

COPY OF TRANSCRIPT

DOCKETED
USNRC

UNITED STATES OF AMERICA

January 10, 2003 (3 16PM)

NUCLEAR REGULATORY COMMISSION

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

Before the Atomic Safety and Licensing Board

In the Matter of)	Docket No. 72-22
)	ASLPB No. 97-732-02-ISFSI
PRIVATE FUEL STORAGE)	
L.L.C.)	DEPOSITION OF:
)	
(Private Fuel Storage)	<u>DR. MOHSIN R. KHAN</u>
Facility))	
)	
_____)	(Utah Contention L/QQ)

Tuesday, March 5, 2002 - 12:10 p.m.

Location: Office of Parsons, Behle & Latimer
201 S. Main, Suite 1800
Salt Lake City, Utah

Reporter: Vicky McDaniel
Notary Public in and for the State of Utah

Template = SECY-028

SECY-02



50 South Main, Suite 920
Salt Lake City, Utah 84144

AT&T CLEAR REGULATORY COMMISSION

Docket No. _____ Official Exh. No. PP
In the matter of PES
Staff _____ IDENTIFIED
Applicant RECEIVED
Intervenor _____ REJECTED _____
Other _____ WITHDRAWN _____
DATE 4/30/02 Witness _____
Clerk pmf

1 Q. When you say a correct solution --

2 A. For the input parameters that you use.

3 Q. I guess it means they gave you the same
4 solution?

5 A. That's right, for the parameters that you
6 use.

7 Q. And suppose you input the wrong parameter in
8 the SAP -- in both codes, for example.

9 A. Then you will have both wrong results, sure.
10 But for same, identical input, both give identical
11 solution. For those parameters, it's benchmark.

12 Q. So if the input's wrong, the output's wrong
13 on both of them?

14 A. Exactly.

15 Q. Garbage in, garbage out?

16 A. Exactly, sure.

17 Q. Now, in paragraph 62 you describe ANSYS as
18 a, I believe another general purpose program?

19 A. Yes.

20 Q. I take it by use of the word "other" that
21 SAP2000 is also a general purpose structural analysis
22 program?

23 A. Yes.

24 Q. And what do you mean by a general purpose
25 code?

1 drop the cask and it's 5 percent damping. How far
2 should that cask be going back up?

3 A. I mean, I don't know how much it will bounce
4 back, but --

5 Q. Can you calculate, if you know the damping
6 is 5 percent, you drop a cask from 10 inches and the
7 damping is 5 percent, can you tell me -- can you
8 calculate how much the cask will bounce back up?

9 A. I'm sure, given all the programs, one could
10 find. But to me is, again, when you are dropping this
11 cask, there is no -- there is no damping associated to
12 the cask when it touches the surface. At that time
13 energy start dissipating, and the stiffness of the
14 restraining object is the one that's absorbing most of
15 the energy, okay? It is not the damping.

16 So if you are assuming that the damping is a
17 significant contributor, you have to quantify it.
18 You're taking two components which are resisting the
19 motion. We don't know what the damping is. All we
20 know is, for an object that deforms significantly,
21 depending on the energy level, you could assume in that
22 direction. But in the upward direction you have no --
23 you have no stiffness, so what kind of damping you're
24 going to have in the upward direction.

25 Q. I thought it was only damping that

1 dissipated the energy. Am I wrong there?

2 A. I believe that there are two mechanisms
3 which absorbs energy, absorption of energy. Your
4 spring is absorbing energy to reduce the motion. Okay?
5 When you have pure sliding, your sliding is actually
6 dissipating energy and reducing the motion. When you
7 have zero friction you can slide a long distance.
8 Okay? When you have -- so in a vertical direction your
9 spring is providing similar kind of behavior as your
10 friction is providing in an unanchored system when it's
11 moving on a horizontal surface.

12 Q. So you're saying that when I drop something,
13 it's not the damping that's dissipating the energy but
14 it's the spring on the ground absorbing the energy?

15 A. A significant amount of energy is absorbed
16 by the crushing of the springs that you have.

17 Q. Well, I take a spring, okay. Take a spring.
18 I push it down. Doesn't the spring push back up at me?

19 A. That's your spring action, but that's not
20 the damping action. You could take this thing and
21 crush it, okay? It's not the damping that has stopped
22 it. It is the stiffness at the start of the motion.

23 Q. But doesn't the spring force back up again,
24 or forces the cask back up again?

25 A. The spring will force it back again.

1 Q. And there's basically some damping
2 associated with the movement of the spring in that
3 sense, but the spring doesn't go -- doesn't force the
4 cask back up as high as it was before?

5 A. It's only based on a small amount of
6 damping. We don't know what that will be. It depends
7 on the level of energy that you have. It depends on
8 level of stress you have in the system. If you have a
9 zero stress, you will have no -- very small damping.

10 Q. In your model, okay -- what did you say
11 about zero stress again, now, just a second ago? Can
12 you read that back?

13 (The record was read as follows: "It's only based
14 on a small amount of damping. We don't know what that
15 will be. It depends on the level of energy that you
16 have. It depends on level of stress you have in the
17 system. If you have a zero stress, you will have no --
18 very small damping.")

19 A. See, the Reg Guide I believe 161 defines for
20 various level of earthquake for the kind of structures
21 that you have which are going through certain
22 deformation what kind of damping you should have. So
23 if your structure is going through a state of
24 deformation that you expect it's going to have, you
25 associate damping with those values. And that's why,

1 you know, if you have an anchored cask where you are
2 going to see high level of stresses in the anchored
3 board or a structural member, you use 4 to 5 percent
4 damping. For low-level earthquake where your stress
5 level in the component are smaller, you use low damping
6 values. And that's the basis of damping.

7 Q. Are you familiar with the term "impact
8 damping"?

9 A. Yes.

10 Q. What does that mean?

11 A. The damping that could be associated during
12 an impact. And that's experimentally determined, by
13 the way.

14 Q. And so you have the cask impacting the pad;
15 there would be impact damping between the cask and the
16 pad?

17 A. Yeah. And that would depend on the level of
18 impact, type of impact. It's a function of the
19 amplitude.

20 Q. Do you account for impact damping in your
21 modeling?

22 A. There is some small amount of damping equal
23 to what I reported in this calculation that's for every
24 structural element that's associated.

25 Q. In your model does the spring element

1 dissipate any energy?

2 A. Every element is used to deform, and
3 therefore it absorbs energy or interacts against the
4 motion.

5 Q. It's appropriate to have the spring to
6 absorb energy, then?

7 A. Sure. We use spring all the time.

8 Q. Going back to my example of the ball. If
9 you drop the ball from a foot or ten inches, whatever
10 the case may be, and if you have no damping, doesn't
11 the ball bounce back as high as it was before?

12 A. It's a coefficient of restitution depending
13 on how the ball is -- it also depends on the gravity is
14 pulling, you know. Let's say we can jump 50 feet, but
15 we will always come back to earth because the gravity's
16 always pulling you down. So it has nothing to do with
17 damping. You will always be on the ground.

18 Q. But if you have no damping and you drop the
19 ball at a certain force, it will go back up the same
20 distance that you drop it from?

21 A. Well, if you don't have the absorption of
22 energy as it bounces, if you have a perfectly rigid
23 surface, infinitely rigid surfaces, you could say the
24 coefficient of restitution between the two is such that
25 you have no dissipation of energy. But you still have

1 the gravitational forces acting against an object, and
2 it will always try to bring it back to the earth.

3 Q. You mentioned something, restitution?

4 A. Coefficient of restitution.

5 Q. What's the coefficient of restitution?

6 A. I think it's the -- as the -- when you drop
7 the ball, the ratio between the force impacted and the
8 reactive force, it gives you, whether it's a perfectly
9 rigid bounce or it's an elastic bounce.

10 Q. And if you have a perfectly elastic surface,
11 what happens then?

12 A. Well, perfect elastic surface, it should
13 bounce back. But there is no perfectly elastic
14 surface. There is no such thing as perfectly elastic
15 and there is no such thing as perfectly plastic.
16 Everything on this earth deforms. Okay? So a ball
17 will always go back to the ground after a certain
18 bounce.

19 Q. Now, the coefficient of restitution, is that
20 a function of damping or is that a function of
21 something else in addition to damping?

22 A. It could be function of whole bunch of
23 phenomena surrounding when the ball falls. Could be,
24 if there's a high wind, that could stop it. If it's in
25 a vacuum, you may have a different thing. Surrounding

1 does affect what happens to the ball.

2 Q. Can you measure the loss of energy by the
3 percent of coefficient of restitution? In other words,
4 if something goes down and it comes up only so high, it
5 means it's lost a certain amount of energy, correct?

6 A. But see, the question is, which is the
7 absorbing phenomenon? Is your energy being absorbed by
8 the surface that deforms it, or is it something else?
9 And I think it's anybody's guess. It could be the
10 elastic surface is absorbing some of the -- as it
11 crushes, it absorbs energy. So it could be a
12 combination. I can't say for sure.

13 Q. Suppose I throw a ball. Give you another
14 example. Suppose I throw a ball, horizontal motion.
15 Suppose I throw a ball against a wall and it comes back
16 a certain amount, okay? And it doesn't come back all
17 the way. What absorbs some of the energy? Is it the
18 spring or damping or what?

19 A. Like I said, it could be a combination.
20 Could be anybody's guess. It could be air resistance,
21 actually.

22 Q. What studies have you done with respect to
23 impact damping percentage, coefficient of restitution?

24 A. We never -- we never relied upon impact
25 damping values.

1 Q. So you didn't do any work on impact damping
2 values?

3 A. In our judgment we felt that the duration of
4 impacts were too short to include those damping, so we
5 used simply pure stiffness values. For local element
6 where it impacts, for that element it was purely
7 elastic collision and no damping were allowed.

8 Q. So no damping?

9 A. For that element.

10 Q. So you didn't study impact damping or
11 analyze it?

12 A. No.

13 Q. We've used a couple terms, okay, energy
14 absorption and energy dissipation. Used it in
15 connection with different elements -- damping, spring,
16 etc. Could you define what you mean by energy
17 dissipation, first of all?

18 A. That's a loss of energy.

19 Q. A loss of energy?

20 A. Yes, during friction phenomenon.

21 Q. During friction?

22 A. Yeah, loss.

23 Q. Excuse me?

24 A. During friction to surface.

25 Q. Can it be loss of energy other than

1 friction?

2 A. Sure.

3 Q. So it's a loss of energy from an object?

4 A. Yeah. You could have damping in the system,
5 you could have a crushing in the system, you could have
6 a permanent deformation in the system.

7 Q. And how do you define energy absorption?

8 A. Energy absorption?

9 Q. Yeah.

10 A. You apply force and something deforms, and
11 it does not respond. It captures that energy and
12 retains it. You have loss of energy. That's how you
13 absorb the energy.

14 Q. Suppose I crush a Coke can, okay? Is that
15 absorption or dissipation?

16 A. It's an absorption. This is absorption.

17 Q. Does a linear elastic spring dissipate
18 energy, or does it only absorb energy?

19 A. Absorbs energy.

20 Q. It doesn't dissipate?

21 A. No, it does not dissipate. The damping
22 associated with that elastic motion would dissipate
23 energy. So a spring always when it is associated with
24 a damper, that's why they call it spring damper
25 element. A damper basically dissipates the energy

1 using the damping effect.

2 When you have an equation of motion you have
3 three components to it, and they all are in equal
4 degree. You have inertia, you have forces which are a
5 function to velocity, and then you have forces which
6 are a function to stiffness. When you add them
7 together, that forms the equilibrium of the equation.
8 And then you may also have in it frictional phenomena
9 as an item, friction effect.

10 Q. One last question in this area. It's your
11 position that 5 percent is too much, whether you view
12 it as energy dissipation by damping or energy
13 absorption by the spring. Is that correct?

14 A. That is my judgment.

15 Q. So it's not a matter of how you define it?

16 A. Yeah.

17 Q. You're claiming that there's no loss of
18 energy that's sufficient -- equal to 5 percent?

19 A. Yeah, for this -- when you're doing this
20 sliding and taking friction into consideration, using 5
21 percent -- equivalent to 5 percent damping for those
22 gap elements is high.

23 Q. And for that you would include any energy
24 absorption by the spring itself?

25 A. Yeah, because you are absorbing all the

1 energy through friction anyways, and I would use a very
2 small damping.

3 Q. If you have vertical motion up and down,
4 you're basically saying it's all through friction?

5 A. No. There's no friction when it's vertical
6 motion up and down.

7 Q. Isn't that a part of the modeling here?

8 A. If you model as it as a 3-D model, then
9 friction is dominating your phenomena. Okay? What is
10 the most dominant phenomenon, okay? If your most
11 dominant phenomenon is your sliding, then the friction
12 is the one that's taking care of all the energy in the
13 system.

14 (Recess from 4:33 to 4:45 p.m.)

15 Q. I if could turn to some of the results you
16 have in your table in the report. First of all, I'd
17 just like to look at Table 3. This is, Table 3 is the
18 result of the third mathematical model where you've
19 assumed motion in all three directions, X, Y, and Z?

20 A. Plus cask height, effect of cask height,
21 whatever the structural properties are.

22 Q. Now, you have in here -- in this Table 3 you
23 have a column called Stiffness for Non-Linear Elements,
24 and we have the vertical stiffness column.

25 A. Yes.

1 A. We use stiffness values all the time, every
2 time we analyze the structure. For an anchored cask it
3 could be zero in the upward direction.

4 Q. So how many times have you picked a contact
5 stiffness value for sliding analysis?

6 A. A program --

7 Q. How many times have you picked a contact
8 stiffness value for sliding, for lift-off analysis?

9 A. For this case?

10 Q. No, just in general. How many times have
11 you picked a contact stiffness analysis for purposes of
12 analyzing sliding or tipping?

13 A. This is the case.

14 Q. This is the first case?

15 A. Yes.

16 Q. First time you've done it, correct?

17 A. That's right.

18 Q. Okay. Dr. Khan, you say in paragraph 70, I
19 believe it is, "The Altran analysis did not take into
20 account for the amplification due to soil structural
21 interaction in the 2,000-year earthquake input time
22 histories." Then you go on to say, therefore, the
23 vertical input motions at the base of the cask should
24 be higher. I'm confused what you're saying in that
25 paragraph 70. I think you also have something in your

1 provide you this value you should use for the
2 stiffness.

3 Q. I said, did you follow the guidance that
4 ANSYS provides in determining what stiffness to use?

5 A. ANSYS never provided any guidance on
6 sliding, how to calculate the stiffness for a sliding
7 problem.

8 Q. Did you follow the guidance of ANSYS in
9 terms of how to arrive at appropriate contact stiffness
10 guide for the problem you were looking at?

11 A. They would never give you an answer.

12 Q. So there is no guidance from ANSYS?

13 A. I used their program.

14 Q. You didn't use any guidance from them in
15 terms of how to develop the appropriate contact
16 stiffness for the problem you were working?

17 A. They would never say for a sliding problem
18 what contact --

19 Q. I'm not asking that. I'm just saying, you
20 did not follow the guidance of ANSYS with respect to
21 arriving at the proper contact stiffness?

22 MS. NAKAHARA: Asked and answered.

23 A. There is no guidance. All I can say is,
24 there is no guidance from ANSYS how to solve a
25 nonlinear sliding problem with large horizontal

1 motions.

2 Q. Okay. In paragraph 72 of your declaration,
3 I believe you say that, in your opinion, "the only way
4 to validate Holtec's analyses is for Holtec to
5 benchmark its sliding displacements calculated by
6 Holtec's non-linear mathematical model with actual
7 shake table test data. This is common practice in the
8 seismic performance field. I frequently perform shake
9 table tests to benchmark mathematical models."

10 How would you go about doing a shake table
11 test for the Holtec cask?

12 A. Well, you know, find a shake table, maybe in
13 Japan or someplace. I'll have a prototype model, shake
14 it and apply the ground motion that you see. And
15 you'll benchmark your nonlinear solution with a sliding
16 displacement, impact loads inside the casks, and then
17 substantiate your model, that this is what you're
18 getting from your analysis and from your testing for
19 sliding, displacement, tipping, and whatnot. And then
20 you could go and use a bigger cask, a different size,
21 because at that time you have a basis, parametric basis
22 for that model.

23 Q. You've mentioned Japan. Why do you mention
24 Japan?

25 A. They have a bigger table.