UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

CHAIRMAN

June 1, 2001

The Honorable Edward J. Markey
United States House of Representatives
Washington, D.C. 20515-2107

Dear Congressman Markey:

On behalf of the Commission, I am writing in response to your letter of April 13, 2001, concerning the partial loss of offsite power at the Seabrook nuclear plant on March 5, 2001, during a winter storm. Responses to your questions are enclosed.

The Nuclear Regulatory Commission (NRC) Region I office sent a Special Inspection Team to Seabrook on March 12, 2001, to evaluate this event. This inspection was initiated in response to the loss of offsite power, an event that was complicated by some safety-related equipment failures. The inspection assessed the licensee's root cause evaluation and corrective actions, independently evaluated the risk significance of the event and equipment failures, and reviewed possible generic implications.

We determined that the licensee's evaluation of the event was comprehensive and that the operators took appropriate actions to maintain plant safety. However, the special inspection team found that the licensee failed to fully address some previous equipment problems which contributed to this event. While these findings were determined to be of very low safety significance, we are monitoring the licensee's corrective actions to address these findings, and more broadly, to improve its corrective action process. Please refer to the enclosed Special Inspection Team report for detailed information.

The Commission appreciates your concern regarding this event. If you have further comments or questions, please contact me.

Sincerely,

Richard A. Meserve

Enclosures:
1. Responses to Questions
2. NRC Special Inspection Team
   Report No. 05000443/2001-005

RESPONSES TO QUESTIONS

QUESTION 1. What are the standard procedures for nuclear plants in severe or dangerous weather? Is it established practice to reduce power or shutdown in the face of severe weather? Why was it not expected that the offsite power was in danger of being cut off by the storm?

ANSWER.

The NRC throughly evaluates and analyzes nuclear power plants in the United States prior to granting an operating license. One element of the staff review is assessment of the capability of a power plant to withstand natural phenomena, such as seismic events, hurricanes, and other potential serious external events associated with the physical location of the plant. Although plants are designed to withstand adverse environmental conditions, each plant is required by the NRC to have response procedures if and when such events occur. In addition to response procedures, nuclear power plants usually have procedures in place which, on the prediction of adverse weather, require implementation of precautionary measures to ensure appropriate staffing and steps to monitor plant activities, such as maintenance actions. In the case of plants along the east coast which are subject to hurricanes, plant procedures generally provide direction to shut down the reactor prior to severe conditions on site.

The Seabrook licensee has established plant procedures for severe weather conditions, although there are no operational limits in the Seabrook license or Technical Specifications for severe weather. The plant procedures describe actions that the licensee takes to prepare the station in advance of severe weather and provides recommendations to the operators regarding power operations for various severe weather conditions. For example, for an imminent impact of a storm with sustained high wind conditions exceeding 96 miles per hour, the recommended

course of action is to shut the reactor down and stay in a hot standby condition. The recommendations are not requirements, but guidelines that the station director considers in response to severe weather.

The licensee monitored the severe weather forecast for March 5, 2001, and concluded that there was no need to shut down the reactor. However, as a precautionary measure the licensee prepared for storm conditions, deferring work activities that could have removed important equipment from service, sending nonessential staff home, and stationing essential staff, including emergency responders, near the site so that they would be able to staff the emergency response organization if needed. As a result of the unexpected degrading conditions of the transmission lines during the storm, the plant operators initiated a power reduction. However, the automatic shutdown occurred about nine minutes after the initiation of the power reduction when another transmission line experienced flashover and the connecting circuit breakers opened. That line was carrying the electrical output from the main generator. Due to the sudden loss of load on the main generator, an automatic reactor shutdown occurred, as designed.

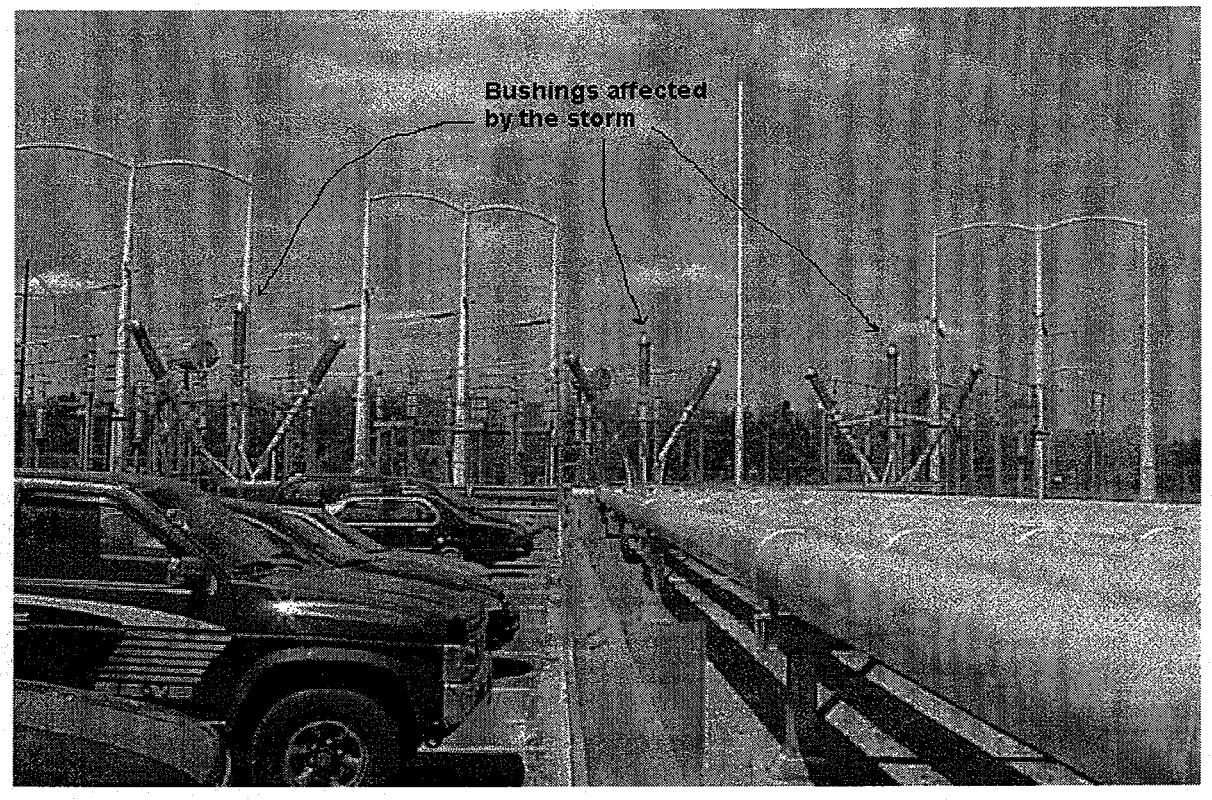
QUESTION 2. What steps will Seabrook and the NRC take to ensure that transmission lines to power plants will be better protected against severe weather events in the future? What, if any, changes in procedures will Seabrook and the NRC make to ensure that a shutdown from full power during severe weather conditions does not occur again?

ANSWER.

The licensee is evaluating longer-term actions to improve the reliability of the bushings in the termination yard during storm conditions. This shutdown from full power during a snowstorm was within the design basis of the plant. The March 5, 2001, event was the first reactor shutdown caused by a weather related event at Seabrook in its 10 years of operation. During this event, there was always at least one transmission line providing power to the plant switching station. The NRC will monitor the licensee's efforts to put enhancements in place, but further restrictions on plant operation are not warranted for this event due to its infrequent occurrence, low safety significance, and the fact that the plant is designed to respond to such conditions. The following is a more detailed discussion of the event.

Seabrook Station has three 345 kV transmission lines that tie to the New England transmission grid and connect to the termination yard at Seabrook. The design criteria for the transmission structures and lines at Seabrook meet or exceed the requirements for heavy loading, as described in the National Electrical Safety code and the requirements of the Commonwealth of Massachusetts. Near the 345 kV termination yard at Seabrook is the 345 kV switching station. The switching station has eight 345 kV circuit breakers that provide flexibility and reliability during operational conditions since any circuit can be isolated under normal or fault conditions without affecting any other circuit. Seabrook has a Technical Specification requirement that two

Looking away from plant toward 345kv lines



physically independent circuits be operable from the offsite transmission network to the onsite vital buses; otherwise the plant must be shut down and cooled down to a cold shutdown condition. The problem at Seabrook during this storm was arcing at the bushings in the 345 kV termination yard. The bushings provide a transition point from the overhead 345 kV lines to the insulated bus sections of the 345 kV buses. For each of the offsite 345 kV lines, two of the three phase bushings are angled and the third bushing is mounted vertically. During the March 5, 2001, storm, wet, heavy snow was driven by high winds onto the bushings. Most of the snow and ice fell off the angled bushings but adhered to the vertical bushings, eventually causing a flashover (arcing) from the line to ground.

In 1997, Seabrook experienced a partial loss of the transmission lines during a less severe snowstorm. However, the transmission system was not as adversely affected in that event as during the March 2001 storm, and the plant did not automatically shut down nor was the vital onsite power system left dependent upon the emergency diesel generators (EDGs). The licensee implemented corrective actions after the 1997 event, including changing the slope of the lines where they connect to the top of the bushings. The licensee believed that this action would be sufficient to improve the performance of the bushings.

The NRC special inspection team reviewed this previous experience. The team found that the partial loss of offsite power during March 2001 had the same cause as the 1997 event. Snow buildup on the vertical bushings for the termination yard caused a short to ground, which opened circuit breakers in the offsite power switching station. After the EDGs energized the vital buses during the event in March 2001, the operators had the ability to restore power to the vital buses from offsite power. However, the operators decided to wait until the problem with the bushings was investigated.

Based on the March 2001 event, the licensee implemented procedure changes to improve the response to flashover at the bushings during severe weather. The operating crews now have specific instructions on performing timely restoration of the circuit connections to the transmission lines. The NRC special inspection team viewed this measure as an appropriate, interim corrective action. Seabrook also entered this condition into its corrective action program to determine what, if any, long-term solutions or enhancements should be implemented. The NRC will monitor the licensee's corrective actions through the normal baseline inspection program.

The NRC monitors transmission line reliability by comparing the observed reliability to the assumptions concerning the reliability of the lines in the risk analyses for nuclear power plants. Transmission line reliability has remained satisfactory, and therefore does not warrant additional regulations.

QUESTION 3. Did the EDGs behave satisfactorily during the "Unusual Event?" Were there any failures of those systems?

ANSWER.

The emergency diesel generators (EDGs) performed satisfactorily during the Unusual Event. Due to the loss of voltage on the vital electrical buses, both EDGs started automatically and provided power to the vital buses. When power was restored to the vital buses, the safety-related electrical loads were automatically energized as designed. The EDGs and the remainder of the onsite emergency electrical power system did not experience any failures during the unusual event.

QUESTION 4. According to the Daily Event Report, Seabrook's "steam-driven emergency feedwater pump failed to automatically actuate." What is the significance of the emergency feedwater pump failing? Why did it fail? What steps has the licensee taken to ensure that this system does not fail in the future?

ANSWER.

Seabrook has two pumps for emergency feedwater (EFW), either of which has the capability of supplying sufficient water to the steam generators for decay heat removal. One pump is motor-

driven, powered by the B vital bus, with emergency power available from the B EDG. The second EFW pump is driven by a steam turbine with control power from the station vital batteries. The plant is designed to maintain plant safety even if there is a single failure of any safety-related component.

Although the turbine driven EFW pump failed to actuate as designed, the motor-driven EFW pump actuated, powered from the B EDG, and supplied sufficient water to the steam generators to remove the decay heat from the reactor during the March 5, 2001, event. The ability to achieve safe plant shutdown validated the design, and thus the loss of the turbine driven EFW pump had little safety significance. From a risk perspective, the turbine driven EFW pump is also credited in the analysis of an event involving the loss of all alternating current, and therefore a decrease in the reliability of the turbine driven EFW pump has other impacts on plant risk analyses. However, the loss of all AC is a low probability event, since the offsite transmission lines and both EDGs must fail in order to reach this condition. Also, the licensee had performed a successful surveillance test of the turbine driven EFW pump on February 28, 2001. These factors resulted in a finding of very low risk significance for this equipment failure.

One other noteworthy fact regarding the design capability of the EFW system is that Seabrook has a non-vital, startup feedwater pump that can also provide sufficient makeup water to the steam generators to remove decay heat from the reactor. This pump is normally powered by a non-vital electrical bus. However, the operators have the capability of powering this motor-driven pump from the A vital bus, with power from the A EDG, if necessary. In the unlikely event that both the motor-driven and the turbine driven EFW pumps fail, the startup feedwater

pump provides an alternate capability to remove decay heat. This pump was available for use during this event.

The turbine driven EFW pump tripped shortly after it automatically started on March 5. The licensee determined that the pump tripped due to overspeed. The cause of the overspeed was attributed to rubbing of components in the pump seal and impeller. Inlet steam pressure increased in response to the impeller slowing down. Subsequently, the "rub" broke free resulting in a momentary overspeed condition. Before the restart of Seabrook after this event, the licensee fully repaired and satisfactorily tested the turbine driven EFW pump to demonstrate that the cause of the pump failure was corrected and the pump was restored to its design condition.

QUESTION 5. According to the Daily Event Report, atmospheric dumps were used as the heat sink. This would mean that the walls of the steam generator tubes were then providing the main barrier against a radiation leak. However, previous problems at other nuclear power plants have indicated that the integrity of steam generator tubes is suspect. What circumstances led to the use of the atmospheric dumps? What protocols generally lead to the use of atmospheric dumps? What procedures are in place in the event of all of the steam generator tubes leaking during situations in which the atmospheric dumps are being used?

ANSWER.

The plant Technical Specifications set very low limits on allowed steam generator tube leakage before the licensee is required to shut down, inspect, and repair any leaking tubes. In addition,

most pressurized water reactors have administrative limits set lower than the Technical Specification limits, providing additional margin to the plant's design basis for transients and accidents. Prior and subsequent to the March 5 event, Seabrook monitored the operational leakage from the steam generator tubes and determined that it was well below the allowable values specified in the Technical Specifications. Further, Seabrook had restarted from a refueling outage just prior to this event. Seabrook, like all pressurized water reactors, conducts a detailed inspection and evaluation program to ensure the structural integrity of the steam generator tubes. During the recent outage, Seabrook acceptably implemented this program, which included the inspection of all the tubes in two of the four steam generators for potential crack indications.

The partial loss of offsite power resulted in an automatic shutdown of the main turbine-generator and the reactor. Initially, power to all non-vital plant equipment was lost during this event sequence, including power to the circulating water system. The circulating water system removes heat, including reactor decay heat after a shutdown, from the main condenser. Without the ability to remove heat using the main condenser, the plant operators use the atmospheric steam dumps for decay heat removal. Generally, atmospheric steam dumps are used whenever the main condenser is not available to remove heat and the reactor is not in cold shutdown. The shutdown cooling system is used for decay heat removal when the reactor is in cold shutdown.

In the unlikely event of a large steam generator tube leak, or a tube rupture, the operators would implement emergency procedures to shut down the reactor, and rapidly cool down the reactor and equalize the pressure between the affected steam generator secondary side pressure and the reactor coolant system (RCS) pressure, minimizing the RCS leakage. These

procedures also generally require the operators to identify and isolate the affected steam generator rapidly and use the unaffected steam generators to remove the decay heat from the reactor, either by sending steam to the main condenser, if available, or through the atmospheric steam dumps, if the main condenser is not available. This minimizes any radioactive releases from postulated steam generator tube leaks. Although Seabrook has four steam generators, two are sufficient to provide core decay heat removal. In the unlikely event that all the steam generators are leaking and the main condenser is not available, the operators will select the atmospheric steam dumps of the steam generators with the smallest amount of leakage.

QUESTION 6. What, if any, provision does the Seabrook emergency action plan make for the possibility of a radiological emergency during a severe winter snowstorm of the type New England experienced in early March? What impact would such a storm have on evacuation and emergency response efforts?

ANSWER.

The NRC and the Federal Emergency Management Agency (FEMA) are the two Federal agencies responsible for evaluating emergency preparedness at and around nuclear power plants. The NRC is responsible for assessing the adequacy of the onsite emergency plans developed by the licensee, while FEMA is responsible for assessing the adequacy of the State and local government emergency plans. The Seabrook Station Radiological Emergency Plan and its associated procedures describe the roles and responsibilities of the onsite and offsite emergency response organizations for any declared emergency at the plant. The plan provides that the licensee is responsible for determining and conveying specific accident information, including issuing Protective Action Recommendations (PARs), to the appropriate offsite

authorities. The PARs may include recommending an evacuation of the general public. The offsite authorities are responsible for evaluating this information and then determining and implementing appropriate protective actions for the public in accordance with the established offsite emergency plans.

In the postulated case of a radiological emergency occurring coincident with a severe winter snowstorm, the licensee's actions would be focused primarily on trying to bring the plant to a safe condition, while monitoring and evaluating the radiological emergency. The licensee would make PARs based primarily on the status of the plant accident conditions, but would be in continuous contact with the offsite authorities to discuss strategies for dealing with severe weather. For implementation of the protective actions for the public, the offsite authorities would determine the appropriate protective actions to be taken considering the emergency conditions at the plant as well as the effects of the storm conditions on the area around the plant. For specific information on the provisions in the offsite plans for coping with severe weather, we have requested FEMA to provide us information on the provisions contained in the State and local emergency plans for the area around the Seabrook Station that address response actions for a radiological emergency which may develop concurrent with a severe winter storm. We will provide you a copy of FEMA's response upon our receipt of the requested information, which is expected by June 29, 2001.

QUESTION 7. I have obtained a copy of a letter from the NRC to the Seacoast Anti-Pollution League dated April 8, 1993, responding to their concerns about a snowstorm from March of that year. The letter reads, in part: "There may, in fact, be circumstances (such as a severe winter storm) where, in the event of a radiological emergency, sheltering rather than

evacuation would be the appropriate protective action because evacuation in storm conditions would pose greater risk to the public." What is the acceptable radiological exposure for members of the general public that use "sheltering rather than evacuation?" What are the relevant limits for children and pregnant women? Later in the same letter, the NRC stated: "As long as the Seabrook plant remained within its license conditions and technical specifications, there was no safety reason for the plant to shut down during the snowstorm." What extremes could be reached in a snowstorm that would cause the plant to exceed its license conditions and technical specifications? Do the license conditions and technical specifications pertain to the integrity of the offsite power supply?

ANSWER.

There is no specific value established that is considered an acceptable exposure level, or limit, which determines the choice between evacuation or sheltering of the general public. Effective emergency management decision-making during an event must consider all the relevant factors. The overall objective of emergency response plans is to minimize dose to the population for a spectrum of accidents that could produce offsite doses in excess of Protective Action Guides (PAGs).

The PAGs are established in the Environmental Protection Agency document EPA 400-R-92-001, "Manual of Protective Action Guides and Protective Actions for Nuclear Incidents" (May 1992). The PAGs are expressed as a projected dose range of from one rem to five rem. (As a reference, the average person receives a dose of about one-third of a rem per

year, primarily from natural background radiation.) The protective action recommended could be evacuation or sheltering, or some combination of both. Section 2.3.1, "Evacuation and Sheltering," of EPA 400-R-92-001, states, "...analysis indicates that evacuation of the public will usually be justified when the projected dose to an individual is one rem. This conclusion is based primarily on EPA's judgement concerning acceptable levels of risk of effects on public health from radiation exposure in an emergency situation. The analysis also shows that, at this radiation dose, the risk avoided is usually much greater than the risk from evacuation itself." The document later explains in Section 2.3.1 that sheltering may be preferable to evacuation as a protective action in some situations, particularly under unusually hazardous environmental conditions. There are no specific exposure limits for children or pregnant women established by the PAGs. However, the PAGs do indicate that evacuation would normally be appropriate at the projected dose of one rem for an incident that occurs when children are in school.

There are Technical Specifications pertaining to the integrity of the offsite power supply that could be affected by a snowstorm. In the extreme, if two independent circuits were not maintained operable from the offsite transmission network to the vital buses for any reason, the plant would be required to shut down and cool down to a cold shutdown condition.

QUESTION 8. Please provide me with the report from the Special Inspection Team when it is completed.

ANSWER.

We have enclosed the Special Inspection Team report for your review. The NRC found that Seabrook's evaluation of the event was comprehensive and that the operators took appropriate actions to maintain the plant safe. However, important conditions, which led to or complicated

the event, were previously observed at the plant but were not addressed appropriately through Seabrook's corrective action process. These issues, coupled with the recent emergency diesel generator failure, gave rise to an NRC concern regarding identification and resolution of problems at the station.

Based on the results of the inspection we found that Seabrook failed to implement timely and appropriate corrective actions to address two known equipment deficiencies involving the turbine driven emergency feedwater pump and the 345 kV line bushings. Regarding the turbine driven emergency feedwater pump, we also determined that a violation of regulatory requirements occurred. This violation is being treated as a non-cited violation, consistent with the NRC's Enforcement Policy. Regarding the 345 kV line bushings, we determined this did not involve a violation of NRC requirements, since the bushings are not in a safety-related system. The report describes that both findings were determined using the NRC risk significance determination process (SDP) to have very low safety significance.