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BEFORE THE UNITED STATES

ATOMIC ENERGY COMMISSION

In the Matter of)

Consolidated Edison Company) Docket No. 50-247
of New York, Inc.)
(Indian Point Station, Unit No. 2))

Answers of Applicant to Questions Raised by Atomic Safety and Licensing Board on March 24, 1971

Part I

May 8, 1971

KEY TO IDENTIFICATION OF QUESTIONS

(B) Question by Mr. Briggs

(G) Question by Dr. Geyer

(J) Question by Mr. Jensch

(Tr. 680) - Transcript Page 680

Question No. 1 (B) (Tr. 680)

"With reference to Question 1 in the answers by the Applicant, the question had to do with the effect of operation of Indian Point Unit No. 1 on the radiation in the environment around the plant.

The answer provided is helpful; however, I am not sure it quite answered the question. For instance, the Applicant had a program of environmental monitoring in effect before Indian Point 1 went into action. Presumedly some information was gained from that and some background level was established on the basis of that monitoring.

The reply to the question didn't indicate what the background level was prior to the operation of Indian Point Unit No. 1. They didn't indicate what the constituents were in the background.

In other words, what radioactive isotope made up the background and I sort of expected the answer to contain some information on that. Then it discussed the effect of the operation with the plant in 1969.

Again not indicating what radioactive isotopes made up the background, the calculation seemed to indicate that one couldn't measure the difference but there was some question about what the monitoring is for.

Presumedly the monitoring is done to show either there is no difference between the measurements prior to the operation of the plant and the measurements during the operation of the plant or to show there is some difference or to show that the numbers are so vast that you can't distinguish a difference.

So, as I say, it might be worthwhile to provide some additional information on what these measurements have been and what they establish. That information is available in the periodic reports that have been published and is available in reports that have been published by the State of New York and others and the hope here was that a summary would be prepared that would give a good summary of the results to the Board and the general public, something they could understand.

I think this is not treated at all in the FSAR. There are one or two pages where there are some general statements made about the effects of operation on the background but no qualitative information that I could find."

Answer:

ENVIRONMENTAL MONITORING PROGRAM

A. Introduction

The object of the Con Edison environmental monitoring program has been to:

a) Measure levels of radiation and radioactive material in the environment, and changes in these levels.

b) Determine whether changes in these levels are from fallout, plant operations or other sources.

c) Evaluate the dose to the local population from this source, if nuclear plant operations are found to contribute to these levels.

Those responsible for measuring doses from nuclear plant operation do so within an environment of naturally occurring and manmade radiation. Radiation dose received by persons in an area comes from four different sources:

(1) cosmic radiation,
(2) terrestrial radioactivity,
(3) airborne radioactivity, and
(4) internal radioactivity.

1. Cosmic radiation. For a given location, cosmic radiation is relatively constant in time except for minor short term variations because of solar activity and fluctuations in atmospheric pressure. It increases rapidly with elevation above sea level. The cosmic radiation dose rate in the vicinity of Indian Point is about 30 mrem/year and is constant at different points around the plant.

2. Terrestrial radioactivity. Radiation emitted from naturally occuring radioactive isotopes which are contained in earth, rock, brick, wood, etc., consists primarily of naturally occuring radioisotopes potassium-40 and the uranium-238 - thorium-232 series and to a very small extent from natural and manmade isotopes which fall out of the atmosphere onto the ground.

3. Airborne radioactivity. Consists primarily of naturally radioactive noble gases emitted from the ground, principally radon and its daughters, naturally airborne radioisotopes produced by incoming cosmic radiation, and manmade radioactivity from weapons testing and to a slight extent from reactor operation.

4. Internal radioactivity. Radiation emitted from radioisotopes deposited in the human body consists mostly of naturally occuring potassium-40. There is also a small amount of manmade radioactivity from weapons testing. Such radioactivity reaches the body as a result of the intake of food, water and air containing radioisotopes of natural and manmade origin. The average human body receives about 20 mrem/year from this source.

Radiation levels in environmental samples are not static but constantly changing. Changes in the levels of radiation that have occurred since the plant has been in operation and that might be attributed solely to the plant are so small as to be nearly undetectable. Radioactivity in environmental samples analyzed during the period 1958 to August, 1962 (before the plant first became critical) were substantially greater than currently measured levels, because major quantities of nuclear bomb debris from weapon testing fell to earth during the 1958-1962 period. Data previously provided (Applicant's Exhibit 2, Answer to Question No. 28) on the gross beta-gamma particulates in air shows that high fallout periods occurred also from 1959 through 1960 and from mid-1960 through 1964. This heavy fallout, ever changing, is reflected in all environmental samples collected in these periods. Some of the major radioisotopes associated with fallout are the same fission products produced by plant operation. Nevertheless, health physicists have devised several techniques to distinguish between the contributions from fallout and those of plant operation.

1) Noting that the distribution of radioactive materials from fallout are widespread, whereas those from nuclear plant operation are local, the two can be distinguished by comparing environmental levels at the site with those remote from the site.

2) Some isotopes might be expected to appear in both nuclear plant releases and weapons fallout; other isotopes are present primarily in plant releases, but not in fallout. The cesium isotopes are typical examples. Cesium-137 is found in both fallout and plant releases. Cesium-134, on the other hand, is present in plant releases but not in fallout. The radioactivities of the two isotopes found in fish are measured and compared to distinguish the effects of fallout from those of nuclear plant operation.

3) Age measurements based on the ratio of isotopes can be used to trace and pinpoint the origin of the isotopes to a bomb test.

All of the above techniques can be used to evaluate environmental radiation levels.

B. Background Radiation Measurements at Indian Point

When one measures the dose rate from "background" radiation, one normally measures the radiation received by a radiation detector at a given spot. Thus the measurement includes "external" terrestrial, airborne and cosmic sources but not the internal sources. Manmade radioactivity contributes to this "external" radiation in two ways: (1) manmade gaseous and particulate radioisotopes contribute to the airborne radioactivity; and (2) manmade particulate radioisotopes "fall out" from the atmosphere and become part of the terrestrial radioactivity.

In 1961 the measured doses to detectors in the open air from all external sources of radiation varied from 61 mrem/year to 131 mrem/year depending on detector location. The average reading was 105 mrem/year. In 1969 the doses ranged from a minimum of 70 mrem/year to a maximum of 155 mrem/year with an average of 94 mrem/year. Analyses of the energy spectrum of this external background radiation show only radiation from naturally occuring radioisotopes potassium-40 and members of the uranium-238 - thorium-232 series. This doesn't mean that other radioisotopes, both natural and manmade, are not present but only that their contribution to the external background is so small compared to the above-mentioned sources as to be indistinguishable.

The fact that manmade radioactivity cannot be seen when the overall external background is measured is to be expected since the calculated dose at the site boundary resulting from Indian Point Unit No. 1 airborne releases during 1969 was 0.013 mrem while the dose from cosmic, airborne and terrestrial radiation during the same year was on the average 94 mrem, or over 7000 times as great. Of course, the dose from Indian Point, Unit No. 1 airborne releases decreases with distance from the site making its detection even more difficult.

C. Monitoring Paths of Radioactivity to Man

While the environmental monitoring program is designed to detect significant change in the overall external background radiation, the program is devoted primarily to monitoring possible paths for radioactivity to enter the human body and then contribute to the internal dose.

Much of the data which has been collected is summarized in the graphs presented in responses of Applicant to questions raised by the Atomic Safety and Licensing Board (Applicant's Exhibit 2, Answer to Question No. 28). The significant path by which radioactivity from Indian Point, Unit No. 1 might enter the body is through radioisotopes released to the river and taken up directly or indirectly by fish destined for human consumption.

Air particulate and fallout measurements vary greatly due to weapons testing. The isotopes generally found in air particulates and fallout are: I-131, Ce-144, Ba-140 - La-140, Ru 103-106, Cs-137, and Zr-95 - Nb-95.

Gaseous releases are only a small percentage of the allowable releases and the resultant dose is small. Over 99% of the releases are inert noble gases. Although the amounts of the noble gases released from the plant are so small as not to be detectable by the air monitoring station, they are measureable at the stack. External doses may then be calculated from measurements of stack releases using known meteorological dispersons. The remaining small percentage (less than 1%) are particulates. Therefore, radioactive airborne particulate and fallout around Indian Point, Unit No. 1 is essentially from weapons testing and not from the plant. Samples of drinking water have shown the same isotopes as fallout, as expected. Indian Point, Unit No. 1 operation has not contributed any detectable activity in drinking water.

The exposure to man from radioactivity in the Hudson River is partly from natural and partly from artifically produced radioactivity. The most important pathway for radionuclides to be recycled to man by the aquatic food chain appears to be the consumption of indigenous and migratory fish caught for recreation and commerce. Assuming a fish eater would eat 50% more than the national average, or would have an average daily intake of 30 grams of fish taken solely from the vicinity of Indian Point, during 1969 Cs-137 in fish from fallout would have given him a whole body dose of 0.01 mrem/year. Releases of radioactivity at Indian Point would have resulted in radionuclide levels in fish that gave about 0.03 mrem/year to the whole body.

D. CONCLUSION

In conclusion, the environmental monitoring program has shown:

1. Indian Point, Unit No. 1 has made no measureable contribution to the overall external dose rate in the vicinity. The calculated addition to the external dose rate was 0.01 mrem in the worst year.
2. No radioisotopes attributable to Indian Point, Unit No. 1 have been found in the atmosphere or fallout.

3. Radioisotopes from plant operation have been found in sediment, algae, and fish in the Hudson River, but contribute a very small percentage of the permissible dose to man.

Question No. 2 (B) (Tr. 682)

"I continue to have some problems with the inspection proposed for the reactor, after it has begun to operate as I understand this is the first of the higher powered series of the Westinghouse reactors.

I suppose the pressure vessel for the reactor is one of the largest that has been made. When I say largest, I take into account diameter of wall thickness, one of the first large vessels that have been made. To some extent I would think that the fabrication of this vessel must have had some problems and there must have been some development that was required and the fabrication of the vessel itself must have been in a sense a development operation.

Since I have wondered from time to time whether this could have constituted a part of the research and development that has been done with the plant, that is, its operation and the safe operation of the vessel and the experience with the vessel which would contribute to the technology of pressurized water reactors and larger sizes.

In the development program, one would ordinarily think that more than ordinary precautions would be taken in the operation of the plant and with the inspection of the components of the plant and that maybe very special methods would be used in the inspections to provide assurance that this plant is a safe one and that plants following it could be expected to be safe, even more safe. However, the inspection program that was proposed for the reactor vessel in particular apparently was based on Section 11 of the ASME boiler codes which says it is possible to inspect the reactor vessel at the end of ten years of operation.

It appears to me this decision to inspect at the end of ten years of operation by the Boiler Code Committee wasn't based upon necessarily the safety requirements. It seemed to be based at least as much on convenience for the operator. It is indicated that methods aren't developed for doing these operations as yet and we make the inspection at the end of ten years and if methods haven't been developed, maybe the rules can be changed in that period of time.

I believe in the reply the Applicant said methods have been developed for doing some inspections. I think it is important that more information be provided on what will be done to assure there will be inspections at the end of a reasonable period on this reactor and to examine whether ten years is a reasonable period for the first inspection on the reactor vessel itself."

Answer:

The Indian Point Unit No. 2 reactor vessel was the first 173-inch diameter 4-loop reactor vessel constructed for Westinghouse. The following tabulation of several large size reactor vessels, both for PWR and BWR plants already in operation indicates that the Indian Point Unit No. 2 reactor vessel diameter is smaller than that of BWR vessels already in operation and its wall thickness is less than that of the San Onofre, Connecticut Yankee and H. G. Robinson vessels.

Vessel	No. of R. C. Loops	Design Code	Inside Diameter	Belt-line Thickness
San Onofre	3	VIII	142"	9-3/4"
Connecticut Yankee	4	VIII	154	10-5/8"
H. B. Robinson	3	III*	155 1/2	9-5/16"
R. E. Ginna	2	III	132	6 1/2"
+Dresden II	N.A.	III	251	6-1/8"
+Oyster Creek I	N.A.	I & VIII	218	7-1/8"
Indian Point 2	4	III	173	8-5/8"

Thus, the vessel diameter and wall thickness for the Indian Point Unit No. 2 vessel were well within the existing

* Plates sized for Section VIII

\+ BWR

manufacturing technology. This is further evidenced by the fact that no unusual fabrication problems were encountered during the course of manufacture. Fabrication of the vessel did not constitute part of the research and development identified at the construction permit stage for Indian Point Unit No. 2. No need for new research and development programs with respect to fabrication developed for the Indian Point Unit No. 2 reactor vessel during construction and existing standard core design formulation was applicable.

Finally, no unusual limitations on operation of the Indian Point Unit No. 2 vessel have been found to be necessary.

The inspection program for the Indian Point Unit No. 2 reactor vessel imposed by Westinghouse on the vessel manufacturer during its fabrication is indicated in the following table:

Reactor Vessel	RT	UT	PT	MT
Forgings				
Flanges		yes		yes
Studs		yes		yes
Head Adaptors		yes		yes
Plates		yes		yes
Weldments				
Main Seam	yes			yes
CRD Head Adapter Connection			yes	
Instrumentation Tube			yes	
Main Nozzles	yes			yes
Cladding		yes	yes	
Nozzle Safe Ends	yes		yes	yes

RT - Radiographic Examination
UT - Ultrasonic
PT - Dye Penetrant
MT - Magnetic Particle

Special requirements are imposed by Westinghouse on the quality control procedures for both the basic materials of construction and on the various subassemblies and final assembly for the primary loop components. These requirements supplement the rules for quality assurance spelled out in the applicable design codes. Examples of the Special Quality Assurance requirements beyond code requirements are: (based on 1965 edition)

A. Ultrasonic Examinations

1. 100% volumetric shear wave UT of plate material.
2. UT of Clad bond to a 1/4" x 3/4" unbonded area repair standard.
3. All Stud material is 100% volumetric examined with longitudinal wave.
4. Weld buildup areas to which the core-support pads are attached are examined 100%.
5. Selected areas of the completed vessel are ultrasonically mapped after hydrotest to provide a base for future in-service inspection.

B. Dye Penetrant Testing

1. Dye Penetrant test all clad surfaces and other vessel and head internal surfaces after hydrotest.

B. Dye Penetrant Testing (cont'd)

2. Dye penetrant examine the weld between the bottom head and instrumentation tubes after each 1/4" of weld is deposited.

3. Dye penetrant examine weld between Control Rod Drive Mechanism housing and closure head after first layer and each 1/4" of weld is deposited.

4. Dye penetrant examine weld between the lower core support pad and the vessel shell after the first layer and each 1/2" of weld metal is deposited.

C. Magnetic Particle Testing

1. Magnetic particle examination of all exterior vessel and head surfaces after hydrotest.

The contract for the Indian Point Unit No. 2 reactor vessel was made by Westinghouse and Combustion Engineering in January 1966, and had already been completed prior to publication by the ASME of Section XI of its Boiler and Pressure Vessel Code. This section was developed by an Ad Hoc Task Group under the sponsorship of the ASME as a co-operative effort by the USA

Standards Committee N-45 and the U. S. Atomic Energy Commission. This Committee was formed in January 1968 and worked closely with the AEC which had representation on the Task Group. Section XI was adopted formally by the ASME in January 1970. However, before the advent of the N-45 Ad Hoc Committee, Westinghouse had determined the importance of an inspection program during fabrication, as evidenced above, and of an ultrasonic pre-service map of the reactor vessel in selected areas as a base for future inspections. Technical requirements on pre-service mapping of high radiation and high stress regions were instituted in December 1966. Westinghouse also required the reactor vessel and internals be designed to facilitate in-service inspections from the vessel interior. Incorporated in this design are an uncluttered inside diameter in the core region and completely removable internals.

Inspection Program

The in-service inspection program of the reactor vessel is described in the Technical Specifications. While it is true that the inspection interval is ten years, there are inspections that will be accomplished before the end of ten-year period. These inspections are:

Item	Description of Inspection
1.2	A volumetric inspection of a portion of the welds between the head flange weld and the control rod drive shroud.
1.3	A volumetric inspection of the head flange weld.
1.8, 1.9 1.10	Various inspections of the closure studs, nuts, washers, bushings and stud hole ligaments.
1.13	A visual and liquid penetrant inspection of the closure head cladding.
1.14	A visual inspection of the vessel cladding that is accessible through ports in the core barrel support flange.
1.15	A visual inspection of internal surfaces and supports, as permitted during normal refueling.

Also, directly related to the evaluation of the vessel for service are the reactor vessel irradiated specimens. These specimens "see" a higher flux than the vessel and thus, will conservatively indicate detrimental material changes. Two of the eight capsules, which contain these specimens, are scheduled for examination at intervals within the first five years of operation. The data from these specimens and from the accomplished inspections will be used to evaluate the vessel after five years of service. This evaluation will be submitted for AEC review. We expect the established inspection program to provide sufficient data to determine adequately the suitability of the reactor vessel for service during the first ten years of operation. However, the following additional inspections are scheduled throughout the first ten years, contingent upon the development of appropriate equipment, and should provide further useful data:

Item	Description of Inspection
1.4	A volumetric inspection of the inner radius of the outlet nozzles. These inspections are planned for refueling outages during the third and sixth year.

Item	Description of Inspection
1.7	A volumetric inspection of the safe end welds for the outlet nozzles. These tests are planned to coincide with those in Item 1.4.
1.12	A volumetric inspection of the integrally-welded vessel supports. These tests are planned to coincide with those in Item 1.4.

We are confident that the needed inspection equipment will be developed within the next ten years. There are four firms actively developing this type of equipment. Southwest Research Institute, for one, has already performed remote ultrasonic examinations on two reactors, one foreign and one domestic. However, this equipment was custom-built and used procedures and methods that were individually developed. Southwest Research Institute has equipment under development for inspections at San Onofre and Point Beach. This equipment may be suitable for use at Indian Point Unit No. 2 without significant modifications. In any event, similar equipment could be custom-built for Indian Point Unit No. 2. Also, pre-service inspection base line data is being taken for all inspection areas. These data will be used as a reference to establish any changes in the vessel. Thus, Con Edison considers its in-service inspection to be both adequate and realistic.

The ten-year interval required by ASME Section XI has been determined on the basis of searching for possible deleterious long-term service effects. These inspection intervals are frequent enough to detect growth of flaws before they reach a critical size. A sampling inspection is required by Section XI (IS-242) in intervals as short as 3-4 years in certain high-stress regions. If, as a result of these inspections during short intervals, anomolies are uncovered, then the number of inspections must be increased as required in Section XI (IS-244).