ORIGINAL

STATE OF CONNECTICUT

SITING COUNCIL

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CONNECTICUT LIGHT & POWER COMPANY AND UNITED ILLUMINATING COMPANY

APPLICATION FOR A CERTIFICATE OF ENVIRONMENTAL COMPATIBILITY AND PUBLIC NEED FOR THE CONSTRUCTION OF A NEW 345-kV ELECTRIC TRANSMISSION LINE AND ASSOCIATED FACILITIES BETWEEN THE SCOVILL ROCK SWITCHING STATION IN MIDDLETOWN AND THE NORWALK SUBSTATION IN NORWALK, CONNECTICUT

DECEMBER 15, 2004
(10:00 A.M.)

DOCKET NO. 272

* *

BEFORE: PAMELA B. KATZ, CHAIRMAN

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. . .Verbatim proceedings of a hearing before the State of Connecticut Siting Council in the matter of an application by Connecticut Light & Power Company and United Illuminating Company, held at Central Connecticut State University Institute of Technology & Business, 185 Main Street, New Britain, Connecticut, on December 15, 2004 at 10:00 a.m., at which time the parties were represented as hereinbefore set forth . . .

CHAIRMAN PAMELA B. KATZ: I'd like to call this continuation of the hearing on Docket 272 to order.

I have a brief opening statement and then we're going to invite first selectmen and mayors who wish to make a limited appearance to speak to us. And then we are going to get into ABB and H -- DC Light.

This Council realizes that having the ROC group report come into the record late into the proceeding presents special challenges. In fact, the Vice Chairman and I have been meeting on this one issue actively in the past few weeks. While we cannot yet report to our fellow Council members our findings, I am happy to report there are several possible solutions, and none of the solutions require new legislation to accomplish. So, I'm asking you

to keep the faith. We are aware and we are working on this issue.

This docket is far from being a fait accompli. We are spending much of January taking in new evidence into the record. And the Council realizes how much blood, sweat, and tears and money have been spent by both the towns and the ratepayers of Connecticut. Late night I read an e-mail that went to the service list that talked about the Council abdicating their responsibilities. I can assure you we will not. We take this very seriously. Unfortunately, I now have to get a computer monitor because it was damaged by a flying sneaker. (Laughter).

Today -- oh, let me bring up one more thing. There was a -- our Executive Director Derek Phelps gave an excellent quote yesterday to the Stamford Advocate that summarizes our procedure and I encourage you to ask him to repeat that quote.

Today, first we would like to invite the mayors and first selectmen who would like to make a limited appearance to give us their thoughts. We're especially interested in thoughts on the buffer zone now that people have had an opportunity to look at maps and yellow dots and things like that. If you have further

thoughts on this issue, we'd like you to share them with us. These are not evidence, you will not be sworn in. We will treat them as a limited appearance.

And then after that, immediately following that we will take into the record various reports from ABB on DC and then we will proceed from there.

At this time, I will call on anyone -- mayors and first selectmen who wish to speak, just, you know, a show of hands, come on up to the microphone and introduce yourself. Yes? Are we going north to south?

MR. CHARLES AUGUR: Yes, Chairperson.

CHAIRMAN KATZ: Yes.

MR. AUGUR: I'm Charles Augur, First Selectman of Middlefield, Connecticut.

CHAIRMAN KATZ: And if you could just spell your name for the record.

MR. AUGUR: A-u-g-u-r. I'm here on behalf of a family in Middlefield, our second largest taxpayer, Lyman Orchards Corporation, one of the oldest active farms in the United States of America, dating back to 1741. They also own two of the top 10 golf courses in Connecticut. And I feel obligated to come here and read into the record their testimony they prepared for me to read to you today. Thank you for letting me testify by

the way.

This is from Steve Sizkowski (phonetic), the President and Chief Executive Officer of the Lyman Farm, Incorporated, to -- regarding Northeast Utilities upgrade to 345-kilovolt. It's dated October 13, 2004.

"Our position concerning the upgrade of transmission lines through Lyman property hasn't really changed since we talked to Northeast Utilities some two years back. We recognize that our current easement with Northeast Utilities is something that probably would allow the upgrade to monopoles and higher voltage lines running through our property. However, we expressed concern then and again now that if this process is to move forward, that it does not diminish the present and future value of our business.

Under the assumption that the process takes the current route through our property, we are very concerned about the disruption to our business, the aesthetic effect, and resulting value for a round of golf. The parcel of land affected is currently part of our Jones -- Robert Trench Jones Golf Course. Forty years ago much of this was meadow and supported a dairy operation. The point being is that this land is currently residentially zoned and future land use is difficult to assess at this

time. So therefore, we are in favor of all efforts to minimize the effect on future land use.

Recently the concept of establishing buffer zones was introduced. These zones may or may not be supplemented with signage identifying them as potential health hazards. This would again be a major concern to Lymans and the effect it may have on attracting golfers to our course.

We recognize the need for a mutual solution to the energy problem and would support all efforts to minimize any adverse effect on the Lyman Farm, Incorporated, our business now and in the future." Thank you, Chairperson.

CHAIRMAN KATZ: Thank you very much. The First Selectman of Durham.

MS. MARYANN BOORD: Good morning, Chairman Katz and members of the Council.

My purposes in addressing you today are two-fold. First, I'd like to focus on the Council -- to focus the Council's attention on two outstanding requests made by Durham together with other towns on two -- in this proceeding. And to request favorable Council action on those requests. Second, I wish to urge the Council to correct -- to protect the residents of three Durham

neighborhoods in particular who will be harmfully impacted by the facilities under review in this proceeding based upon current indications.

Durham, together with Wallingford, submitted a procedural motion to the Council nearly four months ago in July requesting that the Council reconsider and reverse its decision in Docket 217 approving the Phase 1 line. That motion also requested that the Council consolidate the proceedings in Docket 217 and this proceeding. Durham still requests a ruling by the Council on that motion.

In addition, Durham, together with five other towns, submitted an objection to the Council's scheduling notice dated November 1, 2004 concerning the Towns' procedural due process rights. Durham requests that the Council respond to the points made by Durham and the other towns in that objection.

As set out in Durham's motion, we believe the proper course for the Council in this proceeding is to evaluate Phase 1 and Phase 2 together as a single facility, for that is, in fact, what they are. The obstacles faced by the ROC group in attempting to fashion a solution in Phase 2 appeared to be caused in large measure by the configuration approved in Phase 1.

Moreover, given that the ROC group has yet to submit a workable solution for Phase 2, it is doubly inappropriate to continue to conduct proceedings in Phase 2 as pointed out in the objection.

Also, the ROC submission of December 9th in which they state that they will file an analysis of the KEMA and ABB submissions next week on December 20th, further establish the hearings on KEMA's and ABB's reports should be deferred until after that ROC submission has been submitted to the Council and the parties have had an opportunity to review that report.

Finally, with respect to the KEMA and ABB reports, I am dismayed that initially KEMA did not study any undergrounding in the area east of Beseck and that ABB still has not studied undergrounding in that area, which includes Durham.

Public Act 04-246 requires undergrounding in all residential areas unless it is proven technically unfeasible. If it hasn't even been studied, where is the proof.

If the Council continues on its current course in this proceeding, I must conservatively assume that the result of that process will be an overhead 345-kV line in Durham even though I on behalf of Durham have

expressly and repeatedly urged an all underground route within Durham.

Without waiving any of Durham's rights to contest that result, my obligation to my constituents compel me to address that reality and submit the following comment and request for relief at this time. The residents of three residential areas in Durham, the Royal Oak neighborhood, Foothills Road, Arbutus Street and Johnson Lane and Powder Hill Road, Skeet Club Road, and Elihu Drive must be protected from the EMF effects of the new lines by means of bypass around all three of these residential areas.

Durham interprets the term residential areas contained in Public Act 04-246, which the Legislature directed to this proceeding, to mean all locations wherein existing residential structures are located without regard to the number of residents, thus qualifying each of these three Durham neighborhoods for protection under Public Act 04-246. Therefore, I request on behalf of Durham that in the event the Council certificates aerial lines through Durham, that the Council direct CL&P to construct bypasses around those three neighborhoods. This is necessitated by the narrowness of the right-of-way and the proximity of the homes to the

right-of-way in those neighborhoods. As the Council is aware, some of those homes are actually in the right-of-way.

Furthermore, given the preference for undergrounding in Public Act 04-246, it would not be appropriate to mitigate the EMF effects of the new 345 lines by other methods proposed by the Applicants, enormous and ugly towers which would destroy the viewsheds over a wide area and cause other environmental impacts, including to nearby wells and mature trees.

Additionally, Durham requests that the Council direct the existing 115-kV line into the bypasses as well for the following reasons. First, as stated by the Applicants, the Phase 1 facilities, which were approved by the Council without input from Durham, will most definitely raise EMF levels in those 115-kV lines. Second, because CL&P has indicated that the existing 115 lines are to be reconfigured in some fashion, the Council should direct CL&P to move the existing 115-kV lines into the bypasses or to bury them in lieu of such reconfiguration.

It seems clear from the KEMA testimony yesterday that further study, especially in my town, could result in additional undergrounding.

I was also encouraged by the visits of Council staff to three substation area sites, which confirmed that there is room at those sites for C-type harmonic filters, reactors, and resistors, which could also permit additional undergrounding.

I would encourage the Council to do whatever is necessary to permit KEMA to determine how many additional miles of undergrounding could be available in Phase 2.

On the other hand, I was disappointed to learn yesterday that the Council apparently will not allow further inquiry into additional modeling of Phase 1, which could ultimately benefit the towns in Phase 2.

In closing, I make the observation that at least two of the Siting Council members have personal experience working within the constraints of municipal budgets. The Phase 2 municipalities have demonstrated heroic efforts in cooperating to conserve legal dollars, sharing expertise and information, keeping each other informed, although not always agreeing on the best resolution. We do not have the sources of funding and expertises -- and expertise that are available to the Applicants. Therefore, we must rely on the Siting Council members to deal with us fairly and judiciously, looking

out for the health and well being of our constituents. We entrust you with that vitally important task. Thank you for the opportunity to speak before you this morning.

CHAIRMAN KATZ: Thank you. Next. The Town of Orange.

MR. MITCHELL GOLDBLATT: Good morning, Mitch Goldblatt, First Selectman, Town of Orange.

CHAIRMAN KATZ: Could you spell it please.

MR. GOLDBLATT: Sure. G-o-l-d-b-l-a-t-t. Chairman Katz, Executive Director Phelps, and Members of the Siting Council, thank you for allowing the chief elected officials of the affected towns to address you this morning.

As I'm sure you are aware by now, the Town of Orange has the most densely populated community within the Northeast Utilities' current right-of-way. While obviously people have chosen of their own free will to purchase homes there, the proposal under Docket No. 272 by Connecticut Light & Power and United Illuminating to upgrade the current transmission system to 345 kilovolts is frankly something no one expected nor anticipated. And now since the beginning of this process, these residents are dealing with an ever-changing landscape based on the conflicting testimony that this docket has brought. The

only satisfactory solution is to order these lines to be placed underground.

Both the KEMA report on the feasibility of an additional 20 miles of undergrounding for the 345-kilovolt AC lines and the ABB report on the feasibility of DC Light cannot be dismissed lightly. On the contrary, these reports warrant the time, attention, and study to be fully explored. You are charged with maximizing undergrounding by statute. And these reports suggest the means to accomplish that end. We have an opportunity to be a leader in this effort, to make sure that we have done the right thing not just for today, but for decades in the future. With that as your goal, you should require whatever studies are necessary and complete every analysis needed to make such an informed decision. If the Connecticut Siting Council needs more time or money in order to complete their work, I offer to go with you to the Connecticut General Assembly with that request.

It is imperative that the possibility of additional under-streeting be exhausted before a decision is rendered. This is not only important to the future of energy transmission in Southwestern Connecticut, but is important to the people who have invested their life savings into their most cherished possession, their home,

the same people who listened intently to the presentations by United Illuminating and Connecticut Light & Power over the last two years assuring them that everything and every one would be safe, and trusting the fact that the height of the new poles would average 100 feet or less in our town, are now scared, uncertain, and confused. That is because today they don't hear those same assurances that they will be safe. They hear that poles may reach double the original promised heights. And now over 200 families in Orange, over four percent of the homeowners in the entire town could lose their homes in this process. Well, I have tried to assure them that this will not happen. It is only you that can really make that promise. The absolute best way to give everyone this assurance is by requiring the lines to be buried. Do what you need to do, require whatever time and studies are necessary, and validate the KEMA and ABB reports that you so wisely commissioned to extend the burial through the most densely populated communities in the power line phase -- in this power line phase.

In today's society where we try to recapture our environment, where we are more aware of the dangers of our own technologies, and where there is a heightened concern over homeland security, there is only

one answer; choose the most direct route under our roads and instruct Northeast Utilities to under-street these lines. Let the Connecticut Siting Council be a leader in addressing the need for upgrading our transmission system. Thank you very much.

CHAIRMAN KATZ: Thank you. The Town of Woodbridge.

MS. AMEY MARRELLA: Thank you, members of the Siting Council. My name is Amey Marrella. I am the First Selectman of the Town of Woodbridge. A-m-e-y. Marrella, M-a-r-r-e-l-l-a.

I actually did not plan to speak this morning, but in light of Chairman Katz's comments at the beginning, I would like to offer a few minutes of comment. And forgive me if I stumble because I wrote this on a pad of paper just now.

MR. COLIN C. TAIT: So did Abe Lincoln.

MS. MARRELLA: Excuse me?

MR. TAIT: Abraham Lincoln did okay.

MS. MARRELLA: Well, we'll see -- (laughter) -- that's tough competition, but I'll try.

I want to start by applauding the Chairman and the Vice Chairman for their careful consideration of the unique problems presented by the ROC group's lengthy

review of the original application.

The ROC group originally promised to report to the Council in August. It is now December. For almost six months the Towns' hands have been tied. We cannot prepare our direct case until we know the Applicants' proposal. Several months ago Woodbridge allocated money for expert assistance in preparing our direct case. We have not been able to move forward. Fortunately, the Siting Council's own expert, KEMA, has been able to provide some promising analysis on the feasibility of further undergrounding. I could not attend yesterday's hearing, but I understand that KEMA's testimony suggests we may be able to achieve additional undergrounding as long as KEMA is given time to do the initial analysis. It is essential that they have this time.

In sum, please ensure that KEMA, your own expert, that Woodbridge, other towns, and the Woodbridge community organizations have sufficient time to analyze the ROC group's report. Please make sure that Woodbridge, the other towns, and the Woodbridge community organizations have sufficient time then to prepare our own direct cases and to present those direct cases to you, the Siting Council.

Woodbridge has the highest concentration of

children directly along the proposed aboveground route at the JCC, the Jewish Community Center, and at the Ezra B'Nai Jacob campus. Please take the time that is necessary to fully analyze this proposal. Those children on this campus will be old, they may die before we ever come up with another round of what we're going to do about utilities. This ultimate construction will last throughout their entire lifetimes. So if you need more time to fully analyze this proposal and come to a decision which is based on a full record, I urge you to do what is ever necessary for their sake and the sake of all the other children who want to come to these institutions and be there in the future. Thank you.

CHAIRMAN KATZ: Thank you. Next? (No audible response).

MR. TAIT: Alright, let's move on.

CHAIRMAN KATZ: At this point, then we will go into the portion of the meeting concerning the KEMA -- I'm sorry -- ABB. We need to ask that the ABB witnesses come up to the table.

MR. S. DEREK PHELPS: Let's go off the record.

CHAIRMAN KATZ: Let's go off the record for a moment.

(Off the record)

CHAIRMAN KATZ: Good morning, gentlemen.

VOICES: Good morning.

MR. TAIT: There's a lady --

CHAIRMAN KATZ: I'm sorry, where -- oh, I meant them. They don't count -- (laughter) --

MR. ROBERT L. MARCONI: Not as witnesses, Madam Chairman.

CHAIRMAN KATZ: The -- what I'd like you to do is before Mr. Marconi swears you in and while you're still close to a microphone, I'm going to ask you to go down the table and give your name, spell your name, and also give your -- and give your title if you could. And then we'll have you sworn in. So why don't we start on this side.

MR. DAVE DICKMANDER: Yes. My name is Dave Dickmander. The last name spelling, D-i-c-k-m-a-n-d-e-r. I'm a principal consulting engineer in the consulting group in Raleigh, North Carolina.

MR. RANA MUKERJI: Rana Mukerji, M-u-k-e-j-j-i. I'm Vice President for Electric Systems Consulting for ABB.

MR. MICHAEL BAHRMAN: Michael Bahrman, B-a-h-r-m-a-n. I'm Manager of HVDC & FACTS for the U.S.

MR. LEIF RONSTROM: I'm Leif Ronstrom. The last name is R-o-n-s-t-r-o-m. I'm lead engineer with HVDC in Sweden, the Swedish part of ABB. I work with -- I worked with this technology that we presented in our report since the last five years and with the Cross Sound Cable intensely in technical management and commissioning.

MR. MAGNUS LARSSON-HOFFSTEIN: My name is Magnus Larsson-Hoffstein. My last name, H-o-f-f-s-t-e-i-n. I'm working as cable engineer at ABB, high voltage cables, in Karlskrona, Sweden.

CHAIRMAN KATZ: And able counsel.

MR. CHARLES ANDRES: Charles Andres, A-n-d-r-e-s, Tyler, Cooper & Alcorn, local counsel for ABB.

CHAIRMAN KATZ: Okay.

MR. MARCONI: Before we actually swear everybody in, I do want to mention one renumbering of exhibits. What's on page 22 under 164A and B, well the A and B are going to become 22A and 22B on page 4. So they will be Council exhibits. The VSC HVDC System Feasibility Study, which is Part I is 22A and Part II is 22B. So, I wanted everybody to realize that change there. 164 itself, the report, will still be an Applicants' exhibit. I discussed this with Applicants' counsel ahead of time. Does that square away with your understanding, Attorney

Fitzgerald?

MR. ANTHONY B. FITZGERALD: Yes, sir.

MR. MARCONI: Okay. Thank you very much. At this point, I would ask all members of the witness panel to stand and be sworn.

(Whereupon, the ABB's panel of witness was duly sworn in.)

MR. MARCONI: Gentlemen, please be seated.

CHAIRMAN KATZ: Okay. Mr. Andres, we have -- do you have the hearing program? We have a number of exhibits that we are going to have your witnesses verify.

MR. ANDRES: Yes, Madam Chairman.

CHAIRMAN KATZ: Do you want to go ahead and -- according to my list, we have numbers -- on page 4 -- 8, 10, 11, 12, 19, and as Mr. Marconi just mentioned 22A and 22B.

MR. MARCONI: And 15 --

CHAIRMAN KATZ: And 15 also.

MR. ANDRES: Madam Chairman, should we address these individually?

CHAIRMAN KATZ: Uh -- (pause) -- Mr. Marconi says we're doing them individually.

MR. ANDRES: Okay. I believe Item 8 is simply the curriculum vitaes for the witness panel. So, I

would ask could I collectively ask the witnesses whether the -- should I do that with each individual witness or do it collectively?

MR. MARCONI: Collectively is fine.

CHAIRMAN KATZ: Collectively is fine.

MR. ANDRES: Okay. I would ask the members of the witness panel, Mike Bahrman, Dick -- Dave Dickmander, Rana Mukerji, Magnus Larsson-Hoffstein, Leif Ronstrom, with respect to the curriculum submitted for the record is -- are those true and accurate to the best of your knowledge and belief?

MR. LARSSON-HOFFSTEIN: Yes.

MR. RONSTROM: Yes.

MR. BAHRMAN: They are.

MR. MUKERJI: Yes.

MR. DICKMANDER: Yes.

MR. ANDRES: And do you have any corrections or additions?

MR. LARSSON-HOFFSTEIN: No.

MR. RONSTROM: No.

MR. BAHRMAN: No.

MR. MUKERJI: No.

MR. DICKMANDER: No.

MR. ANDRES: Madam Chairman, I would ask

that these be offered as full exhibits?

CHAIRMAN KATZ: Any objection to making Exhibit 8 a full exhibit? Hearing none, it's a full exhibit.

(Whereupon, Siting Council Exhibit No. 8 was received into evidence as a full exhibit.)

MR. ANDRES: Next is Item 10, the ABB responses to the first set of Connecticut Light & Power and United Illuminating Company interrogatories dated November 18, 2004. And I'd ask that the witnesses who prepared or assisted in the preparation of those interrogatory answers to identify themselves and could you state your names for the record.

MR. MUKERJI: Rana Mukerji.

MR. BAHRMAN: Mike Bahrman.

MR. RONSTROM: Leif Ronstrom.

MR. LARSSON-HOFFSTEIN: Magnus Larsson-Hoffstein.

MR. ANDRES: And first of all, I would ask did you all prepare or assist in the preparation of these interrogatory answers?

MR. LARSSON-HOFFSTEIN: Yes.

MR. RONSTROM: Yes.

MR. BAHRMAN: Yes.

MR. MUKERJI: Yes.

MR. ANDRES: Are there any corrections or additions you'd like to make to them?

MR. BAHRMAN: Yes, I have one correction. And this is in one of the attachments where we're talking about the rating of the cables. This is on page 2 of 4 of the attachment on the calculation methods for rating of the cables. And on Item 3 on page 2 of 4, electrical data, it says for three parallel circuits. For this particular set of calculations there are two parallel circuits. Change three to two.

MR. ANDRES: Okay. Are there any other corrections or -- corrections you'd like to make to this exhibit?

MR. BAHRMAN: No.

MR. ANDRES: With that correction is the exhibit true and accurate to the best of your knowledge and belief?

MR. BAHRMAN: Yes.

MR. ANDRES: And if the rest of the witnesses would also respond.

MR. LARSSON-HOFFSTEIN: Yes.

MR. RONSTROM: Yes.

MR. MUKERJI: Yes.

MR. ANDRES: Very well. Your Honor, I'd like to --

CHAIRMAN KATZ: Any objections to making No. 10 a full exhibit? Hearing none, No. 10 is a full exhibit.

MR. ANDRES: Okay.

(Whereupon, Siting Council Exhibit No. 10 was received into evidence as a full exhibit.)

MR. ANDRES: The next exhibit is identified as No. 11, the ABB, Inc. responses to the first set of interrogatories to ISO New England, Inc., dated November 18, 2004. I would ask that the members of the witness panel who prepared or assisted in the preparation of this exhibit identify themselves and could you state your name for the record.

MR. MUKERJI: Rana Mukerji.

MR. BAHRMAN: Mike Bahrman.

MR. RONSTROM: Leif Ronstrom.

MR. LARSSON-HOFFSTEIN: Magnus Larsson-Hoffstein.

MR. ANDRES: Okay. And let me ask again are there any corrections or additions you'd like to make to this exhibit?

MR. BAHRMAN: Yes. One typo on page 4,

Interrogatory No. 6, about eight lines up from the bottom there is a sentence that starts with however, and there is a typo, unless validated through system studies, it's though, it should be changed to through.

MR. ANDRES: So changing the word though to through?

MR. BAHRMAN: Correct.

MR. ANDRES: Okay. Are there any other corrections or additions?

MR. BAHRMAN: No.

MR. ANDRES: As corrected are these answers to the first set of interrogatories true and accurate to the best of your knowledge and belief?

MR. BAHRMAN: Yes.

MR. LARSSON-HOFFSTEIN: Yes.

MR. RONSTROM: Yes.

MR. MUKERJI: Yes.

MR. ANDRES: Madam Chairman, we'd offer this as a full exhibit.

CHAIRMAN KATZ: Is there any objection to making -- we were up to -- 11 a full exhibit? Hearing none, it's a full exhibit.

(Whereupon, Siting Council Exhibit No. 11 was received into evidence as a full exhibit.)

MR. ANDRES: The next one is Item 12, which is the ABE -- ABB, Inc. responses to the first set of interrogatories of the Town of Cheshire, Milford, Orange, Weston, Wilton and Woodbridge, dated November 18, 2004. I'd ask that the members of the witness panel who prepared or assisted in the preparation of these answers identify themselves and again could you state your names.

MR. MUKERJI: Rana Mukerji.

MR. BAHRMAN: Michael Bahrman.

MR. RONSTROM: Leif Ronstrom.

MR. LARSSON-HOFFSTEIN: Magnus Larsson-Hoffstein.

MR. ANDRES: And are there -- again are there any corrections or additions to these interrogatory answers?

MR. BAHRMAN: Yes. Interrogatory No. 18 on page 5, the answer given is no, and it should be disagree.

MR. ANDRES: Okay. Are there any other corrections or additions?

MR. BAHRMAN: No.

MR. ANDRES: Okay. With that correction are the answers to these interrogatories true and accurate to the best of your knowledge and belief?

MR. BAHRMAN: Yes.

MR. LARSSON-HOFFSTEIN: Yes.

MR. RONSTROM: Yes.

MR. MUKERJI: Yes.

MR. ANDRES: Madam Chairman, we'd offer this as a full exhibit.

CHAIRMAN KATZ: Any objection to making 12 a full exhibit? Hearing none, 12 is a full exhibit.

(Whereupon, Siting Council Exhibit No. 12 was received into evidence as a full exhibit.)

MR. ANDRES: The next item is Item No. 15 on the program, ABB, Inc. responses to the Town of Durham and Wallingford interrogatories, dated December 3, 2004. I'd ask that the witnesses who prepared or assisted in the preparation of these interrogatory answers identify themselves.

MR. MUKERJI: Rana Mukerji.

MR. ANDRES: Anyone else?

MR. RONSTROM: Leif Ronstrom.

MR. LARSSON-HOFFSTEIN: Magnus Larsson-Hoffstein.

MR. ANDRES: And are there any corrections or additions to these answers?

MR. MUKERJI: No.

MR. ANDRES: No, okay. Are the answers

true and accurate to the best of your knowledge and belief?

MR. MUKERJI: Yes.

MR. RONSTROM: Yes.

MR. LARSSON-HOFFSTEIN: Yes.

MR. ANDRES: Madam Chairman, I would offer this as a full exhibit.

CHAIRMAN KATZ: Is there any objection to making 12 a full exhibit --

MR. ANDRES: I believe that was 15.

CHAIRMAN KATZ: I'm sorry -- 15, you're right. Any objection to making 15 a full exhibit? Hearing none, it's a full exhibit.

(Whereupon, Siting Council Exhibit No. 15 was received into evidence as a full exhibit.)

MR. ANDRES: Next I believe is Item 19, that's ABB, Inc. responses to CL&P/UI interrogatories dated December 8, 2004. I'd ask that the witnesses who prepared or assisted in the preparation of these answers identify themselves and could you --

MR. MUKERJI: Rana --

MR. ANDRES: -- state your name.

MR. MUKERJI: Rana Mukerji.

MR. RONSTROM: Leif Ronstrom.

MR. LARSSON-HOFFSTEIN: Magnus Larsson Hoffstein.

MR. ANDRES: Are there any corrections or additions to these interrogatory answers?

MR. MUKERJI: No.

MR. ANDRES: And are the interrogatory answers true and accurate to the best of your knowledge and belief?

MR. MUKERJI: Yes.

MR. RONSTROM: Yes.

MR. LARSSON-HOFFSTEIN: Yes.

MR. ANDRES: Madam Chairman, we'd offer Exhibit No. 19.

CHAIRMAN KATZ: Any objection to No. 19 being a full exhibit? Hearing none, it's a full exhibit.

(Whereupon, Siting Council Exhibit No. 19 was received into evidence as a full exhibit.)

CHAIRMAN KATZ: We'll now go to page 22, Item 164, which is now 22A and 22B, the feasibility studies.

MR. ANDRES: Next I want to refer to the -- what is now 22A, the VSC HVDC System Feasibility Study, issued October 3, 2004, and ask the witnesses responsible for the preparation or who assisted in the preparation of

that exhibit to identify themselves?

MR. MUKERJI: Rana Mukerji. It was done under my supervision.

MR. ANDRES: Okay. And that -- is the exhibit true and accurate to the best of your knowledge and belief?

MR. MUKERJI: Yes.

MR. ANDRES: Are there any corrections or additions?

MR. MUKERJI: No, there isn't.

MR. ANDRES: Okay. We offer Item 22A as a full exhibit.

CHAIRMAN KATZ: Thank you. Any objection to making 22 -- is that A and B or just A?

MR. ANDRES: That's just A at this point.

CHAIRMAN KATZ: 22A a full exhibit? Hearing none, 22A is a full exhibit.

(Whereupon, Siting Council Exhibit No. 22A was received into evidence as a full exhibit.)

MR. ANDRES: Next would be what's numbered 22B, the VSC HVDC System Feasibility Study issued October 3, 2004, Part II. Now perhaps, Madam Chairman, I may want to -- I want to make sure that the witnesses weren't confused -- I notice the program labels these both

feasibility studies. There were two reports issued by ABB and one of them is labeled feasibility study. There is also a report that has the title Technical Description of the VSC HVDC Converter and Cable Technology.

CHAIRMAN KATZ: Mr. Cunliffe, do we need any clarification on 22A and B and what they're called?

MR. TAIT: Are there dates -- did we put down the dates?

MR. FRED O. CUNLIFFE: The dates are there, October 3, 2004 --

MR. TAIT: October 1 --

MR. CUNLIFFE: I have October 3rd.

CHAIRMAN KATZ: October 3rd.

MR. TAIT: I have October 1 --

CHAIRMAN KATZ: Are they both October 3rd according to you?

MR. ANDRES: Well, I -- my understanding for 22A, the VHSC HVDC Feasibility Study issued October 3, 2004 Part I bulk, that's how it's labeled in the exhibit, the actual -- that corresponds with the VSC HVDC System Feasibility Study that's issued October 3, 2004 -- that's - that's one of the documents.

CHAIRMAN KATZ: Okay.

MR. ANDRES: And that's been --

CHAIRMAN KATZ: That's been verified --

MR. ANDRES: -- verified by Mr. Mukerji.

CHAIRMAN KATZ: Okay.

MR. ANDRES: The second document is something that I think was submitted at the same time called a Technical Description of VSC HVDC Converter and Cable Technology, and that actually has a date of October 1, 2004.

MR. TAIT: Yes, October 1.

MR. ANDRES: Right.

CHAIRMAN KATZ: Right, okay.

MR. TAIT: We want to change it to make sure it's a different report.

MR. ANDRES: Right.

CHAIRMAN KATZ: We will make that note --

MR. ANDRES: Okay --

CHAIRMAN KATZ: -- that that's what 22B is.

MR. ANDRES: Assuming 22B refers to that October 1 report, which is the Technical Description, I'll ask the witnesses who prepared or assisted in the preparation of that document to identify themselves and could you verbally state your names for the record.

MR. BAHRMAN: Michael Bahrman.

MR. RONSTROM: Leif Ronstrom.

MR. LARSSON-HOFFSTEIN: Magnus Larsson-Hoffstein.

MR. ANDRES: And I would ask are there any corrections or additions to this document?

MR. BAHRMAN: Yes, there is. Page 21, Section 3.51, Magnetic Field Standards and Requirements, the second paragraph, the third line, it talks about the static magnetic field exposure standard. It should be 40 millitesla and not microtesla as stated. The written text is incorrect. The abbreviation that follows is correct.

MR. ANDRES: Are there any other corrections or additions?

MR. BAHRMAN: No.

MR. ANDRES: So corrected is the document true and accurate to the best of your knowledge and belief?

MR. BAHRMAN: Yes.

MR. LARSSON-HOFFSTEIN: Yes.

MR. RONSTROM: Yes.

MR. ANDRES: Madam Chairman, we'll offer that as a full exhibit.

CHAIRMAN KATZ: Any objection to making 22B as clarified a full exhibit? Hearing none, it's a full exhibit.

(Whereupon, Siting Council Exhibit No. 22B was received into evidence as a full exhibit.)

MR. ANDRES: Thank you, Madam Chairman. Our witnesses are available for cross-examination.

CHAIRMAN KATZ: Thank you. And we appreciate you making yourselves available, though I did offer to have the Siting Council go to Sweden and have this session there -- (laughter) --

A VOICE: You did --

CHAIRMAN KATZ: Okay, we're going to start this off with some --

MS. LINDA RANDELL: Madam Chairman.

CHAIRMAN KATZ: Yes?

MS. RANDELL: Can I just have clarification on the exhibits?

CHAIRMAN KATZ: Sure.

MS. RANDELL: I have no objections to those. However, my understanding is that there's a Part II of the feasibility study. And I think technically speaking, the witness panel only adopted Part I.

CHAIRMAN KATZ: Okay. Can we have your witness clarify that --

MR. ANDRES: Yes --

CHAIRMAN KATZ: -- that 22A is Part I and

Part II?

MR. ANDRES: Right. For what's been identified as 22A, which is labeled in the exhibit VSC HVDC System Feasibility Study issued October 3, 2004, Part I, could -- I would ask the witness to identify the documents that are part of that exhibit?

MR. MUKERJI: We have the VSC HVDC System Feasibility Study, that was -- that was the report. And there were --

CHAIRMAN KATZ: And there were two parts, correct?

MR. MUKERJI: There was just one report. The other report was that technical document.

CHAIRMAN KATZ: Let's --

MS. RANDELL: (Indiscernible, not near mic) -- perhaps I can clarify --

MR. MUKERJI: There were appendices --

MS. RANDELL: There are two of these --

MR. MUKERJI: Yeah --

MS. RANDELL: -- all --

CHAIRMAN KATZ: Miss Randell, you know better than to use visual --

MS. RANDELL: Yes, that's why I said -- there are two bulk exhibits that were submitted by ABB. I

just want the record to be clear that they're both in.

CHAIRMAN KATZ: Okay.

MR. MARCONI: Attorney Randell --

MS. RANDELL: If the witnesses would just clarify that when they adopted 22A as the feasibility study, they included all bulk exhibits? That's probably the better way to do it rather than Part I and II.

MR. MUKERJI: That's fine --

MR. ANDRES: Let me clarify the -- one of the exhibits had attachments, is that correct?

MR. MUKERJI: Yes.

MR. ANDRES: And what exhibit was that?

MR. MUKERJI: The feasibility study.

MR. ANDRES: Okay. And do those include certain bulk exhibits?

MR. MUKERJI: Okay.

MR. ANDRES: And they're included as part of the document, is that correct?

MR. MUKERJI: Okay, yes.

CHAIRMAN KATZ: So both volumes are in?

MR. MUKERJI: Yes.

CHAIRMAN KATZ: Thank you.

MS. RANDELL: And we have a question --

CHAIRMAN KATZ: Sure.

MS. RANDELL: -- as to an earlier correction, a change from the three circuits to two parallel circuits. There are pages 2(4) relating both to three times 370 and two times 530. We're not clear on which of these pages is being corrected.

MR. BAHRMAN: Okay --

MR. ANDRES: You're not referring to the corrections to the interrogatory answers, you're referring to the correction to the exhibit, is that correct?

MR. BAHRMAN: There are two attachments dealing with a rating of the underground cables, the thermal rating of the cables. One has -- if you look at the first page, 1 of 4, it says rating Middletown/Norwalk, three times 370 megawatt circuits. And in that case the electrical data states three parallel circuits. That is correct --

MS. RANDELL: Okay --

MR. BAHRMAN: -- it corresponds to the main title. If you look at the second of the two attachments on rating, the first page it states rating Middletown/Norwalk, two times 530 megawatt circuits. For that, the following data on page 2 of 4, Item No. 3 should correspond, that should be 3 too. So it's the second of the two.

MS. RANDELL: Thank you. We also have a request that errata sheets be submitted per the Council's usual procedure.

CHAIRMAN KATZ: We'll -- that is the Council's usual procedure and we'll ask that request, so that this record to perpetuity is accurate. Anything else, Miss Randell?

MS. RANDELL: No.

CHAIRMAN KATZ: Okay. We're going to start off with some direct by the Council staff and then we will go to cross-examination by the -- first by the Applicant. Mr. Cunliffe, Mr. Phelps.

MR. PHELPS: Thank you, Madam Chairman -- am I up, Joe -- thank you, Madam Chairman.

Speaking to the prime facilitator here, would you identify yourself, sir, again?

MR. BAHRMAN: Michael Bahrman.

MR. PHELPS: Thank you, Mr. Bahrman. What is the name of your firm as a legal entity for the record and where is it based?

MR. BAHRMAN: I will defer to Rana.

MR. MUKERJI: It's ABB Limited based in Zurich, Switzerland. The units involved in this effort was ABB, Inc., which is U.S., and ABB Power Technologies

AB based in Sweden, which are affiliated ABB companies.

MR. PHELPS: How would you describe your firm's services?

MR. MUKERJI: ABB is a global leader in power and automation technologies headquartered in Zurich, Switzerland, with U.S. headquarters in Norwalk, Connecticut. ABB employs over a hundred thousand people worldwide and approximately 5,000 in the U.S. Our global revenues are approximately 20 billion dollars.

ABB's Power Technologies Division is the number one provider of transmission and distribution equipment and systems in the world. Our range of supply to electric utilities includes AC and DC systems, electric equipment such as transformers and circuit breakers, power electronics equipment such as STATCOMs, static VAR compensators, high voltage DC. ABB's consulting group aims to provide objective advice and technology applications and system planning to electric utilities worldwide.

MR. PHELPS: Please give some examples of your most common types of clients?

CHAIRMAN KATZ: Can you just pull your microphone a little closer, sir.

MR. MUKERJI: Yes.

CHAIRMAN KATZ: Thank you.

MR. MUKERJI: Our clients are major electric utilities in the U.S., Pacific Gas and Electric, Georgia Power, National Grid, Northeast Utilities, major electric utilities as well as industrial customers in the U.S. and worldwide.

MR. PHELPS: How did you come to be involved in this docket proceeding, sir.

MR. MUKERJI: We were engaged by Northeast Utilities to study a DC based underground option from Beseck to Norwalk as an alternate to the Phase 2 AC solution. We submitted the report to Northeast Utilities on October 1st. Northeast Utilities submitted the report to the Council. And we have been invited by the Council today.

MR. PHELPS: Would you please brief -- would you please provide a brief outline as to the results of those studies?

MR. MUKERJI: ABB Electric Systems Consulting performed the study on behalf of Northeast Utilities to investigate the feasibility of a DC based underground option as an alternative to Phase 2 AC solution from Beseck to Norwalk. The study considered the HVDC alternative against system criteria established by

Northeast Utilities and ISO New England. ABB developed three HVDC based fully underground alternatives which were technically feasible. Two reports were submitted to the Northeast Utilities. The first was a feasibility study incorporating HVDC into Southwest Connecticut and the second was a technical description of VSC HVDC converter technology and cable technology.

MR. TAIT: Sir.

MR. MUKERJI: Yes?

MR. TAIT: Has any member of the Council staff or any member of the Council consulted you concerning your reports to Northeast Utilities?

MR. MUKERJI: No.

MR. TAIT: Have we in any way influenced you in your recommendations or your results?

MR. MUKERJI: No.

CHAIRMAN KATZ: Thank you. At this time we're ready to begin cross-examination by the Applicants.

MS. RANDELL: Thank you. Good morning, gentlemen. I think I've got your names down correctly, but if I mess up, do let me know.

Picking up on Mr. Mukerji, on your responses to Mr. Phelps' questions regarding ABB Limited and the various affiliates with respect to the resources

and such --

CHAIRMAN KATZ: Pull the mic a little bit closer --

MS. RANDELL: Sure.

COURT REPORTER: One moment please. (Pause).

MS. RANDELL: ABB Limited lacks an investment grade credit rating, doesn't it?

A VOICE: I'm sorry --

MS. RANDELL: Okay. Try it again? Okay. ABB Limited lacks an investment grade credit rating today, doesn't it?

MR. MUKERJI: I believe so from the Standard & Poors credit rating.

MS. RANDELL: And it hasn't had an investment grade credit rating for a good couple of years?

MR. MUKERJI: I believe that's accurate.

MS. RANDELL: And earlier this month the Wall Street Journal reported that ABB was forced to cancel a planned bond exchange?

MR. MUKERJI: That's correct.

MS. RANDELL: Are you familiar with the J.P. Morgan Research Report from October of this year regarding disappointing third quarter results for ABB?

MR. MUKERJI: No.

CHAIRMAN KATZ: Miss Randell, I'm going to interrupt you for a moment. How is this relevant to the -- to this technical report that we have from ABB? Are you going to --

MS. RANDELL: I absolutely am. And I was going to do that much later on, but it's picking up on the witness's response to Mr. Phelps indicating that they a solid entity with, you know, X dollars of revenue and business and so on. I can pick it up later if you'd like.

CHAIRMAN KATZ: Let's go off the record for a moment.

(Off the record)

CHAIRMAN KATZ: On the record. The Council recommends that the Council allow some leeway in this cross-examination with the hopes that we tie this back in quickly into the reason that we are all here on the technical feasibility of a DC line.

MS. RANDELL: I will absolutely do that.

MR. ANDRES: May I just state an objection for the record. Obviously, we were not -- we thought the cross-examination was about the report, the technical feasibility. The panel is all engineers. We haven't brought our financial people or other officers. They're

not prepared to discuss the state of the corporation. Had we known this, we -- we don't believe it's relevant, but if the Council thought it was relevant, perhaps we could have brought someone more appropriate to address this.

CHAIRMAN KATZ: Understood. And we -- we'll note your objection for the record. And if the witnesses are asked any question that is outside their realm, then they should just say so, and we will hopefully get to the business at hand quickly.

MS. RANDELL: Has there been a low work load in HVDC at ABB?

MR. MUKERJI: Absolutely not.

MS. RANDELL: Alright.

MR. BAHRMAN: I'd like to --

A VOICE: Say that again please?

MR. MUKERJI: No.

MR. BAHRMAN: I'd like to elaborate on that, in that we have three --

CHAIRMAN KATZ: Can you speak into the microphone.

MR. BAHRMAN: Okay --

CHAIRMAN KATZ: I know --

MR. BAHRMAN: My name is Michael Bahrman --

CHAIRMAN KATZ: Don't be polite, be -- talk

to the microphone instead.

MR. BAHRMAN: Okay. We -- we have a number of projects in the order stage and in execution stage. We have three -- four -- 3,000 megawatt DC projects, two of them commissioned in China, and one new project. So that is not the case.

MS. RANDELL: Do you agree that as of the end of the third quarter of 2004 that there was growth in all business areas of power technologies at ABB except for power systems?

MR. BAHRMAN: This is a line of questioning that we're not prepared. I think we would --

CHAIRMAN KATZ: The next question --

MR. BAHRMAN: -- pass on that question.

MR. ASHTON: Miss Randell, I have to admit I'm puzzled by your line of questioning. My experience with ABB is that they're one of the largest purveyors of electrical equipment in the world. They are a successor to Westinghouse. Where are we going with this line?

CHAIRMAN KATZ: Mr. Marconi has indicated that we should allow some leeway and I'm going to --

MR. ASHTON: Well, I just -- I'm really puzzled by it.

CHAIRMAN KATZ: But --

MS. RANDELL: We're --

CHAIRMAN KATZ: -- I'm going to allow it.

MR. ASHTON: Okay.

MS. RANDELL: I'll go on, and in response to Mr. Ashton, bear with me if you would, we'll get to it very quickly.

Now, gentlemen, we asked in interrogatories to ask which witness was responsible for which interrogatory. And the response was you all were. So when we get to specific questions, would you let me know which person was primarily responsible?

MR. BAHRMAN: Yes.

MR. MUKERJI: Yes.

MS. RANDELL: Thank you. Okay. Now in your reports and for ease of discussion, we'll have the technical description and the feasibility study. Agreed? In those reports you say that ABB uses HVDC Light and VSC HVDC interchangeably, correct?

MR. BAHRMAN: That is correct.

MS. RANDELL: And HVDC Light is an ABB trademark?

MR. BAHRMAN: That is correct.

MS. RANDELL: For VSC?

MR. BAHRMAN: Yes. As the inventor of the

technology, we chose that.

MS. RANDELL: And VSC is voltage source converter?

MR. BAHRMAN: That is correct.

MS. RANDELL: And ABB has 36 patents on VSC HVDC?

MR. BAHRMAN: We have a lot of patents. I'm not aware of the exact number, but yes.

MS. RANDELL: A lot, okay. And all VSC HVDC installations that are in operation today are ABB?

MR. BAHRMAN: That is correct with respect to HVDC technology. There are other voltage source converter applications for other -- for instance FACTS technologies.

MS. RANDELL: Yeah, put those aside, we're talking strictly today the VSC HVDC --

MR. BAHRMAN: That --

MS. RANDELL: -- transmission and converters.

MR. BAHRMAN: That is correct.

MS. RANDELL: Okay. And there's eight of them in operation today?

MR. BAHRMAN: There are five projects in operation. Some projects consists of multiple DC links in

parallel. One is under commissioning.

COURT REPORTER: One moment please.

(Pause).

MS. RANDELL: Your report lists eight.

MR. BAHRMAN: If you look at our report, Item 8.2 --

MS. RANDELL: Page 43, the technical description?

MR. BAHRMAN: That is correct. We have the prototype project, Hellsjon, which is listed there, that was an original development project, which is not a commercial project. It's a development project where a lot of this technology was tested --

MS. RANDELL: It's also not H, high voltage, right? It was plus or minus 10-kV?

MR. BAHRMAN: That is correct.

MS. RANDELL: Okay.

MR. BAHRMAN: So we're looking at Gotland, Tjaereborg, Directlink, Cross Sound Cable, and Murraylink. We pass on Eagle Pass because this is not a high voltage DC project, this is a FACTS project where we have two STATCOMs which can be connected and back to back. The primary purpose of that project is for voltage support in the area. But that being said, it can be used as a back

to back interconnection for trade with Mexico, but it is not high voltage. The Troll Project is the project that is being commissioned as we speak.

MS. RANDELL: So it's not in operation?

MR. BAHRMAN: Not in commercial operation, yes.

MS. RANDELL: Not in commercial operation. And the Tjaere -- that's T-j-a-e-r-e borg --

MR. BAHRMAN: That is correct.

MS. RANDELL: -- a project is plus or -- 9-kV. So that's not H either, right?

MR. BAHRMAN: It's using the same technology, the same valves, the same control. It was a project designed to look for large offshore wind projects, but it is not high voltage because it's low power.

MR. BAHRMAN: And of these five projects that we're now down to, two of them, Gotland and Tjaereborg, are both wind generation interconnection?

MR. BAHRMAN: Gotland is used in parallel of AC transmission, the combination of the two on the island of Gotland. It brings wind power to the load center, which is on the other opposite end of the island, and the DC Light is an all underground solution. It operates in parallel of AC. And the additional voltage

support not only transmits the power, but it also regulates the reactive power requirement of the wind and it increases the utilization and the transfer capability of the AC transmission.

MS. RANDELL: Mr. Bahrman, when I ask a question, try to limit the answer. So let's -- let's try that again. Gotland and Tjaereborg are wind generation interconnection, yes?

MR. BAHRMAN: Yes.

MS. RANDELL: Thank you. And the Troll Project, which is not in commercial operation, is a connection to an oil platform?

MR. BAHRMAN: Gas extraction platform, yes.

MS. RANDELL: And the Directlink project, which is one of your five --

MR. BAHRMAN: Yes?

MS. RANDELL: -- that is -- that connects asynchronous systems?

MR. BAHRMAN: Originally yes, but no longer. It operates in parallel. There is a parallel AC tie. So it is a synchronous interconnection to date.

MS. RANDELL: Okay. And we talked about the prototype. And there are two projects that were designed to interconnect electricity marketing areas,

Murraylink and Cross Sound?

MR. BAHRMAN: You could say so, yes.

MS. RANDELL: Okay. And your chart on page 43 has an order date of December 2000 for Murraylink. And that was commissioned late in '02?

MR. BAHRMAN: That is correct.

MS. RANDELL: And Cross Sound Cable began commercial operation in August of '03?

MR. BAHRMAN: Well of course there's a history there that everyone is aware of --

MS. RANDELL: The Council is aware of that. I'm just trying to get the dates --

MR. BAHRMAN: So --

MS. RANDELL: -- because the order --

MR. BAHRMAN: -- the final commercial operation -- and most recently then the cables are now being put to the required depth.

MS. RANDELL: Okay. The order dates in your chart don't match to the operation dates, right?

MR. BAHRMAN: That is correct.

MS. RANDELL: Okay. Now, Cross Sound Cable is 330 megawatts?

MR. BAHRMAN: On the receiving side it can deliver 330 megawatts, yes.

MS. RANDELL: And it uses a 330-megawatt converter?

MR. BAHRMAN: A little bit bigger because it has to go two ways --

MS. RANDELL: Um-hmm --

MR. BAHRMAN: -- yes.

MS. RANDELL: Okay. And you -- you were very careful to say that it was 330 megawatts on the receiving side. That's because there are system losses?

MR. BAHRMAN: That is correct.

MS. RANDELL: And so on the -- the amount input has to be greater?

MR. BAHRMAN: That is correct with any transmission system.

MS. RANDELL: Right. And the converter for Cross Sound is the largest converter for VSC HVDC in operation?

MR. BAHRMAN: Correct.

MS. RANDELL: And before that, the largest size was for which project?

MR. BAHRMAN: Well, Murraylink came on a little bit earlier, and that is 200 megawatts.

MS. RANDELL: And before that, you were dealing with 60-megawatt converters?

MR. BAHRMAN: Yes. In -- in the transition from Directlink and Gotland, Directlink is 180 megawatts, but it's made up of three parallel circuits, a total of 180 megawatts delivered. And then there was a doubling in voltage and current going from there to Murraylink and Cross Sound.

MS. RANDELL: Thank you. Adding up the megawatts for the five projects you listed, do you know what the total is?

MR. BAHRMAN: Not offhand, but we can all do the exercise if you'll bear with us. I mean if you look at the total number of converters and add them up -- I'll let Leif do that.

MS. RANDELL: Sure.

(Pause)

MR. RONSTROM: I reach the number of 767 megawatts.

MS. RANDELL: It works for me. So of the total of 760 megawatts in operation, nearly all of them have been in service for less than five years, right?

MR. BAHRMAN: Correct.

MS. RANDELL: And the longest one in service came in in 1999 and that was 50 megawatts?

MR. BAHRMAN: By means of long, you mean

duration?

MS. RANDELL: Duration yes --

MR. BAHRMAN: Yes --

MS. RANDELL: -- I'm sorry, not length. Thank you. And more than half of the megawatts in operation have been in operation for two years or less?

MR. BAHRMAN: That's correct.

MS. RANDELL: Thank you. And none of these five systems is a multi-terminal?

MR. BAHRMAN: That is correct.

CHAIRMAN KATZ: Could you elaborate on what multi-terminal is?

MR. BAHRMAN: Yes. If you look at the study results, there were three configurations that were identified for study, we called them options 1, 2 and 3.

MS. RANDELL: Mr. Bahrman, would it help if we put that up on the screen so that you could explain the multi-terminal for Option 2 versus the others? We can do that if that would be helpful.

MR. BAHRMAN: I'm not prepared to do that, but if you are, yes.

MS. RANDELL: We can do it if you think it would be helpful in describing it to the Council --

MR. BAHRMAN: I don't --

MS. RANDELL: If not --

MR. BAHRMAN: I don't -- I don't need it --

MS. RANDELL: Fine.

MR. BAHRMAN: -- if we -- it is -- for those of you following along, if you look at the technical report on the technology, there are -- there's a figure --

MS. RANDELL: Pages 7 and 8?

MR. BAHRMAN: Pages 7 and 8. And there's a Figure 8 -- and bear with me here --

CHAIRMAN KATZ: Okay, please proceed with your answer --

MS. RANDELL: Would it be helpful --

MR. BAHRMAN: Figure 5 and Figure 8, they list the -- Figure 4 through 8 list the different options. Option 2 is multi-terminal --

MS. RANDELL: Indeed, and what does --

MR. BAHRMAN: -- and there are variations of that --

MS. RANDELL: What distinguishes -- what makes Option 2 multi-terminal and Option 1 and 3 are not?

CHAIRMAN KATZ: Just -- I'm going to interrupt here -- we think it might be helpful to members of the audience to have the visual on this. So we're going to go off the record for a moment and allow that to

be put up on the screen.

MS. RANDELL: Certainly.

MR. TAIT: It would be helpful to the Council.

MR. BAHRMAN: Okay.

(Off the record)

CHAIRMAN KATZ: I'm going to ask that you begin your answer again using this figure.

MR. BAHRMAN: Thank you. There were three options identified, there could be others, but there were three options that were studied, and there are three options for which we have given price estimates.

Option 1 is -- consists of point to point transmission. And that is distinguished from multi-terminal in that you have an input converter station and an output converter station. It is bi-directional, but it's a two terminal circuit. And you see that in Option 1. A terminal is represented by the box with the AC to DC conversion symbol inside.

The Option 2, this is the basic option where you see intermediate taps at Singer and Devon. This is distinguished from Option 1 by the fact that you have more than two terminals on the link.

Option 3 is another two terminal -- Option

3 is in Figure 8 and it is -- keep going please -- and this is a hybrid solution where we have AC underground cable as proposed for Phase 2, Norwalk, Singer, East Devon. And then we have three parallel two terminal DC links, not multi-terminal, for the longer section where the all undergrounding is problematic. There is not a limitation with this, but these are two terminal lines in parallel. The rating is similar to Cross Sound. The configuration is similar to Directlink.

CHAIRMAN KATZ: So Option 3 is not multi-terminal?

MR. BAHRMAN: No. Only Option 2 and the variations thereof are multi-terminal.

MS. RANDELL: And Mr. Bahrman or whoever -- this might be you, Mr. Mukerji -- there are no models according to your reports that enable you to do load flow or stability on multi-terminal?

MR. MUKERJI: I think Dave --

MR. DICKMANDER: That is correct. The models that are available for study of stability are point to point models.

MS. RANDELL: You also concluded that Option 3 is not feasible, correct?

MR. BAHRMAN: Well, what the DC -- one of

the criteria to be addressed is --

MS. RANDELL: Mr. Bahrman, just let me stop you. Your -- does your report say that ABB has concluded that Option 3 is not feasible?

MR. BAHRMAN: No.

MS. RANDELL: No, okay. Go ahead.

MR. BAHRMAN: What it identified is that one of the criteria was not met at the stations Norwalk and Singer. And that criteria specifically is the third harmonic, the low order harmonic resonance that has been identified as being problematic with all the capacitors and all the capacitance from the cables. But as far as at Beseck and Devon, the DC does not contribute additional capacitance and the converter impedance suppresses that. But at the end where it cannot influence, at the opposite end, Norwalk, with the hybrid scheme, the feasibility would depend on the same low order harmonic filters that have been proposed for Phase 2 with an AC solution.

MS. RANDELL: Putting those issues aside with filters, don't you also have the issue with Option 3 that you're separating the AC Devon to Norwalk section from the strong source at Beseck?

MR. BAHRMAN: I -- I don't think we're separating. They are interconnected by means of

transmission capacity of over 1100 megawatts. So what you will -- what you can say and perhaps the basis for your question is that the DC circuits do not contribute significantly to the short-circuit levels at Devon. The short-circuit contribution is limited to the rating of the converters themself. But on the other hand, the voltage support from the converters is as if there were a virtual generator there. The converters not only control the real power, but they regulate the voltage and control the reactive power just like a generator would at Devon.

MS. RANDELL: Now for Option 1, you did a load flow study?

MR. DICKMANDER: Correct.

MS. RANDELL: And what size converters were used for the load flow study?

MR. DICKMANDER: In the initial runs in the load flow study, they were 370. I believe they were increased to 530 for later runs. We did not attempt to optimize that. That was something the -- the final choice on that was left for later detailed analysis.

MS. RANDELL: And you did stability using what size converters for Option 1?

MR. DICKMANDER: I would need to do a little bit of checking to answer that question.

MS. RANDELL: Okay.

MR. BRIAN EMERICK: Would you repeat the question please, Miss Randell?

MS. RANDELL: I'm sorry?

MR. EMERICK: Would you repeat the question.

MS. RANDELL: Yes. I asked what converter size they used in modeling the stability analysis for Option 1.

MR. EMERICK: Thank you.

CHAIRMAN KATZ: Off the record.

(Off the record)

MR. DICKMANDER: That was inadvertently left out of the report. We'll need to come back with an answer on that.

MS. RANDELL: Thank you. And then on Option 2 you didn't do either load flow or stability analysis, correct?

MR. DICKMANDER: That is correct. However, the results from the Option 1 load flow we would expect to have similar conditions in Option 2 since the number of converters are the same at the four terminals. We would not expect a huge difference in load flow results between Option 1 and Option 2. But no, Option 2 has not been

studied --

MS. RANDELL: And --

MR. DICKMANDER: -- for load flow --

MS. RANDELL: -- one would need to do that, correct?

MR. DICKMANDER: Yes. If Option 2 were selected, that would need to be done.

MS. RANDELL: Now, the proposals that you've made in these two reports are not the first proposal and first contact with Northeast Utilities on HVDC for this project, right?

MR. MUKERJI: I'm sorry, could you repeat the question?

MS. RANDELL: Sure. I'll rephrase. Mr. Phelps at the beginning of the hearing asked how ABB came to be involved. And you --

MR. MUKERJI: That's right --

MS. RANDELL: -- one of you gentlemen testified that ABB was engaged by NU to do studies and that's what's shown in the report, correct?

MR. MUKERJI: Yes.

MS. RANDELL: Didn't ABB prior to being engaged by Northeast Utilities present an unsolicited proposal to Northeast Utilities regarding the use of HVDC

-- VSC HVDC?

MR. MUKERJI: I believe so. There was one meeting with Northeast Utilities.

MS. RANDELL: And it was a marketing presentation?

MR. MUKERJI: That's correct.

MS. RANDELL: And you had a similar marketing presentation with United Illuminating?

MR. MUKERJI: I believe so, yes.

MS. RANDELL: Anybody else?

MR. MUKERJI: We do marketing presentations for DC Light to almost every utility in the country.

MS. RANDELL: Let me rephrase --

MR. MUKERJI: Yeah.

MS. RANDELL: And what's the timeframe of these proposals, the marketing proposals to NU and UI?

MR. MUKERJI: I don't believe there was a marketing proposal as such. It was a -- it was a technology presentation, as viable technology for Southwest Connecticut.

MS. RANDELL: And did you make a similar proposal or have a similar meeting with anybody else in Connecticut about using HVDC -- VSC HVDC for the Middletown/Norwalk project?

MR. MUKERJI: Personally, I'm not aware of any.

MR. BRIAN O'NEILL: Madam Chairman, if I may?

CHAIRMAN KATZ: Yes.

MR. O'NEILL: I'd like to clarify the record. I understand these are technical studies and not proposals. Are they, in fact, proposals or are they studies?

MS. RANDELL: I'll ask the gentleman the question. Are these proposals for technically feasible options that you think could be used for the Middletown/Norwalk project?

MR. MUKERJI: Northeast Utilities asked us to come with technical alternatives, which -- to study technical alternatives which would be -- which be feasible in terms of criteria developed by ISO New England and Northeast Utilities, employing underground DC technology.

CHAIRMAN KATZ: So they are studies of technical alternatives?

MR. MUKERJI: That's correct.

MR. O'NEILL: Thank you, Madam Chairman.

MS. RANDELL: Is anyone else on the panel aware of any other presentations made by ABB prior to

being engaged by Northeast Utilities with respect to the use of VSC HVDC for this project?

MR. BAHRMAN: Not I.

MR. RONSTROM: I'm not.

MR. LARSSON-HOFFSTEIN: Not I.

MS. RANDELL: Thank you. I take it from your response that this is not a proposal, that the cost and data you've submitted are not a cost estimate to do this work, is that correct?

MR. BAHRMAN: They are indeed a cost estimate to do the work. We have broken it down into converter costs on a turnkey basis, cable costs and cable installation costs. The -- the -- they should be pretty good budgetary estimates. We have stated the assumptions on which they're based, what's included, what's not included. The range that was given for cable installation costs and the assumptions for cable installation costs, there we have the greatest degree of uncertainty because that would require a detailed route survey. But I will defer to Magnus and he can talk about the basis for those estimates.

MS. RANDELL: Well, let's do that question by question so we can follow it. Now in response to your answer to CL&P and UI Interrogatory 16, which provided

converter cable and installation, the companies asked for a disaggregation of costs by components. We asked you to take that apart by labor, material, equipment, overhead, and contingency. Do you recall that question?

MR. BAHRMAN: Yes.

MS. RANDELL: And your response says that you are not prepared to give more details at this stage. Do you mean you don't have more details or you're not going to provide us more details?

MR. BAHRMAN: We very well know the details on which the estimates are based. We regard the breakdown to be proprietary information. So this is what -- we think you have a sufficient breakdown for the cables. We have stated the assumptions and the uncertainties and what is included and what is not included.

MS. RANDELL: Your answer --

MR. BAHRMAN: If you would like, you know, the overheads from project to project basis, they are in our annual report for the ABB group, but we do not disclose those.

MS. RANDELL: And the overheads are embedded in these numbers or on top of these numbers?

MR. BAHRMAN: They're embedded in these numbers.

MS. RANDELL: Okay. Your answer indicates that you based these numbers on your Phase 1 bid, ABB's Phase 1 bid to bury 115-kV XLPE cable for the Bethel to Norwalk project, is that correct?

MR. LARSSON-HOFFSTEIN: That's correct.

MS. RANDELL: Did you modify those --

CHAIRMAN KATZ: Just -- could we have a verbal answer on that one.

MR. ASHTON: An audible --

CHAIRMAN KATZ: Audible.

MR. LARSSON-HOFFSTEIN: Yes.

MS. RANDELL: Yes. Did you modify that estimate to take into account differences between the Bethel to Norwalk route and the Middletown to Norwalk route?

MR. LARSSON-HOFFSTEIN: We were limit for it with respect to the length of the route and the number of cables.

MS. RANDELL: Anything else?

MR. LARSSON-HOFFSTEIN: The actual width and depth of the required trench.

MS. RANDELL: Did you compare the roads in which the cable will be installed for the Bethel to Norwalk route on the one hand and the Middletown to

Norwalk route on the other?

MR. LARSSON-HOFFSTEIN: No.

MS. RANDELL: Did you look to see whether the roads had the same materials composition?

MR. LARSSON-HOFFSTEIN: No.

MS. RANDELL: Determine whether the same types of materials might be beneath the road surface?

MR. LARSSON-HOFFSTEIN: No.

MS. RANDELL: Did you consider the number and density of other utilities buried beneath the road surface?

MR. LARSSON-HOFFSTEIN: No.

MS. RANDELL: The ability to use the shoulder for construction versus traffic lanes?

MR. LARSSON-HOFFSTEIN: No.

MS. RANDELL: Did you consider Connecticut Department of Transportation procedures for doing installation in state highways?

MR. LARSSON-HOFFSTEIN: Only to the degree that it was known for the Phase 1 bid.

MS. RANDELL: And did you consider what would be required to do street reconstruction?

MR. LARSSON-HOFFSTEIN: Yes, according to what's required on the Phase 1.

MS. RANDELL: Okay, you assumed that whatever you would have to do for Phase 1, you would do for Phase 2?

MR. LARSSON-HOFFSTEIN: Yeah.

MS. RANDELL: Now all of these factors that I've just listed, materials composition, materials beneath the road, number and density of utilities, shoulder versus traffic lanes, reconstruction and installation requirements of the State Department of Transportation, they will all affect the cost of installation, won't they?

MR. LARSSON-HOFFSTEIN: Yes, certainly.

MS. RANDELL: As well as the time?

MR. LARSSON-HOFFSTEIN: Yes.

MR. BAHRMAN: I'd like to add one additional part. And that is that the underground for the cable installation is not constrained by length. With the AC underground, you know, solution there is the desire to make it as short as possible because of all the issues that have been discussed here before. However, with the DC there is not a limitation on length. So a more indirect route could be used in some areas. And in some areas it wouldn't necessarily have to be in duct banks. It could be direct buried for instance. And this would be an off setting, you know, cost. This would reduce the

cost. So it depends on the route.

MS. RANDELL: You're not talking limitations on the ability to construct AC, correct you're talking about --

MR. BAHRMAN: Well, the physical --

MS. RANDELL: -- electrical --

MR. BAHRMAN: -- the physical, yes, ma'am.

MS. RANDELL: Fine. How many river crossings are included in your estimate for the Phase 1, Bethel to Norwalk project?

MR. LARSSON-HOFFSTEIN: I don't have the number here --

CHAIRMAN KATZ: Would you like to go off the record for a moment?

MR. LARSSON-HOFFSTEIN: That's --

CHAIRMAN KATZ: We'll go off the record.

(Off the record)

CHAIRMAN KATZ: On the record.

MR. BAHRMAN: On the record. Did you -- one clarification. Did you ask about the number of river crossings for Phase 1 or for Phase 2?

MS. RANDELL: I asked for Phase 1. In doing -- you said that the estimate -- the cost estimate here is based on your cost estimate from Phase 1. And I'm

asking how many river crossings are included in your Phase 1, Bethel to Norwalk estimate?

MR. LARSSON-HOFFSTEIN: I don't have that information available.

MR. BAHRMAN: We'll have to come back on that.

MS. RANDELL: Subject to check --

MR. BAHRMAN: Yes --

MS. RANDELL: -- assume with me the number is zero, how many river crossings are there -- will there be required to install the HVDC cable for Phase 2?

MR. LARSSON-HOFFSTEIN: I don't have that information available. It is the number that was indicated on the maps on the Applicants' Siting Council application.

MS. RANDELL: But you didn't cost those out separately?

MR. TAIT: When we're talking about river crossings, is this for the whole line or for what?

MS. RANDELL: The underground installation.

MR. TAIT: Well that could be the whole line. So what -- what -- what are you talking about? It could be 20 miles, it could be --

MS. RANDELL: Mr. McDermott tells me the 17

is for the portion between East Devon and Norwalk. There may be more along the line. A very good question. Thank you, I appreciate the clarification. There are at least 17. But you didn't cost out river crossings separately, right?

MR. LARSSON-HOFFSTEIN: This one -- the longest one -- I don't remember the name -- (pause) -- this one close to Devon I think that they made us -- looked on separately. The other one we didn't look at separately.

MS. RANDELL: So for one river crossing, then you say you modified your Phase 1 estimate to include that river crossing? I -- I misunderstood. I thought you testified -- Mr. Hoffstein?

MR. LARSSON-HOFFSTEIN: Hoffstein.

MS. RANDELL: Hoffstein. I thought you testified that you didn't modify Phase 1 at all for anything other than -- I'm sorry, I did not write that down -- you did not modify Phase 1 estimates at all for river crossings? Did I misunderstand?

A VOICE: Phase 1?

MR. LARSSON-HOFFSTEIN: The --

MS. RANDELL: Length -- I'm sorry -- length and number of cables were your two changes to the Phase 1

estimate. So you're now adding something to that?

MR. LARSSON-HOFFSTEIN: I have to correct myself. For the underground part, except the river crossings, we used the Phase 1. And we -- we have included that for all the -- except the longest river crossing. The longest river crossings we looked into separate and -- except on what -- we made estimate for that separately.

MR. TAIT: Miss Randell, I guess this goes to Mr. Fitzgerald as well, as you read the new legislation is cost a factor in our determination of whether to go underground or not or has the Legislative told us that cost is --

MS. RANDELL: I think we'll each take a shot at that --

MR. TAIT: Because my question goes to relevancy --

MS. RANDELL: Yes --

MR. TAIT: -- how far do we get -- do we get into costs?

MS. RANDELL: Yes, I believe cost is relevant. And we'll be happy to brief this --

MR. TAIT: At some point I think we need that --

MS. RANDELL: -- and maybe we already have -- I would -- I would argue that if something is so expensive that no one would reasonably build it, that that is not feasible.

MR. TAIT: Judgment notwithstanding the verdict, huh?

MS. RANDELL: And that -- also that would be inconsistent with the Council's requirement --

MR. TAIT: Well --

MS. RANDELL: -- of only siting things at a reasonable cost.

MR. TAIT: Okay. I'm not saying --

MS. RANDELL: I hear you --

MR. TAIT: -- don't go forward, but we would like some briefing at some point on how far we go into this with the new legislation.

CHAIRMAN KATZ: From all parties and intervenors.

MR. TAIT: From all parties.

MR. FITZGERALD: I -- I'm hurt because I think we already submitted a brief on that.

MR. TAIT: Then it's my fault if I haven't done my homework. If you would refer me to it or send me a copy, I'll read it avidly.

MR. FITZGERALD: But I'd also say that regardless of the answer to that question, these questions are still relevant --

MR. TAIT: But they seem to be leading --

MR. FITZGERALD: -- because you're looking at a -- you could be looking at a choice between undergrounding technologies for one thing and it also relates to --

MR. TAIT: The environment --

MR. FITZGERALD: -- the overall credibility of the whole report.

MR. TAIT: And the environmental effects and --

MS. RANDELL: To the extent things were or were not included or underestimated, we think it is relevant to credibility of the witnesses and the feasibility.

River crossings are generally more expensive than installing in the streets, correct?

MR. LARSSON-HOFFSTEIN: Generally, yes.

MS. RANDELL: And to the extent you did include any river crossing within these estimates, what dollar amount is reflected for the river crossing?

MR. ASHTON: Are we -- Miss Randell, would

you be willing to qualify that a little bit? Are we talking an incremental cost of going under a river or are we talking the components it cost to -- just what exactly -- what costs are you referring to here?

MS. RANDELL: I'll take it in whatever fashion the witness is most comfortable, whether it's incremental to the cost of -- if it would cost X dollars to install in the streets for that length of the river crossing, does it -- how much more than X dollars does it cost to do the river crossing in your estimate?

MR. LARSSON-HOFFSTEIN: We have not estimated that in detail.

MS. RANDELL: Okay. Did you take into account in your estimate in your report here for options 1, 2 and 3, increases in raw materials costs since you submitted the bid to install in Phase 1 for Bethel to Norwalk?

MR. LARSSON-HOFFSTEIN: No, we have not included that in our interrogatories. Copper has increased since that. It was based on two thousand eight hundred U.S. dollar and today it's up more than three thousand.

MS. RANDELL: And to the extent you use steel and aluminum, they've gone up significantly as well

in the last year, haven't they?

MR. LARSSON-HOFFSTEIN: Usually when we make offers, we have made variation close.

CHAIRMAN KATZ: I'm going to interrupt here. Gail, are you picking up this witness?

COURT REPORTER: Yes, I am.

CHAIRMAN KATZ: Great. Thank you.

MS. RANDELL: You also indicate in your cost estimate that you have certain assumptions versus the amount of excavation, rock volume, ability to blast and the like. Did you attempt to validate those assumptions?

MR. LARSSON-HOFFSTEIN: This numbers yes, but rough cost estimate. And we expect at later state if there would be a request for quotation, there will be some road survey made so we'll know that numbers at that stage.

MR. BAHRMAN: This is why we gave a range for the cable installation costs, whereas we did not give a range for the other costs because it does indeed require a detailed route survey. And the range is quite broad so it can allow for certain things, but before you get a precise estimate on the cable installation, whether it's AC or DC, you need to do a detailed route survey.

CHAIRMAN KATZ: Let me follow up on that. Theoretically if the Council was interested in a detailed

route survey from East Devon to Beseck or East Devon further north to like Oxbow, how long would it take ABB to develop the costs for a detailed route?

MR. LARSSON-HOFFSTEIN: Usually it takes about three to four months.

CHAIRMAN KATZ: Three to four months?

MR. LARSSON-HOFFSTEIN: Yeah.

CHAIRMAN KATZ: Thank you.

MS. RANDELL: Mr. Hoffstein, when you prepared the range -- well let me start with did you prepare the range, this is your range on the cost estimates in answer to CL&P/UI Interrogatory 16, and it's also in your report?

MR. LARSSON-HOFFSTEIN: Could you repeat the --

MS. RANDELL: Yes, certainly. Was this your range of total price in cable installation range? Did you prepare that or did somebody else?

MR. LARSSON-HOFFSTEIN: I got information from somebody else at our installation department.

MS. RANDELL: So you -- you -- you prepared numbers and then someone added a range to it?

MR. LARSSON-HOFFSTEIN: Our installation department have used numbers from contractors for Phase 1

and they had indicated this range.

MS. RANDELL: I think we've talked about what's in your numbers or what isn't in terms of the comparison between Phase 1 and Phase 2 on installation. Am I correct that your cost data, the cost numbers shown on Interrogatory 16 and in your report, don't include the cost of land acquisition?

MR. LARSSON-HOFFSTEIN: That's correct.

MS. RANDELL: And that would include the land for 10 converter stations?

MR. RONSTROM: That is correct.

MS. RANDELL: How much land is required per converter?

MR. RONSTROM: I will answer that. That depends on the solution. At the end of the technical description document there are indicative maps over sites required for a different number of converters --

MS. RANDELL: Well, let me try it a different way, Mr. Ronstrom. How large is the converter site, fence line to fence line for the Cross Sound Cable 330-megawatt converter? Pick either the New Haven or the Long Island side.

MR. RONSTROM: I can't -- I don't remember those figures --

MS. RANDELL: Okay --

MR. RONSTROM: -- in my head.

MS. RANDELL: And the -- maybe during the lunch break you could check on that?

MR. BAHRMAN: We will come back.

MS. RANDELL: Thank you. And the cost of land could run into tens of millions of dollars?

MR. RONSTROM: I have no figures on the cost of land.

MS. RANDELL: Okay. And you didn't include taxes and permit costs?

MR. RONSTROM: That is correct.

MS. RANDELL: Mr. Hoffstein, does your estimate include the cost of constructing the portion of the project from Middletown to Beseck?

MR. LARSSON-HOFFSTEIN: No, it does not.

MS. RANDELL: And do you know what the --

CHAIRMAN KATZ: Can I -- can we just --

A VOICE: What was your answer please?

CHAIRMAN KATZ: Can we have that answer again please.

MR. LARSSON-HOFFSTEIN: Middletown to Beseck is not included.

MS. RANDELL: And if the companies were to

construct this project, they would have to incur those costs? Yes?

MR. LARSSON-HOFFSTEIN: Yes.

MS. RANDELL: And did you include in your cost estimate the work at the AC substations and switching stations at Scovill Rock, Beseck, East Devon, Singer, and Norwalk that would need to occur?

MR. RONSTROM: We did not include any costs for Scovill Rock.

MS. RANDELL: Wouldn't Scovill Rock need to be expanded for this project?

MR. RONSTROM: Maybe, but that was not in the scope of what was requested from ABB to study.

MS. RANDELL: And you didn't include costs for Beseck, East Devon, Singer, and Norwalk either, did you?

MR. RONSTROM: We included all the substation costs, yes.

MS. RANDELL: The AC substations and switching stations?

MR. RONSTROM: Let me think a minute here.

CHAIRMAN KATZ: Off the record.

(Off the record)

MR. RONSTROM: We have included all costs

for the substations for the AC part also up to the point of connection to the grid. That is probably at the fence of the converter site.

MS. RANDELL: How much did you include for the cost of building the Singer Substation as a 115-kV station?

MR. RONSTROM: Now you're asking me to go into details of numbers that we already said we didn't want to do.

MS. RANDELL: You can tell me in aggregate what number you used for work at the AC substations and switching stations at Scovill Rock, Beseck, East Devon, Singer and Norwalk? And then tell me, if you would, where on the table in Interrogatory 16 those would appear?

MR. RONSTROM: As I said before, we did not include anything for Scovill Rock.

MS. RANDELL: Okay. Then let's focus on the others, Beseck, East Devon, Singer and Norwalk, what column --

MR. RONSTROM: In the table -- in the answer to Interrogatory 16 we state the price for converter station price, that would be Column No. 3 from the left.

MS. RANDELL: And that includes something

more than the cost of the converter itself and your associated HVDC equipment?

MR. RONSTROM: That includes the cost of the converter itself and the equipment needed to connect to the AC grid.

MS. RANDELL: And that includes building a new substation in Bridgeport, a new 115-kV substation at Singer?

MR. RONSTROM: It includes the part that would be necessary to connect the converter station. Whatever other installations that the utility would want to do on the 115-kV side is not included.

MR. ASHTON: May I ask one question in this same area? Typically when you are working with the first cut at the cost of a system facility, what have you, you use fairly high contingency costs because there are a lot of unknowns. As you get into -- closer to a specific project with specific design details, more becomes known, the contingency costs drop. What percent contingency did you use in these numbers as a percent, not the dollars?

MR. TAIT: If any?

MR. ASHTON: If any? He said they used some.

MR. RONSTROM: I can't answer that

question.

MR. ASHTON: May I ask why you can't answer it?

MR. RONSTROM: Well, basically because I don't know for sure.

MR. ASHTON: What do you believe is the figure subject to check?

MR. RONSTROM: Well --

MR. ASHTON: Or figures if you used different ones on different elements --

MR. BAHRMAN: I think we can respond by saying that you're correct, qualitatively we have a higher contingency in budgetary estimates --

MR. ASHTON: Yeah --

MR. BAHRMAN: -- than we do where we know all the details --

MR. ASHTON: Right --

MR. BAHRMAN: -- I mean that's natural. But what the level of that is we can't say right now.

MR. ASHTON: Why is it you can't say?

MR. BAHRMAN: Well, No. 1, we don't know. And No. 2, then it's a further breakdown that we discussed earlier, so -- so there is a contingency included --

MR. ASHTON: There's nothing proprietary

about a contingency percentage, is there?

MR. BAHRMAN: Not exactly.

MR. ASHTON: Would you be willing to think about it and share it with us --

MR. BAHRMAN: We'll --

MR. ASHTON: -- maybe after lunch?

MR. BAHRMAN: We'll look into what we have in the estimates.

MS. RANDELL: Did you include in your cost estimate, Mr. Hoffstein, AFUDC, interests costs on the company's investment?

MR. LARSSON-HOFFSTEIN: Uh -- (pause) -- no, it's not included.

MS. RANDELL: Did you include the cost of creating the Beseck Switching Station and adding two new positions for converters?

MR. RONSTROM: As we said before, we included -- we did not include the cost of the land for the Beseck Switching Station. We included the cost of the equipment, buildings, and for the converter -- the converter itself and the equipment necessary to connect to the 345-kV system at Beseck.

MR. BAHRMAN: I would like to clarify a little bit. When we're talking about substation costs

that are included, we're talking about the additional circuit breakers, protections, measuring equipment that is necessary to tie the converters in to the substation. We are not talking about the external work of looping additional AC lines into the substation when you get into Beseck. So what we're saying there are some partial offsets to the estimates, but it doesn't include everything in a substation to loop in the lines as planned for whatever reason at Beseck. So some of the substation costs would be included, those associated with tying in the converters. It could be additional breaker bays and circuit breakers, measuring equipment.

MS. RANDELL: Did you include, Mr. Hoffstein, in the cost of your estimate the cost of posting a letter of credit or other security?

COURT REPORTER: One moment please.

(Pause).

MR. RONSTROM: No, it's not included

MS. RANDELL: And would it be appropriate to require the posting of a letter of credit or other security given that ABB's credit rating is below investment grade? It would be a reasonable thing to require?

MR. BAHRMAN: I think we can go back to the

earlier statement that this is technical. I will surmise by saying that we have a number of projects ongoing where our clients have not asked us for a letter of credit, have not asked us for a performance bond. We have some that have, typically municipalities. It's common that they do so.

MS. RANDELL: Mr. Hoffstein, you referenced a request for solicitation, is that correct, or did I misunderstand you? I thought a few minutes ago you talked about a request for solicitation?

MR. LARSSON-HOFFSTEIN: No.

MS. RANDELL: No? Okay. If VSC HVDC were selected for this project, ABB would be the only manufacturer of both the cable and the VSC HVDC converter who could supply this project, correct?

MR. BAHRMAN: Correct.

CHAIRMAN KATZ: Just the concept that you're exploring that someone could be a monopoly is ironic.

(Laughter)

MS. RANDELL: Well, our industry has been restructured as you probably know --

MR. ASHTON: There's not too many transmission competitors.

MS. RANDELL: I used to -- well never mind, we won't go there -- (laughter) --

MR. BAHRMAN: Others have tried. You know, it may come --

MS. RANDELL: But not --

MR. BAHRMAN: -- but if we go back, you know, with the introduction of DC, there became -- once there became a market, there were competitors. Cables -- I have heard that there may be solid dielectric cables for DC developed, but I don't know that they're in service or that they have passed muster in terms of testing.

MS. RANDELL: Exactly. Thank you for helping me out with that question. Aren't there business risks associated dealing -- with dealing with a sole source vendor?

CHAIRMAN KATZ: I -- I'm hesitant here because these are technical people. You -- we've brought a bunch of engineers in and you're starting to ask them questions that are more business questions. So, I'm going to --

MS. RANDELL: Well, might I be heard on that? I believe that Mr. Bahrman is the U.S. marketing manager for HVDC. And I think that does include issues related to, you know, sole source and financial --

CHAIRMAN KATZ: I'll allow it.

MR. BAHRMAN: I might add, as someone said, I'm not just a marketing guy. I have experience with DC for 30 some years. I've seen the technology evolve. I have project experience. I have experience doing system studies. And we see a gradual improvement of the technologies. And so -- so I do work to help our customers with technical solutions, which includes marketing sales, yes.

MS. RANDELL: Actually, I think my question was isn't there business risks associated with dealing with a sole source vendor?

MR. BAHRMAN: That's up to the utilities to ask.

MS. RANDELL: And your 30 years reference isn't with respect to VSC HVDC? As we discussed earlier, over half the megawatts for VSC HVDC have been in service for about two years?

MR. BAHRMAN: That point has been made before, yes.

MS. RANDELL: Okay.

CHAIRMAN KATZ: Miss Randell, are we getting to a good point in your cross-examination for the lunch break, or was there a thought you'd like to finish

before --

MS. RANDELL: Could I just do a couple hopefully quick ones --

CHAIRMAN KATZ: Okay.

MS. RANDELL: -- quick questions -- thank you. In dealing with a sole source vendor, doesn't a utility need to be concerned about the availability of spare parts in the future?

MR. BAHRMAN: Yes.

MS. RANDELL: And the availability of maintenance capabilities in the future?

MR. BAHRMAN: Yes.

MS. RANDELL: And here where there may be a need to add VSC HVDC converter stations in the future, it's a legitimate business concern for the utility to be sure that those converters will be available when needed, correct?

MR. BAHRMAN: Yes.

MS. RANDELL: And for the future we're talking 30 or more years?

MR. BAHRMAN: Um-hmm.

MS. RANDELL: Thank you. This would be a good time.

CHAIRMAN KATZ: Great. We are adjourned

until 1:00 o'clock -- or recessed I should say.

(Whereupon, a luncheon recess was taken.)

CHAIRMAN KATZ: I think we're ready to resume. Miss Randell, I'm trying to plan our afternoon in an orderly manner. Can you just give me an idea of where we are in your cross-examination?

MS. RANDELL: Probably about an hour left.

CHAIRMAN KATZ: Okay.

MS. RANDELL: Maybe a little longer.

CHAIRMAN KATZ: Okay. We're --

A VOICE: An hour --

CHAIRMAN KATZ: We're going to ask, therefore, the witnesses to please give brief answers and then wait for a follow-up question from the Applicants' attorney.

A VOICE: (Indiscernible) --

CHAIRMAN KATZ: Yes -- yes --

A VOICE: (Indiscernible) --

CHAIRMAN KATZ: Right. We have an expression here at the Siting Council about being good Navajos, and that's just reminding you that you not step on each other's words. Wait until the other person completely finishes their statement. It makes for a better transcript. Thank you.

Okay. Do we have a question pending or are we --

MS. RANDELL: No.

CHAIRMAN KATZ: Okay. Please proceed then.

MS. RANDELL: Thank you. I think -- Mr. Dickmander, following up on an answer I think it was you who gave me regarding the load flow studies, would that have been you this morning?

MR. DICKMANDER: Yeah, I believe so.

MS. RANDELL: And I asked you whether you used the 530-megawatt converters or the 370's --

MR. DICKMANDER: That's correct --

MS. RANDELL: -- in doing the load flow studies. And I believe you testified that you did 370's and then you also did the 530's?

MR. DICKMANDER: There were some initial runs with 370's. Later on in the course of the study the converter size was changed to the 530's.

MS. RANDELL: Your load flow report that you submitted with -- as an attachment to the feasibility study relates strictly to the 530's, doesn't it? Let me refer you to page 8 of that report where you state for the purposes of the power flow analysis, the 530-megawatt converters were assumed, differences in results between

370-megawatt converters versus 530-megawatt converters have not been investigated. Would the report be accurate?

MR. DICKMANDER: Which page is this now?

MS. RANDELL: Page 8.

(Pause)

MR. DICKMANDER: It's accurate in the sense that the difference in performance between the two converter sizes has not been investigated in any level of detail. The initial runs that made with 370 megawatts were not later reinvestigated with 530 megawatts to determine differences. Likewise, the runs with 530 megawatts were not rerun with 370 megawatts to determine differences. So in that sense, no conclusions could be made regarding for the various cases which would be more appropriate or not.

MS. RANDELL: Mr. Dickmander, you didn't include any of the results from the runs with the 370-megawatt converters in your report, did you?

MR. DICKMANDER: I would need to investigate that further to answer that.

MS. RANDELL: What would you need to look at?

MR. DICKMANDER: I would need to look at the cases and exactly what the flows were to determine

what that would be.

MS. RANDELL: Let me refer you to page 13, Table 3-1. Does that reflect the cases?

MR. DICKMANDER: Yes, it does.

MS. RANDELL: And wouldn't that indicate that you used 530-megawatt converters?

CHAIRMAN KATZ: Miss Randell, could you just pull your mic a little --

MS. RANDELL: I'm concerned about the tea --

CHAIRMAN KATZ: I want the people in the well-compensated seats in the back to be able to hear you.

MS. RANDELL: Got'cha.

MR. DICKMANDER: Yeah. I mean I believe that Table 3-1 does indicate that 530 megawatts were used.

MS. RANDELL: And in fact, the load flows are 450, I think there's a 500 there?

MR. DICKMANDER: That's correct.

MS. RANDELL: Now, you were going to look to determine what size converters you used for the stability analysis because that's not reflected in the stability report that you filed. Were you able to determine that over the lunch break?

MR. DICKMANDER: We were not. The person

that we were trying to contact over the lunch break was not -- was not -- we couldn't reach that person. So we are waiting to get that information.

MS. RANDELL: Let's turn to system losses. CL&P and UI asked about losses associated with the VSC HVDC system in our Interrogatory 15. Do you recall that?

MR. BAHRMAN: Yes.

MS. RANDELL: And who's the witness on that?

MR. BAHRMAN: Leif will testify to the losses --

MR. RONSTROM: I have trouble hearing what you're saying.

MS. RANDELL: Sorry. Mr. Ronstrom, are you the witness responsible for the answer to Interrogatory CL&P/UI 15, which relates to VSC HVDC system losses?

MR. RONSTROM: Yes, I am.

MS. RANDELL: Do you have that in front of you?

MR. RONSTROM: I do.

MS. RANDELL: Hopefully I will in just a moment -- (pause) -- for the VSC HVDC there are losses on the converters, the stations, as shown in the table, and losses on the cables themselves, correct?

MR. RONSTROM: Yes.

MS. RANDELL: And for Option 1, the total system losses for the VSC HVDC part of the system at a hundred percent power, total up to 6.68 percent, correct?

MR. O'NEILL: Madam Chairman.

CHAIRMAN KATZ: Yes.

MR. O'NEILL: For the benefit of those attending this meeting today, I think it would be helpful if this was shown on the screen.

CHAIRMAN KATZ: Do we have this for --

MS. RANDELL: Actually, we do. And I think -- perhaps Mr. Davenport can help. We do have that --

MR. O'NEILL: Thank you --

MS. RANDELL: -- and I think the math that I gave you may have been incorrect. If we add 5.82 and .92, we get 6.74 percent?

MR. RONSTROM: Well, the table speaks for itself. I mean you can do the addition --

MS. RANDELL: Well, I --

MR. RONSTROM: -- I came to the other number than you did, so I was a bit confused, but -- the station losses are 5.82 and the cable losses are 0.92, estimated losses.

MS. RANDELL: 6.74 percent for the system?

MR. RONSTROM: Yeah, that --

MS. RANDELL: Now, I'll hold until we get this up --

MR. BAHRMAN: And I would clarify that's at full load --

MS. RANDELL: At a hundred percent power --

MR. BAHRMAN: -- and that's for all the converters, yes.

MR. RONSTROM: Yes.

MS. RANDELL: And there are 10 converters?

MR. RONSTROM: Yes.

MS. RANDELL: We're just going to hold until we get it up on the screen for the Council and the other participants.

(Pause)

CHAIRMAN KATZ: Should we have Mr. Davenport linger up here for the remaining of the cross-examination? Will there be other graphics we'll want to show?

MS. RANDELL: Only one perhaps --

CHAIRMAN KATZ: Okay --

MS. RANDELL: -- but he can sit there if it would make it easier.

CHAIRMAN KATZ: Are we off the record or --

off the record.

(Off the record)

MS. RANDELL: And --

CHAIRMAN KATZ: On the record.

MS. RANDELL: For Option 2, the VSC HVDC system losses are 4.41 percent at full power?

MR. RONSTROM: Yes.

MS. RANDELL: Do you know what the equivalent AC system losses are in New England for the 345-kV AC system at peak?

MR. RONSTROM: I cannot answer that personally, I don't know.

MS. RANDELL: Anyone on the witness panel?

A VOICE: No.

MS. RANDELL: The VSC HVDC system losses are quite a lot larger, aren't they, than AC system losses on the transmission system at -- on the transmission system?

MR. BAHRMAN: I think if you look at converter losses for voltage source converters, they are higher from conventional converters. They include the converters themselves, the auxiliary systems, the transformers. Also, we have the cable losses which correspond to the line losses. So one is the substation

loss or the total of all the substation losses at full load and the other is for the transmission losses. So -- so on the other hand, you are -- so -- so we don't know the numbers, but this is just --

MS. RANDELL: Gentle --

MR. BAHRMAN: -- explained the AC --

MS. RANDELL: Is any of you gentlemen aware of what the transmission system losses would be -- and let's define that -- the entire transmission system down to the low size of the distribution transformer in New England -- at peak in New England or anywhere in the country? You can say no.

MR. BAHRMAN: Well, I mean studies show -- and it's based on the dispatch what the losses are --

MS. RANDELL: Is it your testimony -- let me try that again -- is it your understanding that if you compared the VSC DC system losses including the converter and the cables, that that would be significantly higher than the losses associated with the AC transmission system defined as I did, transmission lines and all the way down to the low side of the distribution transformer, which is going to be higher?

MR. BAHRMAN: The converter losses are higher because they include converters and transformers

for a given loading for a given capacity rating.

If you're looking for a generic answer, it may indeed be that the system losses -- and we will exclude the distribution because we're talking about transmission versus transmission -- so we believe that the distribution would be common. And -- but we have come across DC transmission where there actually are lower losses for two reasons. One is you have a longer circuit than we do here, so the converter losses are more than offset by the transmission losses. You're talking about the whole country here. With a shorter line of course you don't have that.

The other thing is is that you can control -- let's say you have in the case of Connecticut a loop, you have 345-kV, you have part of the loop being made up of DC in the case of these options, and one thing you can do with the DC is control the sharing between the more lengthy 345-kV path going up to the north of this and this path. So there are some offsets to the converter losses where you can optimize the loading on the DC, you can control and maybe force another share of loading, which you can't do with AC on the longer the path which may be underutilized. So there are general conversion losses. You're talking about additional equipment are higher. The

system losses in a short line may be higher, but there are some offsets to that, and that would be varying depending on the dispatch and the generation schedule.

CHAIRMAN KATZ: A question. You design a system to get the adequate power after the system losses, so why isn't it important to know whether system losses for DC are more or less than AC?

MR. BAHRMAN: I didn't ask the question --

CHAIRMAN KATZ: Well --

MR. BAHRMAN: -- I just answered it, but --

CHAIRMAN KATZ: I want you to contemplate it though. Why -- why should this Council care which has more system losses, AC or DC?

MS. RANDELL: Can I follow up with a question?

CHAIRMAN KATZ: Uh -- would you prefer -- I mean if the witness can answer --

MR. BAHRMAN: No --

CHAIRMAN KATZ: -- my question directly --

MR. BAHRMAN: No, I -- I assumed -- I mean the whole line of questioning has addressed a number of differences in costs and I suppose this is related to those.

CHAIRMAN KATZ: Okay. Yes, you may follow

up.

MS. RANDELL: Thank you. And sorry, I didn't mean to preclude the witness from answering, I thought he wasn't. We talked earlier today about the converter stations and converter size. And we have three 370-megawatt converters at the Norwalk end on Option 1, right?

MR. BAHRMAN: That is correct.

MS. RANDELL: Totaling 1,110 megawatts?

MR. BAHRMAN: That is correct.

MS. RANDELL: Assume complete through-put as you do in your answer to Interrogatory 15, and to get 1,110 megawatts out at Norwalk, how many megawatts have to go in at Beseck? And let's start with a hundred percent load and then you can give me 50 percent load if you'd like.

MR. RONSTROM: Well, the figures are already in the table, but you would have to do the calculation or the percentage. So if you receive 1100 megawatts at Norwalk, you would have to add -- what was it -- 6.74 percent that would go in at the other end.

MS. RANDELL: Subject to check, and please do check my calculation if you'd like, the losses associated with that scenario, input at Beseck, output at

Norwalk, there would be 74.1 megawatts of losses, power that started out at Beseck that didn't make it out to Norwalk, is that right? Sound about right?

MR. RONSTROM: If your calculations are correct, yes.

MS. RANDELL: And that has a cost factor associated with it, correct?

MR. RONSTROM: Yes.

MS. RANDELL: And it has an emissions factor because you have to have generation going for that 74 megawatts?

MR. RONSTROM: Obviously, yes.

MS. RANDELL: And so if the AC system had fewer losses, there would be a cost benefit to AC because you have fewer losses, right, on that item?

MR. BAHRMAN: The capitalized cost of losses --

MS. RANDELL: Yeah --

MR. BAHRMAN: -- would be a factor in --

MS. RANDELL: And also you would have that much less generation. Assume with me, if you would, that in New England the average losses at peak for the AC 345-kV transmission system down to the low end of the distribution transformer is about 2.5 percent. If that's

the case, then your option -- and that's at the hundred -- at peak -- then your Option 1 proposal would have nearly five times as much losses as the AC, correct?

MR. BAHRMAN: I don't think you're comparing apples with apples. You're talking about the net system losses as a percent. As a percent of what? Percent of load? I don't know --

MS. RANDELL: Assume the percents are equivalent, Mr. Bahrman.

MR. BAHRMAN: I don't follow the assumption.

MS. RANDELL: Okay. Is it your testimony that you believe that the HVDC system you are proposing here would have greater losses than the AC system, that's right, isn't it?

MR. BAHRMAN: Yeah --

MS. RANDELL: Okay --

MR. BAHRMAN: -- I believe that point has been made, yes.

MS. RANDELL: Okay. And at 50 percent power, the losses on your Option 1, a little over three percent, the equivalent of about 35 megawatts?

MR. BAHRMAN: Correct.

CHAIRMAN KATZ: For Option 3, East Devon to

Beseck, how many megawatts loss are we talking?

MR. BAHRMAN: We have 3.4 -- about -- about 4.4 percent of 1110 megawatts at full load for the cables and the converter stations.

CHAIRMAN KATZ: Thank you.

MR. RONSTROM: While we are discussing, I just discovered an error here. It said the Option 3, or DC cables between Beseck and East Devon, and they are shorter than -- around less -- a bit less than 60 percent of the other routes which go all the way from Beseck to Norwalk. So they -- the cable losses in the last -- in the very last column should be corrected to about 60 percent of the value given there.

MS. RANDELL: Is --

MR. BAHRMAN: We will correct the table and resubmit.

CHAIRMAN KATZ: Thank you.

MS. RANDELL: Mr. Ronstrom, is that on the station side?

MR. RONSTROM: No, it's on the cables.

MS. RANDELL: Only on the cables?

MR. RONSTROM: Yes.

MS. RANDELL: And the --

MR. RONSTROM: The cable length in all the

other --

MS. RANDELL: Okay --

MR. RONSTROM: -- it's the full length from Beseck to Norwalk --

MS. RANDELL: Okay, so looking at a hundred percent power, Option 3, the cables, the losses are stated to be .92. So that would go down -- percent -- that would go down to about .5 --

MR. RONSTROM: Around --

MS. RANDELL: -- .4 --

MR. RONSTROM: Around .5.

MR. BAHRMAN: Thirty-one miles over the total circuit length.

MS. RANDELL: Okay. So at a hundred percent power, rather than having 4.41 percent, it would be about four percent losses?

MR. RONSTROM: Yes, that's correct.

MS. RANDELL: Are you familiar any of you gentlemen with the term loss factor?

MR. LARSSON-HOFFSTEIN: I am familiar. It's often used for cables.

MS. RANDELL: And that reflects a loss -- average losses taking into account all hours in the year?

MR. LARSSON-HOFFSTEIN: Through different -

- different issues it could be yearly variation, it could be daily variation.

MS. RANDELL: But essentially, it's average divided by peak?

MR. LARSSON-HOFFSTEIN: Yes.

MS. RANDELL: And the loss factor for your VSC HVD system -- DC system is higher, isn't it, than for an AC system?

MR. TAIT: Miss Randell --

MR. BAHRMAN: The loss factor for AC and D -- higher for DC over AC --

MR. LARSSON-HOFFSTEIN: For the cables it's the same.

MS. RANDELL: What about for the system?

MR. BAHRMAN: We've heard that for the cables it's the same. And you can see whether it's AC or DC, the strong IzR, the component that's proportionately the square of the current in both, so that it will go down for both, but the -- the net fact is that the conversion losses are higher than typical substation losses.

MR. TAIT: Miss Randell, I have a question. You're comparing DC with AC overhead or AC underground?

MS. RANDELL: I think it applies to both I'm told.

MR. TAIT: There will be no difference? Line losses are the same for aboveground or underground? Are we comparing apples and apples or do we have apples, oranges and lemons -- (laughter) -- sorry, the last lemon is not attributed to anyone's option.

MS. RANDELL: I am informed there would be at most a slight variation, but for the purpose of here essentially the same.

MR. ASHTON: Miss Randell, if I may. Just so we're clear, would you all agree that in designing a system, in considering system alternatives, the economic value of losses is a legitimate factor in looking at design?

MR. BAHRMAN: Agreed.

MR. ASHTON: Okay.

CHAIRMAN KATZ: If cost is a criteria --

MR. ASHTON: Absolutely --

CHAIRMAN KATZ: -- correct?

MR. ASHTON: My question and answer are correct.

CHAIRMAN KATZ: That's still uncharted waters --

MR. ASHTON: We've got a regulatory issue here.

CHAIRMAN KATZ: Yes, please proceed.

MS. RANDELL: I've been corrected that I should not be speaking of the New England total losses. Would you gentlemen agree with me that I should be speaking of the losses associated with the 345-kV line for the Phase 2 Middletown to Norwalk project and those numbers would be less percentage-wise?

MR. BAHRMAN: I believe then you can have a comparison. If you are having a given dispatch and you have a DC alternative, any one of the ones that were given, and you scheduled generation in some manner, and you allocate the flow in some manner so that you equally utilize the Phase 2 DC alternative, one of them, and the Phase 2, and you run the same case and you look at the total system losses for that case versus, you know, for the AC solution, whichever one you choose, and for the DC solution, whichever one you choose, and you look at the total system losses for there, then you have a comparison.

MS. RANDELL: Well, let me start with your assumption that you would dispatch the system to minimize losses. That's inconsistent, isn't it, with the Security Constrained Economic Dispatch that's generally run in New England?

MR. BAHRMAN: No. The flexibility of

controllability allows --

MS. RANDELL: We can start -- we can leave it at no.

CHAIRMAN KATZ: Just wait for the follow-up question.

MR. BAHRMAN: Okay.

MS. RANDELL: Correcting to deal with the losses associated with the Phase 2 345-kV AC line down to the low end of the distribution transformer, assume that it's 1.46 percent, that is significantly lower than the numbers you have in your table for losses, correct?

MR. BAHRMAN: You're comparing system losses with transmission losses. I -- I'm not familiar with the first number you quoted, what it is, where it comes from.

MS. RANDELL: Assume it's the transmission line itself.

MR. BAHRMAN: Yes, if that's the assumption.

MS. RANDELL: Okay. Neither your VSC HVDC nor the 345-kV AC system will affect distribution losses, right, those are what they are?

MR. BAHRMAN: For a given load and dispatch, yes.

MS. RANDELL: Alright. Now in your answer to this interrogatory you state -- we'll put up a table -- George, could you just roll up to the graph -- (pause) -- thank you -- you state a typical relation between losses in the grid versus voltage is shown in the figure below. What is the source of that figure?

MR. RONSTROM: These are based on investigations made by my colleagues in my company, that we put together a graph for illustration of the effect of the loss -- effect on the losses of the voltage level.

MS. RANDELL: So was that intended to represent only transmission losses or entire system losses including distribution?

MR. RONSTROM: To my knowledge, it was only transmission losses.

MS. RANDELL: And you were not involved in creating that?

MR. RONSTROM: No, I was not.

MS. RANDELL: Looking at the numbers, it looks to me that at a per unit voltage of 1.0, you're looking at upwards of seven percent transmission losses that you're claiming for the AC system. Does that -- is that correct?

MR. RONSTROM: Yes. But the sentence above

the figure says that the typical relation between losses in the grid versus voltage is shown, and they -- it's -- the relation is typical. And we are not -- we don't -- the exact figures here are not chosen for this part of the network.

MS. RANDELL: So you really don't mean to have any numbers on the Y-axis, that this was just representational only?

MR. RONSTROM: Well it -- it was suppose to give you an idea that if you can vary the voltage with plus/minus 10 percent, you have loss changes in the range of a few couple of percent, three percent -- what did you say -- from six up to nine, yes. That's --

MS. RANDELL: So we shouldn't pay attention to the six to nine, but just note that you're suggesting that, you know, as you increase the voltage per unit, the losses go down?

MR. RONSTROM: Yes.

MS. RANDELL: Thanks. Do you know what -- what voltage the New England system generally runs at?

MR. RONSTROM: Not exactly. I know that 345-kV is the normal voltage and the -- I believe around 357-kV -- but I -- I don't know for sure.

MS. RANDELL: And the VSC HVDC improvement

that you talk about in your answer and that Mr. Bahrman referred to, that relates primarily to increasing the voltage on the system, right?

MR. RONSTROM: Increasing voltage is one part. And as we -- as we said also in the same answer, reduction of reactive currents in the AC lines also affect the losses --

MS. RANDELL: Now --

MR. RONSTROM: -- which can be mitigated.

MS. RANDELL: Assume with me that the prevailing voltage in New England is about 1.035 per unit, that's pretty close to the maximum you can operate this system at, isn't it, on average?

MR. ASHTON: Miss Randell, I'm a little troubled by that. 1.35 applying from Greenwich to almost -- well up to the New Brunswick line is a pretty darn broad brush for voltages. What's the basis for the claim of this 1.035?

MS. RANDELL: If you give me a moment, I'll tell you.

MR. ASHTON: I'd be delighted to hear it. And at what -- what load levels are we talking about?

MS. RANDELL: (Pause) I am told that the 1.035 per unit number comes from the ISO New England OP-

12, which schedules voltage at heavy load.

MR. ASHTON: And that's the 345 system, or 115 or what, or 230?

MS. RANDELL: (Pause) I'm told that it is primarily 115, but does include some 345, and that the 345 system is generally upwards of like 1.03.

MR. ASHTON: Okay.

MS. RANDELL: Without getting into then specifics, Mr. Ronstrom, the benefit that you get is a small amount compared to the overall losses of the VSC HVDC system, isn't that correct?

MR. RONSTROM: You -- yes.

CHAIRMAN KATZ: I'm going to interrupt here for a moment. The attorney for the Applicant is -- the questions are indicating that undergrounding has a price. And at the end of the afternoon, I'm going to be asking you, and I want you to start thinking about, what the price, the differential cost is of doing a DC cable from East Devon to Beseck versus an overhead cable from Devon to Beseck. So, I just want you to start thinking about that. Back to you.

MS. RANDELL: Thank you. Let's turn to expandability of the system if the VSC HVDC were installed. It's a reasonable concern, isn't it, that the

system be able to -- or not impair the ability to expand the electric system in Southwest Connecticut? That whatever we put in today not hamstring the system planners and operators in the next 30 or 40 years?

MR. BAHRMAN: Yes.

MS. RANDELL: Okay. And there are two aspects of that expandability. One is the interconnection of new generation and the second is the ability to add a substation to strengthen the system --

MR. BAHRMAN: Yes --

MS. RANDELL: -- correct?

MR. BAHRMAN: -- um-hmm.

MS. RANDELL: Any other aspects of expandability --

MR. BAHRMAN: Yes --

MS. RANDELL: -- that I haven't listed?

MR. BAHRMAN: Yes. The ability to stage incremental to the system additions.

MS. RANDELL: Alright --

MR. BAHRMAN: If you build an overhead 345-kV line and you're looking towards the future, in the initial years you may not need the whole capacity, you need the interconnection. But you're looking towards the future, so -- but you have to build that first incremental

step change.

MS. RANDELL: Well, I understand --

(gavel)

MR. BAHRMAN: If you have several parallel circuits, you can stage it and incrementally increase it.

MS. RANDELL: Um-hmm. Planner --

MR. BAHRMAN: Uh --

MS. RANDELL: Oh, sorry.

MR. BAHRMAN: So that's another aspect that you did not mention.

MS. RANDELL: Okay. It's a planner's job to look toward the future, Mr. Bahrman?

MR. BAHRMAN: Yes.

MS. RANDELL: Let's look at the interconnection of new generation. And I want to take two aspects of that if your VSC HVDC system were installed. Let's focus first on Singer, Devon and Norwalk --

MR. BAHRMAN: Um-hmm --

MS. RANDELL: -- where there will be substations --

MR. BAHRMAN: May I ask to have the options put on in anticipation of your question, the configurations?

MS. RANDELL: I don't think we need it --

well -- but sure, if you'd like it, we'll get to it.

MR. BAHRMAN: Okay.

MR. ASHTON: Why don't you put them on just so people know what we're talking about.

MS. RANDELL: And actually, I'm sorry, I misspoke, we will need it. Thank you.

MR. ASHTON: I don't mean to be contrary, but it helps.

(Pause)

MR. ASHTON: That's good.

(Pause)

MS. RANDELL: Okay, we all set? Okay. Page 6 of your feasibility study states that interconnecting new generation at Singer, Devon and Norwalk may not require adding new converters. Do you recall that? And I don't know which one of you gentlemen is answering --

MR. BAHRMAN: You're referring to the study, the feasibility study?

MS. RANDELL: The feasibility.

MR. BAHRMAN: Okay.

(Pause)

CHAIRMAN KATZ: We'll go off the record for a moment.

MS. RANDELL: Sure.

(Off the record)

MR. FITZGERALD: (Indiscernible) -- a reference --

CHAIRMAN KATZ: On the record or off?

A VOICE: Off --

MR. FITZGERALD: Either -- I don't think we need to be on the record.

CHAIRMAN KATZ: Okay, we're still off the record.

(Off the record)

MR. TAIT: And if they haven't, they might think about it.

CHAIRMAN KATZ: And again we will repeat our invitation to -- based on the public act of last year, if cost is a consideration for the Council, and if so or if not, please elaborate.

MR. MARCONI: Would I be able to get a copy from Attorney Fitzgerald of that letter to which he had earlier referred?

CHAIRMAN KATZ: It's on our website.

MR. MARCONI: Okay.

CHAIRMAN KATZ: Okay, we are on the record and we have a question pending. And is the witness panel

ready to answer it?

MR. MUKERJI: Yes. Answer to criteria 5 in the report meant that existing generation, depending on the size and location, may be accommodated -- could be accommodated depending on the size and location on the existing AC buses.

MS. RANDELL: And it might not?

MR. MUKERJI: And it might not, yes.

MS. RANDELL: What -- when would you make that determination? Is it when the generator is proposed so that you'd have to study it -- not you ABB -- so that one would have to study it?

MR. MUKERJI: Well, that's -- ISO New England does that on a routine basis.

MS. RANDELL: And that's when the generator is proposed? You couldn't say today --

MR. MUKERJI: Correct --

MS. RANDELL: -- what would work or not?

MR. MUKERJI: Yes.

MS. RANDELL: Okay.

MR. ASHTON: Well, let me -- let me ask on that score, suppose someone comes in with a 700-megawatt generator --

MR. MUKERJI: Um-hmm --

MR. ASHTON: -- would you expect that to go on the 115-bus or would you expect that to go on 345 because of its size?

MR. MUKERJI: If there was a 345-kV bus available, it would be better to be on the 345.

MR. ASHTON: Wouldn't -- isn't it reasonable that large generators would be much more akin to operate on a 345 system than 115? Smaller ones, 20 megawatts, 50 megawatts, may well go on 115, is that fair to say?

MR. MUKERJI: That's correct, and --

MR. ASHTON: Okay.

MR. MUKERJI: -- yeah.

MS. RANDELL: And following up on Mr. Ashton's comment, in looking at your page 6, you say that you might be able to connect the new generators directly to the AC substations 345-kV or 115?

MR. MUKERJI: Um-hmm.

MS. RANDELL: There aren't going to be -- if we went with the VSC HVDC that you're talking about --

MR. MUKERJI: Yes --

MS. RANDELL: -- that ABB is talking about, there would not be a 345-kV substation at Singer, correct?

MR. MUKERJI: That's correct.

MS. RANDELL: And there would not be a 345-kV substation at Devon?

MR. MUKERJI: That's correct, except for Option 3, which was the hybrid solution.

MS. RANDELL: And for Option 3 between -- between -- is it East Devon and -- maybe George, you could just go there --

MR. BAHRMAN: Beseck.

MS. RANDELL: Between Beseck and Norwalk -- excuse me -- between Devon and Norwalk, that would be the company's AC solution and, therefore, there wouldn't be an issue with respect to interconnection, you would have the substations?

MR. MUKERJI: That's right, yeah.

MS. RANDELL: Okay. Now, with respect to generation at other locations where there isn't a substation of some sort, you state in the feasibility study that they too may require new converters and may require DC cables, correct?

MR. MUKERJI: If there was a significant large generator that needed to be interconnected, one of the options would be a new converter and make it into a multi-terminal DC. That is one of the options.

MS. RANDELL: And again, as we discussed

earlier today, there are no multi-terminal VSC HVDC installations in existence today?

MR. MUKERJI: A VSC multi-terminal, that's right.

MS. RANDELL: Right. And in fact, you didn't even have any models to study it?

MR. MUKERJI: Well again, Mike can comment on the -- we have long experience with multi-terminal. And VSC is not that big a departure from the existing multi-terminal we have on conventional DC.

MR. BAHRMAN: I think -- one general comment -- you're looking at completing a 345-kV loop in Connecticut for Phase 2. And for EHV transmission in general, from reliability purposes you don't -- you want to minimize the tapping. I mean you want to bring power into Southwest Connecticut. And of course everyone tries to be all things to all people, but if you simply tap every few kilometers to accommodate a new generator, it's better to -- that in itself decreases the bulk power transmission reliability by putting more elements that are exposed to contingencies. So each and every time you put in a tapping of a substation, it's just like putting in a multi-terminal.

However, if you put in a ring bus and

circuit breakers and a new switchyard, then you can accommodate the new generation with another switching station, another Singer, another Norwalk, another 345-kV switchyard that has the additional in-feeds of looping the lines and looping the new generator needs. You wouldn't want to just tap it because then you would have a fault on a generator transformer that would take out the whole transmission.

So an ideal case, if these generators are clustered, there's permitting issues and there's cooling issues, there's emissions issues, if there's a general place where generators locate, for instance around Bridgeport near Singer, it's better to have from a reliability point of view to collect that generating power and inject it into EHV. In other words, you want to minimize the amount of switchyards and tappings of that line. That applies whether it's AC or DC. But that being said, if you do it and AC, the power level is not enough for the underlying transmission, you either have to reinforce that to get to the switching station, be it Singer or Devon, and if it's the Option 2 or Option 3, then to bring that up to the DC then would require a new converter station. And a new converter station costs more than an AC substation like --

CHAIRMAN KATZ: But --

MR. BAHRMAN: -- we've said before.

CHAIRMAN KATZ: -- let's go with Option 3 for a moment and let's assume for this hypothetical that we have an AC underground from Norwalk to East Devon and then we have DC from East Devon to Beseck and we can only put generation in either at Beseck or at East Devon, connect new generation, or if a power plant wants to be built in Orange or Woodbridge or something, they would have to build that perhaps on the footprint of the power plant, that converter station to link into the DC line? Is that -- is that technically feasible or would you just tell them, sorry, we only can link in new generation at Beseck or at East Devon?

MR. BAHRMAN: So you're talking about a point between --

CHAIRMAN KATZ: Correct --

MR. BAHRMAN: -- East Devon and Beseck?

CHAIRMAN KATZ: -- right.

MR. BAHRMAN: I mean if it were in the middle --

CHAIRMAN KATZ: Yeah --

MR. BAHRMAN: -- so it would be problematic --

CHAIRMAN KATZ: -- let's say in the middle --

MR. BAHRMAN: In the middle, then this would be, you know, either add a new AC line or you tap the DC underground cable with a converter station --

CHAIRMAN KATZ: Okay --

MR. BAHRMAN: -- and you could segment it like in Option 1 or you could make it multi-terminal.

CHAIRMAN KATZ: Okay.

MR. ASHTON: Let me join in on this for a little bit. Are you aware of any generator of any consequence that this hung on a three-terminal line --

MR. BAHRMAN: (Indiscernible, overlap of talking) -- the Radison

MR. ASHTON: -- where it taps into the middle of --

MR. BAHRMAN: -- LG 2A Radison is hung on a multi-terminal DC line.

MR. ASHTON: Would you agree with me that it is very rare at most to say that a generator would be hung on a three-terminal line, rather it comes into its own bus. And the bus may contain a multiplicity of looped or multi-terminal lines, but you don't normally hung a generator off on a T-connection type of thing?

MR. BAHRMAN: Yeah, whether it's AC or DC -
-

MR. ASHTON: Right --

MR. BAHRMAN: -- it's not a good idea. And obviously, you don't connect -- I mean there is an AC switchyard, you have a generator step-up transformer. And from there you go either up with AC or you have a DC converter station.

MR. ASHTON: And would you agree with me that if you -- if for whatever reason a -- using Option 3 a generator was hung in the middle, or was sought to be placed in the middle, the most logical option, barring extreme circumstance, would be to loop -- cut that one line and loop it through the new station?

MR. BAHRMAN: That is, like I said, a variation of Option 1 that could be applied, yes, sir --

MR. ASHTON: Right, but that --

MR. BAHRMAN: -- but then you -- then you have two -- at least two outlets --

MR. ASHTON: You have two --

MR. BAHRMAN: -- for that generator --

MR. ASHTON: -- two terminal lines supplying that station or going from that station --

MR. BAHRMAN: Yes, sir. You can do it

either way.

MR. ASHTON: Okay. You can, but normally you'd go from a two-terminal line --

MR. BAHRMAN: Yeah. And I might add --

MR. ASHTON: The simple --

MR. BAHRMAN: -- that there's a lot of examples of DC serving as generator outlet facilities --

MR. ASHTON: Um-hmm --

MR. BAHRMAN: -- for generation. But in the regard of multi-terminal, we have only your neighbors to the north.

MR. ASHTON: That's pretty rare?

MR. BAHRMAN: Yes.

CHAIRMAN KATZ: Thank you.

MS. RANDELL: And since options 1 and 3 might need to be converted in the future to a multi-terminal operation as you've suggested on page 6 of your feasibility report, wouldn't you need to know right now that a multi-terminal would work? You'd have to do all the studies and you would -- and this -- well, let me stop there -- you'd have to do all the studies today?

MR. BAHRMAN: Do you want to --

MR. MUKERJI: As far as feasibility, yes.

MS. RANDELL: And multi --

MR. MUKERJI: Yes --

MS. RANDELL: -- terminal?

MR. MUKERJI: -- yes.

MS. RANDELL: And you could well in the future be the first actual installation of multi-terminal if that were required here, say Option 1 or Option 3?

MR. MUKERJI: We have a multi-terminal in conventional --

MS. RANDELL: VSC --

MR. MUKERJI: VSC, yes.

MS. RANDELL: Thank you. Now, following up on a comment I think by Mr. Bahrman in his answer, you stated, assuming my notes are correct, that there's a reliability impact from having more elements exposed to contingencies. Do you recall that?

MR. BAHRMAN: Yes.

MS. RANDELL: Aren't each of these converter stations that you're talking about an element that would be exposed to contingencies?

MR. BAHRMAN: Yes. But we have parallel elements. We have redundancies. And in fact, if you look at Option 3, you have three circuits versus one in the Applicants' because there they have a single circuit. So yes.

MS. RANDELL: Subject to check, Mr. Bahrman, would you agree with me that you misspoke that with respect to the DC -- oh, excuse me -- with respect to the underground, the companies have proposed two or three circuits?

MR. BAHRMAN: The overhead transmission I'm aware of from East Devon to Beseck, the -- that I have seen I thought was a single circuit.

MS. RANDELL: I think -- and the underground --

MR. BAHRMAN: And --

MS. RANDELL: -- is two or three?

MR. BAHRMAN: The underground is -- as shown there for Phase 2 --

MS. RANDELL: Two circuits?

MR. BAHRMAN: -- in red, two circuits.

MS. RANDELL: Okay. So you didn't mean to --

MR. BAHRMAN: So we're talking about Option 3, yes.

MS. RANDELL: Okay. And the power controls that are utilized -- let me rephrase. Aren't power controls a critical component of VSC HVDC?

MR. BAHRMAN: For any DC the power is

controlled. Therein lies the flexibility.

MS. RANDELL: And the power electronics, each element of that is yet another element exposed to contingencies, correct?

MR. BAHRMAN: Yeah, the converter station consists of the converters themselves, the auxiliaries, the control system, and the transformers and AC switchyard equipment, yes.

MS. RANDELL: And in terms of redundancy, if you only have one converter connected to a generator and that converter goes down, then the generator's output can't get out to the system, correct?

MR. BAHRMAN: If that converter is the sole generator outlet facility, yes. But normally you have multiple generator outlet facilities because if you lose a single one, you would lose a generator.

MS. RANDELL: So if you take Mr. Ashton's question regarding a generator right in the middle that would need -- well let's assume it would need a converter, it would actually need two converters, wouldn't it, for reliability purposes?

MR. BAHRMAN: It depends on the viewpoint, the failure rates, the overall analysis. Typically, generators only have one generator step-up transformer.

If you lose it, you lose the generator. So if you were, you begin the redundancy.

MS. RANDELL: Isn't the forced outage rate for generation step-up transformers quite small?

MR. BAHRMAN: Transformer failure rates are well published. They are small, they are finite. Once very 70 years or something like that.

MS. RANDELL: And what's the cost of one of these converter stations that would be necessary to connect new generation?

MR. BAHRMAN: If you look at the technical report on VSC HVDC converter and cable technology, Section 7 on page 39 you see the cost of different groupings of converters and you see the number and you see the price, and you divide the number by the price and you come up with about 51 million dollars per station at 370 megawatts.

MS. RANDELL: And what would be the cost -- I'm sorry, what is that number?

A VOICE: 51 --

MS. RANDELL: Fifty-one million for a 370-megawatt --

MR. BAHRMAN: Roughly --

MS. RANDELL: -- converter?

MR. BAHRMAN: Yeah.

MR. ASHTON: And that's the installed cost?

MR. BAHRMAN: That is the installed cost as stated in the report --

MR. ASHTON: Okay --

MR. BAHRMAN: -- (indiscernible, overlap of talking) -- it's exclusive --

MR. ASHTON: The report is not widely circulated --

MR. BAHRMAN: Okay, it's exclusive --

MR. ASHTON: -- so we need a little help --

MR. BAHRMAN: It's installed costs in terms of installation and everything that we mentioned before, and excluding the land costs, excluding taxes and cost of permits.

MR. ASHTON: And cost of permits?

MR. BAHRMAN: Yes.

MR. RONSTROM: And excluding the equipment and lines and so on outside of the converter station as explained before --

MR. ASHTON: Yeah, it's just the box of the converter station.

MR. BAHRMAN: And just the breakers you need to connect it to the AC substation --

MR. ASHTON: Yeah --

MR. BAHRMAN: -- it doesn't include the AC substation. That point was made earlier.

MS. RANDELL: And to avoid the sole output problem we just talked about, a generator might need two of those 51 million dollar converters, correct?

MR. BAHRMAN: If you wanted to have redundancy, yes. And if you wanted to have a hundred percent redundancy, yes.

MR. ASHTON: Is it possible and practical to operate that converter station in steps of say 20 percent or something like that?

MR. BAHRMAN: It's entirely controllable between zero --

MR. ASHTON: Okay --

MR. BAHRMAN: -- and a hundred percent, yes.

MR. ASHTON: I'm thinking of a contingency within the converter itself. There was -- I thought -- I had the table and now I've misplaced it, where it was about -- oh, here it is -- it's -- this is on the November 18th answers of ABB and it's the response to Question 12 on page 6 --

MS. RANDELL: Excuse me, Mr. Ashton. Is

that the reliability data from Murraylink and Cross Sound?

MR. ASHTON: Yeah.

MS. RANDELL: We can put that up here as well.

MR. ASHTON: Okay. I was going to not -- not bore in on too much of the details, but it makes me wonder how much in the case of Miss Randell's generator what sort of faults or failures are likely to occur and whether they can be remedied by going to part capacity? If you have a fault in a generator step-up transformer, you're usually out of business except on very large units where there may be two 50 percent or 60 percent GSUs --

MR. BAHRMAN: Um-hmm --

MR. ASHTON: In a converter station what's likely to occur, what remedy is there for the long-term? I guess I'd like to hear an answer on that.

MR. BAHRMAN: Yeah, I -- you could say that redundancy is used in auxiliary systems, control systems, and cooling systems, but when you're talking about main circuit equipment and redundancy in the converter valves themselves, so you can have a number of failures, component failures and continue to operate with no de-rating. However, if you have the transformer or something

that's in the main circuit --

MR. ASHTON: Um-hmm.

MR. BAHRMAN: -- then an outage of that would cause a forced outage of the converter station and then you would have time to replace or repair the failed element.

MR. ASHTON: That was what I suspected. The thing that struck me from this table was the sixth column headed capacity reduction during outage and percent and they were all a hundred percent and they were for a variety of different things, the causes. And I was a little bit puzzled by that. I would have expected to find some percent reduction other than a hundred percent in the outage.

MR. RONSTROM: Well, this table is compiled based on the protocol used by SEGRRE (phonetic) for reporting failures in HVDC substations --

MR. ASHTON: Yeah, I understand that --

MR. RONSTROM: -- in HVDC systems. And -- and the owners report forced outages -- huh -- (pause) -- and failures in systems that are redundant with meaning that you could have a failed component in the system but the operation and the power transmission would still continue are not included in this because they are not --

they don't cause a forced outage.

MR. ASHTON: So that --

MR. BAHRMAN: I would elaborate by saying that these are single circuit projects. There are projects which are bipolar --

MR. ASHTON: Yeah --

MR. BAHRMAN: -- or have multiple converters --

MR. ASHTON: Yeah --

MR. BAHRMAN: -- in which case you can have a partial outage with a partial reduction of capacity.

MR. ASHTON: Okay, so there's a whole set of outages that are not covered by this table that may be partial outages, is that correct?

MR. RONSTROM: They're --

MR. BAHRMAN: These are single DC circuits, so when you have a forced outage, you're losing a hundred percent capacity. If you take a bipolar system and you have a forced outage, you're losing 50 percent of capacity.

MR. ASHTON: Yes, that I understand --

MR. BAHRMAN: Okay --

MR. ASHTON: -- but within a monopole system can you get an outage which restricts the capacity

to something less than a hundred but more than zero or is it all or nothing?

MR. RONSTROM: Well, that would not be an outage in that case. It would be some kind of restriction put on the -- by the system operators or the owners --

MR. ASHTON: Okay. Is the answer yes or no?

MR. RONSTROM: I would say no, you -- you have either a hundred percent --

MR. ASHTON: Okay --

MR. RONSTROM: -- power reduction or zero.

MR. BAHRMAN: I think if you have a cooling malfunction and it's the hottest day of the year, you may have a slight de-rating.

MR. ASHTON: Yeah --

CHAIRMAN KATZ: Okay.

MR. ASHTON: That's not a --

CHAIRMAN KATZ: We need to move on. We have much to cover in the next three hours.

MS. RANDELL: I think, Mr. Bahrman, you testified that the only time you would need two converters would be for redundancy. If you had a generator that was larger than 530 megawatts, wouldn't you need two converters anyway?

MR. BAHRMAN: Well, would you put that generator in with one line or two lines? If the answer is two, you would have two converters.

MS. RANDELL: And as to the 530-megawatt converters you're talking about, there aren't any of those in commercial operation, correct?

MR. BAHRMAN: That is correct. It is the same voltage rating as Murraylink and Cross Sound, but it's a higher current rating. It's the same components, it's just that there are more of them in parallel.

MS. RANDELL: Now, we talked a lot about interconnection of new generation. Let's focus on the situation of adding a substation to strengthen the system. Would there be the same considerations --

MR. BAHRMAN: Yes --

MS. RANDELL: -- on expandability?

MR. BAHRMAN: Yes.

MS. RANDELL: Turning now to reliability, Mr. Wakefield testified from KEMA yesterday afternoon, and I don't think you gentlemen were in the room in the afternoon, but I'd like to read you a response that he gave to a question from Mr. Ashton and ask if you agree with it. If everything else is equal, then the one, and by that he means system, the one that you have to adjust

or switch in and out would be the less reliable case because human beings are subject to making mistakes once in awhile, and whether they do it or they program a computer to do it, there is always the possibility it won't be switched in or out when it should be or the wrong settings were made, so it's always better if you can have a system designed so that an adjustment of that sort doesn't have to be made. Do you agree with that?

MR. BAHRMAN: That's a broad statement. I would prefer to answer by saying -- well, I'll start with no. And --

MS. RANDELL: That was no?

MR. BAHRMAN: -- and let me elaborate on that please -- and the -- if you look at variations in power flow to get power across Connecticut, you're used to switching in shunt capacitor banks with cables. You may have reactors that you're switching. So you have a number -- you have different things that you have to do. You have power flow, which is dispatched. And with the AC solution, that is done by allocating schedules to different generators. You have hundreds of them in New England. If you recognize that you have a variable load both daily and annually, you have a reactive power demand associated with variation and loading on the transmission

and you have to control the voltage, especially when you're remote from generation. And you do that -- you support that by switching in capacitor banks and those sorts of things. So in that regard, the more you switch, the more the operator has to do either manually or automatically. With conventional DC, that's also true because you're matching the reactive power demands of the converters by switching in filters. And so you have this variable O&M component with the variations in loading.

With voltage source converters there is no switching of filters or reactive power compensation required because it carries its own reactor. You can operate a unity power factor, you can use it like a generator to support the voltage, so there is no switching of elements. There is a schedule change that would need to be made. It's a controlled element. It gives you more flexibility, but with that becomes the responsibility to schedule it. So therefore, you're talking about set points. The same kind of set points that go to generation, one more degree of freedom. If you look for instance at Option 3, you could call it a tri-polar system, one set point to cover the transfer schedule from Beseck to Devon, and that would automatically -- could certainly be automatically allocated between the three

parallel circuits, just like it is for conventional bipolar DC transmission.

MS. RANDELL: Isn't it the case that every time you have to do something, whether it's manual or computer driven because there had to be some manual input into the computer, something can go wrong?

MR. BAHRMAN: Yeah. The point is you don't have to do anything other than schedule changes.

MR. ASHTON: Does that mean you -- if the transmission system for one schedule suddenly changes, a line trips somewhere in the system --

MR. BAHRMAN: Um-hmm --

MR. ASHTON: -- should you reschedule then?

MR. BAHRMAN: Yeah, what's typically done, and it's alluded to in the technical report, if we look for instance at Option 3, that you have one power order that is entered by the system operator or dispatcher, and it's designed to accommodate the desired transfer, whether it's associated with generation or --

MR. ASHTON: Come hell or high water, it's going to --

MR. BAHRMAN: -- and now -- and now you have an automatic allocation for a contingency, the loss of one pole, one parallel link. Within the capacity on

the remaining links, they would automatically adjust. Okay --

MR. ASHTON: But still --

MR. BAHRMAN: -- now you reach a new --

MR. ASHTON: -- still trying to hold the set value?

MR. BAHRMAN: Yes, exactly. And -- now that's common. What's not so common and not normally needed is if there is parallel AC transmission and it should suffer a contingency, let's say the northern 345-kV loop, you may not need to, but you can sense that and use that to increase the power on the DC, but I mean I would gather that -- that that may or may not be necessary. I --

MR. ASHTON: Miss Randell, may I go a little further --

MS. RANDELL: Sure --

MR. ASHTON: -- I don't mean to interrupt your cross --

MS. RANDELL: I'm fine.

MR. ASHTON: Okay.

CHAIRMAN KATZ: Briefly.

MR. ASHTON: Two questions that occur to me. First of all, does a converter station require an on-

site operator?

MR. BAHRMAN: No, it does not. There are many stations that -- today that operate from remote.

MR. ASHTON: Fully automatic, no attendant at all?

MR. BAHRMAN: That is correct.

MR. ASHTON: Okay. The second one is I'm aware from history that DC of any type, you name it, has been typically used to connect systems where there is a question as to the -- as to how well they could operate in synchronism. Tokyo had a back to back 50 to 60-hertz DC/AC -- D -- AC/DC/AC conversion system because they had a 50-hertz system and a 60-hertz system side by side. New Zealand, two islands, I think it was a DC connection. Again it was -- the two systems were nominally the same frequency, but they had a problem of maintaining synchronism --

MR. BAHRMAN: Um-hmm.

MR. ASHTON: -- and so DC has been typically utilized where there was a conversion for one frequency to another or where there was a question of the ability to maintain synchronism. This is the first application that I'm aware of where it is really an integral part of an AC network and not a question of

maintaining synchronism at all. Are you aware of any other systems where DC has become an integral part of an AC network that is fully synchronized?

MR. BAHRMAN: Yes.

MR. ASHTON: Then maybe you'd help me out by telling me what they are --

MR. BAHRMAN: Yeah, we --

MR. ASHTON: -- I couldn't think of any --

MR. BAHRMAN: -- we -- first of all, asynchronous interconnections between adjacent grids or non-adjacent grids there is -- DC offers a decoupling mechanism --

MR. ASHTON: Right, right --

MR. BAHRMAN: -- you have a -- and you have this -- you don't have to go all the way to New Zealand --

MR. ASHTON: England, France, New Zealand --

MR. BAHRMAN: Quebec -- between Quebec, between the east connect -- the east/west interconnection, and between Ergot (phonetic). And that can be a back to back tie like Highgate or it can be a long distance transmission, so like Phase 2, Quebec and New England.

Now if you look in the U.S., those systems which operate in parallel with AC links that aren't

asynchronous, there is a parallel path, Vancouver Island to the mainland there is a parallel AC path. Cross Sound the same thing, you have a parallel AC path. The CU project --

MR. ASHTON: The which --

MR. BAHRMAN: The CU project, which is between North Dakota and Minnesota, that operates in parallel with AC transmission. The Square Butte project, which is also in that same neck of the woods between Minnesota and North Dakota, operates in parallel with AC transmission. The Pacific DC inter-tie --

MR. ASHTON: Yeah --

MR. BAHRMAN: -- operates in parallel with AC transmission and is scheduled in an optimum way to balance the flows between the DC tie and the AC tie, and it is scheduled based on economic transfers, on an hourly basis, and it's also to take care of bilateral contracts. The IPP project operates in parallel with AC. This is from Utah into southern California. There are others, Gotland we mentioned, Directlink we mentioned, that operate in parallel. I think the term in a lot of the interrogatories are -- use the term embedded. By that we take the fact that there are -- it's parallel, it is not an asynchronous connection, both ends -- there's a --

there's a parallel path --

MR. ASHTON: Let me -- let me be a bit more restrictive then. I'm familiar with a number of these. Are there any embedded connections, DC connections for a system that's comparable to Southern New England where the connection we're talking about is let's say in the 25 to 30 mile range that you can think of? The Pacific Northwest tie is, what, a 500-mile line? Utah to California is an awful long line. There are some synchronism issues that were associated with those when they were built. I don't recall the ones up in the North Dakota area, but I suspect they're fairly weak AC systems. This is a relatively strong AC system where we're proposing -- where we're considering a DC link within that system. Are there anything that are more comparable to that situation?

MR. BAHRMAN: Well, Cross Sound. You have --

MR. ASHTON: Yeah, that's --

MR. BAHRMAN: -- parallel and AC --

MR. ASHTON: I --

MR. BAHRMAN: -- you happen to have some water in between, but --

MR. ASHTON: There's a synchronism issue

there too, and --

MR. BAHRMAN: Well, they operate asynchronous because --

MR. ASHTON: Well, I know them well --

MR. BAHRMAN: Yeah, okay --

MR. ASHTON: I know well what they do, but the point is there's still only one other weak connection into Connecticut and that's the Norwalk to Northport line, which is one foot on a banana peel as far its durability goes --

MR. BAHRMAN: Yeah -- of course you have a roundabout through New York --

MR. ASHTON: And that's a problem too. The circulating current in New York -- or the New York connection is not a good connection as far as my understanding of transmission goes, it's a peculiar one. So, I would -- I would -- well again, I'm looking for something that's really embedded tightly in a network. The AC network in Connecticut is a pretty -- a pretty strong system. And I can't think of a link comparable where they have a DC.

MR. BAHRMAN: I think we've listed all that there are.

MR. ASHTON: Yeah. Thank you. That's my

questions. Sorry, Miss Randell. I owe you one.

MS. RANDELL: No problem. In all these --

CHAIRMAN KATZ: Miss Randell, we're going to take a quick break from your cross-examination --

MS. RANDELL: Sure --

CHAIRMAN KATZ: -- and take care of another matter.

At this time, I'd like to recognize two members of the Legislature who are here today, Senator Criso and Representative Adinolfi. They have graciously agreed to come back in January and speak to us at greater length because of our time commitments today, but I just wanted to give a chance to recognize them and their presence here today, and welcome.

REPRESENTATIVE AL ADINOLFI: Thank you, Madam Chairman. Senator Crisco is here also.

Basically, we had wanted to speak today, the group of us from PLUG, and although we would have preferred to speak today here, we understand that with the very busy hearing agenda and the need to get as much information as possible from the cross-examinations, waiting until a later date was preferable to you, and we have agreed to delay our testimony until Thursday, January 13, 2005 at 10:00. And for the purposes of coming up over

here, we wanted to make sure that that gets on the record and we gave you a letter accordingly.

CHAIRMAN KATZ: Thank you.

REPRESENTATIVE ADINOLFI: And we want to thank you for the opportunity.

CHAIRMAN KATZ: We appreciate you being gracious on that, and we will accommodate you in January.

REPRESENTATIVE ADINOLFI: Thank you.

SENATOR JOSEPH CRISCO: Thank you very much.

CHAIRMAN KATZ: Thank you very much for coming. I should indicate that the letter I received is signed by Senator Crisco, Representative Klarides, Senator Smith, and Representative Adinolfi speaking to those points.

A VOICE: (Indiscernible) -- in the record --

CHAIRMAN KATZ: And we will put it in the record. Okay, back to you.

MS. RANDELL: Okay. Following up, Mr. Bahrman, on your discussion with Mr. Ashton, in all the examples you gave, the HVDC link is small relative to the size of the systems it's connecting, isn't that right?

MR. BAHRMAN: In the Pacific DC inter-tie

it's 3,100 megawatts, but the receiving system is strong. There is another one coming in that's 1960 megawatts into the L.A. basin. And so even though they're big, their relative percentage is small. In Brazil we have -- and in Winnipeg -- but these are conventional terminals, particularly in Winnipeg where the Manitoba Hydro may -- you know, three-quarters of their power is delivered via DC.

MS. RANDELL: The West Coast one, you mentioned I think 3,000 megawatts for the HVDC. The California load is 45,000, isn't it?

MR. BAHRMAN: If -- at peak I don't know what exactly the number is, but when you're talking about the receiving system, the load in the L.A. basin yeah -- so you're talking about the relative size, yes.

MS. RANDELL: And for the Phase 2 New England line, the New England/Quebec line, the New England system runs at about 25,000 at peak load and Quebec is 35,000 megawatts?

MR. BAHRMAN: Um-hmm.

MS. RANDELL: And so the Phase 2 line is a relatively small percentage of that?

MR. BAHRMAN: Two thousand megawatts.

MS. RANDELL: Less than 10 percent of each

system?

MR. BAHRMAN: Two thousand megawatts in the Phase 2 and another 2,000 megawatts in the back to backs, 4,000 megawatts total. Some of that goes to New York.

MS. RANDELL: And you mentioned Manitoba. That's remote generation and not a system interconnect, right?

MR. BAHRMAN: The DC is used to -- two things, one is to deliver energy to native load and the other is for export. There's kind of a winter peak, summer peak situation there, so.

MS. RANDELL: And Cross Sound Cable that this Council is well familiar with is 330 megawatts?

MR. BAHRMAN: Correct.

MS. RANDELL: And the New England system is 25,000 megawatts and the Long Island and New York system are -- when you take all of New York, greater than that?

MR. BAHRMAN: Yes.

MS. RANDELL: And Long Island is a pretty large load?

MR. BAHRMAN: Yes.

MS. RANDELL: So 330 megawatts is really quite a small percentage of that?

MR. BAHRMAN: Yeah.

MS. RANDELL: Okay. Just looping back, no pun intended, to the generator interconnection, in New England doesn't the generator in a deregulated market have to pay for the converter station and include that additional cost in its project costs?

MR. BAHRMAN: That's my understanding.

MS. RANDELL: And if you need two converter stations, you're looking at another hundred million dollars to the cost of the generation project?

MR. BAHRMAN: If you have a hundred percent redundancy.

MS. RANDELL: Or as we spoke, you have a large generator?

MR. BAHRMAN: I mean you -- no, I mean you could put in two worth 50 percent for instance.

MS. RANDELL: And the generator needs to recover those costs in the New England marketplace?

MR. BAHRMAN: Yes.

MS. RANDELL: And a hundred million dollars is a pretty hefty percentage of a generator project cost?

MR. BAHRMAN: Yes.

MS. RANDELL: Okay, reliability -- George, if you could get the answer to CL&P/UI Interrogatory 12 up.

(Pause)

A VOICE: Page 7, George --

MS. RANDELL: Oh, I'm sorry -- it's on my page 6 -- okay, I've got that the other way around. Okay, could you scroll up to the question -- that's good, thanks.

CL&P and UI asked for statistics for outages and reductions in rated capability for all the existing commercially operating VSC HVDC systems and we asked for causes and such. Now in response to a question earlier today, you said that there are five such systems that we should be talking about, correct?

MR. BAHRMAN: Yes.

MR. RONSTROM: Yes.

MS. RANDELL: And your answer to this interrogatory said ABB has access to outage data only for Cross Sound Cable and Murraylink?

MR. RONSTROM: Yes.

MS. RANDELL: Do you have the data and you just chose not to provide it or do you not have data?

MR. RONSTROM: We do not have data. May I explain why?

MS. RANDELL: Sure.

MR. RONSTROM: The data for commercial --

for commercial -- well for HVDC systems that are taken over by the owner, they are data collected by the owner and distributed by the owner if the owner so chooses. And as I mentioned before, the SEGRRE protocol gives the owner the opportunity to share this data with the public or at least the utility business. In this case the owners have chosen not to.

MS. RANDELL: When did you obtain the data from Cross Sound and Murraylink in order to answer Interrogatory 12?

MR. RONSTROM: Cross Sound and Murraylink are somewhat special in this case because we are still under contract for guarantees with the owner, so therefore we are reported -- we get reports on failures. And for the same reason we are not sharing this data with others if -- other than the owner approves.

MR. BAHRMAN: I would like to add one comment. If you look in general at the SEGRRE reporting protocol, there are -- a lot of the DC transmission owners do not even keep these statistics. So it's -- it may not be just a matter of sharing. I mean they've gotten used to it, they don't bother to keep the statistics, and certainly they don't report them to us. Hydro Quebec for instance does not keep statistics on their stations.

MS. RANDELL: In your answer to CL&P/UI Interrogatory 17, which was a follow-up asking for disaggregated data for these projects, you responded that data are confidential --

MR. RONSTROM: Yes --

MS. RANDELL: -- do you recall that -- did you ask the project owners if you could release the data?

MR. RONSTROM: I did.

MS. RANDELL: And they declined to release it on a disaggregated basis?

MR. RONSTROM: That's correct.

MS. RANDELL: Did you ask any of the other project owners if you could release the data?

MR. RONSTROM: No.

MS. RANDELL: In response to Interrogatory 17 you referred CL&P and UI to two papers, one --

MR. RONSTROM: Yes --

MS. RANDELL: -- both by TransEnergie, Cross Sound and Murraylink? Are those --

MR. RONSTROM: The papers were actually cooperation written by ABB and TransEnergie.

MS. RANDELL: Now, the data in those papers are different but perhaps overlapping with the data you put in your answer to Interrogatory 12, is that right?

MR. RONSTROM: Explain how you mean? I don't understand what -- which way are they different --

MS. RANDELL: We'll take it piece by piece, that's fine. Well for starters, would you agree with me that reliability of transmission systems is important?

MR. RONSTROM: Yes.

MS. RANDELL: Especially if there's not a lot of experience on them?

MR. RONSTROM: Yes.

MS. RANDELL: And before going into any large scale project, it would make sense to determine the reliability of the existing installations?

MR. RONSTROM: Reliability is one issue. Availability is another issue. Different -- different owners put stress on different -- sometimes on availability, meaning that you can allow outages but you have to be quick on-line again. Others take a lot of importance on reliability.

MS. RANDELL: And just so that we -- everyone understands what we're talking about, availability relates to the number of hours in the year that the equipment system or whatever is available?

MR. RONSTROM: That's correct.

MS. RANDELL: And it's typically expressed

in a percentage?

MR. RONSTROM: That's correct. And it also takes into account the percentage of available power. So it's usually talking about energy availability, meaning 100 percent of the power 100 percent of the time.

MS. RANDELL: And do you know the availability of the existing AC 345-kilovolt transmission lines in New England?

MR. RONSTROM: I do not.

MS. RANDELL: Okay. Do you have aggregate data on availability for any of these projects that we've been speaking about today, Cross Sound, Murraylink, Directlink, and the other two?

MR. RONSTROM: We've looked into availability figures on -- for Cross Sound and Murraylink, and -- as stated in these two papers, and those availability figures are around 98 percent.

COURT REPORTER: One moment please.

(Pause).

MR. RONSTROM: That is forced -- unavailability due to forced outages and unavailability due to schedule, and the total of those.

MS. RANDELL: When you look at the Murraylink paper that you referred us to in your answer to

Interrogatory 17, and that's numbered B4-103, ABB is a co-author of this paper?

MR. RONSTROM: Yes.

MS. RANDELL: And under operational experience, it states commercial operation started on October 1, 2002?

MR. RONSTROM: Yes.

MS. RANDELL: And yet when we look at your answer to Interrogatory 12, right up above the table -- yeah, you need to scroll down, George -- you state that the data you're recording for these projects, Murraylink, was started at the commencement of the warranty period. Did the warranty period start October 1, 2002 or May 1, 2003, which is the beginning of your table?

MR. RONSTROM: It started on May 1, 2003.

MS. RANDELL: Okay. And so the data contained in your table in response to Interrogatory 12 don't include what the authors of the Murraylink project state to be the most serious forced outage, which was due to a DC transmission cable fault that caused an outage between December 22nd and 28, 2002?

MR. RONSTROM: That's correct, it does not include it here.

MS. RANDELL: And the paper goes on to

state the cause of the DC cable fault was most likely due to localized damage during installation. Am I to understand that to mean that the actual cause of the cable fault has not been definitively determined?

MR. RONSTROM: I'll let Magnus answer it.

MR. LARSSON-HOFFSTEIN: It's almost always impossible to definitely determine the cause of a cable fault. But we found when we --

MS. RANDELL: Could -- you need to speak up --

A VOICE: (Indiscernible) -- his mic went out --

MS. RANDELL: Oh, I'm sorry.

MR. RONSTROM: The mic went out --

MR. LARSSON-HOFFSTEIN: What we found when we made some dissection of the cable was there was scrap marks -- there was scrap marks on the outer sheet of the cables close to the failure point. That's usually what's found -- can be found when there's something related to the installation.

CHAIRMAN KATZ: (Indiscernible) -- mongoose.

A VOICE: The microphones --

A VOICE: The microphones are off --

A VOICE: The microphones are off --

MS. RANDELL: Yeah --

MR. BAHRMAN: Just for clarification --

MS. RANDELL: Now they're back on --

MR. BAHRMAN: -- Magnus, I heard you say you found scratch marks on the cable adjacent to the fault, which were indicative of some mechanical damage having occurred to the cable?

MR. LARSSON-HOFFSTEIN: Yes, that's true.

MS. RANDELL: Who was in charge of installation of the Murraylink cable?

MR. LARSSON-HOFFSTEIN: ABB.

MS. RANDELL: And ABB essentially functioned as an EPC contractor for Murraylink?

CHAIRMAN KATZ: Can we avoid the acronyms.

MS. RANDELL: Yes.

MR. LARSSON-HOFFSTEIN: Yes.

MS. RANDELL: Engineering design construction procurement?

MR. LARSSON-HOFFSTEIN: Yes.

MS. RANDELL: And did ABB serve that function for the Cross Sound Cable?

MR. RONSTROM: Yes.

MS. RANDELL: Any of these other of the

five projects -- Directlink?

MR. RONSTROM: Directlink no. The construction of the contract was different.

MS. RANDELL: Was the cable contract for any of those projects competitively bid for other VSC HVDC suppliers?

MR. RONSTROM: I don't think I can answer that question. I don't know the full answer of that.

MS. RANDELL: Okay. And again looking at the Murraylink paper, they state availability was in the 97 percent range for the first year of operation. Do you agree with that?

MR. RONSTROM: Yes, I agree with that.

MS. RANDELL: And they note that there were several forced outages. Is that correct?

MR. RONSTROM: Yes.

MS. RANDELL: Many of which may not be reflected in the answer to Interrogatory 12 because they related to a different time period?

MR. RONSTROM: That's correct.

MS. RANDELL: And with respect to the Cross Sound Cable paper, again Mr. Ronstrom, you're an author of this one?

MR. RONSTROM: Yes, I am.

MS. RANDELL: Do you agree that it says the Cross Sound Cable availability was approximately 97.5 percent for the period ending December 31, 2003? Is that correct?

MR. RONSTROM: Yeah, I believe that's correct.

MS. RANDELL: That sounds right?

MR. RONSTROM: Um-hmm.

MS. RANDELL: And that's about four and a half months of actual operation?

MR. RONSTROM: Can you repeat that period --

MS. RANDELL: Sure. If Cross Sound Cable --

MR. RONSTROM: No, the period of time.

MS. RANDELL: If Cross Sound Cable went commercial on or about mid August of 2003 and this data relates to the period ending December 31, 2003, we have -- assuming I counted on my fingers right --

MR. RONSTROM: Yes --

MS. RANDELL: -- about four and a half months of data?

MR. RONSTROM: Yes, that's correct.

MS. RANDELL: Now, the most serious forced

outage, according to this paper for Cross Sound, lasted 14.6 hours, do you recall that outage, during those four and a half months.

MR. RONSTROM: At this time I do not recall exactly what that was.

MS. RANDELL: Now, turning to the table, the table's period of time is May 1, 2003 up to August 31, 2004. For the period May 1 of '03 to the middle of August of '03, that would only have related to Murraylink, correct?

MR. RONSTROM: Well, the -- the guarantee period for Cross Sound Cable started June 1, 2003, but as we all know Cross Sound was not in operation until August --

MS. RANDELL: So --

MR. RONSTROM: -- 15 I think for 2003.

MS. RANDELL: So it couldn't have had any outages?

MR. RONSTROM: No.

MR. O'NEILL: May I ask -- (indiscernible) -- may I ask what the guarantee period is? How long is the guarantee period you're referring to?

MR. RONSTROM: To my quick recollection, we're talking about three years. But there are -- there

are some differences for different equipment, so I can't give you an exact answer right now.

MR. O'NEILL: Thank you.

MS. RANDELL: How many operating months for these systems are reflected in your answer to Interrogatory 12?

MR. RONSTROM: For Cross Sound -- sorry, you're referring to the table?

MS. RANDELL: Yes, the table.

MR. RONSTROM: Yeah. For Cross Sound, it would be one year and a half a month.

MS. RANDELL: Okay. Let's -- let's say 13 months.

MR. RONSTROM: Okay. And for Murraylink from May 1, 2003 to August 31, 2004, that will be I guess 16 months.

MS. RANDELL: Sixteen months?

MR. RONSTROM: Yeah.

MS. RANDELL: So we have about 29 months of experience and 25 forced outages?

MR. RONSTROM: Yeah, that's correct.

CHAIRMAN KATZ: You're talking Cross Sound?

MS. RANDELL: We are talking a combination of Cross Sound and Murraylink because ABB has declined to

disaggregate.

CHAIRMAN KATZ: Miss Randell, I'm going to ask you to over the next five minutes take us to a logical break point.

MS. RANDELL: Will do. Twenty-five forced outages in about 29 operating months?

MR. RONSTROM: That's correct.

MS. RANDELL: And according to your table, each time there was such an outage there was a 100 percent reduction in capacity?

MR. RONSTROM: That's correct.

MS. RANDELL: And in addition to those 25 forced outages, there were 24 scheduled outages during 29 months of operation?

MR. RONSTROM: Yes, that's correct.

MS. RANDELL: And again each time there was a 100 percent reduction in capacity?

MR. RONSTROM: Yes, that's correct.

MR. TAIT: Miss Randell, you're doing what Mr. Monte used to do, is just reading a chart that's in evidence and asking for asked and answered questions. You have time to rebut -- I mean you can argue your case later.

MS. RANDELL: Okay.

MR. RONSTROM: May I point out that this was the first year of operation and all systems have a tendency of having more outages in the first years of operation. The trend is that these outages go down to a very low number.

MS. RANDELL: Since Murraylink came on-line October 1 of '02, that's nearly two years of operation included for Murraylink -- or it had already been. It was well into its second year of operation, correct?

MR. RONSTROM: That's correct, yes. Sixteen months of operation.

MS. RANDELL: I can -- we can stop now or I can do a couple of quick technical questions.

CHAIRMAN KATZ: Let's do a couple of quick --

MS. RANDELL: Okay.

CHAIRMAN KATZ: I'm using your words remember.

MS. RANDELL: I understand. I'm guessing that, Mr. Dickmander, you're the one I should talk to about the stability study?

MR. DICKMANDER: Yes.

MS. RANDELL: Okay. Doesn't the stability

study of Option 1 indicate that a three phase -- that in a three-phase fault at Beseck -- if that occurs, that all the HVDC lines will trip?

MR. DICKMANDER: I'm going to answer that, but I have the answer to the question that you raised a little bit earlier if you'd like that now?

MS. RANDELL: Yes, please.

MR. DICKMANDER: We did get the information that the stability study was based only on the 530-megawatt converter size --

MS. RANDELL: Thank you --

MR. DICKMANDER: -- we got that confirmation. Now, again if I understand your question, you're referring to a fault which would result in loss of three DC lines or --

MS. RANDELL: Yes. And I refer you to page 5 of Attachment D, which is the stability study.

MR. DICKMANDER: Page 5 of Attachment D. Yeah -- the stability study itself is Attachment D, is that what you're saying?

MS. RANDELL: Yes.

MR. DICKMANDER: Okay. Page 5, correct, um-hmm.

MS. RANDELL: Just making sure we're

understanding this correctly, a three-phase fault at Beseck will result in all the HVDC lines tripping?

MR. DICKMANDER: That was what was simulated in that particular case. I'm not familiar with the details of that case, the rationale behind that, but that is what the table shows.

MS. RANDELL: Thank you. And then just to follow up, if 530-megawatt converters were used for the stability analysis and for the load flow studies, why did you use 330-megawatt converters in costing out the project?

MR. BAHRMAN: Did you say in costing out?

MS. RANDELL: Yes. In your cost estimate --

MR. BAHRMAN: Okay. We actually --

MS. RANDELL: Your cost estimates are based on 330-megawatt converters and yet you studied 530-megawatt converters for the load flows and the stability?

MR. BAHRMAN: Actually, we have cost estimates for all of the alternatives, one of which has a variation that uses 530-megawatt converters. The rest are all with 370-megawatt converters. You can see that based on the number of converters and the ratings. So in the table you have cost estimates for both.

MS. RANDELL: Could you take a look at the table with respect to Option 1, page 10. It's your answer to Interrogatory 16. (Pause). Are you with me? The last question or we could stop now and get this set up and come back to it.

CHAIRMAN KATZ: We'll recess for 10 minutes.

(Whereupon, a short recess was taken.)

CHAIRMAN KATZ: Let us resume. We have a question pending.

MS. RANDELL: I -- I think the point is made --

CHAIRMAN KATZ: Okay, let's move on --

MS. RANDELL: -- I'll withdraw. And I -- I am done, but Mr. Fitzgerald has a few questions --

CHAIRMAN KATZ: Okay --

MS. RANDELL: -- and then the companies are done.

CHAIRMAN KATZ: Great.

MR. FITZGERALD: Good afternoon, gentlemen. DC lines do not become overloaded in the event of a contingency on the AC system because their power flow would be controlled, is that right?

MR. BAHRMAN: Correct.

MR. FITZGERALD: And on an all AC system, just so we have context, when a line trips out, the power on that line will automatically flow onto the remaining lines in the system?

MR. BAHRMAN: In some fashion --

MR. FITZGERALD: In some fashion --

MR. BAHRMAN: -- some split, yes.

MR. FITZGERALD: Yeah. And that kind of event has the potential of overloading the remaining lines in an AC system, right?

MR. BAHRMAN: It does.

MR. FITZGERALD: So therefore, the AC system is planned and operated so that the remaining lines will be able to absorb the excess power flow in the event of the forced outage of a line?

MR. BAHRMAN: Yes.

MR. FITZGERALD: I don't think any of us are on the mics at this point.

MR. BAHRMAN: Okay.

AUDIO TECHNICIAN: You're on the record, but the --

MR. FITZGERALD: Yeah.

CHAIRMAN KATZ: Do you want to go off for a minute while you --

AUDIO TECHNICIAN: Yeah, I need to find out what's going on.

CHAIRMAN KATZ: Okay, let's go off the record for a minute while we --

(Off the record)

CHAIRMAN KATZ: We're on the record.

MR. FITZGERALD: Okay. So should a DC line that's embedded in an AC system trip out, it will not impose excess flows on the AC system because the converters will shut the DC line flow off, is that right?

MR. BAHRMAN: Getting to your first question, the intent was that the DC circuits, the power through them is controlled and limited to the rating of the circuit itself. In the case of cable, it would never be an overloaded cable. And so that was the point. If there is loss of the DC circuit, then you have parallel AC circuits which may take up some of the slack, or as we mentioned before you can have parallel DC circuits which can be made, as in a bipolar system, to take up the slack commensurate with their rating.

MR. FITZGERALD: If one of the AC lines fails, a DC line that is embedded in that system will not automatically pick up any portion of the power that had been flowing on the failed line in the same manner that an

AC line would, isn't that right?

MR. BAHRMAN: It will -- it will not do so unless told to do so --

MR. FITZGERALD: Right --

MR. BAHRMAN: -- it can be told to do so manually or automatically.

MR. FITZGERALD: Fine. And in many cases in your interrogatory responses you have referred to the Security Constrained Economic Dispatch Algorithm and the Emergency Management System. And is it the case that you envision that that software would be used to program responses of the embedded DC system to contingencies?

MR. BAHRMAN: I will start and then I will ask Rana to continue --

MR. MUKERJI: Yeah, that's correct.

(Laughter)

MR. BAHRMAN: Thank you, Rana.

CHAIRMAN KATZ: We appreciate the brevity.

MR. FITZGERALD: And that software is software that is used by ISO New England to operate the New England power system, right?

MR. MUKERJI: The same software that is used to schedule the several hundred generators in New England.

MR. FITZGERALD: So the answer to my question is yes?

MR. MUKERJI: Yes.

MR. FITZGERALD: And has ABB met with ISO New England to explain how it envisions its system being operated by the ISO New England software?

MR. MUKERJI: We were invited by ISO New England to meet with them for this very purpose. And we had a one-day meeting with them.

MR. FITZGERALD: And have you received any communication from ISO New England as to whether it agrees that programming of the response of a DC transmission system to potential AC system contingencies would be an appropriate application of its Secure Economic Dispatch Algorithm and its Emergency Management System?

MR. MUKERJI: We have received no official response from them.

MR. FITZGERALD: Have you received an unofficial response?

MR. MUKERJI: No, they haven't answered that. They asked a lot of questions and they're assembling the information I believe.

CHAIRMAN KATZ: Just -- can we -- I'd like to just make sure we're clear on this. You met with ISO

New England --

MR. MUKERJI: We were invited by ISO New England to give them an update --

CHAIRMAN KATZ: Right --

MR. MUKERJI: -- on how the HVDC system would operate within the ISO New England framework.

CHAIRMAN KATZ: And did you walk out of that meeting with the impression that ISO could get the DC system to work within the grid or did you walk out with -- that there were programming problems? I mean what was your --

MR. MUKERJI: It was not a programming problem. What we maintained is that the DC -- the flows in the DC lines are all to be scheduled just like the several hundred generators are being scheduled.

CHAIRMAN KATZ: Just like Cross Sound is scheduled, correct?

MR. MUKERJI: Cross Sound is scheduled -- I believe it's not scheduled as part of the Security Constrained Economic Dispatch, but it is scheduled by the ISO.

CHAIRMAN KATZ: Okay.

MR. MUKERJI: So in here the DC segments would be scheduled as part of the Security Constrained

Economic Dispatch, a function of the ISO.

MR. ASHTON: How fast is that response rate --

MR. MUKERJI: I believe that --

MR. ASHTON: -- for DC?

MR. MUKERJI: DC, you can -- the generation -- just the generation is scheduled. The ISO runs the Security Constrained Economic Dispatch every few minutes --

MR. ASHTON: Yeah --

MR. MUKERJI: -- and then the response of the DC is quite rapid. Mike can tell you how many cycles or whatever --

MR. BAHRMAN: Well, the point is --

MR. MUKERJI: Yeah --

MR. BAHRMAN: -- to give -- you know, you have two parts, one is the actual execution of the ramp to get from Schedule A to Schedule B, that's fast. It can be made very fast. It's a selectable ramp rate just as it is for generators --

MR. ASHTON: Again, I'm looking for quantification --

MR. BAHRMAN: The question is you have a re-dispatch of generation as one recourse to take care of

overloads, but you have another -- and that's taken care of by these programs. You have another recourse, another degree of flexibility, is that you can also change the schedules in response to --

MR. MUKERJI: On the DC --

MR. BAHRMAN: -- on the DC itself.

MR. MUKERJI: Almost instantaneous, yes.

MR. ASHTON: Almost -- I want you to quantify it, is it two cycles, ten cycles, fifty cycles, what?

MR. BAHRMAN: For -- for normal schedule changes you have a controllable ramp rate to match generation if you so like. But for a contingency such as loss of a parallel circuit, it's within tens of milliseconds, hundreds of milliseconds --

MR. ASHTON: Okay. So you're talking a sixth of a second, which would be 10 cycles.

MR. BAHRMAN: Yes.

MR. ASHTON: Let me just -- pursuing this a little bit further if I may, two years ago we had a very significant blackout affecting Ohio, Michigan, Ontario, New York, and it got into Connecticut. And one of the things that I recall from that was the figure that a line rated at about a thousand ampere roughly suddenly

experienced swings of about 2,000 amperes and they each lasted for a couple of cycles, but they were significant enough to cause some damage to equipment. How would the DC system operate under that kind of an environment where there were very large power swings, power in and out of the system affecting very few lines? I understand that it would hold whatever the load level was that was being assigned to it, but this was before there could be any signal from ISO to change loadings. It would just -- I assume, and I'm asking you if I'm correct, that the DC would just do what it was told to do and that was it?

MR. BAHRMAN: It would not participate in the uncontrolled power flow to the extent that -- regardless of the phase angles on either terminal --

MR. ASHTON: Yeah.

MR. BAHRMAN: -- it's a controllable element. But it would participate to the extent that the voltages are affected at its terminals --

MR. ASHTON: Okay --

MR. BAHRMAN: -- however, it could help to support those voltages by injecting reactive power. So -- so there are two elements to that.

MR. ASHTON: Arguably I guess it could be either a help or a hindrance depending on the

circumstances.

MR. BAHRMAN: Well, yeah --

MR. MUKERJI: DC contributed to New England being -- both the Quebec ties and the --

MR. ASHTON: Yes --

MR. MUKERJI: -- and the --

MR. ASHTON: Yeah, I --

MR. MUKERJI: -- and the Cross Sound --

MR. ASHTON: I understand that. What I'm playing over in my mind so that it's clear, is that insofar as we have parallel circuits, AC, going to a tie point, swings would be shared by the two circuits. Insofar as we have one AC and one DC circuit going to a tie point, the swing would all be borne on the single AC circuit. Is that a reasonable approximation?

MR. BAHRMAN: In the general case if you do nothing, yes. Many of the DC systems which operate in areas -- in parallel with AC transmission that operate in areas that are prone to instability, many of these systems, for instance Square Butte, the CU, the Nelson River schemes, they have what is known as a damping system, which is like a stabilizer on a generator, and that will sense deviations in frequency that lead to swings and can provide damping. These are not applied in

all DC links, but they are applied in some.

MR. ASHTON: The question I would have to ask, and I'm happy to hear that, is how fast will they react?

MR. BAHRMAN: Within the bandwidth of the oscillation. And typically the highest frequencies are one and a half hertz. Generally, they're much lower than that, but -- so typically one hertz or less.

MR. ASHTON: Okay. Thank you, that's helpful --

MR. MUKERJI: And especially a voltage source converter DC has all the benefits of a STATCOM in terms of enhancing system stability --

MR. ASHTON: Um-hmm.

MR. MUKERJI: -- it's -- it's better in that respect than a conventional DC.

CHAIRMAN KATZ: Thank you.

MR. ASHTON: Thank you.

CHAIRMAN KATZ: Back to you, Mr. Fitzgerald.

MR. FITZGERALD: I have nothing further.

CHAIRMAN KATZ: Thank you. That concludes the companies cross-examination. Okay --

MR. BAHRMAN: Madam -- Madam Chairman?

CHAIRMAN KATZ: Yes?

MR. BAHRMAN: Can we elaborate on one point that happened just before the break before we had a chance to complete our answer, and I'll make it very short I promise?

CHAIRMAN KATZ: Okay.

MR. BAHRMAN: The -- the -- the stability study that had a three-phase fault on the bus at Beseck, this was a boundary case to determine the worse case, it lost all three circuits. You would never have that happen in reality. If the fault were external to the converter protective zone, for instance out on a bus element, you would have a voltage collapse to zero during the fault, there would be -- whether it's AC or DC, zero power transmission during that fault. But if the fault were external, then immediately when the fault is cleared, you would be back in business on those ties. If however the fault were in the converter protective zone, for instance on the transformer, then that converter and that converter alone and the circuit with which it's associated would be tripped, so you would still then have -- in the case of Alternative 3 for instance, you would still have two-thirds of the power carrying capability.

CHAIRMAN KATZ: Thank you. Let me go

through the list. Representative Megna? Not here. Representative Adinolfi? Not here. The Town of Middlefield, Attorney Knapp?

A VOICE: No questions.

CHAIRMAN KATZ: Mr. Knapp says no questions. Milford, etcetera, Mr. Ball, Miss Kohler, questions?

A VOICE: Mr. Buturla will --

CHAIRMAN KATZ: Mr. Buturla.

MR. RICHARD BUTURLA: Richard Buturla on behalf of the Town of Cheshire --

AUDIO TECHNICIAN: Grab a microphone before you speak.

MR. BUTURLA: What do you want me to do?

AUDIO TECHNICIAN: Grab a microphone so we can hear you.

MR. BUTURLA: Richard Buturla on behalf of the Town of Cheshire.

CHAIRMAN KATZ: Okay.

MR. BUTURLA: I want to go over just briefly some of the early testimony regarding ABB's financial capacity. First of all, all of you gentlemen, if I understand it, are engineers or have engineering backgrounds, is that right?

MR. BAHRMAN: Correct.

VOICES: That's correct.

MR. BUTURLA: And prior to today you all submitted, I take it, your resumes. So your resumes were part of the package that all of the parties and intervenors to this matter had before today's testimony, is that right?

MR. BAHRMAN: That is correct.

MR. BUTURLA: And if I understand your testimony, ABB -- first of all, how long has it been in business?

MR. BAHRMAN: Well, it's a formation of several companies, including Westinghouse, T&D operation, Assaya (phonetic), BBC. It's gone through some acquisitions, it's gone through some divestitures, but --

MR. BUTURLA: An approximate?

MR. BAHRMAN: -- about -- over a hundred years.

MR. BUTURLA: Over a hundred years. A hundred thousand employees. And I heard the figure I think 20 billion?

A VOICE: In revenues.

MR. BUTURLA: In revenues --

MR. BAHRMAN: That's correct.

MR. BUTURLA: Is that on an annual basis, 20 billion in revenues?

MR. BAHRMAN: That's correct.

A VOICE: Yes.

MR. BUTURLA: I just want to clear this up. A company your size, you don't have some concern that -- entering into a contract with relatively small companies like CL&P, NU and UI, is that right? You can answer that.

MR. BAHRMAN: That's right.

MR. BUTURLA: That's what I thought. Now, if I understood -- you know, we've done a lot -- we've looked at all of the information you've submitted and we heard the questions that have been asked. And I'm going to try to parrot back some of the questions I have because some of them have been touched upon by both the Council and yourselves in some of the answers, so just bear with me. Your HVDC systems are integrated and operated with parallel AC transmission systems in a number of instances, is that right?

MR. BAHRMAN: That is correct.

MR. BUTURLA: I think you said five?

MR. BAHRMAN: That's for voltage source converters, there are a number of projects. Some of those, Murraylink -- excuse me -- Directlink, Gotland, and

Cross Sound are operated in parallel with AC systems.

MR. BUTURLA: And those are VSC systems?

MR. BAHRMAN: Those are VSC. There are a lot operated on the conventional DC side.

MR. BUTURLA: And your firm was the entity that designed those systems I take it?

MR. BAHRMAN: That's correct.

MR. BUTURLA: The VSC technology is your technology under patent?

MR. BAHRMAN: It is.

MR. BUTURLA: Alright. And is it fair to say that your firm probably has more experience than any other firm in the world in terms of designing HVDC systems?

MR. BAHRMAN: That is correct.

MR. BUTURLA: In addition to the five that you mentioned, I think there was a reference in the documents and again a reference this morning to one project being commissioned. Is that a project that's already been constructed and is in the test phase?

MR. BAHRMAN: That is correct. There are two parallel circuits. The first of those circuits is in the test phase.

MR. BUTURLA: And is that a project that's

designed in such a way to function in parallel with an AC system?

MR. BAHRMAN: No, that one is not.

MR. BUTURLA: That one is not. Could you tell us where that project is?

MR. BAHRMAN: It's from Norway, the mainland of Norway, offshore to a production platform in the North Sea --

MR. BUTURLA: Alright --

MR. BAHRMAN: -- it's called Troll, that's the project.

MR. BUTURLA: Alright. And --

A VOICE: Trolls are big in Norway.

MR. BUTURLA: And with respect to the various projects that are operated in -- parallel to AC projects, I take it there are various control techniques that are utilized and have been recommended by ABB, is that right?

MR. BAHRMAN: Yes, sir.

MR. BUTURLA: And what are some of those techniques?

MR. BAHRMAN: The very simplest is for a bipolar system; you lose a pole, the other pole automatically compensates, just like an AC line would do.

That is a local control, it doesn't involve the system operator.

For other stations where generation uses DC as an outlet, there is scheduling that is automatic between, you know, the operator aide so to speak, special controls that can allocate a portion of the generator dispatch to the DC and allow another portion to remain on AC. This is done on IPP, CU, Square Butte, to name a few.

MR. BUTURLA: Alright. And in addition to various control techniques, I think you testified or it's set forth in your literature that the converter technology that is utilized is both established and proven. Is that your opinion?

MR. BAHRMAN: Yes, that is our opinion. It's newer than conventional, but it's much easier to integrate and offers -- it's much easier to control and operate. It has less of a track record in terms of megawatt years of operation.

MR. BUTURLA: Alright. And I think you have also stated that the ratings have doubled between successive projects. Is that a statement that you have made?

MR. BAHRMAN: That is correct.

MR. BUTURLA: Alright. And can you tell

the folks on the Council and the rest of us what you mean by that?

MR. BAHRMAN: Well if we take the Gotland DC link, it's plus/minus 80-kV, 50 megawatts, then there is basically a copy of that link that is an element of the Directlink project. The Directlink project is -- it consists of three parallel projects, 60 megawatts plus/minus 80-kV, so if you take -- and that's -- that 60, 50, 60-megawatt level and you double the voltage, you're at approximately plus/minus 150-kV, so a doubling of the converter voltage, a doubling of the cable voltage. And if you look at -- that of course increases the power. By the same token, you go from a nominal current of 500 to a nominal current of 1,000 amps, so that doubles the current. So we have four times the power rating and --

MR. BUTURLA: Alright. In your literature you also use the term scalable I believe. Is that the same thing?

MR. BAHRMAN: In -- yes, it is. I mean it follows the tradition of conventional DC from the introduction of power electronics to replace the old mercury arc valves. There was a similar growth that was very rapid in the initial years of the technology.

MR. BUTURLA: Alright. Now, two projects

are currently in operation with the same DC voltage level as proposed for the project that we've talked about here today, is that right?

MR. BAHRMAN: That is correct.

MR. BUTURLA: And what projects are those?

MR. BAHRMAN: Murraylink and Cross Sound Cable across Long Island Sound.

MR. BUTURLA: Alright. Now, Option 2 uses -- first of all, let me go over the options and make sure I understand them. Option 1 comprises several point to point -- is essentially a point to point system, is that right?

MR. BAHRMAN: Yes.

MR. BUTURLA: And Option 2 includes multi-terminal DC transmission links, right?

MR. BAHRMAN: Option 2, yeah. There's the base option, which has redundancy, and then there's some variations of that using higher power or maybe a simpler topology. It doesn't necessarily have the same degree of redundancy. So those are all multi-terminal --

MR. BUTURLA: Alright --

MR. BAHRMAN: -- 2A and 2B.

MR. BUTURLA: And I take it that with respect to the 13 criterion -- criteria that you -- that

your firm evaluated in connection with the feasibility study, Options 1 and 2 satisfy all 13 in your opinion, is that right?

MR. BAHRMAN: In our opinion, it does. Yes, sir.

MR. BUTURLA: Now, Option 3 -- you were cross-examined to some extent about Option 3 this morning. I think you -- to paraphrase your report you said it was marginal due to some harmonic resonance issues, is that right?

MR. BAHRMAN: That is -- that is correct.

MR. BUTURLA: Now, the harmonic -- just so I understand this, the harmonic resonance issues that make Option 3, the hybrid, marginal, those issues are with respect to the 24 miles of the AC system that are proposed to be buried between the Bethel to Norwalk route, is that right?

MR. BAHRMAN: That is correct --

CHAIRMAN KATZ: Do you mean Norwalk to East Devon?

MR. BUTURLA: I'm sorry, Norwalk to East Devon. Thank you -- thank you, Madam Chair. Is that right?

MR. BAHRMAN: That -- that is correct. And

the solutions that had been proposed to mitigate this resonance would apply whether you have the hybrid scheme or the all AC scheme. And I might add that we are -- in many conventional DC systems where we have a large concentration of filters and shunt capacitor banks for reactive power compensation for the DC terminal, we don't need that for Light. You have a similar situation in a weak network where you have a parallel resonance. And in many cases -- and we have a great deal of experience, Radison for instance, and Phase 2 of the Quebec/New England project, we do have indeed low order harmonic filters that are there to mitigate the resonance. This is done in projects all over the world because DC is often used where you have a weak network. And you have a similar situation that's been -- what's been identified here.

MR. BUTURLA: And with respect to Option 3 and your conclusion, the hybrid, that it was marginal, you didn't factor in, if I understand it correctly, any of those various mitigation techniques, is that right?

MR. BAHRMAN: Dave, I'll let -- he did the studies and I'll let him answer that.

MR. DICKMANDER: That's correct. Option 3, the conclusion regarding marginality, a limited number of

cases were run on Option 3. We found that it gave a harmonic resonance characteristic that was no worse than the Phase 2 AC solution alone. We selected options 1 and 2 for further detailed harmonic analysis because they gave the best opportunity to further move the resonance point above the third harmonic. But comparing -- we have limited analysis on Option 3. But from the analysis that was done, the cases were no worse than the Phase 2 AC solution.

MR. ASHTON: What -- may I inject --

MR. BUTURLA: Go ahead --

MR. ASHTON: -- for clarification, you said that the system was no worse than the AC system. You're talking about the underground AC system, is that correct -- -

MR. DICKMANDER: Yeah, I'm speaking of the --

MR. ASHTON: -- and not the overhead one?

MR. DICKMANDER: Well the overhead AC from Beseck down to East Devon and then underground from that point --

MR. ASHTON: Okay, I want to be sure we get the overheads and undergrounds properly placed, otherwise it gets very confusing --

MR. DICKMANDER: Correct --

MR. ASHTON: -- we've got more alternatives here than Carter's got little liver pills -- (laughter).

MR. BUTURLA: Just following up, if I may, so there are mitigation techniques, for example such as C-filters that were talked about yesterday by the folks from KEMA or other types of mitigation techniques that could be factored in to the 24 miles of underground AC that would have an impact on the viability, the feasibility of Option 3, is that right?

MR. DICKMANDER: That could be considered, yes.

MR. BUTURLA: Yes. And are there also techniques that could be utilized with respect to the DC side of Option 3 to enhance the viability of Option 3 with respect to the third harmonic?

MR. DICKMANDER: With respect to the DC --

MR. BUTURLA: Well, looking -- looking at Option 3, we have the AC side, we have the DC side, it's a hybrid, right? Is that yes?

MR. DICKMANDER: That's correct.

MR. BUTURLA: Okay. Now, we've talked about mitigation -- mitigation devices that may be utilized on the AC side that would enhance the viability

of Option 3. You're with me so far, right?

MR. DICKMANDER: That's correct.

MR. BUTURLA: Now -- and I don't know any better, so I'm asking you is there something that can be done to the DC side in terms of mitigation measures or other types of devices that could be utilized that would make -- that would deal with the issue of -- the harmonic resonance issue to make it viable, to make it not marginal?

MR. DICKMANDER: There are other possibilities that could be explored that have not been explored to this point, such as introducing some active filtering of the third harmonic into the control system of the DC. That has not been explored in detail, but that is a possibility that could be considered.

MR. BAHRMAN: I'd like to --

MR. BUTURLA: If you will --

MR. BAHRMAN: -- add to Dave's answer if I may? If you look into the system from the Norwalk side, there you have substantially the same with the AC solution, the hybrid AC underground and AC overhead to be clear. So there the converters are two buses removed, so the ability of the converter itself to affect that resonance on that bus is limited because it is somewhat

removed. And there you would apply the same techniques. You could consider applying the same techniques as suggested by KEMA.

And -- now if you go over to Devon and you're looking at the DC converters, there you do not have a large concentration of harmonic filters like you would with conventional DC, or if you were to go further east with underground AC, so you eliminate that part. Furthermore, you have a converter whose characteristic is in favor, it -- it will raise the resonance. So the converter inherently in and of itself will help at Devon. It's limited in what it can do at Norwalk, so there you would need perhaps the filters. And this could be studied.

MR. BUTURLA: And would you expect if matters such as that were taken and designed into the project, that that would in fact change your conclusion with respect to Option 3 to make it other than marginal, to make it viable?

MR. BAHRMAN: Dave.

MR. DICKMANDER: That is possible, yes.

MR. BUTURLA: And that's something that would need, I take it, further study on your part?

MR. BAHRMAN: Correct, yes.

MR. DICKMANDER: Yes, I believe so.

MR. BUTURLA: Now, Directlink -- you've referred to Directlink a number of times. Could you tell me what the Directlink project is?

MR. BAHRMAN: It's between two states in -- I'll let you answer that, you've been there.

MR. RONSTROM: It's a connection between two states, Queensland and New South Wales in Australia.

CHAIRMAN KATZ: Field trip. (Laughter) Sorry.

MR. ASHTON: Council first.

MR. BUTURLA: And is -- if I understand it, you have three VSC transmission links parallel with an AC transmission system there?

MR. RONSTROM: That's correct. Today as we pointed out before, it was built before the parallel AC connection was existing.

MR. BUTURLA: And your firm was involved in that?

MR. RONSTROM: Yes.

MR. BUTURLA: Okay. Now, how is that project similar to what you're proposing here?

MR. RONSTROM: In the sense that there are three parallel and independent DC circuits working

together with a parallel AC system.

MR. BUTURLA: Alright. And the Cross Sound project, I take it, has the same power level as the project that's proposed here?

MR. FITZGERALD: Objection. What does he mean by power level?

CHAIRMAN KATZ: Plus --

MR. BUTURLA: Withdrawn. I'll --

CHAIRMAN KATZ: -- we've already --

MR. BUTURLA: I'll withdraw it. I --

CHAIRMAN KATZ: We've done that --

MR. BUTURLA: I just want to --

CHAIRMAN KATZ: We've done that question, so let's move on.

MR. BUTURLA: Well if I may, I just want to -- I want to follow up on this for a bit. How is the project that you've proposed here similar to the technology that has already been implemented by ABB around the world?

COURT REPORTER: One moment please.

(Pause).

MR. RONSTROM: Cross Sound Cable is -- uses the same DC voltage as been discussed in this -- in the options we have presented. The power level is

approximately the same, 330, 370.

MR. BUTURLA: Okay. In addition to that are there converter stations presently in use relatively similar in size to the converter stations that would be required under any of the three options here?

MR. RONSTROM: The converter station, yes. If you look -- I would then say that the Cross Sound Cable and the Murraylink converter stations, they have one converter on each site. And some of the options here have two or three converter stations on the same site. So they would differ in the amount of space required in that respect.

MR. BUTURLA: Alright. Now, to follow up on some questions from Mr. Fitzgerald, you have suggested that the Security Constrained unit program be utilized with respect to a DC cable, is that right?

MR. MUKERJI: That's correct.

MR. BUTURLA: Now, you have also stated I think that it is similar -- I think you said this in your study, it is similar to other software programs that have been incorporated in other DC projects, is that right?

MR. MUKERJI: That's correct.

MR. BUTURLA: And what do you mean by that?

MR. MUKERJI: You can talk about the

controllability.

MR. BAHRMAN: There are models for DC transmission links in other independent system operators' models. I mean they don't involve the same number of converters or links, but -- for instance, in WECC, the Pacific DC inter-tie is incorporated into such a model. In Korea there's a DC link to an island which is incorporated in such a model. The Bass Link, which is a project underway between Australia and an island, that will be incorporated into the system operator controls. And there's a number of local controls too to take care of problems in response to contingencies, much like we talked about the compensation for loss of a pole, or in the case of Highgate where you have a very weak system and you lose an AC line somewhere in the network, you have a stability problem so you reduce the maximum power level which you can transfer. So one you have local controls, the other you have more or less operator aids.

MR. BUTURLA: Alright. And -- and I think you've segued into my next question frankly and I'm not sure you may have just answered it. You stated in the report that the control features of the HVDC system will give operators greater flexibility than they have today. That's a statement you folks made, is that right?

MR. BAHRMAN: That is correct, you have controllable transmission. That is something that goes hand in hand with the DC transmission.

MR. BUTURLA: Alright. And that's something that's different, and in your view better than an AC system?

MR. BAHRMAN: If you use it right, yes. It gives you more flexibility. No. 1, you can control utilization in this case of a loop, certainly of the individual circuit, and you may be able to minimize losses or preposition the flow by means additional to re-dispatch of generation to be able to better survive a contingency. For instance if you have a short path with low impedance, which you would have with AC cables, and then you have a more circuitous path with an overhead line, which has a higher impedance, the shorter path will hog the load much like a larger pipeline would hog the water flow. The fact that you can throttle back on the short segment with the low impedance, the big pipeline if you will, and better utilize the roundabout way, therefore if you were down the line to have a contingency on the short path, you would not have such a bump. So there's two ways, one for optimizing losses, that's one way. This is used in Gotland for instance where you have parallel AC and DC.

And the other is to better utilize the transmission assets, you don't have to have necessarily a hundred percent redundancy or an over-capacity.

MR. BUTURLA: Alright. This morning you asked some questions with regard to the -- what was included within your estimates. And you had a pretty wide range in terms of construction costs. I think in many instances as much as 50 million dollars, is that correct?

MR. BAHRMAN: This has to do with the cable installation costs?

MR. BUTURLA: Yes.

MR. LARSSON-HOFFSTEIN: Yes.

MR. BUTURLA: And just to follow up on Mr. Ashton's question, I mean that's -- that's normal to give such a large range, I take it, at this preliminary stage of -- I'll use the word proposal -- is that right?

MR. LARSSON-HOFFSTEIN: Yes.

MR. BUTURLA: Okay. Now, one of the other advantages I think of a DC system like this underground is that you're not constrained in terms of length. Is that what you said this morning?

MR. BAHRMAN: That is correct. So you have more flexibility in a right-of-way.

MR. BUTURLA: That's exactly where I was

going. So for example, if there are issues in terms of the DOT in terms of the right-of-way, that can be re-routed elsewhere? It can be re-routed around? There can be a variety of things done, I take it, because you're not constrained in terms of length, is that right?

MR. BAHRMAN: That is correct. There is no --

MR. FITZGERALD: I'm going to object to the question. He -- to say that you're not constrained in terms of length is one thing, that -- that's a factual issue. But if he's going to say that it could be routed around, I think --

MR. BUTURLA: Around obstacles, Mr. Fitzgerald --

MR. FITZGERALD: I think the question ought to include around what.

CHAIRMAN KATZ: Can you rephrase the question?

MR. BUTURLA: Well, I'll do my best. I do think it's a fair question.

The point is, I take it, that because you're not constrained with respect to length, you have greater flexibility with respect to obstacles that may be encountered within the right-of-way, is that right?

MR. BAHRMAN: Yes.

MR. BUTURLA: Okay. And that would have an impact in terms of the construction costs, is that right?

MR. BAHRMAN: Yes.

MR. BUTURLA: You also mentioned this morning that --

MR. ASHTON: But you -- you don't know whether that's up or down because any savings in avoiding an obstacle may -- would be off set presumably by a longer cable at a cost, so that the net effect we're uncertain of all together, aren't we?

MR. BAHRMAN: Yeah. If you go one step further, you could say that if the shortest route basically because of congestion, physical congestion along the right-of-way has to be under streets, you may say that the longer route could be adjacent to another right-of-way which -- where you could direct bury. So even though you have a longer cable, the fact is you save considerably on the installation costs --

MR. ASHTON: Right --

MR. BAHRMAN: -- net savings.

MR. ASHTON: So wouldn't it be wise to really focus on specifics of a routing rather than --

MR. BAHRMAN: Absolutely. This is why we

have a range for a lot of reasons.

CHAIRMAN KATZ: Okay, let's move on.

MR. BUTURLA: Thank you. Now, you also mentioned this morning with respect to Options 1 and 2 that they had not been optimized. What do you mean by that?

MR. BAHRMAN: Dave.

MR. DICKMANDER: With respect to which -- which context of the question?

MR. BUTURLA: Well, I -- I heard the word that -- you were testifying, I take it, that -- with respect to some analysis that they had not been optimized. And I -- I didn't know what you meant and I didn't hear the context, so --

MR. DICKMANDER: Okay. I think the question was regarding the power flow study, the choice of the converter sizes in the power flow study. What I was saying was that there was not an attempt in the power flow study to come to a firm conclusion as to whether 370 or 530 were the most appropriate. In other words, there were not ABB comparison done for each case for the two sizes. What was settled on ultimately in the study was the 530, but there was not an effort taken to try to make a clear determination of one over the other.

MR. BUTURLA: That is something that could be done with further analysis I take it?

MR. DICKMANDER: Yes.

MR. BAHRMAN: I would like to add one point from the converter technology point of view. If you look at the table, we do have some estimates for the converters for the 530-megawatt size, I believe it's Option 2B. So if you look at the cost per converter, you can sense and see directly that there is an economy of scale. So it's a matter of reliability and redundancy versus economy of scale in the converter size, just to point that out.

MR. O'NEILL: Excuse me. As a follow-up to that statement, in your feasibility study you mentioned that as part of the scheme -- as far as the scope it's never been built to this kind of specifications before, has it, using the voltage source converters --

MR. BAHRMAN: The higher power ratings have not been built. It uses the same controls, the same design, the same technique, the same voltage level. The only thing really that's different in the semi-conductor positions we have allowance for incremental expansion to a higher current rating. And with Cross Sound those positions are filled up to two thirds. So we have the capability to increase the current by 50 percent

approximately. And that is what the change is really, going from 370 to 530.

MR. O'NEILL: So the unique nature of this design shouldn't cause us to take note and be concerned about the reliability of this equipment?

MR. BAHRMAN: We -- other than the fact that you have two parallel circuits versus three, I would say no.

MR. O'NEILL: Could a 115 AC share an underground trench with a 345 DC --

MR. BAHRMAN: Uh --

MR. O'NEILL: -- would there need to be a large degree of separation between the two?

MR. LARSSON-HOFFSTEIN: No, they can I guess share the same.

MR. O'NEILL: Thank you.

MR. BUTURLA: And just to -- just to conclude, you're not proposing any new technology here, is that right?

MR. BAHRMAN: That is correct.

MR. BUTURLA: You're proposing utilizing established, well-proven DC technology parallel to an AC system, is that right?

MR. BAHRMAN: That is correct. You could

say that the overall experience base is less, the learning curve we have followed. And even if you look at the reliability/availability statistics for Murraylink aggregated with Cross Sound, we found many of those have been corrected. And I think, Leif, you told me that a subset of those you determined would remain -- I mean -- I think you used the number of three, and please elaborate.

MR. RONSTROM: Yeah, the -- you're referring to the number of forced outages. And I previously stated that that's what could be expected in the first year of operation. And we have been looking over this. And I would expect in -- if we -- a new measurement in one year from now we would be down to around three forced outages per project in year. That's a normal figure that you would have after some years of operation.

MR. O'NEILL: As a follow-up to that --

A VOICE: We can't -- we can't hear --

MR. O'NEILL: As a follow-up to that, would this system meet nationally accepted reliability standards?

MR. BAHRMAN: I mean we're talking about --

CHAIRMAN KATZ: Start off with yes and, or no and.

MR. BAHRMAN: Yes. The standards to which I assume you're referring are the reliability criteria for meeting network reliability in terms of being able to survive credible, plausible contingencies. It's a network security test.

MR. O'NEILL: Thank you.

CHAIRMAN KATZ: Does that conclude your cross-examination?

MR. BUTURLA: It concludes mine. I think Mr. Stone has some questions.

CHAIRMAN KATZ: Mr. Stone.

MR. BRIAN STONE: I -- I have a couple of questions. I'm going to try real hard not to be repetitive of what's already been asked.

I'd like to follow-up just briefly with something that Mr. Ashton was discussing which kind of intrigued me and it's within your feasibility study on page 10, paragraph 3, when you're talking about the harmonic resonances for Option 3, which is at -- and I'll read the sentence, it says further damping may also be possible through active filtering at third harmonic with the VSCs. Do I understand that correctly that your variable -- variable source converters can actually serve as filters?

MR. DICKMANDER: Yes, that's correct if they are programmed that way.

MR. STONE: And in your studies did you -- your harmonic studies of Option 3, did you take into account utilizing the variable source converters as filters?

MR. DICKMANDER: No, we did not --

A VOICE: Voltage source --

MR. DICKMANDER: -- the converter representation in the frequency scan studies strove to correctly represent the impedance of the converter for harmonic frequencies. It did not attempt to investigate other types of control features such as an additional control loop that would actively filter a harmonic. That would be an additional control feature that we did not include in the investigation.

MR. STONE: So if -- so it would be possible to do that investigation, is that correct, further investigation?

MR. DICKMANDER: Yes, it would be possible to look into that.

CHAIRMAN KATZ: How long would that take?

MR. STONE: My next question.

MR. DICKMANDER: I think we would need to

confer with some of our colleagues to come up with an answer on that.

MR. BAHRMAN: I would -- I'd like to make, you know, one point. The studies considered a range of impedances and it shows that by the presence of the converters, the resonances increased. If you -- if you look at the actual converter impedance, it may be a few hundred ohms. And with controls, maybe you can make it less than that. But in the studies that Dave has done -- and Dave you can jump in -- the converter characteristic itself as proposed provided an impedance, which together with the network mitigated the resonance -- the lower harmonic resonance problem.

MR. STONE: Except in certain circumstances? In certain --

MR. BAHRMAN: The case --

MR. STONE: In certain --

MR. BAHRMAN: The case --

MR. STONE: In certain dispatch scenarios it did not, correct?

MR. BAHRMAN: Well, not so much the dispatch, but the topology with Option 3 looking in at Norwalk, the fact the converter is remote so to speak, it doesn't have the same impact on that bus.

MR. MUKERJI: Yeah, as far as the time length for doing additional studies, we did this whole study in less than three months. So studying Option 3 in greater detail would take considerably less than that.

CHAIRMAN KATZ: Thank you. And I think that gives us a window there.

MR. STONE: Now, I think you also stated that this technology, the voltage source converter technology could eliminate the need to use STATCOMs, is that correct?

MR. MUKERJI: That's correct.

MR. STONE: And -- I know one of the issues has been converter size. If you compared the converter size of -- I'm going to say DC Light because it's easier for me to spit out -- but a DC Light converter versus a substation -- a conventional AC substation with a STATCOM, could you -- can you draw some kind of comparison in size?

MR. BAHRMAN: I mean we have of course figures provided for the different size converter stations. And AC stations they -- depending on what's in them and how many lines are coming in and out and the transformers, they can vary in size, or you could reduce them by using GIS. If you add to that station some STATCOMs or some C-filters, they of course have a

footprint, require some area, and they will expand upon that AC size. So a STATCOM, essentially, is very much like a voltage source converter. In fact, that's what it is. The only difference is that you generally don't have a high voltage, so therefore to get the megaVAR or the rating that you need, you may need several of these in parallel, which means that that kind of eats away at the area required as well.

MR. STONE: Okay. Now, one of the advantages -- let me rephrase that -- not advantages because I don't know if you'd characterize it that way -- but one of the flexibilities that Option 3 provides over Option 2 is to meet one of the criteria for additional load because it provides you with the option of connecting substations to the 345 AC line to provide that additional load, is that -- is that correct?

MR. BAHRMAN: At least to the west of East Devon --

MR. STONE: Well, I am talking now --

MR. BAHRMAN: Yeah --

MR. STONE: -- in the section where you would not have the underground DC.

MR. BAHRMAN: Yes.

MR. STONE: Now, back on page 6 of your

feasibility study when you -- let me just see if I can find it -- oops -- I went from page 8 to page 12, I did that real well -- sorry -- you talk about new load serving stations and you point out that one of the ways to provide new load with the fully underground DC between Norwalk and East Devon is by additional 115 lines off the substations there, is that correct?

MR. MUKERJI: That's correct.

MR. STONE: And you indicate -- and you point out that the lower capacitance of a 115 line versus a 345 -- and I assume you're saying that that -- that there's some advantage to that, is that correct?

MR. MUKERJI: Dave.

MR. DICKMANDER: Yes, that's correct.

MR. STONE: And am I correct that that advantage is that those -- that new load is going to result in new capacitance, additional capacitance in the system, which is going to then create more harmonic resonance issues as you add -- add those lines? Is that --

MR. DICKMANDER: Well, the loads themselves I would not expect to add capacitance to the system. But the cable itself, the 115 would add a small amount. It would be a very small amount as compared to a 345-kV AC

cable.

MR. STONE: And is that -- and is the issue with that harmonic resonance ultimately?

MR. DICKMANDER: Well, the -- you know, any addition of capacitance will tend to lower the resonant frequency. But the point is that by adding 115-kV cables, the influence on the resonant frequencies would be dramatically less severe than adding 345-kV AC cables.

MR. STONE: Understood. In your stability analysis you only modeled Option 1, correct?

MR. DICKMANDER: That's correct.

MR. STONE: And you -- one of the -- one of the reasons that you didn't model Option 2 is because there are no models? You'd have to create the model? Is that accurate?

MR. DICKMANDER: That's correct.

MR. STONE: Is that something that you're capable of doing?

MR. DICKMANDER: We can explore that possibility. But yeah, exploring that is something that could be done.

MR. STONE: Was the -- was the timing issue one of the -- one of the reasons why you didn't do that?

MR. MUKERJI: As far as more stability

studies were not done, because of the schedule that we had to finish the study rather than non-availability of models. We had finite amount of weeks and we did -- we looked at the criteria and we could not do all the stability runs which could have been done.

CHAIRMAN KATZ: How many weeks did you have?

MR. MUKERJI: We did the report in less three months, the whole -- the three options. So -- and we -- and we ran only a few stability cases because of time constraints.

MR. STONE: I have no way of knowing this, but maybe you can answer the question, would you -- would you expect in your professional experience that -- that if you did those stability studies, would there be -- likely to be much variation between Options 1 and 2, or Options 1 and 3, or Options 1, 2 and 3? I know that's a multiple question, but I think they're all consistent, so --

MR. DICKMANDER: I think that would be very hard to speculate without actually running a study.

MR. STONE: How long would it -- how long would it take you to run those studies?

MR. MUKERJI: Several weeks.

MR. STONE: This may be repetitive, but I'm

going to ask it anyways. On --

CHAIRMAN KATZ: (Indiscernible) --

(Laughter)

MR. STONE: If it -- if it is, I will accept your hammer gracefully.

In the technical description portion of your report, you talk about the reactive power capability of the VSC converter being a virtual -- and I think this is a quote -- a virtual generator at each part of delivery. Can you -- can you explain what that means and what the -- what the advantage of that is over AC?

MR. BAHRMAN: Yes. The -- the point is that a generator has both the ability to inject real power into network, that which turns meters and does work. It also has the ability to supply, usually on demand from a voltage regulator that's part of the generator expectation system, reactive power for the purpose of regulating the voltage. So you have a real power and a reactive power in terms of megaVARS.

Now a voltage source converter acting as an inverter is injecting power and it also has the ability within its capability to provide reactive power support very quickly and dynamically. It has attributes of an SVC or STATCOM together with that of conventional DC. And

what this means is that any variation in real power on the line does not have to be compensated for reactive power going up or going down. It's much easier to integrate compared to -- but what it also means is that should there be a contingency loss of an AC line, the loss of a generator that requires a reshuffling of the flows, that sometimes that's accompanied by low voltage, and sometimes that low voltage can be severe in Southwest Connecticut, it's rather weak, and for instance a STATCOM has been added, and you could say that within the capability of the converter that the DC terminals have the attributes of a STATCOM, whether it's at the sending end or the receiving end, but the virtual generator refers to the receiving end. So -- so that's what is meant.

And if you quantify that, if you -- if you take the megawatt rating of the converters that have been proposed one-by-one, you can add about 80 to 90 percent power level, you still have the ability to control roughly half the real power and reactive power. So let's say we have 370 megawatts, that's the rating, and you're at 80 or 90 percent, wherever, there might be some corners cut off there, 80 or 90 percent of real power, you have the ability to swing maybe 160, 170 megaVARS, plus or minus. Similar to a generator PQ capability curve. So that's

what's meant by virtual generator.

MR. STONE: It causes me to ask a question which may be really stupid, but I'm going to ask it anyways, and that's does that -- as time goes on and demand increases, does that kind of delay the need for -- that flexibility, does that -- will that delay the need for new generation in the future, I know it won't end it, but in Southwest Connecticut, or to bring more power from the north?

MR. BAHRMAN: No, something has got to generate the power. This is just the delivery mechanism. But to understand the concept I just made, there is a figure, 25, in the technical report on page 34 that one could refer to to look at this PQ capability curve. I don't think we have to dwell on it now, but if --

CHAIRMAN KATZ: Good, we're going to move along --

MR. BAHRMAN: That's just to -- just to state where you can see this figure.

MR. STONE: Okay, then I'll look at it at my leisure. I want to go back to this expandability issue just very briefly. Does the fact that your existing DC circuits in parallel with AC circuits in the existing systems that you have, the fact that it's a small

percentage of the total load versus what would be in this proposed circuit, which would be a larger percentage, does that have any significance?

MR. BAHRMAN: Not in my opinion, either the length or the percentage of load served.

MR. STONE: One last question. There was a big distinction made of the fact that this is a technical feasibility study and not -- not a proposal. If -- if the question had been reversed and you were asked to put together a proposal for a DC circuit that would meet this reliability criteria, would -- would it look any different than this feasibility study in substance?

MR. BAHRMAN: Well, there's two aspects, one is the study, and the other is the -- as you said, a proposal. What we have given is a budgetary estimate that involves some uncertainties, particularly with local costs. We give a range for the cable costs. But if we were asked for a proposal, then as Magnus said, they would do a detailed investigation of the route that was selected or routes, alternatives, and he'd be able to then give a proposal for such, you know. So more work would be done and there would be a greater degree of accuracy based on installation costs especially.

MR. STONE: Thank you.

CHAIRMAN KATZ: Thank you.

MR. STONE: Nothing further.

CHAIRMAN KATZ: Does your cross also cover Wallingford and Durham or is that separate?

MR. STONE: They may -- they may, yes.

CHAIRMAN KATZ: Mr. Curto?

MR. ALAN CURTO: I've got five minutes.

CHAIRMAN KATZ: Fine. We have -- we have an hour. So we are going to move briskly through the next hour with short questions, short answers, and avoid repetition. That's what your brief is for.

MR. CURTO: Then I will be brisk.

CHAIRMAN KATZ: Great. Thank you.

MR. CURTO: Good afternoon, Madam Chairman and members of the Council, gentlemen. I have only a few brief questions --

CHAIRMAN KATZ: I just need you to identify yourself for the record.

MR. CURTO: I'm sorry. Alan Curto, Halloran & Sage, the Towns of Durham and Wallingford.

I have only a few brief questions and I'll direct them to the panel generally and whoever feels most qualified to answer, just chime in.

In Exhibit 22A, and particularly the

executive summary, page Roman V -- I don't know whether you need to reference it other than to know where I'm talking about -- it says that HVDC Options 1 and 2 are feasible and capable of meeting the performance criteria set out by NU, UI, and ISO New England. Is it possible to say with any certainty whether that conclusion would still apply if Options 1 and 2 were extended east from Beseck for approximately seven miles? Is there anything you could -- at all you could say to that question based on the studies that you've done so far?

MR. MUKERJI: We have not studied that option. And you could not -- I mean you could add underground DC basically from any point to any point, but we have not studied that option or the system impact of that option.

MR. CURTO: So -- so there's nothing inherent about VSC HVDC that would prevent an additional seven miles from working?

MR. MUKERJI: That's correct. It depends on where the converters are going to be located.

MR. CURTO: Okay, fair enough. On page 4 of the study it says -- and this is in regard now to Option 3 -- in that case you replace the overhead 345-kV part of the Phase 2 AC solution with underground DC. And

that's the case in which HVDC Light is used between Devon and Beseck. You didn't mean to suggest by that statement that Devon to Beseck is the sole part of the overhead 345-kV system in Phase 2, correct, because there are additional segments of Phase 2, particularly Oxbow to Beseck that were not studied?

MR. MUKERJI: That's right. Our study -- we were specifically asked to study Norwalk to Beseck --

MR. CURTO: Alright. And --

MR. MUKERJI: -- in the scope of the study we were asked to do.

MR. CURTO: And nothing else?

MR. MUKERJI: Nothing else, yes.

MR. CURTO: Okay. Okay, that -- that leads right to my next question. Page -- page Roman I of the executive summary states that ABB was engaged by NU, UI, and ISO New England to conduct a study. And then going to Exhibit 15 -- or Item 15, excuse me, which were the interrogatories from Durham and Wallingford to ABB, in your response to Question 2A you state that the main focus and scope of the ABB study as discussed with the Applicants was -- and there's no need to go any further -- by Applicants I infer that you mean CL&P and UI?

MR. MUKERJI: Yes.

MR. CURTO: Okay. And then in the response to Question 2B, the same item, it says that the original study was done under contract with Northeast Utilities. So in those three instances it seems like you're saying that the study was commissioned by UI, NU, and ISO New England on the one hand, NU and UI on the other, and on the third hand just NU. Can I ask you who in fact commissioned the study --

MR. MUKERJI: Well --

MR. CURTO: -- because it's unclear to me?

MR. MUKERJI: The purchase order for the study came from Northeast Utilities --

MR. CURTO: So it was Northeast Utilities --

MR. MUKERJI: -- and the participants -- as far as people who participated on the advisory of the study were representative from C&L -- CL&P, UI, and ISO New England as well.

MR. CURTO: And part of that purchase order dealt with what segment of the project was to be studied?

MR. MUKERJI: As far as the scope, it was decided by the people who commissioned the study.

MR. CURTO: Okay, fair enough. Madam Chairman, at this time -- and I don't think it's an

appropriate question for this panel, but at some point I'd like to reserve the right to question NU and to give them an opportunity to explain their decision to study just that segment.

CHAIRMAN KATZ: Okay. We'll ask them to please have a witness available on cleanup day --

MR. CURTO: Okay --

CHAIRMAN KATZ: -- for that issue.

MR. CURTO: That's all I have.

CHAIRMAN KATZ: Okay, thank you.

MR. CURTO: Thank you, Madam Chairman.

CHAIRMAN KATZ: Next is the City of Norwalk? No questions. The Town of Westport? No questions. State Representative Fritz? No questions. The City of Meriden? No questions. Assistant Attorney General Wertheimer?

A VOICE: No questions.

CHAIRMAN KATZ: He said no questions. Representative Kalinowski? Not present. The City of Bridgeport? No questions. The Communities for Responsible Energy?

A VOICE: (Indiscernible).

CHAIRMAN KATZ: They said no questions. The Office of Consumer Council, Mr. Johnson? No

questions. Representative Klarides? No questions. Woodlands Coalition?

A VOICE: No questions.

CHAIRMAN KATZ: They said no questions. ISO New England, Mr. Macleod.

MR. ANTHONY MACLEOD: Thank you, Madam Chair.

CHAIRMAN KATZ: Can I have a show of hands of parties and intervenors after Mr. Macleod who have questions for this witness panel. Yes, PSEG and DOT. Okay, thank you.

MR. MACLEOD: Good afternoon. My name is Tony Macleod representing ISO New England.

Now, I think you responded to Mr. Buturla that VSC is your technology under patent? Whoever is the appropriate person to respond to these question, please take the jumpball, I'm not sure who to address any of them to.

MR. BAHRMAN: That is correct in as we have defined it. There are other suppliers. If you for instance look at their website, they claim to be offering similar technology. How they get around the patent issues is another story.

MR. MACLEOD: Well if -- so if this sort of

technology were employed in this system, it could be supplied either by ABB or by somebody else and the result would be comparable?

MR. BAHRMAN: We certainly could supply it.

MR. MACLEOD: I beg your pardon?

MR. BAHRMAN: We certainly, as ABB, could supply the technology.

MR. MACLEOD: Okay. And let me ask about replacement parts. I assume that if you built it, you'd be able to supply replacement parts?

MR. BAHRMAN: We've been in the DC business since 1954, yes, sir --

MR. MACLEOD: Okay --

MR. BAHRMAN: -- and in fact, we are providing replacement parts for other suppliers who have exited the business.

MR. MACLEOD: And would other suppliers be able to supply replacement parts?

MR. BAHRMAN: Yes.

MR. MACLEOD: You've mentioned Highgate -- the Highgate converter a couple of times today. Are you familiar with the problems that the Highgate converter has in obtaining spare parts when replacements are necessary?

MR. BAHRMAN: No, I am not.

MR. MACLEOD: Okay. Are you familiar with the operation of the Highgate converter?

MR. BAHRMAN: Yes.

MR. MACLEOD: Would it surprise you to learn that it has experienced outages over the last few years for which replacement parts were necessary?

MR. BAHRMAN: The -- I don't know the details.

MR. MACLEOD: Okay. In order to kind of shortcut this and in order to observe Professor Tait's prescription against reading from interrogatory responses, I'm going to refer to the interrogatory responses that you provided to ISO dated November 18th and I'm simply going to ask you whether or not you agree with what I'm going to characterize as your responses.

It strikes me in reading your interrogatory responses that there were perhaps 10 or so responses in which you indicated in answer to questions by ISO concerning the need for adjustments to the HVDC system to respond for example to system changes and in answer to questions ISO had about things like operator intervention, that it was -- it was envisioned, basically, that the HVDC flows would be scheduled in accordance with the -- I'm going to hopefully say this once and then I'm going to

refer to it as SCED -- Security Constrained Economic Dispatch Algorithm that is used by ISO, is that correct?

MR. MUKERJI: That's correct.

MR. MACLEOD: And subject to check, is it accurate to say that that was your response to questions -- Interrogatory Responses 2, 5 -- I'm just going to read them off and we can worry about it later when the record reflects what you've said -- 2, 5, 6, 14, 15, 17, 18, 19 and 21?

MR. MUKERJI: Yes, you're correct.

MR. MACLEOD: Okay. And in response to questions 15, 17, 18, 19 and 21 you made reference to the SCED algorithm?

MR. BAHRMAN: Yes.

MR. MACLEOD: Again in response to concerns that were raised in the questions about the need for adjustments to flows, changes in response to system conditions, and the need for operator intervention, correct?

MR. MUKERJI: That's correct.

MR. MACLEOD: Okay. Is it fair to say then that you've put a lot of confidence in that SCED algorithm to be able to respond to system needs?

MR. MUKERJI: The SCED algorithm is used by

ISO New England to schedule all the generators you have on the system. And that algorithm would be used to schedule the DC flows as well.

MR. MACLEOD: I understand that. But in terms of who's saying that that's how it would be scheduled -- these are your responses to ISO's questions and it strikes me that you're telling ISO that they are going to schedule this -- these HVDC flows using their SCED system. That's how I read your responses.

MR. MUKERJI: When we did the technical feasibility study, we assumed that the DC flows would be scheduled as part of the Security Constrained Economic Dispatch Algorithm --

MR. MACLEOD: So that was an assumption made by you?

MR. MUKERJI: Yes, in terms of -- the systems are -- other systems are scheduled in that manner.

CHAIRMAN KATZ: When you met with ISO, did they give you any reason to believe that it would be otherwise?

MR. MUKERJI: No.

MR. MACLEOD: Well, let's talk about that. I was not frankly clear on what you said the result of the meeting was in terms of an understanding in that regard.

Can you tell me roughly the date that you met with ISO?

MR. MUKERJI: It was approximately a month ago. I don't remember the exact date.

MR. MACLEOD: Um-hmm --

CHAIRMAN KATZ: Was it in Holyoke?

MR. MUKERJI: Yes.

MR. MACLEOD: And was it before or after you prepared these interrogatory responses, do you remember?

MR. MUKERJI: I think it was before --

A VOICE: Yeah.

MR. MUKERJI: Yeah, it was before.

MR. MACLEOD: So you met with ISO before you prepared these interrogatory responses?

MR. MUKERJI: Yes.

MR. MACLEOD: And it was your understanding after that meeting or walking out of that meeting that ISO agreed with you that it would schedule the HVDC flows --

MR. MUKERJI: No, we -- we did not get any indication from ISO.

MR. MACLEOD: Oh, you did not --

MR. MUKERJI: No --

MR. MACLEOD: -- okay. So just to make sure that we're crystal clear here, ISO did not

communicate to you either officially or unofficially that it could use its SCED algorithm to schedule HVDC flows?

MR. MUKERJI: That's right.

CHAIRMAN KATZ: Okay. Mr. Macleod, do you think on a cleanup day we could have an ISO witness on this issue?

MR. MACLEOD: We are absolutely going to have one.

CHAIRMAN KATZ: Thank you.

MR. MACLEOD: Now --

CHAIRMAN KATZ: Yes -- excuse me, Mr. Macleod.

MR. O'NEILL: Yes. In earlier testimony I thought I understood you to say that presently ISO was controlling the Cross Sound Cable flow through the SCED system?

MR. MUKERJI: Not through the SCED system. They were responsible for the schedule, but they did not schedule it within their SCED algorithm.

MR. O'NEILL: Thank you.

MR. MACLEOD: And this is -- actually in terms of Cross Sound Cable that's scheduled as a load, correct?

MR. MUKERJI: Yes.

MR. MACLEOD: You may have to speak up. I don't know if they're catching you --

MR. MUKERJI: Yeah. I mean it depends on the flow. It could be -- it flows either way, so it could be scheduled as a load or a generator.

MR. MACLEOD: But you don't -- are you telling me that it could be either way but you don't know how it is?

MR. MUKERJI: It could be either way.

MR. MACLEOD: But you --

MR. MUKERJI: It depends --

MR. MACLEOD: Do you know how it is?

MR. MUKERJI: No, it depends on the load --

MR. MACLEOD: Okay --

MR. MUKERJI: -- the load profile, and the season and so on.

MR. BAHRMAN: To elaborate, it's a schedule interchange between two adjacent system operators.

MR. MACLEOD: Do you have the responses to the ISO interrogatories available to you?

MR. MUKERJI: Yes.

COURT REPORTER: One moment please.

(Pause).

MR. MACLEOD: Okay. If you could turn to

Interrogatory Response 14, the last sentence of that response, the question there was how the proposed embedded multi-terminal VSC HVDC line would be scheduled and operated. You indicated in that response that the schedules determined for VSC HVDC will always maintain the system in a secure state, i.e. no overloads, no voltage or stability problems, and the ability to withstand multiple contingencies. Is that some sort of guarantee that this system is never going down and will never fail? It will withstand multiple contingencies always?

MR. MUKERJI: It simply says that the DC would be scheduled in the same manner as generation is scheduled to leave the system in a secure mode, which --

MR. MACLEOD: Well, I think in reading it, my interpretation was that it went farther than that, and it said, first of all, it would always withstand multiple contingencies --

MR. MUKERJI: That by definition is what a Security Constrained Economic Dispatch does.

MR. MACLEOD: So you're speaking about the schedules and the SCED system rather than the HVDC system?

MR. MUKERJI: The schedule that the SCED system would come up, which we assumed would include the DC flows --

MR. MACLEOD: Um-hmm --

MR. MUKERJI: -- would leave the system in a secure manner, which implies that it would be -- which would be able to sustain contingencies and system --

MR. MACLEOD: Okay, so this --

MR. MUKERJI: -- operating criteria.

MR. MACLEOD: This response in other words -- if -- you're referring to the SCED schedules, is that correct, is really talking about the schedules used by ISO?

MR. MUKERJI: The schedules developed by ISO, yes.

MR. MACLEOD: And are you putting words in ISO's mouth to the effect that ISO will always guarantee that the system will withstand multiple contingencies?

MR. MUKERJI: All --

MR. MACLEOD: We -- we have to know who this is coming from. Is it coming from ABB or are you putting words in ISO's mouth?

MR. MUKERJI: We made an assumption when we conducted the study. And the assumption was that the DC flows would be scheduled by the Security Constrained Economic Dispatch program, and which is the same program that the ISO uses to schedule all the generators in New

England.

MR. MACLEOD: And that schedule alone will take care of all these problems that are mentioned in response to Interrogatory 14?

MR. MUKERJI: Yes, the schedule would. But the schedule developed -- the schedule is developed by the Security Constrained Economic Dispatch Algorithm every few minutes, which leaves the system in a secure state.

CHAIRMAN KATZ: Mr. Macleod, it's obvious that the witness panel has made certain assumptions about the ISO system. But I think the Council is best served in just having an ISO witness here in the future on what the system can do and cannot do based on --

MR. MACLEOD: Well again, Madam Chair, we fully intend to provide that witness, but I think that it is germane to the proceeding and to an understanding of what we're being told the system is capable of doing and the HVDC program is capable of doing in order to find out what these witnesses have to say about it as well. And then if there's any conflict, we can match it up and see where to go from there.

MR. GERALD J. HEFFERNAN: (Indiscernible) -- Mr. Macleod, have you ever heard, you know, since that meeting that the system was incapable of doing this? I

mean --

MR. MACLEOD: I -- I cannot answer that question, Mr. Heffernan, I'm not aware.

MR. HEFFERNAN: So it just seems that -- they said we think your system can do it. You seem to me to be putting out doubt whether or not the system can do it the way they've proposed. But no one is -- you know, there's nobody that can answer the question --

MR. MACLEOD: Well --

MR. HEFFERNAN: -- the way I understand it.

MR. MACLEOD: I suppose -- I suppose I can -- I can take a look at the timing of the responses to these interrogatories compared to the time the meeting took place --

MR. HEFFERNAN: And see if these are related --

MR. MACLEOD: -- and say if we had concerns, why would we have asked the questions, but --

CHAIRMAN KATZ: Right. I just don't want to spend a lot of time today circling the issue when at a later time we can go directly to the issue. And we'd appreciate it if that witness could be someone who was actually at this meeting.

MR. MACLEOD: Well, we'll provide -- I

think we'll provide a witness that will satisfy you in that regard.

CHAIRMAN KATZ: Great, thank you.

MR. MACLEOD: Now in that regard again in response to Question 21, Interrogatory 21, about a little more than halfway down -- and this question is related to operation experience that ABB might have with respect to multi-terminal HVDC solutions, which might indicate what additional operating considerations ABB believes HVDC Light would impose on operators-- and a little more than halfway down you have a sentence that says the HVDC will be scheduled within the SCED algorithm used by ISO and, therefore, requires no additional operational burden on ISO operators. Correct?

MR. MUKERJI: That's correct, that's what's stated in the response.

MR. MACLEOD: Okay. That's what the response says. And do you agree with that response?

MR. MUKERJI: Yes.

MR. MACLEOD: Could you turn to Interrogatory Response 20, I need some clarification. Now -- did I hear somebody say something?

MR. MUKERJI: Go ahead.

MR. MACLEOD: In that regard, that question

talked about the need for a parallel multi-terminal HVDC solution to require constant operator vigilance --

MR. MUKERJI: There's -- there's a difference here.

MR. MACLEOD: Okay.

MR. MUKERJI: The distinction is -- our assumption was that the HVDC flows would be scheduled so that they leave the system in a secure manner --

MR. MACLEOD: Um-hmm.

MR. MUKERJI: Now, secure to survive single or multiple contingencies, if a contingency does happen, the system does meet -- the system still remains but it might be under -- operating under emergency limits.

MR. MACLEOD: Um-hmm.

MR. MUKERJI: To bring it from the emergency limit back to normal operating limit, you would need to take certain what we call remedial actions. And the -- and the actions developed in the report -- to responses to Question 2 are remedial actions which are again planned for and studied by the ISO and incorporated as operating guidelines or procedures. So the response to Question 21 refers to the Security Constrained Economic Dispatch schedules --

MR. MACLEOD: Yes --

MR. MUKERJI: -- the response to Question 20 refers to what remedial actions could be taken with HVDC controls following contingencies.

MR. MACLEOD: Okay. Now, you have the statement in there that it's fair to say that the higher number of terminals -- there may be greater demand on the operators --

MR. MUKERJI: Yes --

MR. MACLEOD: -- depending on the desired mode of operation?

MR. MUKERJI: That's correct.

MR. MACLEOD: Would that statement apply whether or not you were responding to a contingency event or simply scheduling with respect to the SCED algorithm?

MR. MUKERJI: The scheduling would not require any -- it's automatic and incorporated within the SCED --

MR. MACLEOD: Okay --

MR. MUKERJI: -- but on the remedial actions it's more complex with a multi-terminal.

MR. MACLEOD: More complex. So in other words, the more terminals you have, the more complex the operator action is going to be?

MR. MUKERJI: Yeah, following

contingencies.

MR. MACLEOD: Following contingencies.

MR. BAHRMAN: Question 20 addresses two things. One is the rescheduling, the repositioning for a subsequent contingency. But what's addressed here is that where you lose a pole or you lose a converter, those changes are automatic based on local control. Reaching that state, then the operators can get ready for the new state. So there's two things being addressed here and one is the automatic controls, so-called remedial action scheme if one is needed, or it could be a scheme where you compensate, and that's the distinction.

MR. MACLEOD: And I think you said either in response to 20 or 21 that the need for remedial action would need to be studied and documented --

MR. MUKERJI: By the ISO --

MR. MACLEOD: -- correct -- and that -- that has not been done yet --

MR. MUKERJI: No, it has not --

MR. MACLEOD: -- to your knowledge?

MR. MUKERJI: No.

MR. MACLEOD: Okay. Now, I know that you've placed a significant amount of confidence apparently in the SCED operating algorithm, correct?

MR. MUKERJI: Yes.

MR. MACLEOD: That's how I read your responses. You say in response to Interrogatory 7 of the Towns of Cheshire, Milford, et al -- basically you were asked to explain whether or not the conclusions in your reports were based on theory rather than operating experience. And Interrogatory 7 asked you to explain your response to that question. And you indicated -- I'm looking at page 3, it's the last paragraph of your response -- that another area where operational experience is limited is with the modeling and scheduling of the DC links into Security Constrained unit commitment and Security Constrained Economic Dispatch software. Is that correct?

MR. MUKERJI: Yes.

MR. MACLEOD: What gives you the apparent degree of confidence that you have in the SCED system to be able to respond to 10 to 12 questions by ISO in its interrogatories about concerns using the operator interventions and system changes if in fact operational experience with SCED software is limited? Have I misread your response to this interrogatory somehow?

MR. MUKERJI: We have examples where DC lines are scheduled as part of the operational SCED

algorithms and it -- incorporating DC into the ISO New England system would not be any significant change to the existing algorithms --

MR. MACLEOD: Well --

MR. MUKERJI: -- so the -- but we do not have the operational experience in New England. That's for -- that's for sure on scheduling DC within the ISO New England system.

MR. MACLEOD: Okay. So in other words, this again is an assumption on your part --

MR. MUKERJI: Yes --

MR. MACLEOD: -- in large part?

MR. BAHRMAN: We know of systems where a single bipolar system is incorporated into the software, as you say SCED. What -- what we're referring to here is that one of the options involves multi-terminal. And this would mean that that model would have to be expanded to incorporate these more complicated topologies.

MR. MACLEOD: But the statement holds --

MR. BAHRMAN: Correct --

MR. MACLEOD: -- that you made in the interrogatory response?

MR. BAHRMAN: Yes.

MR. MACLEOD: Thank you. No further

questions.

CHAIRMAN KATZ: Thank you, Mr. Macleod. Next is DOT, Mr. Walsh.

MR. CHARLES WALSH: Good afternoon, Madam Chair. My name is Charles Walsh, Assistant Attorney General, representing the Connecticut Department of Transportation.

I just want to switch gears a little bit and talk about some of the constructability issues with regard to the VSC HVDC transmission line.

Good afternoon, gentlemen. I'd like to refer you to your response to the Applicants' interrogatories, your response dated November 18, 2004.

CHAIRMAN KATZ: Number?

MR. WALSH: This would be Exhibit 10. And I'd like to refer you to an attachment, I believe it's identified as ABB Power Technologies 2004-09-14, 3(4) at the top of the page. There's a diagram of Figure 1 of a three-circuit duct bank. I'd like to ask the question, Figure 1 shows the top of the duct bank at approximately 60 inches below the surface, is that correct?

MR. LARSSON-HOFFSTEIN: Yes, that's correct.

MR. WALSH: That is correct. Thank you.

Is that an optimal depth of burial for VSC HVDC cable?

MR. LARSSON-HOFFSTEIN: It's an assumed depth, deeper than the average depth. We had -- in the magnetic field study we had lower depth that we -- I think it was three and a half feet that would be the average depth. That we foresee that will be some parts where there will be obstacles that we need to go deeper, and the thermal calculations of cable must consider the deepest point.

MR. WALSH: So you are -- are you stating that the 60 inches is the deepest point for your thermal calculations?

MR. LARSSON-HOFFSTEIN: Yes.

MR. WALSH: Would burying the cable or the duct bank at a lower depth or deeper, would that change your calculations?

MR. LARSSON-HOFFSTEIN: Yes.

MR. WALSH: And would that create greater resistivity in the cables to the flow of current?

MR. LARSSON-HOFFSTEIN: It will keep the same rating of the cable. It will force us to have great -- larger conductor area.

MR. WALSH: So you'd have greater cable losses if it was buried deeper, is that correct?

MR. LARSSON-HOFFSTEIN: Not necessary.

MR. WALSH: Could you explain?

MR. LARSSON-HOFFSTEIN: To keep the same rating we will need to have larger conductors. And larger conductors means that the losses will not increase.

MR. WALSH: Alright, thank you.

MR. ASHTON: Can I see if I understand that? You're saying as I understand I think, that if you bury the cable deeper, the problem with heat transfer away from the cable increase, is that correct?

MR. LARSSON-HOFFSTEIN: Yes.

MR. ASHTON: And so to minimize that effect, you'd have to increase the conductor cross sectional size to reduce the losses, is that correct?

MR. LARSSON-HOFFSTEIN: Yes.

MR. ASHTON: Okay, thank you. I've got it right.

MR. WALSH: And when you increase the distance between the cables -- well, let me rephrase that. Since we're dealing with a direct current system here, there's no concerns about electromagnetic fields, correct?

MR. BAHRMAN: We have stated a reference in our report, but there are fields, they are tabulated in our technical report, they are calculated for the

different topologies. The point being that they are static fields --

MR. WALSH: So --

MR. BAHRMAN: -- similar to those from the earth's magnetic field. There is no induction effect --

MR. WALSH: Okay, so --

MR. BAHRMAN: -- and --

MR. WALSH: Well if I can follow up on that, to the extent that you increase the distance between the cables, there's no -- there's no change in the fields that are generated by the cables, is that correct?

MR. LARSSON-HOFFSTEIN: There will be a change of the magnetic field from the cable if we change the separation.

MR. WALSH: There would be or would not be, I'm sorry?

MR. LARSSON-HOFFSTEIN: It -- it would be.

MR. WALSH: There would be. And would it be greater or lesser?

MR. LARSSON-HOFFSTEIN: Probably greater.

MR. WALSH: Greater. Okay, thank you. Let me -- let me refer you to page 7 in your response to Interrogatory 13.

CHAIRMAN KATZ: Whose 13?

MR. WALSH: I'm going to refer you to the diagram --

MR. ASHTON: Which set of --

MR. WALSH: Again we're still on Exhibit 10, the November 18, 2004 --

CHAIRMAN KATZ: Okay --

MR. WALSH: -- answers to the Applicants' interrogatories.

MR. ASHTON: Okay.

MR. WALSH: I believe there's a Figure 2.

CHAIRMAN KATZ: With friction and -- that one?

MR. WALSH: Correct.

MR. LARSSON-HOFFSTEIN: On page 7?

MR. WALSH: Excuse me. Page 7, correct. In the language leading up to that you talk about both XLPE AC cables and VSC HVDC cables. Is this diagram -- and actually both diagrams in Figure 1 and Figure 2, are those diagrams of XLPE AC cables or of VSC HVDC cables?

MR. LARSSON-HOFFSTEIN: It could be either of them.

MR. WALSH: It could be either?

MR. LARSSON-HOFFSTEIN: Yeah.

MR. WALSH: They both perform in a similar

manner?

MR. LARSSON-HOFFSTEIN: Yes.

MR. WALSH: Okay, thank you. In Figure 2 on that page it shows that the cables are secured by clamps prior to the joint, is that correct?

MR. LARSSON-HOFFSTEIN: Yes, that's correct.

MR. WALSH: In order to accommodate expansion in the cable, it appears that you have a snaking length involved, is that correct?

MR. LARSSON-HOFFSTEIN: Yes, that's correct.

MR. WALSH: So that -- so would it be fair to say that there's a significant amount of flexibility in the cable?

MR. LARSSON-HOFFSTEIN: There is some flexibility in the cable, yes.

MR. ASHTON: There is --

MR. WALSH: Would it --

MR. ASHTON: There is sufficient flexibility to allow it to bend during expansion in a cable vault, is that correct?

MR. LARSSON-HOFFSTEIN: Yes.

MR. WALSH: Thank you. And again, the

joints are secured by the clamps prior to the splice, correct?

MR. LARSSON-HOFFSTEIN: Yes, that's correct.

MR. WALSH: Would it be possible to have the joint at a 90-degree angle rather than a 180-degree angle in a vault?

MR. LARSSON-HOFFSTEIN: I think it would be difficult. It would -- it will need larger vaults I would say.

MR. WALSH: If -- if you had a wider vault --

MR. LARSSON-HOFFSTEIN: Yes --

MR. WALSH: -- that was not as long, would you be able to have a splice that is 90 degrees?

MR. LARSSON-HOFFSTEIN: Depending of the bending radius of the cable, I would say the vault would be significantly larger.

MR. WALSH: Could you give me an estimate as to the size?

MR. LARSSON-HOFFSTEIN: The bending radius is typically 15 times the diameter of the cable. Let me see -- (pause) -- we would need a bending radius of about a little more than one and a half meter.

MR. ASHTON: That's five feet.

MR. WALSH: And that would be to have a 90-degree joint, correct?

MR. LARSSON-HOFFSTEIN: What?

MR. WALSH: To have a joint of approximately 90 degrees?

MR. LARSSON-HOFFSTEIN: Yes.

MR. WALSH: And --

MR. ASHTON: No, wait, wait -- I'm not sure you're both communicating. The witness is saying the bending radius on the cable is five feet. So if you have a joint that's across the vault, you're going to need two 5-foot radii, that's 10 foot, plus the length of the splice -- and I don't know what that is -- five or six feet, two meters?

MR. LARSSON-HOFFSTEIN: Yes.

MR. ASHTON: So you're talking in round numbers the minimum distance of 16 feet.

MR. WALSH: Sixteen feet.

MR. ASHTON: At minimum distance.

MR. WALSH: And if you did that, would you be able to reduce the length of the vault?

A VOICE: Probably --

MR. LARSSON-HOFFSTEIN: The length would be

-- yes. But the wide would be much --

MR. WALSH: Would be much shorter?

MR. LARSSON-HOFFSTEIN: (Indiscernible) --

MR. WALSH: Is that -- is that yes?

MR. LARSSON-HOFFSTEIN: I think we have to look more in detail for construction --

MR. WALSH: Would it be reasonable to assume if you had a 90-degree joint where the ducts came in at a 90-degree angle to one another, the vault would not be as long? Would that be a correct assumption?

MR. LARSSON-HOFFSTEIN: I'm not a hundred percent sure. I think we will need to do some engineering work to see that --

MR. WALSH: Would it be slightly shorter?

MR. LARSSON-HOFFSTEIN: Possibly --

MR. WALSH: Or would it be -- would it be the same length? You don't know?

CHAIRMAN KATZ: Let's move on.

MR. WALSH: Alright. Thank you.

MR. ASHTON: I think it's -- well --

MR. WALSH: Alright. I have no further questions. Thank you.

CHAIRMAN KATZ: Let me just clarify something. This DC cable doesn't necessarily have to be

under the streets, does it? Could it be under the edge of the transmission right-of-way? I mean does it -- is there anything preventing that, that you know of?

MR. LARSSON-HOFFSTEIN: No, not -- not for the cable. It depends on the transport possibility of the cable to the site -- if there are access roads to the base where the cable should be buried.

CHAIRMAN KATZ: Okay, thank you. Thank you, Mr. Walsh.

MR. O'NEILL: Have you built these systems under forest -- through forests and fields for example as opposed to under streets?

MR. LARSSON-HOFFSTEIN: In fields we have quite large experience. And we have large experience besides the roads.

MR. O'NEILL: Thank you.

CHAIRMAN KATZ: Thank you. Next is PSEG. Can I have a show of hands of anyone else before we get to the Council who wishes to cross-examine this witness panel. Seeing none, okay.

MR. DAVID REIF: Thank you, Madam Chairman. David Reif representing PSEG Power Connecticut.

Gentlemen, let me just address a couple of questions. We are a generator and let me speak to some

generator concerns. Do I understand correctly, Mr. Bahrman, your testimony that at least from ABB's point of view it is the sole source for VSC technology?

MR. BAHRMAN: We have -- we are the only supplier that have such installations in commercial operation. Other competitors are offering it. You can attest to that by looking at their websites.

MR. REIF: You did testify though that at least in ABB's view the technology that you offer is patented technology?

MR. BAHRMAN: Many aspects are indeed.

MR. REIF: And I think you said that -- in response to the earlier question that you weren't sure how in light of those patents other suppliers could make that offer on their website but that the offers were there?

MR. BAHRMAN: Yeah, I guess I made that side comment.

MR. REIF: Okay. Now let me just address a concern from that. I think you indicated that there are a total of -- that ABB has a total of five installations that you would say are similar, correct?

MR. BAHRMAN: We gave a list of DC links involving voltage source converters, yes.

MR. REIF: And there were five?

MR. BAHRMAN: Five in operation, yes.

MR. REIF: And those are the only five in the world in operation?

MR. BAHRMAN: If -- that -- that is correct.

MR. REIF: Okay. Now you said I think that ABB has been in the HVDC business since 1954?

MR. BAHRMAN: That is correct.

MR. REIF: How long have you been in the VSC HVDC business?

MR. BAHRMAN: If you refer to the table, you can look at the projects, and the first commercial project was ordered in 1997 --

MR. REIF: Okay --

MR. BAHRMAN: -- so you see the development leading up to that. So the answer is seven years.

MR. REIF: Alright. If I turn to the table, there was -- and I'm referring to page 8 --

CHAIRMAN KATZ: Wait a minute. Can you just run that math by me again? 1997?

MR. BAHRMAN: 1997 was the date that -- he asked how long we've been --

CHAIRMAN KATZ: Oh --

MR. BAHRMAN: -- in the VSC business.

CHAIRMAN KATZ: Okay.

MR. BAHRMAN: So the first booking --

CHAIRMAN KATZ: Yeah --

MR. BAHRMAN: -- of a commercial project was awarded in 1997, and that was for Gotland.

CHAIRMAN KATZ: Okay.

MR. BAHRMAN: So now we're in 2004.

CHAIRMAN KATZ: No, I thought you said five years, that's why I was confused --

MR. BAHRMAN: No --

CHAIRMAN KATZ: -- never mind --

MR. BAHRMAN: If I did, it was a big mistake.

MR. REIF: And since the year 2002, if I refer to the table -- and for the panel -- or for the Council this is page 40 of the technical description -- since 2002 there have only been really -- there has only really been one HVDC Light facility that's come on-line, correct, Troll?

MR. BAHRMAN: It's in the commissioning stages, yes.

MR. REIF: Okay. So when you say in the commission stages, then the reality is that since 2002 there have been no HVDC Light facilities that have

actually come on-line?

MR. BAHRMAN: That is correct.

MR. REIF: Okay. Now if I understand this technology, if there were to be a converter in place, we could agree that at some point along the line spare parts are probably going to be required?

MR. BAHRMAN: Yes.

MR. REIF: Okay. And as I understand the warranties that you described, your warranty is generally about three years, correct?

MR. BAHRMAN: The warranties are subject to the conditions and terms that the person issuing the RFP has put forth. That is a typical number. And there are warranties on performance and there are usually warranties on the equipment provided. And with the -- and so there are two different types of warranties that are common.

MR. REIF: And as a sole source, if at the end of a warranty period you've decided to -- for whatever business reasons to remove your patented technology from the marketplace, you would certainly be free to do so, correct?

MR. BAHRMAN: This is -- that's not a technical question.

MR. REIF: Fair enough. But would you

agree -- well, you're --

MR. BAHRMAN: I mean --

MR. REIF: When you say not a technical question --

MR. BAHRMAN: Yeah, okay --

MR. REIF: -- let me just ask your present position is a sales and marketing position, correct?

MR. BAHRMAN: That is correct.

MR. REIF: Okay. So my question -- let me ask you as a sales and marketing person, at the end of the warranty period if ABB wanted to, it would be able to withdraw its patented technology from the market, correct?

MR. BAHRMAN: Well, I mean you have to look back at the history --

MR. REIF: Let me not look backward --

MR. BAHRMAN: -- and look at the track record --

MR. REIF: Let me not look backward, let me look forward --

MR. BAHRMAN: Um-hmm --

MR. REIF: -- would you at the end of the warranty period, if you wanted to, you could withdraw your patented technology from the marketplace, correct?

MR. BAHRMAN: Yes.

MR. REIF: Okay. Now, the anticipated life that you would expect this converter to be in place though would be more than that three-year warranty period, correct?

MR. BAHRMAN: Absolutely.

MR. REIF: Generally, how long do you figure that one of these facilities would be on -- would be expected to be on-line?

MR. BAHRMAN: Thirty to forty years is typical.

CHAIRMAN KATZ: How many?

MR. BAHRMAN: Thirty to forty years --

CHAIRMAN KATZ: Thank you --

MR. BAHRMAN: -- is typical from our customers.

MR. REIF: Now, let me just address a couple of items if I might. If I understand from your Option 1, the chart that was up on the line, which for the Council is at page 3 of the system feasibility study, that anticipates that at the Singer site, which is where PSEG's current facility is, that there would be two AC/DC -- HVDC Light converters, is that correct?

MR. BAHRMAN: You're referring to Option 2?

MR. REIF: Well, let's start with Option 1.

MR. BAHRMAN: Yes. One in either direction.

MR. REIF: Okay. And in fact, your Option 1 in the feasibility study assumes that there would be two converters provided at each station, correct?

MR. BAHRMAN: For Option 1 again?

MR. REIF: For Option 1.

MR. BAHRMAN: Yes.

MR. REIF: Okay. Now, let's talk about size because that is a somewhat limited space. Would -- as I understand each of these converters is larger -- each of these converters individually is longer -- larger than a GIAS transformer facility, correct?

MR. BAHRMAN: A GIS substation?

MR. REIF: A GIS substation.

MR. BAHRMAN: Because there you're dealing with switch gears, so I'd like to draw a distinction between transformers and switch gear --

MR. REIF: Well --

MR. BAHRMAN: -- and the answer is yes.

MR. REIF: Okay --

MR. BAHRMAN: Air insulated is a large -- you know, a substation. And GIS is a smaller more compact version of that.

MR. REIF: Okay, and -- and your converter is -- each of your converters is larger than the GIS substation?

MR. BAHRMAN: I don't know which GIS, but it makes sense, yes. You have the dimensions --

MR. REIF: Well, in fact -- in fact --

MR. BAHRMAN: -- they're on the record.

MR. REIF: Sure. Well -- and in fact, that's what your -- that's what your feasibility study says, correct?

MR. BAHRMAN: Yes.

MR. REIF: Okay. Now, let me just -- let me just turn to one other area if I might -- oh, I'm sorry -- and do I understand based on the feasibility study that if a -- if another generator were to go on-line in either Option 1 or Option 2, that two more converters would be required at that location if you wanted full backup?

MR. MUKERJI: It depends on the size of the generator.

MR. REIF: Okay. Let's assume -- well as I understand, the second converter would serve two purposes, right? One for backup, correct, if someone wanted full backup?

MR. MUKERJI: Yeah.

MR. REIF: Okay. And the other based on the size of the facility, the generating facility, correct?

MR. MUKERJI: I mean if you have a hundred or 200 megawatts, you could come to the existing substation. But if your generating coming on line is 500 to a thousand, then you would probably need one or multiple converters.

MR. REIF: Okay. And each of those converters, if I understand your answers to the interrogatories, would be something that ABB would be selling for somewhere around 51 million dollars. Is that correct, Mr. Bahrman?

MR. BAHRMAN: Yes.

MR. REIF: Okay. That brings me to sort of my last area of questions and let me see if I'm clear. You testified earlier that there is limited operational experience in scheduling DC through the SCED system, correct?

MR. BAHRMAN: For multi-terminal, yes. There is some experience with two-terminal.

MR. REIF: Okay. But with multi-terminal there's limited --

MR. BAHRMAN: Yes --

MR. REIF: -- correct?

MR. BAHRMAN: Yes.

MR. REIF: And what you're basically saying is that we should -- is that it should be taken on faith that -- from your testimony and your feasibility study that in fact there would be satisfactory operations with multi-terminal and SCED. Fair to say?

MR. BAHRMAN: Rana.

MR. MUKERJI: Yeah.

MR. REIF: Okay. Now if I also understand --

CHAIRMAN KATZ: Do you agree with the taken on faith part of that statement or just that it would work?

MR. MUKERJI: It would work.

MR. REIF: And -- and the reason that you say it would -- the reason we believe that it should work is because you told us it worked?

MR. MUKERJI: No, it is because you would use the same system you used to schedule all the generators in New England.

MR. REIF: But you've never -- we can agree that you have never done the multi before in New England, correct?

MR. MUKERJI: That's right.

MR. REIF: Okay. Also if I understand, you have never -- and I'm turning to page 5 of the executive summary -- you have never installed underground a 530-megawatt HVDC Light, am I correct on that?

MR. MUKERJI: That's correct, yeah.

MR. REIF: But you're telling us it would work, correct?

MR. MUKERJI: Yes, because the present technology is scalable.

MR. REIF: And we -- and the reason that we should take that on faith is because you're telling us that it's scalable, correct?

MR. BAHRMAN: We've -- we've done it before. The package is additional semi-conductors within the same position. And so it is a higher current rating, the same voltage rating, the same control. There are many simulators -- similarities. We are increasing the current rating and --

MR. REIF: There's many similarities, but --

MR. BAHRMAN: -- and we have done so in the past going from Directlink and Gotland, we have mentioned that before.

MR. REIF: Okay. But you have -- but you have never -- but if -- you have never done a multi-terminal VSC as you have -- as you propose in Option 2 either, correct?

MR. BAHRMAN: Option 2 is multi-terminal and that has not been done.

MR. REIF: Okay. And the fact that we can -- that it can be done is something that we should take on faith because you've said it?

MR. BAHRMAN: This would have to be studied more --

MR. REIF: Okay --

MR. BAHRMAN: There are --

MR. REIF: -- now let me --

MR. BAHRMAN: It's much easier -- I will just add it's much easier to do it with voltage source converters, and that's addressed in the interrogatories.

MR. REIF: But you haven't done it before?

MR. BAHRMAN: With conventional we have and with VSC we have not.

MR. REIF: Okay. And -- well -- so that we're communicating, this is VSC not conventional, correct?

MR. BAHRMAN: What we have looked at in

these studies is VSC, yes.

MR. REIF: Okay. And you have not done it before, multi-terminal, correct, with VSC?

MR. BAHRMAN: That is correct.

MR. REIF: Okay. Now if I also understand with Option No. 3, you did not -- for the reasons that were described before, you did not analyze Option 3 once you determined that the first harmonic resonance was not shifted above the third harmonic frequency, correct?

MR. MUKERJI: That's correct.

MR. REIF: But you're telling us that that's something that should not be a problem?

MR. MUKERJI: No, we -- go ahead.

MR. DICKMANDER: No, we're saying it's comparable and no worse than the Phase 2 AC cable option.

MR. REIF: And those numbers are not -- those numbers are not in the report, correct?

MR. DICKMANDER: There is a limited set of calculations of that in the report and not a full set of calculations.

MR. REIF: Okay. So we should -- we should accept that -- we should accept that on the basis that you've told us that?

MR. DICKMANDER: No, I think I said earlier

that this is something that could be explored further, but what I'm saying is that the preliminary calculations that are in the frequency scan show that the Option 3 harmonic response is no worse than the Phase 2 AC solution.

MR. REIF: Okay. Based on what we need to take on faith, let's --

CHAIRMAN KATZ: Can we avoid that characterization --

MR. REIF: Sure. Based on what --

CHAIRMAN KATZ: -- taking on faith --

MR. REIF: Yes, ma'am --

CHAIRMAN KATZ: Thank you.

MR. REIF: Based on what you have told the Council that has not either -- that has not yet happened, let's -- let's just sort of look at what you've called a feasibility study. If I understand, Mr. Bahrman, you said that -- well, let me withdraw the question. A proposal, if I understand, is where somebody from ABB comes in to make a sale to a customer. Would I be characterizing that correctly?

MR. BAHRMAN: The word was proposal?

MR. REIF: Yes, sir.

MR. BAHRMAN: Yes.

MR. REIF: Okay --

MR. BAHRMAN: Proposal as in response to an RFP.

MR. REIF: And I think what you told us is that the difference between a proposal, which is in response -- well an RFP is a request for proposal --

MR. BAHRMAN: Yes --

MR. REIF: -- that hopefully would ultimately lead to a sale, fair enough?

MR. BAHRMAN: You win some, you lose some, yes.

MR. REIF: Fair enough. And if I understand correctly, what you've told us is that the difference between your feasibility study and a proposal is that the proposal would have greater certainty in terms of pricing, fair enough?

MR. BAHRMAN: Well, first of all, the feasibility study, to distinguish that from the technical report, the feasibility study addresses system issues --

MR. REIF: Okay --

MR. BAHRMAN: -- this was done by ABB Consulting. But a proposal is based on firm bids, for instance for subcontractors as we mentioned before, so there is a greater level of detail and a greater level of accuracy in those.

MR. REIF: And the greater level of detail deals primarily with pricing?

MR. BAHRMAN: We have a good -- primarily with installation costs.

MR. REIF: Okay.

MR. BAHRMAN: The equipment costs we are much -- and engineering costs we know much better.

MR. REIF: Okay. So the equipment costs and the engineering costs essentially would -- for this particular project then would essentially be what are set forth on page 6 of the answers to the interrogatories?

MR. BAHRMAN: It is not a proposal, it is a budgetary estimate. We give a range for the installation costs on the cable installation where we have the greatest degree of uncertainty.

MR. REIF: Fair enough. But whether it's a proposal or an estimate, your estimated costs, let me put it that way, that are set forth on page 6 of the answers to the interrogatories would be costs that would be paid to ABB? Do I have that right?

COURT REPORTER: One moment please.

(Pause).

MR. BAHRMAN: They are prices, estimated budgetary prices.

MR. REIF: And those are price -- estimated budgetary prices for ABB pricing, correct?

MR. BAHRMAN: Yes.

MR. REIF: So in other words, if I -- if I understand correctly, if Option 1 were to be entered -- if Option 1 were to be the plan that was followed in this case, ABB would be looking to make somewhere between 780 and 830 million dollars, correct?

MR. BAHRMAN: No, we would not make that. That would be the price.

MR. REIF: Fair enough. ABB would be charging somewhere between 780 and 830 million dollars, correct?

MR. BAHRMAN: For Option 1, if that's what the tables says, then --

MR. REIF: Well take a look at the table --

MR. BAHRMAN: Yep -- yes --

MR. REIF: -- I don't want to misstate --

MR. BAHRMAN: Yes, that's what it says.

MR. REIF: Okay. For Option 2, somewhere between 630 and 830 million dollars, correct?

MR. BAHRMAN: Yes. There are some variations there, but yes.

MR. REIF: And even for Option 3, ABB -- if

its -- if its technical -- let me use your term -- if its technical feasibility were adopted, would be making somewhere between 465 million and 495 -- charging somewhere between 465 million and 495 million dollars, correct?

MR. BAHRMAN: The price that's indicated there includes ABB scope. It also includes some installation scope both for the converter stations and the cable installation, and that would -- typically is subcontracted out to an installation contractor.

MR. REIF: Subcontracted out by ABB?

MR. BAHRMAN: That is correct.

MR. REIF: I have nothing further.

CHAIRMAN KATZ: Thank you, Mr. Reif. Mr. Cunliffe. As you in the audience have probably figured out, we're going to keep going.

MR. CUNLIFFE: Thank you, Chairman. Gentlemen, you earlier testified that integrating additional converter stations along the line is possible, right?

MR. MUKERJI: Correct.

MR. CUNLIFFE: But you also said that it could also complicate matters in operations, is that right?

MR. BAHRMAN: Yes.

MR. CUNLIFFE: The addition of these additional converter stations, would they either -- could they affect either the line or the converter ratings? As you add on into a multi-terminal system, would it affect the line rating?

MR. BAHRMAN: Well not the cable rating itself, but when you deal with multi-terminal, and let's say a tap, and you have an input and an output, perhaps two inputs and two outputs, you can get a mismatch, it depends on the ratings of the station. What I'm saying is you get -- what goes in, must come out. So there has to be a balance there. So if you're delivering to one point, you may not have -- a two-terminal you could have a hundred percent utilization. You can't -- you -- with four-terminal you can have a hundred percent utilization under some dispatches. For three-terminal if you have the same ratings, obviously there's some -- just like when you have parallel transformers.

MR. CUNLIFFE: And the converters treated the same way?

MR. BAHRMAN: Yes.

MR. CUNLIFFE: How flexible is the VSC HVDC system in a changing urban/suburban environment?

MR. BAHRMAN: I don't really follow the --

MR. CUNLIFFE: Say -- say the loads are changing from year to year or there's a fast growth in an area, how quickly could you adapt the VSC HVDC system?

MR. BAHRMAN: You mean increase the capacity --

MR. CUNLIFFE: Yes --

MR. BAHRMAN: -- and to accommodate -- you would -- the normal way that's been done with conventional DC is if some years down the line you want to increase the capacity -- you know, if it's just a couple of years, you install it initially. That's the most economic. If it's five, ten years down the line, then you would have another parable investment, like adding a transformer to a substation.

MR. CUNLIFFE: Thank you.

CHAIRMAN KATZ: Or adding a parable cable?

MR. BAHRMAN: Yes.

MR. CUNLIFFE: What are the contingency plans for the unavailability of a HVDC line?

MR. BAHRMAN: Dave -- the -- I mean you have -- I think this addresses the contingency analysis that was done on the system studies, the load flows.

MR. DICKMANDER: Are you talking about

contingency losses of the HVDC line or --

MR. CUNLIFFE: Right. If you use the HVDC line, how do you -- how do you move the power?

MR. DICKMANDER: We included -- if I recall correctly, we included cases in our power flow analysis of losses of the HVDC -- individual HVDC lines. And this gets back to the concept of scheduling the DC links using the Security Constrained Dispatch Algorithm. The intention of that algorithm would be to already consider the possibility that one of the links could go out and then have the other -- have all of the links prescheduled to take that into account, such that after the loss of that one link, there would not be overloads on remaining AC circuit elements.

MR. CUNLIFFE: And a worse case scenario, say you lost all the links on a forced outage?

MR. DICKMANDER: That has not been studied. And that's not really considered a realistic possibility. I think Mike could probably expand on that.

MR. BAHRMAN: Well, Dave --

MR. MUKERJI: (Indiscernible, overlap of talking) -- minus 1 and minus 2 --

MR. BAHRMAN: Yeah --

MR. MUKERJI: -- for the DC --

MR. BAHRMAN: Dave mentioned the one particular case that we addressed before, but if you look at for instance Option 3, you have three parallel links and it's very easy to utilize the capability remaining in two parallel links should one be lost. If -- if they're already loaded to the hilt, then you lose one-third in the case of Option 3, the capacity. The remaining flow that was flowing on there, like it would in any loop system, would follow a parallel path. In this case, it would go around the horn on the 345-kV AC to the extent that couldn't be accommodated on the parallel DC. And you know, really that can be -- you know, it has nothing to do with the New England ISO or rescheduling. Once that has occurred, then you kind of look ahead, what's the next contingency. So you have an outage that's a cable fault, there's a time to repair it, that affects the unavailability of that circuit whether it's AC or DC. And so -- so I guess that answers the question.

MR. CUNLIFFE: Thank you. What's the expected failure rate of a voltage source converter?

MR. BAHRMAN: Leif.

MR. RONSTROM: It's a bit difficult to say. It depends on what the owner in the contract would put stress on, availability or reliability. But as I said

before, I would expect the existing installations to be around -- down to a figure of three forced outages a year as -- yes.

CHAIRMAN KATZ: Is that the weakest link?

MR. RONSTROM: I -- I am now referring to the total forced outage regardless of where in the system that takes place. The sensitive parts are duplicated normally so that you would have a fault -- you wouldn't see that in the forced outage rates.

CHAIRMAN KATZ: So that's why you would have backup converter station?

MR. BAHRMAN: I think --

MR. RONSTROM: Not really.

CHAIRMAN KATZ: Oh.

MR. BAHRMAN: It -- it's -- one thing also is the cable. We're talking about whether it's AC or DC cable. Magnus can talk about the cable failure rates, but there are certain weather related outages that often occur on transmission lines that are exposed to elements, ice storms and so on, and the cable is kind of not exposed to that. But on the other hand, the time to repair on an overhead line is much shorter than that of a cable. And I think the report addresses the location of faults and a little bit about the repairs. And so there are a number

of elements in the overall system to consider.

CHAIRMAN KATZ: Okay, let's leave it there.

MR. EMERICK: Madam Chair.

CHAIRMAN KATZ: Yes, Mr. Emerick.

MR. EMERICK: Can we not leave it there?

CHAIRMAN KATZ: Okay.

MR. EMERICK: Because the rest of the record -- when we've looked at other lines, whether they be cables or overhead transmission lines, we've talked about failure rates per mile. And in this we're just kind of lumping the converter and the cable system together. And I think you just offered that we could -- you could share with us a cable failure rate?

MR. BAHRMAN: Yeah -- I mean we're talking about substation equipment and the failure rates of the converter. There is also -- the one that is per unit length would apply to the line itself.

MR. EMERICK: So I think it would be useful if we could have a rate for both, shall we in converter station failure rate and cable failure rate. And also if we could put some bounds, a failure lasts -- what's a typical failure duration would be helpful too.

MR. ASHTON: You mean the time between failures and duration --

MR. BAHRMAN: Let's address the cables, Magnus.

MR. LARSSON-HOFFSTEIN: The cables -- I don't have the specific number of failure rates, but for the 115-kV HVDC Light we have -- only have had one cable failure. There's been one on Murraylink.

CHAIRMAN KATZ: So do you have a rate per mile?

MR. EMERICK: And I'm willing to accept this as homework. If we could have a rate per mile?

MR. ASHTON: Or kilometer.

MR. LARSSON-HOFFSTEIN: Well, the -- the -- well yeah, kilometer --

MR. EMERICK: I'd like the answer consistent with what we have in the record already, whatever it is, whether it's kilometers or miles --

A VOICE: Miles --

MR. EMERICK: -- but I think it's miles.

MR. ASHTON: Miles.

MR. LARSSON-HOFFSTEIN: I don't have that number available, but I think we can -- I can have --

CHAIRMAN KATZ: Can we have a late file on that --

MR. RONSTROM: I could give you -- I mean

the distance in Murraylink, the cable length is approximately 180 kilometers, and the distance from end to end.

MR. ASHTON: That's about a hundred miles --

MR. BAHRMAN: And that's for two cables.

MR. RONSTROM: Yeah. And the distance between the stations in Cross Sound Cable is around 40 kilometers. That adds up to 220 kilometers. Correct me if I'm wrong. And then there are two cables, so that means 440 --

MR. EMERICK: Yeah --

CHAIRMAN KATZ: That's just for Cross --

MR. RONSTROM: -- kilometers of cable lengths --

MR. EMERICK: I think he's got the method --

CHAIRMAN KATZ: That's just for Cross Sound --

MR. EMERICK: -- I think we want the answer --

MR. RONSTROM: No, it's both.

CHAIRMAN KATZ: Oh. Hmm?

MR. EMERICK: I think he has the method

down. We want the answer.

CHAIRMAN KATZ: Okay.

MR. RONSTROM: And the -- so there is one cable fault in 440 cable kilometers.

MR. BAHRMAN: Which --

MR. ASHTON: Why don't you check your --

MR. EMERICK: Over what period of time --

A VOICE: Yeah, what period of time --

(Multiple voices overlapping, indiscernible)

MR. ASHTON: Give us a late file on it. I think --

CHAIRMAN KATZ: Give us a late file. Please do the calculation, the failure rate per mile.

MR. EMERICK: And -- and if you need help in terms of what we're looking for, there's already an exhibit in the record that presents information on failure rates given in a number per mile per year. And I think that's Exhibit 113.

MR. ASHTON: At the same time you mentioned the outage rate in converter stations, the number per year. It would be helpful to also give the average duration of the outage. Are these momentary, are they five-hour, two-day, what have you? And I think that can

be on the same late file.

MR. BAHRMAN: Okay, we have noted --

MR. ANDRES: Thank you, Madam Chairman. We will provide a late file exhibit.

MR. O'NEILL: As a follow-up to that, if you could supply us with a failure rate from a direct burial method as opposed to a vault installation, that would be helpful as well.

MR. ASHTON: I'm not sure they can differentiate --

CHAIRMAN KATZ: Because Australia was direct burial, correct?

A VOICE: Yes --

MR. ASHTON: All of these are direct burial I think, aren't they?

(Pause)

CHAIRMAN KATZ: Well, okay. Mr. Emerick, does that -- anything else?

MR. EMERICK: No, that will do it.

CHAIRMAN KATZ: Okay. Back to you, Mr. Cunliffe.

MR. CUNLIFFE: Is it possible to use overhead DC lines between VSC terminals?

MR. BAHRMAN: Not with the present design.

CHAIRMAN KATZ: Why can't you hang it?

MR. BAHRMAN: It's -- it's designed for underground operation. It -- if it were overhead, there would be exposure to pull the pole short circuits due to lightning, ice storms. And if you had a lot of those in rapid succession, then you'd have to design for that and in the converter cost. So there would be a cost impact in order to be able to accommodate that.

CHAIRMAN KATZ: Thank you.

MR. CUNLIFFE: Do you believe the operation of a VSC HVDC system would be more complex than a conventional AC system?

MR. BAHRMAN: You have to schedule the power, so the answer is yes.

MR. CUNLIFFE: Thank you. I want to go back to the addition of terminals along the line. And if you were to add stations, you said there would be a cost of about 51 million per converter, is that about right?

MR. BAHRMAN: For the 370-megawatt, yes.

MR. CUNLIFFE: Okay. And would you believe that this could serve as a barrier to siting new generation?

MR. BAHRMAN: It's like joining the country club, you have to pay the initiation fee, yes.

CHAIRMAN KATZ: Let's -- let's go back to the question.

MR. BAHRMAN: I mean it's an economic penalty for the generator.

CHAIRMAN KATZ: That someone who was siting not near a DC line would not be paying the surcharge, correct, of trying to --

MR. BAHRMAN: Well, the generator if he's located remote from transmission, he's got to get to the transmission --

CHAIRMAN KATZ: No, but somebody who's near -- who could upload through a 345 overhead AC line is paying less at that power plant than the person who has to add to their power plant something to --

MR. BAHRMAN: Yes.

CHAIRMAN KATZ: Thank you.

MR. CUNLIFFE: Would there be any requirement for new software to integrate an HVDC system into an independent system operator's area?

MR. BAHRMAN: For a multi-terminal, the models would have to be extended to that. For Option 3, you might not, and really could make the case that you don't need to integrate it at all because you have point to point with parallel paths and the rescheduling could be

done manually.

MR. CUNLIFFE: And the implementation of the new model, like you said, if you had to add to it, could that -- what's the success rate for that to be implemented? Would you have some problems in the near term?

MR. BAHRMAN: Well, I mean, first of all, we are not the supplier of the software being used at New England ISO. Certainly we could develop the models and share that with New England ISO for implementation into their existing EMS system. And I've got to hand it these guys, with all the deregulation and all the transactions and everything, they've done an amazing thing with time tagging and everything else, so add this to the list.

MR. CUNLIFFE: Thank you. And lastly, but not least, does ABB have any reservations or clarifications of their conclusion made in the summary that this analysis is -- can be done, 100 percent underground between Beseck and Norwalk?

MR. BAHRMAN: Yes.

MR. CUNLIFFE: Thank you.

CHAIRMAN KATZ: Mr. Emerick.

MR. PHELPS: Whoa --

MR. ANDRES: Yes, what?

CHAIRMAN KATZ: I'm sorry.

MR. PHELPS: Restate the question.

CHAIRMAN KATZ: Yes you have reservations or no, you don't have reservations?

MR. BAHRMAN: Oh, I'm sorry. Is it technically feasible --

MR. CUNLIFFE: Do you --

MR. BAHRMAN: -- is what I heard you to say, but at this stage in the day --

MR. CUNLIFFE: Do you have any reservations or clarifications based upon your conclusion --

MR. BAHRMAN: No.

MR. CUNLIFFE: Okay.

MR. BAHRMAN: Sorry.

CHAIRMAN KATZ: Mr. Emerick.

MR. BAHRMAN: Thank you.

MR. EMERICK: Yes. In the technical description on page 21, it's entitled Magnetic Field Standards, and you indicate that there's an international commission on non-ionizing radiation protection that's published guidelines for exposure. What is the basis of those guidelines?

MR. BAHRMAN: We are not experts in this. We refer to a link that has a wealth of information on all

studies and deals with the guidelines. Magnus, do you have anything further regarding the standard and how it was set?

MR. LARSSON-HOFFSTEIN: No.

AUDIO TECHNICIAN: Mr. Emerick, would you put your microphone closer to you.

MR. EMERICK: Let me try and narrow it down. Do you know if the guidelines are based on health effects or is it shock hazard?

MR. BAHRMAN: They would be health effects. There is a qualification for people with pacemakers, and that's stated. And we were dealing with a cable with shielding around it, there's not an induction effect, not into fences or other underground objects which may run in parallel, so if you were to touch something, it would not have any induction effect. If it's an overhead line, there would not be any electrostatic discharge or corona which could lead on an insulated object to some accumulated charge, in which case you might get a carpet shock if you were to touch, you know, something that was grounded. So -- so this would be -- I would refer to the link and all the references there, but this would not be a shock effect.

MR. EMERICK: Okay. And in that same

paragraph you talk about the actual exposure level and you indicate with a term microtesla. Most of the testimony on magnetic fields have been in terms of milligauss. Could you translate that to milligauss?

MR. BAHRMAN: We can do that and provide that as an action item.

CHAIRMAN KATZ: We will take that as a late file.

MR. BAHRMAN: A late file. Sorry.

MR. FITZGERALD: Multiply by 10 --

MR. ASHTON: By 10 --

A VOICE: That's good.

CHAIRMAN KATZ: Is that all it is?

A VOICE: Yeah.

MR. BAHRMAN: Yeah. And if -- I mean you have -- all these curves are all --

CHAIRMAN KATZ: Okay --

MR. BAHRMAN: -- in tesla.

MR. ANDRES: So we don't need to file a late --

CHAIRMAN KATZ: Correct. If tesla to milligauss is multiplied by 10, then we're okay.

MR. BAHRMAN: Okay.

MR. EMERICK: Thank you.

CHAIRMAN KATZ: Mr. Heffernan.

MR. HEFFERNAN: Yeah, just one question. Many people --

AUDIO TECHNICIAN: Mr. Heffernan, grab a microphone.

MR. HEFFERNAN: Okay -- I'm usually loud enough -- (laughter) -- many people today have talked about replacement parts and you being a sole provider. And I'm just curious. No. 1, do you ever guarantee that you'll replace broken parts in a contract up to a prescribed period of time? That's one question.

And the second question is if -- what they're talking about for whatever strange reason you went out of business, how long would it be for somebody to fill the void on the most difficult part you thought you had to replace?

MR. BAHRMAN: The answer to your first question is that we have been requested to provide guarantees for replacement parts over a certain period of time. This is particularly true with software and source codes and all of these sorts of things in the event that we should go out of business. And we have -- so I think to answer the first question, yes, on occasion we have been asked to provide something. Usually it's specific to

a certain piece of equipment. Because if you look at it, we have transformers, we have circuit breakers, we have cooling equipment --

MR. HEFFERNAN: Right --

MR. BAHRMAN: -- and these are all standard components. What's unique is the control and protection, the converter valves. Within the converter valves is what's unique. It's a semi-conductor. These semi-conductors are used in -- they've all but taken over from other types of semi-conductors for AC drives. What's unique here is how they're packaged, how they're used at high voltage. So there are suppliers of these components and -- that could take over. And if there is -- you know, with a consolidation, the rights to the technology go with the consolidation. If you look at when ABB acquired Westinghouse T&D, we got all of their patents for transformers, power transformers, and we are doing replacement for those, life extensions for those, and there's a technology passing.

MR. HEFFERNAN: That's fine, thank you.

CHAIRMAN KATZ: All set?

MR. HEFFERNAN: Yeah.

CHAIRMAN KATZ: If -- if the ISO is hesitant about integrating a DC line into the -- into the

New England grid, why would you think they would be hesitant?

MR. BAHRMAN: Well, they have their hands full with the day-to-day operation dispatching generation and with deregulation and all that sort of stuff, and -- I mean the status quo is comfortable in an industry that's changing a lot. I'm just speculating here.

Obviously, they don't want to -- well, from what I understand, they would -- from the questions here they have reservations about the manual rescheduling of things. And there are ways to -- you know, operator aids. I mean, obviously, they don't manually schedule each and every generator every hour or every, you know, few minutes. This is -- there's a calculation behind that. And I think the point that Rana has made is that those same calculations apply to the control element transmission, whether it's DC or AC transmission with phasing regulators, which often are used to accompany cables, it's an added -- it's an added flexibility with that. They have -- they have some scheduling to do. It's a controllability, it has advantages, but the onus is on them to schedule it. I mentioned how automatically, you know, one link could compensate for the other, and that's -- that's common whether it's VSC or conventional DC.

Other customers who are looking at interconnections have incorporated and talked about incorporating -- there's a history -- if you have a certain time of the year, a certain temperature, you predict the loads, you can also then predict the load profile on the DC link, and these could be programmed into the controller locally and you could have a family of load profiles that would suit. And so there are ways of -- different ways of doing it. One --

CHAIRMAN KATZ: But it's -- it's basically something they haven't done before.

MR. BAHRMAN: Yes.

CHAIRMAN KATZ: Let me ask you this, in the northern -- I think you mentioned there's a project in the northern Midwest that went from one state to another?

MR. BAHRMAN: Yeah. There are two in the upper Midwest --

CHAIRMAN KATZ: Okay --

MR. BAHRMAN: -- from Minnesota -- I mean --

CHAIRMAN KATZ: Did their -- did their version of the ISO have to take on new software or new procedures, whatever, to take that DC which was embedded into that grid?

MR. BAHRMAN: The -- those two projects were -- were done in the late 70's. And the -- the power pool or the region is -- it was a map region. And now it's kind of complicated with the Midwest ISO kind of encroaching there. But in that case certainly all of the reliability criteria for NERC had to be met in terms of the system studies. The operation of the two systems is in parallel with AC transmission. The -- and the operators there -- you know, they're operating aides. Essentially what they do on those links and similar to that of IPP is that they schedule the generation, and a percentage of that generation goes on the DC and a percentage goes on the AC, and there could actually be other transactions superimposed on that schedule, so you stack the transactions. And so you have a tie-line control and a generator control and the DC power is automatically adjusted for that. If something new comes along, then you can bias that up or down --

CHAIRMAN KATZ: Okay.

MR. MUKERJI: Can I just clarify. The -- the complexity of -- to schedule it adds a degree of complexity. And that's what the ISO might have some reservations about because they do not have the complex --

CHAIRMAN KATZ: Okay --

MR. MUKERJI: -- AC now. But it's technically feasible.

CHAIRMAN KATZ: We will explore that with them.

MR. MUKERJI: Yeah.

CHAIRMAN KATZ: Thank you.

MR. ASHTON: Quickly. Am I correct in believing that a pair of 550-megawatt converter stations would require about two hectares of land plus, or about five acres, is that fair to say?

MR. RONSTROM: Well, I checked on what two 530-megawatt converters would require, the length of 115 meters by the width of 145 meters. That's -- these --

MR. ASHTON: That's --

MR. RONSTROM: -- are available in our report --

MR. ASHTON: Right. But I was looking at the diagram in the back and I quickly scaled it off and I came out with 18,750 square meters, threw in a little bit for the fence, and came up with 20,000 square meters --

MR. RONSTROM: Um-hmm --

MR. ASHTON: -- that's two hectares, which is about five acres. Okay?

CHAIRMAN KATZ: Subject to check.

MR. RONSTROM: Yeah.

MR. ASHTON: Okay.

(Laughter)

MR. ASHTON: Do you know if that kind of land is available at East Devon or Singer?

MR. RONSTROM: I don't know for sure. I have been personally at both sites and -- but I don't know the ownership of this land --

MR. ASHTON: Okay --

MR. RONSTROM: -- and if it's possible to buy or not --

CHAIRMAN KATZ: Did anyone ask --

MR. RONSTROM: -- but it seemed to me that it was available.

CHAIRMAN KATZ: Did anyone from ABB ask anyone at CL&P or UI on the -- whether there was a footprint available for this, or is this something to be determined?

MR. ASHTON: It sounds like it's to be determined, is that fair?

MR. RONSTROM: It's to be determined.

CHAIRMAN KATZ: Thank you.

MR. ASHTON: Okay, let's move on. In the event of a catastrophic loss of a converter station,

something happens and just wipes out the building, how long would it take to get that facility back in operation? The foundations are intact, the building is not intact, but that's a minor item, you can get that fairly quickly, but the guts of the building are severely damaged and have to be replaced. How long?

MR. BAHRMAN: Being an engineer, I'd have to say, you know, it depends on the extent of the damage. I mean the normal --

MR. ASHTON: Everything in the building in one station, 500 megawatts, is damaged. How long would it take to replace it?

MR. BAHRMAN: I -- I really can't answer that, no. I mean if you have to completely rebuild the station --

MR. ASHTON: The only thing left is the foundations for everything you mount this equipment on.

MR. BAHRMAN: Okay. Then you have --

MR. ASHTON: And the ducts.

MR. BAHRMAN: Then you basically have another -- you have to manufacture the replacement equipment --

MR. ASHTON: Yeah --

MR. BAHRMAN: -- you have to install it,

and you're talking a period of --

MR. MUKERJI: Two years.

MR. RONSTROM: Two years or --

MR. BAHRMAN: Minus a little bit because you don't have the civil work and the foundations and --

MR. RONSTROM: Fifteen months --

CHAIRMAN KATZ: So is that line -- is that DC line therefore out for those two years?

MR. ASHTON: That terminal is --

MR. BAHRMAN: I mean if you consider the scenario as proposed and you -- the DC line needs a converter in order to operate. So then in the case of parallel converters, you'd have one third --

MR. ASHTON: You'd operate half the capacity --

MR. BAHRMAN: -- or half the capacity over that time.

MR. MUKERJI: The lead time for a large transformer is also several months.

MR. ASHTON: I'm sorry?

MR. MUKERJI: If a large 345-kilovolt -- if a kV transformer goes -- as a -- is damaged --

MR. ASHTON: That's correct --

MR. MUKERJI: -- and the lead time for that

is also quite long.

MR. ASHTON: If a spare is on site, it's about one month?

MR. RONSTROM: Yeah.

MR. MUKERJI: Yeah.

MR. ASHTON: A similar and related question, by -- from what I read by any standards, a DC system which involves two -- four or more terminals, 500 megawatts plus a piece, is a pretty big order. This is the biggest facility in the world by what I see in terms of equipment. How much -- how long will it take to produce that equipment? If the order is given today, how long would it take you to manufacture 2200 megawatts of terminal equipment?

MR. RONSTROM: The typical delivery time from order means the contract has been negotiated and to handing over for operation is in the range of 20 months, 22 months --

MR. ASHTON: Okay. But this is the biggest order by far --

MR. RONSTROM: Yeah, but --

MR. ASHTON: -- that you've ever received. Do you have the capacity to build it in one shot or do you have to build 500 and then another 500, then another 500?

Can you build 2,000 in parallel or do you have to do in series?

MR. RONSTROM: I will guess we cannot build it completely entirely. A little bit -- how you say --

MR. ASHTON: Sequentially?

MR. RONSTROM: Yeah. But not -- not completely. We can -- overlapping.

MR. ASHTON: What's your capacity to build in parallel megawatt lines?

MR. BAHRMAN: I mean you look at the elements. The transformers are a major element --

MR. ASHTON: I understand --

MR. BAHRMAN: -- and you have to look --

MR. ASHTON: -- (indiscernible, overlap of talking) --

MR. BAHRMAN: -- we'd have to -- we'd have to look at that. And I think --

MR. ASHTON: I'm more questioning the valve issue. The transformers are more a bread and butter item, more --

MR. BAHRMAN: Actually, they take longer to produce. They're the longest lead time of any of the components --

MR. ASHTON: Okay --

MR. BAHRMAN: -- if you look at the semi-conductors, there's a production and there's a testing cycle. And I would prefer -- we're not -- you know, if we could come back --

MR. ASHTON: A late file --

MR. BAHRMAN: -- if you -- if you want, to see the effect --

CHAIRMAN KATZ: Mr. Andres --

MR. BAHRMAN: -- of a couple of stations.

MR. ANDRES: Can I have the question again to be able to address --

MR. ASHTON: I'd just like to know what's the production time for a minimum order of 2200 -- let's say -- let's say 2200 megawatts of converter terminal capacity, which is four terminals only --

MR. ANDRES: Um-hmm.

MR. ASHTON: -- and that's the low end of the number of terminals we've been talking here.

MR. ANDRES: Okay.

CHAIRMAN KATZ: Thank you.

MR. ASHTON: I have nothing further. Thank you very much.

CHAIRMAN KATZ: Mr. O'Neill.

MR. O'NEILL: Yes. Could you supply us

with a comparative cost analysis of XLPE cable and HPFF cable installations compared with HVDC cable installation? Would it be fundamentally the same, higher, or lower per mile?

MR. LARSSON-HOFFSTEIN: Our -- our estimate is that it would be higher for HPFF compared to XLPE.

MR. O'NEILL: Do you know how much higher that would be relative?

MR. LARSSON-HOFFSTEIN: No. We have not made any quantification.

MR. O'NEILL: Thank you.

CHAIRMAN KATZ: Thank you. Mr. Wilensky.

MR. EDWARD S. WILENSKY: Yes. Going along with some of Mr. Emerick's questions on page 21 on electromagnetic fields, the magnetic fields that would emanate from this installation, would they be greater or less than an installation of a different type of cable? Would you have any idea of what it is above the ground?

MR. BAHRMAN: The figures 15 through 21 give the fields calculated for maximum loading for different cable arrangements as a function of horizontal distance and at grade and I believe one meter above grade. So -- so, I would refer to those figures, I think they answer your question.

MR. ASHTON: That's in the technical description?

MR. BAHRMAN: This is in the technical description --

MR. WILENSKY: Is that on page 22? Is that what you're referring to?

MR. BAHRMAN: Yeah, the figures are on 22 through page 25.

MR. WILENSKY: If I was standing over this line if it was installed underground at whatever depth you recommend --

CHAIRMAN KATZ: You would have a full head of hair -- (laughter) --

MR. WILENSKY: That's how I -- that's how I lost my hair standing under the lines.

And I was standing under an overhead cable, which would be greater, which would be less, or does it -- is it --

MR. BAHRMAN: These are --

MR. WILENSKY: -- is there a difference?

MR. BAHRMAN: -- DC fields --

MR. WILENSKY: Yes --

MR. BAHRMAN: -- as opposed to --

MR. WILENSKY: No, no, an AC field.

MR. BAHRMAN: Uh -- well --

MR. WILENSKY: A DC underground, an AC aboveground.

A VOICE: That -- that's not a fair question.

MR. BAHRMAN: We only address the DC fields here --

MR. WILENSKY: Okay.

MR. BAHRMAN: -- we have not -- you know, it depends on the configuration of the line and the loading --

MR. WILENSKY: Yeah --

MR. BAHRMAN: -- and it's outside of what we have presented.

MR. WILENSKY: Would you say then it would be safe if I was over a DC field, standing over it?

MR. BAHRMAN: This is what the link refers to, it's a static field, there's no induction effects. If you read all these references, there's hundreds of them --

MR. WILENSKY: Without reading it, what can you tell me verbally?

MR. ASHTON: Very quickly -- (laughter) --

MR. BAHRMAN: The standard accepted terms -- and again I'm not an expert --

MR. WILENSKY: Neither am I --

MR. BAHRMAN: -- is that there are no --

MR. WILENSKY: -- and that's why I'm asking you --

MR. BAHRMAN: -- there are no effects, no known health effects really from the static fields. We live in them every day. They're equivalent to that of the earth's magnetic field.

MR. WILENSKY: Okay. Thank you very much.

CHAIRMAN KATZ: Thank you.

MR. WILENSKY: Thank you, Madam Chairman.

CHAIRMAN KATZ: Mr. Murphy.

MR. JAMES J. MURPHY, JR.: No questions.

CHAIRMAN KATZ: Okay. Are we finalized as far as cross-examination?

A VOICE: Madam --

CHAIRMAN KATZ: Yes?

MR. FITZGERALD: Could I just follow up on one thing you asked before? I think that the panel will confirm for you that the installation considerations for DC cable going over land, like putting it in a right-of-way, they're really the same as for AC XLPE. If you could put one in one place, you could put the other. If you can't put the other there -- if you can't put one, you

can't put the other, but the limiting characteristics of the terrain are the same.

CHAIRMAN KATZ: Is that what the witness panel is indicating?

MR. ASHTON: The question is do you agree that there is very little or no consequential difference between the installation of an AC cable and a DC cable?

MR. LARSSON-HOFFSTEIN: If you compare AC XLPE and the DC Light cables there are no differences. But if you compare HPFF cables --

MR. ASHTON: The same type, it doesn't make any difference if it's AC or DC?

CHAIRMAN KATZ: Can you give us -- if you had an AC overhead line from East Devon to Beseck versus a DC line from --

MR. ASHTON: Overhead or underground --

CHAIRMAN KATZ: -- underground of course from East Devon to Beseck, how much more is the DC going to cost than the overhead AC?

MR. BAHRMAN: We have only the tabulated figures for the DC circuit --

CHAIRMAN KATZ: Okay, we'll do the math --

MR. BAHRMAN: -- nothing for the AC.

CHAIRMAN KATZ: We'll do the math. Thank

you. Any other -- yes, sir?

MR. RONSTROM: I got some information on the production rate for converters --

CHAIRMAN KATZ: Yes.

MR. RONSTROM: -- we believe we can supply four converter terminals, whether they are 370 or 530 megawatts, it doesn't make any real difference, in 20 months.

CHAIRMAN KATZ: Thank you.

MR. RONSTROM: And we could --

CHAIRMAN KATZ: We'll cross that off the list, Mr. Andres.

MR. RONSTROM: We could -- we could -- if we were to deliver 10 stations as in Option 1, we could do that in 32 months.

MR. ASHTON: Four in 20, ten in 32, okay.

CHAIRMAN KATZ: Thank you.

MS. RANDELL: I have just a very quick follow-up. Mr. Dickmander, there's been lots of discussion of Option 3 and frequency scans today. Just so I'm clear, the nature of the work that you did is you did -- you looked at scans on nine buses, full load, no contingencies, all capacitor banks in, is that right?

MR. DICKMANDER: That's correct.

MS. RANDELL: So you didn't look at less load or any contingencies to see how the system would work?

MR. DICKMANDER: That's correct

MS. RANDELL: Thank you.

CHAIRMAN KATZ: Thank you. Anything else? We are going to resume this hearing on January 5th. First I'd like to thank ABB for providing all these witnesses, they were very helpful.

On January 5th is a cleanup day, correct, Mr. Phelps?

MR. PHELPS: Yes, it is.

CHAIRMAN KATZ: So what we will do is probably get out some suggested topics and find out what witnesses people need.

MR. PHELPS: I would like -- I would like to have -- (indiscernible) --

AUDIO TECHNICIAN: Could you go to a microphone --

MR. PHELPS: Yes, sir. I would suggest that parties and intervenors should communicate with staff as to recommended topics. And then we could turn that around into a notice document.

CHAIRMAN KATZ: Right. And then we will

ask people what witnesses they need back for those topics so that we can use the best use of the first cleanup day.

MR. PHELPS: Mr. Cunliffe, can you -- am I still on --

CHAIRMAN KATZ: Okay --

MR. PHELPS: Mr. Cunliffe, is there a date by which we should ask for comments to be submitted?

MR. CUNLIFFE: I would suggest before Christmas.

MR. ASHTON: I think you need that faster than that, Fred --

MR. CUNLIFFE: Faster than that?

MR. ASHTON: We need scheduling notices --

CHAIRMAN KATZ: Okay, we'll go with that. And we still expect the ROC report on the 20th?

MR. CUNLIFFE: The 22nd. (Laughter).

MR. FITZGERALD: The stuff is still coming in.

(Multiple voices overlapping in background, indiscernible)

CHAIRMAN KATZ: We're adjourned.

(Whereupon, the hearing adjourned at 5:35 p.m.)

HEARING RE: CL&P and UI
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ABB PANEL OF WITNESSES:

Michael Bahrman
Dave Dickmander
Rana Mukerji
Leif Ronstrom
Magnus Larsson Hoffstein

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INDEX OF SITING COUNCIL EXHIBITS

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In witness whereof I have hereunto set my hand and do so attest to the above, this 22nd day of December, 2004.

Paul Landman
President