Regulatory File Cy.

REGULATORY DOCKET FILE COPY

UNITED STATES ATOMIC ENERGY COMMISSION

IN THE MATTER OF:

CONSOLIDATED EDISON COMPANY

(Indian Point Station, Unit No. 2)

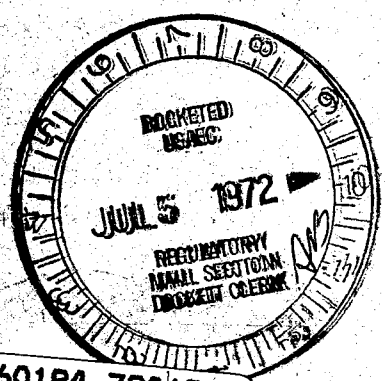
Docket No. 50-247

Place - Croton-on-Hudson, New York

Date - 20 June 1972

Pages 5919 - 6062

DUPLICATION OR COPYING OF THIS TRANSCRIPT BY PHOTOGRAPHIC, ELECTROSTATIC OR OTHER FACSIMILE MEANS IS PROHIBITED BY THE ORDER FORM AGREEMENT



Telephone:
(Code 202) 547-6222

ACE - FEDERAL REPORTERS, INC.

Official Reporters

415 Second Street, N.E.
Washington, D. C. 20002

NATIONWIDE COVERAGE

REGULATORY DOCKET FILE COPY

CR 6447
Waga

mil-1

UNITED STATES OF AMERICA

ATOMIC ENERGY COMMISSION

In the matter of:	
CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.	Docket No. 50-247
(Indian Point Station, Unit No. 2)	

Springvale Inn
Croton-on-Hudson, New York

Tuesday, June 20, 1972

Hearing in the above-entitled matter was reconvened, pursuant to ~~adjournment~~ notice, at 9:00 a.m.,

BEFORE:

SAMUEL W. JENSCH, Esq., Chairman, Atomic Safety and Licensing Board

MR. R. B. BRIGGS, Member

DR. GEYER, Member

APPEARANCES:

(As heretofore noted.)

mi12

CONTENTS

P R O C E E D I N G S

CHAIRMAN JENSCH: Please come to order.

Did the parties have an opportunity to confer after the recess last evening to develop an agenda for today?

MR. MACBETH: Yes, we did, Mr. Chairman. I have now rephrased three contentions. If you like, I could read ~~them~~ Hun at this point. These will be them subject to cross-examination today after we finish the topics we began with Dr. Lawler and Dr. Raney.

The third one will be the matter for stipulation between the parties. We won't put the contentions on the record at this time.

CHAIRMAN JENSCH: I didn't hear the last thing you said.

MR. MACBETH: The third contention I will read at this point is one on copper concentrations which will be a matter of a stipulation between the parties and then so direct testimony at a later date from the Intervenors.

CHAIRMAN JENSCH: Let us continue with your interrogation of Dr. Lawler, please.

MR. MACBETH: Dr. Lawler, I would like to pick up just one point that I missed yesterday. Let us go back to the situation in which we have the present configuration and the discharge at Indian Point. We have a situation in which Indian Point 1 alone is working.

You said there that there would be a recirculation

eak 2

of .2 degree, I believe. Was that for a full flow or reduced flow?

Whereupon,

DR. JOHN P. LAWLER

resumed the stand, and having been previously duly sworn, was examined and testified further as follows:

CROSS-EXAMINATION (continued.)

DR. LAWLER: I am quite sure it was for reduced flow. Let me just check my notes. Yes, that was for throttle flow condition.

MR. MACBETH: That was the intake at Indian Point 1 that the measurement was made on, is that correct?

DR. LAWLER: That is correct.

MR. MACBETH: What would you expect to find at the intake of Indian Point 2?

DR. LAWLER: Based on the comments I made yesterday, I would expect to find of the same order.

CHAIRMAN JENSCH: Would you use the microphone, Dr. Lawler, please.

DR. LAWLER: Certainly.

CHAIRMAN JENSCH: Carry the case, if you will, please.

DR. LAWLER: Fine. I will repeat that. Based on the testimony I gave yesterday, I would expect the recirculation in the second unit, in the area of the second unit to be the same, approximately.

eak 3

MR. MACBETH: Let me turn now to the thermal plume, the spring temperatures at which the fish could migrate up the river.

When the river temperature is at 45 to 50 degrees at Indian Point 1 and Indian Point 2 are operating at full power and full flow, at the most adverse part of the tidal cycle, where would you calculate the one degree isotherm would fall both at the surface and also through the water column?

CHAIRMAN JENSCH: I think we are losing the last part of your answer. I think you feel it's kind of a conversation between you two. If you would keep your voices up, we would appreciate it.

MR. MACBETH: Fine.

DR. LAWLER: I would expect the one degree isotherm to be seen generally throughout the entire area. This is the temperature rise that you would expect to see beyond the very near field -- the plume.

MR. MACBETH: When you say throughout the area, would it extend to the other bank of the Hudson?

DR. LAWLER: It's possible that it could.

MR. MACBETH: Would that be at the surface only or also through the water column?

DR. LAWLER: I would not expect it to be through the water column. I would expect it to be in the upper depths, or upper quarter of the water column, upper half.

MR. MACBETH: When you say the upper half, the upper quarter, is that an estimate for all types of the day or would there be some periods that it would be more likely to be in all of the upper half and other times just in the upper quarter?

DR. LAWLER: I think you are trying possibly to be too specific about this. We would expect to see a one-degree rise, or thereabouts, as the overall effect of the condition

which you have described, in the general vicinity of Indian Point. There would certainly be places where the temperature would not be as high as one degree, and there would be other places where the temperature would tend to range between one and two degrees.

MR. MACBETH: You say there are other places where it would tend to range between one and two degrees. Is that, again, generally through the entire cross section perpendicular to Indian Point and through the upper half of the water column?

DR. LAWLER: It's certainly not with the entire cross section. I would limit the appearance of any kind of measurable temperature rise over any significant extent to the upper half of the water column, the so-called upper layer of the river's flow.

MR. MACBETH: Assume that at the same time the Lovett Plant is operating at full power, obviously the south point on the opposite bank, would its -- where would the one-degree isothermal in that plant fall?

DR. LAWLER: Well, the one-degree ~~isothermal~~ isotherm at the Lovett plant tends to be generally on the west side of the river. We have made many measurements at the Lovett plant.

The temperatures tend to move to the south during an ebb tide and move to the north during a flood tide, but generally appear on the west side of the river.

MR. MACBETH: When you say the west side, are you talking roughly half the river or an area closer to the bank there?

DR. LAWLER: Well, the one-degree ~~isothermal~~ isotherm -- I better refer to some notes on the one-degree ~~isothermal.~~ isotherm

My notes show that the one-degree ~~isothermal~~ isotherm from the Lovett plant ranges anywhere from virtually zero during some tidal conditions to a maximum of 50 percent under the low water slack condition at approximately 750 feet north of the plant.

MR. MACBETH: How far downstream does the one-degree isothermal from Indian Point extend?

DR. LAWLER: I would expect to see one-degree water from Indian Point, as I testified a moment ago, in the entire vicinity, in the area we are talking about.

CHAIRMAN JENSCH: Excuse me. I wonder if you could give us a little more specificity. What is the entire area you are talking about?

DR. LAWLER: I would expect to see the one-degree isothermal move to a flood tide north in the Peekskill area, and at ebb tide I would expect to see it move south beyond the Stoney Point into the head of Haverstraw Bay.

MR. MACBETH: Would there be conditions under which the one degree isothermal at Indian Point and the one-degree isothermal from Lovett would cross, or is it always a

condition where we have first the isothermal from Lovett and then an ambient condition and then the plume from Indian Point?

DR. LAWLER: You don't really talk about one-degree isotherms crossing. You either have one-degree or you don't. I would say that the appearance of one degree to the south of Lovett plant during an ebb tide, as I just said a moment ago, extending beyond the Stoney Point, which is roughly a half-mile to a mile below the Lovett plant, would be the net result of the two units at the Indian Point operating as well as the one unit -- as well as the five units at the Lovett plant operation.

MR. MACBETH: How far down the water column would the one-degree isothermal at Lovett be?

DR. LAWLER: I would refer to some notes again at that point.

#2

mil-1

MR. MACBETH: Yes.

DR. LAWLER: The notes show that the percentage of the river's cross-section, which is one way of measuring what you are after, would generally be less than five percent due to the Lovett plant discharge.

Let me rephrase that. The one degree isotherm resulting from the Lovett plant discharge generally will consume -- consume is a poor word. Let us say extend over no more than five percent of the river's cross-section, and generally it will be concentrated toward the surface and extend over lesser and lesser a lateral distance as one moves down in depth.

MR. MACBETH: Let's take the situation where, again, Indian Point 1 and 2 are both operating at full power, but at reduced flow at the same temperature, 45 degrees to 50 degrees. What would be the pattern of the one degree isotherm from Indian Point 1 and 2?

DR. LAWLER: We would expect it to be identical to what I described over the last set of questions. I don't think the throttle flow case will materially affect the distribution of the one degree isotherm.

MR. MACBETH: Let us assume only Indian Point 2 is on line. The first full flow, will it have the same condition or different conditions?

DR. LAWLER: Generally you would have the same condition, but it would be less extensive because you are

mil-2

dealing with roughly 60 percent of the heat load that you are looking at when you include the Lovett plant and Unit 1 at Indian Point.

MR. MACBETH: I was leaving Lovett out for the moment. I was looking at the plume from the Indian Point side.

DR. LAWLER: I'd like to point out that my description of the extent of the one degree isotherm includes the effect of the Lovett plant.

MR. MACBETH: When you describe the situation with Indian Point 1 and 2 both on line, and said the one degree isotherm had extended across the river, did that include the Lovett plant?

DR. LAWLER: Yes, it did.

MR. MACBETH: What would the condition have been if the Lovett plant was not operating?

DR. LAWLER: Well, it is very difficult to say. Basically what it would come down to is that there might still be a section where you would see a one degree effect. It would be certainly less of an effect than you see when both stations are operating.

MR. MACBETH: Could you give an indication of how much less?

DR. LAWLER: Well, it is really very difficult to describe a one degree isotherm. The thrust of the whole thing is, you have so much heat and you have so much

mil-3

capability of the river to dissipate and dilute and move that heat. The net result of all this is, you tend to see an average of one degree or slightly higher than one degree in the upper reaches of the river in that general vicinity. If I reduce the case to -- that case I just described is for both units at Indian Point and the full operation at Lovett. So proportions may be pertinent here.

The total heat load that would affect that case consists of 20 percent due to the Lovett plant, 20 percent due to the first unit at Indian Point, and 60 percent due to the second unit at Indian Point. So if you are looking at only the second unit at Indian Point, your heat load to the river is roughly 60 percent of the case that I described. As a rough statement, the extent of the one degree isotherm would be on the order of 60 percent of what it would be when all units are running.

MR. MACBETH: Would it make a difference in the way in which the heat was distributed vertically through the water column, or would it simply mean that over the 60 percent, the eastern side of the river, we would have the same kind of distribution to the water column as you described earlier?

DR. LAWLER: Well, again, the major concentration appears to be in the surface. Every field measurement that you make shows that the major extent of any of the isotherms including the one degree isotherm is at the surface. As you go down in

mil-4

the water column, the extent laterally, let's say, out from the shore, tends to be less and less. If you reduce the load, the extent of everything would tend to be less.

MR. MACBETH: By reducing it and having only Indian Point 2 operating, we would not get a more marked change in the depth to which the one degree isotherm would go as we would in the cross-section?

DR. LAWLER: Would you repeat that.

MR. MACBETH: You have described the situation in which, as we reduce the total heat load to the river to the Indian Point 2 plant, the cross-section of the one degree isotherm is reduced. Is it the same magnitude of reduction that is involved in the amount of water at 20 or 30 feet that would be reduced as well?

DR. LAWLER: Let me state it this way: I would expect the extent over which one sees the one degree isotherm, whether you are talking in depth or in the lateral distance, to decrease as the heat load decreases. It won't necessarily in every situation decrease precisely proportionately. From the kind of temperatures we are talking about, it would be very difficult to become any more specific than I have been.

MR. MACBETH: Let us take the situation with a three degree isotherm, and again when the river ambient is 45 to 50 degrees, Indian Point 1, Indian Point 2, and Lovett all operating at full power and full flow, would you describe

mil-5

the position of the three degree isotherm?

DR. LAWLER: The three degree isotherm is a much more local situation than the one degree isotherm. The precise location of the three degree isotherm would depend on the face of the tide and which plant you were talking about, and in general is not terribly extensive. You do see three degree temperature rises immediately in front of the Indian Point discharge. You would certainly expect to see three degree rises immediately in front of the Indian Point discharge. You also see three degree rises immediately in front of the Lovett discharge. When the tide is moving to the north, the appearance of the three degree isotherm in the Indian Point area is not terribly traumatic. You don't see too much three degree heat in a flooding condition.

At Lovett, for the -- when you talk about Lovett, you have to talk about the fact that the fifth unit at Lovett, which comprises roughly half the load at the Lovett plant, moves to the north. So that in a flood condition you would see three degree isotherms pretty much hugging the shore. I would say they extend between 150 and 300 feet out from the shore, and at the peak of the flood they would extend north on the order, at the most, 3000 feet.

In an ebbing condition, that discharge from the fifth unit at Lovett tends to break up, but you then see a similar condition for the first four units at Lovett which

mil-6

discharge south.

At the Indian Point plant, the three degree isotherm, it would appear it would generally tend to stay on the east side of the river and move south. I would not expect to see its appearance generally in the order of 3000 or 4000 feet. That ~~It~~ would be about the extent of it.

MR. MACBETH: Three thousand or four thousand feet downstream or cross-section?

DR. LAWLER: Downstream, its extent in the cross-section during an ebbing period at most would reach -- well, it varies, really. It would reach on the order of 1000 feet.

MR. MACBETH: And in the flooding condition?

DR. LAWLER: In the flooding condition, I indicated you won't expect to see it. It tends to break up in the flooding condition. The major temperatures you see in the flooding condition at Indian Point are two degrees and one degree.

MR. MACBETH: Would it be accurate to say that the largest extent of the three degree isotherm would be, at the cross-section, 1000 feet during the ebbing tide?

DR. LAWLER: During the ebb tide, that's correct. That is what I said. And that would appear to the south rather than to the north.

End 3

MR. MACBETH: It was during the ebb that you said the Lovett plume broke up and you would not see a three degree isotherm or would you see a small distance into the river?

DR. LAWLER: I indicated that the -- first of all, I would like to point out that I am referring to strictly surface isotherms here and not expect to see the three degree isotherm under any of these conditions much more than a couple of feet in depth.

The condition at Lovett during ebb, I think you just asked, would be at the northern directed discharge which is the unit 5 discharge and tends to break up. The southern directed discharge at the south end of the plant, in an ebb flow, tends to move along the east -- not the east -- along the west shore in the cove just to the north of the Stoney Point.

MR. MACBETH: How far would it extend into the cross-section of the river?

DR. LAWLER: Into the cross-section of the river?

MR. MACBETH: Yes.

DR. LAWLER: I would have to take a look at notes on that. I will have to draw on my recollection on that. I could check it for you later. I would say it is on the order of 500. It is between 500 and 1,000 feet. I will check that point.

MR. MACBETH: Now, let us turn for a moment to the depth in the water column which is the three degree isotherm

extent. Would you describe that for the Indian Point 3 degree isotherm during the ebb period and extending 1,000 feet.

DR. LAWLER: I think I indicated a few moments ago that the extent in depth to which you would expect to see this would be, at most, say two or three feet. That would not be over the full extent of the thousand foot. The thousand foot would be the maximum that you would see at one point along the longitudinal access of this three degree plume and the depth to which the three degree isotherm would extend at that section would be on the order of a few feet, as I indicated a moment ago.

MR. MACBETH: And that would be over virtually all of the 1,000 feet?

DR. LAWLER: No. I said it would not. It would start from zero and move down to the order of two or three feet and then extend for that depth perhaps half of that lateral extent and then move back to zero at the other end. What you have to picture here is a relatively narrow band of three degree water moving downstream. Its maximum width would be on the order of 1,000 feet. At that point in depth, the depth would extend from zero at either edge down to a few feet and then back to zero again.

MR. MACBETH: And roughly 500 feet would be a two to three foot depth?

DR. LAWLER: That is probably a good statement.

MR. MACBETH: And would the same proportions apply to

eak 3

the Lovett plume?

DR. LAWLER: No. In the Lovett plume you are talking of less total heat and the extent of the three degree depth as well as lateral extent as well as longitudinal extent would be less in the Lovett plume.

MR. MACBETH: I realize the width would be. Would it also extend to two to three feet over half of the width with a gradual fading away to zero at either end?

DR. LAWLER: I think that would be fair to say.

MR. MACBETH: That takes the situation of 45 to 50 degrees. If the ambient river temperature is at 60 degrees in the spring, would we find the same series of conditions -- I will take this piece by piece. Essentially, it would be the same situation again I covered in one question.

DR. LAWLER: I would expect to see the situation that I described to be essentially the same for the condition of 60 degrees.

MR. MACBETH: And the condition at 65 to 70 degrees?

DR. LAWLER: Yes, I would -- there will be differences or there can be differences. Those differences are of the lesser order than the numbers that I described. Basically, the only thing you are changing is the ambient temperature. You are not changing any of the other conditions, I presume.

MR. MACBETH: That is right.

DR. LAWLER: The ambient temperature will not have

eak 4

that much of a control and effect on the extent and the distribution of the isotherms. Of course, as you move from 45 to 50 and 55 to 60 degrees, you will change the real climatic and hydrological conditions which will have an effect on the distribution of isotherms.

MR. MACBETH: Could you describe the changes that you think would take place? I am not sure what kind of range and order of magnitude of change you are thinking about.

DR. LAWLER: Let me put it this way. The situation I described is for what we consider to be the minimum flow condition in the river, the minimum condition of dilution and mixing, dispersion and flow. It corresponds to a net downward movement of approximately 20,000 cfs. That is cubic feet per second. Take May of this year. This year's May was an extremely wet year, in fact, the wettest on record. The monthly average flow for this May was closer to 60,000 cfs than 20,000 cfs. So, from a straight dilution standpoint, the numbers that I described a moment ago would tend to be cut significantly.

In general, in the springtime condition that you are referring to, your flows generally are on the order of 30,000 to 40,000 cfs.

MR. MACBETH: Would the periods during which the ambient temperature of river water increased from 45 to 70 also be periods in which the run off was also increasing?

DR. LAWLER: Not necessarily. You made a big skip,

eak 5

from 45 to 70. You can generally see the run off increasing in March and April and sometimes in February, and the temperature changes that you are talking about of 45, you would expect to see in late March and April, and then the 70 you begin to see in June, toward the end of June.

So, the flow conditions that you will normally go through for that range would be first an increase and then, as you move into May and particularly into June -- I couldn't say the last few days to verify that. Generally your flows will drop off. That there fresh water run off will drop off, as you move up into the 70 degrees bracket, that is.

end 4

MR. MACBETH: Let me go back to the original case that we first discussed at 45 and 50 degrees.

I take it you have been assuming, in answering that question, that there is minimum fresh water run-off of probably 20,000 cfs; is that correct?

DR. LAWLER: I said that the net downward movement, the net effect -- and this is described in detail in several of the items of testimony put in -- will be on the order of 20,000 cfs. It's described in the testimony as the fresh water flow drops off, and you have a situation which assists the net dilution effect.

So 20,000, the number that I am describing, is not necessarily simply fresh water flow.

MR. MACBETH: Would the 20,000 also be a reasonable minimum to consider at 60 degrees?

DR. LAWLER: The 20,000 is certainly the minimum. I would say during conditions of 50 to 60 degrees, since you are talking the months of April and the early part of May, very often in most years you would have more than 20,000 cfs in the river.

MR. MACBETH: Assume 30,000, how much would that change the figures that you gave us for the three-degree isothermal at Indian Point?

DR. LAWLER: It isn't simply a reduction of 33 percent or 50 percent, depending on how you figure your

reductions.

In other words, if you move from 20,000 to 30,000, your 30,000 has the dilution capacity, strictly as flow alone, of 150 percent of what the 20,000 flow has.

You also have to factor in dispersion and other factors -- if you multiply the effect by two-thirds, you would be close to the situation I am describing.

MR. MACBETH: At the time when the river ambient is at 60 degrees, what would be a reasonable minimum for the -- I have the phrase wrong -- the net down-river movement as you described the term a moment ago?

CHAIRMAN JENSCH: We are losing those last words. They sound good.

MR. MACBETH: I believe Dr. Lawler described it as the net down-river movement.

DR. LAWLER: I would say that the reasonable minimum would vary between 20,000 as an extreme minimum, and 30,000 as a more normal condition during that period.

MR. MACBETH: What about the situation when the river ambient is between 65 and 70?

DR. LAWLER: Well, this is described in very great detail in several items of testimony. Generally I would not expect to see the net available dilutent to vary much beyond the 30,000 cfs.

There is some evidence that it's higher than this,

but as is pointed out in the testimony, you use what appears to be a more conservative estimate of that net dilution flow.

MR. MACBETH: I would just like to pick up two items briefly, from yesterday's testimony.

You described a situation when the river ambient was below 40 degrees in which the water being discharged from the Indian Point plant at a temperature higher than 40 degrees would be more dense than the river water. What would be the general pattern of that discharge water's movement?

Would it sink in the river?

DR. LAWLER: We don't have hydraulic model results on this condition. I would expect that the same order of temperature distributions would exist due to the mixing that takes place in the jet discharge. The actual location of the isotherms might be somewhat different.

In other words, you would not, I would expect, tend to see as much of a concentration at the surface as I described, but the amount of temperature would appear somewhere in the water column. I doubt that it's extensiveness would be much greater than what I have described previously.

MR. MACBETH: Do you know where in the water column it would appear?

DR. LAWLER: Not without some experimentation. I won't hazard a guess. I think it's fair to say that you would expect to see less of the temperature effect at the

surface than you do once your temperature exceeds 40 degrees. But beyond that I think it becomes conjecture.

MR. MACBETH: Let me try one more question on this; would you expect, in a situation where the ambient is below 40 and the discharge is below 40, woudl you expect the warm water to be near the bottom than the surface?

DR. LAWLER: It's really hard to say. You have this mixing effect. The whole thrust of it is as rapidly as possible, bring your temperature down to the order of the one to two degrees that we described before.

I suppose, if the density -- for instance, in the calculations that one makes with the submerged jet, when the density differential yields a density in the jet lighter than the ambient condition, you do tend to rise. So I suppose once you apply a density condition that is heavier, you would tend to move downward.

To say that it moves along the bottom, I wouldn't want to say that unless I had actual measurements to support it.

MR. MACBETH: I assume no measurements have been made at Indian Point 1 at the time of its operation. You have no direct test data on this situation, do you?

DR. LAWLER: I don't have any measurements that have been made under this condition. It's not the world's easiest thing to get out in the river under this condition.

There is usually ice out there, and it's probably the one time of the year that you are not out in the river making measurements.

MR. MACBETH: Finally, let me turn back to the chart on dissolved oxygen materials which we discussed yesterday.

Do you have any correction to make to that line of figures?

DR. LAWLER: I still haven't checked that point.

mil-1

MR. MACBETH: I have no further questions from this witness at this time.

MR. KARMAN: I just wanted to clarify one thing in my own mind.

Dr. Lawler, you indicated when you were discussing with Mr. Macbeth, the movement of that three degree plume, you indicated that it traveled in a narrow band. I believe you also said 1000 feet, is that correct?

DR. LAWLER: That's correct. I said that the band at its widest point -- and this is during an ebb condition now, might be on the order of 1000 feet.

MR. KARMAN: And that would be approximately what, one-fifth of the river's width?

DR. LAWLER: No. It would be closer to one-quarter of the river's width.

MR. KARMAN: I have nothing else.

CHAIRMAN JENSCH: Any redirect?

MR. SACK: Yes, Mr. Chairman.

Could we have a brief recess before the redirect?

CHAIRMAN JENSCH: Yes. At this time, let us recess, to reconvene in this room at 10:00 o'clock.

(Recess.)

CHAIRMAN JENSCH: Please come to order.

Have you concluded your examination with Dr. Lawler?

mil-2

MR. MACBETH: Yes, I have.

CHAIRMAN JENSCH: I wonder if you could give us a summary of your position with reference to the evidence that you developed in your cross-examination. That is with reference to your contentions.

MR. MACBETH: Well, this was in reference to the contention, two different contentions. The first is one that dealt with yesterday, the heated water that will attract fish to the intakes of Indian Point 1 and 2 that would be subject to impingement. There, the discussion, of course, was a question of whether or not there will be recirculation in warm water at Indian Point 2. There will be some more evidence later on the question of what the rate of fish kills has been at Indian Point 1. That is why I went into the question of what the recirculation temperatures have been in the past.

This morning, of course, I was dealing with, again, the kind of plume that would be present at the time when the fish are migrating, and that will be connected to the evidence on cross-examination of Dr. Raney as to where the attractive quality of the heated water for the fish is. I was pursuing these low figures since Dr. Raney said the fish are sensitive to and attracted by quite low temperatures.

We will ourselves later be putting on direct testimony on these issues as well. So that I have tried to clarify what I consider the important factual points in the

mil-3

Applicant's testimony. This is not our complete case on these issues. I think they probe the basis on which the Applicant opposes our contention, and we will later be adding further direct testimony of our own.

So that we are in a sense halfway through this.

Those, I think, to put it very broadly, are the points I am indicating.

MR. SACK: Mr. Chairman, this comes as a complete shock to us, that they are only halfway through these issues. We had no knowledge that there is going to be additional testimony. The evidence on this has been in the record for quite some time. I think the normal procedure is that Applicant submits testimony and Intervenor submits testimony and then each cross-examines. That is the way we pursued other issues. We are surprised to hear now that after our cross-examination is going to be additional testimony, and we are only halfway through issues which we thought were going to be disposed of this week.

CHAIRMAN JENSCH: It is kind of a thermal shock to you, is it?

MR. SACK: That's correct.

MR. MACBETH: This comes as a surprise to me. In my conversations with the Applicant, I have made it clear that the Hudson River Fishermens Association will be submitting testimony from Mr. Clark on the whole range of fish issues. A

mil-4

very good part of that is in testimony submitted here on the 5th of April. The Applicant has certainly been aware that a longer statement was coming. I think I have been quite clear that it covered these matters, too. I apologize to the Applicant if he is unhappy about that.

CHAIRMAN JENSCH: Who is the next witness for cross-examination?

MR. MACBETH: I think the Applicant had some redirect.

MR. SACK: We have some redirect of Mr. Raney.

I would like to have --

CHAIRMAN JENSCH: Excuse me for interrupting. I think on one occasion yesterday -- you were out for the moment -- the New York State Atomic Energy Council, do you have any cross-examination?

MR. MARTIN: No.

CHAIRMAN JENSCH: Will you proceed, Applicant?

MR. SACK: Mr. Chairman, I would not like to drop this so quickly. We have a problem here of proceeding with the hearing in an orderly fashion for the presentation of evidence of the parties. If each party is going to be free to submit evidence at any time on any issue from time to time as they see fit, I don't think we can have an orderly conduct of the hearing.

CHAIRMAN JENSCH: The Applicant has followed that

mil-5

procedure to some extent by bring in additional evidence from time to time in addition to that which was originally filed with the FSAR. Any portions of the testimony, even of previously identified witnesses, that is. I don't think it is too much of a change. I do agree that we try to envision the scope of each party's presentation as soon as possible. Sometimes the party's presentation can not be fully determined until the other party has fully presented its case. Those things necessarily cause adjustments. We can't get it into a mathematical computer in programming. We try to keep within certain degrees of certainty in that regard.

If you feel you have ~~somewhat due~~ some undue prejudice, will you review it when you have suffered some prejudice or disruption or dismay or something that you want to ascertain? Will that be agreeable?

Let us proceed with redirect, please.

MR. SACK: We have some redirect for Dr. Lawler first.

CHAIRMAN JENSCH: Proceed.

REDIRECT EXAMINATION

MR. SACK: Dr. Lawler, under natural conditions, that is in the absence of a power plant, during the period of spring migration of fishes, are there temperature changes that would be encountered by migrating fish that are similar to one degree isotherm that would be created by Indian Point 1

mil-6

and 2?

DR. LAWLER: In my opinion, there are. During the course of the upward or upstream movement of the fish, one would have to presume that he would pass virtually every tributary in the river -- in our case, the Hudson River -- from its source to however far he goes. During the spring of the year, the shallow, generally shallow tributaries warm up faster. At the junction of the confluence of the tributary stream and the river, you will see sometimes somewhat substantial temperature differences between the tributary stream and the river itself. Evidence of this is in the environmental report in Appendix K, where there are surface isotherms shown from the south of the Indian Point, Lovett plants where Cedar Pond Brook enters the Hudson River just to the south of the Stony Point on the west side of the Hudson. The temperature differentials of six and even seven degrees are seen there.

Secondly, on the north where Ansville Creek enters the Peekskill Bay area, you again see a rather substantial temperature difference. I think you can find out what your difference is up to eight or nine degrees between the warmer Ansville Creek and the Hudson River.

Generally at that time of the year -- and this is also in the appendix that I am referring to -- you see rather rapid changes in temperature from point to point along the

mil-7

river. This would be expected because this is the period of the year where the river is warming. So you don't have an equilibrium situation and you should expect to see natural temperature changes on the same order of the temperature changes that are referred to as coming from the power plants.

MR. SACK: That's all we have on redirect of Dr. Lawler.

MR. BRIGGS: Dr. Lawler, you mention these creeks coming into the Hudson. How does the volume of water from these creeks compare with the volume of water that is put through on the condensers at Indian Point 1 and 2?

DR. LAWLER: I haven't specifically calculated that. That could certainly be done. I would have to get the records for those creeks.

I live in the general area of the Cedar Pond Brook, and I would say the flows there are during the flooding season and are of the order of the Indian Point plant flow. I would have to actually get the flow records to compute that.

MR. BRIGGS: Would it be possible to put in some information like that in conjunction with the redirect testimony that you just entered?

DR. LAWLER: I think it would. I'm pretty sure they are available. I have to check to see whether there is a gauge there. If there isn't a gauge, it would be an estimate.

CHAIRMAN JENSCH: On that subject, Dr. Lawler, what do you say Cedar Pond Brook is comparable to the Indian Point plant flows -- what are the Indian Point plant flows that you referred in volume?

DR. LAWLER: Well, the appendix that I'm referring to is a condition when the first unit at Indian Point was operating. Just in looking at the way the temperatures spread

and recognizing at that point the confluence at Cedar Pond Brook actually is the confluence of two major drainage ~~streams~~ streams for Rockland County, that is, Cedar Pond Brook as well as the Minisceongo Creek.

During the spring of the year you can have some fairly substantial flows.

CHAIRMAN JENSCH: Will you put a figure on that? First I want your understanding of the Indian Point Plant flows to which you referred.

DR. LAWLER: The Indian Point plant flow, at Indian Point 1 it's a flow of 280 gpm, which is a flow of something on the order of 600 cfs, 600 to 700 cubic feet per second.

During spring flow run-offs you could certainly have flows on the order of 4 or 5 cfs per square mile. The drainage area of those two combined areas is certainly on the order of 50 to 60, and possibly more than that.

That would get you up in the area of 200 to 300 cfs. Beyond that point you really have to look at the particular days the temperature measurements were running, and find out what kind of flows were there.

CHAIRMAN JENSCH: I am back to my question:

I want to understand just what comparison you were making between the Cedar Pond Brook flow and Indian Point plant flow. You said they seem to be comparable. What

figures did you have in mind to the Indian Point plant flows when you gave that answer?

DR. LAWLER: Indian Point Unit 1 plant flows on the order of 600 to 700 cfs.

CHAIRMAN JENSCH: And Indian Point 2 would be expected to be what?

DR. LAWLER: Roughly three times that.

CHAIRMAN JENSCH: So it would be 1,800 cfs, and something like 700 or 840 thousand gpm; is that right?

DR. LAWLER: That's right.

CHAIRMAN JENSCH: And it's your thought that the Cedar Pond Brook flow in the springtime is comparable to that total of -- let's see if I can add this well -- 1,200,000 gallons per minute; is that your thought?

DR. LAWLER: No.

Let me clarify my thought. When I said it's on the order of, I meant the same general magnitude.

CHAIRMAN JENSCH: What is the difference there, please?

DR. LAWLER: The second point -- I will describe that in a moment.

The second point is that I was referring to the actual measurements that were made, which was for a condition of one unit at Indian Point rather than the multiple unit case.

So the comparison of flow that I would be making would be a flow for Indian Point 1 between 600 and 700 cfs to a flow in the brook -- I'm guessing now because I don't know the particular run-off conditions that existed at that time. I am saying, just knowing it was in the month of April, I would expect that the run-off could have been between 200 and 300 cfs.

When you use the expression "order of magnitude" you normally are talking about quantities within a factor of ten. I am not saying -- I will include any flow that is as much as one-tenth of the Indian Point flow.

I am not suggesting that. I am suggesting that the Indian Point flow ranges between 600 and 700 cfs. I am guessing that the Cedar Pond and Minsceongo Brook complex is of the order of -- I should say an order, a range of 200 to 300 cfs. So one is half the other.

The major point I was trying to make is --

CHAIRMAN JENSCH: You used that comparable in the fact that even though one is twice the other, you say it's still comparable; that is your thought?

DR. LAWLER: Comparable to describe the phenomena that I am trying to describe, namely, that the river at that point, at that confluence, sees temperature differences up to the particular set of measurements I am referring to, up to six degrees.

CHAIRMAN JENSCH: How far out in the river is that,

or -- take a line from the shoreline of the Hudson River and then go back up the Cedar Pond Brook. How far back from that shoreline were these six or seven degree temperature differences noticed, or vice versa, and how far out into the river did you get that?

DR. LAWLER: These were noticed. We are not back in the stream at all. We are at the actual mouth of the stream where it joins the river.

CHAIRMAN JENSCH: What do you mean by that, the actual mouth?

You mean a line presumably extending along the shoreline at a point where Cedar Pond Brook comes into the Hudson River; is that right?

DR. LAWLER: That is correct.

CHAIRMAN JENSCH: And were those measurements made during a flood tide, ebb tide, or whatever other situation there is?

DR. LAWLER: Let me refer to the environmental report. This is Appendix K.

CHAIRMAN JENSCH: This is in that which was filed by the Applicant, is that right?

MR. TROSTEN: That is correct, yes.

CHAIRMAN JENSCH: Give us the page number on that.

DR. LAWLER: Right now I'm looking at Figure 12 in Appendix K.

CHAIRMAN JENSCH: Thank you very much.

You say this occurs at a warm time of the year when the river is warming up. How long is that period?

DR. LAWLER: Well, generally the so-called equilibrium temperature or the ambient temperature reaches the equilibrium premium temperature in February.

At that point the river is neither warming nor cooling. From that point through to the end of July or mid-August, the river is warming, at which point it reaches, again, a condition of neither warming nor cooling.

So the river is warming from February all the way through August. That is also shown in the environmental report. That would be Appendix J. It's either Figure 3 or Figure 4 in that Appendix J.

CHAIRMAN JENSCH: Thank you. What is the period of time to which you referred in your answers that you found a six or seven degree difference during the warming period? You used the designation April at one time. Did you intend to limit it to that period?

DR. LAWLER: The particular measurements were made on April 6th. That is what I was referring to.

CHAIRMAN JENSCH: But you don't know how long that condition prevails, whether it is one day or two?

DR. LAWLER: No, I do not.

CHAIRMAN JENSCH: Did you make a measurement in the morning or afternoon? Can it be narrowed down that this six or seven degree difference happened on one day of one week of one month in one year? Is that the extent of your measurements?

DR. LAWLER: The measurement I am referring to is on one day or maybe over a period of two days but I would expect to see this kind of phenomena at that time of the year during high run off conditions in a situation where you had a stream where the natural temperature rise of the stream exceeded the temperature rise of the river. I don't find it at all surprising. I think it is probably fairly common. The exact rise, whether six or seven or two, three or four will depend on the particular stream and the particular river into which it is discharging and probably also to some extent, the flow in the stream.

CHAIRMAN JENSCH: You say you wouldn't be surprised if it didn't continue for a longer period than the one day or two days in which you make the measurement. I take it you wouldn't be surprised if someone didn't expect what you expect until either one or both of you have some data and we are limited to a consideration and the one measurement you made on one or two days in one month of one year, and is that the extent of the data available?

DR. LAWLER: I wouldn't say it is simply one measurement. It is a whole series of measurements made during one to two days of one year, that is true.

CHAIRMAN JENSCH: If you say you have a six to seven degree difference at this point at the river where the Cedar Pond Brook enters the Hudson River, how far did that plume get out into the Hudson River, as you mentioned that?

DR. LAWLER: Well, this is shown in the figure that I referred to in Appendix K. It appears that you go roughly half way across the river before you get down to what appears to be the ambient river condition.

I might point out that there is one substantial difference between the power plant situation at Indian Point that I described and the flows in these brooks even if the temperature rise and the flow rate were to be the same or roughly the same. That is that the stream, of course, enters the river in a purely natural fashion. If its temperature is higher, it

would tend to ride up and out over the surface. Whereas, the plant is designed to mix very rapidly with the river water. So, the extent to which -- on the surface you could see the creek even if its flow rate is less and its heat content is less, extending farther out into the river than you would see the power plant, or extending farther out into the river at temperature isotherms of three and four and five degrees.

end 8

mil-1

CHAIRMAN JENSCH: When you are speaking of the surface flow, you are talking of something within a foot or so of the top of the Hudson River, are you not?

DR. LAWLER: Well, the measurements were made right at the surface. They were infra red measurements. So I really wouldn't know how deep it went. I wouldn't suspect it was terribly deep.

CHAIRMAN JENSCH: You said it was not deeper than three inches.

DR. LAWLER: I wouldn't ~~sant~~ want to say that. If I was guessing, I would say on the order of a foot or two feet.

CHAIRMAN JENSCH: Something that wouldn't affect the fish because they are not up at that surface of the river, is that correct?

DR. LAWLER: I will pass to the fishes' behavior.

CHAIRMAN JENSCH: I wouldn't want you to guess about that one. I thought you might have some indication about it. You said these measurements were made by infra red. You can't say how deep it was, is that correct?

DR. LAWLER: That's correct, you don't know how deep they are.

CHAIRMAN JENSCH: And if you don't know how deep they are, you wouldn't want your testimony to be construed that the Cedar Pond Brook releases of temperature have any effect on fish, would you?

mil-2

DR. LAWLER: I didn't say they did.

CHAIRMAN JENSCH: I had understood that was the purpose of your changing the temperature, showing the temperature changing of fish coming up the stream or river, as I understood your testimony on redirect.

You really don't have much of an accurate measurement of the distance the plume from the Cedar Pond Brook would extend into the river nor the depth of it, is that correct?

DR. LAWLER: The distance that the plume extends into the river, I think, is fairly well shown on the data that I described. The depth we don't have information on.

CHAIRMAN JENSCH: I appreciate that. Your chart may show it. I was wondering what the measurements were. Whether you drew the chart without having much knowledge of distance, I was trying to inquire into that. I suppose the plume measurement is based on your infra red reading as well, is that correct?

DR. LAWLER: That's correct.

CHAIRMAN JENSCH: Is that done by flying over?

DR. LAWLER: Yes.

CHAIRMAN JENSCH: At what altitudes? Do you know that?

DR. LAWLER: The altitude doesn't show.

CHAIRMAN JENSCH: Would that be related to

mil-3

its accuracy at all?

DR. LAWLER: The altitude, my understanding of infra red, is that the altitude will have some effect on the measurements. My ~~understand~~ understanding of these measurements is that they have been coordinated with the ground control or calibrated with the ground control and are correct.

CHAIRMAN JENSCH: How do they calibrate that? Supposing the plane is flying at 5000 or 10,000 feet and looking for an infra red reading? Whatdo they calibrate? What do they do on the ground to calibrate that?

DR. LAWLER: Well, infra red technology is not my particular field.

CHAIRMAN JENSCH: I guess I better drop the whole thing.

Thank you very much.

Did you have something further? I think Dr. Geyer has some questions.

MR. SACK: Mr. Chairman, can I clear up something? I think in the light of your questions there may be some confusion about the original question on these streams. The original question simply related to the one degree isotherm, since that had figured in the cross-examination.

CHAIRMAN JENSCH: We will see the record and what your question was.

Thank you.

mil-4

DR. GEYER: Dr. Lawler, in conducting the infra red flights, were they carried out over full tidal cycles so that you could see how the temperature distribution patterns changed in the course of the river?

DR. LAWLER: The fly-overs were made at several different tidal conditions.

DR. GEYER: On the same day?

DR. LAWLER: That's correct, on the same day.

DR. GEYER: Did they cover the Lovett plant as well as Indian Point?

DR. LAWLER: Yes, they did.

DR. GEYER: Was Indian Point operating at this time?

DR. LAWLER: It appears to have been operating.

CHAIRMAN JENSCH: They have been operating or were operating?

DR. LAWLER: Dr. Geyer asked if the Indian Point plant was operating during the time the fly-overs were made. I said that it does appear that it was operating because there are temperature differentials in the area of the plant.

DR. GEYER: Do you know whether the Alden Lab at Worchester Polytechnic was operated for the same conditions that were observed during the time the infra red surveys were made?

DR. LAWLER: The Alden Lab was operated for essentially the same tidal conditions. I don't think it was

mil-5

operated for the same fresh water run-off conditions. I would have to check that for you.

DR. GEYER: It would be very nice if you could check the Alden Lab results with the infra red flight results with your theoretical calculations. Has this been done?

DR. LAWLER: There have been comparisons made between the computations we have made, field measurements, and the Alden measurements. I simply don't recall what kind of correlation was made between Alden and the particular thermal overflights. It may have been done. This was four or five years ago when this was done and I would have to look back to see what checks were made on it.

DR. GEYER: If Indian Point is operated, is it planned to confirm some of these results by actual field measurements?

DR. LAWLER: Yes, that is very definitely planned.

DR. GEYER: Thank you.

CHAIRMAN JENSCH: Any further questions of this witness?

MR. MACBETH: Just a couple of points on recross.

RECROSS-EXAMINATION

MR. MACBETH: Can you describe the configuration of the bottom of the Hudson River at the confluence of the Cedar Pond Brook and the Ansville Creek with the Hudson?

DR. LAWLER: Not without cross-sections at those

mil-6

two points, which I don't happen to have with me at this moment.

MR. MACBETH: Could you procure cross-sections? I would be interested in that.

DR. LAWLER: I am fairly certain I can. We have quite extensive cross-sections in the whole area. I will look to see what I have.

MR. MACBETH: Thank you.

CHAIRMAN JENSCH: If there is nothing further at this time, Dr. Lawler, you are temporarily excused.

(Witness temporarily excused.)

CHAIRMAN JENSCH: Do you have an additional witness for examination?

MR. SACK: Yes, sir. We are now ready for redirect examination of Dr. Raney. Dr. Raney, will you resume the stand, please?

Whereupon,

DR. EDWARD C. RANEY

resumed the stand, and, having been previously duly sworn, was examined and testified further as follows:

REDIRECT EXAMINATION

MR. SACK: Dr. Raney, will the interactions of the two plumes from Indian Point 1 and 2, together with the Lovett plant as described by Dr. Lawler this morning, will the interactions of these plumes form a block to the migration of fishes?

mil-7

DR. RANEY: Not in my opinion.

MR. SACK: What is the basis for that statement?

DR. RANEY: The behavior of migrating fishes have been observed on many rivers. An excellent example is the Connecticut River where the shad, blueback herring, alewife migrate. Some 20 miles upstream we have a moderate size nuclear plant which has a large heated effluent. This heated effluent has a plume which extends at times almost the width of the river.

Studies including detailed observations, sonic tagging, tagging using spaghetti tags, ~~which~~ which are inserted in the fish, in conjunction with a lift which is located upstream at Holyoke, Massachusetts, has indicated that there has been no interference of this heated plume with the migration of the fishes mentioned, but in particular the American shad.

There is no evidence in the Hudson River at the present time that there is interference with the migration of shad due to the plumes from the various power plants which are present and operating, and the plumes from the various tributary streams which are present and which normally carry warmer water during late April and May when shad are running.

From personal experience in the Delaware River where the ~~fished~~ fish must pass a great number of power plants which have plumes, many of which occupy one-third of the width of the river, there is no block to the migration of fishes due to heat. The block which does occur normally in late May occurs because oxygen becomes reduced to a point lower than three parts per million, at which time, the shad, rather than continuing up the Delaware River, pass through the Chesapeake and Delaware Canal and spawn in the vicinity of the Conowingo Dam on the lower Susquehanna River.

The latter results have been confirmed by tagging done in the past four years.

MR. SACK: Will some fish migrating in the Hudson never see the thermal plume, never experience it?

DR. RANEY: In view of the day to day fluctuations, fluctuations from place to place, day and night fluctuation, a difference of up to five degrees certainly in the fall migration is an insignificant difference. Differences of one to two degrees fahrenheit during the spring migration of American shad, striped bass are insignificant. By insignificant I mean that they do not have a basic ecological effect on the fish. It must be remembered that the basic drive of an American shad or a striped bass on its way to spawning ground is a hormonal drive. It is returning to the place where it was imprinted in its youth. This drive is such that it can overcome

almost any obstacle.

MR. SACK: How do you reconcile this statement with the testimony yesterday on temperature preference?

CHAIRMAN JENSCH: Could you give us the transcript reference, please?

MR. SACK: I am referring to the whole line of questioning that fishes prefer certain temperatures.

CHAIRMAN JENSCH: Pick ~~it~~ one out of that whole line.

MR. TROSTEN: We will provide this in a moment, Mr. Chairman.

CHAIRMAN JENSCH: Proceed.

DR. RANEY: The testimony given yesterday had to do with what happens to a fish when it encounters a plume. There are three possibilities. A fish does nothing or it may be attracted or it may be repelled. In order to confirm what has been observed many times in nature over the last 50 years by numerous observers, we performed a series of experiments where fishes were given an opportunity to either go toward a temperature or go to a roughage of an ~~acclamated~~ acclimated temperature.

These experiments which were done over a period of a year and which include white perch and striped bass almost every month of the year, give [redacted], I think, as good explanation of why late in the fall, during the winter and in early spring, you get concentrations of fishes around heated plumes. It also is an explanation of why fish mortalities are rarely, if ever,

seen in the vicinity of heated plumes.

When fishes are migrating up the river for spawning, as I have indicated before, this tremendous hormonal drive, and they are on their way to the spawning grounds, this is one of the reasons that during the late spring and summer and early fall, normally you don't find concentrations of fishes around heated plumes.

Normally, fishes which migrate in the temperate regions of the world, particularly in the Hudson River, migrate in the spring and come back down in the fall. These are periods when, generally speaking, temperatures are changing fairly rapidly. That is both in the spring and in the fall.

The migratory period, particularly for American shad and striped bass, which are two of the fishes of major interest, occupies a period of approximately six weeks in length. Generally these may be modified to some extent by temperature run off, changes in salinity, the time it takes the fish to adjust as it comes in from the ocean, and adjust osmodically to the shift to a fresh water environment. But no matter what adjustments need to be made by the fish during this period, these ultimately are made and it is the sexual drive, the drive to get back to this imprinted area upstream which is the dominant drive at the moment.

Obviously, if one of these species of fishes or an anadromous fish had been imprinted, that is had been spawned in or near one of these tributaries that have been mentioned

previously by Dr. Lawler, or in or near one of the heated plumes, this is the area to which you probably would return and spawn. The majority of the American shad in the Hudson River run fairly far upstream as Poughkeepsie.

MR. SACK: When you said that migrating fish move fairly close to the surface at night, what depths did you have in mind at that time?

DR. RANEY: The depth at which migrating fish are found varies with the species, the time and surface temperature, the salinity and a number of other variables.

Generally speaking, fishes migrating at night migrate closer to the surface than they do when they are migrating during the day. In my experience in the Delaware -- and that's where my experience has been -- the fishes normally migrate both day and night in the upper 30 feet of water. You are dealing with the night only and considering only adult fish, most of them are found in the upper 20 feet of water.

In the downstream migration in the fall of the year, during the day I don't think shad migrate in deeper water. It's basically in water 10 to 20 feet deep. They rise to the surface at dusk and move downstream at dusk and up to midnight or so on over close to the surface.

These illustrate the difficulties of making a prediction about where a fish is going to migrate at a given time unless you are given a set of variables. Even under these conditions you probably ~~not~~ can always generalize.

MR. SACK: Are the migrating fish in the late winter and spring, are those fish adult fish?

DR. RANEY: I assume you are talking about the fish such as alewife, American shad, blueback herring, which are spring spawners.

These fish do come in from the ocean in late winter. The American shad are three, four, five years old as males. The females ~~mostly~~ mostly four, five and six years old. They come into the river, undergo a period of milling around until such time as they have become adjusted to fresh water.

Then they move upstream. The entire migratory period within the river still may take a period of up to six weeks. In some rivers where the fishes can go many hundreds of miles, such as the Columbia River where the American shad was introduced many years ago, the period of migration and spawning may be in excess of two months.

MR. SACK How do these adult fish compare with the fish that are collected on the intake screens at Indian Point?

DR. RANEY: The data I have seen have indicated that there are very few adult fish taken on the screens at Indian Point in recent years. The size of the fishes that I observed on the screens at Indian Point are normally white perch that are two or four inches long, most of which have gone through either one or two winters.

The other fishes that I have seen on the screens at Indian Point have been basically juvenile fish.

MR. SACK: Talking about juvenile fish for the moment, not the migratory ones: If a juvenile fish contacts a thermal plume, such as would be found at Indian Point during the cold winter period, what portion of the plume would the

fish prefer?

DR. RANEY: It comes in contact with the plume and it will move into the plume until it reaches a point where the temperature basically is 10 or 11 degrees Fahrenheit higher than the ambient temperature, or this is what we can assume will happen in light of the rather extensive experiments that we have been able to do with white perch under winter conditions.

So that if the plume indeed has this magnitude of difference from one to ten degrees, I would expect the greatest concentrations in winter to be in the warmer part of the plume.

There is evidence from our studies in the Delaware River that this is true. Fishes in the winter are concentrated in the warmest part of the plume. This is also true of the outlet of the Pepsico plant, on the Patuxent River, and dozens of other plants where observations have been made in winter.

MR. SACK: Well, when you referred in your testimony yesterday to an unusual over-wintering area for white perch, what area of the Hudson River did you have in mind?

DR. RANEY: I was speaking of the lower Hudson River, up to and including the area near the Indian Point plant.

This area extends at least as far downstream as the Tappan Zee Bridge, which I think I mentioned yesterday

-- this area is something like 17 miles long, and the upper part of it is probably close to a mile in width.

The lower area is probably close to three and a half miles in width. It's a tremendous body of water and capable of over-wintering a very great number of white perch because, at this time of the year, they feed very little or when the water temperature gets below 40 degrees Fahrenheit.

MR. SACK: When you mentioned peak temperatures in the Hudson River in the 80's, at what portions of the river did you find those temperatures?

DR. RANEY: In my experience, in the days in the early fifties we were seeing striped bass and other fishes in the Hudson, we investigated all sorts of habitats along the shore to make sure we were not missing habitats where young striped bass might occur.

In the weedy lagoon habitats, particularly the shallow habitats, we found temperatures in the 80's. I personally or students working with me or ichthyological associates have not done anything in the channel of the Hudson River. I am not aware personally, from personal experience, what maximum temperatures are in or near the channel in the summer.

I do know, however, that in the ~~wee~~ weedy shallow lagoons shallow temperatures reach the low 80's.

CHAIRMAN JENSCH: Up near the shore it gets pretty warn, that is your thought?

DR. RANEY: You may have a shallow bed where several hundred feet from shore you get that. You have temperatures that might heat up to the low 80's in August, the end of a hot day. You go back to the same areas the next morning and you may get temperatures of 75 degrees Fahrenheit.

You may get ranges of up to 80 degrees. These are not unusual. The fishes which live in these places are adapted to these daily fluctuations. If they were not, they could not exist and we would not be involved with our present state where large numbers are present.

CHAIRMAN JENSCH: I don't want to interrupt your examination.

MR. SACK: This type of area where you have seen these 80-degree temperatures, that is the Indian Point intake?

DR. RANEY: No. I have never taken a measurement at the Indian Point intake, except for the record which is familiar to you. I did not know what the temperatures are there.

MR. SACK: That ends our redirect examination, Mr. Chairman.

A transcript reference of the type you are looking for would appear on page 5835 where Dr. Raney began to discuss the temperature preferences when a fish is acclimated to a temperature of 63 degrees Fahrenheit.

CHAIRMAN JENSCH: Thank you.

DR. GEYER: Dr. Raney, will the anticipated rises in temperature of the Hudson River affect the spawning time of the spring-spawning fish?

DR. RANEY: Not in my opinion, sir.

DR. GEYER: I have heard it postulated that such shifts might adversely affect the young because it appears at a time when their food supply was not what it was expected to be.

DR. RANEY: Yes. This hypothesis has been advanced. There is no evidence that this has happened with any of the fishes occurring, for example, in the Columbia River, which is my study, in the Delaware River, in any of the tributaries of Cheasepeake Bay, many of which have been studied over long periods of time.

Basically the spawning period of any fish is such that, for example, if it lasts over a period of approximately six weeks at any given point, the males arrive first, are all right, and stay in the area, take advantage of any females that arrive. Spawning reaches a peak. Females sooner or later disappear from the area. Ripe males are still present.

So that at any given point you have a fairly long period when young fish first become available.

There is a spring bloom which occurs in most of these same rivers. The spring bloom of butterfly plankton and other plankton is such that normally it occurs weeks before.

In estuaries or rivers there appears to be no lack of food of the proper size at the time that the mouth of a larvae actually opens and begins to feed. This is not always true of ocean fish. Some of them may starve to death because the size of organism which they require is not immediately available.

I think perhaps, Dr. Geyer, you also may have heard the hypothesis on occasion that in these heated plumes you unfortunately have some of the aquatic insects coming out of the water as maturing and becoming adults, and being in the unfortunate position of not being able to find a mate because of the unseasonal ascent from the depths. People that have advanced this hypothesis have a very strange idea of what the sexual relationships are among insects.

It's inconceivable that this could happen to the male only.

DR. GEYER: Thank you, sir.

mil-1

CHAIRMAN JENSCH: Dr. Raney, you mentioned the column by a river and the Connecticut River. Did you participate in the experimental work done over there, or was this done by this gentleman who was writing the doctoral thesis?

DR. RANEY: The studies in the Connecticut River were extensive studies. Through the Essex Marine Laboratory, there were up to 12 scientists involved. These studies are still underway and will be for another six months. Some of the results have appeared. The studies on shad are continuing. I was a member of the advisory board that set up the study schedule and participated in regular visits and have been out in the field. I know the situation. I am familiar with the results.

CHAIRMAN JENSCH: Good. What I wanted to ask was, there have been some concern in another field, if I may say, at the moment, where small tests had been construed to be of not much relevancy to a large-scale operation. I was wondering whether the small fish were used to extrapolate the conduct of the large fish. In other words, the old fish act like the small fish.

DR. RANEY: No. Fish are like humans and other animals, as the young or larvae behave quite differently and often live in different places than do the adults. However, our results on the Connecticut River, at the

mil-2

Connecticut Yankee Atomic Plant, as observed in the river, confirm the tests which Sanford Moss made, using small specimens with small pieces of experimental gear. The studies were done four years ago. Studies recently completed in the field confirm his basic findings, to-wit: Temperature and changes up to five degrees have no ecological significance for small American shad, which is migrating downstream.

CHAIRMAN JENSCH: My understanding in the nuclear field is that there are no limits to which activities can be conducted in any of the experimental analyses. I have wondered whether the fish might be expanded to a scale similar to some of the activities you see in the nuclear field, and in particular I have in mind the Connecticut River. As I recall, the Connecticut Yankee -- even George Washington had a little trouble throwing that dollar across there. Is there any possibility of putting a wire fence across the Connecticut River and then finding out exactly, with the large fish, what happens with plumes and contacts and temperature changes, and we don't have to worry about this little tank down in the Delaware where there is the expertise, but take a look at some real live models and get kind of a blown-up loss of coolant affair or some such consideration, some chained-off areas? Would that be a feasible thing to do?

DR. RANEY: What we have done, I think, is even better than that.

mil-3

CHAIRMAN JENSCH: Calculations and extrapolations I would like to avoid for the moment.

DR. RANEY: I would ask you to refer to the experiments which really were done out in the river. In the beginning of the study seven years ago, we were down to Saybrook 20 miles downstream, and taking American shad on the upstream runs. We got in there and started to do this before there was any heated plume in the river, before the plant went critical. We had two years of these studies.

We also inaugurated the sonic tagging studies to be able to track a given specimen of fish upstream. Several papers have a period describing the results up until about a year ago.

We also had an opportunity of looking at the water, the water quality, the plankton, both the phyto and zooplankton, the benthos, including a very small benthic organism, or worms, as well as the 40 species of fishes which live in the area, some of which are resident and others which, of course, are migratory, with adequate financing. This is the best study, in my opinion, that has ever been done. The indication is that that very extensive heated plume has not affected the migration of the American shad or all other anadromous fishes in the sense that there has been any diminution due to the heated water.

We have had several year classes come back. There

mil-4

are difficulties which are involved in getting good base line studies because of the fluctuations in your classes among fishes.

Our studies on the lower Delaware, Salem plant, were begun in 1968. That plant may go into operation in 1973 or '74. We will be studying that plant site for another 10 years under directions from the Delaware River Basin Commission. All plants of the magnitude of the Salem plant, includes two 1100 megawatt units, should, in my opinion, be studied for a comparable period of time. I am certain this is not going to reach the proportions of the area that we have passed through. I do think that we are probably just at the beginning of real significant long-term studies with regard to the environment in relation to nuclear plants.

End 12

CHAIRMAN JENSCH: I appreciate your statement. Do you think the study undertaken is a good one. I would like to come back to my question,if I may, to getting a pool that you definitely know what you are talking about. I presume you have some difficulty maintaining an identity with them because they may look alike or you have seen one and you have seen them all or something like that. You need a pretty good tagging program to kind of know that you are talking about the same one you looked at some time ago.

I have particular reference to the thermal block situation you referred and indicated you did not think it would be a factor. If you don't know how many want to go up, how do you know how many are blocked off?

DR. RANEY: We do know how many want to go up because we attack them at the mouth of the river.

CHAIRMAN JENSCH: Every one?

DR. RANEY: Every one that we catch. You can't, in a river like the Connecticut where the passage at Holyoke, 100 miles upstream, is in the order of 60,000 fish. You can't catch everyone of them in or near the mouth of the river. Assumptions are that those which are taken in the gill nets are a random sample of the population. The evidence from these taggings, as well as the sonic tagging indicates that once a shad in the Connecticut River has become osmodically adjusted, has gone from the salt water to the fresh water stage, they go

right up through the heated plume or under the heated plume and travel at a rate of approximately 20 miles a day until they get up to Holyoke, except for a group which stop and spawn at the Enfield Dam or rapids. This is the way you have to handle these fish, which incidentally, sir, we do recognize. We only recognize the individual if they are tagged. We have done that.

This gives me confidence in my statement that the plume at Indian Point and the possible interactions of other plumes either on the Hudson River or other rivers. We are not going to be able to interfere substantially with the remarkable sex drive that is exhibited by anadromous fishes.

CHAIRMAN JENSCH: At the present time it is based entirely on opinions, is it not?

DR. RANEY: No, sir, it is not based on opinion. It is based on our observations in a plume that is much more extensive than any combination of plumes that I can envision in the Indian Point area. It is based upon observations of the very same species of fishes which occur in the Hudson. It is based upon seven years of solid studies.

CHAIRMAN JENSCH: As related to those fish which you were able to tag and trace, is that correct?

DR. RANEY: That is correct, sir.

CHAIRMAN JENSCH: You say that you think you tagged a representative sample. How did you determine whether it was a representative sample? Is that size, age, color, source?

DR. RANEY: No.

CHAIRMAN JENSCH: What factors?

DR. RANEY: We assume that our sample is representative that appeared from our catches in relation to the catches made by other commercial fishermen fishing both above and below. It varied somewhat in the direction than ours did. Fishes don't migrate at one time. They usually come in in schools. When you begin to catch them, other fishermen usually catch them both upstream and downstream. We attempted to tag fishes of all the sizes and age classes that were representative. You can't actually tell the age of them until you look at the scales. You can't do this until some time later. You try to get a representation of the various sizes and assume that within the sizes for males that you have 3, 4 and 5 year old fish, and from the females, 4, 5 and 6 year old fish. This can only be confirmed at a later date when the scales are examined.

As we have done in the Connecticut River, tag a substantial number, 3,000 or 4,000 fish, we feel that this is an adequate sample.

CHAIRMAN JENSCH: If I understood your words, you have looked at the commercial fishermen's catch and looked at your catch and tried to distinguish between the male and the female.

DR. RANEY: We can do that very easily, sir. We can differentiate the sexes easily enough.

CHAIRMAN JENSCH: And then you say you did 3,000 or

eak 4

4,000 and it is representative. I wonder if there are not some other factors that should go into determining a representative sample rather than taking a look as to whether they are male and female and looking at the fishing boat next to where you are catching and say it looks all right and this is representative because 3,000 or 4,000 may be only a portion of 3 or 4 million. I don't know.

DR. RANEY: We know it isn't 3 or 4 million. These fishes are tagged and recaught. We get tag returns on them and make population estimates, so that we have an estimate of the population that is run in the Connecticut River in the last seven years. These population estimates are plus or minus. They are fairly good.

CHAIRMAN JENSCH: Your population estimates, again, are based upon some tagging which you believe is a representative sample on the whole, and you don't know what the whole is except --

DR. RANEY: You can't find out the whole of any organism that lives in the water without draining everything through a small sieve. This isn't possible. So that we have to use these indirect methods. Statistically I believe, the methods are sound.

CHAIRMAN JENSCH: Of course, what I am trying to come back to is whether or not if you really want to know about these things to put a chain across the river and open up the gate and flag them as they go through and give them kind of a name

plate as they go up the river and you have a list of where they are going and you kind of know a little more about whether you are getting a thermal block or not because your thermal block may be at the surface and they swim under a plume or may go through it. I confered that what you want to convey is, if they go through it, it is all right. Many of them don't go through it at all but underneath it. I am trying to understand your testimony as to the extent of the thermal blockage.

DR. RANEY: Well, in my concept, if they move up the river, there is no block to the migration. That is whether they go under the plume or through the plume or through some part of plume, is immaterial.

CHAIRMAN JENSCH: But the point is, we are trying to find out, if they go through the plume, what happens. That is the whole object of our inquiry. If they go around it, you can forget there is a plume there at all.

DR. RANEY: We have some evidence in the sonic tagging, in the Connecticut River, that they actually pass through heated water.

CHAIRMAN JENSCH: How do you tell that?

DR. RANEY: By following these tagged fish in the boat and keeping them located and staying with them several days.

CHAIRMAN JENSCH: Do you have a boat for each fish?

DR. RANEY: For each fish you tag, you follow on a boat.

eak 6

CHAIRMAN JENSCH: And how do you watch him and measure the temperature, whether he goes through the plume at the same time?

DR. RANEY: Well, we have measurements of the plume at three different depths. We know where the fish is.

DR. GEYER: I think there is some confusion. You are talking about sonic tags and a different type of tag which is reported when the fish is caught, is that correct?

DR. RANEY: That is right, Dr. Geyer. In order to get population estimates, we ~~tagged~~ tag a great many fish. We tagges as many as we can, practically. But to get details of the movement through the plume or in any given area, we use a sonic tag which give off a beat which you can pick up the fish and locate him in the water column. These experiments are tedious and it takes a good many years to get good data. But for the Connecticut Yankee plume, we do have good data and we know that fishes both pass under the plume and through the plume.

CHAIRMAN JENSCH: And the ones that you have tagged through the plume you have found no problem about their spawning activity, is that right? They return all right and they can be caught and eaten, is that correct?

DR. RANEY: These fishes on the way upstream, sir, the American shad is on its spawning ground and it is at this time that they are captured by commercial fishermen or sports fishermen and it is at this time that they are either eaten or

eak 7

they are roe. The eggs are eaten. We have recovered dead fishes bearing sonic tags because a certain proportion of any migrating fish dies after it spawns, as the older fishes die on the way down. In some rivers, there is only one year class spawns and the rest of them die on the way down because of unusual conditions in lower rivers, generally speaking, in the rivers of North Carolina or South where shad spawn only once. In the north they may spawn three times.

There is no evidence whatsoever from a substantial amount of evidence gathered in the Connecticut River that any harm is done to these fishes by passing through a plume. No one, however, has actually seen a fish which has been tagged with a sonic tag spawn subsequently to my knowledge.

CHAIRMAN JENSCH: What would be the number that you would estimate to be applicable to the fish who were tagged which went through the plume and spawned and returned to the ocean?

DR. RANEY: I don't want to answer that in an off-hand manner. I would have to come back to the data.

CHAIRMAN JENSCH: Can you tell whether a fish which -- you say some of them have gone through the plume and go up the river and spawned and died on the return trip, whether they dies because they were within the natural cycle of death of spawning fish or whether they were dead from going through the plume?

eak 8

DR. RANEY: Well, on rivers where there are no plumes, we got the same type of life history behavior as the older fish in the run. They are the ones that are at the end of their days. To answer your question specifically, with regard to Connecticut, I cannot tell.

CHAIRMAN JENSCH: I suppose that is true for any. You can't tell whether a fish returning from its spawning has died within the spawning cycle or whether he was killed because of too much heat from the plume? That would be true for every river, would it not?

DR. RANEY: You are talking about rivers where there are plumes?

CHAIRMAN JENSCH: Yes.

DR. RANEY: There are many, many rivers where there are no plumes. The behavior is basically the same. The older fish die off.

CHAIRMAN JENSCH: The question is, you can't tell the difference whether the fish died from the natural cycle or affected by the heat of the plume, can you?

DR. RANEY: No.

CHAIRMAN JENSCH: Thank you very much, Dr. Raney.

Any further questions?

MR. MACBETH: I have some recross.

CHAIRMAN JENSCH: Proceed.

xxx #14
mil-1

MR. MACBETH: Can you give us the width of the Connecticut River at the Connecticut Yankee plant?

DR. RANEY: Not accurately. One can make an estimate. It is not very wide, but I couldn't throw a dollar across it.

CHAIRMAN JENSCH: The dollar doesn't go very far for anybody any more.

DR. RANEY: I think at the mouth of the out-fall of the mouth of Salmon Creek, it is probably 2500 feet wide.

MR. MACBETH: Where does the plant sit in relation to the channel?

DR. RANEY: The plant sits upstream. The effluent from the plant flows downstream through a long mouth and enters the Connecticut River at a point about a mile below the plant. The channel is approximately mid-river as it is. The effluent comes in basically on the surface. It is the magnitude of the current, two, two and a half feet per second.

MR. MACBETH: How many fish were sonically tagged?

DR. RANEY: In all the years?

MR. MACBETH: Yes.

DR. RANEY: I can't bring you up to date on it because they have been doing it the last few weeks, and I am not familiar with the number. I would say probably fewer than 100.

MR. MACBETH: How many were seen or were fallen and known to go through the plume?

mil-2

DR. RANEY: I can't answer that offhand. I would have to go back to the data. I don't want to put a guess on the record on this. We can furnish you the published records.

MR. MACBETH: I would appreciate it if you would furnish both the number tagged and the number that went through the plume.

DR. RANEY: Yes.

MR. MACBETH: Were you sonic tagging only shad or also herring and alewife?

DR. RANEY: Only shad.

MR. MACBETH: Are there any striped bass that migrate up the Connecticut River?

DR. RANEY: Very rarely. In the 15 years that Holyoke has been operated, I have seen less than a dozen striped bass. However, I did mention yesterday that two winters ago there was a concentration of striped bass in the lower Connecticut. They were in the area of the plume and serves as a basis for sport fishery.

MR. MACBETH: Were any of this very small number of striped bass completed in any of your studies on migration in relation to the plume?

DR. RANEY: Not in the Connecticut.

Actually there were not enough taken there to really do anything about it.

MR. MACBETH: You said the plume extended almost

mil-3

across the river. What magnitude was that?

DR. RANEY: The delta T varies quite a lot, but it is a much hotter plume. ~~Halfway~~ halfway across the river than we will have from Indian Point 2.

MR. MACBETH: On the other hand, it is coming in the river in a different manner? Do you know how far across the river it extends?

DR. RANEY: To some extent on certain tides, it covers the entire width of the river at the surface.

MR. MACBETH: And it is flowing out across the surface?

DR. RANEY: Yes.

MR. MACBETH: On the Hudson you said there was no evidence of any block of the shad at the present time. What studies have been made in the Hudson on shad in relation to plumes?

DR. RANEY: The evidence that I am referring to is the evidence from my own experience where I have seen small shad and found in the upstream areas at a very small size at a stage where one could infer that they had been spawned locally. ~~This has~~ There have been, after a passage up the Hudson River, various fluctuations in temperatures that an adult shad would encounter on this trip. These studies to which I am referring are the ones that were done from 49 to roughly 1954. However, subsequently the State of New York also has done

mil-4

similar studies. So that at the present time I am told that there are young shad as far upstream as Coxsachie, for example.

MR. MACBETH: Are these studies essentially relative estimates of population?

DR. RANEY: Well, in some cases you could not really call them that. It is an attempt to get an estimate of the relative success of a year class. The techniques basically are to wade out shoulder deep with a 20-foot bag and put the thing down, pull it toward shore and count the number of fishes which are taken, and start downstream, run the high tide upstream, do this under comparable conditions and do it over and over and over again each week. Such studies give a relative estimate of the success of a year class.

MR. MACBETH: Is it your opinion that such studies give an accurate interpretation of the accurate estimate of the population?

DR. RANEY: It is an estimate of the population. You see, when you talk about an estimate, you are estimating and you are going to have obviously some range.

MR. MACBETH: Would it be fair to characterize it as a rough and ready estimate?

DR. RANEY: I think it is a way of getting a rough estimate.

MR. MACBETH: As I understand it, these studies do not focus on the relation of the plume to the migration habits?

mil-5

DR. RANEY: They were basically done before the plant was built.

MR. MACBETH: You did not mention striped bass on the few instances on the Hudson. Have studies of striped bass on the Hudson in relation to plumes been undertaken?

DR. RANEY: Not to my knowledge.

MR. MACBETH: You next discussed the Delaware. There you said there were many plants, but the plumes did not extend more than a third a way across the river.

DR. RANEY: Not more than a third.

End 14

MR. MACBETH: How do these plants sit in relation to the channel?

DR. RANEY: The plants are located on shore. Most of them have a surface discharge. The channel varies somewhat but it's a dredged channel. For the most part it's midstream.

I am talking now about the distance from Delaware Memorial Bridge or Wilmington, upstream to a point just north of Philadelphia.

MR. MACBETH: Do sqriped bass migrate up the Delaware?

DR. RANEY: Yes.

MR. MACBETH: In large numbers?

DR. RANEY: In some years.

MR. MACBETH: How have the years been recently?

DR. RANEY: Your class of 1969 in the Delaware was a surprisingly larger class. We found this out the past winter when these fishes, in late winter, when these fishes moved out and moved up along the Jersey Coast and were caught in great numbers in the vicinity of the mouth of the Mullica River.

MR. MACBETH: You described the situation with the shad in the Delaware in which they suffered an oxygen block.

DR. RANEY: The river actually suffered the block.

MR. MACBETH: Is it predictable what the reactions of fish species would be when they meet a block, either of oxygen or temperature?

DR. RANEY: I discussed the matter of temperature yesterday. The fish will either do nothing; it will be attracted, or be repelled.

MR. MACBETH: I guess that covers all possibilities?

DR. RANEY: Basically the same thing is true when a fish reaches an area where the oxygen maybe limiting for it. Periods of high flow in the Delaware, such as we had this spring, the oxygen stays fairly high. We had an early spring run, which is about equivalent to the run which occurred in 1963.

So it's also a very good run. In our tagging experiments done in the Salem area, which is located about 50 miles below the point where the oxygen block develops, we have found over several years that the shad which move up into the Delaware late in the season, at which time the oxygen is lower than three parts per million, will go up, mill around in the area where the oxygen is low, move back downstream, pick up a good supply of well-oxygenated water which comes out of the Chesapeake-Delaware Canal, move westward through this canal and then move up the Susquehanna River some nine miles and spawn below the dam.

This is the evidence that can be effected by

oxygen blocks. I think it's probably some of the better evidence that is in existence.

MR. MACBETH: Is that pattern of fish behavior -- would that pattern of fish behavior clearly have been predictable before it was observed?

DR. RANEY: I think so, sir, on the basis of principle. You can predict that if a fish can be caught where a river was blocked by oxygen, that it would turn around and get out of there. This is what I would have said ten years ago.

Since that time we have been doing experimental work on the effects of various levels of oxygen on fishes. These experiments confirm what we find in the field as far as this is concerned for the American shad, alewife, blueback herring, which are a relatively sensitive fish as far as oxygen is concerned.

They will turn around and get out of areas where the oxygen is three parts per million or less.

However, the catfishes that live in the same area are undeterred by this. They can live in water with oxygen values of less than one part per million. Here again you have tremendous variations with species.

MR. MACBETH: Let me turn to the last matters you checked out, the preference of the fish for the plume in the winter. How long would it take a fish starting at the

edge to move down the 11-degree area?

DR. RANEY: I could assume if conditions were ideal and the same as our experimental conditions, they could do this in basically a matter of four or five hours. They might move much more rapidly than that. We have no knowledge -- we can't confirm this by observations in the field or have not been able to do it as yet.

MR. MACBETH: What would happen to the fish if they found the ten to eleven degrees isothermal apparently crowded with fish?

DR. RANEY: There would be competition among the fish for that particular space. As you move from the hotter spot, you would get fewer and fewer fishes.

MR. MACBETH: Would you have, say, at nine degrees more fish than you would in the river ambient?

DR. RANEY: Yes, sir. This is in the winter?

MR. MACBETH: Yes.

MR. RANEY: Yes.

R. MACBETH: And that would continue slipping down the gradient until you reached the ambient, is that correct?

DR. RANEY: In a rough way, yes. We have no good observations on this, except we know that the hottest parts of the plumes near existing fossil fuel plants on eastern North American rivers are places where a great many fish

concentrate in various hot parts of the plume in the winter.

MR. MACBETH: Do you have observations or knowledge of how rapidly the number of fish in a heavy wintering area would decrease the gradient from ten or eleven degrees to ambient --

DR. RANEY: No, sir.

mil-1

MR. MACBETH: Mr. Chairman, could we have a five or ten minute recess at this point so we can look over our notes on Dr. Raney's testimony on redirect?

We might have a few more questions. We would like to be able to wrap this up now. If we could have that time and look at the notes, it would be helpful.

CHAIRMAN JENSCH: What else do we have after Dr. Raney?

MR. SACK: The next item on the agenda would be the cross-examination of Dr. Lauer on the entrainment of organisms other than fish.

After that we have some cross-examination on chlorine.

CHAIRMAN JENSCH: We would be able to clean those two up this afternoon, I take it.

MR. MACBETH: Yes.

MR. SACK: Is that the end of us, Mr. Macbeth?

MR. MACBETH: Yes.

CHAIRMAN JENSCH: That completes what we can do at this session, is that correct?

MR. MACBETH: Yes.

CHAIRMAN JENSCH: Let us recess, to reconvene in this room at 11:50.

(Recess.)

CHAIRMAN JENSCH: Please come to order.

Are we ready to proceed with further interrogation?

mil-2

MR. MACBETH: Yes.

CHAIRMAN JENSCH: Will you proceed, please.

MR. MACBETH: I have a few questions.

Dr. Raney, could you describe the discharge at Connecticut Yankee a little more fully? In particular, the way in which the water coming out of the discharge canal meets the river water.

DR. RANEY: It is a surface discharge. As I recall, it is maybe eight or ten feet deep at the point where it meets the river. It meets the river almost a right angles.

MR. MACBETH: In other words, there are no submerged discharge ports at the Connecticut Yankee plant?

DR. RANEY: No, sir, there are not.

MR. MACBETH: And the hot water essentially would flow out across the surface of the Connecticut River?

DR. RANEY: Yes. It is not a jet discharge. Basically in the summer, at least the heat would be mostly on the surface.

MR. MACBETH: Do you have any idea of how deep it would be?

DR. RANEY: The plume has been studied and has been published upon by William Boyd. It appeared as a bulletin in the Essex Marine Laboratory and is available from him. I don't happen to have it available.

MR. MACBETH: Would the sonically tagged shad,

mil-3

which went through the heated plume, do you know what part of the plume they went through?

DR. RANEY: The data are fairly precise. The pathway was followed and entered on the map. Here again, I do not have the tracks before me of the various shad that were tracked. I can't answer that.

MR. MACBETH: When you give it to us, could you provide the track of where they went through the plume?

DR. RANEY: Yes. I can provide the written documents which have been made available, both published and in the reports.

MR. MACBETH: Thank you.

Do you have any knowledge of a situation in which the channel of a river has been heated at all, and the relation of a situation of that sort to migration patterns of fish?

DR. RANEY: Yes, sir.

MR. MACBETH: What experience is that?

DR. RANEY: Well, the experience at the Hanford plant on the Columbia River.

MR. MACBETH: Which fish were migrating there?

DR. RANEY: These are steelhead trout and several species of Pacific salmon.

MR. MACBETH: Any of the fish that we have been primarily discussing here, shad?

mil-4

DR. RANEY: To the best of my knowledge, shad did not get that far. I would have to check this. There have been extensive studies done, however, on this plume, and there is considerable literature available.

MR. MACBETH: Do you know whether they are either alewife, blueback herring, or striped bass?

DR. RANEY: They did not occur in the Columbia, neither the alewife or the blueback herring.

MR. MACBETH: And the striped bass?

DR. RANEY: The striped bass is found occasionally near the mouth of the Columbia. It is not abundant there.

MR. MACBETH: Do you know of any other situations in which the channel has been heated? That is particularly any studies of the relationship between the heated channel and the migration patterns of fish.

DR. RANEY: I can't think of any offhand. Some of the effluents which are planned to use diffusers, I am under the impression that some of them in the TVA system do use diffusers which go out into the channel. The Watts City Plan, on the upper Mississippi is going to use a diffuser ~~and~~ ab such time as they outfit another system -- but to my knowledge, I don't know of any out-fall or effluent entering the channel in the East.

MR. MACBETH: The salmon and steelhead, do they migrate in the channel?

mil-5

DR. RANEY: They migrate on the shore.

MR. MACBETH: On the shore?

DR. RANEY: Yes. It was certainly wise of the biologist who made the original recommendation to put the outfall in the channel in that case of the Hanford plant.

MR. MACBETH: That concludes my recross.

CHAIRMAN JENSCH: Is there any further examination of Dr. Raney?

If not, thank you, Dr. Raney. You are excused.

(Witness temporarily excused.)

CHAIRMAN JENSCH: Who is the next witness for the other two subjects?

MR. SACK: Mr. Chairman, before we leave the question of thermal discharge for a second, I was wondering if we can get a statement of Mr. Macbeth when the additional testimony he has suggested would be available.

MR. MACBETH: My position on this, Mr. Chairman, has been that it would be best to wait until we had the final statement from the Staff. There are different topics and different emphases brought up in each round of the testimony that is presented. It would seem to me to be most fruitful to put in our testimony so they could answer whatever was presented by the Applicant at this point, but also by the Staff in a final statement. We could do it before that. I have a feeling that it is likely to mean that there will be some

mj1-6

issues here and there that will have to be put in by another round of testimony. I think that looking at the hearing, the probable hearing schedules, it will make more sense to do it as it meets the issues in the final statement.

MR. SACK: I think the issues have been defined by the contentions. If the final statement should raise some completely unforeseen aspect that relates to this contention, then maybe additional testimony would be permissible at that time. But I don't believe that is a reason to hold up everything on this question where Applicant's case is complete. Intervenors have had access to our documents for many, many months. Now we have completed the cross-examination in advance of the Intervenors' testimony. I think the Board has already been very generous to the Intervenors.

CHAIRMAN JENSCH: That hasn't been the basis of any Board action to either the Applicant or the Staff or the Intervenors at all. The decision made by the Board has been in an effort not only to expedite the proceedings, but to avoid duplicative presentations. I infer from the Hudson River Fishermens Association that they probably could bring in something now, but they reserve the right to supplement when the Staff position is made known.

It is customary in these proceedings, and illustrated certainly on radiological safety matters, that the Staff position is made known before the parties complete the hearing.

mil-7

We are vey consistent in that regard.

There is a proposal for a rule now that the Staff position will not be made known until the final impact statement is out. The Boards are encouraged to go ahead and examine those matters presumably that will not involve duplicative presentations as can be anticipated at the time. I think any person who has such a position in the proceeding as the Staff, having theopportunity to express a view, is of great assistance to the proceeding, and parties' positions can finally be determined when the Staff has asserted their position.

For instance, the Staff should take a position on a certain matter that the Intervenors would otherwise have presented. The Intervenors may well be inclined to say, while the Staff has urged that opinion, they won't articulate. They did. They might withhold presentation.

It seems to me we are going to get into a lot of duplicative presentation unless we know both what the Staff and the Applicant propose to be done here. The Staff waits for Applicant's position. As far as we can, I suppose we should interrogate to the extent we can.

We are going to get to a lot of wasted motions and complaints and reports of delay and anxiety to expedite when the parties do duplicate their inquiry and presentations. In this transitional state, we are going to have some

mil-8

duplication in any event.

MR. MACBETH: I frankly feel, Mr. Chairman, the generosity to a large extent has been onthe side of the Intervenors. I think we could reasonably ask to wait to begin the cross-examination until the Staff position was ready. We have gone ahead to try to expedite this on issues where the Applicant felt his case was fully prepared and was ready to step forward. We have gone forward with our cross-examination on those topics and working on stipulations. I think that the sensible thing is to really wait until we have the final statement before us and then focus our contentions against that, and the Applicant can focus his against that. We can proceed in an ultimately more rapidly focused matter.

CHAIRMAN JENSCH: Is there any statement of any kind that you could submit even though the Staff final statement is not out?

MR. MACBETH: We could take the testimony that was presented on the 5th of April and the affidavit that was presented in May and make those fuller and deal with a handful of issues that came up in the draft statement that was presented after that and the testimony which the Applicant presented at that time and has presented since then.

It means reworking to make it a full and coherent statement. It is already that testimony -- it is the testimony that runs 60 or 70 pages. I really wonder how much is going

mil-9

to be gained by doing that before the final statement is out.

CHAIRMAN JENSCH: Give the Applicant what you can give them. It might turn out to be that it will eliminate some duplicative presentation. If it doesn't, however, we won't expect to hear any word from the Applicant that it looks like the Intervenor is going over the same subject again. It may be doing it in part as a necessary consequence in trying to initiate something in the beginning without the complete data before the Intervenor at the time.

MR. SACK: If the Intervenor submits additional evidence before the final statement is out, we agree that they could then submit additional evidence on any new unforeseen matters that arise in the final statement. I would not think it would be duplicate. This would be additional.

CHAIRMAN JENSCH: It is new and unforeseen and it may be anticipated somewhat in part and credible to make a fine distinction between what is anticipated and that which they know now. I think if you can supply data or give some indication as to what you intend to present to such witnesses, it may be helpful to all parties, if you can.

MR. MACBETH: I will do the best we can.

End 16

MR. TROSTEN: The Commission has amended its rules, to provide that the Staff's position will not be presented until the final detailed statement is made available to the public. However, this will not preclude Applicant from presenting its case on environmental matters.

It seems to me, sir, that the thrust of the Commission's present regulations and the thrust of all the Board's actions to date has been to encourage the parties to proceed with as much of the hearing on the full-term full-power license as can possibly be accomplished without duplication, sir, after the final detailed statement has been presented.

This is what we have been trying to accomplish with the Intervenors here. But the Intervenors have had the benefit of a great deal of information from us.

Discovery has been going on in a very free and open manner. The intervenors have been able to meet with consultants of the Applicant. All of the information presented by Dr. Raney today could have been made available to the intervenors through the process of discovery.

We were intending to have a hearing on an interim license starting in early April. We received what we thought was the intervenor's case which presumably included all matters of concern on April 5th. I believe, sir, that with the benefit of all this information, including all the information

in the draft detailed statement, that the Intervenors certainly are in a position now to come forward with their entire case.

As Mr. Sack has pointed out, of course, if there was something completely unforeseen in the final detailed statement, then the parties and the Board will have to look at that. Everything is pretty far along.

The Staff is going to have its final statement out, we hope, very soon. I would hope that the Intervenors could therefore make their case known to us in its entirety now.

CHAIRMAN JENSCH: Very well. Let us proceed.

MR. SACK: The next ~~testimony~~ taskimony on the agenda is entrainment of organisms other than fish. I believe we should begin with Mr. Macbeth stating the contention.

MR. MACBETH: The contention, as we have worked out to the satisfaction of both parties last night, reads as follows:

At ambient summer temperatures a significant number of gammarus and neomysis entrained to the condenser system will be killed by the combined effects of chlorination, loss of dissolved oxygen, turbulense, pressure changes, and increased temperature.

MR. SACK: Dr. Lauer is ready to be cross-examined on his testimony of April 5th. Dr. Lauer has been previously sworn, and need not be sworn again.

CHAIRMAN JENSCH: Proceed.

Whereupon,

G. LAUER

resumed the witness stand and, having been previously duly sworn, was examined and testified as follows:

CROSS-EXAMINATION

MR. MACBETH: Dr. Lauer, let's begin with a quick question:

On Table 13 on page 38 of the testimony, you have a note saying percent survival and exposure, and you have an asterisk of the percent of survival, and it says,

"Numbers in parenthesis indicates number of experiments done."

I was unable to find the parenthesis on the page. Should there be parenthesis somewhere there?

DR. LAUER: I think you are right. That is a note that was put on there with the intention of putting in the number of experiments that were included for each one of those numbers, and inadvertently the parentheses were not put in.

MR. MACBETH: Could we have the number of experiments for each of these situations?

DR. LAUER: I will have to get those for you. I don't have that information here.

MR. MACBETH: You state, at the bottom of page 37

and going over to page 43, skipping the tables in between, that the percent of fammarus and neomysis in the samples of discharge canal from Unit 1 and from the far end of the discharge canal near the discharge ports to the river, were virtually identical to the percent found in the intake samples.

These reflect the percentage figures that appear on Table 15, I assume, ten observations of 77 percent survival of the intake; 80 and 81 of the discharge.

Do you draw the conclusion from those figures that passage through the condenser tubes in fact increases the survival of neomysis?

DR. LAUER: No, I do not.

That is not a very great difference in any case. Those kinds of differences appear just because of the variability of the data among the replicus experiments.

MR. MACBETH: Could you explain the experiment in particular? How do you control it to be sure that the samples that you are picking up in the discharge canal are in fact ones that have gone directly through the condenser tubes?

DR. LAUER: There is no way of doing this directly with these kinds of organisms. It would have to involve kind of a marking procedure to ensure that these have come through the condensers.

However, the water is transporting through the

system at quite a good velocity. We catch these things by the fact that they are moving with the water into nets. The process of the water moving down the discharge canal, that is.

If the water were not carrying them, they would not tend to be carried into the nets and concentrated into the nets. I think the presumption can be made quite strongly that the majority of these are coming into the plant and the intake water coming through the plant and going through the discharge canal.

It's also possible that there are organisms that do live constantly in the discharge canal, in which case they would, of course, be exposed to longer temperature exposures than would be the case if they were in transit through the cooling water.

Whichever the case may be, and in the latter case they would have the longer temperature exposure, then you might expect this would have a more severe affect on them if this were a stressful temperature.

Whichever that case might be, the percent survival in those samples in the nets taken from those two locations -- or actually three locations, are very similar. We can't be absolutely certain that anyone gammarus that we look at has been through the condenser system.

MR. MACBETH: Would you expect to find a

difference in the reaction of gammarus or neomysis which was exposed to a rapid increase in temperature, as opposed to one that had gradually acclimated to higher temperatures?

DR. LAUER: In a general sense, yes; but it very much depends on the amount of temperature change relative to the ambient that they have been acclimated to.

In order to look at that directly, we have been, along with these intake and discharge canal studies, been doing experiments in the laboratory with organisms collected both from the intake and the discharge canals, and organisms collected from the river, wherein the organisms are exposed to an instantaneous increase to a variety of temperature increases.

Also for a variety of times of exposure to those temperature increases, whereupon once through that period of exposure they are -- some of them we have dropped immediately back to an ambient temperature as if there would be an instantaneous reduction from the delta-T down to ambient. Others we have held and brought down in temperature gradually back down to the ambient as would be more closely approximated by the organisms going through a plume.

MR. MACBETH: I will come back to the experiments later. I want to work with the discharge situation.

The experiments at the discharge canal were done at delta-T of 5.4 to 9 degrees. Does that mean when you cite

that figure, were some of them done at 5.4 and some at 9? What does that range mean?

DR. LAUER: That is a range of delta-T that existed among the ten observations.

MR. MACBETH: In other words, one delta-T for each of the different --

DR. LAUER: The plant operations vary from time to time and place. We studied what it is doing.

What this means is that in those ten studies, among those ten studies, the delta-T ~~ranged~~ ranged from 5.4 to 9.0.

MR. MACBETH: The normal delta-T that would be expected when Indian Point 2 is operating is approximately 15 degrees; is that correct?

DR. LAUER: That is correct.

MR. MACBETH: Have you done any experiments with delta-T at 15 degrees?

DR. LAUER: We have. We have done experiments at that level and beyond to the point where we can determine stressful effects, either shock or lethal effects.

MR. MACBETH: Perhaps it was an ambiguous question. Have you done any experiments or tests in the discharge canal as you have here on Table 15? You have compared survival of the intake and survival of the discharge. One delta-T was at 15.

DR. LAUER: Not at those ambient temperatures.

These were the temperatures that existed at Unit 1 relative to these ambient temperatures. We do have data at higher delta-T at cooler ambient temperature conditions than this.

MR. MACBETH: But knowing which approximates -- these are summer conditions, 75 and 77?

DR. LAUER: Yes.

MR. MACBETH: Knowing that approximate summer condition?

DR. LAUER: Not as far as intake and discharge canal is concerned, no.

MR. MACBETH: When you remove the gammarus and the neomysis from the discharge canal, how long did you observe them?

DR. LAUER: We observed them for variable periods of time. These particular experiments quoted here, I think as is indicated in the testimony, if my recollection is right -- it has been a while -- were observations made generally within five minutes to an hour after they were collected from the discharge canal.

They were looked at as soon as possible after collection in order to be sure that we were looking at the condition of the organisms as they came from the canal rather than to have storage time ~~of~~ as an effect.

At this stage of the game we didn't know how well they could be kept in culture. We wanted to look at them

as soon as we could.

MR. MACBETH: Those taken out of the discharge canal, do they show any signs of abnormal behavior except for that percentage which did not survive at all?

DR. LAUER: No. The organisms represented in these experiments showed no defect I believe or quantifiable difference in behavior that would indicate a stressful condition. It's quite obvious, when they are stressed, to the eye, when they are under stressful conditions, to be able to observe those through these laboratory experiments that you said you would come to.

MR. MACBETH: Do you know what chlorinization was taking place at the plant at the time these observations of gammarus and neomysis were made?

DR. LAUER: Well, I know what the general schedule was at that particular time. To the best of my knowledge, there was no chlorination going on when these samples were taken from the intake and discharge canal. We were trying to look at the effects of heat here as distinct from chlorinization.

MR. MACBETH: Have you done tests and experiments on gammarus and neomysis at the intake and discharge in the summer conditions when chlorinization was taking place?

DR. LAUER: Yes, we have. That is reported in the other document having to do with chemical effects. It contains

a table. This is my testimony of April ~~15th~~ 5th.

It contains a table. I thought it did. I guess it didn't include the table. I guess I just included the results.

We did do studies on neomysis and gammarus at times when chlorinization was going on, through studying the intake and discharge canal. Again, this was based on immediate observations of these organisms. The data did not show any significant difference in survival between the intake and the discharge. We are continuing those studies, however.

MR. MACBETH: Could you give us the survival -- what I would like to do is get a table that would be comparative to Table 15 in the testimony.

Can you tell us, for those observations, when there was chlorinization going on, what the ambient range was?

DR. LAUER: The ambient range of survival?

MR. MACKBETH: No, the ambient range of river water temperature.

DR. LAUER: It was approximately the same as to Table 15 to which you have been referring. Let me dig a little bit and see if I have that information.

DR. GEYER: On page 9 you would find it, of the testimony on chemical discharges. It says ambient temperature of 70 degrees.

DR. LAUER: Thank you.

MR. MACBETH: Seventy degrees?

DR. LAUER: Yes.

MR. MACBETH: Somewhat lower than that without chlorination?

DR. LAUER: Yes.

MR. MACBETH: And the delta-T was 6 to 10. What was the number of observations made?

DR. LAUER: I think there were four, to the best of my recollection.

MR. MACBETH: What was the survival of the intake?

DR. LAUER: I have to continue to look for that information. I think I will have to get that to you at a later date because I don't see it in the folder where it should be. I will have to get that.

MR. MACBETH: Is that also true for the survival of discharge points 1 and 2?

DR. LAUER: That is correct, it would all be on the same table.

MR.MACBETH: I would appreciate having that.

Again, with chlorination, have you done any or made any observations where the ambient was above 70 degrees?

DR. LAUER: With respect to chlorination?

MR. MACBETH: Yes.

DR. LAUER: No, we haven't. We will be doing so ~~if~~ but the river temperature has not gotten that high yet this year. We

have gotten more of a frequency of samplings of the general description that are reported here through this year. But the river temperatures are not that high yet partly due to all of the rain we have been having.

MR. MACBETH: And also you have done it on higher delta-T, is that correct?

DR. LAUER: With respect to what?

MR. MACBETH: With chlorination.

DR. LAUER: With chlorination?

MR. MACBETH: Yes.

DR. LAUER: Yes.

MR. MACBETH: But you have it not in combination with the ambient? You really can't get the combination of the ambient.

Do you know what the flow rate through the condenser tube was at the time these experiments were done?

DR. LAUER: The temperature or the chlorination or both?

MR MACBETH: Both.

DR. LAUER: I don't have that information right here with me. I am sure it was variable because the delta-T are variable. The flows vary as do the load capacities on the plant. We look at whatever is coming through at the time. I am sure that that information can be gathered together. I don't have it here.

MR. MACBETH: Let me turn now to the thermal shock

experiments on gammarus. Could you tell us first the number of observations that were involved in these experiments?

DR. LAUER: There are many, many observations that go into this, not all of which produce meaningful data or, at least, data that is meaningful to produce because a lot of it involves temperatures at which no discernable effect is concerned at all. In general, what we have reported here in the testimony represented in various of the tables and figures are only those data at which we did see some kind of an effect on survival. We were looking to find out and to define what the stressful temperatures were more than we were to determine what they were not.

So, therefore, there is a lot of data that is not represented here. We simply gave the data here that is relative to a stressful effect that was measured.

In some manner -- I haven't bothered to count these up. The data that exists for each of the lines, for example, on Figure 8, to give a fair indication of the number of experiments that were involved at the various temperature ranges to determine percent survival. That is relative to ambient temperatures.

This kind of information is contained in Figures 8 and 9. As a kind of summary bit of information of the most important and pertinent type of information, there is a whole raft of data of the type I just described that would not have added anything really to the conclusions and so were not included

eak 4

here.

MR. MACBETH: Taking then the table of the bottom of Figure 8, does that indicate that there were five observations made in the ambient of 45 degrees, or five batches of observations?

DR. LAUER: Well, it indicates -- let's see. It indicates -- that would be approximately right. There may have been some additional experiments done at lower delta-T that are not included here because they would have all fallen down the line of the 100 percent survival. So, again, we only reported those that got to be within the stressful range as far as these figures are concerned. All the rest would fall on that vertical ordinate and wouldn't show up as far as survival is concerned.

MR. MACBETH: I had a little trouble running a line out, a parallel percent survival line. It seems to indicate to me that a degree range of, say, from about 45 to 47, you move from 100 percent survival to 20 percent survival. Is that accurate?

DR. LAUER: That is right. Once a stressful temperature is approached, there is a very narrow range beyond which you get a very significant effect in terms of survival.

MR. MACBETH: In the testimony you talked about these as survival figures. You have been talking now about stressful range. Is there a range of temperature below this survival point at which stress on the organisms is visible?

DR. LAUER: Yes. Generally, on the order of two to three degrees less than what you begin to see to cause increased mortalities. You would begin to see obvious signs of distress on the parts of the organisms.

MR. MACBETH: That would mean that at an ambient temperature of 78 degrees, you begin to see stress on the organisms at about 15 degrees delta-T, is that correct?

DR. LAUER: That is right. When the ambients are that high and if there were to be a full 15 degree delta-T, you would begin to see some evidences based on their behavior of stress, that is correct.

MR. MACBETH: When you did these experiments on thermal shock, were they solely related to the effective thermal increase, or were you also adding any and other factors such as loss of disolved oxygen or chlorination, pressure changes?

DR. LAUER: Well, in these earlier experiments, any loss of dissolved oxygen that would have occurred due to the temperature rise would have been present with the difference in change of temperature with the delta-T. We made no move to maintain oxygen levels at a constant rate relative to the experimental time. So, any oxygen losses that would have occurred did occur.

As far as chlorination is concerned, these results do not include the presence of chlorine to the best of our knowledge.

We use river water for these. But we did not take water that we knew to have been chlorinated as far as what is reported in these tables and figures.

MR. MACBETH: And pressure changes?

DR. LAUER: That is correct, pressure as well. We are not attempting to do it.

MR. MACBETH: There was no pressure, is that what you are saying?

DR. LAUER: I wouldn't say no pressure. There is no applied pressure.

MR. MACBETH: No purposeful change of pressure over the period?

DR. LAUER: No, there wasn't.

MR. MACBETH: And turbulence of the water?

DR. LAUER: No, there was no attempt made to simulate any increase in turbulence.

MR. MACBETH: The experiments reported here apply to gammarus. Have you done similar experiments on neomysis and rapid thermal increases?

DR. LAUER: We haven't been able to do anything of substance yet on neomysis. At the time we were going to attempt to do this sort of study on neomysis, they disappeared from the Indian Point plant site because, presumably, the fresh water flows increased in the salinity and the front moved downstream. So far as of this year, they haven't come back yet. The way the rains

keep coming, they may never come back this summer. But we do need to get data on those. If we can't get data by having them come to the plant, I think we are going to have to go down and find out where they are and collect them, along with the water they exist in, in order to get this kind of information. We can get the laboratory information this way if they don't come within proximity of the plant this year. Then we are not going to get the intake discharge studies. We have seen two specimens of neomysis this year in total in our sampling.

mil-1

MR. MACBETH: Is the salt water intrusion generally present inthe area of Indian Point at the time of high summer ambient river temperatures?

DR. LAUER: Well, that is variable. It frequently is. It is very much controlled by fresh water flows. This year is a good example of it, in the case where it has not yet started coming up in the vicinity of the plant. But in general, the salt water intrusion into the vicinity of the plant tends to take place in the latter part of the summer months, July, August, and September. In the fall the rains come and push it back downstream again. Then as things get frozen up in the wintertime, it tends tocome back because of a reduction in fresh water flow at that time.

MR. MACBETH: And the higher river ambient temperatures, do they also fall in July, August, and September?

DR. LAUER: That's correct.

MR. MACBETH: In the other testimony on the effects of chemical discharges on the river chemistry, you state that "Studies have been made of the phytoplankton and zooplankton population over three years." Can you describe what is involved in those studies with relation to gammarus and neomysis?

DR. LAUER: I don't think I understand the question. I understand the words, but I don't understand what you want me to get into.

MR. MACBETH: Did you study gammarus and neomysis in

mil-2

those population studies?

DR. LAUER: We did not at New York University during those three years. We have done this now -- we are in our second year of this wherein we are using gear that would sample gammarus and neomysis. Gammarus and neomysis were included in the Raytheon studies, however.

MR. MACBETH: When you say studies were made over a period of three years, is that with reference to Raytheon or NYU or both?

DR. LAUER: That specific reference is talking about studies that we have done at NYU wherein we have been studying phytoplankton and zooplankton, and in this sense I am talking about the microzooplankton forms to the exclusion of gammarus and neomysis. The gammarus and neomysis require different techniques similar to what is used for collecting fish eggs larvae. We were not doing those studies up until last year.

MR. MACBETH: In other words, this entire paragraph on page 9 starting, "While it is expected --" the first full paragraph on page 9 has no reference to gammarus and neomysis.

DR. LAUER: It was not intended in that first paragraph. I prefer to speak mostly from work we have done ourselves. The Raytheon studies did include the other organisms, gammarus and neomysis. My recollection from reading their reports were that they saw no aberrations in abundance of gammarus and neomysis in the near vicinity of the plant

mil-3

during the term of their studies as compared to other stations.

I was referring primarily to phytoplankton and microzooplankton in this paragraph, yes, that's correct.

MR. MACBETH: When you say you preferred to rely on your own studies, are you suggesting that you don't have entire confidence in the results of the Raytheon studies?

DR. LAUER: Not at all. I just happen to know better what we have done than what they did. I can speak better to it because I know more details about it. I only know what they have done through reading their reports. That is not as great a degree of depth of knowledge. I can only recall it not as specifically as I can recall my own. I have no reason to think that their methods were, for sampling gammarus and neomysis, for example, were inadequate. We are using generally the same techniques as they did, the same gear. I presume their studies were fine.

MR. MACBETH: Essentially your position on the Raytheon studies would be that they speak for themselves and you have no further independent knowledge that would indicate something had been added in or any changes should properly be made as to what is stated there?

DR. LAUER: In relation to the gammarus and neomysis?

MR. MACBETH: Yes.

DR. LAUER: Yes, that's correct.

mil-4

MR. MACBETH: Is it your opinion that loss of dissolved oxygen of, say, point three parts per million would have an adverse impact on gammarus and neomysis when the ambient dissolved oxygen was at five parts per million, or perhaps slightly less?

DR. LAUER: Well, it depends kind of where and when and over what expanse that would occur. I don't really think if the ambient dissolved oxygens were five parts per million, at least as far as gammarus is concerned, which we have a lot more experience with in the laboratory, than neomysis, I don't really think that three-tenths of a part per million, plus or minus five, would be of any significance in any case, even if it was a prolonged exposure. They are pretty tough critters. We have held those in laboratory tanks without any aeration stones or anything else for periods of months, and they just keep on going and reproducing. In fact, we do this to use it as food for fish to maintain our fish cultures.

So I don't really think that three-tenths of a part per million, plus or minus five, would have any significant effect on gammarus. I am dubious that it would on neomysis.

MR. MACBETH: Is your opinion on neomysis based on any study or just general knowledge?

DR. LAUER: In general, it is based upon where and when they occur in the Hudson River. You do find considerable numbers of them in the shallower back water areas of the Hudson

mil-5

River which were being described earlier as having wide temperature fluctuations. These areas of the river also have pretty wide dissolved oxygen fluctuations from day to night. They occur there and appear to thrive. So it is based on that kind of a general bit of information that I can make that comment.

MR. MACBETH: Assuming you took the river summer ambient temperatures, 75 degrees higher, would you expect a synergistic effect on gammarus and neomysis if they were exposed to the turbulence and pressure changes passing through the condenser tubes, the thermal shock of 15 degrees Fahrenheit and chlorination that would be greater than what you find with each one of those individually?

DR. LAUER: Well, you have covered a lot of territory there in that question.

Our studies that we have done so far in the intake and discharge canal, when compared to the laboratory studies that we have done, where we have been able to look at these factors over comparable delta-T, our laboratory results have agreed very well with the intake and discharge canal studies. As you know, we have just explored the fact. We haven't gotten to see a 15 degree delta-T in the intake discharge canal.

We have had opportunities to study the plant when it was on -- the circulation system was running, but the plant was not on line. So the turbulence and pressure was there,

mil-6

but not the heat.

We were not able to see that passage through the plant or at least operation of the plant under those conditions had any effect on the survival of the organism. This would be looking at those in isolation from heat. Adding heat into that did not appear to change the picture. It really appears that for the gammarus especially, which we have studied the most, the thing which is going to affect them the most is going to be the temperature if it is going to be affected. We haven't seen any evidence of synergism.

With respect to chlorine, chlorine is a biocide. It is conceivable that if the organisms are being stressed by, say, temperature and then chlorine is added, the resultant effect may be different than if they were there in isolation, one or the other. This would not be a surprising finding. At the timesof chlorination you may see a greater effect if the plant is on line and producing a 15 degree delta-T than if the chlorination was going on and there was no delta-T at 15 degrees.

MR. MACBETH: At summer ambient temperatures of 76 and 78 degrees, you have seen stress of the 15 degree delta-T on gammarus where they are not being exposed to turbulence or pressure change or chlorination?

DR. LAUER: In the laboratory experiments?

MR. MACBETH: Yes.

mil-7

DR. LAUER: That's correct. We haven't seen any mortalities, but we have seen that they become agitated and show signs of stress.

MR. MACBETH: Can you give an opinion as to whether you would expect to see greater stress or mortality if you added turbulence and pressure change in that situation?

DR. LAUER: Well, I guess there is a potential for this. But for these forms like the gammarus and neomysis that have hard exoskeletons and live alternately as benthic organisms and ultimately as more planktonic forms at night, they are living in turbulent conditions all the time. In handling these things, they can take a lot of handling and abuse compared to some of the body forms which don't have that harder exoskeleton. I couldn't discount entirely, but there is some potential if you add all these things together you may get a greater reaction than only if one or two were present. I don't really think so far as we have been able to see, that the turbulence and pressures have any significance, really, relative to the other two.

MR. MACBETH: Let me turn to the chlorine at this point.

MR. SACK: Excuse me, Mr. Macbeth. Is this the next subject?

MR. MACBETH: Yes.

MR. SACK: Are we through with the other?

mil-8

MR. MACBETH: It overlaps slightly since we are talking about the end of the discharge and also on gammarus and neomysis. I have finished certain major thrusts on gammarus and neomysis.

MR. SACK: Perhaps you might state the next contention and Mr. Stein and Dr. Lawler might join us at the table.

MR. MACBETH: The next contention is chlorine and/or its compounds that will have a toxic effect on fish and its immediate discharge.

MR. SACK: Mr. Stein has been previously sworn.

MR. MACBETH: Perhaps I have one last question on gammarus and neomysis. Do you know of other studies under conditions that would be comparable to the operation of Indian Point 2 in summer ambient temperatures that focus on the effects on gammarus and neomysis?

DR. LAUER: I have been involved in a short-term study looking at the effects of passage through the plant on gammarus and neomysis with reference to the Astoria plant that came close to being at the maximum summer ambient conditions.

These were short-term studies. The location was different. The water quality was considerably different, especially in relation to salinity, but also with respect to general water quality. In the main the results of those studies agreed as far as their temperature tolerance was

mil-9

concerned pretty closely with what we have been seeing at Indian Point.

Also some studies have been done by Mihursky that are reported, at least as far as I know they weren't published previously. They are reported in a new volume called Marine Biology, edited by Kenny, which came out last year. Those have some relativity in that Mihursky determined 24 hour TLM data. That is tolerance lethal median data for gammarus. He also produced data which is reproduced in that document that I just made reference to, which shows mortalities at other than the 50 percent TLM temperatures. It includes some data that is relative to ambient. These were all laboratory experiments. These were not just intake discharge studies.

MR. MACBETH: What about the situation in Astoria? Is that a laboratory experiment with East River water or is that actual measurements at a plant?

DR. LAUER: Intake discharge canal studies there, wherein we had the plant operate at approximately between 15 and 16 degrees Fahrenheit delta-T. We took samples at the intake and from the discharge and determined percent survival. It was that type of experiment similar to what we have been doing at Indian Point.

MR. MACBETH: You make the difference in water quality. Is it considerably worse at the Astoria plant?

DR. LAUER: Yes, considerably. Dissolved oxygen

mil-10

is quite low there.

MR. MACBETH: Does that result in a much lower population of the organisms?

DR. LAUER: They actually appear to be surprisingly abundant. You hear frequent reference to that part of the river being a dead river, but actually there were a lot of organisms there as well as considerable numbers of fishes in the vicinity of that plant, larvae fishes as well as mature fishes. We saw quite a lot of fish larvae, gammarus, neomysis, phytoplankton forms and plankton forms in that water despite its poor quality, which is generally recognized as being poor.

MR. MACBETH: What were the ambient temperatures at which you did those tests?

DR. LAUER: Those temperatures, as I recall, started at about 71 or 72 degrees Fahrenheit, and we were on the downhill side of the summer. I think they went down to about 65 before we were finished.

MR. MACBETH: How many observations did you make?

DR. LAUER: These observations were made over a period of about two and a half weeks. This is a guesstimate at the moment in terms of numbers of samples. I would say it was probably on the order of a dozen samples each from the intake and the discharge.

MR. MACBETH: What were the relative survival rates?

DR. LAUER: I don't recall what they were. There

mil-11

is not a significant difference between the intake and the discharge, as I recall, but what the absolute numbers were, I don't recall either. I don't have that information here. I would have to get it for you.

MR. MACBETH: Could you provide that?

DR. LAUER: Yes.

CHAIRMAN JENSCH: Is this a convenient place to interrupt your examination?

MR. MACBETH: Yes.

CHAIRMAN JENSCH: Is 30 minutes adequate for lunch? I hear no objection.

At this time, let us recess, to reconvene in this room exactly 1:30.

(Whereupon, at 1:00 p.m., the hearing was recessed, to reconvene at 1:30 p.m., this same day.)

AFTERNOON SESSION

(1:30 p.m.)

CHAIRMAN JENSCH: Please come to order.

Hudson River Fishermen Association, are you ready to proceed?

MR. MACBETH: Yes.

Whereupon,

WALTER STEIN

was recalled and, having been previously duly sworn, was examined and testified further as follows:

CROSS-EXAMINATION

MR. MACBETH: Turning now to the chlorine situation in the discharge canal area immediately outside of the discharge, what is the concentration of residual chlorine when it leaves the condenser tube and before it makes the one to one dilution noted on page 7 of Dr. Lauer's testimony of April 5th?

MR. STEIN: The concentration will vary, sufficient concentration to keep the condenser tubes clean. It generally runs up to a maximum of one part per million.

MR. MACBETH: What form is that free residual chlorine at that point?

MR. STEIN: The free residual chlorine is as hypochlorite ion.

MR. MACBETH: The discussion goes on to talk about dissipation of the chlorine demand. The chlorine demand of the

eak 2

river and lost air concentration to usually .1 pbm. What is the chlorine demand of the river water?

MR. STEIN: Are you asking me for a definition or an order of magnitude type number?

MR. MACBETH: Order of magnitude.

MR. STEIN: It will vary from essentially zero to a maximum of about 2 ~~pbm~~ PPM, averaging to a range of 1 ~~pbm~~ PPM.

MR. MACBETH: What is that chlorine demand made up of?

MR. STEIN: Chlorine demand is organic matter and other substance that are subject to oxidation by chlorine in the water which would change the form of the chlorine to chloride.

MR. MACBETH: In all cases would the form of chlorine be changed to chloride?

MR. STEIN: No. There are other compounds it might be changed to as well.

MR. MACBETH: What are those other compounds?

MR. STEIN: Compounds of chlorine such as chloramine, such as hypochlorus acid, such as various compounds containing chloride. Carbon containing compounds, inorganic ions, organic compounds.

MR. MACBETH: Let us turn to the chloramines. Of the total amount of free residual chlorine, what part do you estimate would be changed to chloramines?

MR. STEIN: I believe Dr. Lawler could speak to that

into chlorides or the other compounds not included in the free chlorine and combined chlorine?

DR. LAWLER: No, I just don't know what that split is.

MR. MACBETH: Could one measure for those chlorides at the end of the discharge canal?

DR. LAWLER: Excuse me?

MR. MACBETH: Could one measure for those chlorides at the end of the discharge canal?

DR. LAWLER: Which chlorides?

MR. MACKBETH: As I remember --

MR. STEIN: The existing concentrations of chlorides in the river is too high as a background to be able to detect the small levels to be able to be added to the chlorine.

DR. LAWLER: I would definitely agree with that statement.

MR. MACBETH: I have no further questions of the witnesses at this point.

CHAIRMAN JENSCH: That has concluded all the examination you had that you discussed last evening, is that correct?

MR. MACBETH: Yes. There is a third contention which --

CHAIRMAN JENSCH: You will stipulate?

eak 4

CROSS-EXAMINATION (Continued.)

DR. LAUER: There are two differences made to McKee and Wolf. At least, there are two paragraphs with respect to which are you asking, or are you asking to both?

MR. MACBETH: Let me start with the reports of concentrations less than 2 pbm. The exposure times or harmful exposure times are 7 to 23 days. With their studies there that didn't give any exposure times?

DR. LAUER: There was one.

MR. MACBETH: Do you know the sizes of the fish involved in those studies?

DR. LAUER: No, I don't. That kind of information isn't given here in this kind of digested form. One would have to go back to the original reference in order to determine that.

MR. MACBETH: Do you know in all cases what kinds of fish were involved?

DR. LAUER: In one case, it just says fish. In all other cases, it is specified.

MR. MACBETH: In the cases with concentrations above .2 pbm, where harmful effects were found, how many of those were time and exposure not given?

DR. LAUER: Five.

MR. MACBETH: Again, are there cases therein which the type of fish involved is unknown?

DR. LAUER: For the most part, it is specified. In

eak 5

one instance it just says many types. In another instance it just says fingerlings. It doesn't specify which fingerling. In that respect in one part of the list, however, it would indicate that they are small fish appropos of your previous question.

MR. MACBETH: The one that says fingerlings?

DR. LAUER: That is correct. As a general rule, people can do this test corresponding to standard methods which include a recommendation that small fish generally young of the year between two and three and a half to four inches are used. I think it would be reasonable to assume that most of these tests were run with fish of that general size range, although it is possible that some of the tests were not.

MR. MACBETH: It would be an assumption?

DR. LAUER: That is true, yes.

MR. MACBETH: It is also noted there are 13 additional observations where concentrations of .1 to 5.0 pbm caused no fish mortality. For how many of those are no exposure period given?

DR. LAUER: Six.

MR. MACBETH: And in all cases is the type of fish involved known?

DR. LAUER: No. As I look at the list, it appears that two out of that list just say fish. One of them says tadpoles which specifies it is not a fish.

MR. MACBETH: Do any of the entire series of McKee

eak 6

and Wolf studies indicate that striped bass were studied?

DR. LAUER: No, they do not. I think there ought to be some clarification on your question, though. These are not studies by McKee and Wolf. These are studies by others.

MR. MACBETH: Reported by, I should say.

DR. LAUER: Yes.

MR. MACBETH: And also for white perch, is there any indication there are reports of studies on white perch?

DR. LAUER: No, they are not.

MR. MACBETH: Alewife, herring, shad?

DR. LAUER: No.

MR. MACBETH: Turning to the laboratory bioassay tests by New York University.

DR. LAUER: Yes.

MR. MACBETH: Could you describe how the tests were conducted, and in particular how the chlorine was originally administered and whether you attempted to keep any chlorine residual, or was it naturally dissipated?

DR. LAUER: These tests that are referred to, the bioassay tests, were essentially tests done according to standard methods as would be described for a 48-hour static bioassay test.

This technique was specified by the New York State Department of Environmental Conservation as to what they would like to see in making their own determinations about their permits that they would issue for the plant.

There was no effort made to maintain concentrations in the containers once fish were placed in the containers.

MR. MACBETH: What kind of water was used in the tests?

DR. LAUER: Hudson River water.

MR. MACBETH: Was the presence of any chloramines detected in the course of these studies?

DR. LAUER: Chloramines were not analyzed separately from the chlorine analysis that was done.

However, the conditions of the test were that

river water was placed in the containers. The hypochlorite, as used in the plant, was used to generate concentrations in those tanks, and then the fish were placed in the tanks for the bioassay. So that if chloramines were formed, and presumably some probably were, they were there in the concentrations that they would be generated by the hypochlorite introduced into each of the tanks.

The fish were held in those tanks. It was not a matter of choice. They were held in the tanks for the full term of the test or until such time as either the fish were dead or there was no longer any chlorine residual that could be detected. Then the results of the tests were noted.

MR. MACBETH: I have a question about when chlorine could be detected.

You gave a figure of dissipating chlorine residuals to undetectible limits. Then you give the limit, .1 pbm. How do you know it was .1 pbm if you did not attempt it?

DR. LAUER: That is the lower limit of detectability for that method. If it's less than that, the method would not detect it.

MR. MACBETH: In the course of the three hours, do you know the rate at which the chlorine was being dissipated?

DR. LAUER: Some of those rates are indicated. For example, in the testimony on page 8, it indicates that in an exposure system wherein the initial concentrations were

.75 parts per million and .6 of a part per million, initial total chlorine residuals, these dissipated to undetectible limites, 0.1 parts per million, in one and one-half hours.

MR. MACBETH: Is that a steady rate of dissipation?

DR. LAUER: No, it's not a steady rate. It's generally quicker initially and goes at a slower rate as time passes. The chlorine demand is exerted relatively rapidly and in greater amounts early, and to less extents later.

MR. MACBETH: Do you know how much of the chlorine in these experiments was lost to the air, and how much was lost into compounds in the water?

DR. LAUER: We do not.

MR. MACBETH: Have you run other experiments with the white perch and striped bass and with chlorinization? The last time you suggested that you tried other concentrations as well?

DR. LAUER: Well, we haven't. We have done, however, concentrations ranging from less than what is expected or they eventually get what is expected to be discharged from the plant. In all cases they were initially higher than is expected to be discharged from the plant.

That runs from roughly .3 of a part per million up to three parts per million. In fact, we have gone up to almost eight parts per million in some of the experiments. We have covered quite a range of chlorine concentrations,

initial concentrations through these bioassay tests that were done to provide information to the State.

MR. MACBETH: In what form is the chlorine put into the water?

DR. LAUER: The chlorine is put into the water in the same form used at the plant. It was a hypochlorite solution which is taken from the vats that supplied the plant with chlorine for their chlorinization purposes.

MR. MACBETH: Dr. Lawler, have you received the data from your car?

DR. LAWLER: Yes.

MR. MACBETH: Let us return to those questions.

DR. LAWLER: The answer to your question, as the split between free chlorine and chloramines that we observed in the discharge canal is 85 percent of the total residual chlorine in the free form, and 15 percent was in the combined form of chloramines.

MR. MACBETH: Do you know how much of the chlorine is lost to the air in comparison to what is taken up in the river watter?

DR. LAWLER: No, I don't.

MR. MACBETH: Going back to the fractions of free chlorine and chloramines.

DR. LAWLER: Yes.

MR. MACBETH: Could you give those figures in parts

per million?

DR. LAWLER: We observed at the end of the discharge canal, prior to entry into the river, .07 parts per million of free chlorine; .01 parts per million of compound chlorine.

MR. MACBETH: How many observations were made on the basis of this analysis?

DR. LAWLER: The number of observations made at that point before the number of observations which made up the 85-15 percent split were 12. The other measurements were made at points slightly farther upstream in the discharge canal.

MR. MACBETH: Would you expect any marked changes in the amount of the concentration of chloramines as opposed to free chlorine to occur with normally varying conditions in the river?

DR. LAWLER: I don't know of any offhand. If we lost the ~~amonia~~ ammonia in the river, I suppose you would have even a higher fraction of free chlorine.

MR. MACBETH: Do you know what the source of the ~~amonia~~ ammonia in the river is?

DR. LAWLER: I presume the ~~amonia~~ ammonia in the river is due to sewage decomposition products.

MR. MACBETH: And that is a steady flow down the river, is that correct?

DR. LAWLER: Well, the ~~amonia~~ ammonia concentration will never be the same value. I would suspect that the amonia ammonia concentrations would not vary tremendously in the river.

MR. MACBETH: When the observations were made of the free chlorines and chloramines, what were the conditions of flow in the plant?

DR. LAWLER: The plant was operating at full flow.

MR. MACBETH: The figures on the concentration of free chlorine and combined chlorine give a value of .08 residual chlorine.

Is that the typical value, or is .1 the typical value?

DR. LAWLER: These measurements were made with an Amperometric titration unit. They were done with that unit to get a greater degree of precision.

MR. MACBETH: Among the observations was there any range or did they all come out at .08?

DR. LAWLER: No. There was a range: In three of the four of them it was zero, and another was .02. In the values for free chlorine in the four samples it was .09, .05, .09, and .06. The .06 value was the sample that had the .02 residual -- chloramine residual.

MR. MACBETH: Is it now known what part of the residual chlorine at the point of discharge lost at the end of the discharge canal goes into the air and what part of it goes

into chlorides or the other compounds not included in the free chlorine and combined chlorine?

DR. LAWLER: No, I just don't know what that split is.

MR. MACBETH: Could one measure for those chlorides at the end of the discharge canal?

DR. LAWLER: Excuse me?

MR. MACBETH: Could one measure for those chlorides at the end of the discharge canal?

DR. LAWLER: Which chlorides?

MR. MACKBETH: As I remember --

MR. STEIN: The existing concentrations of chlorides in the river is too high as a background to be able to detect the small levels to be able to be added to the chlorine.

DR. LAWLER: I would definitely agree with that statement.

MR. MACBETH: I have no further questions of the witnesses at this point.

CHAIRMAN JENSCH: That has concluded all the examination you had that you discussed last evening, is that correct?

MR. MACBETH: Yes. There is a third contention which --

CHAIRMAN JENSCH: You will stipulate?

MR. MACBETH: Yes.

CHAIRMAN JENSCH: Is there any further interrogation of these witnesses?

Regulatory Staff?

MR. KARMAN: I have no questions.

CHAIRMAN JENSCH: New York State Atomic Energy Council is not represented here.

Any redirect from the Applicant?

MR. SACK: Could we have two or three minutes?

CHAIRMAN JENSCH: We won't be in formal recess.

MR. SACK: Mr. Chairman, by way of redirect, we would like to introduce into evidence a document. I apologize for not furnishing it to the Board previously. This is because we did not realize the contentions that would be raised until very recently.

This document was prepared in connection with our comments on the AEC draft statement, and Mr. Macbeth has had it in his possession since June 1. The document has been prepared by Mr. Stein. It's being reproduced at this minute, and we hope to have enough copies to distribute momentarily.

As of now the only document is in Mr. Macbeth's hands, the only copy in the room is in his hands.

CHAIRMAN JENSCH: Is it your thought that you wanted this document incorporated within the transcript?

MR. SACK: That is correct.

CHAIRMAN JENSCH: You will furnish the necessary copies?

MR. SACK: Yes.

CHAIRMAN JENSCH: And if you have any extra, the Board would like to have a copy.

MR. SACK: Mr. Stein, this document entitled Chlorination at Indian Point, has this document been prepared by you or under your supervision and direction?

MR. STEIN: Yes, it has.

MR. SACK: Is this document true and correct to the best of your knowledge?

MR. STEIN: Yes. It is.

MR. SACK: Do you desire to have this document received in evidence in this proceeding?

MR. STEIN: Yes, I do.

MR. SACK: Mr. Chairman, I now offer this document as redirect testimony of the Applicant in this proceeding.

CHAIRMAN JENSCH: Is there any objection?

Regulatory Staff?

MR. KARMAN: No objection.

CHAIRMAN JENSCH: Hudson River Fishermen's Association?

MR. MACBETH: No objection.

CHAIRMAN JENSCH: The request of Applicant's

counsel is granted and the statement by Witness Stein, to which identification has just been made, may be physically inc incorporated within the transcript and shall constitute evidence from the Applicant.

(THE FULL TEXT OF THE DOCUMENT FOLLOWS.)

Appendix D

CHLORINATION AT INDIAN POINT

A sodium hypochlorite system is provided at Indian Point Units 1 and 2 for the specific purpose of preventing the growth of fouling slimes on the inner surfaces of the condenser cooling water system.

When sodium hypochlorite is dissolved in water, it dissociates to form sodium ions and hypochlorite ions. The hypochlorite ions then react to form hypochlorous acid. The ratio of hypochlorous acid to hypochlorite ion depends upon the pH of the solution. Since it is hypochlorous acid that is the principal disinfectant in chlorine solutions, the efficiency of disinfection will be substantially greater at low pH values where the hypochlorous acid content is greater.

If ammonia is present, chloramines will be formed upon the addition of sodium hypochlorite to the water. The disinfecting properties of chloramines are only a few percent of that of hypochlorous acid. Increasing the amount of ammonia decreases the acid concentration, increases the pH and thus decreases the rate of kill. Chloramines are more persistent in the natural environment than hypochlorous acid but are not necessarily more toxic.

Chlorine is dissipated in water by reacting with reducing agents as well as with organic substances and organisms. This loss represents the "chlorine demand" of the water. Hypochlorous acid is also decomposed to exposure to daylight (ultra violet rays from the sun).

The Unit No. 1 condenser at Indian Point has four condenser sections. Chlorine , as sodium hypochlorite, is introduced by manually starting a pump injecting a sodium hypochlorite solution into the cooling water at a point between the travelling screens and the circulating pumps. It is first introduced into two sections of the condenser for one-half hour during the daylight hours. The chlorine is then similarly introduced into the remaining two sections for one-half hour, so that only one-half of the cooling water is chorinated at a given time. Control of the amount of chlorine injected is achieved by adjustment of the hypochlorite pump stroke and observation of the tank level. The water from the chlorinated and unchlorinated sections mix within seconds after leaving the condenser resulting in a 1:1 dilution. The chlorine residual dissipates quickly from exposure to daylight and the chlorine demand so that the discharge concentrations have usually been 0.1 ppm or less. This is based upon actual measurements taken during chlorinations since 1968. The overall time during which chlorine is added to the condenser is one hour. This procedure is repeated as required on alternate days for a maximum of 3 days each week.

The Unit No. 2 condenser has six sections. The chlorination procedure will be similar to Unit No. 1. That is, one-half of the condenser (3 sections) will be chlorinated manually during the

daylight hours for one-half hour, followed by chlorination of the other three sections for one-half hour. Since the procedures for chlorination on Unit No. 2 are similar to those used on Unit No. 1, the discharge concentrations during chlorination of Unit No. 2 should also be 0.1 ppm or less. Flow of sodium hypochlorite will be regulated by adjustment of flow control valves and observation of tank level.

Chemical tests are performed on the condenser outlet as a basis of controlling chlorination levels in the condenser sections. Tests are also performed on the discharge canal to insure that compliance with the concentration limit of 0.5 ppm is maintained.

Present plans call for chlorination of Unit No. 1 and Unit No. 2 condensers on alternate days so that chlorine would be introduced into the cooling waters of either Units No. 1 or No. 2 for a maximum of six days of the week for one hour each day. During full capacity operation the volumes of water treated with chlorine at a given time would be 140,000 GPM from Unit No. 1 and 420,000 GPM from Unit No. 2.

The targets of the chlorine are the fouling organisms growing on the inner surfaces of the condenser cooling system. An exposure time of one-half hour, three days per week has effectively controlled such growths at Indian Point Unit No. 1.

In comparison with the target fouling organisms, the organisms passing through the condensers in the cooling water at the time of

chlorination are exposed to full application concentration in the condensers for less than 15 seconds, and exposure to the decreasing concentrations in the cooling water discharge for an additional few minutes, the exact concentration and time depending upon the effective dilution and dissipation rates.

While it is expected that some of these non-target organisms in the cooling water are killed during the chlorination period, studies of the phytoplankton and zooplankton populations have no indicated that chlorination had no discernible effect on these populations in the river.

Of the data in McKee and Wolf (1) on toxicity of free chlorine residual compiled from many sources, 13 of 18 concentrations reported to be harmful exceeded 0.2 ppm. The five reports of concentrations less than 0.2 ppm that were harmful involved exposure times of 7 to 23 days. Three of those reports involved trout and salmon.

McKee and Wolf report on thirteen additional observations where concentrations from 0.1 to 5.0 ppm caused no fish mortality. The reported exposure times for these observations ranged from 2 to 100 hours.

Laboratory bioassay tests on fish found in the Hudson River near Indian Point by New York University resulted in 100% survival of small white perch and striped bass for three hours when exposed to 0.75 ppm and 0.60 ppm initial chlorine residuals that dissipated to undetectable limits within one and one-half hours.

Although other references quoted in the USAEC Detailed Statement, dated April 13, 1972 (Merkens (2), Zillich (3), Basch (4), Arthur and Eaton (5)) indicated toxic effects at concentrations below 0.1 ppm, the exposure times encountered were in the order of 96 hours to 15 weeks. Times of exposure in the Hudson River at Indian Point will be much lower. In addition the species quoted by the AEC are not found in the Hudson River near Indian Point and moreover bioassay tests of the species at Indian Point resulted in no mortality.

Since chlorination practices have not and are not expected to cause any measureable damage to the environment, other programs for maintaining condenser cleanliness have not been investigated in detail. Mechanical and thermal cleaning systems have been used at some locations but only with limited success. In addition, the alternate systems will not prevent growth on the cooling water pipes and on the walls of the condenser water boxes.

At the present time however, a program is underway to reduce further the frequency and duration of chlorination. The Indian Point Unit No. 1 condensers have not been chlorinated since January 11, 1972. Inspection of the condensers have been performed regularly to determine the effect of the reduction in chlorination frequencies. Preliminary results show no appreciable growth of fouling slimes during this winter period. Indications are, therefore, that chlorination frequencies can be reduced during the winter months.

This program will continue throughout 1972. After completion of this program, the minimum effective amount of hypochlorite per dose will be determined and new operating instructions will be issued for both Indian Point 1 and 2.

References:

(1) Water Quality Criteria. J.E. McKee and H.W. Wolf, Editors. The Resources Agency of California State Water Quality Control Board Publ. No. 3-A

(2) Merkens, J. C., "Studies on the Toxicity of Chlorine and Chloramines to the Rainbow Trout, " J. Water Waste Treat. 7, 150-151 (1958)

(3) Zillich, J. A., "A Discussion of the Toxicity of Combined Chlorine to Lotic Fish Populations, "Michigan Water Resorces Commission Report, 13pp. (unpublished), 1970.

(4) Basch, R. E., "In-situ Investigations of Toxicity of Chlorinated Municipal Waste Water Treatment Plant Effluents to Rainbow Trout (Salmo gairdneri) and Fathead Minnows (Pimephales promelas), "Completed report Grant 38050G22 Environmental Protection Agency, National Water Quality Office, 50pp. (1971).

(5) Arthur, J. W., and Eaton, J. G., "Chloramine Toxicity to the Amphipod. Gammarus pseudolimneaus, and the Fathead Minnow, Pimephales promelas," Environmental Protection Agency, National Water Quality Laboratory, Duluth, Minn. (1971).

mil-1

MR. SACK: The next item is, Dr. Lawler has the answer to the last question asked this morning by Mr. Macbeth concerning a table in the testimony on dissolved oxygen.

DR. LAWLER: This table was discussed yesterday. Since there are no page numbers in the copies of the testimony that was submitted, this appears as the last paragraph or shortly before the last paragraph in item C or part C of item 1 of my testimony on dissolved oxygen. The numbers that are given in the final column marked delta DO and changed to DO are correct. The column heading is slightly misleading. It indicates that the fifth column is to be subtracted from the fourth column to get the values which appear in that last column. That is incorrect. It is correct for the first case, which is an average, but it is not correct for either the maximum or the minimum values. This becomes very clear when one references or looks at table 3, which is the complete table of that data.

Very simply what happened here is the maximum and minimum values of both the intake dissolved oxygen and discharged dissolved oxygen measurements are shown in this table that is inserted at the point in the testimony referred to. But the maximum intake DO and maximum discharge DO did not occur at the same time. So therefore you can't subtract and the same response holds for the minimum case.

So in summary -- I indicated yesterday afternoon

mil-2

that at first glance it appeared that the numbers were incorrect. They are correct. Simply the table heading should be corrected to simply read delta DO.

MR. MACBETH: In otherwords, the intake DO was 10.30 at a different time than the discharge DO is 10.10, is thatcorrect?

DR. LAWLER: That's correct. If you recall my aside yesterday afternoon, that is what I had in the back of my mind, but I wasn't sure of that. I'd like to point out, however, two errors that I did come across in rereading this testimony. The first is very simple, but it may cause some confusion.

In the summary on page S-1, the last paragraph in item 1, number 1, there is a reference to an item, III. That should be changed to II. There is no III in this testimony.

Secondly I came across some typos, most of which were juxtaposition of letters and resulted in incorrect spellings. There was one juxtaposition of numbers that could cause a problem. On page S-2 and also the same statement is made on the page immediately prior to the page where that table was referred to a moment ago. There is a statement that reads in the third paragraph on page S-2, "During the DO measurement survey unit number 1 was operating at rated capacity including water flow at 204,000 GPM." That should read 240,000 GPM. That's all I have.

mil-1

CHAIRMAN JENSCH: Does thatconclude all that we can handle at this session?

MR. MACBETH: I have one last question of Dr. Lauer, if I may.

CHAIRMAN JENSCH: Proceed.

MR. MACBETH: Have you done any work on the attraction or avoidance of fish or plankton to various concentrations of chlorine or chloramines?

DR. LAUER: No, I have not.

MR. MACBETH: Thank you.

Has anyone else done it for Con Edison? I assume I am directing this to --

MR. TROSTEN: Repeat the question, please.

MR. MACBETH: Has anyone for Con Edison done work on the attraction or avoidance of fish or plankton organisms and various concentrations of chlorine or chloramines?

DR. LAUER: Not to my knowledge.

MR. SACK: I have a few procedural points.

First, we tried to reach an agreement with Mr. Macbeth as to when his additional testimony we discussed earlier would be

mil-2

furnished. It is my understanding we have agreed on July 15 of this year.

MR. MACBETH: We never discussed the year, Mr. Sack.

MR. SACK: That is why I wanted to clarify it.

CHAIRMAN JENSCH: I think as soon as you tell us when you get it down to the core, we can perhaps fix the time.

MR. SACK: That will be this year, too, Mr. Chairman.

The next point that we now, in view of Mr. Macbeth's statement, understand that the Hudson River Fishermens Association and the Environmental Defense Fund have completed their cross-examination on the contentions which have been discussed these two days, unless, of course, the final ~~detail~~ detailed statement raises some issue that could not have been foreseen at this time.

MR. MACBETH: That is a course of cross-examination of the Applicant and cross-examination of the Staff, and also hold out that if the Applicant puts in more testimony on these points, we would feel free to cross-examine on that.

MR. SACK: We understand that.

CHAIRMAN JENSCH: Very well.

MR. SACK: I'd like to make a request of the Board at this time, as we move into later sessions of the environmental hearing -- and this part of the hearing, unlike the radiological one, we have witnesses who are not employees of

mil-3

Con Edison. Some of them travel from great distances and have teaching duties, et cetera. In general, to the extent that it is feasible, we would like the cooperation of the Board and parties in scheduling witnesses so as to minimize needless transportation and things of that nature.

CHAIRMAN JENSCH: That will be done. I think it is well, as the parties confer among themselves in reference to further sessions, that the parties indicate the specific witnesses that would be needed for the interrogation and make some flexibility in your schedules so that in case a witness has other engagements at the time, adjustments can be made. The Board will be flexiblt in its arrangement. Bear in mind that the parties have the responsibility of indicating the agenda that will move this case along without delay.

Is there any other matter to be taken up?

MR. SACK: Thank you, Mr. Chairman.

We would just recommend, before we adjourn, that we determine to reconvene the hearing on the full environmental review not later than 30 days after the final ~~detail~~ detailed statement is issued by the Atomic Energy Commission Staff.

CHAIRMAN JENSCH: How is that statement getting on?

MR. KARMAN: Mr. Chairman, as I indicated at the last session, the Regulatory Staff was shooting for July 19th as the date for the issuance of the final environmental statement. As of this moment, that is still the date.

mil-4

CHAIRMAN JENSCH: Very well. There is one other matter that the Board would like to have. I wonder if this could be supplied now within some general range. Perhaps information is available in a general way. Whatisthe total investment in Indian Point No. 2? Do you know that approximately at this time?

MR. CAHILL: I believe I can get a closer check. I believe it is about $150 million. It is somewhat higher than that.

CHAIRMAN JENSCH: Could you take time out to find that out now?

MR. CAHILL: Yes. We'll get getting a more precise check. It won't be to just today, but our estimate.

CHAIRMAN JENSCH: You don't happen to have an annual report from Con Edison available?

MR. CAHILL: Not right here.

CHAIRMAN JENSCH: Is the 1971 report out?

MR. CAHILL: Yes, sir. We can mail copies.

CHAIRMAN JENSCH: I thought from that you would be able to discern it.

MR. CAHILL: It won't be in there. That is lumped with the total construction program for the company. But the plant investment is roughly $150 million. Then there is some $20 million or $30 million worth of fuel investment as well.

MR. BRIGGS: I think yesterday when we talked a

mil-5

bit about the foreign material in the reactor, it was concluded that there was more than a teacup full, but less than a basket full of foreign material. Could you be more specific?

MR. CAHILL: Yes, sir. I think it is closer to a teacup full, maybe two teacups full. The trouble is, it is well dispersed.

MR. TROSTEN: Mr. Chairman, would you want us to send the information to you by telegram or telephone?

CHAIRMAN JENSCH: If we can take it now, we will wait for it. The way the mail goes and telegrams, it may be longer than waiting for it now. In case there is any doubt, the witnesses are excused.

(Witnesses excused.)

MR. SACK: There is a man on the telephone scribbling numbers very rapidly.

CHAIRMAN JENSCH: We only want one number.

MR. SACK: Unfortunately these people work with great precision and something as big as -- I am not sure the record is clear on my request that we reconvene within 30 days after the final statement. Is that still pending?

CHAIRMAN JENSCH: We will have to study that carefully. It may be that we will request some data from the Applicant about that time, specifically in reference to crud.

MR. SACK: I am not sure there is a direct correlation between the crud and the reconvening of the hearing

mil-6

on the full NEPA review.

MR. CAHILL: Let me clarify the term "crud." There is a technical connotation to crud. It is corrosion product deposits which usually builds up after long-term operation. So we are using the term "crud" here in the slang sense. These are visible particles, machine chips, slivers, beads of metal that you can see with the naked eye. The chip which caused the major binding was fairly large, about roughly an inch or so in length. There are small bits of sixteenth, eighth inch diameter that are in between.

CHAIRMAN JENSCH: Are these things floating around in there? Are there any effects on your fuel assemblies or control rod guides? Have they been cutting and slicing and chipping and picking into the internals?

MR. CAHILL: Not in the internals, but in the guide tube thimble where the control rod moves up and down, these could cause a rubbing type of action.

MR. BRIGGS: There was mention, I believe, of taking dimensions, checking dimensions. Is there any reason to believe that the dimensions of the rod thimbles or the spacing of the rod thimbles or anything like that was --

MR. CAHILL: The diameter of the rod thimbles in the lower portion, which is the so-called snubber or dash part sections in close tolerance, and there were some tight clearances there which we picked up by these measurements

mil-7

and corrected. It is stretching the tube with a precisely shaped tool.

MR. TROSTEN: The rounded number, including plant and fuel, Mr. Chairman, would be $210 million.

CHAIRMAN JENSCH: And the fuel itself, as I understand, Mr. Cahill, between $20 million and $30 million?

MR. TROSTEN: Roughly $34 million or $35 million.

CHAIRMAN JENSCH: And that figure of $210 million is inclusive of fuel and also inclusive of the land cost allocated to the Indian Point 2 plant?

MR. TROSTEN: I believe that's correct, Mr. Chairman.

CHAIRMAN JENSCH: And separate and distinct from Indian Point No. 1 land costs?

MR. TROSTEN: Yes.

CHAIRMAN JENSCH: If you find there is any substantial difference in the figure you have given us, send it by telegram, please, and we will proceed on the basis you have given us.

MR. TROSTEN: Thank you.

CHAIRMAN JENSCH: Is there any other matter we can hear at this time?

I hear no such.

This evidentiary session is concluded.

(Whereupon, at 2:35 p.m., the hearing was adjourned, subject to the call of the Chair.)