OFFICIAL TRANSCRIPT
PROCEEDINGS BEFORE

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	
LONG ISLAND LIGHTING COMPANY	)	Docket No. 50-322-OL-3
	)	
(Shoreham Nuclear Power Station	)	
	)	
Unit 1)	)	

DEPOSITION OF STANLEY G. CHRISTENSEN

Hauppauge, New York

Wednesday, May 23, 1984

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of:	:	
LONG ISLAND LIGHTING COMPANY (Shoreham Nuclear Power Station, Unit 1)	:	Docket No. 50-332-OL-3 (Emergency Planning)

Hauppauge, New York
Wed., May 23, 1984

DEPOSITION OF STANLEY G. CHRISTENSEN,

called for examination by counsel for LILCO in the above-entitled action, pursuant to notice, the witness having been duly sworn by NICHOLAS TORRE, a Notary Public in and for the State of New York, at the offices of the Suffolk County Executive, H. Lee Dennison Building, Veterans Highway, Hauppauge, New York, at 10:00 a.m., the proceedings being taken down by Stenotype by NICHOLAS TORRE, and transcribed under her direction.

APPEARANCES:

On behalf of Suffolk County and the Witness:

MICHAEL S. MILLER, ESQ.
Kirkpatrick, Lockhart, Hill, Christopher, & Phillips
1900 M Street, N.W.
Washington, D.C. 20036

On behalf of Long Island Lighting Company:

ODES L. STROUPE, ESQ.
Hunton & Williams
333 Fayetteville St.
P.O. Box 109
Raleigh, N.C. 23212

On behalf of Transamerica Delaval, Inc.:

DAVID E. ROSS, ESQ.
PETER A. RAGONE, ESQ.
Guggenheimer & Untermyer, Esqs.
80 Pine Street
New York, N.Y. 10005

ALSO PRESENT:

SIMON K. CHEN, President
PEI Consultants

CONTENTS

STANLEY G. CHRISTENSEN, having been previously sworn, was examined and testified further as follows:

MR. STROUPE: We are continuing this deposition, so the witness need not be sworn.

EXAMINATION (cont'd) BY MR. STROUPE:

Q Prof. Christensen, you recall, I take it, on May 8th and 9th, I took your deposition out in California.

A Yes.

Q You and I discussed certain components in the Transamerica Delaval engines at Shoreham. You recall those discussions, generally?

A Yes. Generally.

Q I will ask you, had we, in fact, discussed pistons, crankshafts, and cylinder heads?

A I can't recall now, sir, exactly what we had discussed then.

Q That is my best recollection, so that I will try not to go over anything that we have already discussed, except for a couple of areas that I have specific questions on.

I will ask you this question. You had indicated to me at the outset of the deposition, that deposition, at the start, that you were looking at a number of components. I believe you read over a list of the so-called 16 components, and you had indicated to me that you were going to be looking at most, if not all, of those components.

I will go through some of the components and see if I can get any conclusions or opinions that you have come to with regard to some of the.

Sir, do you have an intention to examine connecting rods and/or connecting rod bearings?

A Yes.

Q We will take connecting rods themselves, first, please, sir.

Have you had an opportunity to form any preliminary opinion as to the reliability of the connecting rods in the Shoreham EDG's?

A Yes, my preliminary opinion was that the area around the bottom end bearing was weak in certain areas.

Particularly, this is so in the area of

earlier, which were taken from a list of 16, I believe. The five things that I was most interested in were what I would call critical high priority areas: Crankshaft, connecting rod and connecting rod bearings, the pistons, cylinder heads, cylinder block.

I think that makes up the five.

Q Do you have, sir, an order of priority among those five components? Do you treat them as of equal significance?

A Well, no, obviously to me, if there is any failure of the crankshaft, the whole engine is gone. If there is a failure of a cylinder cover, only part of it is gone.

I would fix my priorities in that area. If a cylinder cover cracks, you may lose the entire engine from a hydraulic lock situation in starting.

You have buckled the shaft, bent main bearings and you have a disaster on your hands.

Q If we can talk about the cylinder heads for a second, you are aware, are you not, that IIICC Has instituted a barring over procedure, with regard to attempting to detect water in the cylinders of the TDI?

A Yes, I am aware of that.

Q You have an opinion as to whether that procedure will enable IILCC to detect water in the cylinder?

MR. MILLER: Do you have a copy of the barring procedure that you are referring to?

MR. STRCUPE: No.

MR. MILLER: You are asking the witness from memory to discuss the procedure with you?

MR. STRCUPE: Yes. The record should reflect in the witness' deposition taken in July of 1983, he discussed it in fairly much detail, with the person deposing him at that time.

I believe he has a copy of that procedure, or he had a copy of that procedure at a time.

MR. MILLER: No reason to dispute that. I would point out that was July of 1983. This is almost June of 1984.

I am not sure if the witness has even seen the procedure since last summer.

If you wish to question about the procedure, why not show him a copy of it.

MR. STROUPE: I don't have a copy. Mr. Dynner spent many portions of days this week and last asking the witness, witnesses, about various things of which he didn't furnish copies.

I would like an answer to the question.

I will try hard to ask the kinds of questions that don't require the witness to give a specific detail, any specific details of these things.

I am asking for a general recollection. If he doesn't know, he can tell me.

Q Are you aware of the LILCO barring over procedure?

A I am aware of the procedure, yes.

Q Do you know whether it calls for barring over within a certain period of time, after the engine has been in operation?

A Yes. If I remember correctly, I think that there were periods of four hours, or maybe a lesser period, but a time period, time periods after running of the engine, in which they would bar over, and after the completion of that period, they would not proceed over with the barring over procedure.

I did, at the time that I looked at that, consider that rather dangerous from the point of view of the history of the failures of the cylinder covers.

If a leak develcped at some period subsequent to the final barring over, then the engine could start, and we would have a possibility of the hydraulic lock situation.

The next thing on that was, if you have a hydraulic lock situation, you have a disaster on your hands.

Q Not to interrupt you, but I would like to ask you about the disastrous results that could happen, that you referred to.

Is it likely, Prof. Christensen, that if the last barring over of the TDI diesel generators occurs 12 hours after the engine has been run, that a crack or indication, whatever, can thereafter leak water into the cylinder, if no water is detected at the 12-hour mark?

MR. MILLER: Is it likely that would happen?

MR. STROUPE: Yes.

MR. MILLER: Would you define that, likely.

MR. STROUPE: That is a generally-accepted term.

Q Do you understand "likely"?

A Not here, and I don't want to split hairs, but when you say "not likely," I don't know whether you gave me a negation of likely or not, first.

Q Is it probable that that can occur?

A There is always probability; yes, I think so.

Q You are saying it is probable rather than possible?

A Well, we are in a very, very awkward area of definition here.

Are we speaking of probability in the full statistical term, where I would have to go back and reference the definition for the term?

Q I am generally using that in the sense that it is more likely to happen than not, sir.

A I am going to say with the history we have of the cylinder covers, one could consider there

was every possibility it might happen. I don't know if that satisfies you.

Q Can you tell me how you would have or could have a leak that would not be detected within the 12-hour period, that could thereafter result in water entering into the cylinder?

A From the fact that I do believe, from looking at the design of the cylinder cover, that a crack, if it commences, would most likely commence from the inside and move outwards. That is from the cool side of the fire deck to the lower side of the fire deck.

I think that would be the direction of propagation of a crack.

Now, if you had corrosion within that cracked area, then there would be--it would be possible for a crack to continue growing after the 12-hour period of shutdown, and then for a leak to occur. Yes, it is possible.

When I say that, possible, within the realms of probability, with the case history they had, they have had on these heads.

Q Would it not be more likely if that is

going to happen, it would happen within the 12-hour period, immediately after the running of the engine?

A Not necessarily so, no.

Q Why is that?

A Well, I can give you cases of one ship, one class of ship, where we were running around with cracked pistons for quite a few years, and we didn't know it, mainly because the crack had been sealed by the chemical additives we have been using in the cooling water.

As the crack developed, the leakage was sealed off from the build-up of the chemical within the crack.

That exacerbated the crack growth to an extent.

Then, due to some problems that were arising in another area with this cooling treatment, we changed the additive we were using from a chemical additive to a soluable oil.

Then we discovered, right through this class of ship, with this class of engines, that we had cracked pistons in every engine.

So, there are so many things which can occur which will bring the crack to light and allow water to leak into the cylinder head long after you decided that that was a safe period to end barring.

I don't think there is a safe period to end barring if there is a doubt, any doubt, about covers.

Q How long would it be your recommendation that this barring over period or procedure go on with the TDI engine?

A It is difficult to put a time on things like this. Here, in a case, in these surroundings, one can only generalize.

I think, if there is any doubt about a cylinder cover, that the barring over procedure should not stop at all. Of course, the answer to the problem is to get a cover that is reliable, that we know is reliable and has stood the test of time.

Then we may dispense with the barring over procedure entirely.

Q Do you know whether the NRC has recently issued guidelines which indicate that barring over procedure for nuclear service EDG's should take place at

the same levels that LILCO barring over procedure is designed to do?

A I wouldn't know what they had issued recently, no.

Q This corrosion that you described as affecting crack propagation, that could only occur if the crack or indication occurs on the waterside of the head?

Isn't that true?

A I am mainly thinking of it in this area, yes. I am not going to say that a crack couldn't propagate from the other side.

I think I can see mechanisms whereby this could occur, but I would have to think them out. As to that possibility.

Q Since we are on the subject of cylinder heads, let me ask you a few more questions about that:

You have stated, I believe, and correct me if I am wrong, in your previous deposition with me, that you very much wanted to obtain an isothermal of the TDI cylinder head on the Shoreham EDG's?

A I said that would be extremely desirable,

that we have those.

Q I believe, did you not, that you indicated to me that you didn't understand why TDI didn't have that available?

A That was the belief that I had expressed, yes.

Q Now, you had an opportunity, did you not, to attend Dr. Chen's deposition in Washington, D.C., last week?

A I did hear that, yes.

Q Did you have occasion to hear Dr. Chen's discussion regarding doing an isothermal study of a cylinder head such as the TDI heads on the Shoreham engines?

A I was very much surprised that he decried any experimentation along these lines.

I was most surprised, and if memory serves me correctly, I believe he said it was more or less a waste of time and a very, very costly process and was not cost effective in answering problems. I completely disagree with his views.

Q Didn't he say that it might cost a

million dollars and would take several years for a large group of PhD's to attempt to do?

A I don't think it takes a large group of --

Q Isn't that what you recall his testimony to be, though, sir?

A That was his testimony, but I recall that testimony was, if you were going to try to do this mathematically. What I am going to say, this is usually done experimentally in the areas that I know that it has been done.

Also where I know it has been done, it has been done out of sometimes problems arising in areas, and in doing research so they can draw up a set of isothermals, where they have found the answer to the problem and have modified it.

Now, usually, the savings are so great over the costs, that it is most cost effective. I know many engine builders do these studies, both by calculation and experimental method.

Q Have you, Professor Christensen, ever seen an isothermal of a cylinder head that was not related to a two-cycle engine?

A Yes. I have seen isothermals for two-cycle and four-cycle engines.

Q What four-cycle engines can you recall having seen an isothermal of the cylinder head for?

A Recently, I have seen some for an engine -- I can't recall which engine, but they are shown in many, many textbooks. Examples of isothermals for engines.

I think there are isothermals of four-stroke engines shown in a book that I mentioned earlier, "Diesel Engines," authorized by Carl Stinson.

I think there are some American-built engines there where isothermals are shown, if I remember correctly.

Q Would you tell me how you would attempt to do an isothermal of a TDI cylinder head?

A Well, no, I have not investigated that. I am sure that there must be ways and means.

Q You say you are sure there are ways and means. Why are you sure there must be ways and means?

A Well, one of the things which happens with the TDI engine cylinder head, there are weaknesses

in that head which make them go to the extent of welding on the covers which cover the core holds or the core fastenings, whereas in many, many other engines that is a bolted coverplate which can be removed.

If you are going to weld on coverplates, you would introduce difficulties. This comes back to what I call excellence in design in the first place.

Q What does that have to do with ways and means of doing isothermals on TDI cylinder heads?

A There have been lots of problems with the cylinder heads. No one can deny that.

Q That is not the question.

A If there is a problem existing, then I think it is encumbent upon the manufacturer to overcome that problem so that he can sell a reliable engine.

Q I understand that. What I am asking, what ways and means that you have indicated would you utilize to do an isothermal of the TDI cylinder head?

MR. MILLER: The witness told you he didn't investigate how he would do an isothermal of the TDI head. He told you he has seen in textbooks, isothermals of four-stroke engines, including

American-built engines.

MR. STROUPE: He mentioned ways and means. I want to know what these are.

THE WITNESS: Whether we start an investigation of this nature, I don't have a drawing of a TDI cylinder head in front of me.

I can't give an answer to that question in a few words in a deposition. That might be a study of two or three days, before I come up with an answer of how I would tackle that problem.

Q Would you agree that the TDI head is geometrically a complex component?

A It is a complex component, just the same as the other cylinder heads have been analyzed for their isothermals. No different from any of the others.

I don't see how a problem should exist with checking out the isothermals on a TDI head any different from any other engine manufacturer, who makes a head of a similar design to TDI.

What is commonly called a four-valve in-head cover or head.

Q Do you know whether any of these

isothermals that you have described having seen in texts or publications attempted to determine the isothermals of various areas within the cylinder head?

A Yes. Obviously, the main areas of concern in the cylinder head are where you get changes in section; where you get a high to a low heat transfer rate; these are areas which would be considered.

To bring things out of my head, it is difficult at this point in time. In this very, very complex area, we are talking about, to bring things out -- well, as I am going to say and/or repeat, where this has usually been done, it has been done in some cases, in the realm of pure research where an engine builder wants to know more about his engine, and in other cases, in problem areas.

I believe I have seen in technical papers on troubleshooting that they have investigated localized areas of isothermals to get answers to problems.

I don't know whether I have drifted off the question in giving the answer, or whether I have headed on course and given you the answer that you wanted.

Q Have you ever done an isothermal of any cylinder head?

A No.

Q Have you ever attempted to do an isothermal of a head?

A No, I have never had occasion to.

Q And that would be both experimentally and mathematically?

A Neither way, no.

Q Have you ever been involved in a team effort, sir, which attempted to do an isothermal of a cylinder head?

A No, but I have spoken to engine manufacturers in this area if isothermals.

So that, I think I can say that I am acquainted with quite a few of the problems which arise.

Q Would you agree with me, sir, that doing an isothermal on a two-cycle engine would be easier than doing an isothermal on a four-cycle engine?

A You would have to define the method of scavenging the cylinder before I give you an answer to that question.

Q What do you mean, "scavenging"?

A The way the exhaust gasses are removed and the way the air is brought into the cylinder.

Q Take a Sulzer engine. Would it be much, much less difficult to do an isothermal on the Sulzer head than to do an isothermal on the TDI head?

A I would say that Sulzer manufacturers engines today in which both types of head are there. One with one form of scavenging, and another with another. You will have to tell me which engine.

I would have to know whether it was an RTA engine type or one of the other types. Whether a M-type, or an earlier type than M.

There are so many different types of design for cylinder covers for the Sulzer, you can go back to Sulzer engines with an identical cylinder cover to the TDI.

You would have to define that for me.

Q Regardless of scavenging, would you not agree with me it is easier to do an isothermal of a two-cycle engine cylinder head, as opposed to an isothermal of the four-cycle cylinder head existent upon

the TDI diesels at Shoreham?

A Do you want a journalization or to be specific?

Q I would like a yes or no, and then you can specify or journalize.

A I can't give you a yes or no answer. It has to be an answer where I have to define things, and where you would have to define things to me.

I can go and show you a two-stroke engine which has almost an identical cylinder cover to the TDI engine. There are so many different designs of cylinder covers, that I would have to know which type of cylinder cover you talk about, to give you a complete answer.

Definitely, if you want a yes or no answer, I would have to know the type of cover.

Q How about a looped scavenging Sulzer engine?

A Where are we going back to now, ten or fifteen years ago?

Q Take at the present time.

A Present looped scavenging engine. Going to a bore-cooled head or a normal hollow head?

Q Take the bore-cooled head.

A Comparatively as -- relatively as compared with the TDI engine.

But, Sulzer's have produced isothermals for their heads with four valves in the head, where the head is almost identical to the TDI engine. I don't -- there is obviously -- obviously, some engines have a head easier to design than others.

Q You don't know how long it took Sulzer to produce the isothermal of the head that is comparable to TDI's or a four-cylinder head, do you?

A I don't know, no.

I do know this, they considered it prudent to make an investigation along these lines.

That is irrespective of what it cost or how long it took.

Q Would I be correct in assuming that your bottom line would be that you disagree with what Dr. Chen indicated about the difficulty in doing an isothermal of the R-4 cylinder head?

A I don't disagree with the difficulties. Many things in life are difficult. I do disagree with

his statements in regard to cost effectiveness and other things there, particularly in the area of cost.

So much depends on how many engines we are making in a year. I know this that if I were an engine builder, I would want to protect my good name.

I would certainly make it my business to find out as much as I could about my engines, so that I have the best reliability possible.

Q You don't feel you would know that unless you had an isothermal of the cylinder head?

A I feel that the isothermal of the cylinder head would give you an answer to many of the problems that have been experienced with these heads.

Q If we can jump to pistons for a few minutes.

A Fine.

Q I am somewhat of a novice in this area.

You indicated, I believe, in your prior testimony, that you were concerned about piston size loading in the TDI Shoreham diesel?

A Yes.

Q I believe you indicated that you had

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	
LONG ISLAND LIGHTING COMPANY	)	Docket No. 50-322-OL
(Shoreham Nuclear Power Station, Unit 1)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of SUFFOLK COUNTY'S MOTION FOR RECONSIDERATION OF PORTIONS OF BOARD'S JULY 5 EDG ORDER, dated July 10, 1984, have been served on the following this 10th day of July 1984 by U.S. mail, first class, except as otherwise indicated.

Lawrence J. Brenner, Esq.*
Administrative Judge
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dr. George A. Ferguson*
Administrative Judge
Atomic Safety and Licensing Board
School of Engineering
Howard University
2300 6th Street, N.W.
Washington, D.C. 20059

Dr. Peter A. Morris*
Administrative Judge
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Edward M. Barrett, Esq.
General Counsel
Long Island Lighting Company
250 Old Country Road
Mineola, New York 11501

Mr. Marc W. Goldsmith
Energy Research Group, Inc.
400-1 Totten Pond Road
Waltham, Massachusetts 02154

Mr. Stuart Diamond
Business/Financial
NEW YORK TIMES
New York, New York 10036

W. Taylor Reveley, III, Esq.
Hunton & Williams
P.O. Box 1535
707 East Main Street
Richmond, Virginia 23212

Mr. Jay Dunkleberger
New York State Energy Office
Agency Building 2
Empire State Plaza
Albany, New York 12223

James B. Dougherty, Esq.
3045 Porter Street, N.W.
Washington, D.C. 20008

Robert E. Smith, Esq.
Guggenheimer & Untermyer
80 Pine Street
New York, New York 10005

Mr. Brian R. McCaffrey
Long Island Lighting Company
Shoreham Nuclear Power Station
P.O. Box 618
North Country Road
Wading River, New York 11792

Joel Blau, Esq.
New York Public Service Commission
The Governor Nelson A. Rockefeller Building
Empire State Plaza
Albany, New York 12223

Martin Bradley Ashare, Esq.
Suffolk County Attorney
H. Lee Dennison Building
Veterans Memorial Highway
Hauppauge, New York 11788

Atomic Safety and Licensing Board Panel
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Docketing and Service Section
Office of the Secretary
U.S. Nuclear Regulatory Commission
1717 H Street, N.W.
Washington, D.C. 20555

Bernard M. Bordenick, Esq.*
Edwin J. Reis, Esq.
Richard J. Goddard, Esq.
Office of Exec. Legal Director
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Stephen B. Latham, Esq.
Twomey, Latham & Shea
P.O. Box 398
33 West Second Street
Riverhead, New York 11901

Mr. Frank R. Jones
Deputy County Executive
H. Lee Dennison Building
Veterans Memorial Highway
Hauppauge, New York 11788

MHB Technical Associates
1723 Hamilton Avenue
Suite K
San Jose, California 95125

Hon. Peter F. Cohalan
Suffolk County Executive
H. Lee Dennison Building
Veterans Memorial Highway
Hauppauge, New York 11788

Fabian Palomino, Esq.#
Special Counsel to the Governor
Executive Chamber
Room 229
State Capitol
Albany, New York 12224

Atomic Safety and Licensing Appeal Board
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Jonathan D. Feinberg, Esq.
Staff Counsel
New York State Public Service Commission
3 Rockefeller Plaza
Albany, New York 12223

Stewart M. Glass, Esq.
Regional Counsel
Federal Emergency Management
Agency
26 Federal Plaza
New York, New York 10278

Alan Roy Dymmer
KIRKPATRICK, LOCKHART, HILL,
CHRISTOPHER & PHILLIPS
1900 M Street, N.W., Suite 800
Washington, D.C. 20036

DATE: July 10, 1984

By Federal Express
* By Hand Delivery