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Vice President

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Regulatory Docket File

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November 29, 1976

Re: Indian Point Unit Nos. 2 & 3
Docket Nos. 50-247 & 50-286

Director of Nuclear Reactor Regulation
ATTN: Mr. Robert W. Reid, Chief
Operating Reactors Branch No. 4
Division of Operating Reactor
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

In your letter of October 4, 1976, you requested information concerning our operating experience with loose-parts and loose-parts monitoring systems (LPMS). According, attached are our responses to the questions enclosed in your letter.

Very truly yours,

William J. Cahill, Jr.
Vice President

Attach

LL/mmg

CC: Mr. George T. Berry
General Manager and Chief Engineer
Power Authority of the State of New York
10 Columbus Circle
New York, N.Y. 10019

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Question 1

Please briefly describe any events in which a loose-part was found in your primary loop. Discuss, for each such event, the procedures used to discover the loose-part, its safety consequences and the measures taken to remove it. Assess the usefulness of a LPMS for each of the occurrences described above.

Response

To date, there has been only one event in which indication of a loose-part has been detected in the reactor coolant system of Unit No. 2 and there have been no instances on Unit No. 3.

Metal impacts were noted at Indian Point No. 2 during pump transients as part of the Westinghouse data collection from the Metal Impact Monitoring System (MIMS). In order to confirm the presence of metal impacts, additional vibration data was recorded on magnetic tape on September 12, 13, 14, and 17, 1976. A number of pump transients were individually recorded with the reactor cold (115°F) and at operating temperature (545°F). The metallic impacts continued during pump transients. Impacts were also noted during steady-state pump operation with one and two pumps. Intermittent impacts were noted with three pump operation. No impacts were noted with four pump operation.

The impact signals on steam generators 21, 23, and 24 were delayed 5-8 milli-seconds from impact signals on the bottom of the reactor vessel. (No clear impacts were noted on steam generator 22 in the reduced data). Notation of the time delays between impacts indicated the source was near the bottom of the reactor vessel.

Two additional accelerometers were attached to the instrumentation thimble guide tubes on the bottom of the reactor vessel to supplement the two accelerometers in place prior to the September 17 data collection. The recorded data from the bottom reactor vessel transducer was used to locate the source by means of triangulation. The results indicated that the source was moving in a random manner and there was no clear indication in the data that the source was confined to any particular quadrant at the bottom of the vessel. It was assumed that there was only one source. The fact that at full temperature impacts were noted during pump transients and none during normal full flow operation indicated that the source was not wedged anywhere and it remained stationary under normal operations.

The magnitude of the impacts measured on the bottom of the reactor vessel vary from about .1 g_{pp} to 3 g_{pp}. The relative amplitude of various frequency components in the frequency signature varied from impact to impact. The differences are attributed to the source impacting different sections of the structure.

To approximate the weight of the source of impacts, a qualitative experiment was conducted. A series of weights (fabricated from a one inch diameter steel cylinder of different lengths, .25 to 3 pounds) were dropped on a large steel plate (84" wide x 144" long x 8" thick and 13.7 tons). The acceleration response was measured with instrumentation similar to the MIMS system. Two techniques were used to analyze the results. One method measured the impulse of the impacting weights and frequency signature of the response. The frequency signature of the calibrated impacts was compared to the impact data recorded at the site to determine the potential energy of the source. Using the potential energy and assuming a velocity of the source compatible with flow condition at the bottom of the vessel, a mass was calculated. The second analysis technique ratioed the low frequency response of the frequency signature to higher frequency responses for both test data and plant data and compared the results. Using the qualitative data, a weight of .2 pound to 1.5 pounds was predicted for the source. It should be recognized that predicting the weight of the impacting object is a very complex problem involving many variables and at best, gives only an approximation.

A review of the potential effects of this object on control rod operation and fuel assembly coolant flow was conducted and it was concluded that the plant could be safely operated with no immediate plans for removal of the object.

Question 2

Please describe briefly: your LPMS and its operation, the length of time it has been in operation, and the extent of monitoring (e.g., continuously, automatic actuation, etc.).

Response

The metal impact monitor is designed to enable detection of loose metallic parts which may be in the steam generator or the reactor vessel. Upon the occurrence of an impact of loose metallic parts, a pressure wave is generated in the reactor system component causing minute displacements in the component material. The step excitation of the impact produces a broadband frequency response with peak amplitude response at resonant frequencies. Many of these resonant frequencies lie in the audible frequency range and are called "Bell" frequencies. Certain of these "Bell" frequencies are especially sensitive to impact excitation due to differing modes of preferred vibration response.

The displacements attendant with an impact wave are insignificant. However, the accelerations caused by the moderately high audio frequencies are very significant. For this reason, acceleration is the parameter chosen to indicate impact.

Acceleration is measured by the use of special transducers (Gulton high-temperature radiation resistant) that convert accelerations to electrical signals by piezoelectric behavior.

These transducers are mounted at specially selected monitoring points on the bottom and top of the reactor vessel and on the inlet side of each steam generator. Two transducers, with associated cabling to the control room, have been located at each monitoring point for reliability purposes.

The sensitivity of an impact measurement is determined by the impact energy (determined by mass and impact velocity) and the distance from the point of impact to the measurement point (damping and geometry changes attenuate the traveling wave).

In addition, the Metal Impact Monitor device excludes all frequency information except for the "Bell" frequencies sensitive to impact. The selected signals are further processed to provide an output DC signal proportional to the impact energy (as seen by the transducer) and a DC signal indicating the rate of occurrence of impact repetition.

Both the impact energy level and rate of occurrence signals are displayed on continuously operating strip chart recorders located in the control room. These records serve to establish a history for establishing when and where impacts were observed. The rate at which impacts occur gives an indication of the amount of debris present in the monitored area while the impact energy is a measure of the weight of the debris. An alarm point for the latter has been provided. Audio indication has also been provided by means of a headphone.

A test circuit is provided for determining the continuity of the monitoring system. The test signal inputs a representative wave form similar to a metallic impact.

In 1971, Con Edison agreed to enter into a development program with Westinghouse in which instrumentation systems were investigated to determine the capability of detecting loose parts during operation in an accurate and reliable manner. The program involved the use of the ex-core detector signals for collection of nuclear noise data indicative of core movement. Also included in the program was a study of acceleromter measurements gathered from monitors positioned on the steam generators and the reactor vessel for the detection of signals in the frequency range expected from small loose parts.

A permanent, continuous LPMS for Indian Point Unit No. 2 was installed during the recent refueling outage and was operational when the plant returned to service in September, 1976. For Indian Point Unit No. 3, the system was installed during the summer of 1975 and was operational when the plant went initially critical in April, 1976. Component "signature acquisition" of the nuclear steam supply system components (base line data) has been obtained from both units, at selected plant operating conditions, for future reference.

Question 3

Please describe the operating experience to date including any false alarms or spurious signals. If either have occurred, please describe each event. Similarly, has any event occurred that should have, but did not, cause a noise indication? If so, please describe each event.

Response

Spurious alarms occur only when control rods are exercised. The transducer mounted on top of the vessel flange transmits the noise from the control rod drive latching mechanism thereby causing a spurious alarm. Westinghouse is designing a circuitry change to interrupt the transducer signal each time the control rods are exercised thereby avoiding spurious alarms. When the desing change is available, we will evaluate it for incorporation into our system.

We know of no event that should have, but did not, cause a noise indication.

Question 4

Discuss the cost/benefit considerations of your LPMS, and your degree of confidence in such systems.

Response

The possibility of damage from loose parts has always been of concern but until recently no reliable equipment was available for detecting such loose parts. It is our opinion that the LPMS installed at Indian Point Units Nos. 2 & 3 will enable us to prevent possible serious damage to the steam generator tubes, reactor vessel internals and fuel, from detached internal structural items or foreign objects. Damage to these components could result in extensive plant outage time for repairs, along with the associated high repair costs.

The original total cost of the LPMS is approximately equal to the daily expense incurred when the unit is shutdown. Therefore, if the LPMS prevents shutdown for approximately one day during plant service life, the original investment is recovered. On this basis, it is our opinion that the LPMS is economically justifiable.