John D. O'Toole
Vice President

Consolidated Edison Company of New York, Inc.
4 Irving Place, New York, NY 10003
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August 7, 1981

Re: Indian Point Unit No. 2
Docket No. 50-247

Director of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

ATTN: Mr. Darrell G. Eisenhut, Director
Division of Licensing

Dear Mr. Eisenhut:

In response to NRC Generic Letter No. 81-14 of February 10, 1981, attached is the requested information regarding seismic qualification of the Indian Point Unit No. 2 Auxiliary Feedwater System.

Should you or your staff have any questions, please contact us.

Very truly yours,

John D. O'Toole

Subscribed and sworn to
before me this 7th day
of August, 1981.

Angela Roberti
Notary Public

ANGELA ROBERTI
Notary Public, State of New York
No. 41-8593813
Qualified in Queens County
Commission Expires March 30, 1982

cc: Mr. T. Rebelowski, Resident Inspector
U. S. Nuclear Regulatory Commission
P. O. Box 38
Buchanan, New York 10511

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Response to NRC Generic Letter No. 81-14
SEISMIC QUALIFICATION OF AUXILIARY FEEDWATER SYSTEMS

Indian Point Unit No. 2
Docket No. 50-247

Consolidated Edison Company of New York, Inc.
August 1981

Response to NRC Generic Letter No. 81-14
Indian Point Unit No. 2

I. Information Requested by Enclosure 1

A. Description of the Auxiliary Feedwater System

The design basis and original features of the Indian Point Unit No. 2 auxiliary feedwater (AFW) system are described in Section 10 of the FSAR. Recent improvements to the system have been made in response to NRC requirements identified during the course of the NRR Bulletins and Orders Task Force review following the accident at Three Mile Island, Unit 2, and set forth in the NRC letter of November 7, 1979 to Con Edison. These changes, and other design details of the AFW system, are described in Con Edison letters to the NRC of December 14, 1979; December 19, 1979; April 14, 1980; July 30, 1980; August 11, 1980, and November 26, 1980.

The AFW system for Indian Point Unit No. 2 has been designed to ensure that adequate feedwater can be supplied to the steam generators for reactor decay heat removal under all circumstances, including loss of power and normal heat sink. Feedwater flow can be maintained until either power is restored, or reactor decay heat removal can be accomplished by other systems.

Three auxiliary feedwater pumps are provided, one turbine-driven 800 gpm pump and two motor-driven 400 gpm pumps. The

turbine-driven pump (no. 22) supplies all four steam generators. Each motor-driven pump supplies water to two steam generators. Motor-driven pump 21 supplies steam generators 21 and 22 while pump 23 supplies steam generators 23 and 24. Operation of one of the three pumps is sufficient for reactor decay heat removal.

Redundancy is also provided in the water supply to the system. The primary water supply is the Seismic Category I Condensate Storage Tank which has a total capacity of 600,000 gallons. Of this total volume, 360,000 gallons are dedicated for supply to the AFW system. This quantity of water is adequate for removal of reactor decay heat for a period of at least 24 hours at hot shutdown conditions. If the amount of water in the Condensate Storage Tank decreases to 360,000 gallons, the tank discharge is automatically isolated from all systems except the AFW system. The secondary water supply for the AFW system is the city water system. This non-Seismic Category I system includes a 1.5 million gallon City Water Storage Tank. The city water supply to the AFW system may be remote/manually initiated from the control room.

Steam supply to the turbine-driven pump is from steam generators 22 and 23. The supply lines are designed so that steam may be supplied from either or both of the generators.

The above provides a general description of the AFW system. Further details are given below in the discussion of specific components of the system.

Enclosure 1 to Generic Letter 81-14 states that the AFW system boundary "shall include those portions of the system required to accomplish the AFW system function and connected branch piping up to and including the second valve which is normally closed or capable of automatic closure when the safety function is required." The design of the Indian Point Unit No. 2 AFW System is such that there are not always two valves which are normally closed or capable of automatic closure between the Seismic Category I AFW system and non Seismic Category I branch piping. Specific cases where system design does not strictly agree with the boundary definition of Enclosure 1 to Generic Letter 81-14 are as follows:

- The auxiliary feedwater lines to each steam generator join the main feedwater lines downstream of a gate valve and check valve in series on the main feedwater lines (Gate valves BFD-7, BFD-7-1, BFD-7-2, BFD-7-3 and check valves BFD-6,

BFD-6-1, BFD-6-2, BFD-6-3). These valves provide the boundary between seismic and non-seismic category I portions of the main feedwater line. The gate valves are normally open. However, should the check valves fail to close completely, sufficient time is available to manually close the gate valves since the AFW system is not required until at least 30 minutes following a reactor trip to prevent the steam generators from boiling dry.

- Air operated butterfly valve LCV-1158 isolates the suction line to the AFW pumps from the non-essential make-up line to the condenser hotwell. As discussed in Section B(3) below, this valve should be capable of operation under SSE loadings. Also, the valve is in a vertical line which is seismically supported to an elevation about 25 feet above the pump inlet. Failure of the non-seismic Category I portion of the line should not adversely affect the water supply to the pumps.

- Check valve CD-109 provides the boundary between seismic and non-seismic Category I portions of the make-up water line to the condensate storage tank. The recirculation lines for the auxiliary feedwater pumps feed into the seismic portion of this line. The recirculation lines for the motor-driven pumps are provided with automatic air-operated valves. The recirculation line for the turbine driven pump is

provided with a normally open globe valve. Sufficient time is available to manually close this valve if for some reason the check valve fails to close completely.

B. Seismic Design of the Auxiliary Feedwater System

The Indian Point Unit No. 2 auxiliary feedwater system is designed, constructed, and maintained in accordance with Seismic Category I requirements and has been included within the scope of seismic-related IE Bulletins 79-02, 79-04, 79-07, 79-14 and 80-11, and IE Information Notice 80-21.

As requested, we have included a copy of Table 1 of Enclosure 1 to Letter 81-14 in this response. Comments have been made on the table regarding certain AFW system components. Detailed descriptions of the seismic qualifications for the various components of the AFW system are given below.

(1) Pumps/Motors

As stated in Section 10 and Appendix A of the FSAR, the auxiliary feedwater pumps are designed as Seismic Category I components.

The purchase specification for the turbine-driven pump required the turbine-pump set to remain functional when subjected to a seismic ground acceleration of 0.15g horizontally and simultaneously with an

TABLE 1

AUXILIARY FEEDWATER SEISMIC QUALIFICATION

(1)	Pumps/Motors	
(2)	Piping	
(3)	Valves/Actuators	(See Section B(3) regarding valve qualifications)
(4)	Power Supplies	
(5)	Primary Water and Supply Path	
(6)	Secondary Water and Supply Path*	(Not applicable since primary supply is seismically qualified)
(7)	Initiation and Control System	(See Section B(7) regarding cable trays)
(8)	Structures Supporting or Housing these AFW System Items	

*Applicable only to those plants where the primary water supply or path is not provided, however, a seismically qualified alternate path exists.

acceleration of 0.10g acting in the vertical direction (i.e., the SSE earthquake). Seismic design was performed utilizing the response spectrum approach. The spectral acceleration curves of Figure A.1-2 of Appendix A of the FSAR were provided to the manufacturer and the percent of critical damping was prescribed as 0.5 percent. To satisfy the no-loss-of-function criteria, maximum strains in regions of local bending were limited to twice yield strains. Also, deflections of rotating parts were limited so that, even though temporary bearing overloads may occur, there would be no impairment to the operational function of the pump. Finally, the individual critical speeds of the pump and the turbine, and the combined critical speeds of the turbine-pump set including the coupling were designed and selected so that no operational difficulties would be experienced.

Seismic design requirements for the motor-driven pumps were the same as for the turbine-driven pumps. That is, seismic design utilized the response spectrum approach, with spectral acceleration curves and a specification of 0.5 percent critical damping given to the manufacturer. Maximum strains in regions of local bending were limited to twice yield strains, and deflections of rotating parts were limited to preclude any impairment of pump function.

(2) Piping

As stated in Section 10 and Appendix A of the FSAR, the auxiliary feedwater system piping is designed to Seismic Category I criteria.

The design criteria for Seismic Category I piping are described in Appendix A and the response to Question 1.9 of the FSAR. Piping is ASTM A106, GR.B and was designed in accordance with ASA B31.1 (1955 edition + code cases). The design approach for seismic stresses utilized span tables based upon static analysis. Design criteria limited the maximum seismic stress to 3000 psi (0.2 Sa where Sa is the allowable stress). Other design criteria included:
maximum deadweight stress of 1500 psi (0.1 Sa);
maximum longitudinal pressure stress of 7500 psi (0.5 Sa); total stress limited to 1.2 Sa; span length between seismic supports limited to assure that the fundamental natural frequency of the piping system did not coincide with the structural exciting frequency.

The response to Question 1.9 of the FSAR outlines the verification analyses performed to confirm the conservatism of the above piping design approach.

(3) Valves/Actuators

Seismic requirements for the AFW system valves were not specifically prescribed in the purchase specifications. However, valves typically possess a substantial amount of inherent seismic resistance since compliance with ASA 16.5 limits the stresses to 7000 psi. In particular, valves that are passive and that do not have extended operators are unlikely to fail as a result of the SSE. Pressure boundaries of these valves are designed to be stronger than attached piping.

Valves having extended operators are more vulnerable to seismic accelerations. The main concern is deformation or failure of the extended operator portion of the valve due to inertial effects on the heavy operator Generic seismic capacities of motor operated and air operated gate and globe valves have been developed by a Con Edison consultant. These capacities were based upon a variety of valves ranging in size from 2" to 48" for motor operated gate and butterfly valves and from 3/4" to 8" for air operated valves. The acceleration capacity for the valves ranged from 0.84g to 23g with a median valve of 7.3g.

Regarding the Indian Point Unit No. 2 AFW system valves, the consultant has determined that the median ground

acceleration capacity of the water regulator valves and the steam inlet valves is about 5g. This acceleration value is much greater than the 0.15g design ground acceleration for the plant. In light of the large seismic capacities obtained and also the wide scope of the consultant's review, other air-operated valves in the AFW system should also have sufficient seismic resistance to withstand an SSE.

The pneumatic operators on the water regulator valves and steam inlet valve to the turbine are supplied by the instrument air system whose compressors are powered from Clss 1E sources. If for some reason the air supply is lost, valve operation capability is assured by an automatic high pressure nitrogen bottle system. The valves also conservatively fail open on loss of power or air supply.

Finally, the water regulator valves and the steam inlet valve may be opened manually in the extremely unlikely event that the "fail safe" designed pneumatic operators do not open the valves.

(4) Power Supplies

The motor-driven pumps and AFW system instrumentation and controls are supplied from Class 1E power sources designed to withstand the Safe-Shutdown Earthquake (SSE) for the site.

The two motor-driven pumps are powered from 480 volt buses located in the switchgear room at elevation 15' of the Control Building. The power feeders for both pumps are routed in 4" PVC conduits under the transformer yard to the pumps which are located in the Auxiliary Feed Pump Building. These underground conduits are encased in concrete and have about one and one-half feet of ground cover. The power feeders are therefore provided with a substantial amount of inherent seismic resistance.

An alternate power source for one of the motor-driven auxiliary feedwater pumps has been provided to assure that the capability to provide water to the secondary side of the steam generators is maintained if, for some reason, the 480 volt bus supplies become unavailable. This normally de-energized emergency power supply is provided from the Indian Point Unit No. 1 440 volt switchgear located at elevation 33' of the Indian Point Unit No. 1 Superheater Building. Cables are routed

through the Turbine Hall at elevation 72'. Although the alternate power system is not Seismic Category I, it does provide a power source to motor-driven pump no. 21 completely independent and physically separated from the normal supply.

Backup power for the 480 volt buses is provided by the three diesel generators which are designated Seismic Category I. As stated in the response to Question 5.16 of the Indian Point Unit No. 3 FSAR, all component parts of the diesel engine were designed to withstand minimum shock loads of 2.5g in any direction. Generators of the type provided have functioned properly after experiencing shock loads of 2g during shipment.

Power for instrumentation and controls is provided from the 118 VAC instrument power buses located in the Central Control Room at El.53' of the Control Building. The four independent buses are powered from separate static inverters. These inverters, in turn, each receive power from an associated battery and battery charger. Manual and automatic backup is provided by independent constant voltage transformers. The inverters, constant voltage

transformers, and batteries are located at elevation 33' of the Control Building.

Seismic design of electrical components is discussed in the responses to Question 1.8, 1.9, 7.4 and 7.27 of the FSAR. The response to Question 1.8 provides the analysis confirming seismic adequacy of the battery racks. The responses to Questions 1.9 and 7.4 describe the vibration testing performed on typical essential electrical components to establish seismic adequacy. This testing is documented in Westinghouse proprietary report WCAP-7397-L titled "Topical Report-Seismic Testing of Electrical and Control Equipment," dated January 1970. Specific components tested included static inverters, Foxboro process equipment (including steam generator feedwater level and pressure), safeguards actuation racks, pressure and differential pressure transmitters (including steam generator feedwater/steam level, pressure, and flow), nuclear instrumentation, and radiation monitoring instrumentation. During the tests, equipment operation was monitored to demonstrate proper performance of functions. No electrical malfunctions occurred, and it was concluded the equipment would perform its design functions during, as well as following, a "low seismic" earthquake, which is defined as an earthquake having an SSE horizontal acceleration of 0.2g or less. The Indian Point Unit No. 2 seismic accelerations are within the specified "low-seismic" acceleration envelopes of the test program.

The response to Question 7.27 clarifies the application of WCAP-7397-L to specific electrical equipment. Information is also given regarding seismic capability of control boards and switchgear equipment. The control boards were specified to "be designed such that the maximum stresses including simultaneous seismic accelerations of 0.52g in the horizontal and vertical directions shall not dislodge or cause relative movement between components such as to impair the functional integrity of circuits or equipment." This acceleration exceeds that which would be experienced by the control boards under earthquake conditions at Indian Point Unit No. 2. Also, control boards of typical construction have experienced shocks of 8-10g during shipment and, when wired, mounted switches have operated without repair.

Switchgear equipment has been specified to withstand accelerations in excess of 0.15g horizontally and 0.10g vertically (i.e., in excess of the SSE ground accelerations). As described in the response to Question 7.27 of the FSAR, vibration testing of switchgear components has been performed to demonstrate operability of the switchgear components under appropriate seismic loadings.

(5) Primary Water And Supply Path

The primary water supply for the AFW system is the Seismic Category I Condensate Storage Tank. The tank has a total volume of 600,000 gallons. Of this, 360,000 gallons are dedicated for use by the auxiliary feedwater system. Adequate supply is thus provided for removal of reactor decay heat for a period of at least 24 hours at hot shutdown conditions.

As noted in the response to Question 1.7 of the FSAR, the Condensate Storage Tank was designed in accordance with the stress limitations of American Water Works Association Standard D100.

Supply piping to the auxiliary feedwater pumps is Seismic Category I, as discussed in item (2) above.

(6) Secondary Water And Supply Path

A secondary water supply for the AFW system is provided by the city water system. In accordance with Generic Letter 81-14, this system need not be considered since a Seismic Category I primary supply has been provided.

(7) Initiation and Control System

The motor-driven AFW pumps will automatically start if one of the following conditions occurs:

- Automatic trip of the main boiler feed pumps
- Two out of three coincidence of low-low steam generator level in any one of the four steam generators
- Unit trip plus loss of offsite power with no safety-injection signal
- Receipt of safety-injection signal

The turbine-driven AFW pump will automatically start if one of the following conditions occurs:

- Two out of three coincidence of low-low steam generator level in any two of the four steam generators
- Unit trip plus loss of offsite power with no safety-injection signal

The AFW system automatic initiation signals and circuits meet safety-grade requirements. Two independent and separate logic trains have been established for auxiliary feedwater initiation. One logic train is associated with motor-driven pump no. 21 while the second logic train

is associated with motor-driven pump no. 23. Each of these two logic trains is powered from a separate D.C. battery. Actuation signals for turbine-driven pump no. 22 were developed from both of these logic trains through an interposing circuit powered from a third D.C. battery.

Class 1E supplies are provided for each of the eight auxiliary feedwater flow regulating valve position controllers (valves 406A,B,C,D for the motor-driven pumps and valves 405A,B,C,D for the turbine driven pump). The power supply circuitry is designed so that the three trains of auxiliary feedwater are unitized to the maximum extent possible. The power supplies for the pump regulating valves have been selected to match the availability of the valves with the availability of their associated pumps and with the availability of respective steam generator level and auxiliary feedwater flow indications.

The auxiliary feedwater flow transmitters satisfy the testing requirements of IEEE-323-1971 and IEEE-344-1971. All four flow channels are powered from a separate and independent Class 1E instrumentation and control bus. The steam generator level indication system is also safety grade and powered from the Class 1E buses.

Seismic qualification for the Class 1E power sources is discussed in item (4) above. Safety-grade initiation and control systems are qualified to withstand an SSE utilizing criteria consistent with other safety-grade systems in the plant, or upgraded criteria.

Manual control of the AFW system is provided as a backup to the automatic initiation and control systems. The turbine-driven pump is provided with manual control switches in the Central Control Room and also locally at the pump. Similar control capability is also provided for both motor driven auxiliary feed pumps.

Instrumentation and control cables for the AFW system are routed in cable trays between the various locations. These trays are essentially unistrut supported and run to the Control Building through rigid, Seismic Category I structures where no amplification of the 0.15g zero period acceleration SSE ground response motion would be expected.

Dynamic testing of tray systems similar to those installed at Indian Point Unit No. 2 has indicated that such systems have inherent seismic resistance capability in excess of 1g zero period acceleration. This result is presented in a report by Mr. Paul Koss titled "Seismic Testing of Electrical Cable Support Systems", Bechtel Power Corporation, Los Angeles Power Division, which was presented at the Structural Engineers of California Conference, San Diego, California in 1979.

(8) Structures Supporting or Housing these AFW Systems Items

All structures supporting or housing AFW system components are Seismic Category I structures. Seismic design of the structures is described in Appendix A and responses to Questions 1.6, 1.7, and 1.9 of the FSAR.

II. Walk-down of the AFW System

Recent walk-downs of the AFW System have been performed, as follows:

1) In response to IE Bulletin No. 79-02, a field inspection and testing program was performed to verify proper installation of pipe support plates and expansion anchor bolts. This program was described in our July 6, 1979 and September 17, 1979 letters to Mr. Grier of Region I Office of Inspection and Enforcement.

2) In response to IE Bulletin No. 79-14, qualified personnel walked Seismic Category I lines 2½" and greater to the extent practicable and verified the existence, location and integrity of identified supports, and verified overall piping geometry. This activity was described in our August 1, 1979 and September 28, 1979 letters to Mr. Grier.

3) As reported in Inspection Report No. 50-247/80-15, the resident NRC inspector conducted a walkdown of all accessible portions of the Auxiliary Feedwater System using the licensee's check off list and flow diagram of the system (Dwg 9321-F-2019 Rev 25). The inspector concluded that:

   - o System was lined up in accordance with the check off list

- All hangers and supports were inspected and appeared to be operable

- Electrical equipment was found to be clear of loose material, jumpers and debris

- Remote position indication on breakers and valves matched the actual position of the breakers and valves

- Metering associated with the system was calibrated within the proper calibration dates

- No unacceptable conditions were identified

4) A recent walkdown of portions of the AFW system was made by Con Edison representatives to verify that system supports continue to be in good condition.