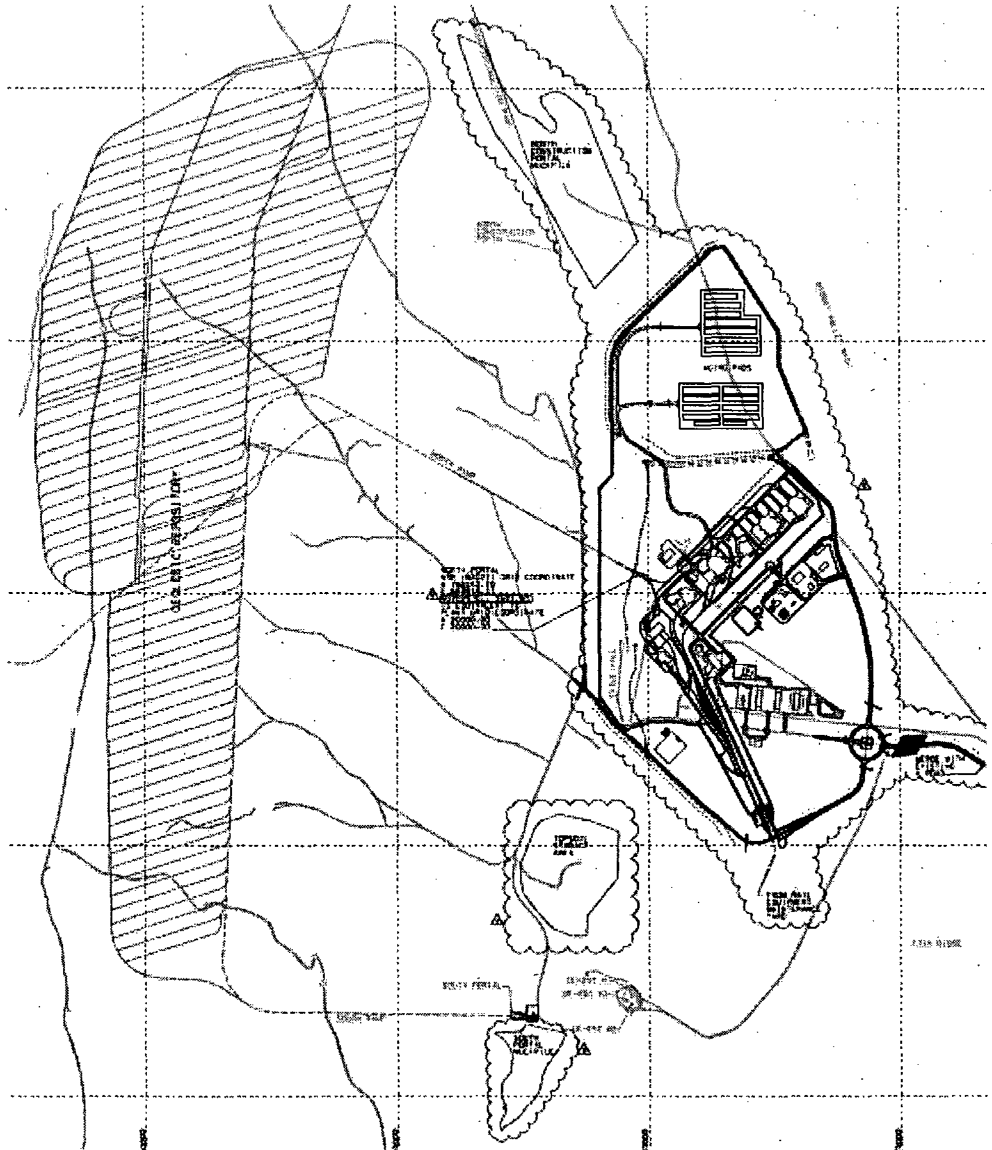
HEMF - Heavy Equipment Maintenance Facility

CCCF - Central Control Center Facility

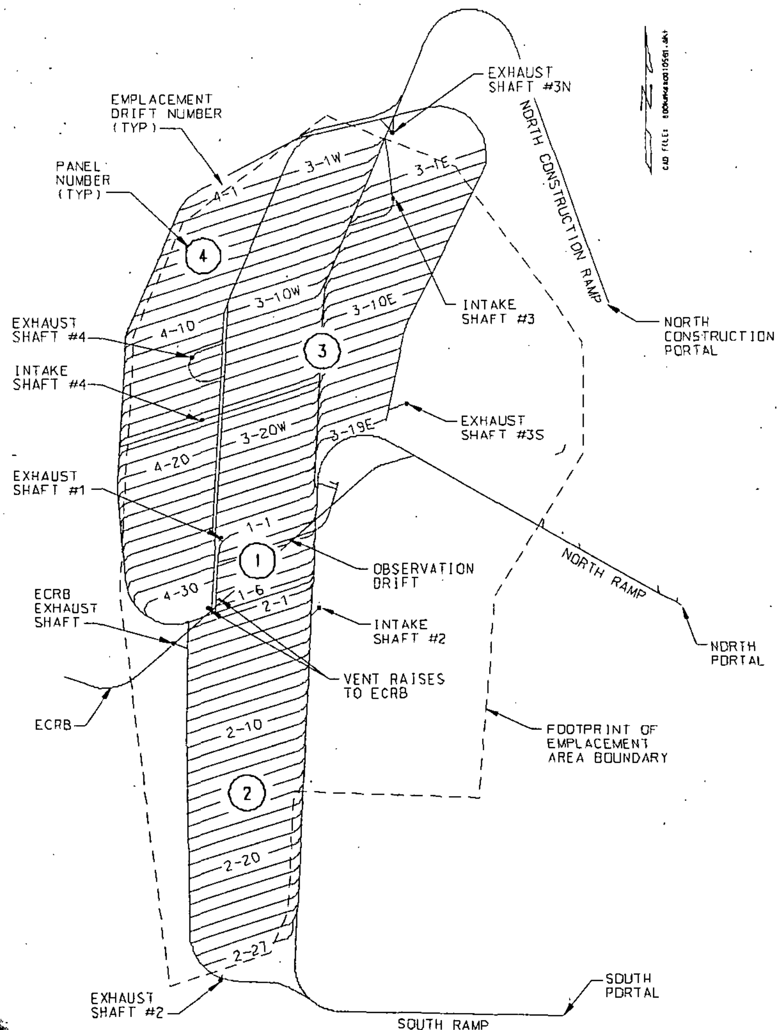
WNNRF - Warehouse and Non-Nuclear Receipt Facility

Utility, Security, and Administration Facilities

Site Overview



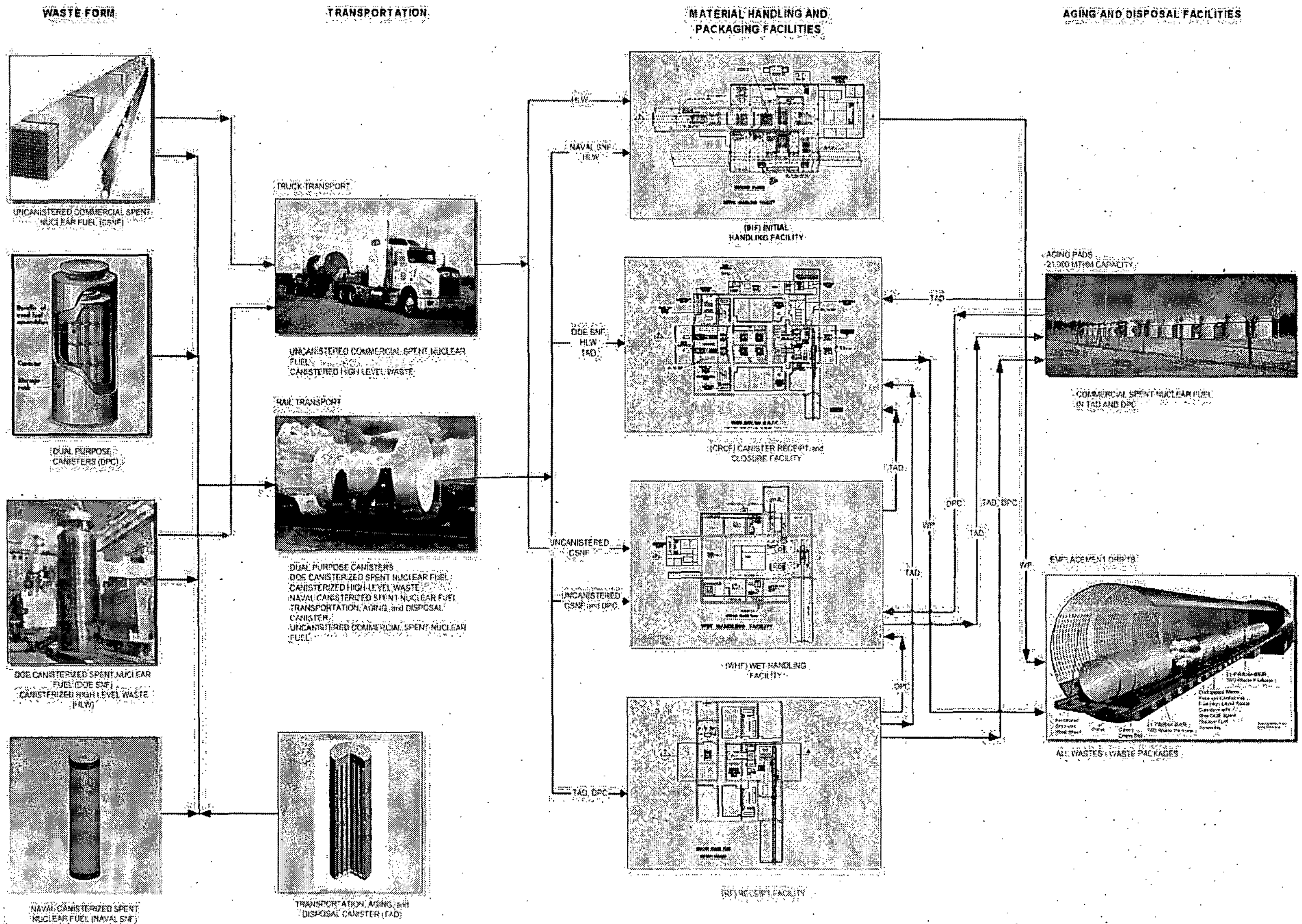
Subsurface Layout



- Panel numbers represent the proposed construction & emplacement sequence
- Sequence:
  - 6 drifts in Panel 1
  - 27 drifts in Panel 2
  - 45 drifts in 3E & 3W
  - 30 drifts in Panel 4
- Total emplacement length available is approximately 41 miles (66 km)

Waste Handling Functions

CONCEPT OF OPERATIONS - NUCLEAR FACILITIES

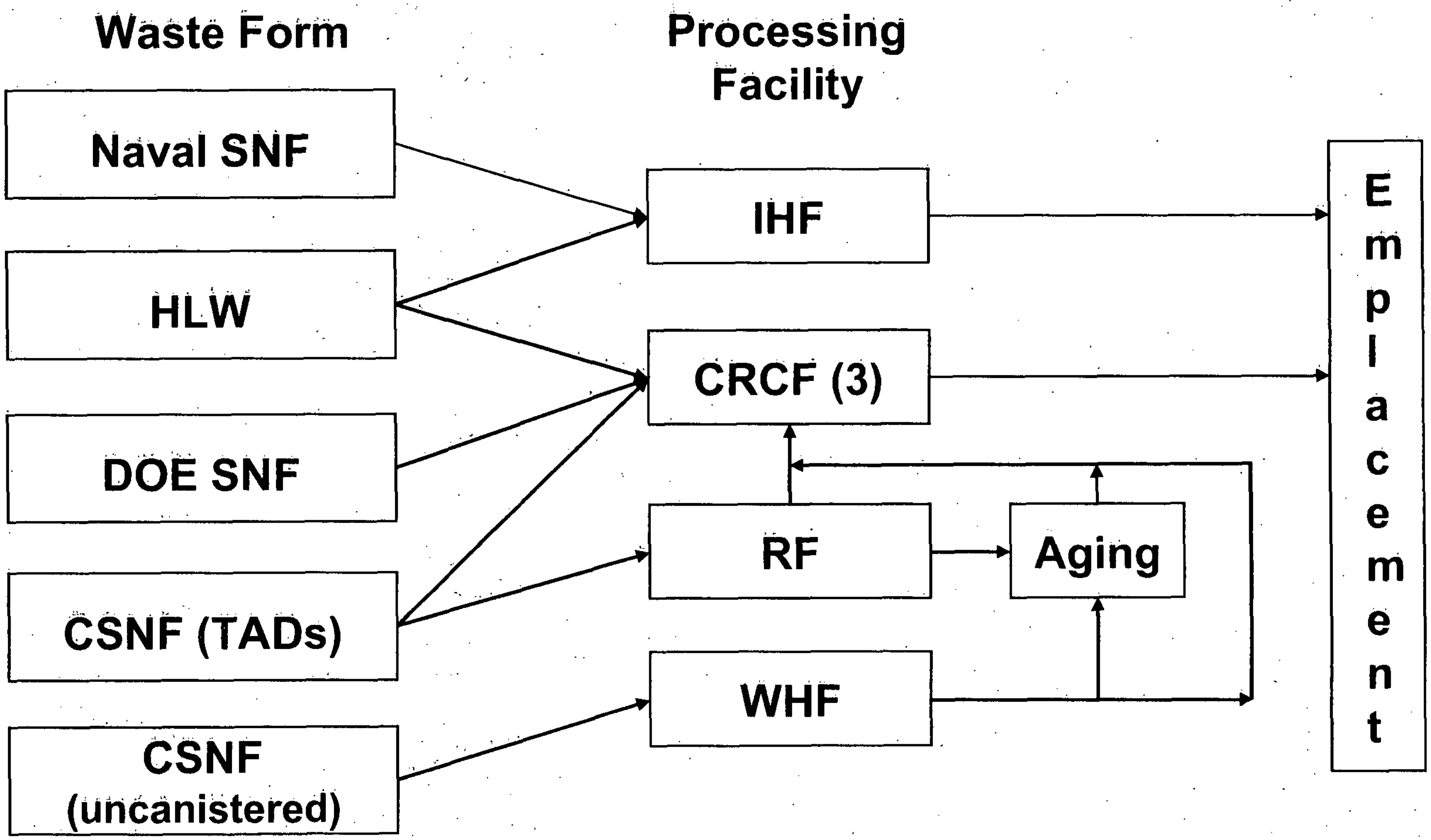


Functional Matrix

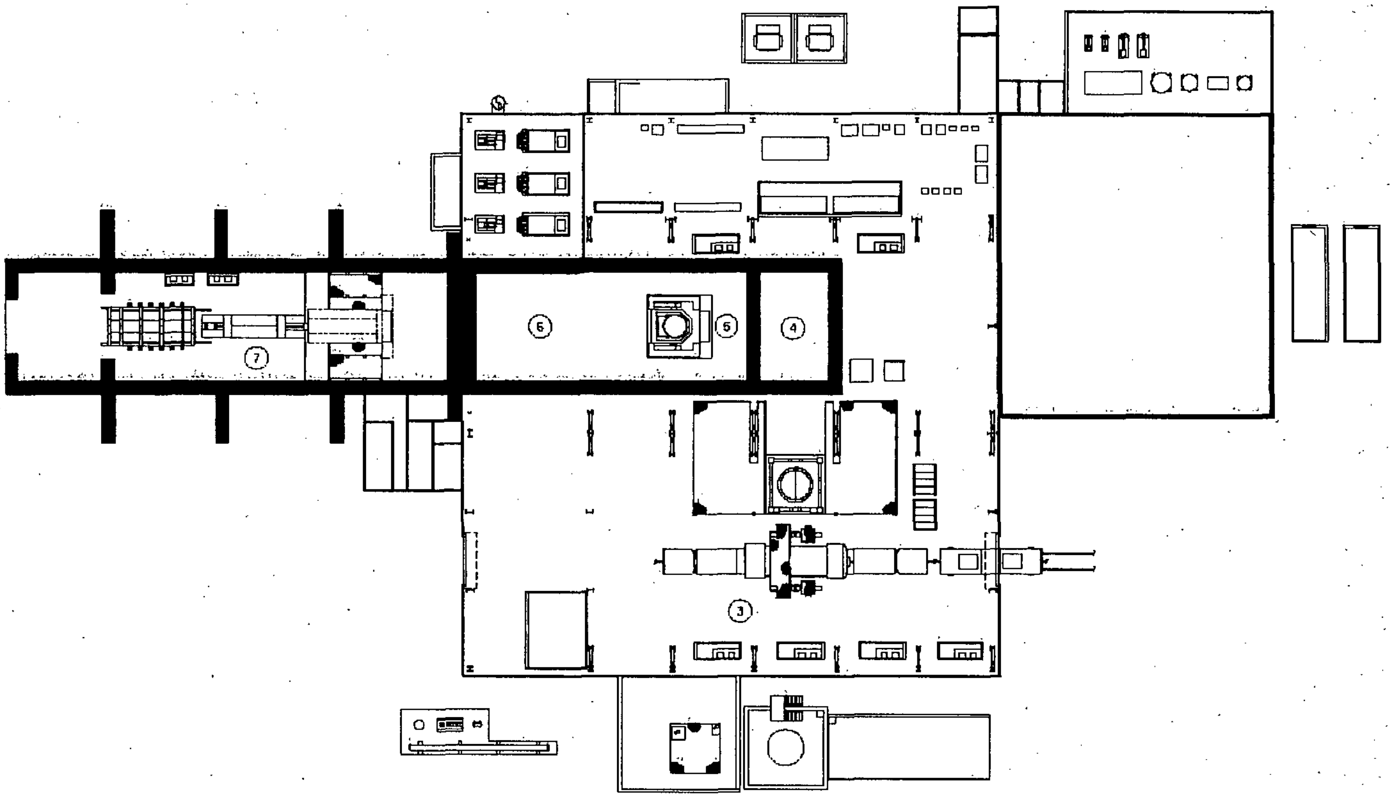
		Facilities			
		Initial Handling Facility (IHF)	Canister Receipt and Closure Facility (CRCF)	Wet Handling Facility (WHF)	Receipt Facility (RF)
Waste Forms					
HLW	Canister	X	X		
Naval SNF	Canister	X			
DOE SNF	Canister		X		
CSNF	Uncanisterd			X	
CSNF	TAD		X	X	X
Phase 1					
Phase 2					
Features					
WP Loading and Closure		X	X		
ITS Seismic Structure		X	X	X	X
ITS Mechanical Handling		X	X	X	X
ITS Confinement			X	X	X
ITS HEPA Exhaust			X	X	X
ITS Emergency Power			X	X	X
Remediation Capability		Dry	Dry	Wet and Dry	Dry

Note: Phases 3 and 4 add CRCF-2 and CRCF-3, respectively

Waste Form Processing Overview



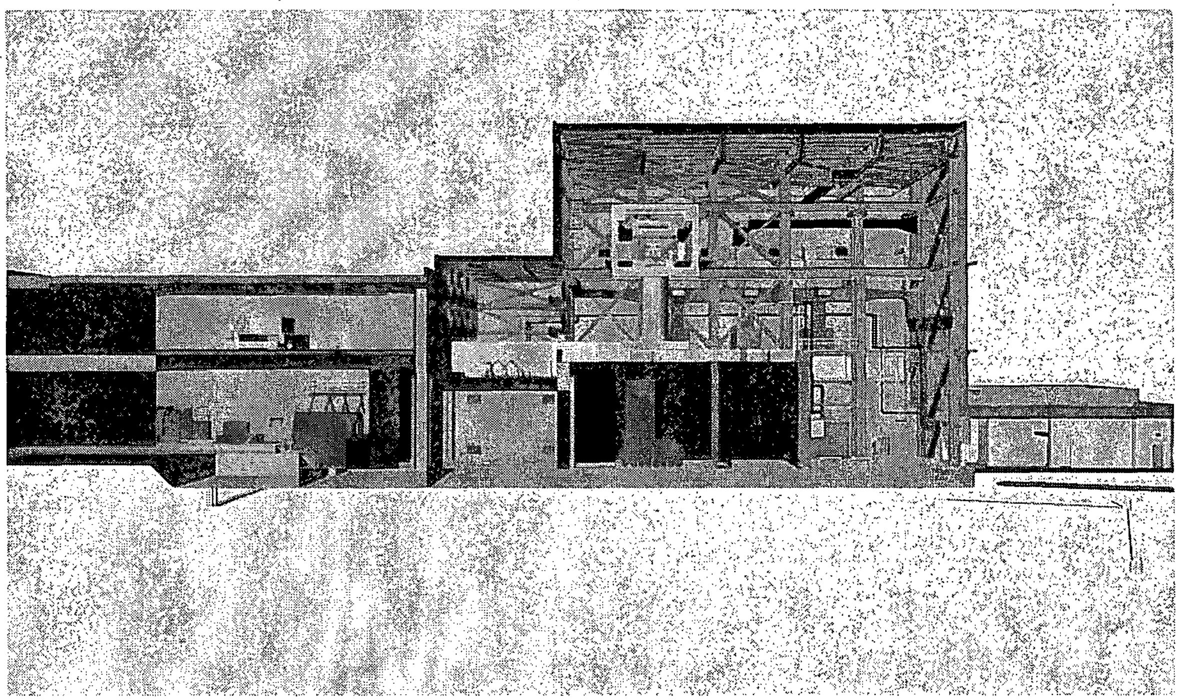
Waste Handling Facilities



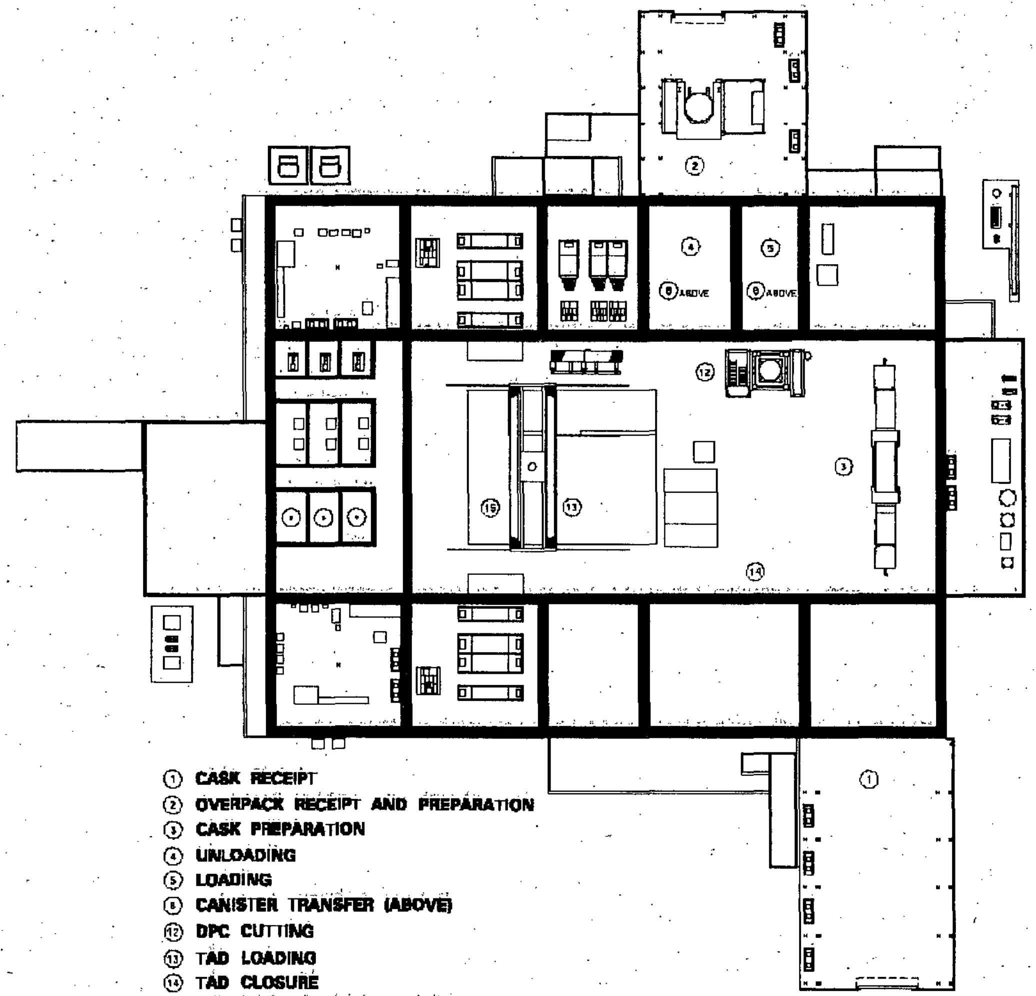
③ CASK PREPARATION
④ UNLOADING
⑤ LOADING
⑥ WP POSITIONING
⑦ WP LOADOUT

GROUND FLOOR PLAN

INITIAL HANDLING FACILITY



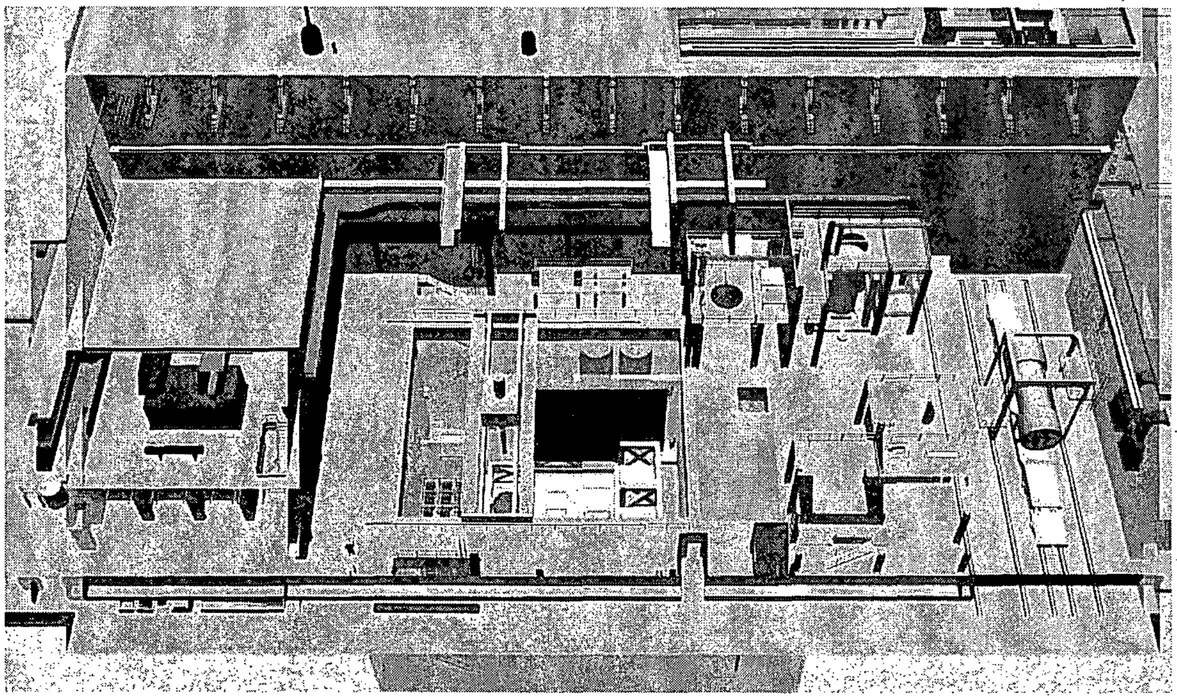
INITIAL HANDLING FACILITY SECTION



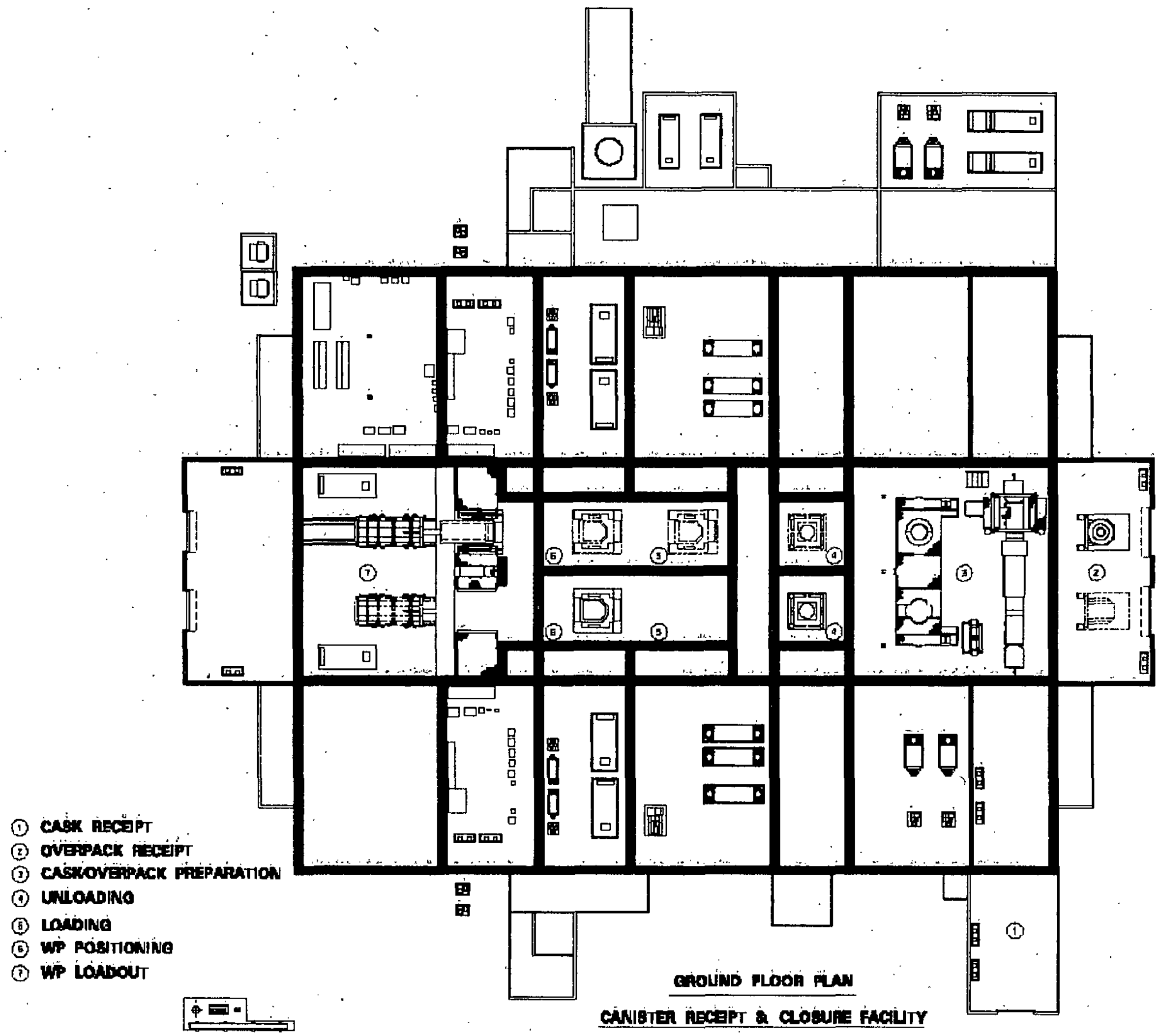
① CASK RECEIPT
② OVERPACK RECEIPT AND PREPARATION
③ CASK PREPARATION
④ UNLOADING
⑤ LOADING
⑥ CANISTER TRANSFER (ABOVE)
⑫ DPC CUTTING
⑬ TAD LOADING
⑭ TAD CLOSURE
⑮ CANISTER TRANSFER (ABOVE)

GROUND FLOOR PLAN

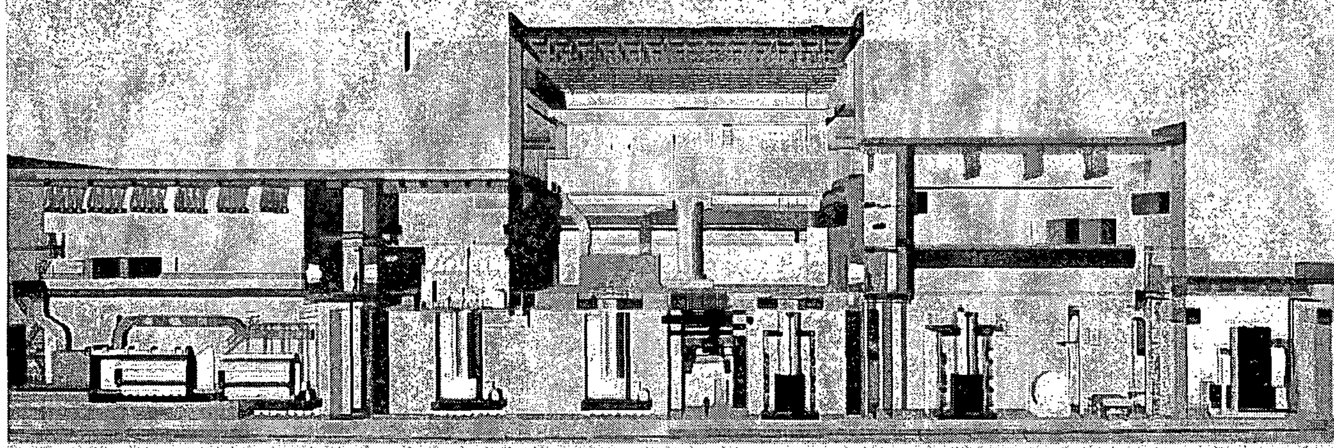
WET HANDLING FACILITY



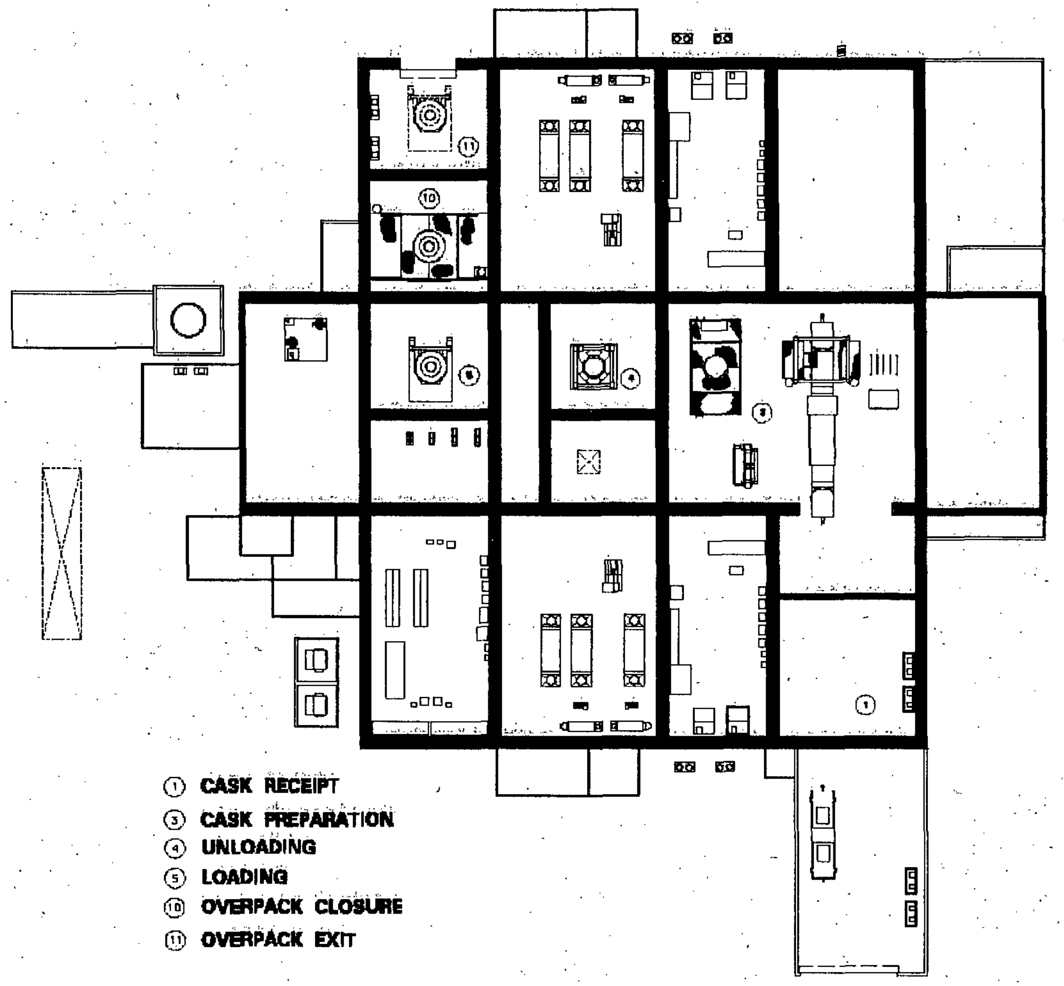
WET HANDLING FACILITY POOL ROOM



① CASK RECEIPT
② OVERPACK RECEIPT
③ CASK/OVERPACK PREPARATION
④ UNLOADING
⑤ LOADING
⑥ WP POSITIONING
⑦ WP LOADOUT
GROUND FLOOR PLAN
CANISTER RECEIPT & CLOSURE FACILITY



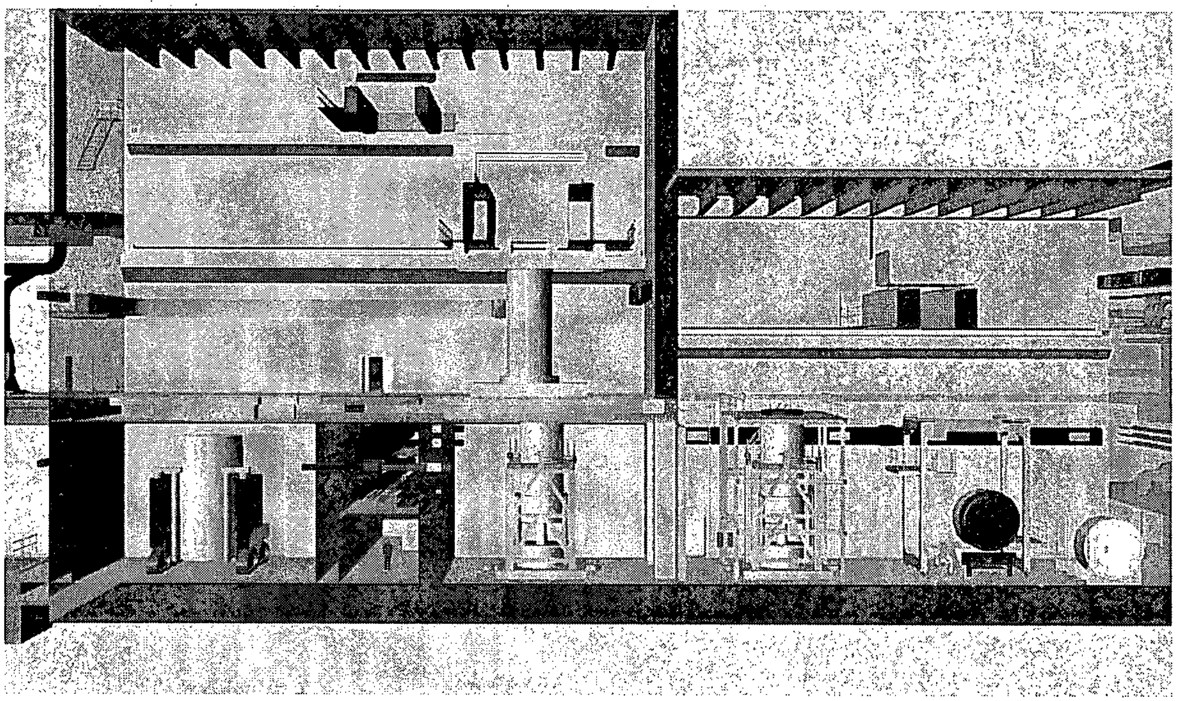
CANISTER RECEIPT AND CLOSURE FACILITY
SECTION



① CASK RECEIPT
③ CASK PREPARATION
④ UNLOADING
⑤ LOADING
⑩ OVERPACK CLOSURE
⑪ OVERPACK EXIT

GROUND FLOOR PLAN

RECEIPT FACILITY

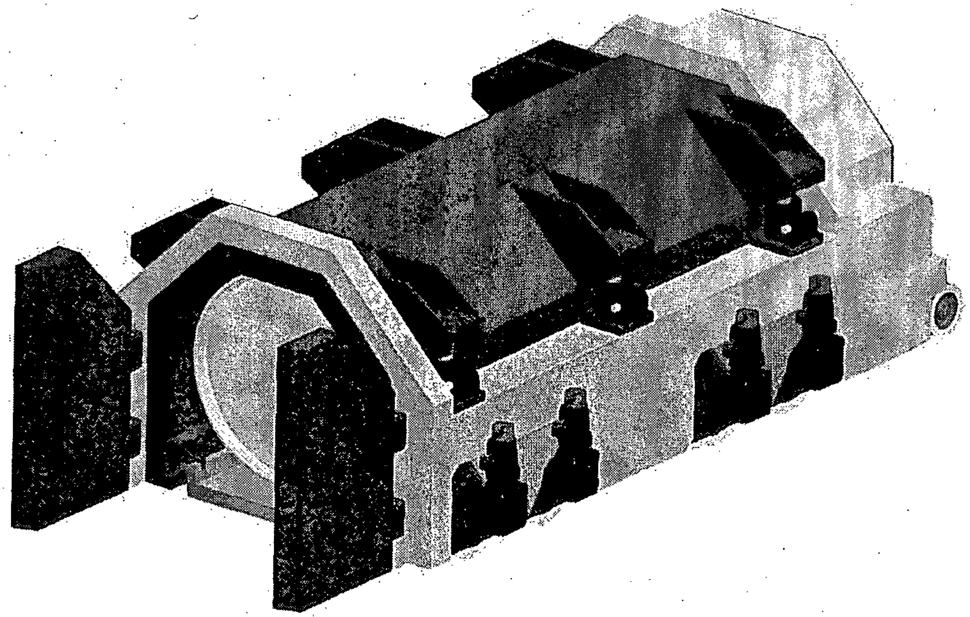


RECEIPT FACILITY SECTION

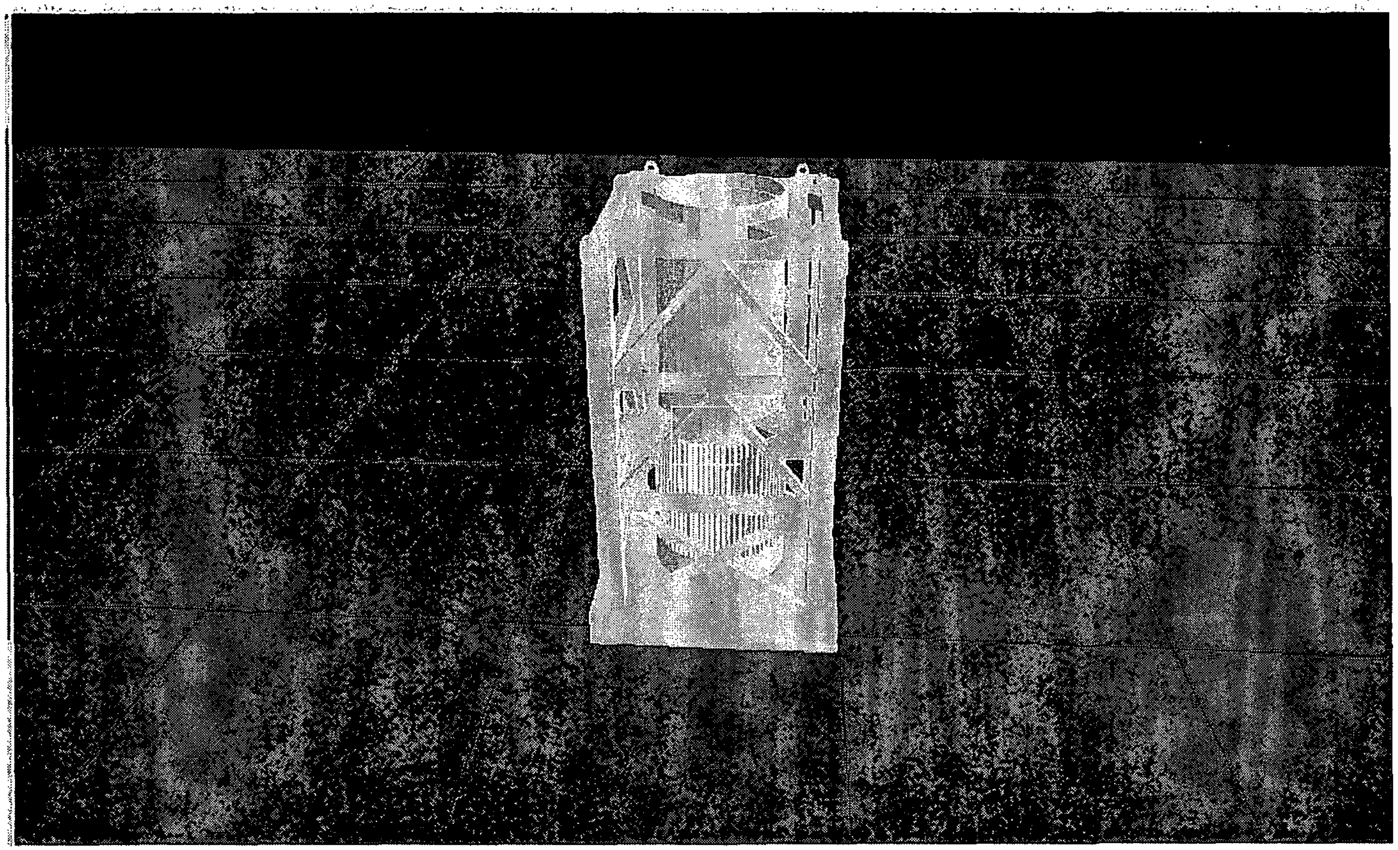
Commonality of Waste Handling Equipment

	Facilities			
	Initial Handling Facility (IHF)	Canister Receipt and Closure Facility (CRCF)	Wet Handling Facility (WHF)	Receipt Facility (RF)
Mechanical Handling Equipment				
Cask Handling Crane	X	X	X	X
Cask Transfer Trolley	X	X	X	X
Canister Transfer Machine	X	X	X	X
Waste PackageTransfer Trolley	X	X		
Transport and Emplacement Vehicle	X	X		
Site Transporter		X	X	X
Spent Fuel Transfer Machine			X	
TAD Closure			X	
DPC Cutting			X	

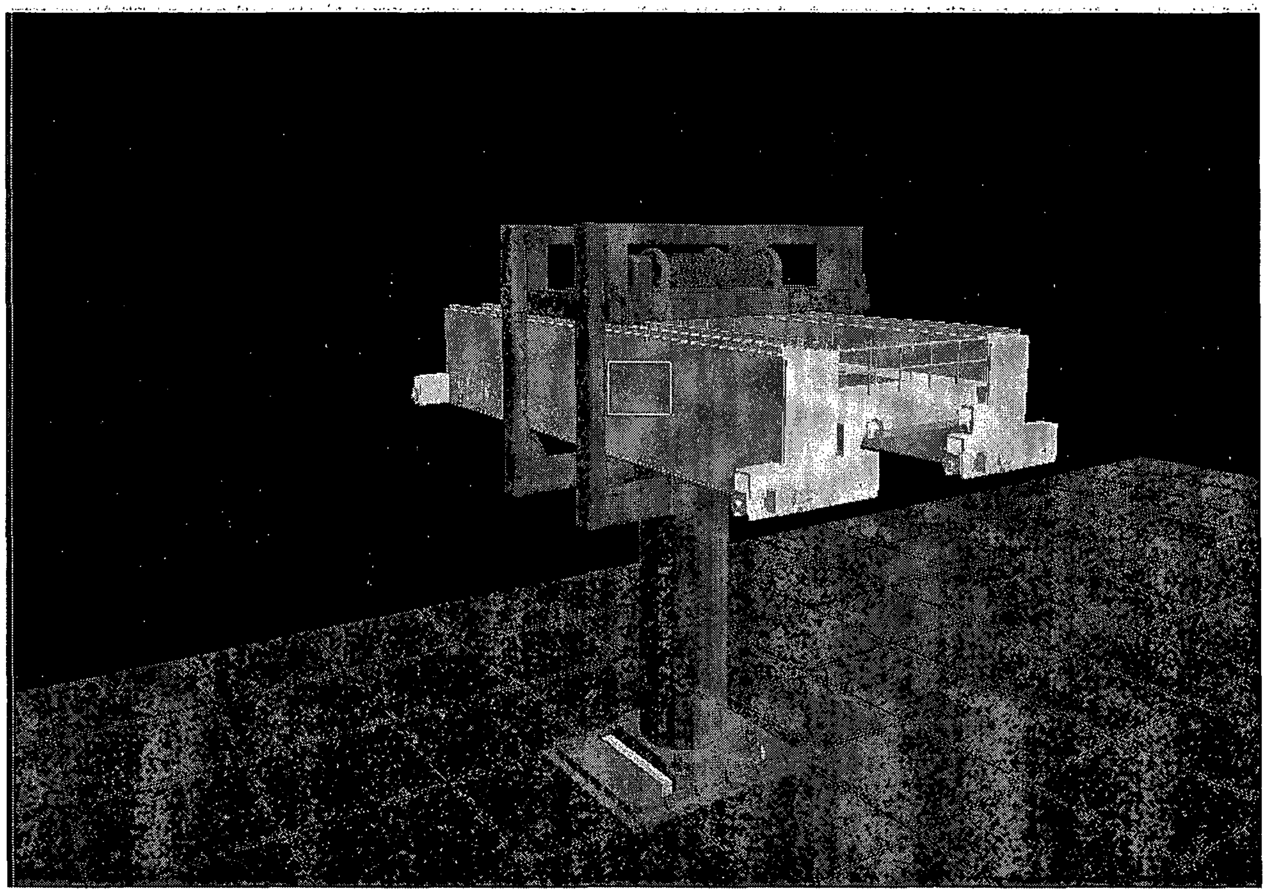
Transport and Emplacement Vehicle



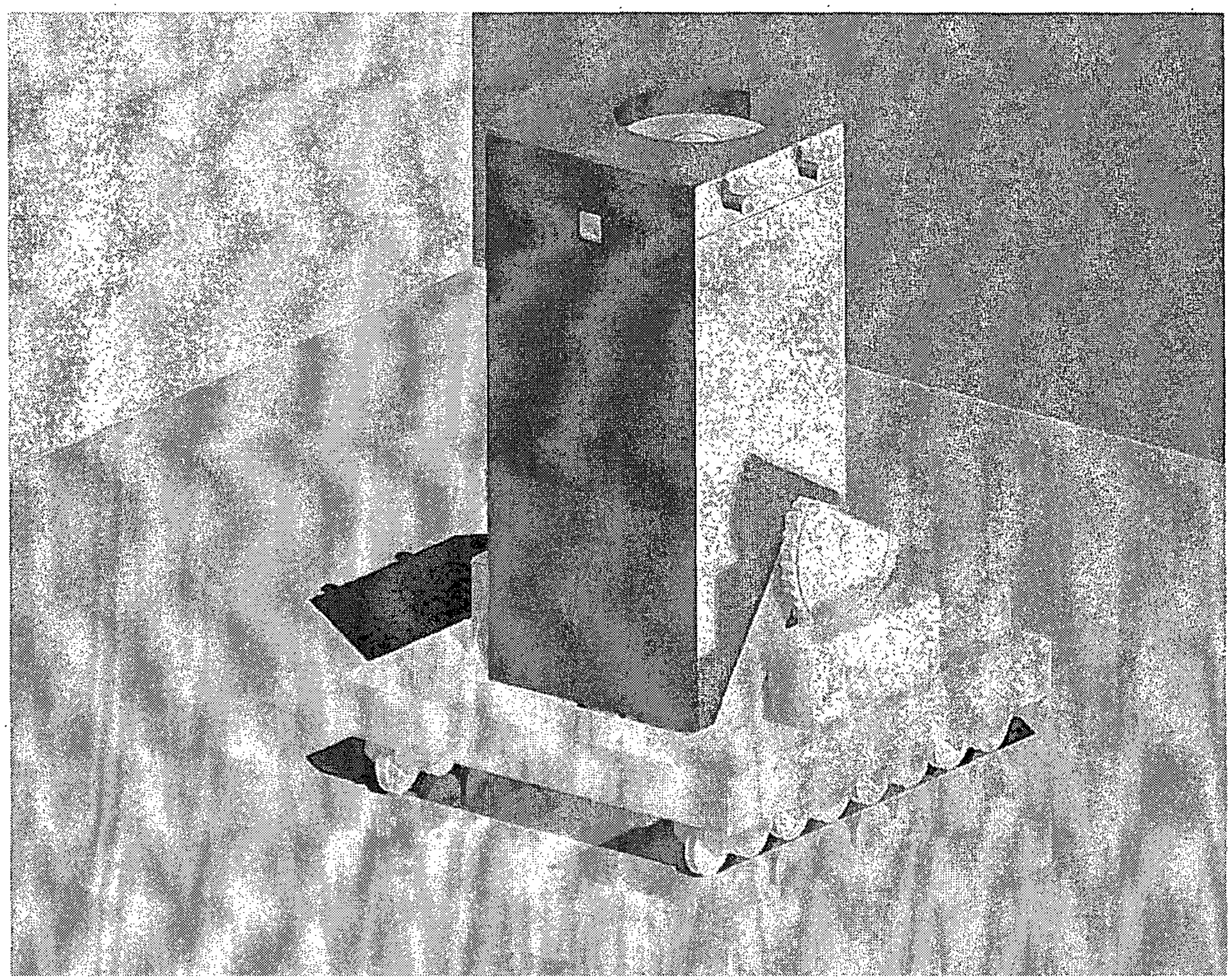
Cask Transfer Trolley



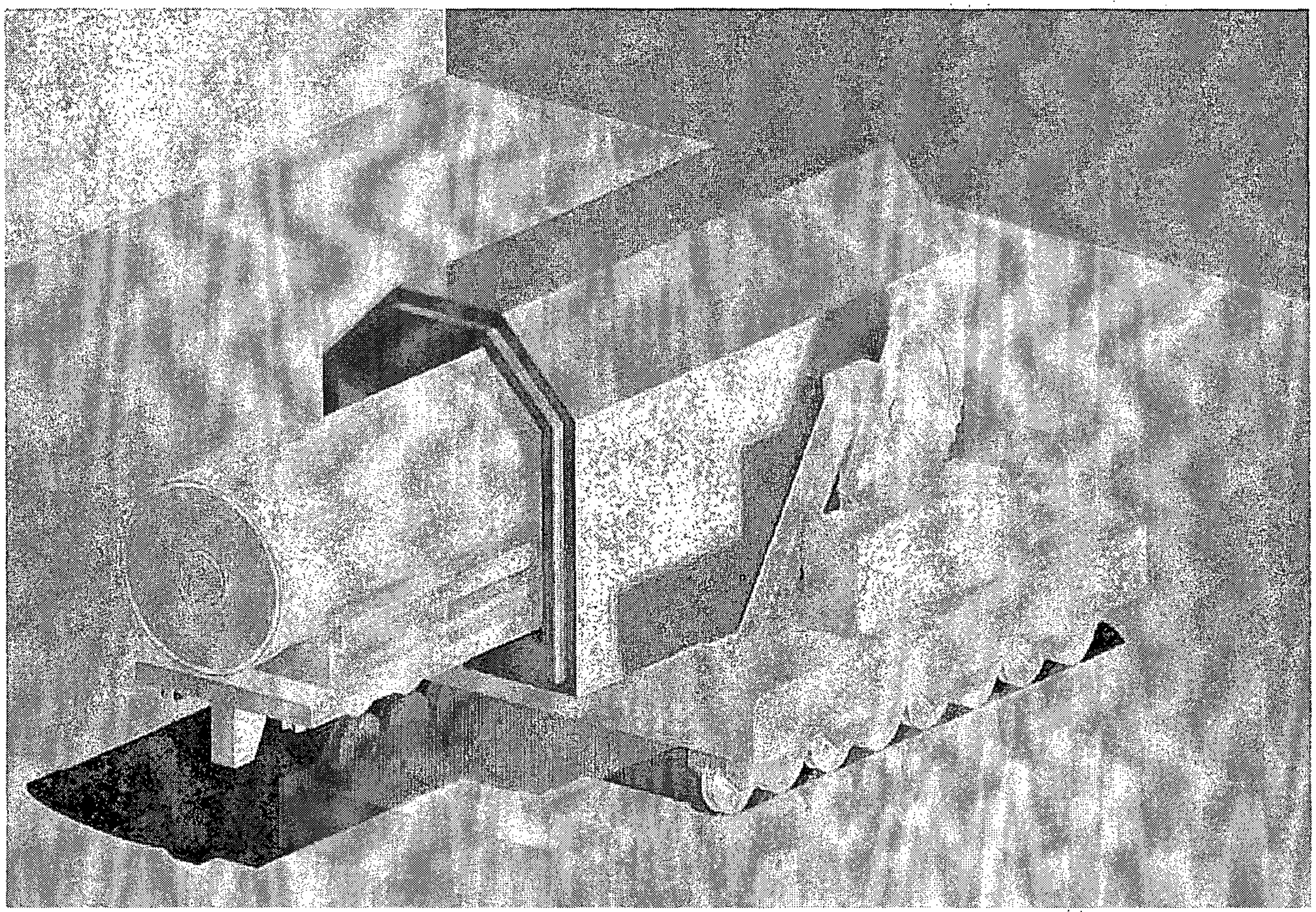
Canister Transfer Machine

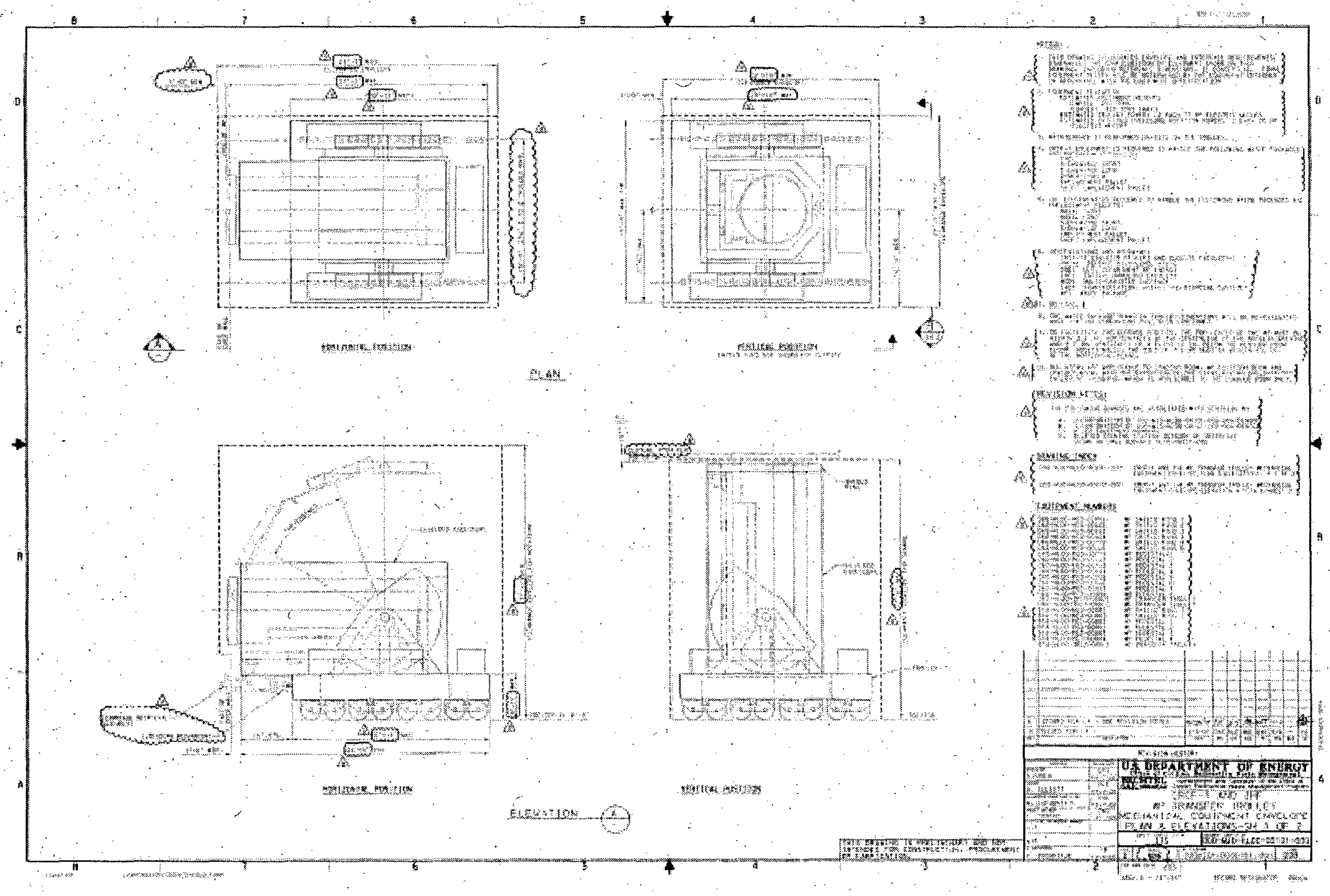


Waste Package Transfer Trolley



Waste Package Transfer Trolley




PLAN
ELEVATION
U.S. DEPARTMENT OF ENERGY

Mechanical Handling Equipment Principal Design Codes

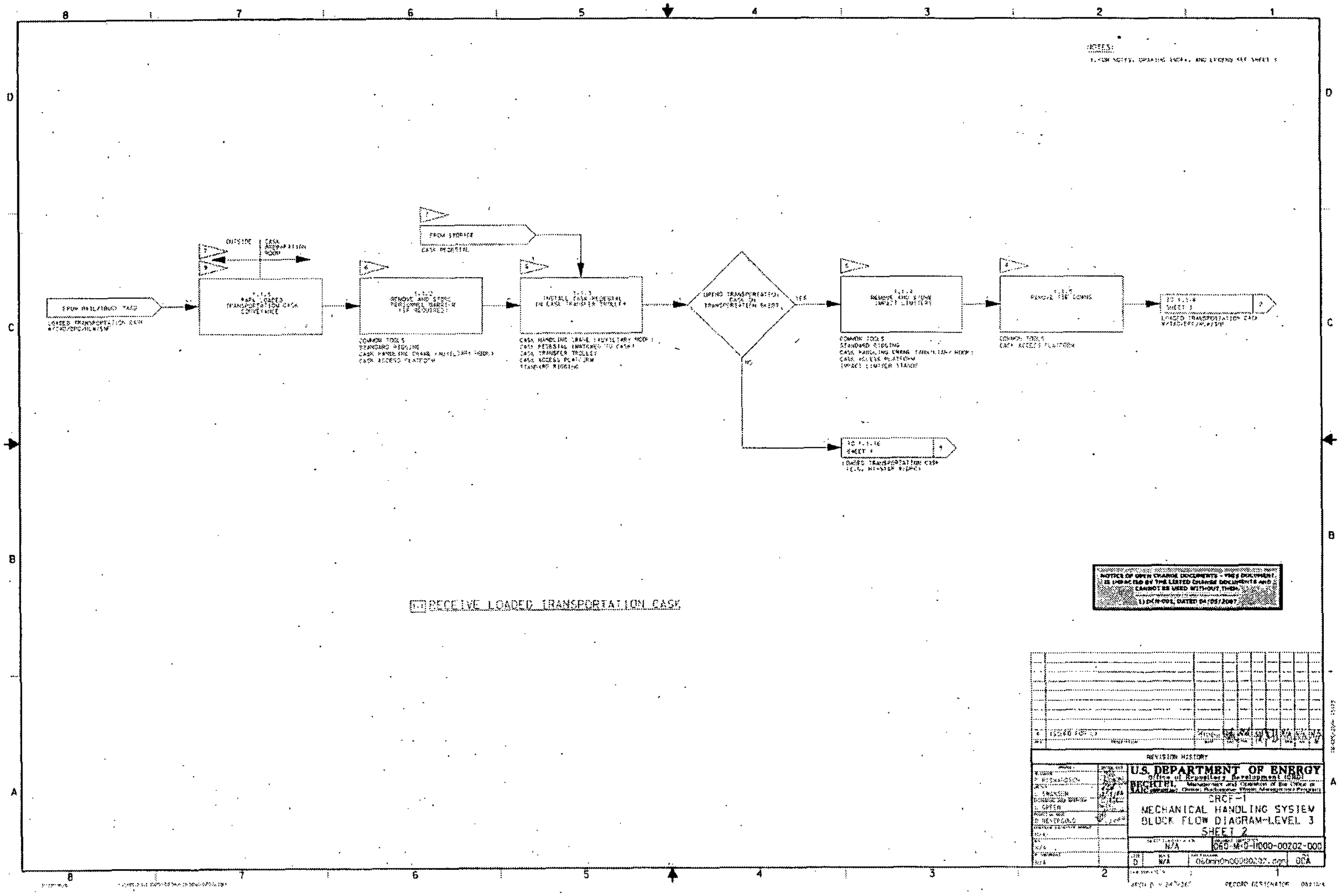
- Cask handling cranes, site transporters, the spent fuel transfer machine, TAD closure equipment and DPC cutting equipment are currently in use at commercial nuclear plants and will be designed to the consensus codes and standards for the type of equipment. For example, the cask handling cranes and spent fuel transfer machine will be designed to ASME NOG-1

Mechanical Handling Equipment Principal Design Codes

- The cask transfer trolley and the waste package transfer trolley do not have a consensus design code and therefore will be designed to the applicable portions of ASME NOG-1 and AISC *Manual of Steel Construction*
- The canister transfer machine is essentially a crane and will be designed to ASME NOG-1
- The transport and emplacement vehicle does not have a consensus design code and therefore will be designed to the applicable portions of ASME NOG-1, and AISC *Manual of Steel Construction*

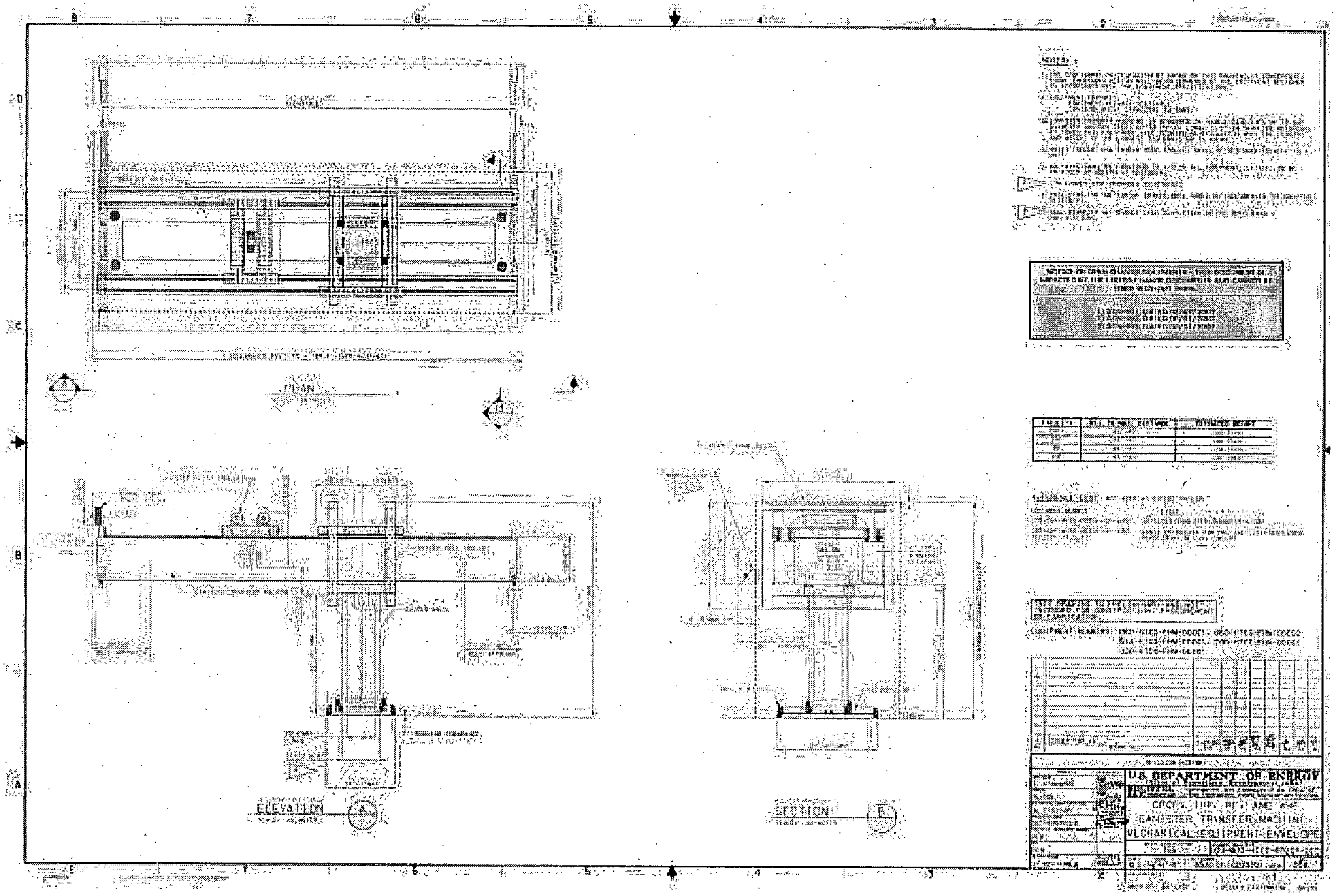
Design Process for ITS Mechanical Handling Equipment

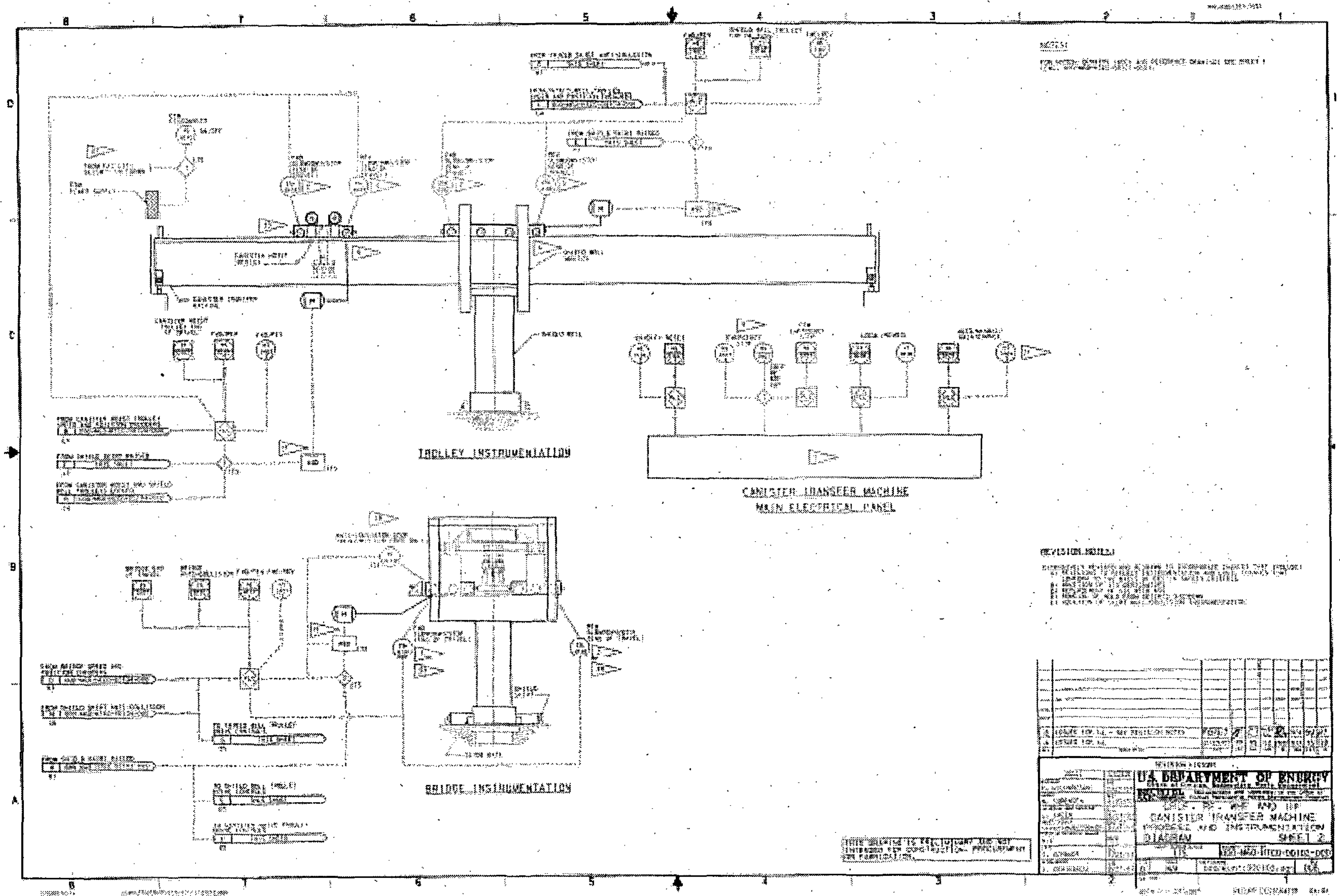
- The Conceptual Design Report (part of the CD-1 package) identified the basic handling concept and arrangement of the nuclear facilities
- The Preliminary Hazards Analysis (also part of the CD-1 package) identified functions of structures, systems and components that will be relied upon to prevent or mitigate event sequences
- A conceptual design for the equipment was developed concurrent with ongoing PCSA assessment of the evolving design
- Block flow diagrams were developed to depict the handling process


RECEIVE LOADED TRANSPORTATION CASK
U.S. DEPARTMENT OF ENERGY
CRCF-1
MECHANICAL HANDLING SYSTEM
BLOCK FLOW DIAGRAM-LEVEL 3
SHEET 2
060-M40-H000-00202-000

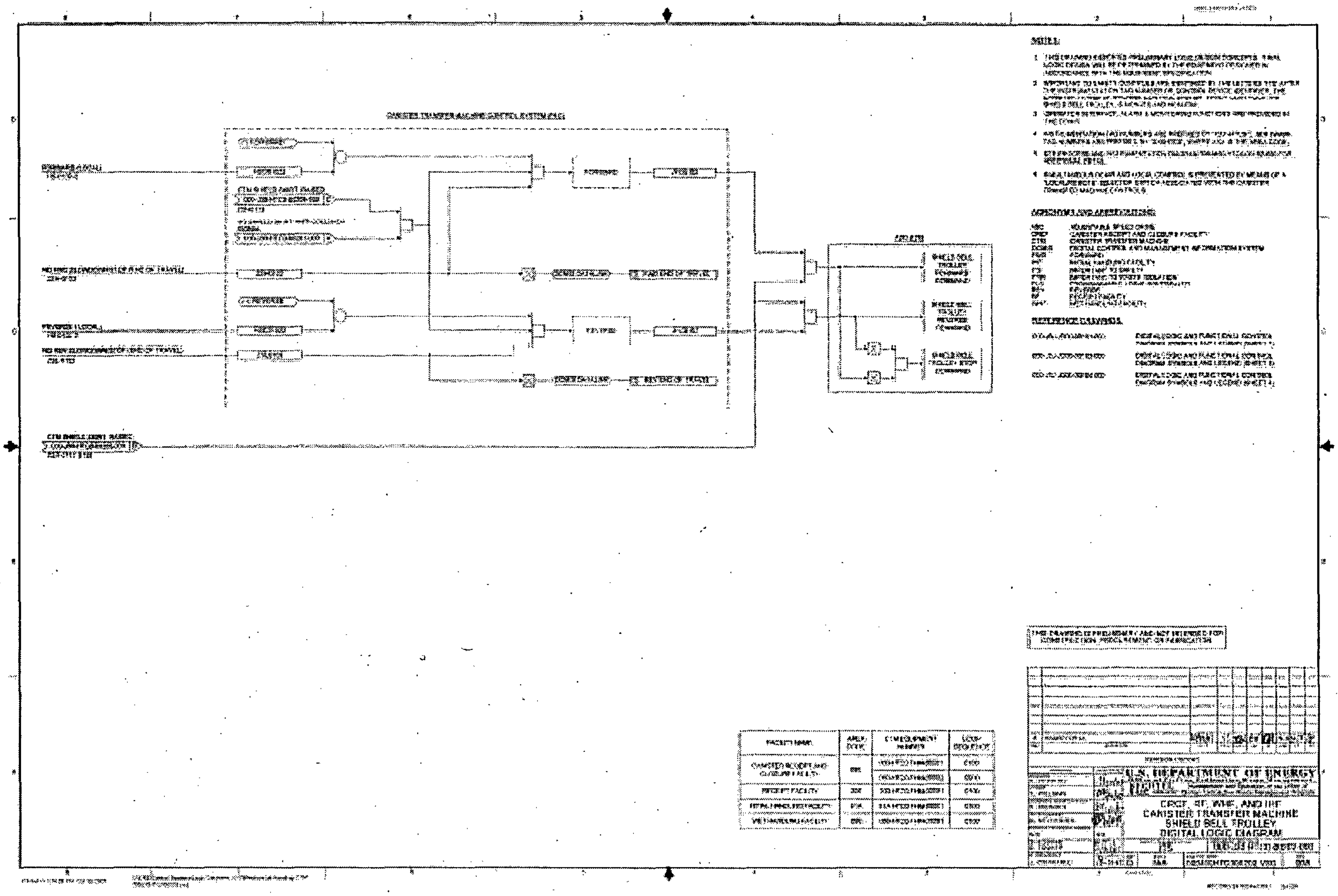
Design Process for ITS Mechanical Handling Equipment

- Mechanical equipment envelope drawings were developed to bound the expected size of the equipment for utilization in the 3-D model development and to identify interface requirements
- Process and instrumentation diagrams were developed to identify the controls, instrumentation and interlocks for the equipment
- Logic diagrams were developed to identify how the controls and interlocks interact





TROLLEY INSTRUMENTATION
CANISTER TRANSFER MACHINE
MAIN ELECTRICAL PANEL
BRIDGE INSTRUMENTATION
REVISION NOTES
U.S. DEPARTMENT OF ENERGY
CANISTER TRANSFER MACHINE
DIAGRAM
SHEET 2


U.S. DEPARTMENT OF ENERGY
CRCF, RF, WHF, AND IHF
CANISTER TRANSFER MACHINE
SHIELD BELL TROLLEY
DIGITAL LOGIC DIAGRAM

Design Process for ITS Mechanical Handling Equipment

- A mechanical handling design report was developed for the conceptual design to demonstrate that the equipment can be expected to perform the functions relied upon by the preclosure safety analysis
- Fragility analyses and fault trees are being developed for the conceptual design to demonstrate the expected reliability of the equipment meets the reliability used in the preclosure safety analysis
- A performance specification will be prepared to procure the equipment
- The selected vendor will prepare the detail design of the equipment including analyses to confirm the equipment is bounded by the parameters used in the preclosure safety analysis

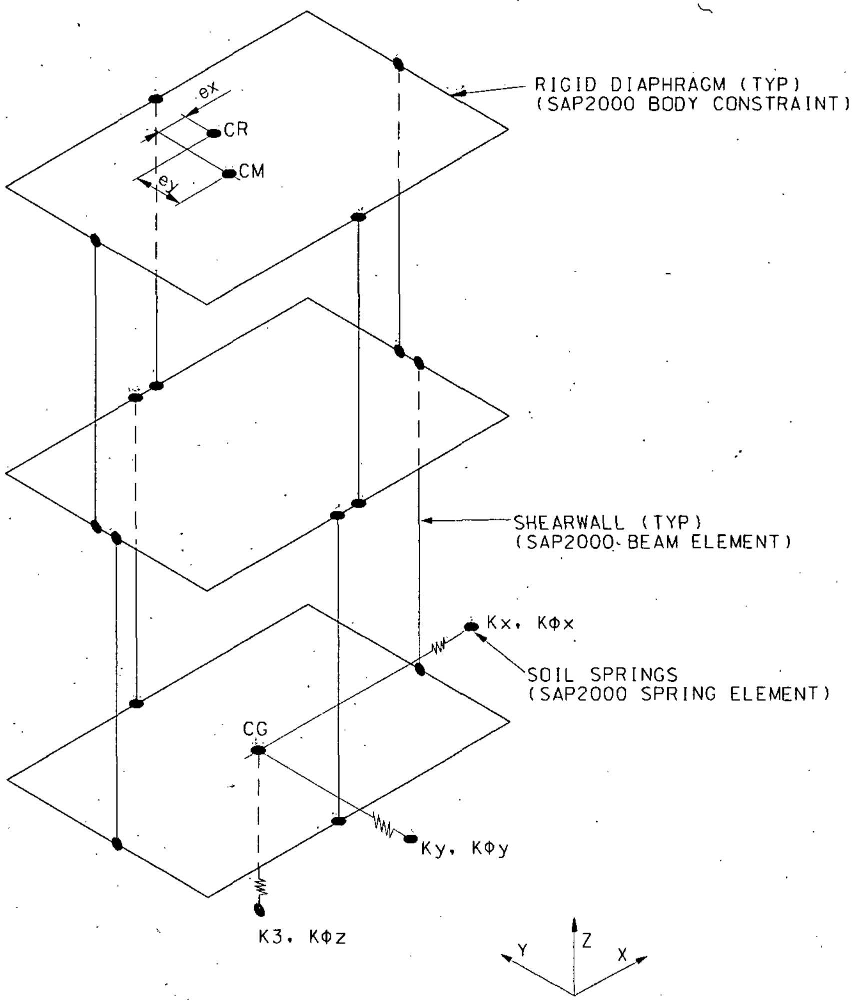
Structural Principal Design Codes

- ASCE Standard 4-98: *Seismic Analysis of Nuclear Structures*
- ACI-349-01: *Nuclear Safety Related Concrete Structures*
- ANSI/AISC N-690-1994: *Steel Safety Related Structures for Nuclear Facilities*

Structural Design Process

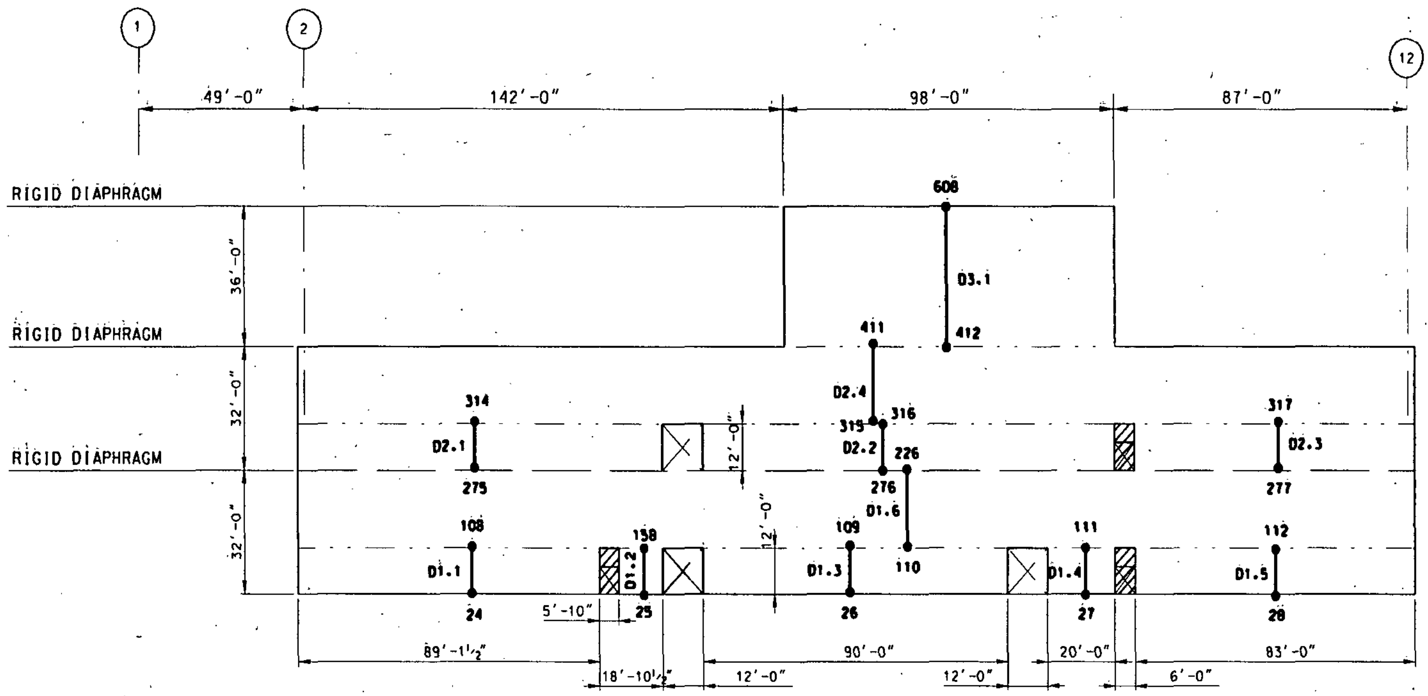
- The facility configuration is set, wall and slab thicknesses have been estimated, and major equipment loads have been identified
- A lumped mass multiple stick model with appropriate soil springs and damping values has been developed and analyzed with appropriate load cases
- The ITS surface structures, systems and components are designed for the 2,000 year return period earthquake (5x10-4 MAPE) with a horizontal PGA of 0.58g and vertical PGA of 0.52g
- Results of the lumped mass multiple stick model analysis confirm the concrete wall and slab thicknesses and determine the reinforcing steel requirements
- Additional analyses of the lumped mass multiple stick model are being performed to determine a fragility curve to demonstrate design margin to evaluate the facility against beyond design basis ground motion earthquakes
- A seismic hazards curve has been developed and is combined with the facility fragility curves to demonstrate the ITS structures can perform their ITS functions for all Category 1 and 2 event sequences

Lumped Mass Multiple Stick Model Schematic



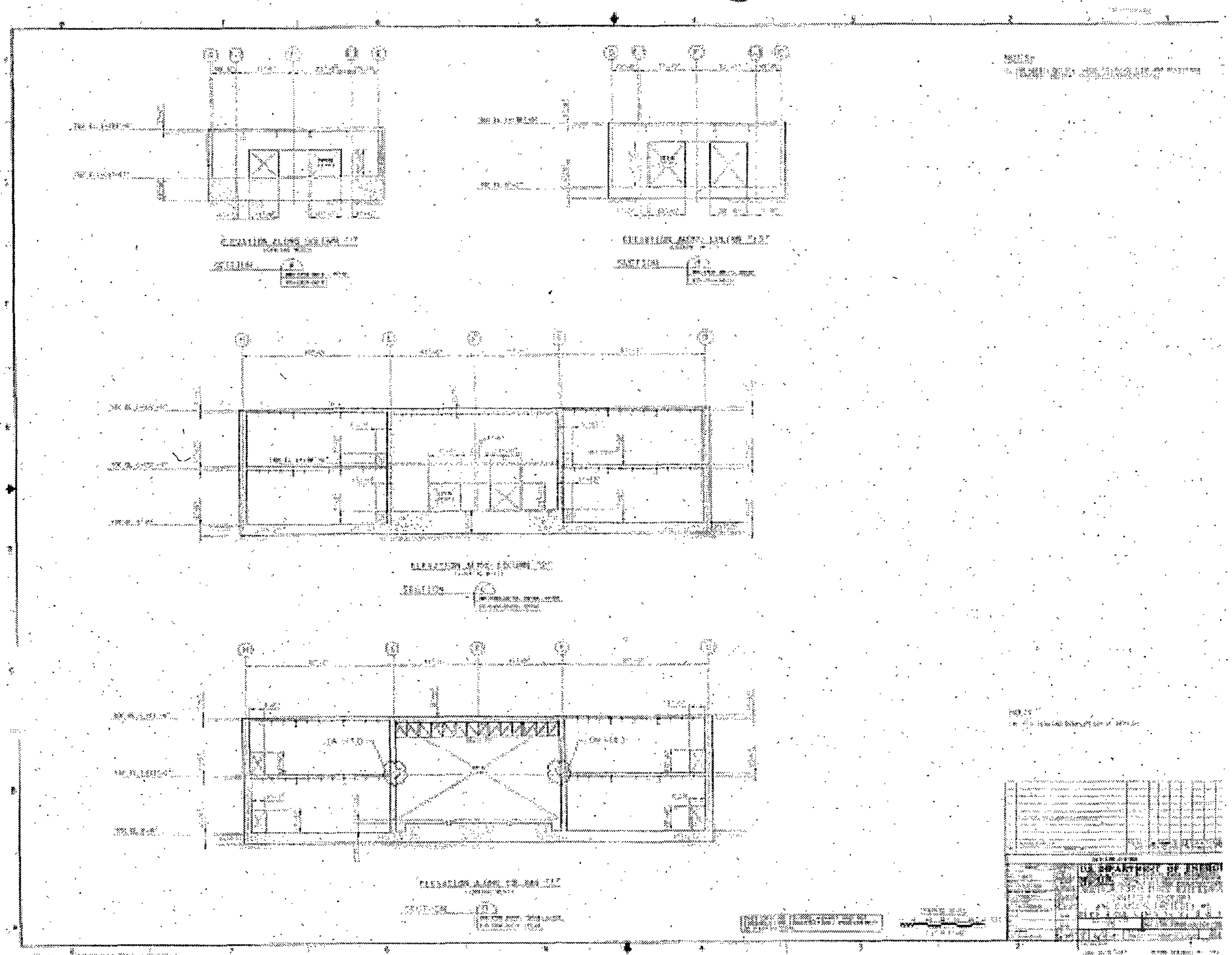
CR:Center of Rigidity
CM:Center of Mass
CG:Center of Gravity

Typical Shear Wall
Stick Element Representation

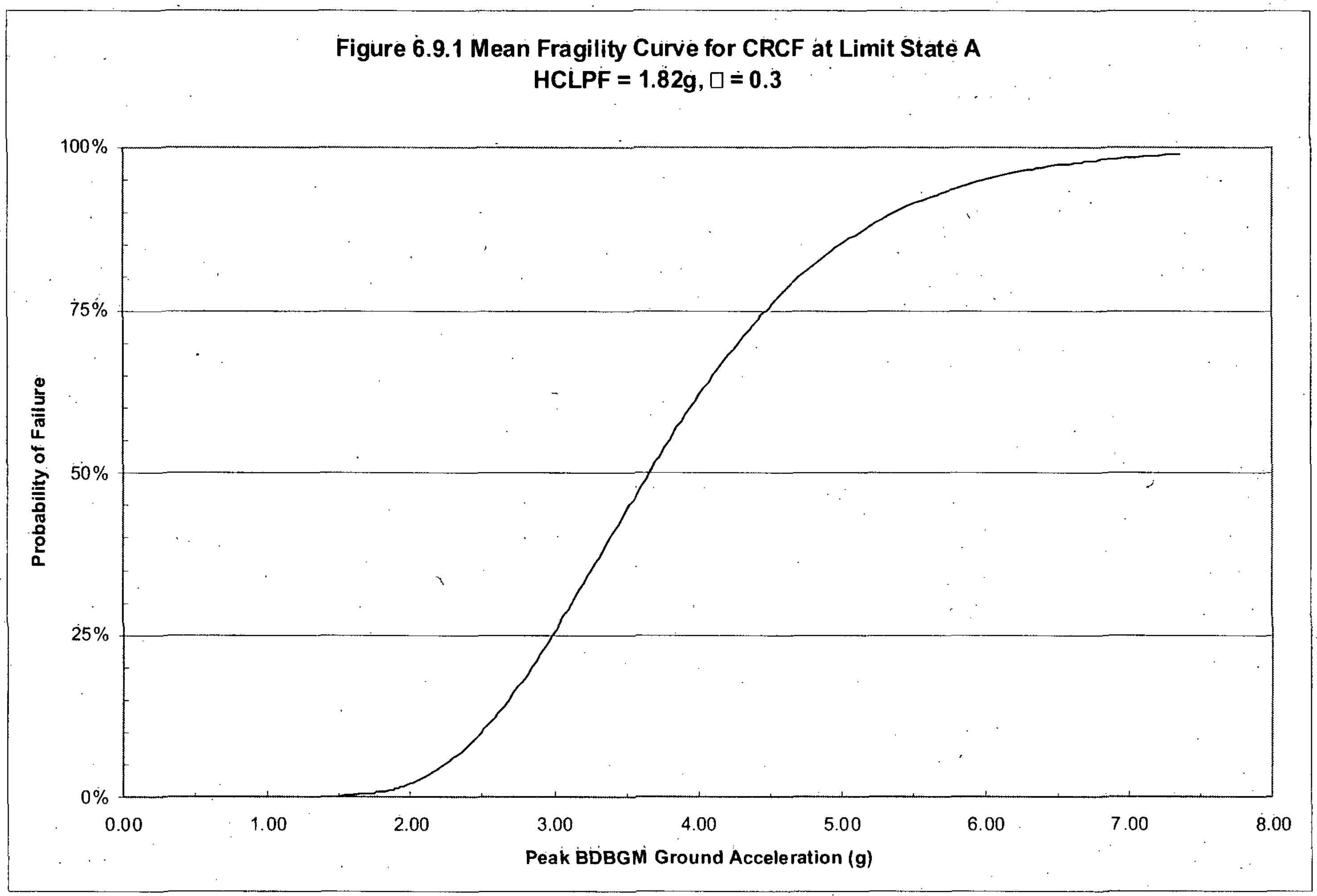


TYPICAL WALL ELEVATION

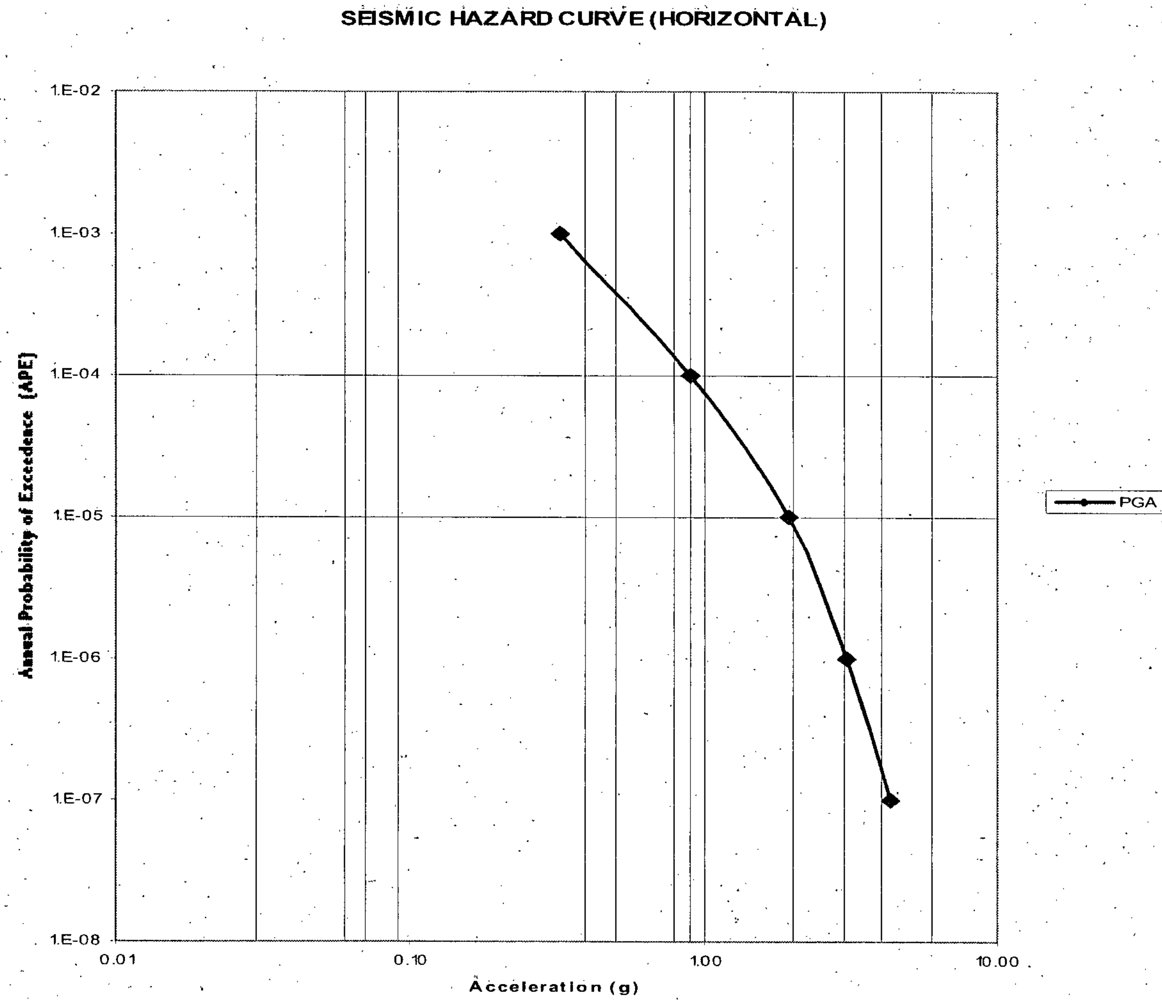
CRCF Concrete Forming Document



Typical Fragility Curve



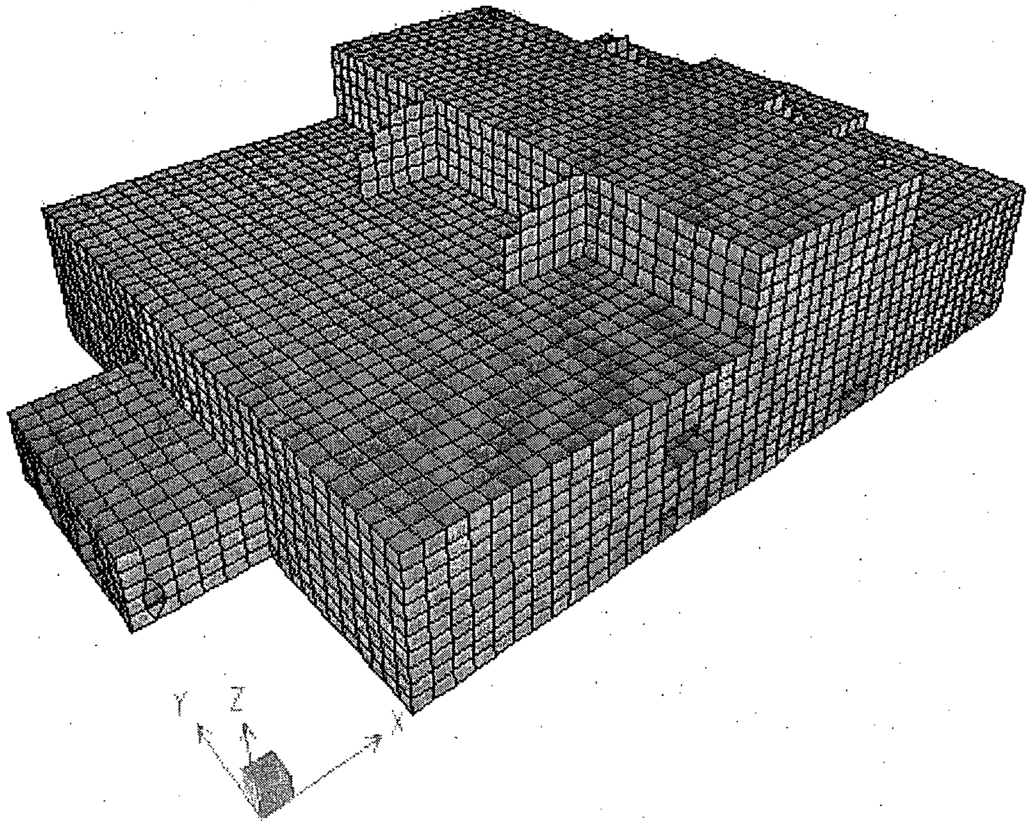
Preliminary Seismic Hazards Curve



Structural Design Process

- Following the demonstration of the adequacy of the structural design, additional modeling of the ITS structures is performed
- A finite element model of each ITS facility is developed including soil-structure interaction generated using SASSI software
- The model will be used as a tool to complete the detailed design of the facilities

CRCF Finite Element Model



Design and PCSA Status

- A total of 1,318 products (calculations, drawings, and reports) are being developed by design and PCSA to support the 71 sections of the License Application
- These products provide a level of detail that is sufficient to demonstrate the safety case for the repository and to allow the NRC to complete its safety evaluation for the repository
- More than 95 percent of the design and PCSA products have been completed to date
- Design products will be completed by December 2007
- PCSA products will be completed by February 2008