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STATE OF CONNECTICUT

SITING COUNCIL

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CONNECTICUT LIGHT & POWER COMPANY AND UNITED ILLUMINATING COMPANY

JUNE 15, 2004
10:35 A.M.

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

DOCKET NO. 272

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. . .Continued 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 and Business, 185 Main Street, New Britain, Connecticut, on June 15, 2004, at 10:35 A.M., at which time the parties were represented as hereinbefore set forth. . .

CHAIRMAN PAMELA KATZ: I will call this continuation of hearing for Docket 272 to order. This morning we are going to first have a explanation of some technical terms by the Applicant and then we are going to have a short audio/visual presentation from the Applicant on the GE modeling and the harmonics. And then we are going to continue -- we'll put some exhibits into the record and then we are going to -- the rest of the morning will be cross examination by Council staff on various issues.

I met with KEMA yesterday to go over some of the issues and it was very informative and I'm going to ask the Council members, there's a certain flow to this, I'm going to ask the Council members to hold all questions on the two presentations we have and on the cross examination of KEMA until after we are completed that cross examination of the Applicant, because I want this to sort of go without any side trips. So I'm going to ask you if you have a question during any part of the morning here please make a note of it and then there'll be an opportunity for Council members to ask questions this afternoon.

But I'm going to try to go out of tradition and we're not going to have our usual clarifying questions as we go. We're going to hold them. Okay? So at this point the first order is Mr. Zak, I guess you're going to go through the technical terms or Ms. Randell, how do you want to do this?

MS. LINDA RANDELL: Yes. The Council asked us to provide an explanation of 15 technical terms.

MR. COLIN TAIT: Do we have copies for ourselves?

MS. RANDELL: Yes. I've left them at the table where Mr. Cunliffe usually sits. And we have some copies that Mr. McDermott can distribute. And Mr.

Zaklukiewicz will provide those.

MR. TAIT: Wait till we have copies.

CHAIRPERSON KATZ: Just one second please while we distribute these.

MS. RANDELL: Mr. Zaklukiewicz will provide explanations of 15 terms provided to us yesterday by the Council.

CHAIRPERSON KATZ: And again, I will ask Council members to hold off their questions and we'll just keep moving forward.

MR. ROGER ZAKLUKIEWICZ: Does everyone have a copy now? Capacitive Admittance. Capacitance is the property of a system of conductors and dielectrics that permits the storage of electricity separated charges when potential difference exists between the conductors. Admittance is the reciprocal of impedance. This is often used for shunt connected devices.

Cable Charging Capacitance is the capacitance due to a cable which is the result of having the conductor of a cable at a given voltage and the shied which is grounded.

Harmonic Amplification --

CHAIRPERSON KATZ: Could I just interrupt Mr. Zak? We have -- feel free to expand on these as you think is necessary for the layman. Okay?

MR. ZAKLUKIEWICZ: -- well, I'm just reading it.

CHAIRPERSON KATZ: Instead of just reading it if you wish.

MR. ZAKLUKIEWICZ: The increase of magnitudes of harmonic currents or voltages at one point in a system compared to another point, typically the point of injection.

Harmonic distortion. The presence of frequency components which are a multiple of the normal fundamental, that is 60 Hz, frequency superimposed on the normal frequency content.

Harmonic Frequency Response is the impedance of the system at frequencies greater than normal frequency, which is 60 Hz.

2nd and 3rd Harmonic. Harmonic is a sinusoidal component of a period wave having a frequency that is in an integral multiple of the normal frequency. For example, a component the frequency of which is twice the normal frequency is called the 2nd harmonic. A component of the frequency which is three times the normal frequency is called the 3rd harmonic. And a 2nd harmonic frequency would be 120 Hz and the 3rd harmonic would be 180 Hz.

Harmonic Resonance. When the capacitance and inductance in a system combine to magnify any stimulus at an integer multiple of the normal frequency.

Inductive Admittance. Inductance is the property of an electric circuit by which an electromotive force is induced in it as a result of the changing magnetic flux. Admittance is the reciprocal of impedance. This is also often -- excuse me, this is often used for for shunt connected devices.

Impedance Resonance. Resonance of a parallel circuit in which the impedance reaches a maximum at the resonant frequency.

Shunt Charging Capacitance. Capacitance due to a line or cable which is the result of having the conductor of a cable at a given voltage and the shield which is grounded.

Stability Screening. A limited evaluation of the system response to disturbances which evaluates whether or not generators will remain in synchronism with the rest of the system.

Switching Transient Analysis. The calculation of the time response of a system to abrupt changes such as the application or removal of faults and the switching of devices. This evaluation typically focuses on events of a duration of a few cycles. Recognize a cycle is $1/60^{th}$ of a second. So --

CHAIRPERSON KATZ: Mr. Fitzgerald, do you want to interrupt?

MR. ANTHONY FITZGERALD: Yeah. Just by way of explanation, the request as we understood it yesterday was actually for definitions of these terms. And so that's what Mr. Zak provided. In terms of, you referred to well, maybe let's put some flesh on it in the way of an explanation. Actually, that's what the GE presentation is designed to do.

CHAIRPERSON KATZ: Great. Okay.

MS. RANDELL: And Mr. Walling from GE has offered on any of these terms to do a chalk talk. We have the easel. Mr. Walling does tend to speak in diagrams sometimes and to the extent that he can roll those into his explanation that could -- we'd be happy to do that as well.

CHAIRPERSON KATZ: Okay.

MS. RANDELL: Because some context is needed to understand these terms. I did ask if there was a little yellow and black book, Electrical Engineering for Dummies, that we could use and I was told, no, that you really needed to put it in context.

CHAIRPERSON KATZ: What we're going to do is sort of listen to the whole thing and assume that you will bring it all together.

MR. ZAKLUKIEWICZ: Just for the record we should know that I asked for one of those little yellow books. Thermal Load Flows. The steady state evaluation of a system. This considers system performance both before and following disturbances, or contingencies as we frequently speak of.

Voltage Excursions. These are the deviations from the desired operating voltage of the system and for the proposed project we're speaking of 345,000 volts or 345 kV.

Transients. The system response due to changing between two steady state conditions. And those are the definitions I believe in totality that we were asked to provide definitions for.

CHAIRPERSON KATZ: For identification purposes we'll call this 109. We'll verify it later when we do all the verifications. Great. So you'd like us to take some seats now for the audio/visual?

MS. RANDELL: Yes. And while you're doing that perhaps Mr. Haines would be able to sear Mr. Walling in?

CHAIRPERSON KATZ: Do you want to do that first?

MS. RANDELL: Sure.

CHAIRPERSON KATZ: Okay. Mr. Walling, can you -- that's fine right there. Can you give your name and spell your name?

MR. REIGH WALLING: My name is Reigh Walling.

COURT REPORTER: Hold on.

MR. WALLING: My name is Reigh Walling.

CHAIRPERSON KATZ: One more time.

MR. WALLING: Okay. My name is Reigh Walling. The last name, Walling, is spelled W-A-L-L-I-N-G and the first name is spelled R-E-I-G-H. I'm employed with GE Energy and the consulting group there.

(Witness sworn)

CHAIRPERSON KATZ: Okay. Why don't we take our seats for this?

MS. RANDELL: That would be good. We will have copies of the written version of Mr. Walling's presentation to pass out. However, I suggest we do that afterwards --

CHAIRPERSON KATZ: Okay. We will call

that --

MS. RANDELL: -- based on our experience it's hard enough to focus on the screen and listen.

CHAIRPERSON KATZ: -- yes. For identification purposes only then we will call that 110.

MS. RANDELL: Sure. Okay. My name is Reigh Walling. Excuse me while we're getting everything ready here. Good morning. My name is Reigh Walling. I work for the energy consulting business of GE Energy in Schenectady, New York. I'm here to talk to you this morning about the issues related to large scale implementation of transmission cables into a system like we have in southwest Connecticut.

While there are many systems with a substantial amount of transmission cable there are some unique characteristics of this system as being planned which do introduce potential for risk, increase risk to system security and to power quality provided to customers that we do need to be aware of and it does set a practical limit on how much cable really can be implemented into the system. I'm going to just give a quick overview of some of these issues which are the challenges to the system, potential impacts of large scale cable addition and then I'll be elaborating on those as I go forward through the slides.

First of all I think it's important to point out that implementation of a large amount of transmission cable into a system like we have in southwest Connecticut results in system characteristics which are to my knowledge unprecedented. And I know quite surely that nowhere in the U.S. do we have any characteristics like that with result and I don't believe I know of anything in the world that would approach that.

The real problem and the crux of the problem is that transient events, disturbances to the system, can potentially result in high over voltages. And these high over voltages can be potentially damaging to utility or customer equipment. And what is really troubling in the utility equipment is not only the expense to the utility, but the fact that some of this capital equipment might have a mean time to replace of at least a year. So if a large transformer is damaged by a transient event the time to procure and have built and install could be exceeding a one year's time. And during that time the system is in a compromised level of security.

A real troubling issue is the fact that you could have consequential failures. You have an event, you plan for an event. Like a fault, lightening strikes somewheres and something fails and you have a fault. What you don't plan for is the fact that that fault, the actual occurrence of that fault causes a fault to occur somewheres else in the system as a consequential result. And there are some unique situations here that we've seen in the simulation work indicating the potential for that. And that's very troubling from a planning standpoint because now you have the potential for a simultaneous event that would never on a random basis ever occur simultaneously.

Difficult here in the analysis of predicting here is the fact that the system behavior is highly, highly dependent on precise system conditions. There's a lot of nomilarities in the system and the academics will tell you this can result in sort of a chaotic response to any change in the system, that it's very unpredictable. You can look at it on a large scale over the bulk of system situations and get a general understanding, but on a detailed point by point basis there are irregularities in how the system responds.

So it really requires looking through a lot of system configurations. And if you see you have a system with 100 elements, lines, transformers, generators, whatever, that could be in or out at any given time, we calculated what the number of configurations possible is in the system and you can see it's very intractable to detail and analyze that, every possible situation. So the best we can do is make typical or exemplary analysis and possibly get into Monte Carlo-type analysis where you're just randomly choosing things and trying to get a broad general picture, but the specifics are very difficult.

So the bottom line is that excessive cable miles in a system can compromise the system security and the amount of cable miles that a system can accept is really a function of another characteristic of the system which is referred to as system strength and I'll be talking about that more as we go along. Now what is it about cable that makes it so different? Its not like we can just take the wire off of the towers and dig a hole and bury them in the ground, okay? The fact is, is that an underground cable has a large amount of charging capacitance. Basically this is because the capacitance of any line is really a function of the surface area of the electrodes, which in this case are the conductors. The material between that point raise the voltage and the grounded object that it's near, the material between and the distance between.

So when you take an overhead line conductor if it's underground it has to be bigger because it can't dissipate heat as well, so it has to be bigger so it doesn't produce as much thermal heat, so it's bigger. It's much closer to a grounded object. Outside of the insulation of the cable is a grounded cable shield, which is necessary to maintain an equal potential gradient on the cable so the insulation can withstand it. And the cable insulation material is not air, but it's a dialectic material, which has the characteristic that it's creates more capacitance over the same distance than air does.

Bottom line is, cable has a lot of what we call shunt charging capacitance. Now we have some concept of MEGA VARS and we're putting capacitor banks in the system to create MEGA VARS, well power lines, transmission lines create MEGA VARS by the very nature of them being energized to voltage. For an overhead line it's a more modest amount. For a 345 kV line typically it's less than a MEGA VAR per mile of line and it's basically there is a charging current. If we just energize one end of that line we would measure a small amount of current going into the line to maintain that electric charge.

However, a high pressure fluid filled cable has 21 MEGA VARS per mile of charging. More than an order of magnitude greater. And 35 ampheres of current would flow into the cable if it were just energized at one end. Now if you have a 10 mile cable section you're up to 350 ampheres. That's a substantial amount of the overall cable capacity -- carrying capacity actually is in this shunt charging.

Now cross link polyethylene granted does have a smaller amount of shunt charging. I'm not prepared to discuss the technical merits of cross link polyethylene versus HPFF cable. There are other witnesses who are experts in that field.

Okay. What really is significant here is how much cable can a system withstand as a function of what we call the system strength. The next slide -- let's go ahead to the next slide and then I'll go back. Strength is -- in the power industry we refer to it as short circuit capacity, which in one sense means how much current would flow into a fault from the system? So analogy would be if you cut a hole in a bucket, how fast is the water flowing out of that hole in the bucket, your fault?

Another way to look at it though is the rigidity of the system. How much does the voltage change when you take a certain amount of current out of the system? A strong system the voltage changes very little for a certain amount of current taken from the system. A weak system the voltage changes quite a bit. You might experience that in your house. Someone -- okay, your heat pump comes on, right? Because of the weakness of the maybe the long secondary run to your house you'll see the lights dim and flicker. However, if you went into an industrial plant and your same heat pump were hooked into their -- you wouldn't see any flicker at all because it's a strong bus. It's the same situation here.

In a strong system you tend to have a tightly meshed grid. For example, Conn Edison, you've got a tremendous amount of load in a concentrated area. You have a lot of cables in Conn Ed., but it's all meshed so that the distance from any point in a system to a number of generators is relatively short and there's multiple paths. If any one of those paths is lost it doesn't change that short circuit strength very much. If you're in a more stretched out system then the distances are greater and there's a greater change in voltage for any amount of current drawn from the system. And also you can have a larger impact from the loss of an element. Usually you design for one element being out of service at any time and the strength can be weakened more significantly in a weaker system. Previous slide please?

Okay. So we do have -- this is a chart here and the color is sort of indicating risk and the horizontal axis is referring to the system's strength. The vertical axis referring to the amount of charging capacitance within that system. Now as you go from overhead lines to underground lines you're picking up capacitance and then you have in this direction from a weak system to a strong system.

Most utility systems probably operate in this very green sector here where you have relatively good strength. You have a lot of generating plants nearby. You have a very meshed transmission system and lines are all overhead. You can go to a system like Conn. Ed. that has a tremendous amount of cables and have a lot of capacitance but they're -- they are so extremely strong that there's a large impact of anybody adding a new generator, a merchant plant in New York City because the short circuit current is so high they can't find a circuit breaker that can stop that current in case of a fault.

Then you have systems, let's say out in Montana, which are very weak, but it's all overhead lines. They're down in this brownish shaded area of moderate risk, but not too great. And the problem here is that the strength in the southwest Connecticut area is moderate to weak and will become weaker as the transmission system is upgraded because the must run plants, the plants that are uneconomic but are maintained simply for voltage support won't need to be operated. As they come off the system will weaker further.

So we're adding cable to a system that is moderate to weak. So we're entering into this region here, this quadrant of higher risk indicated by more red. Two slides.

Okay. What is this capacitance doing to us? In terms of the normal operating frequency, the 60 cycle frequency, the capacitance doesn't really cause us a direct problem because it's compensated out by shunt reactors. They cost a lot but you can cancel it out at the normal frequency. However, transient events in the system introduce higher frequencies into the system and the compensating effect of those shunt reactors is increasingly ineffective to the point at the higher frequencies of system resonances I'll be talking about, they're relatively insignificant.

Okay. Capacitance and inductance. Inductance is, you know, like the impedance of a line. The tendency for the voltage to drop as you go through a distance, put current through a line. Okay. Both inductance and capacitance are energy storage on a cycle by cycle basis. When the voltage is at it's peak there's a lot of energy stored in the capacitance of a system and when it comes off the peak that current is rushing from the capacitance into the -- the energy is going into the magnetic field of inductance. So you're basically flip flopping the energy back and forth between electrostatic field and the capacitance to the electromagnetic field in the -- in the lines.

Okay. Let's -- there is a frequency where this interchange of energy back and forth is optimized. It's the natural frequency of the system where we refer to it as the resonant frequency of the system. Any system that has energy storage components in it has a natural frequency and I have some analogies here to try to illustrate this. A bell has a natural frequency. It's very clear to you. It's the tone that the bell makes when it's struck. And a power system has a natural frequency much like the bell. The striking of the power system bell is when you energize something or if you apply a fault or clear a fault off of a system you're giving a whack to the system and you're making the system oscillate. In addition to the normal frequency of 60 cycles going on the system is also going to oscillate at this natural frequency. And the two superimposed together creates the voltage peaks that you see in the system.

There's another thing regarding resonance in that energy put into a resonance system that's lightly damped stays in there and builds up. Now a number of years ago there was a Memorex commercial with an opera singer who could hit a certain pitch and her voice's pitch would go to a champagne glass. The energy from her voice, even though it was not a tremendous amount, I mean, it wouldn't break your bones or whatever, but the glass that energy from her getting the right pitch goes into the glass and doesn't come out and it just builds up, builds up until she breaks the glass. So it's the same analogy in a power system. We have sources of non-60 Hz current being generated by loads, we call those harmonics. If they happen to coincide with the natural frequency of the system their impact can be greatly exaggerated. Not that the system cracks in half, but it's a good analogy.

Just to sort out from the very complex nature of the actual system model to a simpler system we looked at a number of simulations of a very simplistic model of a power system having shunt capacitance in the form of cable capacitance and system strength and we varied that so that we could see how the peak over voltage coming into play after a fault is removed varies with that resonant frequency. And we see an overall trend that as the resonant frequency of the system drops down to three or two times normal frequency that you're starting to head towards a strong upturn here.

Now point by point if you're looking at one set of conditions it might jag back and forth. So a little change towards a lower resonant frequency could end up in a less severe situation on a microscale. On the macroscale however there's the overall trend that as a resonant frequency gets lower there's a greater risk to the system.

Okay. So to review what we're seeing here in the southwest Connecticut cable projects is that large scale cable additions are being made in a relatively weak system. And emphasizing the fact that the addition of the cables in a way weakens this system from a standpoint

-- one aspect of it is in terms that it's going to tend to take generation off because it'll be more economic for the power to come in from more distant locations and generators are really the source of this short circuit capacity in a system. The resonance of the system is moving towards second harmonic, which means you have an increased risk of sustained over voltage. And Connecticut today operates with the system resonance being 2.9 times normal voltage to nine -- normal frequency to nine times. I want to emphasize though that the 2.9 tends to occur on a relatively unusual and brief periods of time when you have very heavy load and shunt capacitor banks are put on in the area to support the system voltage and probably a line outage also to complicate that.

When this occurs though the system is heavily loaded. Now loading in a resonant system acts as a dampener. If we go back to the champagne glass analogy, if we put water half way full in that champagne glass the opera singer could sing her head off and it would not break the glass because that energy would be dampened, the ringing of the glass would be dampened by the water in it. The same thing in the power system. When it's pretty heavily loaded there's less likely for this resonant amplification. When it's lightly loaded it's a greater issue.

One of the problems with the cable project is that this capacitance will be on the system 24/7, unlike the capacitor banks that are presently used for voltage support tend to be on when loading is heavy and tend to be off when loading is light.

Okay. We've -- this is sort of approximate. We've kind of done some quick estimation here. And along the horizontal axis, the system's strength again, and then vertical axis is composite charging. It's not exactly scientific because the charging is located at various places in the system, we're kind of consolidating it together and applied some estimations to arrive at this. But basically the Connecticut system today with the shunt capacitors off is way down here in the green area with the system resonant frequency up at a high multiple and fundament of 60 Hz.

Then with capacitor banks on under the worst summer day conditions with all of them on we are moving up into this caution area here where we're getting the system resonance down around third harmonic. As we add the Bethel/Norwalk project we're moving further by adding capacitance and we are strengthening the system slightly by that cable going in, but we're moving in this direction and then number four here is if the Middletown/Norwalk was all overhead. You see, we strengthen the system and don't add much capacitance we can move this way, however if it's all underground you can see that we're moving up towards the red. And if you keep adding more and more capacitance you tend to move towards this red area, which the dividing line is the resonant frequency in terms of multiple of the normal frequency.

Okay. How do in a power system do we stimulate these resonant behaviors? First of all, they're a steady state stimulus much like the opera singer singing. Loads, including these fluorescent lights, computer power supply, the PA equipment over here, all takes current that is not smoothly sinusoidal, it has a distortion to that current. And the accumulation of all of that, this distorted current has frequency components that are multiple fundamental, when I say fundamental I mean 60 Hz, that are always out there in the system. They tend to sort of cancel between each other, sort of add up. It's a very statistical process, but there's a background level of distortion in the system caused by loads which can stimulate the system if it happens to be resonant at one of these frequencies.

Now as we get more into disturbances, if we energize a transformer the in-rush to the transformer as it's becoming magnetized puts out a large amount of second or -- amount of harmonics including both even and odd multiples starting with the second and sort of decreasing as you go up to higher orders. Also when you clear a fault you have this in-rush into the transformers as they're becoming re-magnetized after the fall is removed and also the system is being kicked at the same time.

Then there's transient kicks to the system like energizing a capacitor or a cable or a line or application of a fault. In our simulation work on this system we have seen a phenomena, a phenomena that I've heard about but never saw a practical demonstration of it before. The simulation seemed to indicate that a fault somewheres on the cable system resulting in a very high over voltage at some distance away on the 115 kV system at a capacitor bank location. By some distance I'm thinking like 20, 30 miles away. And this raises the specter of having a simultaneous event. A fault occurs in the transmission system you get a very high voltage at some other point in the system, which can be injurious to consumer equipment as you move down into the system. It also could cause equipment failure to occur at that other location and throw another fault on. It could have kind of a cascading effect on the system.

But what are harmonics? Okay. Basically harmonics are multiples of normal system frequency. It might have a device that has a current wave shape like this, which we call distortion, the fact that it's not a smooth sinusoidal wave, it has these bumps on it. These are -- because these bumps are occurring at multiples of the normal frequency they're frequency components are integer multiples of 60 Hz.

Where do they come from? Consumer equipment, industry equipment, however the very large industrial situations that create a lot of harmonic current tend to be filtered and mitigated at their source. Utility equipment also tends to be taken care of and there's a number of examples here of various types of equipment that create -- I mean, many consumer items that you're very familiar with.

Okay. And this is referring to the steady state harmonics, what can it do? Well, it can cause heating in equipment, it can cause failures of capacitor banks, which are needed for voltage support in the system. It can cause relay misoperation. There was an event in 1989 where Quebec went black where harmonic currents caused a misoperation of a relay that brought down the entire Quebec provincial power system, put them in a blackout for a period of time.

The IEEE has developed a recommended practice which says that a utility should -- that the customers are obligated to hold the current distortion that they create to a certain value and the utilities in return are to hold the voltage distortion to these limits here, which are in order of a few percent. As you introduce resonances to a system it gets more and more difficult for the utility to maintain that level of voltage distortion because the nature of a resonance is to amplify the current injected by loads into a higher magnitude of harmonic voltage as a result.

Particular here we're troubled by moving the system resonance close to the second harmonic, or 120 Hz. And the reasons why, first of all, abrupt disturbances like throwing on a fault or taking off a fault if you do a mathematical thing that is called Fourier Convolution you basically see that that has frequency components that are decreasing as you go in higher frequency. So as the resonant frequency gets lower a kick to the system like from a fault has more energy to drive that.

Particularly problematic is that transformers from a disturbance, including faults or energization can drive a large amount of second harmonic current on the order of tens of percent of the rated capacity in terms of second harmonic current into the system for a matter of seconds for a disturbance type event. There's also events related to believe it or not solar storms on the sun causing geomagnetic disturbances on the earth and this can cause a transformer to asymmetrically saturate for hours at a time driving even ordered and particularly second harmonic into the system. This type of event caused a large nuc. plant in New Jersey to be taken out of service for nearly a year. It also is the root cause for that blackout in Quebec in 1989.

One of the other problems also is that as you get to lower frequency, and I don't think I have time to elaborate here more on it, but the distortion of the voltage distorts how transformers behave, which changes the distortion and it's a closed loop and it's very complex that there really isn't an art for analyzing that other than by simulation. And there also have been several documented cases of large utility power electronic devices like high voltage direct current converter stations going into a harmonic instability due to the fact that the system was resonant in your second harmonic and the system becoming unstable from a normal condition just going to where it has to trip off.

This is some simulation results for the Middletown to Norwalk study. This is kind of a distortion that you can get in the voltage following transformer resonation. However you add 20 more miles of cable, you can see that the same transformer resonation results in a significant over voltage peak hitting two times normal voltage and continuing on for a long period of time. Very likely to if unmitigated to develop into a equipment failure.

Over voltages due to fault clearing generally are worse with a weak system and are even worse than what I showed you there for the transformer resonancization case. They're also superimposed by transformer resonancization because as the fault is cleared transformers are re-energized. They're being re-magnetized. There's also at the same time a kick to the system that stimulates the natural frequency. At the same time transformers are injecting the system is ringing.

In conclusion what's problematic about studying this and analyzing this is that the resonances change very much with system conditions in terms of capacitor banked status, number of generators on, lines and cables in and out of service. The art of the engineering power and energy communication does not really have a good handle on how to handle the very dispersed harmonic sources all around the system and how they superimpose into each other. Over voltage results are further complicated by the timing of faults, the exact instance in which it occurs, very complex interactions. And the bottom line is many simulations are needed, but we cannot test every possible thing. We basically are making exemplary simulations and from that deducing what the general behavior of the system is. And the general nature of the system is that as resonances move lower there are more potential issues and risks to the system. Thank you.

CHAIRPERSON KATZ: At this time is there any objection to the Council taking administrative notice in the hearing program of items 23 through 27, plus State Agency comments from DOT dated May 18th, 2004 and DOA dated May 24th, 2004? Hearing no objection, we'll take administrative notice. At this time I'm going to ask the Applicant to verify new exhibits on hearing programs pages 16 and 17 with our understanding that the definitions we heard this morning are 109 and this present -- the hard copy of this presentation is 110. Can we do that at this time?

MR. FITZGERALD: Yes. Thank you Madam Chairman. I'm going to skip over 96, which we'll put in tomorrow. Let me start with number 97 and Ms. Bartosewicz and Mr. Prete, this is a joint letter from you to Mayor Richetelli of Milford, regarding both these proposals. Do you swear that that is a true and correct copy of your letter that the information therein is true to the best of your knowledge and believe?

MS. ANNE BARTOSEWICZ: Anne Bartosewicz. Yes I do.

MR. JOHN PRETE: John Prete. Yes I do.

MR. FITZGERALD: I'll offer that as a full exhibit?

CHAIRPERSON KATZ: Any objections to making that a full exhibit? Hearing none, that will be a full exhibit.

(Whereupon, Applicant Exhibit No. 97 was received into evidence as a full exhibit.)

MR. FITZGERALD: I think we now move to 104. I assume that the reasons 98 through 103 are not shaded is that they're already full exhibits?

CHAIRPERSON KATZ: Correct.

MR. FITZGERALD: 104 is a copy of the comparative analysis of the proposed route and East Shore route and the -- some data is still lacking, but the data that is in there is that true and correct to the best of your knowledge and belief Mr. Prete and Ms. Bartosewicz?

MS. BARTOSEWICZ: Anne Bartosewicz. Yes it is.

MR. PRETE: John Prete. Yes it is.

(Whereupon, Applicant Exhibit No. 104 was received into evidence as a full exhibit.)

MR. FITZGERALD: And now I think we can put in 105 through 107 at one time. 105 are the Applicant's responses to towns of Durham and Wallingford, supplemental response to question 16 with an attachment. 106 is information concerning rights of way ownership. 107 are interrogatory responses to the Siting Council questions 58 through 61, 63, 66 and 67. And actually, let me stop there. Ms. Bartosewicz and Mr. Prete, is the information in Exhibits 104 through 107 true and correct to the best of your knowledge and belief?

MS. BARTOSEWICZ: Anne Bartosewicz. Yes they are.

MR. PRETE: John Prete. Yes they are.

MR. FITZGERALD: I move them as full exhibits?

CHAIRPERSON KATZ: Any objection to making 104 through 107 full exhibits? I mean -- or 105? Hearing none, full exhibits.

(Whereupon, Applicant's Exhibits No. 105-107 were received into evidence as full exhibits.)

MR. FITZGERALD: Mr. Zak, item 108 is a report that we filed related to high temperature low sag transmission conductors. Is that a true copy of the -- what it purports to be?

MR. ZAKLUKIEWICZ: Roger Zaklukiewicz. Yes it is.

MR. FITZGERALD: And Exhibit 109 is the sheet of definitions that you read into the record earlier. Are those definitions true and correct to the best of your knowledge?

MR. ZAKLUKIEWICZ: Yes they are.

MR. FITZGERALD: I'll move 108 and 109 as full exhibits?

CHAIRPERSON KATZ: Any objection to 108 or

109 as full exhibits? Hearing none, they're full exhibits.

(Whereupon, Applicant's Exhibits No. 108 & 109 were received into evidence as full exhibits.)

MR. FITZGERALD: Mr. Walling, Exhibit 110 is a set of slides that you just displayed. Is the information on those slides true and correct to the best of your knowledge and belief?

MR. WALLING: Reigh Walling. Yes it is.

MR. FITZGERALD: Move 110 as a full exhibit. And we also have Mr. Walling's resume, perhaps I could have him --

CHAIRPERSON KATZ: Yes, let's do that now.

MR. FITZGERALD: -- Mr. Walling, Mr. McDermott is handing you a copy of a document, which we obtained from you. Is that a copy of your curriculum vitae?

MR. WALLING: Reigh Walling. Yes it is.

MR. FITZGERALD: And is the information in there true and correct to the best of your knowledge?

MR. WALLING: Yes it is.

MR. FITZGERALD: And I offer that as Exhibit 111?

CHAIRPERSON KATZ: Mr. Walling, did you

work on simulations for the Applicant or simulations for both the Applicant and the towns?

MR. WALLING: I worked on the simulation -- consulted to Mrs. Pratico as an advisor on the work for the Applicant.

CHAIRPERSON KATZ: Thank you. Any objection to making 110 and 111 full exhibits? Hearing none, they're full exhibits.

(Whereupon, Applicant's Exhibits No. 110 & 111 were received into evidence as full exhibits.)

CHAIRPERSON KATZ: Do we have any procedural matters before Mr. Cunliffe starts cross examination?

MS. RANDELL: We have Ms. Pratico with us. It probably makes sense to have her sworn now.

CHAIRPERSON KATZ: Okay. Let's do that now.

MS. RANDELL: And go through her resume as well and then we can just go and --

CHAIRPERSON KATZ: Let's do that now. I'd like to get all this and then open the flood gates.

MS. RANDELL: -- right.

MR. FITZGERALD: Ms. Pratico, Mr. McDermott is showing --

MS. RANDELL: She hasn't been sworn.

MR. FITZGERALD: -- oh, right. So she can't --

MS. RANDELL: We need Mr. Haines.

MR. JOHN HAINES: I would be happy to do that. Ms. Pratico, would you stand and raise your hand?

CHAIRPERSON KATZ: Just before we do that, do we have the spelling -- we'll do that after. Go ahead.

(Witness sworn)

CHAIRPERSON KATZ: Can you -- do you have a spelling? Mr. Vanacone, do you need --

COURT REPORTER: All set.

CHAIRPERSON KATZ: -- okay. So we're all set on that. Anything else procedurally we need to do?

MR. FITZGERALD: Is Exhibit -- what has been marked Exhibit 112 for identification a true copy of your curriculum vitae and is the information in there true and correct to the best of your knowledge Ms. Pratico?

MS. ELIZABETH PRATICO: Liz Pratico. Yes it is.

CHAIRPERSON KATZ: Thank you.

MR. FITZGERALD: I'll offer it as a full

exhibit?

CHAIRPERSON KATZ: Any objection to making 112 a full exhibit? Hearing none --

(Whereupon, Applicant's Exhibit No. 112 was received into evidence as a full exhibit.)

MR. FITZGERALD: Copies will be on the table for those who are interested.

CHAIRPERSON KATZ: Okay. Yes. I would like to make sure our consultants get copies of these resumes. Okay. Anything else we need to do?

MS. RANDELL: No.

CHAIRPERSON KATZ: Okay. Mr. Cunliffe? Just before he utters his first words, we roughly have about half an hour. We will do that and then we'll take a break at noon and then we'll resume this promptly at 1:00 o'clock. If there's any questions that you want the Applicant to maybe give some thought over lunch Mr. Cunliffe try to get those in before -- some of them at least in before noon.

MR. FRED D. CUNLIFFE: Has GE ever done harmonic analysis studies for any other utility?

MR. WALLING: Yes, it has.

MR. CUNLIFFE: And have they done it for underground cables?

MR. WALLING: Yes. Underground cables have been included in other studies.

MR. CUNLIFFE: Do you know of any of the distances that were being analyzed for those cables?

MR. WALLING: I cannot say exactly, however nothing approaching this -- a similar situation.

CHAIRPERSON KATZ: Define, this?

MR. WALLING: The Applicant's plan.

MR. CUNLIFFE: Thank you.

MR. WALLING: Nothing similar to the Applicant's plan.

MR. CUNLIFFE: What studies have you done on harmonics and what do they show?

MR. FITZGERALD: Excuse me. Do you mean in this -- related to this docket?

MR. CUNLIFFE: Yes.

MS. PRATICO: Okay. We have done quite a few studies starting with a feasibility study, dated March 2003. Then there were studies for Phase One in June 2003. Some follow on work to that in October. There was a study of Middletown and Norwalk project in November 2003. A study of an alternative to that, which had additional 40 miles of cable in November 2003. There was another alternative looked at with additional 20 miles of cable in December 2003. And there were in April 2004 studies of alternatives to East Shore. And the results of these studies in terms of harmonics was looking at the resonances that vary, depending on how much cable is in the system and those system resonances also varied somewhat with shunt capacitor banks in service.

And these studies have shown varying system resonances from the existing system as it is today from about 2.9 times normal frequency to about ninth harmonic with capacitor banks out. And including the cables showing that the harmonic -- the resonances in the system moving from about 2.9 harmonic -- or 2.9 times normal frequency lower in frequency in some cases to 2.7, 2.4, 2.2, 2.0, which was the case for the additional 40 miles of cable.

MR. CUNLIFFE: In your presentation this morning you spoke that Connecticut today had a resonance of between 2.9 and nine and now you're telling me your study has determined this?

MS. PRATICO: Yes.

MR. CUNLIFFE: So today's operation is between those resonant frequencies?

MS. PRATICO: Yes.

MR. CUNLIFFE: And the application of the new cables brings it down just to two?

MS. PRATICO: That was the study which had Bethel to Norwalk, Middletown to Norwalk, and additionally 40 miles of cable between East Devon and Beseck, which resulted in resonance at two second harmonic.

MR. CUNLIFFE: Alright. So if I take out the Beseck to Middletown, what is the resonance in the system?

MS. PRATICO: Without the additional 40 miles then it's 2.4.

MR. CUNLIFFE: And what is the goal?

MS. PRATICO: Which is -- that's with all the capacitor banks in as well.

MR. CUNLIFFE: Is the goal one?

MS. PRATICO: No.

MR. CUNLIFFE: No?

MS. PRATICO: A higher -- generally a higher resonance in terms of frequency is better. In general.

MR. CUNLIFFE: Is the system designed for 60 Hz? And you're telling me a second harmonic would be 120 Hz? Is that my understanding?

MS. PRATICO: The system voltage is 60 Hz, but what we're talking about in terms of resonance is dependent on the characteristics of the system. It's not the same as the voltage that it operates at, that should be 60 Hz.

MR. CUNLIFFE: I'm trying to get to what the goal is. My understanding is, is it the two?

MS. PRATICO: No.

MR. CUNLIFFE: Or is it higher?

MS. PRATICO: Operating today without capacitor banks in the resonance is around 9^{th} harmonic.

MR. CUNLIFFE: Is that where we should be?

MS. PRATICO: That's a nice place to be.

MR. CUNLIFFE: Okay. So we need to move in that direction. The system needs to be designed so that we're operating at that level, is that correct?

MS. PRATICO: You don't necessarily have to be at 9^{th}, but I was saying that that's the right direction.

MR. CUNLIFFE: Alright. Is there an optimum harmonic?

MS. PRATICO: Not necessarily.

MR. ZAKLUKIEWICZ: I think in response to your question Mr. Cunliffe clearly when you look at the presentation made and we look at what is the operating harmonic, or what is the design harmonic of an electrical power grid in areas you saw from that one slide where we would be with the proposed project and where we would be with additional underground and where the companies' proposal would be relative to what we believe is the design characteristics of other operating systems in the United States and we believe also in the world. And clearly to our knowledge there are no other systems in the United States operating below the natural frequency, which could be for combinations of generation on, capacitors on, trying to supply load down below the 3rd harmonic. And we've already testified to this saying that we are moving in a direction which is unprecedented in the industry.

When you asked the question what is the ideal, I think the ideal would be to have an all overhead transmission system because then you do not get into the harmonics issues because the capacitance of an overhead transmission line is significantly less than what it is for a cable system of similar capacity. I say similar because unless we install multiple cables in parallel it will never have the same current carrying capability. So I hope that response to your question --

MR. CUNLIFFE: Thank you.

MR. WALLING: I'd like to also add if you look at slide number seven from my presentation, although this is a somewhat simplified representation and not necessarily the southwest Connecticut system it's exemplary in showing that the system risk basically shown by the blue line up at the higher -- when the resonance of the system is at higher multiples it's relatively insensitive. So it's not a critical factor there. However, when the natural frequency of the system gets down below a certain point you have an increasingly -- an increasing rate of accumulation of risk as you go lower and you're sort of coming to a cliff, it's not exactly a sharp cliff, but a rounded over cliff that you're just progressively getting more and more risk. And I believe this indicates that.

MR. CUNLIFFE: And then a strong system would incorporate both generators and tightly woven transmission grid?

MR. WALLING: That's correct.

MR. CUNLIFFE: What is your understanding of what southwest Connecticut is operating under today and what assumptions have been made for the future?

MR. WALLING: The amount of generation in southwest Connecticut is -- there is a relatively small number of generating units operating as we also see in the future that there'll be less needed to operate from an economic basis. The system is not as strung out as something out in the great plains, but it's neither -- is not also the same kind of a tightly meshed system as you might have in Manhattan. So it's in terms of strength it's moderate and heading weaker by economic forces and -- but the amount of cable being added here is very large and this is what raises these questions of risk.

MS. PRATICO: I do want to also point out though that when the 345 kV loop is closed there is some system strength that's added to the system.

MR. CUNLIFFE: Will the system become weaker as this -- if this project were to be developed?

MR. WALLING: There's two factors here that are somewhat in opposition. One, adding transmission tends to strengthen the system, so adding the cable strengthens the system. However, economically it tends to also cause units to be decommitted, generating units to be decommitted and that works in the opposite direction.

VOICE: How does --

CHAIRPERSON KATZ: No, please. Can you

hold off?

VOICE: -- yeah.

MR. CUNLIFFE: How do the units become decommitted if they see a line coming in that they could actually utilize?

MR. WALLING: My understanding -- I'll prefer to defer to NU in terms of that.

MR. ZAKLUKIEWICZ: I think Mr. Cunliffe the issue here is, is as we testified by completing the loop, the 345 kV loop into southwest Connecticut we were making available to southwest Connecticut the ability to transfer additional power into the southwest Connecticut region. If you recognize today the transfer limit is somewheres between 2,150 and 2,600 and with the loop our projections are that the transfer limit will be somewheres between 3,000 and 3,400. That allows a greater transfer into the southwest Connecticut area. That means that a greater portion of the load in southwest Connecticut can be served by generation outside of southwest Connecticut and could be served by generation outside the State of Connecticut, or even outside of New England in places like from New Brunswick, from Quebec, or from New York. The generators within southwest Connecticut we all know that generation is extremely old. We all know that it is inefficient and historically, although we cannot predict what the bid -- how they're going to bid their units in the future, we know that from hour to hour in the day ahead market they have historically not been operating because their bid price is higher than what the bid price is for other generation serving all of New England.

So the concern is, is that as we increase the transfers into southwest Connecticut we make it tougher for the existing generation to operate in the system. And long term, as you also know, when we proposed the project we turned around and made available the ability for new generation to connect to the 345 kV system and that was new, larger, efficient generation, such as the Milford generating unit and so forth to connect to the system, which today they cannot do because the 115 kV system does not support that amount of power on the system. So we have a race going on between making available a transmission system which would allow additional efficient lower cost generation to connect to the system who then can compete with other generation in the entire region and hopefully like the Milford unit be such that they would be base loaded and available and operating on the system all the time.

MR. CUNLIFFE: What is GE's perspective on the optimum number of generators and the voltages of the transmission lines, i.e., would -- if they had the right number of generators in the southwest Connecticut area and had the -- would it be a 115 kV system that could support that, or does the 345 kV play a part in bolstering supply to the area and also moving power out of the area? I'm going back to your strong system scenario again, where more generators tightly woven network. It appears that the generators there and the assumptions that are being made that they're going to go away, that means 345 kV appears to be the solution to bring power into that region. If you had the appropriate number of generators operating down there would a 115 kV be appropriate system to continually operate?

MR. WALLING: That's really not what we studied. We did not do a system planning exercise. We basically are -- our scope of study has been on the transient and harmonic issues related to the proposed system.

MR. CUNLIFFE: Thank you. In your studies did you examine methods for mitigating harmonic resonance?

MR. WALLING: We did not specifically

study those. However our experience we have -- I've done R&D work for Electric Power Research Institute, for example on mitigating measures for this. We also are --

MR. CUNLIFFE: Were you asked by the Applicant to propose any mitigation measures in your studies?

MR. WALLING: -- we did not do that, no. We were not asked.

MR. ZAKLUKIEWICZ: I think Mr. Cunliffe, to mitigate the lower harmonics or lower system resonance that we're seeing with the proposed project there's a couple ways to do this. Number one, you can reduce the number of miles of underground installed cables. It can change the type of cable used as you saw in one of the slides in this morning's presentation. HPFF has a charging current, or a charging MEGA VARS of 21 per mile, cross link polyethylene. The requirement is 12 MEGA VARS per mile.

We could turn around and reduce the number of cables we install in parallel between points, meaning Devon to Singer, Singer to Norwalk, instead of requiring two cables in parallel we just install one cable. What does that mean? It increases the risk such that if you have a cable fault that portion of the loop is broken for weeks at a time, which could equal four, five weeks before a repair is made. It lowers the transfer limits into southwest Connecticut because at any given time the operation of the system has to account for the fact that the loop could open as a result of a single failure and now that power that was being transmitted onto 345 has to be transmitted on the remaining 115 kV systems.

Only having one cable in service dramatically reduces the current carrying capability of that piece of the segment recognizing the overhead transmission line as proposed between Beseck and East Devon had a current carrying capability under normal conditions of I believe 36, 3,800 amperes. If we only install one cable we will be down into the 1,000 ampere range of approximately -- that equates to approximately 650 megawatts. It limits the amount of generation that can be installed in the area if we were only to install a single cable.

It defeats what we were trying to do to provide a transmission system which then allows competing generation to connect onto the interconnected system and anytime you have to worry about the single loss of a facility such as if we only put a single cable in must run generation would be scheduled on day in and day out and Connecticut rate payers would have to absorb the must run cost of running this generation because you cannot afford then to have that cable, the loop, opened up as a result of a single contingency.

The other way to do this is to increase the strength of the system and you can increase the strength of the system by adding significant amounts of generation into southwest Connecticut. Our preliminary indications are that you'd need somewheres between two and 5,000 megawatts of base loaded units. And ensure that they're basically online 24 hours a day, seven days a week because the capacitance of the cables is still there irrespective of what the load is and you would need some additional overhead transmission lines to the area.

So those would be the mitigation factors. There are no other factors, or mitigating factors that can be added to the system.

MR. CUNLIFFE: Mr. Walling, you said you did studies for EPRI on harmonic mitigation, is that right?

MR. WALLING: That's correct.

MR. CUNLIFFE: And what methods are used, or that you found in your study?

MR. WALLING: Well, you could use harmonic filters at times to mitigate discreet harmonic frequencies. Typically these are applied at higher orders. As you get down closer to the fundamental it gets more and more problematic. We were pursuing in this research filter that would counteract the effect of transformers in rushing after a fault clearing and found that such a filter would be extremely large in terms of cost and in terms of expansive space required to accommodate that filter.

Also the transient behavior -- there's really two issues here and I want to -- there are things related that are truly harmonic and that's related to things that are at integer multiples of fundamental frequencies. There's also the aspect of you have a low frequency natural resonance of the system. A harmonic filter, or any filter put into a system introduces a new resonance at a frequency below the point at which it's tuned. If you put a harmonic filter in tune to the 2nd harmonic you would have a new resonance created below the 2nd harmonic, which we believe is also introducing a problem to the system.

So you're basically taking away a problem at one place and creating a different risk elsewhere. Also because the EPRI research was focused towards a single location, in that case it was a AC/DC converter station isolated by itself, we have a situation here where there's transformers all through the southwest Connecticut system and such filters would need to be applied at every -- near every transformer location. So you're talking about a large facility, a large amount of equipment that is very difficult to design multiple places and then probably have a very incomplete solution, possibly introducing new problems.

MR. ZAKLUKIEWICZ: I think Mr. Walling broke the -- Chairman Katz's ground rules. EPRI is Electric Power Research Institute, so we all clearly understand using the acronyms.

MR. WALLING: I used it the first time.

MR. ZAKLUKIEWICZ: The second item there that Mr. Walling needs to be made clear to the Commission is that you need filters at virtually every point of source injection. So where you have transformers injecting second harmonic current upon energization and upon deenergization in particular, we're talking multiple harmonic filters on the system, it's not well, let's select one point and we'll install this second harmonic filter. They would have to be installed because of the size of each of the auto transformers, 345 to 115 kV system. You'd need multiple harmonic filters at those locations. Where we're talking the HVDC terminal in New Haven we would analyze that facility and install the appropriate because it's unique and one of a kind on the system there would be a harmonic filter if necessary installed at that location for that harmonic current injection source.

But I just want to make it clear that we're not just talking let's install one of these devices on the system, there would have to be multiples. And if Mr. Walling does not agree with that comment he can so comment now.

MR. WALLING: I believe that's a reiteration of what I had just said, that multiples would be needed.

MR. ZAKLUKIEWICZ: Okay.

MR. WALLING: Also recognize that a harmonic filter at the normal frequency appears like a capacitor bank and provides MEGA VARS to the system, whether you want them or not because they have to be on all the time if you were to apply that solution you would not need those MEGA VARS during light load situations you would have to also install other equipment to dissipate that MEGA VAR generation. So you're creating another problem from that standpoint as well.

MR. CUNLIFFE: The technology you speak of that you were working with, EPRI, is that available?

MR. WALLING: It was included in an EPRI report and never as far as I know was ever built. It's quite -- of questionable practicality.

MR. CUNLIFFE: And Mr. Zaklukiewicz, how many 345/115 kV transformers are located in southwest Connecticut?

MR. FITZGERALD: Now or if the project --

MR. CUNLIFFE: Today.

MR. ZAKLUKIEWICZ: -- today. Plum Tree has two, Frost Bridge has one, Southington has four, East Shore has two. With the proposed project that goes up significantly with the proposal.

MR. CUNLIFFE: Give me a number?

MR. ZAKLUKIEWICZ: Norwalk would have two autotransformers. East Devon would have one or two autotransformers. Singer substation would have one and a spare.

MR. CUNLIFFE: Is that through? Is that spare portable?

MR. ZAKLUKIEWICZ: Two at Singer, excuse me.

MR. CUNLIFFE: Two, but no spare?

MR. ZAKLUKIEWICZ: Two at Singer and there's probably going to be a spare not energized in the area.

MR. CUNLIFFE: Is that a portable one that can be mobile? That we can take it to another location where you only had one?

MR. ZAKLUKIEWICZ: No, it wouldn't be a portable. It would be a --

MR. CUNLIFFE: No? Stand alone?

MR. ZAKLUKIEWICZ: -- physical transformer ready to be energized if necessary.

MR. CUNLIFFE: Thank you. In the study option were two cable sections of 10 miles each and an overhead section of 14 miles a seven percent series reactor between Devon substation and Devon cable bus was added. This reactor was not included in the single option of 40 miles between Beseck and Devon. Why not? Why was this not included?

MR. ALLEN SCARFONE: Allen Scarfone. The --

COURT REPORTER: I'm sorry. Would you state and spell your name?

MR. SCARFONE: Allen Scarfone. The seven

percent reactor in the single line was for thermal power flow reasons. Can I just confer with Liz on the rule?

CHAIRPERSON KATZ: Off the record.

(Off the record)

MR. SCARFONE: S-C-A-R-F-O-N-E. I believe the seven percent reactor was in both studies and we will verify at lunch whether or not it was normally open in one of the studies.

MR. CUNLIFFE: Okay. And would the added reactor in the 40 mile section change the resident frequency?

MR. SCARFONE: I'll have GE comment on the change in resonant frequency. I'd just like to point out to you that that seven percent reactor has been replaced with a new design of four two percent reactors located at East Devon in Norwalk. So that seven percent reactor is going to be replaced with four two percent reactors.

MR. CUNLIFFE: And did you study the harmonic resonance with that configuration?

MR. SCARFONE: GE has not. They've been concentrating on the towns' analysis.

MR. CUNLIFFE: Was the dampening of the 2nd harmonic in the system considered using dampening filters in place of the shunt reactors?

MS. PRATICO: No, it was not.

MR. CUNLIFFE: And is there a reason why that wasn't considered?

MR. WALLING: A shunt reactor does the opposite of at fundamental -- at normal frequency opposite of what a filter would do. A filter would provide MEGA VARS, a shunt reactor is intended to consume MEGA VARS. In normal situations the cable is producing far too many MEGA VARS for the system -- than the system needs and it needs to be consumed. Using a filter instead of a reactor would do the opposite of what's needed.

MR. CUNLIFFE: Thank you. This would be a good break Chairman.

CHAIRPERSON KATZ: Thank you Mr. Cunliffe. We will resume promptly at 1:00 o'clock.

(Whereupon, a one hour lunch break was taken.)

CHAIRPERSON KATZ: We have much to cover, I'd like to get started. Let us resume. Any procedural matters we need to do before cross examination continues? Hearing none back to you -- yep?

MS. RANDELL: Mr. Scarfone has a correction.

MR. SCARFONE: Not a correction, a clarification.

MS. RANDELL: A clarification.

CHAIRPERSON KATZ: Go ahead Mr. Scarfone.

MR. SCARFONE: In the 20 mile case we asked GE to model the seven gnome reactor. In the 40 mile case that was very limited sensitivity, a very limited scope of analysis. And if you notice in the conclusion they did not I believe specifically did a case with the seven gnome reactor. But I would like to point out that that seven gnome reactor is no longer in our plan, the seven percent reactor is no longer in our plan. That reactor was very problematic with the existing cable design.

We now have to go to right now how it stands per the application for two percent reactors at East Devon and Norwalk. So I'd just like to point out to you that seven percent reactor is no longer there.

CHAIRPERSON KATZ: Okay. Mr. Cunliffe, if you want to follow up on that or go back to something else, go ahead?

MR. CUNLIFFE: Now that you made that clarification does that require you to run new transient studies?

MR. SCARFONE: Yes, at our expense.

MR. CUNLIFFE: And that would be done prior to the conclusion of the hearing process?

MR. SCARFONE: I believe that will be done after we conclude the towns' analysis. I'm not quite sure when the towns' analysis is going to be complete, but as soon as we finish the towns' analysis we'll have GE get back onto our new design.

CHAIRPERSON KATZ: We'd like it pre-filed by July 19th.

MR. SCARFONE: Madam Chairman, I don't think that's possible by July 19th.

CHAIRPERSON KATZ: We will have a post-hearing conference and we will discuss it at that time.

MR. CUNLIFFE: I just want to be clear that the harmonics that you've determined between 2.9 and nine, that's for the way the system is operating today, is that correct?

MS. PRATICO: That's correct.

MR. CUNLIFFE: And with the proposed project it goes down to 2.4, is that right?

MS. PRATICO: We haven't totally studied the proposed project, which includes those series reactors. But in the similar study, which had the seven percent reactor, it went down to 2.4.

MR. CUNLIFFE: And the additional 20 miles goes to?

MS. PRATICO: That was 2.2

MR. CUNLIFFE: And the total underground?

MS. PRATICO: The 40 mile -- with the additional 40 mile was 2.0.

MR. CUNLIFFE: Thank you. You had spoken about shunt reactors or filters and you said you could only either use one or the other in your design of the system, or -- is that right Mr. Walling?

MR. WALLING: I would not -- no, you can use them simultaneously. However, adding filters does not fulfil the function that a shunt reactor fulfills. So in addition if you add a filter you would need the shunt reactor to compensate for the 60 Hz VARS produced by the filter as well as put a filter in for -- put a reactor in for the other need as well.

MR. CUNLIFFE: So they can be used in combination?

MR. WALLING: They can be used in combination.

MR. CUNLIFFE: And then there was some talk about the filters being spread about the system in order for it to be balanced. Do we need them at all, 345 1kV autotransformers or are they only really needed where the cable is located and it's termination points?

MR. WALLING: That really needs to be studied. I can't really speculate that far.

MR. CUNLIFFE: Is that something that the company was considering, to find out if that is a doable proposal?

MR. ZAKLUKIEWICZ: Mr. Cunliffe, I think that there's one item that needs to be clarified here. Even though we install these filters, harmonic filters, recognize that every time the system changes, every time you add additional generation onto the system, or add another transmission line that filter there needs to be either replaced or modified. So it's a point in time as to what the harmonics are that you're trying to tune that harmonic filter to and as the system perimeters change so does the frequency that you're trying to filter. So keep in mind that it's a snapshot in time and it's going to change as generation -- a new generation is added to the system or removed.

MR. CUNLIFFE: Is there other equipment that gets changed out because there's changes in residents besides these filters? What I understand is what Mr. Zak is saying is that if I put these filters in place they're fine tuned to the way the system will be operating the day it gets installed. But then a generator comes online and now you've got to go back to the drawing board, is that the idea?

MR. WALLING: It may change the rating of those filters and the filters may have to be designed differently for that.

MR. CUNLIFFE: So it's very important to know what generators will be online and what will be off at the time you design the system prior to construction?

MR. WALLING: It's more than generators. It's everything effecting the resident behavior of the system. So it's generators, lines, fastener banks.

MR. CUNLIFFE: Alright. So everything that needs to be identified for either correction or knowing that the generator will be there?

MR. WALLING: Filters would be a non-robust solution. By non-robust meaning it would tend to be custom fit to a certain situation. I'm not even implying necessarily it would work right there and because it's sort of a Band-Aid type approach that changes in the system as Mr. Zak has pointed out, requires re-addressing it. It's not a type of solution that has the characteristic of needing little change for significant changes in the system.

MR. SCARFONE: And Mr. Cunliffe, that's very problematic concerning the generation in southwest Connecticut. I think Mr. Zak testified at the last meeting Devon eight is retired and Devon seven may retire at the end of the summer. So that -- knowing what's going to be on in southwest Connecticut with respect to generation is like going to the casino.

MR. CUNLIFFE: This is the worse case that you proposed?

MR. SCARFONE: I can't say that for a fact.

MR. CUNLIFFE: And these proposed changes of these filters that would not constantly need to be addressed wouldn't that also be true under the proposal as it stands today?

MR. WALLING: I believe our results indicate that the proposed system appears to be operable and the negative effect consequences are not so severe as to require that degree of mitigation.

MS. PRATICO: I just want to clarify that we haven't really studied the proposed system, that we've studied the one with the seven percent reactor.

MR. WALLING: That's right.

MS. PRATICO: So that's what Reigh's comments are referring to.

MR. CUNLIFFE: And those are the mitigation measures that you're proposing? Substituting the seven percent reactor with --

MR. WALLING: No, that's not a mitigation.

MR. CUNLIFFE: -- okay.

MR. WALLING: That's for -- that requirement is driven for other reasons.

MR. CUNLIFFE: Alright. Then you've spoken of mitigation measures to the proposal saying it's operable with mitigation measures. Could you identify those?

MR. WALLING: No, I said that the present system to the degree we've studied it we have not determined situations where -- we've not studied the proposed system exactly. We've studied something that approaches somewhat similar to the proposed system and the results of that have not been so severe as to necessitate firmly any specific mitigation measures.

MR. SCARFONE: Mr. Cunliffe, the two percent reactors are for thermal power flow contingencies, not GE&L.

MR. CUNLIFFE: Thank you. And the GE study that -- where the additional 20 miles would be added, your determination used terms of no fatal flaws, do you recall that?

MS. PRATICO: Yes.

MR. CUNLIFFE: What is your definition of no fatal flaws?

MS. PRATICO: Well, an example of a fatal flaw would be something where maybe there's a simulation of a fault case -- fault clearing where it results in some sustained over voltages. That type of scenario is very difficult to mitigate as opposed to energizing cases where you can use pre-insertion resisters and circuit breakers for example to help control these results in switching transients. So a fatal flaw may be something where you have a fault clearing case that shows very high sustained over voltages that are difficult to mitigate.

MR. CUNLIFFE: Thank you.

MR. WALLING: I would say the threshold would be results indicating a clear and present danger to other utility equipment. It's very hard to put a finger on the tolerability of customer-owned equipment because industry standards are very poorly defined in that regard in terms of the degree to which customers' equipment can tolerate over voltage events. There are only some rough guidelines that are not really in the form of any true standard.

Also we studied the bulk transmission system, we did not study down to the consumer level or down to the distribution level. There is a phenomena of magnification that's been reported and can occur where results can be significantly worse at some other point in the system, particularly at a lower voltage operating voltage level due to a coupled resident circuit situation that has been -- has been reported in the literature. We've seen it in various studies from time to time. So we cannot guarantee that the voltages that we see at the modeling simulation of the bulk transmission level and it's truly indicative of what customers will be subjected to. It could potentially be worse.

MR. CUNLIFFE: Could it be better?

MR. WALLING: It could be better from the standpoint that some devices, such as motors, tend to provide a little bit of strength or stiffness down at the operating voltage level. Again, that has not been studied. It could be better, could be worse.

MR. CUNLIFFE: If I could move and segue into the characteristics of an XLPE cable, which you provided in your presentation. The amount of energy to operate is less than that of an HPFF, almost in half, is that correct? From 21 to 12 MEGA VARS per mile?

MR. WALLING: That -- the shunt charging MEGA VARS is significantly less. That's correct.

MS. RANDELL: Madam Chairman, if there are going to be extensive questions on XLPE we do have Jay Williams here with us today.

CHAIRPERSON KATZ: Please bring him up?

MS. RANDELL: And we're getting him to the table now.

MR. CUNLIFFE: Mr. Gregory is here.

CHAIRPERSON KATZ: Mr. Williams and --

MS. RANDELL: And Mr. Gregory is here as well.

CHAIRPERSON KATZ: -- and they've both been sworn, correct?

MS. RANDELL: Yes.

CHAIRPERSON KATZ: Ms. Pratico can you lend your mic. to -- thank you. Okay. Let's repeat the question Mr. Cunliffe?

MR. CUNLIFFE: The amount of MEGA VAR charging required for an HPFF line is 21 MEGA VARS per mile versus an XLP, which is 12, is that right?

MR. JAY WILLIAMS: Yes.

COURT REPORTER: Please identify yourself?

MR. WILLIAMS: I'm sorry. Jay Williams. And the answer is yes.

MR. CUNLIFFE: Mr. Zaklukiewicz, the proposal does not include any XLPE cable, is that right?

MR. ZAKLUKIEWICZ: That was correct.

MR. CUNLIFFE: In Docket 217 did you propose a XLPE 345 kV alternative?

MR. ZAKLUKIEWICZ: Yes, we did.

MR. CUNLIFFE: And did you not testify that that was a viable system to implement?

MR. ZAKLUKIEWICZ: In Docket 217 we identified the use of cross link polyethylene in a porpoising mode of keeping the distance in which XLPE is installed to five miles or less. Alternative F-3 in Docket 217 was an all underground cross link polyethylene solution, which basically resulted in two independent all underground transmission circuits.

MR. CUNLIFFE: Why was it not considered under this docket as a potential alternative?

MR. ZAKLUKIEWICZ: I think from prior testimony the HPFF is a more reliable cable, recognizing the distances are eight miles from East Devon to Singer and approximately 16 miles from Singer to Norwalk. And it's extremely critical of the maintaining the reliability and the availability of the circuits between Singer and Norwalk and Singer and East Devon for the reasons previously testified to, which was the connection of generation onto the 345.

MR. CUNLIFFE: Thank you. Are the resonance characteristics different for a cross link polyethylene cable Mr. Walling?

MR. WALLING: Well, resonance in a system is a function of capacitance and inductance, so it would be strictly a function of the amount of capacitance, so --

MR. CUNLIFFE: And is there -- is there a difference between those two? Between HPFF cable and --

MR. WALLING: -- in a given circuit with the same sized cable running the same distance the resonant frequency would be less if you used HPFF as compared to cross link polyethylene.

MR. CUNLIFFE: Does that move the resonance higher?

MR. WALLING: Cross link polyethylene would serve to increase the resonant frequency and our general results indicate that that is somewhat of a lower electrical system consequence. However, there are other consequences that Mr. Zak has pointed out.

MR. CUNLIFFE: Was any --

CHAIRPERSON KATZ: Mr. Cunliffe, do you need a moment?

MR. CUNLIFFE: -- yeah.

CHAIRPERSON KATZ: Off the record for a moment.

(Off the record)

MR. CUNLIFFE: Back on the record.

CHAIRPERSON KATZ: On the record.

MR. CUNLIFFE: If you were to substitute the proposed HPFF line with an XLPE line would that allow for a better operation under the resonance scenario?

MR. WALLING: One has to be a little bit careful of the global macro trend is towards greater risk at the lower resonant frequency substituting HPFF for -- or substituting cross link polyethylene for HPFF would follow that trend line towards a lower electrical resonant risk situation. However, as I pointed out before, the behavior of the system as a function of small changes along there is somewhat irregular and on a case by case basis it could potentially make things better or worse as you make such a small move.

MR. CUNLIFFE: You would not determine this until a study was done, is that right?

MR. WALLING: Could not come up with firm things until a study is done. And remember also that a study -- the true answer would have to look at the whole global view of all the different configurations and it's a very -- it has to almost be viewed in a statistical manner.

MR. CUNLIFFE: Has the proposal been viewed under those multiple scenarios?

MR. WALLING: We have not done separate studies with different cable types.

MR. CUNLIFFE: I'm asking did the HPFF go through your multiple scenario studies? Just as you said the XLPE would need to go through in order to determine it's effectiveness?

MR. WALLING: We did a large number of simulations of the design using HPFF.

MR. CUNLIFFE: But not for XLPE?

MR. WALLING: Not for XLPE.

MR. CUNLIFFE: If you were to extend that XLPE to the other segments, the other 20 and the other 10/10 scenario with the 14 overhead, would that not be possible?

MR. FITZGERALD: Excuse me.

MR. CUNLIFFE: More possible than HPFF?

MR. WALLING: Possible from what standpoint?

MR. CUNLIFFE: Operable?

MR. WALLING: There are aspects of operability that are outside of my scope. My scope has been related to the resonant and transient behavior aspects and it could be studied both to the same degree HGFF is. Regarding other aspects of reliability and operability that I have to defer to Mr. Zak on.

MR. CUNLIFFE: Mr. Gregory, in Docket 217 you provided a table that summarized faults?

MR. BRIAN GREGORY: I did.

COURT REPORTER: Mr. Gregory, could you just give me your name again please and spell it?

MR. GREGORY: My name is Brian Gregory, G-R-E-G-O-R-Y.

MR. CUNLIFFE: Chairman, the study tables -- or the tables that were presented to us in Docket 217 was Exhibit No. 38 that had these tables of faults and leak rates for XLPE and HPFF and SCFF cables. I would like to bring those into the record?

CHAIRPERSON KATZ: I believe we've taken

administrative notice of the entire docket, but we will note that you're going to ask questions on those specific exhibits.

MR. FITZGERALD: They were also included as an exhibit to an interrogatory response I believe.

CHAIRPERSON KATZ: On this docket?

MR. FITZGERALD: In this docket.

CHAIRPERSON KATZ: Okay.

MR. CUNLIFFE: Thank you. Could you explain your contribution of that table? What did you rely on, what was your data that you relied on to develop that table?

MR. GREGORY: Yes. As I recall I put that on record of where I got it from. The HPFF data was given to me by NUS, which was a U.S. industry collection of HPFF operating experience up to I believe 1986 from inception of 345 kV. The self-contained fluid-filled information, up to 400 kV was based on a study that was done in the U.K. by the manufacturers Pirelli and BICC and that would be about the year 1995 from their inception in the 1960's. Also I looked at a CIGRE working group document that looked at the incidence of outages due to both oil leaks and to faults on SCFF cable. On XLPE cable I used information that came from my knowledge as Chief Engineer of BICC and the involvement that I had with certain electricity utilities who had experienced faults.

MR. CUNLIFFE: Would those faults -- were those faults part of a test of the system or were those faults after the commissioning of a line?

MR. GREGORY: The majority of the faults, and I have my notes here but I would need to look at them, were on lines in service, but recently in service as in energized, but within months on operation.

MR. CUNLIFFE: These would not be ones that were in your tutorial that speaks to XLPE, you talked about other operating lines around the world, most of the ones that you qualified were those that had faults prior to commissioning. Now you're testifying that these were -- these numbers in this table are relied on from your experience to cables that were just commissioned?

MR. GREGORY: No. You said that.

MR. CUNLIFFE: I asked the question, was the data in here based on cables prior to or after commissioning?

MR. GREGORY: The data was based on both. So if a circuit was undergoing it's commissioning tests, for example the AC withstand test and failed that was included. If it was then energized and in service that was included.

MR. CUNLIFFE: Well, why would you want to include those faults prior to a line being commissioned if that's going through a test -- if it's going through a test?

MR. GREGORY: It's still a failure and it still has a serious implication on the date of energization of the circuit and at the time of repairs and the cost of repairs and the implications that that failure could have been -- the cause of it could have been repeated either in the manufacture of the cable in other lengths, or by the jointer that made that particular accessory could have made many other accessories.

MR. CUNLIFFE: Do you know what voltages that these lines were operating at?

MR. GREGORY: The statistics were taken from a range of cable systems. I'd need to look at my notes because I had them listed. From memory they were 230 kV and above, but I would need to check.

MR. CUNLIFFE: Any of them at 345?

MR. GREGORY: Those ones, no. But there have been 345 kV failures since, which are not in those lists.

MR. CUNLIFFE: And what were the length of these cables that you considered, give me a range?

MR. GREGORY: Well, I think probably the recent G-cobble conference listed some typical lengths. So we're looking at in mild terms the longest lengths would be of the old -- of 20 miles and down to about five miles.

MR. CUNLIFFE: And how many years were these cables in operation?

MR. GREGORY: Up to the stage of that -- we're going back now -- I think I gave you this information a year and a half ago.

MR. CUNLIFFE: Yes.

MR. GREGORY: Six -- then I think six years. But again, I would need to look at my notes because I have all of the information down there.

CHAIRPERSON KATZ: Do you wish to give him a moment to look at the notes or do you want to keep going on something else Mr. Cunliffe?

MR. CUNLIFFE: He can look at his notes to confirm his testimony.

CHAIRPERSON KATZ: Do you want to take a moment Mr. Gregory and look at your notes so you can confirm your statements?

MR. GREGORY: Well, if you're going to carry on asking detailed questions about --

MR. CUNLIFFE: No, no. I'm not going to ask you a question is you're looking for your --

MR. GREGORY: -- thank you.

MR. CUNLIFFE: -- you can go off the record if you want.

CHAIRPERSON KATZ: Let's go off the record for a moment and give you a chance to check your notes and then you can clarify any statements you wish.

(Off the record)

CHAIRPERSON KATZ: We're going to have a break around 3:00 o'clock and that will give you and opportunity to take a look. Okay. On the record.

MR. CUNLIFFE: You've conducted a study for high voltage direct current, is that correct?

MR. SCARFONE: I believe yes, we did.

MR. CUNLIFFE: Could you briefly describe what was studied and what was the outcome?

CHAIRPERSON KATZ: Do we need different people at the table Ms. Randall to talk about DC?

MR. FITZGERALD: Yeah, we're just getting --

MS. RANDELL: We're just getting the studies out.

MR. FITZGERALD: -- we're just pulling the study out so we can refer to it.

CHAIRPERSON KATZ: Okay.

(Off the record)

CHAIRPERSON KATZ: Okay. Mr. Cunliffe, do you want to repeat that last question?

MR. CUNLIFFE: Please describe what was studied for high voltage direct current and what was the outcome?

MR. PRETE: We had a Black and Veatch -- is this on? We had Black and Veatch talk -- study the feasibility of a DC link between crossing the Beseck substation in East Devon. The rationale behind the study was to find out if a DC link could be used and meet the needs of the project that are outlined on page G-1 of the application.

MR. CUNLIFFE: I'm going to read a quote here on the first page of the transmittal of that report and it says, "These two substations represent the only two points along the proposed route where the substitution of an HVDC system for the proposed AC system could be made without destroying the integrity of the 345 kV loop." What -- if it's not going to destroy -- what would be destroyed if it wasn't --

CHAIRPERSON KATZ: Rephrase that.

MR. CUNLIFFE: -- yeah. What does this mean?

MR. ZAKLUKIEWICZ: I think -- let me try to clarify -- respond to your question. Placing DC between East Devon and Beseck where you're interjecting generation onto the DC system is not a feasible option. So what we looked at was the locations where it was -- it would serve a purpose and be reliable to install DC. That was a location then between Beseck and East Devon and at the East Devon terminal we would convert from DC back to AC and at that same location that's where Milford and the Devon generating units would interconnect onto the system. Having DC on the rest of the system and having it multi-terminal such that we then have facilities then at Singer and at Norwalk would mean multi-terminal DC facilities, which is not practical and not cost effective to have short runs of high voltage DC.

MR. CUNLIFFE: Besides cost, is there any other reason why the HVDC could not work between Devon and Beseck?

MR. ZAKLUKIEWICZ: Yes. At each location

-- and if you had DC link go from Beseck to Devon and then from Devon to Singer and from Singer onto Norwalk, at each one of those locations you'd have to have converter stations, okay?

MR. CUNLIFFE: I did not ask for that. I asked for an HVDC system between Beseck and Devon, regardless of cost is that a feasible implementation?

MR. ZAKLUKIEWICZ: The answer to that is yes, it's feasible.

MR. CUNLIFFE: Thank you. I believe Mr. Prete might be able to help me and that would in the Cross Sound Cable Docket, the HVDC system implemented there. What's the size parcel for that station?

MR. PRETE: I don't know the exact acreage, but I can get that certainly before 3:00 o'clock.

MR. CUNLIFFE: Alright. Thank you.

MR. WALLING: From the standpoint of system resonance work that we've done we have not studied the DC at GE. However, from my experience with DC, DC converter stations of the convention type require large amounts of shunt capacitor banks to -- both for filtering the higher harmonic frequencies that DC stations characteristically create and to compensate for the rather poor power factor. That combined with the fact that the system on the cable loop, the 345 AC cable loop wouldn't be as strong would tend to complicate those factors which I talked about.

MR. CUNLIFFE: Could a modern voltage source converter technology be implemented to abate that?

MR. WALLING: I've not seen voltage source converter technology offered on the market at that power level.

MR. CUNLIFFE: What power levels are those commercially available at?

MR. WALLING: The only one -- the largest in the world is the one that's not working not too far from here on the tie to Long Island, which I wrote the specifications for that system.

MR. CUNLIFFE: And the voltage?

MR. WALLING: That is plus/minus 150 kV, 330 megawatts.

MR. CUNLIFFE: Thank you.

CHAIRPERSON KATZ: Not working you mean not currently turned on?

MR. WALLING: Not currently in service.

CHAIRPERSON KATZ: Okay. But workable?

MR. WALLING: Workable.

MR. CUNLIFFE: Is it true that the cable footprint of an HVDC system is less than that of the proposed HPFF?

MR. PRETE: Could you define what a cable footprint is?

MR. CUNLIFFE: The trench width, depth in the area where the cables would be laid?

MR. ZAKLUKIEWICZ: Depends on which HVDC technology you're speaking of. If you're speaking of conventional HVDC, which is -- which would operate at 550 kV the answer is yes. If you're talking about utilizing a facility, which is the HVDC like, the ABB, Aza Brown (phonetic), but very light because the system can only operate at 150 kV you're talking four cables to get a 1,200 megawatt transfer. So I would say the cable footprint is probably larger than what it would be for the AC alternative.

MR. CUNLIFFE: By how much?

MR. ZAKLUKIEWICZ: Since we didn't study it I cannot answer that, but if we're talking four sets of cables and I need separation between the cables to dissipate the heat we would be probably talking two trenches separated with two cable systems in each of the trenches.

MR. CUNLIFFE: Is HVDC cable have a black start capability?

MR. ZAKLUKIEWICZ: Do you mean can I turn a HVDC system on black start? The answer is no.

MR. CUNLIFFE: If it was energized could it be a resource to be used as a black start for the grid?

MR. ZAKLUKIEWICZ: If the total grid is down the answer is no.

MR. CUNLIFFE: Define the total grid?

MR. ZAKLUKIEWICZ: If the surrounding AC system in proximity to the DC link is down it can't transfer any power from the AC system if it is at zero. So the answer is it has no black start capability.

MR. CUNLIFFE: Those are my questions and except for those that are still outstanding with Mr. Gregory.

CHAIRPERSON KATZ: Okay. What I'm going to do is I'm going to allow some Council questions at this point and then I want to confer with KEMA and do some follow up. Or Mr. Gregory do you want to wait until after the break I assume?

MR. GREGORY: Yes, if that would be appropriate please?

CHAIRPERSON KATZ: Okay. We'll do that. Let's go to Council questions and we'll start at that end. Mr. Murphy?

MR. JERRY MURPHY: No questions.

CHAIRPERSON KATZ: Mr. Emerick?

MR. BRIAN EMERICK: No questions.

CHAIRPERSON KATZ: Mr. Tait?

MR. TAIT: No questions.

CHAIRPERSON KATZ: Mr. Ashton?

MR. PHILIP ASHTON: I've got a fistful. Mr. -- there was a dialogue --

CHAIRPERSON KATZ: Will you pull your microphone a little closer?

MR. ASHTON: -- sorry. There was a dialogue with Mr. Cunliffe and Mr. Walling to the effect that Mr. Cunliffe asked if you complete the loop does that strengthen southwest Connecticut? Mr. Walling answered yes and no. If closing the loop at 345 does strengthen the system but the loop now allows for removal of generation, get rid of the must run generation so that weakens it. Do the electrical characteristics of the loop itself, of closing it, influence or effect the answer as to whether the system is strengthened? In other words, if you close the loop with overhead or you close it with underground does that effect the answer that you gave?

MR. WALLING: Slightly. Because the series impedance per mile of a cable is typically less than for an overhead line. It tends to provide a little more strengthening to parts of the loop than if it were closed or completed by sections of overhead line.

MR. ASHTON: We've talked about running studies here. Maybe it would be helpful to just back up a little bit and describe how are these studies run? Are these analog studies where you create the system in miniature and then take certain actions to simulate an electrical operation or are they digital studies or just what are they?

MR. WALLING: 20 years ago we would have done it by the analog method of creating a miniature model and I mention that because effectively what we're doing today with digital computer simulation is effectively the same thing. Data is collected from the system, for the system, and the proposed additions to the system, which is reduced down to a network of capacitors, inductances, transmission lines, generators, surge arresters, capacitors, whatever, and this electrical system model is then built and tested, benchmarked against some other separate simulation models that NU might have for example, like short circuit models, which measure the fundamental frequency strength. We compare that and validate our models are close and then we proceed. And then the actual work is done by simulating a disturbance event and we're focusing on phenomena that take place pretty much in less than one second, sometimes in a matter of a few cycles or less. And these are simulated by digital computer simulation model and then we gather the results, which is in terms of voltage and current wave forms and analyze them and make our conclusions from that.

MR. ASHTON: A load flow study takes an instantaneous snapshot of a steady state condition on a system. A short circuit study takes a snapshot of the system's behavior at the time or in the middle of a fault. Does the type of study that you do -- let me back up. A transient stability study tracks the system behavior over a finite, albeit a small period of time. Do the kind of studies you do are they more like a load flow or stability study? Do they track the system?

MR. WALLING: Closer to a stability study. Unlike a stability study where the -- you're only focusing on the fundamental frequency performance and it's done by what we call phaser analysis, mathematical algebraic calculations, it's done by dynamic simulation of everything in the system.

MR. ASHTON: Would the presence of a DC converter terminal at a station influence the -- materially influence the outcome of a transient network analysis?

MR. WALLING: A DC converter station that's taking place of a part of the loop?

MR. ASHTON: No. That's in the loop. For example, there is a DC station as you well realize, it's East Shore.

MR. WALLING: Right.

MR. ASHTON: Let's suppose for the sake of argument that --

MR. WALLING: Alright. We considered that. The response basically those -- that equipment has got a fairly broadband width control that's attempting to hold that as a constant current source, which is a constant current source up to where the control can actually control that. Beyond that it looks like a voltage behind a considerable impedance. The bottom line is, is that the effect of that on the transient phenomena that we are representing is expected and believed to be to the best of our judgement relatively small. There are a lot of other unknowns in the system including behavior of loads and whatever else that are not well defined also. So the -- Ms. Pratico can give the details exactly how we represented it, but it is an approximation that we believe is sufficiently valid.

MR. ASHTON: There is along the shoreline of Connecticut an electrified railroad. It operates at 60 Hz and it serves single phase with power being supplied by a three phase to two phase Scott deconnected transformers at various points. Assuming the load, peak load is on the order of 50, 60 megawatts does that have any material impact on your study of harmonics and that type of thing or is that too much of a too much of a steady state circumstance and doesn't get into the transient magnitudes you find?

MR. WALLING: Well, first of all loads are considered to be of relatively less importance in the transient study world because you are dealing at a higher frequency than loads respond to in general. The -- that particular railroad running 60 Hz single phase, the design of those systems is to try on different train sections to result in a roughly balanced three phase load. And the main factor it contributes is some unbalance in load. It is not really a harmonic source or effect harmonics. However, there is a -- there is a frequency converter station owned by I believe Amtrak and the harmonic filters associated with that converter station are included in at least some of the studies. Ms. Pratico can give details as to that.

MR. ASHTON: Okay. With regard to filter stations am I correct in understanding that each filter for a system, installed on a system would be designed for a specific condition and does that condition vary hourly, daily and so forth so the design is threatened if you will, my word, depending on how much of a variation in conditions exist?

MR. WALLING: The filter is designed to -- typically when you design a harmonic filter you design it for the foreseen range of conditions and it does not effect that much where the filter is tuned. That's usually decided in terms of it's objective that it's trying to perform in the system. However, the rating of the components, the voltage and currents that the filter sees, are a function of the system and usually the system is bounded by some range of perimeters and that's used in the design. However, significant changes to the system can move outside of that range of boundaries and then require the design to be modified.

And if you're particularly considering the resonance problems that have been forecast with regard to lowering the resonance frequency of the system down towards 2nd harmonic bear in mind that the experience in the industry of designing filters down around that range is rather limited and rather of questionable success. There have been in certain HVDC converter stations there have been low frequency resonances down towards 2nd harmonic and filters designed for that operation have a -- been observed to fail partly because the industry does not really have a complete understanding of how to design for that because of the phenomena involved there are different in nature than what you normally design a harmonic filter for. Typically harmonic filters are designed -- for example, let's say you have a rolling mill and you've got constant speed drive motors. They put out typically 5th and 7th harmonic currents at a low level and to meet power quality requirements of the utility the steel mill may be required to put in filters to filter that out.

What you're dealing with the 2nd harmonic is you don't really have a continuous source of that that's of any significant magnitude in the system. What you do have though are short-term sources coming from transformers that become saturated by faults and so forth and it becomes a very large duty over a short period of time and a design approach is to design to withstand that temporary situation for a period of time. But then you have to start making assumptions as to how quickly such an event might repeat itself because a lot of thermal effects for example in a component would be cumulative. And you get a lot of -- it's a very different design field as opposed to a steady state, low level filtering task when you're trying to design for a temporary high input situation.

The work I did for Electric Power Research Institute basically was very -- it was a large amount of surge protection equipment required in the filter to protect and make the components be able to withstand the duty and those kind of components are very susceptible to repeating that same event again and so assumptions has to be made. If the actual occurrence in the system is more severe than what your assumption is, you're in trouble.

MR. ASHTON: You used the term, resonance, both in your prepared talk, which is very useful, and just a few minutes ago. I'm not sure everybody understands resonance. I recall a bridge called the

Tacoma Narrows Bridge about 1940 got into a series of very destructive oscillations due to the wind running transversely across it. Is that an example of resonance?

MR. WALLING: A very good example.

MR. ASHTON: Are you familiar with the bridge collapse?

MR. WALLING: Absolutely.

MR. ASHTON: Okay. It's one where it bounced up and down --

MR. WALLING: I didn't think anybody would believe me if I told about it if they hadn't heard about it or seen pictures of it, so I didn't bring it up.

MR. ASHTON: -- it was Galloping Girddy was another name for it.

MR. WALLING: Right.

CHAIRPERSON KATZ: In civil engineering class they make you watch a little video.

MR. WALLING: Okay.

MR. ASHTON: And that's a mechanical resonance where you're talking electrical resonance --

MR. WALLING: That's correct.

MR. ASHTON: -- which is also equally destructive?

MR. WALLING: Yes, it can be.

MR. ASHTON: Okay. Mention was made of changing a seven percent reactor to two percent reactors. Without running a T&A study is there any indication whether that would have a material effect on the strength of the system or the likelihood for problems or so forth?

MR. WALLING: I think the strength can be sort of estimated, but I think the actual effect that it has because it kind of complicates the resonant behavior of the system it would be very difficult to estimate what might happen.

CHAIRPERSON KATZ: When was the change made from seven percent to 4.2 percent?

MR. SCARFONE: This past spring, early spring.

CHAIRPERSON KATZ: So why wasn't the study run?

MR. SCARFONE: I believe we were getting involved in the towns' analysis and completing of other GE studies.

MR. TAIT: I guess the question is how significant is it? To a layman four times two percent is eight percent. And seven percent, is that a significant difference?

MR. WALLING: No. It's not the total

percent, it's the fact that it's broken up and there --

MR. TAIT: Is it a significant difference?

MR. WALLING: -- the change from seven to eight, or seven to four times two is not as significant as the fact that the two percent values are broken up in different locations with cable sections between.

MR. TAIT: Overall is it a significant difference so that we should run another study?

CHAIRPERSON KATZ: Could it change --

MR. WALLING: I would not be confident in results done with one -- with one design and infer that we would have equivalent results with the other design.

MR. TAIT: So it invalidates your earlier study?

MR. WALLING: It would require rechecking results, it would require confirmation to see that the general nature is still in the same --

CHAIRPERSON KATZ: Has that been done since last spring when you found out there was going to be a change? Has anyone gone back to check and see?

MR. SCARFONE: Could you repeat that question please?

CHAIRPERSON KATZ: Last spring when the change was made did someone ask GE to go back and check their results to see if they were still valid based on this change of going from seven percent to 4.2 percent?

MR. SCARFONE: When I mean last spring, I meant this spring.

CHAIRPERSON KATZ: I know that. I'm sorry.

MR. SCARFONE: Okay. We did not ask them. We knew it was on our plate. We were finishing up some East Shore analysis as we've provided to the Council. We also had the towns' analysis moving to the center plate.

CHAIRPERSON KATZ: Okay.

MR. SCARFONE: We knew we would have to go back and do this.

MR. FITZGERALD: Madam Chairman, I can tell you that I have been present at numerous conversations where when Mr. Scarfone and Mr. Oberlin (phonetic) were given new studies to tell GE to run almost every time they would say, well, should they be studying the project or should we tell them to do this new study first? And the answer was always, no, do the new thing first. Defer our work on the project.

CHAIRPERSON KATZ: I guess my point is that it sounds like to complete these public hearings we need both. So the town studies are reflecting the two percent?

MR. SCARFONE: I don't know what the towns are requesting.

CHAIRPERSON KATZ: Ms. Pratico? Yes.

MS. PRATICO: Can I add something?

CHAIRPERSON KATZ: Yes, please.

MS. PRATICO: I want to point out that in most of the studies we've done the reactor has been normally bypassed and it gets inserted under certain contingency situations. And with the new reactor configuration one scenario is that they're normally bypassed and would be inserted, you know, for certain cable outages. So under, you know, under the normal situation where everything is in service with reactors normally bypassed then the studies that we have done would still apply. But there needs to be other studies which would look at the situations where cables are out of service for an extended period of time with these other alternate sized reactors in place and we have not yet completed those studies.

MR. ASHTON: May I inquire a little further along this line? If I came to GE today and said I would like you to run a T&A study of whatever it is, how much lead time would there be before you could start it? Isn't the -- is the T&A heavily booked up?

MS. PRATICO: Well, normally we're doing all our studies digitally.

MR. ASHTON: Yeah. I'm sorry. I go back a few years.

MS. PRATICO: Yeah. The process is that you first need to get all the data from the customer.

MR. ASHTON: Right.

MS. PRATICO: That sometimes takes some time to get that data. Then there needs to be a model developed and then run simulations, do the analysis and write a report. A typical time for that work is like on the order of four to six weeks.

MR. ASHTON: To go -- from the time you say, go, to the time the report comes out?

MS. PRATICO: From the time that we have all the data until the report comes out.

MR. ASHTON: Okay. Is that for one case or for multiple cases?

MS. PRATICO: Well, that's generally for one configuration of a system. Where you're looking at, you know, multiple simulations of different types of switching events and faults in the system. But it's generally to look at one configuration of the system.

MR. ASHTON: Okay. And if I varied the configuration that would be -- that would drag out the completion time, is that fair to say?

MS. PRATICO: That's correct.

MR. ASHTON: In terms of -- I think this is Mr. Zaklukiewicz's question. In terms of materiality and particularly the words of the Act, which is focusing on significant adverse environmental effect, does a reactor at one place versus another have any materiality in this project in your opinion?

MR. ZAKLUKIEWICZ: I do not believe so because we would put sumps in the substations where the reactors are located should we have a release.

MR. ASHTON: And they presumably would be another piece of equipment installed at a terminal station, isn't that correct?

MR. ZAKLUKIEWICZ: Correct.

MR. ASHTON: Ms. Pratico, you mentioned something called pre-insertion resistors. Can you briefly describe to a lay board what that is? What they are?

MS. PRATICO: Pre-insertion resistors are devises that are sometimes included with a circuit breaker. And what they do is they soften the switching transients and when I say that I mean that when the circuit breaker closes the contacts first actually close into a resistor, which is typically about three to 500 elms and it's inserted for about half a cycle on the 60 Hz basis. And then after that time it's shorted out so that the resistor is not in the circuit continuously, it's only in there for a short time. And what that does it it tends to reduce the transients that result from the switching or the closing of the circuit breaker.

MR. ASHTON: In -- Mr. Zaklukiewicz mentioned that DC from Beseck to East Devon is technically feasible and it was sort of a go, no go type of answer as I heard it. Would you care to explore a little bit with me what you mean by feasible? What -- how -- what's the test as to feasibility?

MR. ZAKLUKIEWICZ: Well, if we were looking at the thermal transfer of power from one point to another installing the -- a high voltage DC link between Beseck and Devon can be used to move large blocks of power from one location to another. And the Beseck to East Devon line which has at present no -- no connections in between the two locations and is approximately 30 miles apart, that would be a location that is suitable for HVDC applications. So would it work in this system?

The answer I believe is, yes, it would work in this system.

MR. ASHTON: What grading were you thinking of when you said large blocks of power, quantify that?

MR. ZAKLUKIEWICZ: It would have to be -- it would have to be somewheres 1,200 megawatts or higher. And the reason it would have to be higher is should there be an emergency the loss of the Bethel to Norwalk loop then transfers between Beseck and East Devon could exceed 1,200 megawatts such that then the DC link has no overload capabilities. So it's not like an AC system, or an AC line, which has a normal rating, an emergency rating, which could be a long-term emergency rating or a short-term emergency rating. The DC link at minimum would have to be 1,200 megawatt capability and to cover the cases where you want to transfer and increase the amount of power for a splitting of the loop you would have to have a greater transfer capability of the DC -- HVDC terminals. So you'd probably be looking at an 1,800 megawatt capability for which a good number of the hours in a year it would be operated at much less than 1,200 megawatts.

CHAIRPERSON KATZ: Can I just follow up?

We saw an example of an HVDC cable for Cross Sound. Would the cable that you're discussing now look similar or bigger or smaller?

MR. ZAKLUKIEWICZ: Well, if you used the technology that is in the Cross Sound cable you'd have to either have five or six of those at each terminal because each one is only good for 330. If you used the conventional high voltage DC then you would use equipment that is operating at 550 kV and therefore you would use a terminal then which is rated and would have to do the measurements as to whether we need one cable or two cables for the 1,800 megawatt transfer.

CHAIRPERSON KATZ: If you had to use two cables would they be in the same trench?

MR. ZAKLUKIEWICZ: In all likelihood, yes.

CHAIRPERSON KATZ: Okay. And this trench could go under the streets between East Devon and Beseck?

MR. ZAKLUKIEWICZ: If you were putting the HVDC underground the answer is yes. If it was overhead you'd have a single overhead conductor. On an overhead no different than what you have on the phase two connection between Hydro-Quebec and New England.

CHAIRPERSON KATZ: Okay. From operability wise is there a preference between having the DC overhead or underground, or doesn't it matter?

MR. ZAKLUKIEWICZ: I think one of the big -- one of the big differences is in cost. The cost of an HVDC underground circuit substantially more.

CHAIRPERSON KATZ: More than what?

MR. ZAKLUKIEWICZ: More than an overhead connection --

CHAIRPERSON KATZ: Okay.

MR. ZAKLUKIEWICZ: -- between Beseck and East Devon.

CHAIRPERSON KATZ: More than -- would an underground HVDC be more than an underground AC?

MR. PRETE: Yes. Primarily because of the converter stations that are needed on both ends.

CHAIRPERSON KATZ: Okay.

MR. ZAKLUKIEWICZ: You mean the whole system or were you talking the cables?

CHAIRPERSON KATZ: No, the cables.

MR. ZAKLUKIEWICZ: The cables would be -- would be the cable technology for that voltage would have to be a mass impregnated cable --

CHAIRPERSON KATZ: Okay.

MR. ZAKLUKIEWICZ: -- it could not be solid dielectric.

CHAIRPERSON KATZ: Okay. Assuming --

MR. ZAKLUKIEWICZ: Okay?

CHAIRPERSON KATZ: -- assuming for a second that cost is not a factor to get underground to work, then you would be able to if I understand your testimony it would be feasible to do an underground HVDC from Beseck to East Devon within the system?

MR. ZAKLUKIEWICZ: If the feasibility -- the feasibility would be there if you exclude the cost. Also recognize that the HVDC does not have the instantaneous pick up of a AC system. I think we spoke to that a number of times in Docket 217. In other words, there would have to be manual intervention to increase the transfer on the HVDC terminal. So we need to clearly understand that it's not like an AC system where upon the loss of an element within the system that AC system automatically responds and the transfer increases. This would have to have a measured import say from CONVEX or some other location to increase the transfer should there be loss of generation within say, southwest Connecticut or the loss of another piece of the loop to increase that transfer. In the interim that power flow then would increase on the existing 115 kV system or some other elements.

CHAIRPERSON KATZ: So there's some human intervention is required?

MR. ZAKLUKIEWICZ: That is correct.

CHAIRPERSON KATZ: And is that doable, that human intervention?

MR. ZAKLUKIEWICZ: Is it what?

CHAIRPERSON KATZ: Doable?

MR. ZAKLUKIEWICZ: I think it's -- I think it's feasible although it would have to be studied with a lot of concern over what is the generation that is going to remain in southwest Connecticut such that before you could intervene if we have a voltage collapse of the system it doesn't do you any good later on to try and increase the transfer. So it would have to be studied carefully. It would have to be studied under an extreme number of conditions Chairman Katz to clearly understand the impacts and the ramifications before I would be able to say, yes, I feel comfortable installing HVDC on that link between Beseck and East Devon.

CHAIRPERSON KATZ: Thank you. Back to you Mr. Tait.

MR. PRETE: Chairman Katz, if I could just add on real quickly?

CHAIRPERSON KATZ: Yes, and then we'll go to Mr. Tait.

MR. PRETE: In the Black and Veatch report I'd like to just make a couple of clarifications. And again, we've just asked them for the feasibility. There are two types of HVDC systems. One is called a Classical, one that has been around for many, many years. The other ones we've talked about is like the Cross Sound, which is DC Light. Both have distinct advantages and disadvantages. The classic one as Mr. Zak has testified has been in service and was reliable, but the disadvantages, and again, those are on page 10 of the report talk about the harmonics that are introduced, number one, and it talks about the inability to have instantaneous pick up. Those are very big disadvantages.

The Classic -- or that was the Classic. The one that is Cross Sound or the DC Light, fortunately resurrects those particular disadvantages insofar as being able to accommodate those. They do theoretically have instantaneous pick up and they do not produce harmonics. However, in Black and Veatch's discussion with the vendors, paralleling for these type of systems, realizing that the Cross Sound is 330 megawatts, paralleling for has never been done and they have expressed concerns about that theoretical nature.

CHAIRPERSON KATZ: Okay. After the break we're going to have further cross on those subjects. Back to Mr. Ashton.

MR. ASHTON: I've got a few more questions that I'd like to talk about on this East Devon DC. You mention Mr. Walling that the DC to Beseck and East Devon would not be -- quoting you I think here, this would not be as strong a system. The DC link there. Would you elaborate a little on that please?

MR. WALLING: Okay. Basically a DC system does not contribute short circuit strength through it. It basically allows power flow, it does not provide system strength. So the system then on the cable loop west of that location, south and west of that location would not have the benefit of the cable tie that would have previously gone up to Beseck. So that would weaken the system from that standpoint. And also if conventional DC is used a large amount of capacitance has to be added at both converter stations, which greatly complicates the issues. I mentioned this research we did for EPRI a number of years ago and that was because of the special problems that have been observed at DC stations working in the weak systems with resonant problems.

Most of the body of knowledge regarding this kind of behavior relates to DC stations and that has been a very significant problem and it's been a major factor to drive towards the DC Light technology where it can be used because you don't -- while the DC Light does not contribute substantially to system strength it at least is not vulnerable to some of the problems that conventional DC has in a weak system.

MR. ASHTON: Mr. Zak, you mentioned the Hydro-Quebec tie. Would you describe what that is, even a little bit please?

MR. ZAKLUKIEWICZ: High level, that is a 2,000 megawatt, 600 plus mile DC link between the generation and Le Grand, which is in the Hudson Bay, all the way down to Sandy Pond in air mass. It has a 2,000 megawatt capability, operates at 500?

MR. WALLING: Plus/minus 450.

MR. ZAKLUKIEWICZ: 450 kV and has been in service for --

MR. WALLING: Since about 1987.

CHAIRPERSON KATZ: How many miles again?

MR. ZAKLUKIEWICZ: I'd say it's about 600 plus miles. And basically there are machines at Le Grand which are isolated from the rest of the Hydro-Quebec system, which specifically feed the DC link itself is in a station called Radison and the Le Grand unit feeds specifically into the DC link such that there's separation. So should the Hydro-Quebec system collapse there would still be a transfer from the generators at Le Grand to the United States independent of what's happening on the Hydro-Quebec system.

MR. ASHTON: So this is plus or minus 450 kV, is that correct?

MR. ZAKLUKIEWICZ: That's correct.

MR. ASHTON: And that's a two pole system?

MR. ZAKLUKIEWICZ: That is correct.

MR. ASHTON: And that would be roughly analogous, would it not, to what is hypothetically proposed between Beseck and East Devon?

MR. ZAKLUKIEWICZ: Yes, that would be comparable.

MR. ASHTON: And so what would it -- I'm sorry. What would it require in the number of cables? Would it be two cables per pole, a total of four cables to get equivalent capacity?

MR. ZAKLUKIEWICZ: For an underground system?

MR. ASHTON: Yes.

MR. ZAKLUKIEWICZ: The answer I believe would be yes and it would be two conductors overhead if it was an overhead facility.

MR. ASHTON: Okay. And I think you mentioned -- Mr. Cunliffe asked would the cable footprint not be -- or be as big as the AC and you thought it would not be. And so I'm questioning --

MR. ZAKLUKIEWICZ: Well, I prefaced that by saying which HVDC system are we speaking to? Are we speaking to the DC Light, which has a plus or minus 150 kV limitation or are we speaking of the traditional HVDC, which can be operated at plus or minus 450 or plus or minus 550?

MR. ASHTON: Okay. You anticipated one of my questions and that is what is --

MR. ZAKLUKIEWICZ: And that then changes dramatically how much current needs to flow for the same power level on the cables.

MR. SCARFONE: I might add also for the voltage source converter DC and especially in this age when you're considering energy conservation, whatever that -- there's a very large -- very substantial amount of power loss in the conversion process and the voltage source converter DC as compared to the conventional DC.

MR. ASHTON: I hate to bang away at it, but what does the word substantial mean, can you quantify it? Are we talking five percent?

MR. SCARFONE: Better. Between five and 10.

MR. ASHTON: Okay. So that if you're transferring 1,000 megawatts, 50 megawatts more or less would be involved as line loss -- as loss, is that fair?

MR. SCARFONE: This is not line loss it's converter loss.

MR. ASHTON: Converter loss I should say. Mr. Zaklukiewicz, let's suppose there was a 2,000 megawatt capacity DC link between Beseck and East Devon. In referring back to the blackout last August, what would your -- how would this system probably respond to the kind of circumstances that it was experienced in New England where there were very large sudden swings in and out of New England, what would have happened over this DC tie?

MR. ZAKLUKIEWICZ: My gut tells me that we would have lost the DC tie because of the electronics which control the flows on the DC terminals. Also recognize that when I lose substantial amounts of source at each of the terminals I require that to operate the system. HVDC does not operate on weak systems on either terminal. You need fairly strong AC sources. So where we lost and had the swings, where we lost the generation in southwest Connecticut as a result of extreme under voltages on the system we would have then had probably the HVDC would have shut itself down because of the loss of the source strength on the southwest Connecticut side of the terminal, meaning the Devon side.

MR. ASHTON: So are you intimating that -- intimating maybe isn't the right word. But are you saying that the DC system does not provide the kind of adaptability that a high voltage AC system would in the event of a significant inner system power swings?

MR. ZAKLUKIEWICZ: From my knowledge of systems I would -- I would say that would be -- my gut would tell me without studying it further that's what would happen when I lose the AC source on either side of the DC link. I require that though to -- for the proper operation of the DC link. Other than that if it's lost it shuts down because of the commutation problems that occur in the DC hardware at the terminals.

MR. ASHTON: I wonder if Mr. Walling or Ms. Pratico have any comments in this area?

MR. ZAKLUKIEWICZ: Further check Mr.

Ashton, we would have to check what happened at Shataquay (phonetic) during the same circumstances on August 14th of whether Shataquay was operating and how far up in the New York system did the swing occur.

MR. WALLING: The -- you would have decidedly different response I think from a conventional DC, which is very sensitive to system strength and the voltage source converter DC technology and to lump both together and call them DC, yes, they both transmit their power through direct current. The control and converter technology is so different you almost need to consider those separately when you're asked, you know, in these type of questions. Conventional DC I'm sure would have gone -- worse than tripped off it might have caused horrendous over voltages on the way out with conventional DC. Because you put on huge amount of -- let's say the conventional DC converter station with 2,000 megawatts transfer you might apply 1,000 to 1,200 MEGA VARS of shunt capacitor banks. And they're not compensated with the shunt reactor, they're compensated by the reactor demand of the converter station as the system goes off if those cap banks are still left on while the active demand of the converter goes away you're left with a tremendous fundamental over voltage, which then drives transformers into saturation, which drives the harmonic resonance, which makes a mess. And then you could end up with longer restoration times because now capital equipment might fail as opposed to just the lights going out.

With the control technology for the voltage source converter technology is basically only available from two vendors. It's relatively new. It's only available at lower power levels and the various control techniques and capabilities are relatively proprietary and are being -- are sort of introductory to the market at this point.

MR. ASHTON: When you say lower power levels, again --

MR. WALLING: Well, Cross Sound is the largest load service converter DC project in the world and it was considerably larger than the prior ones before that and that's 330 megawatts.

MR. ASHTON: So that's one sixth of the 2,000 that we have on the Hydro-Quebec tie?

MR. WALLING: Right.

MR. ASHTON: Mr. Zaklukiewicz, do you know if there was any human intervention whatsoever in the power swings that occurred on that August 15th of last fall? Were they just -- did they just happen because of system response to electric -- certain electrical conditions?

MR. ZAKLUKIEWICZ: There was -- to my knowledge there was no human intervention, no one had the capability to analyze what was occurring on the system and to take any measures during the August 14th blackout.

MR. ASHTON: And do you think a human operator at a DC terminal would be in a similar position if there were a major event?

MR. ZAKLUKIEWICZ: No, I do not.

MR. WALLING: I might want to add that most DC terminals are not manned and usually remotely operated from a dispatch center.

MR. ASHTON: One last --

CHAIRPERSON KATZ: Can -- just -- can you have your human intervention being remotely operating?

MR. WALLING: Yes, you could. Yes.

CHAIRPERSON KATZ: Okay.

MR. ASHTON: But can they do it fast enough?

MR. ZAKLUKIEWICZ: My answer would still say no.

MR. ASHTON: One last question. Mr. Walling, go back to resonance. We've talked about the

Galloping Girddy, has resonance occurred on power system and if so what are the effects?

MR. WALLING: Happens all the time. I mean, if we're talking about the kind of situation driven by steady state harmonics what usually happens is power quality problems and failure of relatively minor equipment, the degree of -- we're talking about a different situation here though where we're talking about resonance at a frequency that is driven by transient and large scale events and power systems haven't -- to my knowledge haven't gone down there and so we are estimating that behavior.

MR. ASHTON: Now why haven't they gone down there?

MR. WALLING: The -- well, to go down there you need a huge amount of capacitance and a moderately strength system. There just hasn't been the need to go down there. And because there have been problems also or, you know, expectations of problems.

MR. ASHTON: Is that kind of thing that a power system operator would willing subject his system to?

MR. WALLING: Well, this is usually addressed in the design stage. So the operating people are not usually confronted with that choice because it's not really a situation that the system gets into under normal circumstances.

MR. ASHTON: Well, let me put it this way. Would allowing a system to be subject to significant resonance be considered good system design practice?

MR. WALLING: No.

MR. ASHTON: Thank you. Nothing further.

CHAIRPERSON KATZ: Mr. Wilensky?

MR. TAIT: After that -- Madam Chairman?

CHAIRPERSON KATZ: Mr. Tait, I'm sorry. Back to you.

MR. TAIT: I'm looking at your presentation this morning, the handout on pages eight and nine. I'm trying to incorporate page eight into page nine and maybe it can't be done.

MR. WALLING: Okay.

MR. TAIT: When you say CT -- on page eight has a resonance between 2.9 and nine is that CT-1 or CT-2 on page nine? Or am I just mixing apples and oranges?

MR. WALLING: Okay. Right now the system operates between CT-1 and CT-2.

MR. TAIT: That's today with capacitors

on?

MR. WALLING: At CT-2. Now bear in mind though that --

MR. TAIT: CT-2 is 2.9 to nine?

MR. WALLING: -- yes. Now CT-2 is right around 2.9. CT-1 is at nine. The system varies between those operating points and I also want to point out that it would tend to be infrequently at the CT-2 --

MR. TAIT: Let me move much more slowly than you're doing.

MR. WALLING: -- okay.

MR. TAIT: CT-1 is nine from page eight?

MR. WALLING: Right.

MR. TAIT: CT-2 is 2.9 from page eight?

MR. WALLING: That's correct.

MR. TAIT: CT-3 is what?

MR. WALLING: CT-3 is --

VOICE: 2.7.

MR. TAIT: 2.7. Where is 2.4, CT-4?

MR. WALLING: I believe that --

MR. ZAKLUKIEWICZ: CT-4 is the 2.4.

MR. TAIT: CT-5 --

MR. ASHTON: CT-4 I'm not sure what it is.

MR. ZAKLUKIEWICZ: CT-4 is the MN project with an all overhead Middletown to Norwalk transmission line.

MR. TAIT: CT-4 is Bethel, Norwalk and the Middletown segment overhead, but segment three and four underground?

MR. ZAKLUKIEWICZ: No. All overhead from --

MR. TAIT: All overhead?

MR. ZAKLUKIEWICZ: -- the Middletown area to Norwalk.

MR. TAIT: Okay. All overhead is CT-4. And do you have a number for that? Is that 2.4, 2.7?

MS. PRATICO: The graph shows somewhere around 2.9, but this is approximate. This wasn't based on any studies.

MR. TAIT: CT-3 is 2.7 you were saying?

MR. ZAKLUKIEWICZ: 2.7 with capacitors on and approximately 3.4 with all the capacitors off.

MR. TAIT: Okay. And CT-5 you gave a 2.4 and a 2.0 figure. Where are those plugged in?

MR. ZAKLUKIEWICZ: CT-5 is the proposed project 24 miles of underground between Devon and Norwalk.

MR. TAIT: And that's 2.4?

MR. ZAKLUKIEWICZ: 2.4 with capacitors on and 2.8 without the capacitors on.

MR. TAIT: And CT-6 is the 2 -- you gave a flat 2 for what scenario?

MR. ZAKLUKIEWICZ: We got -- 2 was the MN project as proposed plus 40 miles of underground.

MR. TAIT: Plus 40 miles of underground.

MR. ZAKLUKIEWICZ: Right. And there shows an arrow of it going up.

MR. TAIT: Yes. Okay.

MR. ZAKLUKIEWICZ: And the numbers were 2.0 with the capacitors on and 2.4 with the capacitors off.

MR. TAIT: Thank you. Brief question on DC and EMF's. If DC is buried there's no EMF problem?

MR. FITZGERALD: Mr. Tait, could you --

MR. TAIT: And DC's overhead --

MR. FITZGERALD: -- could you phrase the question in terms of whether there is EMF with the line without using the term problem?

CHAIRPERSON KATZ: Measurable. Right. Is there measurable EMF if the DC is buried? Would you rather we ask that question tomorrow morning of Dr. Bailey?

MR. TAIT: Well, the next question is, what is it when it's overhead, what are the EMF readings when it's overhead? Tomorrow's fine.

MR. ZAKLUKIEWICZ: Okay. We will confirm it tomorrow, but I believe the answer is, there is none.

CHAIRPERSON KATZ: Okay.

MR. TAIT: Either up or down?

MR. ZAKLUKIEWICZ: Either up or down.

CHAIRPERSON KATZ: Please ask Dr. Bailey to be ready for that tomorrow?

MR. ZAKLUKIEWICZ: We will ensure he's prepared to correlate this response.

CHAIRPERSON KATZ: Great thank you. Mr. Lynch?

MR. DANIEL LYNCH: No questions.

CHAIRPERSON KATZ: Okay. What I'm going to do is we're going to take the break a little early because I want to give time for Mr. Gregory to look at his notes and make any clarifications if he wishes and then also Council staff is going to come back with some further cross examination on some of the issues and answers that we've already gotten. And then we'll do that and then we'll allow other parties and intervenors. And then at the end of the day I want to talk about what studies need to be done still. And we need to get a clarification on that.

MR. FITZGERALD: Could we make that what studies need to be done for what purposes?

CHAIRPERSON KATZ: Yes. Because we've been hearing the line frequently, well, we didn't study that.

MR. FITZGERALD: And I think that we'll find that it's always been the case that there have been studies that have not been done until after the docket to determine equipment specifications for instance.

CHAIRPERSON KATZ: That's different. I'm talking about some more major global issues that perhaps have yet to have been studied. Okay. We're going to take a -- I want to start -- I want to resume at 2:50.

(Off the record)

CHAIRPERSON KATZ: Are we ready to resume? Much to cover.

MS. RANDELL: Madam Chairman?

CHAIRPERSON KATZ: Okay. We're on the record. Ms. Randell?

MS. RANDELL: I hesitate to call this housekeeping because that would be Mr. Johnson's job. We have a little more information with respect to the timing of the GE modeling, how long things take, what's in the cue and so on. We can do it at a post-hearing conference --

CHAIRPERSON KATZ: No, let's get it on the record now.

MS. RANDELL: -- I thought you might want that. It is -- it is my understanding that the towns' modeling will be completed somewhere along the -- around the second week of July and that nothing further can be done on other modeling until that is completed.

CHAIRPERSON KATZ: Okay.

MS. RANDELL: Now there is a potential to partially automate the process, and I put that in quotes, such that future models the time would go down perhaps from six weeks to four weeks, give or take. But that work could be done at simultaneously I think with the modeling on the towns. Now when I say, the towns, that is the towns as a group and not separate Milford proposal or the separate Woodbridge proposal, which will not be done and not be started as I understand it until at least the second week of July.

CHAIRPERSON KATZ: Okay. This Council has to make a decision at some point on whether we're having September hearings. So we'll just keep that in mind and we'll get into what we're going to have in the way of homework assignments, etcetera, as things develop. Okay.

MS. RANDELL: One other point to state the obvious. Until the ISO testifies on Thursday it will be difficult to determine what future modeling makes sense and it has become apparent to me that the assumptions are critical and you can't just say, oh, you know, that one you just did, could you change X? And it's not an overnight thing.

CHAIRPERSON KATZ: Well, I would encourage also dialogue between the attorneys for the various parties on what various people's understanding of what you think is the homework that is left, of what studies need to be done in order for this Council to make a decision and what studies could be done later as part of a design of a decision. So I encourage that dialogue. Your jaw is on the floor Mr. McDermott.

MR. BRUCE McDERMOTT: I'll whisper in Ms. Randell's ear. Thank you.

CHAIRPERSON KATZ: Fine.

MR. PRETE: Madam Chair, I had a question regarding the acreage for the converter station out at East Shore?

CHAIRPERSON KATZ: Yes.

MR. PRETE: Consistent with the Cross Sound is 3.9 acres for the substation, converter station, and about another six acres for the easements for underground to get to the water.

CHAIRPERSON KATZ: Okay. And so are you saying it's approximate -- is your testimony that you need approximately four acres to do a converter station?

MR. PRETE: The converter station is the station associated with the ABB solution or DC Light.

CHAIRPERSON KATZ: Right.

MR. PRETE: That's for 330 megawatts worth of transfer capability.

CHAIRPERSON KATZ: Alright. Well, the question is, is there enough acreage at Beseck or East Devon to do a converter station or would you have to acquire more acreage?

MR. PRETE: We would absolutely have to acquire more acreage.

CHAIRPERSON KATZ: And roughly how much more acreage would you have to acquire?

MR. PRETE: The Black and Veatch study shows about 15 acres at both ends of the associated DC line.

MR. ASHTON: Total or incremental?

MR. PRETE: Incremental.

MR. ASHTON: So --

VOICE: What's there now?

MR. PRETE: Now being where?

VOICE: Either end.

MR. ASHTON: East Devon first.

CHAIRPERSON KATZ: East Devon is an empty lot, right?

MR. PRETE: That is correct. The proposal from the company shows an AC substation that would have to be there as well.

CHAIRPERSON KATZ: Right.

MR. PRETE: And then you'd have to somehow put a converter station.

MR. ASHTON: And so what is the total acreage that would be required at East Devon for a switching station and for a converter station on the capacity in the order of 2,000 megawatts?

MR. PRETE: Subject to check, in and around 24 acres.

MR. TAIT: And how much do you own now?

MR. PRETE: None.

MR. TAIT: And how about at the other end?

MR. PRETE: The other end, which would be

Beseck switching station, again, that would need to go into place and the same type of acreage would be needed, which I believe CL&P presently has 30 some odd acres.

CHAIRPERSON KATZ: Okay. And if you went Black Pond to East Devon?

MR. PRETE: I'm sorry?

CHAIRPERSON KATZ: If you went Black Pond to East Devon?

MR. PRETE: Black Pond does not have anything near that acreage.

CHAIRPERSON KATZ: Okay.

MR. PRETE: And I should clarify, at East Devon I believe the parcel that CL&P is presently trying to acquire is in and around 14 to 15 acres.

CHAIRPERSON KATZ: Okay.

MR. ASHTON: Mr. Prete, you said that Black Pond does not have anything like that. I want to be very clear as to what you're meaning of that is. You mean the total in land available at Black Pond would not be sufficient to build a converter station and a switching station? What is it you mean exactly?

MR. PRETE: I mean the present look that we took to find out if we can move physically Beseck switching station up to Black Pond showed us actually carving into the mountain at that juncture. We then talked about the challenges associated with that. To then think that you can put on another 15 acres in my mind doesn't seem that practical.

CHAIRPERSON KATZ: Okay.

MR. ASHTON: So you're saying to be clear, there ain't enough land at Black Pond?

MR. PRETE: Better said.

CHAIRPERSON KATZ: Okay. So what the Council needs to know then is can -- you said more land would have to be acquired at East Devon to do a DC converter station. We would need to know if there was land available, contiguous land available?

MR. FITZGERALD: By available you don't mean -- you don't mean for sale, you just mean there?

CHAIRPERSON KATZ: There.

MR. PRETE: Vacant?

CHAIRPERSON KATZ: Vacant.

MR. PRETE: I believe at the juncture of East Devon there's streets that are actually around the perimeter of that and of course the river on the other side.

CHAIRPERSON KATZ: Okay. Well, we're going to ask you to just look into that and put it in the record and the City of Milford feel free to offer also some thought on that. Now Beseck is in Wallingford and you said you would have to get more land? Or you don't have enough land at Beseck?

MR. PRETE: No ma'am. I believe that the testimony was that there's adequate land from CL&P's point of view owning that land today.

CHAIRPERSON KATZ: Okay. So it's just East Devon where more land would have to be acquired?

MR. PRETE: Yes.

CHAIRPERSON KATZ: Okay. And we'll -- yeah, for this conversation we'll rule out Black Pond. Okay. At this point does that conclude our quote, unquote, housekeeping?

MS. RANDELL: Indeed.

CHAIRPERSON KATZ: Okay. At this point what I'd like to do is go back to Mr. Gregory and follow up -- he's had a chance to check his notes and Mr. Cunliffe, why don't you go back and why don't you start him off on -- why don't you give him a starting point?

MR. CUNLIFFE: We had discussed the fault rate that you had in Table One and you had given us some information regarding your areas of data that you'd drawn on to make up that table. Do you have any comments or corrections to make on your responses earlier?

MR. GREGORY: Thank you and thanks for waiting. The information was prepared just over two years ago and so I've been looking through two years of notes, so I have them here. First of all, just to add to as I mentioned and that is when I was here on the 15th of January 2003 I was asked to prepare by yourselves these comparative fault rates and I think you sent me away out of the room to do some calculations. And when I finished those I gave you a handwritten note, which was subsequently typed, and these gave the references. There were four of them where I took the information from. And maybe the most significant one was a report that my company wrote for EPRI, as a separately funded project and this was report 1001846, called Cable System Technology Review of XOPE EHV Cables 220 kV to 500 kV. It's 360 pages of statistics on XOP cables.

So that's where the information from this came from and part of that information was included in our report, which was put forward on the docket. It's engineering report 117 of the 22nd of December 2001 and this information is directly comparable with the EPRI information.

MR. CUNLIFFE: Thank you. Also on that

same table you speak to SCFF, that's Self-Contained Fluid-Filled?

MR. GREGORY: Yes.

MR. CUNLIFFE: You identified zero faults in a 100 mile segment, is that correct?

MR. GREGORY: 100 mile year segment.

MR. CUNLIFFE: No fault, is that realistic?

MR. GREGORY: Within rounding to .1, .2, I think it's realistic. I think in the --

MR. CUNLIFFE: So there is a small -- there is a potential for a fault, but it's very small?

MR. GREGORY: -- yes. And the context I gave --

MR. CUNLIFFE: Okay.

MR. GREGORY: -- it in was as with HPFF, they're both mature systems. And I was giving it as the systems are now so if someone chose an HPFF or an SCFF cable they would not experience the initial teething problems that XLPE cable has been experiencing.

MR. CUNLIFFE: Thank you. And in the XLEP you've given us three categories, optimistic, realistically pessimistic and worse case experience. Was any of this hard data?

MR. GREGORY: Yes. And this book is pretty hard. It's full of statistics. And the median figure --

MR. CUNLIFFE: Right.

MR. GREGORY: -- of four faults per 100 miles per year comes from all the data in this book.

MR. CUNLIFFE: Okay.

CHAIRPERSON KATZ: That's updated, the book?

MR. GREGORY: This is the EPRI book so that NU is one of the funders of EPRI and belong to the underground cable task force.

CHAIRPERSON KATZ: And the date of that?

MR. GREGORY: It's dated, final report December 2002.

CHAIRPERSON KATZ: I'm sorry?

MR. GREGORY: Final report December 2002.

CHAIRPERSON KATZ: Thank you.

MR. GREGORY: But the data was produced and it was written some time before that.

MR. CUNLIFFE: And then you gave a worse case experience of 12, and I presume that's one facility?

MR. GREGORY: The worst case was on the basis that if you were unlucky, as the utility power grid was in Singapore, what could happen.

MR. CUNLIFFE: But that's just one -- one facility, not -- one facility out of how many globally?

MR. GREGORY: Oh, I see. One installation?

MR. CUNLIFFE: Yes, yes.

MR. GREGORY: So we're talking the same.

MR. CUNLIFFE: So you're saying the worse case experience would have been 12 and then you sited Singapore. Is that -- so Singapore had 12 faults?

MR. GREGORY: No. Those figures were 12 -- they're rationalized, they're normalized to so many faults per 100 miles per year of service.

MR. CUNLIFFE: Okay.

MR. GREGORY: And so --

MR. CUNLIFFE: But it's not attributed to just one installation, it's attributed to cross numbers of installations?

MR. GREGORY: -- yes.

MR. CUNLIFFE: Okay.

MR. GREGORY: It's in the context of the questions you were asking me the first time I spoke as to what could happen with an XLP circuit. And on the contrary I gave down what I thought was my realistic --

the optimistic one as two and I felt that with good engineering two was a figure to base it on.

MR. CUNLIFFE: Okay.

MR. ASHTON: Mr. Gregory, just in that context, was there any one manufacturer or run of cable that was outrageously bad and just tend to distort the numbers or is it pretty well spread across time, manufacturers and all the rest of it? I don't want to put anybody in the bag here.

MR. GREGORY: I've got to go back to Europe.

MR. ASHTON: And you want to be welcomed back.

MR. GREGORY: There's a certain country I wouldn't dare go to if I said which manufacturer it was.

MR. ASHTON: No, I understand that. You don't have to identify the manufacturer, but I was just wondering if there was any one --

MR. GREGORY: If I can try and quantify that? There were 10 instances listed. 10 of which on one of those instances there were six faults. In other instances there were only one. So one manufacturer and one utility was unlucky enough to have six.

MR. ASHTON: And would that have been a

cable that was early in that class of cable -- class of cable?

MR. GREGORY: No. And it really wasn't a cable problem, it was a joint problem.

MR. ASHTON: A splice problem.

MR. GREGORY: Yeah. Which most of these are. It's unusual to have a cable problem. It's usually accessories.

MR. ASHTON: Okay. Thank you. That's all.

MR. CUNLIFFE: I'd like to go back to the -- how you clarify or define the faults based on tests versus faults after tests. For SCFF and HPFF or any faults from a test scenario included in the data?

MR. GREGORY: No, because in my knowledge and we were major -- when I was Chief Engineer of BIC major manufacturers of self-contained fluid-filled cable, I can't remember any failure in my career, which is -- then was 35 years of fault in commissioning a 275 kV or a 400 kV cable system.

MR. CUNLIFFE: And what is your rationale to include the faults for test of an XLPE?

MR. GREGORY: Because they occurred. I would have included them in SCFF if they had occurred, but that's much better than XLPE.

MR. CUNLIFFE: Would there be a difference in the faults between cables laid in a duct versus direct burial?

MR. GREGORY: They're different installations. We don't have enough data to be able to say -- to answer that question. For example, there's very little cable installed at the system voltage of 345 kV. There's very little cable XLP EHV installed in ducts. So we just don't have the data to answer the question.

MR. ASHTON: But Mr. Gregory, you indicated that a majority, if not all of the failures, occurred at the splices --

MR. GREGORY: Yeah.

MR. ASHTON: -- which would say to me that it makes no difference, the failure rate -- at this stage there's no indicated difference between direct buried and buried in a duct. They're all in the splices.

MR. GREGORY: Not all, one third of them.

MR. ASHTON: Oh, I thought --

MR. GREGORY: Sorry. There are 18 cases here and I think maybe three are in the cable.

MR. ASHTON: -- okay. So --

MR. GREGORY: And since then I'm aware of another -- in the last two years another three or four cases.

MR. ASHTON: -- okay. But there's not -- that wouldn't say to me that it is not a strong indicator one way or another about duct versus direct buried, it being -- the vast majority being failures at the splice?

MR. GREGORY: I think that's fair. The accessories are more vulnerable in XLP systems.

MR. ASHTON: Obviously if you can build in greater level of mechanical protection through a duct casing in concrete or what have you it's going to slow somebody down if they're trying to bang their way through the system, a contractor. But a determined contractor will go through anything.

MR. GREGORY: Yes. I should also say that after this EPRI report there's another one that was published, which I think was mentioned -- maybe it was mentioned at the last hearing two months ago that we've also produced a two-year long study on how to design XLP cables for installation in ducts and in pipe systems. So I think this was to try an answer what you're saying is it's a new cable for installation in ducts and the design techniques are slightly different, but we believe now with computer modeling we have reduced the risks of XLP cable in ducts.

MR. CUNLIFFE: Mr. Gregory, could you opine to Europe's implementation of XLPE at 400 kV, maybe higher, and why they are continually installing this technology and --

MR. GREGORY: Yes. XLP cables have advantages for utilities in reduced maintenance. It's a lower loss cable and it's more efficient in that you can get a higher rating on it. In terms of manufacture it's easier for more manufacturers to address with manufacturing plant so more people can make it and therefore there's more competition. Also I think it's generally recognized as the technology of the future.

MR. CUNLIFFE: Do you see any reason why it couldn't be applied here in Connecticut?

MR. GREGORY: No. And again, I think I've answered that before by saying that it's a new technology. It's as of two years ago when I've prepared these figures, the installations were only three to four years old. The big 500 kV XLP installation in Japan had only been commissioned for one year and had already suffered one failure. So I was exercising caution and said it's doable, but it requires a great commitment from the electricity companies to put engineers in to understand the specifications and the quality issues and to make sure they are involved in pre-qualification tests and in visiting manufacturer's plants. And I made the point that the companies who were successful, Copenhagen Electricity and Berlin Electricity and Tokyo Electric were all companies who put a great deal of effort and knowledge in with the manufacturers to make sure that their projects were successful.

MR. CUNLIFFE: And would you also agree that there are potentials for leaks for a fluid-filled cable versus no leaks with an XLPE cable?

MR. GREGORY: Yes, exactly.

MR. CUNLIFFE: Those are my questions Chairman. I'm done with Mr. Gregory.

MR. GREGORY: Maybe I should just say one thing, which was said before as well. Is that in the world experience most of it is XLP cable in tunnels, which is a protected environment mechanically. It's very difficult to damage a cable that's 60 meters underground in a concrete tunnel. And also it reduces the risk for utilities in the world. So if you have a failure in a tunnel it's not publicly seen and you can remove the cable or repair it much more easily and readily, so it's a lower risk. Ducts -- there are almost no duct installations at EHV XLP that we can base experience on. So that would be new. And the very limited experience indeed on cables that are laid direct in the ground.

So I think this has to be born in mind when we look at what the service experience is. It would still -- and as I said before, if NU and UI go this route and choose more XLP cable you will be world famous in Connecticut. And this is good if it's successful.

CHAIRPERSON KATZ: Yes, but in Europe don't they do more than a four to five mile length of XLPE?

MR. GREGORY: Yes. I think the length typically up to 12 -- 10 to 12 miles. I'm getting kilometers and miles a little confused here.

MR. ASHTON: But those are comparatively few and far between though?

MR. GREGORY: Yes, they are. Copenhagen --

MR. ASHTON: Special circumstances?

MR. GREGORY: -- yeah. But there are not that many installations. Customers do not buy many -- unfortunately for cable companies many cable system. They tend to be years in the planning as here, and maybe one or two years in the manufacturing and installation. So there aren't many about.

CHAIRPERSON KATZ: Okay.

MR. ASHTON: Mr. Gregory, if I may, let me ask you a question along these lines. There is very little experience in this country with self-contained fluid-filled cable, but there is extensive experience elsewhere throughout the world, is that fair to say?

MR. GREGORY: Yes.

MR. ASHTON: And one of the drawbacks in this country to that application of SCFF has been that there has been limited or no experience in splicing and the mechanical attributes of it. The Applicant has proposed a system from Norwalk to East Devon, which involves if my arithmetic is correct, 48 circuit miles -- 48 circuit miles of 345 kV cable. Do you believe that there's enough cable there to make it worthwhile for the Applicant to give serious consideration to SCFF in that it's enough -- it's got enough mass if you will to warrant training some people locally to work that kind of cable?

MR. GREGORY: Yes, insomuch that you'd have to train sufficient jointers for all these cable projects.

MR. ASHTON: I understand.

MR. GREGORY: One needs a number of skilled teams, whether it's an HPFF cable, or a self-contained fluid-filled cable, or indeed an XLP cable. And when we look at the world resources of are there enough cable factories and are there enough joints and a very important consideration, are there enough teams of trained jointers? So I wouldn't see that as significantly different. I think one of the things that I think should be added to your question is for a self-contained fluid-filled cable one needs the special equipment to gasify the oil and evacuate the joint of gasses before it's re-impregnated. And that sort of equipment would have to be kept in Connecticut with trained fluid mechanics ready and on standby to be able to attend these circuits should mechanical damage occur to them. And I think that is a true difference and one would have to have a willingness to keep such people on hand even if they were never used.

MR. ASHTON: Okay. Thank you.

CHAIRPERSON KATZ: Mr. Walling, if the Company did do self-contained fluid-filled would that change the -- would that change the modeling?

MR. WALLING: Mr. Gregory, correct me if

I'm wrong, buy my understanding is that the SCFF and HPFF cables have comparable capacitance and therefore -- oh, it's greater?

MR. GREGORY: No. It's very similar. The insulation dielectric permantivity is effectively the same, it's 3.5 for both an HPFF and a SCFF cable.

MR. WALLING: Okay. So if it's the same capacitance it's basically the same electrical model for the issues that we are investigating.

MR. GREGORY: Yes.

CHAIRPERSON KATZ: Okay. Thank you. Back to you Mr. Cunliffe.

MR. CUNLIFFE: Thank you. Mr. Walling, CL&P and UI did not ask you to analyze any HVDC configuration for transient --

MR. WALLING: That's correct.

MR. CUNLIFFE: -- and Mr. Zak, I don't know if you read Mr. Walling's resume, but he's quite familiar with HVDC. Did CL&P/UI consider another contractor to review an HVDC proposal? You went with Black and Veatch on your submittal to the Council.

MR. ZAKLUKIEWICZ: We did not.

MR. CUNLIFFE: And you were not aware of Mr. Walling's credentials or GE's ability to do an analysis for HVDC?

MR. ASHTON: Are we talking about the same kinds of studies? What was the nature of the study that was -- the Applicant's asked Black and Veatch to perform?

MR. PRETE: The request that we had to Black and Veatch is feasibility of DC given the worldwide experience to find out if we were to construct a line between Beseck and East Devon what would it look like, what type of components with cable, dimensions and more from a constructibility point of view and to identify disadvantages and advantages to the AC.

MR. ASHTON: And did that include or exclude T&A studies?

MR. PRETE: It absolutely did not include T&A studies whatsoever.

MR. ASHTON: So T&A studies would be a separate requirement if it was deemed wise to follow that alternative further down the path?

MR. PRETE: Yes sir.

MR. TAIT: What are T&A studies?

MR. PRETE: Transient and Network Analysis. The study that we had Black and Veatch do on pages nine and 10 talks about the advantages and disadvantages and we talked about the power quality disadvantages of DC, we talked about the inability to do multi-terminal, the inability for instantaneous pickup and of course the cost. And as applicants those are very important issues that we weighed. And in determining those sort of disadvantages the companies believed that it was not a feasible alternative to put forward, although we studied it.

CHAIRPERSON KATZ: But based on the testimony that we got today that it would be feasible to do a HVDC, with the understanding that land would have to be acquired in Milford for a station, in order for this Council to make a decision on whether to -- on a DC cable are there more studies that have to be done?

MR. PRETE: I would say absolutely.

CHAIRPERSON KATZ: And those studies would be this Transient and Network Analysis?

MR. PRETE: They would have to be those, they would have to be thermal studies and of course ISO would need to weigh in on whether or not they would accept a DC link in the heart of an AC system.

CHAIRPERSON KATZ: And we will ask them that question.

MR. PRETE: That would be a great question to ask.

CHAIRPERSON KATZ: Mr. MacLeod, please take note. So you're saying right now we do not have the information that we would need to totally accept or reject DC as an option for this -- as part of this transmission line?

MR. PRETE: That's correct.

CHAIRPERSON KATZ: Thank you.

MS. RANDELL: I think that -- yeah, I agree. I think Mr. Fitzgerald and I are going to the same place. I think the companies have submitted information that the companies believe supports determination that DC is not appropriate. I think Mr. Prete was answering the flip side question was -- which is, were you to determine that you wanted to proceed further with the DC than the company has done, would there be more studies, and the answer is yes.

CHAIRPERSON KATZ: Okay. But I did not interpret Mr. Zak's testimony that DC was not possible.

MS. RANDELL: I don't think possible -- I don't think the companies have ever said it's not possible. They said they just don't think it's a good idea given other alternatives and given the practicality and operation and all the other things that were in the application that I'm not going to repeat.

CHAIRPERSON KATZ: Okay. So Mr. Zak, so that we can have the words come out of your mouth, is it your testimony that this DC line is feasible, but not advisable?

MR. ZAKLUKIEWICZ: Yes.

CHAIRPERSON KATZ: Thank you. And we'll explore that further. Back to you Mr. Cunliffe.

MR. CUNLIFFE: Is the Applicant aware of another HVDC technology, such as series compensated HVDC?

MR. ZAKLUKIEWICZ: I've never heard of that.

MR. CUNLIFFE: Mr. Wallings, have you heard of that?

MR. WALLING: We've done some study, very superficial study work for some Japanese utilities on that concept. It allows operation in a weaker system with a little less -- a little bit reduced system problems, a little less requirement for reactive compensation.

MR. CUNLIFFE: So it seems like it may be a more acceptable solution?

MR. WALLING: May or may not.

MR. CUNLIFFE: And is --

MR. ASHTON: To us that do not recognize

the term would someone be kind enough to define, Mr. Walling would you define series compensated DC system?

MR. WALLING: Well, a capacitor compensated DC -- CCC, capacitor commentated converter --

MR. ASHTON: Well, that's not the same as a series compensation --

MR. WALLING: -- it is a form of series compensation, but it's not like putting a series capacitor on AC line. It's a capacitor in series between the converter transformer and the theristor valves and it effects the commutation process to the converter.

MR. ASHTON: I'm sure everybody --

MR. WALLING: It's been offered by at least one manufacturer. I'm not sure if they've built it or not.

MR. ASHTON: So it's fair to say as yet this is an unproven concept?

MR. WALLING: There's -- I don't know -- I can't speak to whether it's in commercial operation or not. However, if it is it's not a widespread number of applications.

MR. CUNLIFFE: Is HVDC used in the Western Electric Council System for controlling AC power flow?

MR. WALLING: Yes it is.

MR. CUNLIFFE: And could that be an advantage here in Connecticut?

MR. WALLING: I'm not familiar with the dynamic issues in Connecticut to even comment.

CHAIRPERSON KATZ: Does anyone on the panel wish to comment?

MR. CUNLIFFE: And cost comparisons of the HVDC system was based on the overhead lines. Did you compare the cost with an underground?

MR. PRETE: I believe both numbers are both in the Black and Veatch report as well as interrogatory DW014.

MR. CUNLIFFE: Thank you. With all things being equal between HPFF and XLPE, could more XLPE be installed? I'm speaking to transient resonance.

MR. PRETE: We struggled actually greatly with that question and if you could rephrase it maybe we can answer it.

MR. FITZGERALD: More than what? All things being equal, could more XLPE be installed as compared to --

MR. CUNLIFFE: Be installed as compared to HPFF?

MR. ZAKLUKIEWICZ: Are you asking whether the capacitive charging requirements because the HPFF is significantly higher than cross link polyethylene could you -- would 1.6 times the cross link polyethylene cable then equal the charging of an HPFF cable? Is that what you're asking?

MR. CUNLIFFE: Exactly, yes.

MR. ZAKLUKIEWICZ: Or how to integrate it into the system?

MR. CUNLIFFE: No, just as you stated.

MR. ZAKLUKIEWICZ: Which is how to integrate it into the system?

MR. CUNLIFFE: No link. The first time.

MR. ZAKLUKIEWICZ: The answer is clearly HPFF cable requires 21 MEGA VARS per mile and cross link polyethylene approximately I think specifically is 12.4 where we've rounded and said 12 MEGA VARS per mile.

MR. CUNLIFFE: Alright. Thank you.

MR. WALLING: Now if substituting a larger extent of the system with HPFF cable to achieve the same gross combined amount of charging while that gross amount of charging MEGA VARS is a useful rule of thumb the specific performance of the system is also a function of details and where that -- where that cable goes. And although the general trend would be of somewhat similar system risk you cannot say specifically and categorically that would be the case.

MR. CUNLIFFE: So you're saying equal distance for both technologies?

MR. WALLING: No. I'm saying that substitution of longer -- a greater amount of cable distance with HPFF -- with cross link polyethylene in place of the proposed distances with HPFF while from a rough approximation figure of merit would tend to indicate that would be comparable risk levels to the system. The fact that it's extending in different places of the system would indicate that you can't really equate the two exactly and that the particulars of the system might give results that don't indicate the same risk.

MR. CUNLIFFE: Is HV -- the application of porpoising HVDC possible?

MR. PRETE: Do you have a specific example to answer that?

MR. CUNLIFFE: Highway crossing?

MR. FITZGERALD: Excuse me. By porpoising HVDC you mean -- I mean, an HVDC line that's partially overhead and partially underground?

MR. CUNLIFFE: Right. Yes.

MR. WALLING: They're -- one of the points that has been a problem with DC in the past has been the bushings for the DC connection from the converter building to the line and it's involved contamination -- basically, you know, pollen and whatever else being attracted to the bushing and causing flash over. And that would tend to indicate that the transition points would be a weak point of the system and require extra diligence and maintenance and raise the risk of faults occurring. I mean, it's a point of risk. The voltage across the bushing on an AC is graded by the capacitance of it, it's nicely -- can be nicely graded. A DC bushings voltage gradient is very much a function of leakage resistance, which is a function of accumulated contaminants over time.

CHAIRPERSON KATZ: So bottom line?

MR. ZAKLUKIEWICZ: Increased risk with porpoising up and down basically the weak point ends up being the hardware, the part hairs where you go from overhead to cable and then at the opposite end of the porpoise where you now go from cable back up to overhead.

CHAIRPERSON KATZ: So if this Council had a preference for a DC line would the companies prefer a completely underground or a completely overhead line?

MR. ZAKLUKIEWICZ: We prefer an AC

solution.

CHAIRPERSON KATZ: Understood. But if this Council indicated a preference for DC line from Beseck to East Devon does the Company have a preference on an overhead DC line or an underground DC line?

MR. ZAKLUKIEWICZ: All overhead DC lines.

CHAIRPERSON KATZ: Well, how high would those structures have to be to do that?

MR. PRETE: In the Black and Veatch report I believe the last page of that report gives a typical drawing of what that structure might look like in both height and width and what it shows is about a 75 foot structure typically.

CHAIRPERSON KATZ: So this would be a separate structure other than what's on the right of way now?

MR. PRETE: Correct.

CHAIRPERSON KATZ: Okay. So is the right of way large enough to add this new structure? Or would you have to acquire more right of way to add this new 75 foot structure?

MR. PRETE: Subject to check I believe the size of this structure is smaller in most, if not all cases, than our proposed 345 line. So I would assume if that's the case then we would have to acquire land similarly on the segment in Segment One, the two and a half miles.

CHAIRPERSON KATZ: Well, I thought we were just talking Beseck to -- isn't Segment One above Beseck?

MR. PRETE: Correct. That's correct.

CHAIRPERSON KATZ: Okay. So if we're just talking Segment Two and you're going to put an overhead structure in and hang a DC line?

MR. PRETE: Again, trying to answer it by segment in my mind if you take the major segment, which is between Cook Hill and Milford, the 22 miles --

CHAIRPERSON KATZ: Right.

MR. PRETE: -- that right of way there should be sufficiently wide enough since we are reconfiguring the 115 and going from three to two structures --

CHAIRPERSON KATZ: Okay.

MR. PRETE: -- one of those structures would be the 345, so this would take the place of those.

CHAIRPERSON KATZ: But in Wallingford basically from Cook Hill to Beseck you would have to acquire more right of way is what you're saying?

MR. PRETE: I think we'll take a look at

that and get back to you.

CHAIRPERSON KATZ: Could you?

MR. PRETE: Yeah.

CHAIRPERSON KATZ: We'd appreciate that.

MR. TAIT: Would you need more towers per DC circuits than AC circuits spacing? Would you need per mile, would you --

MR. ZAKLUKIEWICZ: I think the spans would be comparable Mr. Tait.

MR. TAIT: -- so whether it's AC or DC it's the same number of poles, structures?

MR. ZAKLUKIEWICZ: Again, we're talking the conventional high voltage DC, so these would be structures at approximately plus or minus 550 kV as opposed to the 345.

CHAIRPERSON KATZ: Thank you. Back to you Mr. Cunliffe.

MR. CUNLIFFE: Thank you. I mentioned in the last hearing the NERC and the regional reliability standards require that transmission planning be done using different dispatch scenarios. Did you model multiple generation units out of service within the local areas as you did for Norwalk, Stamford and southwest Connecticut when planning expansion in other parts of your transmission system?

MR. SCARFONE: Yes, absolutely.

MR. CUNLIFFE: Could you document that you applied modeling of the multiple generation units that are service for planning the other parts of that grid?

MR. SCARFONE: Yes, we can. We can provide you with the 18.4 applications that go with the new Haddam auto transformer in Haddam that taps the existing 345 kV Milstone to Southington line. We're also looking at installing an auto transformer at Tracey, which taps the 345 kV Lake Road to Sherman line. And we're looking at adding an auto transformer at Barbara Hill, which is tapping the 345 kV AC line that goes from Manchester to Ludlow.

MR. CUNLIFFE: Thank you.

CHAIRPERSON KATZ: Getting back a moment --

MR. SCARFONE: With the DC that's -- our dislike about DC is it's very difficult to interconnect new substations versus how we do it today with AC.

CHAIRPERSON KATZ: -- what substations are you planning between Beseck and East Devon?

MR. SCARFONE: Currently we're not planning new ones in this analysis, but DC would make it much more complicated and expensive to tap new substations in the future. That's one of the problems with DC.

CHAIRPERSON KATZ: Well, DC doesn't have any splices, correct?

MR. ZAKLUKIEWICZ: DC --

CHAIRPERSON KATZ: Well, less splices. I mean --

MR. ZAKLUKIEWICZ: -- excuse me? Can you -- I'm not certain --

CHAIRPERSON KATZ: -- I'm just visualizing on the Cross Sound cable.

MR. ZAKLUKIEWICZ: -- it has no splices on the Cross Sound cable because the manufacturing of the cable was 26 miles continuous, was placed on a vessel where it was coiled in the vessel and you could do it on a sealink without a splice so it was a continuous cable.

CHAIRPERSON KATZ: If you're doing it on a truck?

MR. ZAKLUKIEWICZ: In a land-based system you now have to be able to transport the cable from point of entry, which would be a seaport, and it would have the same restrictions as an AC cable, meaning you are into the 1,800, 2,000, 2,200 foot per reel and it would have to be splices at those vault locations just like you would an AC cable. So --

CHAIRPERSON KATZ: Understood.

MR. ZAKLUKIEWICZ: -- on the Cross Sound cable it is one continuous cable, virtually no splices except for the splices in the manufacturing of the cable to basically clean the extrusion heads at the factory.

CHAIRPERSON KATZ: Okay. Mr. Cunliffe?

MR. CUNLIFFE: Has the grid ever experienced all of the units assumed out of service as projected in Scenarios 2B and 5B?

MR. ZAKLUKIEWICZ: Yes, I believe -- and during the testimony of Docket 217 I think there was a day where we turned around and said today here are the number of units out, and there were actually more units out than in the scenario two or scenario five on that given day. And I believe it was close to a winter peak day in addition on that given day.

MR. CUNLIFFE: Would the bundling of the 345 kV East Shore Scoville Rock at the weak section be adequate reinforcement in addition to the underground addition of the East Shore, East Devon, Norwalk?

MR. SCARFONE: Could you repeat that question please?

MR. CUNLIFFE: Would the bundling of the East Shore Scoville Road, that's the overhead 387 line --

MR. SCARFONE: Yes, Scoville to East Shore.

MR. CUNLIFFE: -- okay. At the weak section be adequate reinforcement in addition to the underground 345 from East Shore to East Devon?

MR. FITZGERALD: In other words, this is the one line -- this is the one line East Shore bundled to --

MR. SCARFONE: Do you mean the replacement of the 2156 with bundled 954?

MR. CUNLIFFE: Yes.

MR. SCARFONE: Yeah, the Power Gem studies have indicated that that does not work.

MR. CUNLIFFE: Did they offer a solution?

MR. ZAKLUKIEWICZ: Yes. Install a second transmission line between Beseck and East Shore.

MR. CUNLIFFE: And the Power Gem report attached to Addendum One, and I'm going to direct you to page five --

MR. FITZGERALD: Mr. -- there's several Power Gem reports. If you could indicate which one you're referring to?

MR. CUNLIFFE: -- the Addendum One, I believe it was submitted on December 16th.

MR. FITZGERALD: Oh, Addendum One to the supplemental filing?

MR. SCARFONE: Do you have the date of that study so I can get -- we can get that study?

MR. CUNLIFFE: December 31st, 2003.

MR. SCARFONE: Okay. Yes, we have it. Page five?

MR. CUNLIFFE: Page five.

MR. SCARFONE: Go ahead.

MR. CUNLIFFE: Power Gem was instructed to configure the system by opening and closing certain lines. Could you explain the rationale for each of the steps that were instructed to Power Gem, starting with the open the Southington to Scoville Rock 345 kV line?

MR. SCARFONE: I believe we have answered this in a data request. I can't recall which data request.

MR. CUNLIFFE: Just briefly then?

MR. SCARFONE: What this was doing was taking the original case that they had, Power Gem had, and reconfiguring it and getting it back to the system, each of these steps.

MR. CUNLIFFE: For each of these scenarios that you said you were --

MR. SCARFONE: This was reconfiguring the case to get back --

MR. CUNLIFFE: -- okay.

MR. SCARFONE: To the desired system.

MR. CUNLIFFE: And was there any particular reason why you would want to open the Devon Luchini (phonetic) line, the Middletown Bochem (phonetic) line and the Milford Devon line at the same time?

MR. SCARFONE: It's data request Town's 06, Town's 63, page two of two. And the first paragraph, open the Devon Luchini is to remove the section of the 1690 line to make room for the 345 kV.

MR. CUNLIFFE: Okay. Thank you. If I could go back to the Addendum Two study?

MR. SCARFONE: Do you have a date on that study sir?

MR. CUNLIFFE: January 28th, 2004.

MR. SCARFONE: Okay. There's a 1-1 and a 1-2. One was New Haven Harbor online and New Haven Harbor offline?

MR. CUNLIFFE: Right. One page three you've provided a table.

MR. SCARFONE: Which report do you want me to go to? New Haven Harbor on or off?

MR. CUNLIFFE: New Haven online.

MR. SCARFONE: Yes.

MR. CUNLIFFE: It was reported that it looked like you could operate the system with it on 84 percent?

MR. SCARFONE: You said page three?

MR. CUNLIFFE: Yes.

MR. SCARFONE: I thought you told me to go to the online?

MR. CUNLIFFE: If you're at the on then I would imagine you should see a figure of 84 percent that it's operated --

MR. SCARFONE: Okay.

MR. CUNLIFFE: -- that there is -- it's operating within the allowable reliability criterion?

MR. SCARFONE: That's correct.

MR. CUNLIFFE: Okay. And then with it offline it would go to 107 percent, is that --

MR. SCARFONE: I have a summary table of all of those cases that I'm going to go -- it's easier to look at. Now this is the existing 387 line --

MR. CUNLIFFE: -- yes.

MR. SCARFONE: -- with New Haven Harbor, New York New England at zero, New Haven Harbor off?

MR. CUNLIFFE: Right.

MR. SCARFONE: Clean Energy on?

MR. CUNLIFFE: Yes.

MR. SCARFONE: And the 317 line is at 117 percent normal?

MR. CUNLIFFE: That's off. Right?

MR. SCARFONE: Yep.

MR. CUNLIFFE: Okay.

MR. SCARFONE: 98 percent on.

MR. CUNLIFFE: And you're assuming Clean Energy?

MR. SCARFONE: That's correct.

MR. CUNLIFFE: Do you know the status of that project?

MR. SCARFONE: Clean Energy has received an equal 18.4 approval and we have assumed it in our cases.

MR. CUNLIFFE: Thank you.

MR. ZAKLUKIEWICZ: Mr. Cunliffe, just so we clearly understand --

MR. CUNLIFFE: I'm clear Mr. Zaklukiewicz on the response.

MR. ZAKLUKIEWICZ: -- okay.

MR. CUNLIFFE: What was the rationale in modeling the New Haven Harbor out of service?

MR. SCARFONE: Let me just summarize the configuration. The 387 line goes from Scoville Rock to East Shore. At the East Shore substation interconnected with the 115 kV, which is the low side of the two auto transformers there is New Haven Harbor. New Haven Harbor has a very significant impact on the power flow from Scoville to East Shore. As you've noticed through your analysis of these Power Gem studies with New Haven Harbor on it pushes back on the power flow on the 387 and that power flow is redistributed across other lines to get into southwest Connecticut. When you shut New Haven Harbor off that power flow from the middle of the state, the Middletown area is a very strong source, that power flow goes down the 387 line and significantly increases the power flow down into East Shore. So what we did --

MR. FITZGERALD: So why look at it with New Haven Harbor off?

MR. SCARFONE: -- so what we did is in accordance --

CHAIRPERSON KATZ: Thank you Mr. Fitzgerald.

MR. SCARFONE: -- with reliability standards we cannot design in any must run generation under NEPOOL standards and NEPOOL standards tell you to stress the system. Shutting off New Haven Harbor stresses the system on the 387 line.

MR. CUNLIFFE: And no controls upstream could be implemented?

MR. SCARFONE: Such as a phase shifter? We didn't at -- we did not have Power Gem look at the installation of a phase shifter. The problem with a phase shifter on a 387 line is all you do is move your problem to another line. You're taking the power that you don't want to flow down the 387 and it's redistributed onto the underlying 115 that aggravates their power flow.

MR. CUNLIFFE: Okay. What NEPOOL standard recommends shutting down the whole plant?

MR. ASHTON: New Haven Harbor plant you're talking?

MR. CUNLIFFE: New Haven Harbor.

MR. SCARFONE: Well, in New Haven Harbor there's only one unit. But it's really the NEPOOL reliability standards.

MR. CUNLIFFE: It doesn't allow for half

power on it, or they want to assume that the whole plant is not available?

MR. SCARFONE: What they mean by stress system are shutting down groups of plants or plants to stress the power flows on the transmission system. That's how we stress the system.

MR. CUNLIFFE: And does that reliability criteria address one outage, take the largest unit and assume that's out of service and then you model your system around that?

MR. SCARFONE: No. I think as Mr. Zak has testified at the last set of hearings and a long discussion on dispatch two and five, it's not a single unit. Dispatch two has multiple units out of service. So when we stress the system in NEPOOL standards today we create basically holes in the system and turn on generation remote from the area to monitor the power flows on the existing transmission system.

MR. CUNLIFFE: Back to those scenarios of the 387 line and the in and out of New Haven Harbor station, what were the loadings on the submarine cables between Connecticut and --

MR. SCARFONE: 350. I'm sorry, 330.

MR. CUNLIFFE: -- thank you. And the big

question is how many more miles of underground can we do?

MR. FITZGERALD: More than what?

MR. CUNLIFFE: More than what's proposed, the 20 miles in the proposal between Norwalk and East Devon, how much more can we add to East Devon north or from Beseck south?

MR. ZAKLUKIEWICZ: I believe I testified earlier in this hearing. I think we're at the -- we're at or above the limit. When Mr. Tait, I believe, asked me whether we think it could work I said I believed we could with the 24 miles that's being proposed. I have seen nothing since then that leads me to believe differently. I think the Commission asked us to press the limit up front, which we did, and in our proposal we submitted a proposal, which is stretched by the criteria of any electric power design entity. And I do not believe that we can add any additional 345 kV cable to the system as proposed.

CHAIRPERSON KATZ: Alright. Now are you basing that on the GE modeling, on the Power Gem, what are you basing that on?

MR. ZAKLUKIEWICZ: I'm basing it on partially on the GE studies that have been done on harmonics and transients. I'm basing it on the fact that as I testified before ISO New England has yet to get their models to actually work and to endorse what was proposed by the companies. And as a result of the questions we have, I have as to the operation of this system and the ability to operate it reliability once it's installed.

CHAIRPERSON KATZ: Isn't it fair to say that the GE modeling looked at certain scenarios? For example, they looked at one I believe that was 10 miles additional at each end, but they did not look at a scenario that was just 10 miles of additional underground, did they? Or file miles of additional underground?

MR. PRETE: They were not asked to look at that.

CHAIRPERSON KATZ: Okay. So we can't say based on the GE modeling that you couldn't do five more miles underground then, correct?

MR. PRETE: I think the question was whether or not the Applicants believe any more underground --

CHAIRPERSON KATZ: Right.

MR. ZAKLUKIEWICZ: I think it comes down to a matter of what risk are we willing to accept and

GE's conclusions are that the 24 miles has problems with it, but they believe the risks are acceptable. And based on that recommendation for which we have not done all of the studies, we've done preliminary studies, and more studies are going to have to be done, and looking at the system responses to what is going on, the fact that after months and months of studies we've just concluded that we believe installing four two percent reactors may work for which the ISO has not fully tested or agreed to. Those are issues that are -- if it takes that long to come up with solutions and we are operating in a system that no one else has ever operated in before, as proposed we're down at 2.4 with the caps on. No one else has ever operated a system under those conditions. I do not personally feel I am smart enough to estimate what conditions will arise that we just were not smart enough to think of beforehand and to have a 600 or an $800,000,000 project not operate effectively it is in my mind is not proper engineering and it puts at risk hundreds of thousands of Connecticut customers who are very, very reliant upon a reliable electric system to keep the lights on.

CHAIRPERSON KATZ: Thank you. I guess we'll probably explore this further in July. At this point I'd like to make sure that other parties and intervenors get a chance to cross these witnesses. So I'm going to go through the list and then we'll come back -- we'll come back to that and we'll get you in.

First State Representative Al Adinolfi, questions to this panel? Mr. Adinolfi is absent. Next, Town of Middlefield, Attorney Eric Knapp? Absent. Towns of Wallingford and Durham, Mr. Boucher or Krutow (phonetic)? Woodbridge, Milford? After you get settled in Mr. Ball maybe you can start off by telling us which towns you'll be representing today?

MR. DAVID BALL: I never know. I'm definitely representing the town of Woodbridge.

CHAIRPERSON KATZ: Okay.

MR. BALL: But I believe I'm the only attorney for any of the towns that will be asking questions, so -- on behalf of any of the town.

CHAIRPERSON KATZ: Okay. Well, we'll have great expectations then.

MR. BALL: That's too bad. Mr. Zak, just to follow up on the last line of questioning. Can you state clearly for the record whether or not, particularly in light of the ISO testimony, the Applicant continues to support it's primary preferred route, which includes 23.6

miles of undergrounding in Segments Three and Four?

MR. ZAKLUKIEWICZ: Yes, I do.

MR. BALL: Alright. And you believe that you will be able to get that route to work reliably, is that correct? That system?

MR. ZAKLUKIEWICZ: I believe I've testified before that I think we can work with the ISO to resolve the outstanding issues right at this time. I do not know what those outstanding issues are. On Monday we received the testimony everyone received and even though I asked Mr. Scarfone to discuss with ISO what the issue were, until we meet with ISO New England and their consultant, Powers Micklehoff (phonetic), I do not know the details of their conclusions that operating below 3.0 on a harmonic where the system is tuned to less than three is unacceptable.

And again, I'll reiterate, no one has ever designed a system in the United States to operate down below 3.0.

MR. BALL: Is it fair to say that on June 7th when ISO filed that testimony that was the first time you became aware conclusively as to ISO's position on this?

MR. ZAKLUKIEWICZ: No.

MR. BALL: At what point in time were you aware --

MR. ZAKLUKIEWICZ: I was advised about an hour before the -- I'm trying to tell the truth, so if I said yes -- I was advised approximately an hour beforehand that ISO was going to submit testimony which basically expressed grave concern over what was being proposed. The details of which I read when you all read.

MR. BALL: Now the GE study that's dated November 2003 appears to be the same study that ISO reviewed, correct? Put another way, ISO --

MR. ZAKLUKIEWICZ: I think you're going to have to ask them what they reviewed. I was reminded last week or the week before that I should not speak for others.

MR. BALL: Alright. But you have -- certainly ISO has been aware of your proposed configuration for more than a year?

MR. ZAKLUKIEWICZ: They are in receipt of all of the data and they have been in receipt of all of the studies as part of the southwest Connecticut study group, correct.

CHAIRPERSON KATZ: Don't worry Mr. Ball. We're going to beat up on them on why we're hearing this now.

MR. BALL: Okay. I was giving Mr. Zak the opportunity, but that's fine. I'll move on. Let me ask you and perhaps I should ask this question of the GE representatives, because I don't believe that we've looked specifically at the Phase Two study, which was dated November 2003. But if I could direct your attention to page E-1 of that study? The conclusions and recommendations -- let me just read the first paragraph of it.

"With the be appropriate selection of equipment and implementation of operating practices Phase Two can be operated consistent with Northeast Utilities expectations for transient and harmonic distortion impact." That is your conclusion ultimately, is it not?

MS. PRATICO: Yes, it is.

MR. BALL: And I believe as we've discussed, as of this date you have not undertaken the process of identifying what the operating practices or equipment would be necessary to deal with the issues that came up in the report, is that fair to say?

MS. PRATICO: Yes.

MR. BALL: Okay. And just to clarify, because I thought Mr. Walling may have testified about this earlier, was it your testimony that the problems that you identified in the report of Phase Two were not so severe as to warrant that kind of in depth review at this time, is that accurate?

MR. WALLING: I never said or meant to imply that further study isn't required. I'm saying the results that we did obtain did not indicate a situation that could not be reasonably addressed. However, the depth of that study was not to the point of a full design study that you need to probe out the corners and look at all of the issues. Also I might add that normal planning criterion is a single contingency and one of the problems with this type of problem we see in the system is that while for normal planning load flow and stability, whatever, the penalty of not having the system adequate for a multiple contingency or a second contingency usually is a loss of load. If customers go black or maybe you have a wider black out in a system, but the system can be restored, the risks we want to bring to bear here is that with this type of phenomena that we're studying the risk of a more extreme than normal planning criteria event is possibly something that could hamper restoration. Meaning damage of equipment that could hamper lights getting back on in a reasonable time.

MR. BALL: Alright. Let me ask you about one of the other studies that you did, which was dated April 2004. This was the study of the two different East Shore configurations. And I'm just -- if you have it in front of you on page E-2 I wanted to focus on your conclusions for that study as well. Now --

CHAIRPERSON KATZ: This is the Applicant's East Shore?

MR. BALL: -- this is the -- that's correct.

CHAIRPERSON KATZ: Okay.

MR. BALL: As I understand it and just so that we're clear, the two different East Shore routes that you looked at from a transients and harmonics perspective was one route had three parallel underground cables going seven miles between East Devon and Orange, right?

MS. PRATICO: That's correct. And then there was some overhead with it.

MR. BALL: Okay. Right. And the second configuration was three parallel underground cables that went 13 miles entirely underground between East Devon and East Shore?

MS. PRATICO: Correct.

MR. BALL: Alright. Now your conclusion ultimately is that with either of those configurations there were no overtly fatal flaws, in your language, and that you conclude with the appropriate selection of the equipment and implementation of operating practices the ES-1A and ES-1B configuration could be feasible alternatives to the Middletown/Norwalk configuration from a switching transients and harmonics perspective, correct?

MS. PRATICO: That's correct. And as they could be and further study is needed because we did basically a scoping study to see if there were any obvious flaws. And we would need to do more studies. However, there were some thermal issues that stopped us from going further.

MR. SCARFONE: Sir, I believe that's -- I would like to verify that. But I believe that's with just the existing 387 line we always have made it known that we believe a second line was required.

MR. BALL: I understand that. And just to follow up on that because perhaps I was unclear from some of the testimony a minute ago. Have you in fact concluded the most recent Power Gem study of the East Shore route with one line, but with the 387 line entirely reconductored using Genesie (phonetic) conductors as we had discussed at the last hearing in the Beseck improvements?

MR. SCARFONE: That's in draft.

MR. BALL: Okay. So when do you expect to have that completed? Do you have a sense?

MR. SCARFONE: This is the reconductored of the existing 387 with Genesie conductor?

MR. BALL: Correct. As well as the Beseck improvements.

MR. SCARFONE: Yeah. I believe maybe two to three weeks. The reason why it will take that long is each one of these studies goes through an extensive review through the southwest Connecticut working group, which is made up of ISO, UI, EPRO (phonetic) and NU representatives. We go through it very carefully so that when we supply this information to the Council it has been thoroughly reviewed and that's why I believe it's going to take a few weeks.

MR. BALL: Okay. Then getting back to the GE study on these various East Shore configurations, as you said, you've held off on any further study because of some initial problems in the load flow analysis that Power Gem had done, right?

MS. PRATICO: Well, we got word from NU that there were some thermal issues. I'm not sure where they came from.

MR. BALL: Okay. Assuming those thermal issues could be overcome or a route to be identified that overcame those issues, what is the more comprehensive study that you would do to determine whether that route works from a harmonic and transients perspective?

MS. PRATICO: It would have to include a number of different outages throughout the system. Variations of capacitor banks in service, different cable outages, a lot of different fault scenarios. It would just be a lot of simulations and analysis.

MR. BALL: How much time would that take?

MS. PRATICO: Typical study is like four to six weeks.

MR. BALL: Mr. Gregory if I might ask you a question or two related to your testimony? When discussing the XLPE performance you referred to the EPRI report, which I believe you said was dated December 2002 and that was the source for your statistics that led to your conclusions in the table, is that right?

MR. GREGORY: That's correct.

MR. BALL: Now I believe you also said

that the actual data that is included in that EPRI report relates to the performance of XLPE cables before December 2002?

MR. GREGORY: Yes.

MR. BALL: How many years back does that data go?

MR. GREGORY: We compiled the data about nine months before that date and it went back until XLP cables basically were first installed at these voltages of 230 kV and above.

MR. BALL: What year was that approximately?

MR. GREGORY: One second please. For the actual fault statistic figures the longest time in service that we took was 4.75 years.

MR. BALL: Okay. When did XLPE -- what year did the XLPE cables begin to be used such that it would be reflected in that data?

MR. GREGORY: If I give some examples here, I've got 12, I'll just pick a few. In Japan the 500 kV system -- I beg your pardon, these are failure years. So the 400 kV -- I'm just going through installation commissioning dates now for different systems in Europe at Copenhagen the first circuit was installed in 1997 and the second circuit in 1999. And in Japan 500 kV the 40 kilometer tunnel circuit was commissioned in the year 2000. In Saudi Arabia 380 kV system, 34 kilometers long, was commissioned in 2001. And in Berlin, the two tunnels, the first tunnel was commissioned in 1998 and the second tunnel was commissioned in the year 2000.

MR. BALL: I guess my question is whether or not in light of the testimony in this docket already that performance with both HPFF and XLPE has improved over the years, whether there is a way to get the kind of table that you've created with the most recent data on the performance of XLPE cables?

MR. GREGORY: Yes. It's quite easy. You just increment the times by the period between we took this data and now and take into account whether any other faults have occurred. I think there's been at least one new circuit that's been installed so we would add that in. So the effect would be to reduce the fault statistics.

CHAIRPERSON KATZ: So the technology is getting better?

MR. GREGORY: Time is moving on Chairman. So it's -- as you just keep sampling, if you don't have more faults the situation appears to be improving. We get older, but statistics get better.

MR. BALL: Well, at the risk of asking for homework assignments which we've been careful not to do because we get admonished when we do, if it's not too much trouble I think it would be helpful to get certainly the most updated data in terms of fault rate for XLPE. And if Mr. Gregory just testified that it's not a particularly difficult task perhaps that's something we can get?

CHAIRPERSON KATZ: Any objection from the Companies?

MR. FITZGERALD: Well, let's ask Mr. Gregory. Is that something that he can do?

MR. GREGORY: Yes.

MR. FITZGERALD: Fine.

CHAIRPERSON KATZ: Great. And when will we have that? Thursday?

MR. GREGORY: Certainly Thursday. I'll try for tomorrow.

CHAIRPERSON KATZ: Great.

MR. BALL: Thank you. One question, and perhaps Mr. Zak this is for you, or Mr. Williams. Is it possible to break up the underground segments between

Norwalk and Devon? You've already broken it up in your construction in that the underground miles go through the Singer substation. Is it possible to have one segment, let's say from Norwalk to Bridgeport with HPFF cables and then another segment let's say from Bridgeport to East Devon with XLPE cables.

MR. ZAKLUKIEWICZ: The answer is yes you can do that.

MR. BALL: And in light of the fact that XLPE cables carry less capacitance would that not assist in the problem that we've been talking about with capacitance?

MR. ZAKLUKIEWICZ: Barring all other issues the answer strictly for the capacitance would be, yes, it would reduce -- it would change the harmonic system response.

MR. BALL: Is that something the Companies have looked at at all?

MR. ZAKLUKIEWICZ: Have we studied the cross link polyethylene or combinations of? I believe to -- if you look at what we have proposed we're talking a total of 1,500 MEGA VARS between the capacitance of the exprime on the Bethel to Norwalk project and -- and the proposed Middletown to Norwalk project. If we went to cross link polyethylene we would reduce -- we'd reduce I think the 1,500 down to 1,000 -- over -- approximately a third reduction from the 1,500.

MR. FITZGERALD: Roger he's asking specifically about the one segment XLPE, one segment of Phase Two. One segment XLPE, one segment HPFF.

MR. ZAKLUKIEWICZ: Have we studied -- if that was the case then you would reduce by the factor of the ratio of 12 to 21 for that distance. The reduction in the MEGA VARS of charging for the cable system.

MR. BALL: So might that be something that the Companies look at in terms of mitigating the capacitance issues that we've been talking about?

MR. ZAKLUKIEWICZ: I think in terms of magnitude if you did one cable -- one cable XLP and the other one HPFF for that distance you're talking a difference of approximately 200 MEGA VARS. That means the ratio goes from 2.4 to 2.5 maybe. Yes, it is a mitigation strategy of looking at going with other types of cable and I think I testified earlier this morning over the mitigation strategies that you could use.

MR. BALL: Thank you. Mr. Zak, I'll stick with you on a completely different topic. A demand response program that Mr. Whitley had testified about in

March, I believe. For southwest Connecticut, he referred to it as the 300 megawatt gap RFP. Are you familiar with that?

MR. ZAKLUKIEWICZ: I'm partially familiar with it, yes.

MR. BALL: That program as I understand it is in effect over a five year period in southwest Connecticut, is that correct?

MR. ZAKLUKIEWICZ: That is in effect in Connecticut over a five year period and I believe there was testimony provided by ISO New England at the load forecast hearings on Thursday for the exact megawatts per year in each of the given years over the life of the program.

MR. BALL: And subject to your checking those figures and I'm looking at a slide show from the TEAC-21 conference on May 6th, 2004, are the numbers 125 megawatts for 2004, 218 for 2005, 250 megawatts for 2006 and 256 megawatts for 2007?

MR. ZAKLUKIEWICZ: Those are not ringing a bell with exactly what was provided at the load forecast hearings to my recollection. But I need subject to check what was distributed at the load forecast hearings, especially in 2004, those numbers do not seem to agree.

MR. BALL: Alright. Well, those numbers I'm sure we can get into the record and possibly through the ISO on Thursday. My question for you relates to the Power Gem modeling. When you commissioned your thermal load flow studies did you include an assumption for the benefits of this demand response program?

MR. SCARFONE: No we did not. We assumed the 27.7 case, 27.7 gigawatt case.

MR. BALL: Mr. Prete, I will just ask you a couple of questions. You're aware that the town of Woodbridge has proposed a specific underground route within Woodbridge alone?

MR. PRETE: Yes, I am.

MR. BALL: Alright.

CHAIRPERSON KATZ: Mr. Ball, could you just ask them to remind us how many miles that little section was?

MR. BALL: Within Woodbridge? How many miles?

MR. PRETE: About 3.4.

MR. BALL: Alright. And that -- the route was identified in my letter to your counsel of May 25th, 2004?

MR. PRETE: Correct.

MR. BALL: Alright. Now putting aside issues of -- well, let me just discuss briefly the route with you if I can. Have you actually driven the route?

MR. PRETE: I have.

MR. BALL: Alright. And we discussed a couple of sites for a transition station. One in southern Woodbridge on property that the town has a letter of intent to acquire from RWA.

CHAIRPERSON KATZ: Mr. Ball, for the record you need to specify what RWA is?

MR. BALL: Regional Water Authority. Thank you. And that is Class Three property. I believe we've had some testimony about it. Did you see that site for transition?

MR. PRETE: Yes, I did.

MR. BALL: Alright. And what we also suggested was as you traverse north into Woodbridge that there was a site owned by CL&P near the intersection of Route 63 and Clark Road for the northern point for a transition station, did you see that as well?

MR. PRETE: I did.

MR. BALL: Alright. And then we mapped out, or tried to map out a route connecting those two transition stations along town roads largely, and that's the route that you saw, correct?

MR. PRETE: Yes, I believe it was Johnson Pease Clark, Route 63?

MR. BALL: Exactly. And that route would avoid, if it were to be approved by the Council, it would avoid overhead lines at B'nai Jacob, Ezra Academy and the Jewish Community Center in Woodbridge, correct?

MR. PRETE: They are located in between there so it would avoid them.

MR. BALL: And it would also avoid some of the sensitive wetlands that I believe Landtech talked about, specifically Wetland 133?

MR. PRETE: It's subject to check, that's correct.

MR. BALL: Alright. My question is that strictly from a construction point of view assuming that the Siting Council were to approve that kind of an undergrounding within Woodbridge could you do it?

MR. PRETE: From a constructibility point of view we have on a high level field recognizance believe that is constructible with of course the issues and challenges that we talked to yourself and First Selectman Morella (phonetic).

MR. BALL: And since the proposed route

would be only about three and a half miles could you use XLPE cables?

MR. PRETE: That's certainly a possibility.

MR. BALL: And further, if the Siting Council were to also order the burial of the existing 115 kV overhead line if that was ordered to be buried along side the 345 kV line underground would there be enough room to construct under those roads?

MR. PRETE: Yes. I believe we talked about it, if indeed we went in that direction the 115 XLPE has a better construction reliability history. However, they wouldn't be able to be placed next to each other. You'd have to probably dig two separate trenches along that route.

MR. BALL: And there would be enough room digging two separate trenches to follow the same route, is that right?

MR. PRETE: With the large construction impacts, that's correct.

MR. BALL: Thank you. I have no further questions.

CHAIRPERSON KATZ: Mr. Ball, while we have you at the microphone you asked some questions concerning the East Shore route from down to East Shore and the reconductoring. Do you plan to either -- have the towns planned to either have their own witnesses or to elicit through cross examination the buildability of going from East Shore to East Devon, that portion of it?

MR. BALL: Sure. The answer is yes.

CHAIRPERSON KATZ: Which route were you going to take, through cross examination of other witnesses or your own witnesses?

MR. BALL: On that issue I'm not sure if our witnesses would be able to discuss the issues of constructability, so it would have to be through the Applicants.

CHAIRPERSON KATZ: Okay. And we'll expect that in -- when?

MR. BALL: Well, you know, we were intending to propose in depth with all of our studies the alternatives that made sense that we thought were feasible at the July hearings and I would think at that time it would be appropriate to delve into that.

CHAIRPERSON KATZ: Okay.

MR. BALL: Thank you.

CHAIRPERSON KATZ: You might want to have that discussion with your fellow attorneys.

MR. BALL: Thank you.

CHAIRPERSON KATZ: Because that's an issue that has been under discussed. Okay. Next on the list, Ms. Kohler, did you have cross examination?

MS. JULIE DONALDSON KOHLER: No I didn't.

CHAIRPERSON KATZ: Okay. Town of Westport, Mr. Cederbaum?

MR. EUGENE E. CEDERBAUM: None thank you Madam Chair.

CHAIRPERSON KATZ: He said none. City of Meriden, Attorney Moore? Absent. Assistant Attorney General Michael Wertheimer?

MR. MICHAEL WERTHEIMER: Good afternoon. Michael Wertheimer for the Office of the Attorney General. I've got a couple of questions for the -- gee, I can't see your thing. Is it Mr. Walling, is that correct?

MR. WALLING: That's correct.

MR. WERTHEIMER: See? I was paying attention. The presentation that you provided first thing this morning entitled, Risks Related to System Resonant Behavior Introduced by Transient Cables, that presentation was based on the use of AC lines, is that right, for the route?

MR. WALLING: That's correct.

MR. WERTHEIMER: Okay. And getting back to another concept that was discussed this morning about transmission engineering for -- electric transmission engineering for dummies. There was also discussion today about the use of HVDC cables and you heard all of that?

MR. WALLING: Yes, I did.

MR. WERTHEIMER: Can you just give a brief discussion to the extent you're able about the different qualities characteristics of AC versus HVDC and how if at all it would impact the study or the analysis that you provided to us first thing this morning?

MR. WALLING: It probably would be most appropriate to address the second -- the last question first and then see if we still need to address the prior one. The change that it would make, and we have not studied this, is that within the cable part of the system that the system strength would not be as strong and depending on the DC technology used it might introduce a substantial increase of capacitance at the converter stations. Capacitance on the DC line exist, but it's relatively irrelevant. It does not directly add into the capacitance of the AC system. So it's not been specifically analyzed and if it's conventional DC raises some pretty significant questions regarding some of these same resonant issues that we've talked about where it might even be made worse. If it's the voltage source converter DC it's somewhat different, but we have not studied it.

MR. WERTHEIMER: When you say, different, can you give a direction or is it --

MR. WALLING: Well, the voltage source DC does not require the large shunt capacitor banks adding capacitance to the AC system as large, it requires a small amount of harmonic filtering. And it does have the quality of providing some degree of system strength contribution, but it's relatively small. Not anywheres near the strength the system that you would have if the loop were closed with an AC cable.

MR. WERTHEIMER: Thank you. On the same subject, Mr. Scarfone, this afternoon you said that one of the problems that you had with the DC line was that it would be hard to connect new substations in the future should any of those be necessary, do you recall that?

MR. SCARFONE: Yes, I do.

MR. WERTHEIMER: When you said, one of the problems, I was wondering if there were others?

MR. SCARFONE: I think Roger Zak in

earlier testimony had indicated the other problems.

MR. WERTHEIMER: Okay. So there's nothing else that you all want to put out there relative to HVDC versus AC?

MR. SCARFONE: I was specifically talking about the interconnections of new substations similar to what we're doing at Haddam Neck and Tracey -- or Haddam and Tracey.

MR. WERTHEIMER: Okay. And Mr. Zaklukiewicz, I'll give you the same opportunity. Anything else you want to put on the record with respect to HVDC versus AC?

MR. ZAKLUKIEWICZ: The item I think that was removed from the table by Chairman Katz was the cost factor that is significant in the study done by Black and Veatch. I believe we're talking in the hundreds of millions of dollars depending on whether we're talking in overhead transmission connection of the HVDC terminals and significantly greater if we're talking in underground cables between the HVDC terminals.

MR. WERTHEIMER: Okay. Thanks. That's all I have.

CHAIRPERSON KATZ: Great. And we had asked for briefs on the impact of the new legislation and if you can include in that what you feel the Council's obligation to look at costs is under the new legislation we'd appreciate the insight of all of you on that. Mr. Tait?

MR. TAIT: I was also wondering whether --

MR. FITZGERALD: Is there a due date for that?

CHAIRPERSON KATZ: Did we have a due date set? Mr. Cunliffe, did we set a date on that?

MR. CUNLIFFE: We just recently sent out a memo on that and I would like to say July 19th, subject to check.

CHAIRPERSON KATZ: Okay.

MR. TAIT: -- the issue occurred to me is that assuming we feel that overhead will remove EMF considerations, whether the Council has an option to do that in light of the legislation that says it goes underground without mentioning EMF's regardless of costs, what options do we have under the statute to say, the statute was passed with EMF's in mind, if we can solve EMF's in one way can we go that way or do we have to do what the legislation says and the presumption they created?

CHAIRPERSON KATZ: We are very serious

that we are expecting -- hoping for thoughtful analysis of this new territory for all of us. Okay. Mr. Wertheimer, that completes yours. Okay. The City of Bridgeport, Attorney Howlett? Absent. Communities for Responsible Energy? OCC, Mr. Johnson?

MR. BRUCE JOHNSON: No questions of the panel.

CHAIRPERSON KATZ: Mr. Johnson says no question. Woodlands Coalition?

MS. RUTH ANN WIESENTHAL-GOLD: Madam Chairman, at this time due to the unavailability of our attorney we -- I'm sorry. Ruth Ann Wiesenthal-Gold. Do you want me to spell it? Ruth Ann, two words, R-U-T-H-A-N-N. Last name, Wiesenthal-Gold, W-I-E-S-E-N-T-H-A-L hyphen Gold, G-O-L-D.

CHAIRPERSON KATZ: Go ahead.

MS. WIESENTHAL-GOLD: We reserve the right to cross examine at a later date.

CHAIRPERSON KATZ: Thank you.

MR. TAIT: Ms. -- Ruth Ann, is there anybody in that office that might help you by being present here so they have some idea of what's going on rather than going over new territory, reinventing the wheel when they show up, when Larry comes back?

MS. WIESENTHAL-GOLD: We will be working to keep Larry abreast so that he doesn't have to backtrack and fill --

MR. TAIT: Or call back witnesses from far places?

MS. WIESENTHAL-GOLD: -- right. We understand that Mr. Gregory is not exactly next door, although I think that we should maybe go there to cross him. That idea has been rejected, but we will work to keep him informed.

MR. TAIT: Okay. Keep Larry informed.

MS. WIESENTHAL-GOLD: Yes. Thank you.

CHAIRPERSON KATZ: We tried to get a trip to Scandinavia at Cross Sound and it didn't work. ISO New England, Mr. MacLeod?

MR. ANTHONY MacLEOD: Thank you Madam Chairman. Good afternoon Mr. Walling, good afternoon Mrs. Pratico. I guess I just wanted to start out by framing the perimeters, the purpose for which your study was performed, and I'm assuming of course that that's performed with the ultimate goal of assuring that the transmission upgrade that has been proposed, and the other transmission upgrades that you've studied, contribute to a system that is operable and reliable?

We're on the same page there aren't we?

MR. WALLING: That's correct.

MR. MacLEOD: Okay.

MR. WALLING: However, not all of the studies were carried to that degree. Some of the studies were carried to a initial scoping level.

MR. MacLEOD: At which point you basically said there's no -- there is a fatal flaw, to use your terms?

MR. WALLING: I believe in some of the cases a fatal flaw wasn't found, but it's not sufficient to say that the extent of that study is enough to say that there was not a fatal flaw. It was just a minimal effort to see if there was a obvious fatal flaw.

MR. MacLEOD: Kind of an initial screening, if you will?

MR. WALLING: That's correct.

MR. MacLEOD: Okay. And I heard the testimony that was given previously, your testimony in response to I think Mr. Ball's questions in which there was some characterization of the conclusions that you reached in your studies. Let me take first the March 2003 study, which I think was your study of the proposal as submitted by the Applicants, is that correct?

MS. PRATICO: In March? Did you say March 2003?

MR. MacLEOD: I believe I did. Connecticut Cable Transients and Harmonic Feasibility Study?

MS. PRATICO: That's not the proposed system.

MR. MacLEOD: Okay. I'm --

MS. PRATICO: You may be talking about one of the November 2003 studies, which is the Middletown to Norwalk 24 miles, which included a seven percent reactor.

MR. MacLEOD: -- okay.

MR. PRETE: I believe the March '03 study was an attempt to understand all underground and that study we asked GE to perform was all XLPE from Middletown to Bethel.

MR. MacLEOD: Okay. Thank you. I appreciate that.

CHAIRPERSON KATZ: Middletown to Bethel?

MR. PRETE: Yes ma'am. Would you like to know why?

CHAIRPERSON KATZ: Okay. I'll bite.

MR. PRETE: At the time this particular Middletown to Norwalk project in the -- about a year ago we were on the throws of a muny consultation and we needed to know to what extent the underground would limit our feasible reliable solutions. So we had asked GE in concert with the proceedings of Docket 217 to do an all underground to find out if it was technically feasible. And the result of that study proved that it was not.

CHAIRPERSON KATZ: Okay. There's this sort of 217 vintage.

MR. PRETE: Well again, if we were going to approach the CEO's of the effected towns we needed to have concrete evidence because it became a lot wiser.

MR. MacLEOD: Let me then reference to whatever the study says, since it will speak for itself. I'll just ask you, do you feel in your own mind that you have recommended the Applicant's proposal at this point?

MR. SCARFONE: The final proposal as it stands right now we have not formally studied.

MR. MacLEOD: Okay. So again, further study is necessary before you're willing to sign your name to the Applicant's proposal as --

CHAIRPERSON KATZ: Let's let him please elaborate on what --

MR. MacLEOD: -- okay.

CHAIRPERSON KATZ: -- you said you have

not studied the Applicant's proposal as it now stands. Is this because of the two percent versus the seven percent reactor?

MR. WALLING: At least that. Is there any -- okay. That is the sole issue.

CHAIRPERSON KATZ: Okay. Thank you.

MR. MacLEOD: And I gather your purpose was not to recommend anything but to say whether their proposal would work, not that you recommend --

MR. WALLING: That's correct. We're looking for technical roadblocks to that solution.

MR. MacLEOD: -- you're not recommending anything. There might be a more reliable one that if you were asked to recommend as being more reliable?

MR. WALLING: That's correct. Nor were we addressing a multitude of other issues, including economics, maintainability.

MR. MacLEOD: Thank you.

CHAIRPERSON KATZ: But is there a chance when you do the study of the two percent versus the seven percent that you could find a fatal flaw?

MR. WALLING: That's a possibility.

CHAIRPERSON KATZ: Thank you.

MR. MacLEOD: I'm fascinated by the use of the term, fatal flaw. Are there -- are there flaws which are quite risky in terms of reliability that are not included within your characterization of being fatal?

MR. WALLING: I guess a fatal flaw would be one that would be infeasible to design against. Other flaws can be something that can be Band-Aided. However, anytime you come to a Band-Aid type solution there is a lack of engineering robustness to those solutions, which means they may have to be revisited in future as the system changes. And also there's always -- I mean, right now today a lot of these events do not create any significant over voltage with any of the planned things there's some degree of over voltage which did not appear before, there's always an increased risk when that happens.

MR. MacLEOD: So again, getting to the import to which the term, no fatal flaws, should be given you're not saying that just because you had not identified fatal flaws that the result is a reliable system? Did I have too many double negatives in there?

MR. WALLING: Any change to a system can have an effect on reliability to the system and you can get caught in the definition of exactly what is a reliable system. From the standpoint of load fault and stability analysis there are very defined rules to define what is a reliable system according to NERC criteria.

MR. MacLEOD: Let's take it from a different angle then. If you were designing a system from scratch today would you design a system which operated somewhere between the 2nd and 3rd harmonic or would you encourage design of a system that was somewhere above the 3rd harmonic?

MR. WALLING: I recognize that there are risks of being in that low order resonance regime and it would have to be viewed on a total project need requiring what are the trade-offs, the bigger picture, both you know, economically and whatever else drives that. I have been involved -- I should clarify that there are systems with very low frequency resonances have not been created by adding cables to systems, it's been with HVDC systems in weak system locations. Generally these are remote from habitated areas, or at least not near any heavily habitated areas and not very close to other -- much other utility equipment.

The engineering of these systems has required a lot of critical engineering design and a good degree of risk taking by the utilities involved in it.

MR. MacLEOD: Well, let me get back to

just the plain question. I understand that there could be circumstances in any particular case, which would effect your decision making. But if somebody asks you just on the basis of harmonic resonances alone, is it -- is it a good idea -- let me rephrase that. Is it good practice to design a system to result in harmonic resonances that are typically below the 3^{rd} harmonic?

MR. WALLING: As I pointed out in the --

MR. MacLEOD: With other considerations aside, and that could be --

MR. MacLEOD: -- that would be -- as I pointed out in the presentation this morning that there are increased risks in operating in that regime.

MR. MacLEOD: -- I looked at your Chart Eight, excuse me, I think it's page eight, maybe it's page nine, of your presentation. Page nine.

MR. WALLING: Okay.

MR. MacLEOD: It's the multi-colored chart and I guess I tended at first to see the area between the red and green as gray rather than whatever color it is.

MR. FITZGERALD: You've got one of those black and white copies?

MR. MacLEOD: Well, I looked at it that way first, but let me just ask you first before that, I've seen your reference in your study to low order harmonics. What is low order harmonics? Is that 2nd hand, 3rd?

MR. WALLING: Okay. For example, if -- yeah, anything below 5th is generally referred to as a low order harmonic in the industry.

MR. MacLEOD: Okay. I assume in looking at the chart then that in terms of safety at least you're more safe above the 3rd harmonic than you are below it?

MR. WALLING: I believe my presentation this morning implied that.

MR. MacLEOD: Yeah. Okay. And it would appear from the chart as if the rest of New England operates above the 3rd harmonic?

MR. WALLING: I've not done a detailed study of all of it, but I cannot -- would not expect that to be the case. An exception would be several years ago when the Comerford HVDC converter terminal was in operation and that was a very low order resonant problem at that converter station.

MR. MacLEOD: Does this speak pretty much as of today or as of the time it was done?

MR. WALLING: I believe so. And I also might add that that issue in sensitivity of weakness to the system is one of the reasons why New England Electric decided to decommission the Comerford terminal from the Quebec intertie.

MR. MacLEOD: Looking at that chart, you know, perhaps it's appropriate to look at that middle as caution, as yellow caution? Is that basically -- I think you said something this morning in your testimony as a matter of fact?

MR. WALLING: That's the color. That's a good interpretation.

MR. MacLEOD: Okay. Comparing the points CT-2 and CT-4, which both appear to be given the scale of precision of the chart approximately the same harmonic level, is that correct?

MR. WALLING: That's correct. However, one should recognize that the system at CT-2 is a system with all capacitor banks on, which would not be the typical operating situation. But also CT-4 also was with all capacitors on as well.

MR. MacLEOD: Right. So it's apples to apples there, correct?

MR. WALLING: It is. It is apples to apples.

MR. MacLEOD: Just looking at it on that

basis, which system -- because -- because CT-4 looks like it's a stronger system does that mean it's a better system than CT -- would be a better system than CT-2?

MR. WALLING: I would -- well, for many other aspects outside of my scope of study I would expect that from the standpoint of voltage stability and whatever else it would be a better system.

MR. MacLEOD: Okay. I think with respect to filters earlier this morning you said something to the effect that when you tune a filter to filter out a particular harmonic, and I think you were talking in terms of 2nd level that that would introduce resonances below the 2nd harmonic level, is that correct?

MR. WALLING: Yes, that's correct.

MR. MacLEOD: So would the same be true if you put a filter on to filter out resonances at the 3rd harmonic level, that you would introduce resonances below the 3rd harmonic?

MR. WALLING: That's correct. And often it comes out to land dead on 2nd harmonic.

MR. MacLEOD: Okay. So the more filters you put into a system to tune out the 3rd harmonic then the more resonances you're creating that tend down toward the 2nd harmonic?

MR. WALLING: That's the general nature.

MR. MacLEOD: And if I understood the import of your presentation this morning, that's not good?

MR. WALLING: That's not good.

MR. MacLEOD: Thank you. Your studies did not actually pinpoint any amount of miles that would be acceptable for underground cable, did they?

MR. WALLING: That was not the scope of our study.

MR. MacLEOD: Right. Okay.

CHAIRPERSON KATZ: Mr. MacLeod, we're going to have to go over some homework assignments. I just want to get an idea of roughly how much more cross you have? Because I might ask you to continue it on Thursday.

MR. MacLEOD: Yeah. I may have as much as 20 to 30 minutes.

CHAIRPERSON KATZ: Okay. I'm going to ask you to continue on Thursday. Is there any like a thought question that you need to leave with them?

MR. MacLEOD: I don't think so Madam Chair.

CHAIRPERSON KATZ: Okay. Ms. Randell?

MS. RANDELL: Yeah. If there's only 20 more minutes of cross for Mr. Walling and Ms. Pratico we're going to haul them back Thursday for 20 minutes?

MR. MacLEOD: Well, will they be here in July? If I remember?

MS. RANDELL: Mr. Walling says he'd be thrilled to come back on Thursday.

CHAIRPERSON KATZ: Great.

VOICE: Is that what happened between here and there?

MS. RANDELL: I believe -- it's sort of my interpretation.

VOICE: Oh, okay.

CHAIRPERSON KATZ: But we do have other -- Ms. Randell, we do have other Intervenors I haven't even called yet. So --

MS. RANDELL: Right.

MR. FITZGERALD: Could we take a poll to see if people have -- not for the GE people, but for Brian Gregory, could we just take a poll and find out if people are going to -- if there are unasked questions for Brian Gregory on Thursday?

CHAIRPERSON KATZ: Can I have a show of hands from people who have questions of Mr. Gregory? Mr.

Cunliffe, do we have further questions of Mr. Gregory?

MR. CUNLIFFE: Only the table that he was going to compile and if we needed to scope that form. He had a homework assignment.

MR. FITZGERALD: Right.

CHAIRPERSON KATZ: Yes.

MR. FITZGERALD: Well, maybe we could take care of that quickly tomorrow so that he wouldn't have to stay over till Thursday.

CHAIRPERSON KATZ: Well, we can try doing that first thing in the morning. As long as I don't get in trouble with people that we're cutting into their EMF time, but you'll work that out I'm sure. Okay. Okay. What we're going to do then Mr. MacLeod, we're going to ask you to continue your cross examination on Thursday.

MR. MacLEOD: Okay.

CHAIRPERSON KATZ: Because before 5:00 o'clock I want to go over a list of what we visualize as homework assignments and if there's a discussion then we need to have that. So Mr. Cunliffe, do you want to read your list?

MR. CUNLIFFE: Thank you Chairman. The Council is looking for additional studies of the HVDC both in harmonic and load flows for conventional technology and the HVDC Light.

CHAIRPERSON KATZ: Let us read the whole list then we can discuss.

MR. CUNLIFFE: And fault conditions with load pick-up. We'd also like to see studies of the XLPE versus the HPFF cable in harmonic and load flow studies. As for the proposed route the additional 20 miles of underground and the additional 40 miles of underground.

Also we would add to that studies of harmonic resonance mitigation. And lastly, the -- I believe you've already committed to a study for the four two percent series reactors for the proposed route.

MR. FITZGERALD: Could we take those from the top again?

CHAIRPERSON KATZ: You want to read that again? What I want to -- what I'm going ask you to do is I'd like you to walk out of the room with an understanding of what we're asking for. What I'm going to ask you to do is at a pre-hearing conference tomorrow morning to comment on the feasibility of doing that and the timing. So I'm not looking for that today. I just want everyone to walk out of the room with an understanding of this list.

MR. TAIT: I thought we also wanted Mr.

Zak to talk about EMF's on DC?

CHAIRPERSON KATZ: Yes. But that's Dr. Bailey.

MR. FITZGERALD: Oh, that was -- okay. Yeah, that's easy.

CHAIRPERSON KATZ: Yeah. Okay. Mr. Cunliffe, let's go through it again, one at a time?

MR. CUNLIFFE: The Council is seriously looking at the high voltage DC and there's no way to be able to compare it with the proposal without knowing what it's harmonic characteristics are and it's load flows. So you're going to need to be able to document that both in the conventional technology and the HVDC Light and to include the fault conditions for those two systems.

CHAIRPERSON KATZ: Does everyone understand that one? Okay. Let's go on.

MR. CUNLIFFE: The second was --

CHAIRPERSON KATZ: Hold it just a second.

MS. DONALDSON KOHLER: Is that DC scenario underground or above ground?

VOICE: Both.

MS. DONALDSON KOHLER: Both? Thanks.

CHAIRPERSON KATZ: Okay. Let's go on to the next one.

MR. CUNLIFFE: The other one is the comparison of the XLPE cable versus the HPFF. Again, we need to be able to compare the characteristics from a harmonic resonance and the load flows. As for the proposed route --

CHAIRPERSON KATZ: Wait a minute.

MR. FITZGERALD: Okay. This is --

CHAIRPERSON KATZ: Say it quick.

MR. FITZGERALD: -- no, I was asking for further detail than he's giving.

CHAIRPERSON KATZ: Okay. Okay.

MR. CUNLIFFE: You want to be able to compare those two as the proposed route that you have before the Council for the additional 20 miles of underground that has already been looked at and the additional 40 miles of underground.

CHAIRPERSON KATZ: So right now the proposed --

MR. CUNLIFFE: So you've probably already done some of this -- no? None of this?

VOICE: None of this.

MR. CUNLIFFE: Okay. Alright. Alright. Isn't it done for HPFF? I mean, your analysis included the HPFF for all those three scenarios, now I want to add

XLPE.

MR. FITZGERALD: You want to substitute XLPE?

MR. CUNLIFFE: Yes. Yes.

CHAIRPERSON KATZ: Okay. They're nodding. I think they understood.

MR. CUNLIFFE: Okay. We want to be able to understand what the harmonic resonance mitigation is for these two systems.

CHAIRPERSON KATZ: GE testified they did not get into mitigation factors. Correct?

MS. PRATICO: Which configuration are you talking about looking at mitigation for?

MR. CUNLIFFE: For all of the HVDC and the XLPE. And for the proposed.

MS. PRATICO: For HVDC or for XLPE?

MR. CUNLIFFE: I think you're going to need to speak to all the technologies and what the measures are that could be used. I mean, they may be specific to the technology and it could be generic to all of them.

MR. WALLING: I think most of the work would tend to be generic. The application specifics might be specific, but the body of work is relatively generic.

CHAIRPERSON KATZ: That's fine. That's fine.

MR. CUNLIFFE: And the studies for the four two percent reactors I think you've already said that you have in line to be done. That was the harmonics and the load flows.

CHAIRPERSON KATZ: Because we had testimony again that there may be a fatal flaw, but they don't know yet.

MR. FITZGERALD: Right. I mean, that is a study that was begun -- the thing that's been studied the most, I mentioned that this fully came out today, the thing that's been studied the most is the proposal. And the level of studies that have been done for the proposal is significantly different. The level of things that have been looked at is significantly greater than those for the other things. And it's at the point where they were looking at, well, where are we going to put the reactors? So now they're ready to do another study on the proposal, or they were ready some time ago, but it got deferred for these other things.

These proposals, or these -- if they were under -- I have to talk to them, but I suspect -- XLPE for an additional 20 miles, whatever, that's just not comparable to the study of the proposal with the -- with the series reactors. So that that study is not going to have series reactors in it. The nature of the beast is you've got to get -- you've got to narrow yourself down to something that you're really thinking you might build before you start building in all these -- the finals.

CHAIRPERSON KATZ: I think we have an understanding that some of these things will be done at a higher level to see if they're feasible. Anyway, this is -- now that there's an understanding of what this is I'd like the people to come into the pre-hearing conference tomorrow morning with a discussion of the feasibility and the timing of doing these things.

MR. FITZGERALD: Right.

CHAIRPERSON KATZ: Mr. Cedarbaum? Wait a minute. Just a second. Yes, go ahead?

MR. EUGENE E. CEDERBAUM: Did I understand with regard to the mitigation studies that there were three subsets to that, one for the proposal, one for the HVDC and one for the XLPE?

MR. CUNLIFFE: Yes.

MR. CEDERBAUM: Okay. Thank you. I just couldn't read my notes. Thank you very much.

MR. ASHTON: Madam Chairman?

CHAIRPERSON KATZ: Yes?

MR. ASHTON: Since any comprehensive studies which this apparently is ordaining, or at least ordain that you consider it, considers transient stability to determine the adequacy of the system I would add that I would like comments on what stability studies have been run and how the different configurations might respond for a stability test too. I'm not -- this is not transient network analyzer study, but transient stability study is a different bred of cat. I know that they're complicated like T&A studies, but I'd like to hear what has been done and how that fits into the overall picture.

MR. SCARFONE: We have -- Mr. Ashton, we have started some sensitivity tests --

COURT REPORTER: Start over again.

MR. SCARFONE: -- Mr. Ashton, we have started some sensitivity testing for stability analysis that you requested at the last set of hearings.

MR. ASHTON: Okay. Thank you very much.

CHAIRPERSON KATZ: Okay. Is everyone clear on what we'd like you to think about overnight? And then start thinking about what you're doing the week of September 27th.

MR. S. DEREK PHELPS: The week of September 27th. Either that or the week of the 17th.

CHAIRPERSON KATZ: We've got high holidays in there somewhere.

MR. PHELPS: Yeah. I think there are holidays involved in the week of the 17th. The third week and the last week.

CHAIRPERSON KATZ: Yeah. Okay. Any procedural matters we need to cover before we adjourn for today? So tomorrow morning we'll have this pre-hearing conference, we'll have a brief report on Mr. Gregory and then we will go to -- into EMF and EMF mitigation and then after lunch I believe Representative Aldinolfi has a brief witness and then we're going to go into DOT after lunch. Any questions?

MR. PHELPS: Madam Chair?

CHAIRPERSON KATZ: Yes?

MR. PHELPS: The towns are meeting at 9:15. Our pre-hearing is at quarter to 10:00.

CHAIRPERSON KATZ: Okay. Thank you.

(Whereupon, the hearing adjourned at 5:05 p.m.)

HEARING RE: CL&P and UI
JUNE 15, 2004

INDEX OF WITNESSES

INDEX OF APPLICANT EXHIBITS

CERTIFICATE

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