ATTACHMENT

Safe Shutdown Capability of Indian Point Unit 2 For Tornado High Wind Induced Events

February, 1986

Background

The initial wind effects analysis published in the Indian Point Probabilistic Safety Study (IPPSS) as submiited to NRC in March, 1982, was based on a preliminary analysis of wind hazards, structural fragilities, and failure scenarios. In 1983, soon after the IPPSS was published and during the Indian Point Hearings initiated by the NRC in response to a petition by the Union of Concerned Scientists (UCS), we commenced a revised analysis refining the earlier work, giving greater attention to site specific wind hazard data, to wind fragilities of key and adjacent structures, and the consequences of their potential failure. In addition to Pickard, Lowe and Garrick, Inc., who were contracted for the IPPSS, and Research Triangle Institute (RTI), who had prepared the initial wind and tornado hazard analysis, the revised analysis used Structural Mechanics Associates, Inc. to provide a more detailed structure fragility analysis; Cermak/Peterka & Associates to analyze adjacent building and ground effects on building fragilities, and York Research Corporation for support to RTI with local and regional wind information and effects.

The initial analysis determined that any potential increases in windspeed at the Indian Point site due to wind channelization through the Hudson River Valley would be more than offset by the conservative assessment of terrain roughness attenuation of offshore winds. Peak winds were also assumed in the initial study to occur from any direction. The revised study used site-specific wind data and accounted for wind channelization, hurricane wind attenuation with distance inland, terrain roughness in the vicinity of the site, and differences in wind speed in each of the four principal wind directions. The resultant wind hazard curves for each of the four directions were significantly lower than those presented earlier.

The revised tornado/wind analyses were documented as part of Amendment 2 to the IPPSS submitted to NRC in April, 1984. Thus, while that amendment addressed NRC Staff/SANDIA comments on the original IPPSS wind analysis, its submittal came after the closure of the Indian Point Hearing record. Therefore, the hearings record and decision do not reflect the significantly lower IP2 high wind risk which resulted from the analyses contained in Amendment 2 of IPSSS.

At IP2, the control building, diesel generator building and Condensate Storage Tank referenced in the NRC's letter of February 6, 1986 are not specifically designed to withstand tornados. Their fragilities and frequencies of unavailability were, however, determined in connection with the IPPSS Amendment 2 efforts referred to above. Tornados are rare events in the vicinity of Indian Point. Due to the specific locations of these structures it is even more improbable that a single tornado could cause their simultaneous failure and at the same time cause failure of backup equipment on-site and off-site. Tornado damage to safety related equipment within the control building and diesel generator building was not specifically analyzed in the IPPSS; rather, subsequent failure of all equipment within those structures and their assoicated functions was conservatively assumed.

Potential building failure from excessive wind loading can result in the building frame collapse, or in the loss of building siding from impinging wind pressure, or siding or roofing from negative pressure on the leeward and other sides of the building. Building frame failures were assumed to cause a loss of the entire building, its contents and their associated functions.

Failure of building siding from impinging loads was assumed to be caused by bowing of the siding, with gross leakage of wind into the building, thereby relieving girt loads. This would not necessarily result in the siding tearing away from its girt supports, particularly since the siding often is continuous over its supports. However, a probability was assigned to the failed siding being released into the building and causing damage to the building contents.

Negative wind pressures on the leeward and other side faces of buildings are assumed to cause panels, comprised of siding and girts, to fail by their detachment from the building, thereby exposing the building contents. This condition would not be particularly hazardous to building contents because the negative wind pressure on equipment surfaces resulting from wind flows inside the building would be significantly lower than that on roofing and siding faces.

Described below are various alternate safe shutdown capabilities included in the IP2 design which could accommodate credible failure modes resulting from tornado induced wind damage.

Safe Shutdown Capability

By telephone on January 31, February 3, and February 13, 1986 and by letter dated February 6, 1986 the NRC requested a description of IP-2 safe shutdown capability for the following cases:

1) Tornado caused loss of normal overhead offsite power and resulting high winds striking the diesel generator building, ultimately incapacitating all diesel generators.

2) Tornado caused loss of normal overhead offsite power and resulting high winds striking the control building and/or diesel generator building causing it to become uninhabitable or non-functional, with or without any of the three diesel generators available, and

3) Tornado caused loss of normal overhead offsite power and failure of the condensate storage tank.

Case 1:

The scenario described above for case 1, a loss of A.C. station power, has been analyzed and symptom-based recovery procedures exist for the operators to shutdown IP-2 from the central control room. For this case, the reactor would be tripped, and natural circulation would be established. Decay heat would be removed by the steam turbine driven auxiliary feedwater pump and atmospheric steam relief. The reactor coolant pump seals would be cooled by either seal injection from a charging pump or component cooling to the thermal barriers. It should be noted that recent seal testing without cooling performed by the Westinghouse Owners Group has shown seal degradation to be significantly less than that assumed in the IPPSS. Thus, restoring seal cooling, which requires A.C. power, is much less of concern and would thereby allow more time to restore A.C. station power. If a natural circulation cooldown was commenced, reactor coolant system makeup and boration would be provided by a charging pump and the refueling water storage tank.

480V A.C. power to the charging pump and/or component cooling pump (and service water pump) would be provided by one of several 13.8 KV or 6.9 KV power feeds to the station as shown in FSAR Figure 8.2-1. These are described below:

1) Gas Turbine No. 1 (GT-1) is located on-site at elevation 15'. This unit could be started and loaded in about 15 minutes, providing 13.8/6.9 KV power directly to IP-2. Alternately, GT-1 can provide 13.8 KV power to Indian Point Unit 1 (IP-1) Light and Power (L&P) bus sections which could be transferred to IP-2 6.9 KV buses and 480 V safety buses or transferred to IP-1 switchgear that supplies the IP-2 Alternate Safe Shutdown System. The 13.8 KV connection (13W92) is underground from GT-1 to the L&P room inside IP-1. Presently, Gas Turbine No. 1 can be started remotely from the CCR but has to be loaded onto IP-1's L&P bus sections or IP-2's 6.9 KV buses via breaker controls in the gas turbine building. We are planning to restore these controls to the CCR in the near future.

2) Gas Turbines No. 2 & 3 are located offsite at the Con Edison Buchanan sub-station, approximately 1/2 mile from the IP-2 diesel generator building. 13.8 KV power feeds (13W92 and 13W93) are supplied underground* from these gas turbines into IP-1 L&P bus sections. Either (or both) of these gas turbines would supply IP-2 480 V safety buses in much the same manner as described above for gas turbine No. 1. Gas turbines No. 2 or 3 would be used to supply IP-2 480 V safety buses

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NOTE: *The feeder is run in conduit and the conduit is run underground except for connections to transformers and/or to enter buildings.

should GT-1 not be available. GT-1 is dedicated to the Indian Point site. IP-2 technical specifications contain operability and surveillance requirements for the gas turbines.

3) Other alternate sources of 138 KV or 13.8 KV power are available to IP-2 from:

   a) an underground* connection to overhead 138 KV feeder 95331 from Indian Point Unit 3, 138 KV bus section,

   b) an underground* 13.8 KV connection (13W94L) from Buchanan 138 KV yard to IP-1 L&P bus section, and

   c) two underground* 13.8 KV connections (13W92 and 13W93) from Buchanan 13.8 KV yard to IP-1 L&P bus sections.

4) Alternate 6.9 KV power is available to IP-2 through an underground* connection from IP-3 6.9 KV buses and 13.8 KV feeder 13W93 (via 52 GT/BT). Also, the IP-3 diesel generators could be connected to IP-2 via this connection.

The unique redundancy and diversity of these IP-2 on-site and off-site power sources and connections to the station make it extremely unlikely that A.C station power would not be restored in a short period of time. Nonetheless, should all attempts to restore A.C. station power fail, a highly improbable situation, operators are provided with procedural actions to maintain plant conditions for optimal recovery, thereby allowing restoration of A.C. power at any time. After reactor trip, natural circulation would be established; steam generator water level will decrease due to steam/feed flow mismatch; pressurizer water level will decrease due to loss of heat load; the steam turbine driven auxiliary feedwater pump would remove decay heat, etc. Secondary pressure will no longer be limited to the no-load steam pressure but would rise to the secondary safety valve set pressure. Steam temperature will increase in conjunction with the loss of forced reactor coolant flow and accordingly, pressurizer water level would return to the normal full load range. However, there would be reactor coolant pump (RCP) seal leakage and, as a result, pressurizer level will not stabilize but will begin to fall again. The rate at which the level decreases will depend on the magnitude of the seal leakage. Should the seal remain intact such that leakage rates are only several gallons per minute from each pump, the level drop may only be noticeable over a period of hours.

NOTE: *The feeder is run in conduit and the conduit is run underground except for connections to transformers and/or to enter buildings.

Should the seal deteriorate rapidly due to the loss of seal cooling, a less likely condition, leakage rates could increase causing the pressurizer to empty faster. With decay heat being removed through the steam generator safety valves, and without the ability to replenish water lost through the RCP seals, this situation would eventually result in saturation conditions in the RCS and a stabilization of temperature and pressure at values slightly above those in the steam generator. Under these conditions, the symptom-based emergency operating procedures direct the operators to take actions to rapidly reduce reactor coolant system pressure and temperature. This causes a significant corresponding reduction in reactor coolant pump (RCP) seal leakage. Reducing seal leakage will extend the time available to restore A.C. station power before a potential inadequate core cooling situation can develop. In addition to reducing the amount of water lost from the RCS, reducing RCS pressure and temperature will also reduce the rate and potential magnitude of seal degradation. Finally, decreasing RCS pressure via secondary cooling allows for the injection of the water in the passive low pressure ECCS accumulators to replenish some of the lost RCS inventory and even further extend the time available to restore A.C. station power.

Case 2:

The scenario described above for case 2 is equivalent to those cases analyzed for 10 CFR 50, Appendix R where the CCR, the control building, IP-2 480 V switchgear, and the diesel generators become non-functional due to fire induced electrical failures. In the case of a tornado induced high wind condition striking the control building, the assumed structural damage is the failure of the north wall, exposing the interior of the control building. The operators would initiate plant shutdown from outside the CCR. The procedure which directs the operator can achieve safe shutdown from outside the CCR in any of three different ways. First, safe shutdown control with normal station A.C. power available; second, safe shutdown control with emergency 480 V A.C. power available; third, safe shutdown control with alternate IP-1 power available. For Case 2, since offsite power was lost, the preferred safe shutdown method would involve local control of IP-2 safe shutdown equipment powered from the 480 V emergency buses being supplied by the emergency diesel generators or other A.C. power sources described in case 1. Upon reactor trip RCS decay heat will be removed by natural circulation with steam generator feedwater flow being supplied by either a motor driven auxiliary feedwater pump or steam turbine driven auxiliary feedwater pump and atmospheric relief from the steam generators. RCP seal cooling, RCS makeup and boration would be provided by a charging pump and the refueling water storage tank (RWST). A component cooling water (CCW) pump and service water pump could be used to provide cooling water to the RCP thermal barrier and CCW heat exchangers.

Given control room inaccessibility, concurrent unavailability of the three diesel generators, and unavailability of the IP-2 480 V switchgear, an additional level of defense is provided in the same manner as that for the requirements of 10 CFR 50, Appendix R. Safe shutdown would be accomplished from outside the CCR using the Alternate Safe Shutdown System (ASSS) which circumvents the CCR, the IP-2 480 V switchgear room, the IP-2 control building as well as the diesel generator building. Additional independent and separate power supplies from IP-1 440 V switchgear are provided for certain IP-2 safe shutdown components. The IP-1 power supplies are hardwired to manually operated transfer switches to power IP-2's ASSS. The ASSS includes the necessary instrumentation for achieving hot and cold shutdown. This instrumentation is either pneumatic, mechanical or powered from the same IP-1 power sources that supply the ASSS. Control of the plant shutdown using the ASSS is by local manual operation of transfer switches, circuit breakers, air or nitrogen supplies, motor and air operated valves and hand held radio communications. The ASSS will function with and without normal overhead offsite power. Emergency power to IP-1 is available through any of three gas turbines and separate underground feeders. As discussed above under Case 1, GT-1 is located on-site while GT-2 and GT-3 are at the Buchanan substation (approximately 1/2 mile away) with underground feeders to IP-1. Also, as mentioned above, an underground feeder from the Buchanan 138 KV yard (13W94L) is available to supply IP-1 power and the IP-2 ASSS. Figures 1 and 2 show simplified schematics of the ASSS power system.

The ASSS is independent of the IP-2 control building. At ceiling level in the south east corner on the IP-1 side of the CCR in the IP-1 control building (a separately supported structure), there is a short run of some ASSS conduit. Some of the ASSS cables that run to the Primary Auxiliary Building (PAB) are in these conduits, other cables in the ASSS are routed independent of both the IP-1 and IP-2 control buildings. Both the Unit 1 turbine building and superheater building (which contain the ASSS power/switchgear described above) have high wind resistance capabilities relative to the IP-2 control building. Further, the portion of the control room within the Unit 1 superheater building is more protected than the remainder of the Unit 2 control building. Therefore, although not included in the IPPSS analysis, the ASSS provides a significant measure of backup to avoid wind induced core damage, since operators utilizing the ASSS could safely shutdown the plant. As shown in Figure 3, there is another separate wall inside the IP-1 control building between points and B and D, and points D and E that separates this short ASSS cable/conduit run from the CCR. Wall construction between points B and D is steel panel cladding over a hollow wall with a wall thickness of 5 inches, including the air space. Wall construction between points

D and E is multicourse brick construction as are the walls surrounding the kitchen and locker room in the south east corner. In order to incapacitate both the CCR and the ASSS cables in the southeast corner, the north wall siding or other debris would have to penetrate a) the interior IP-2 and IP-1 control panels, b) the steel panel wall or several multicourse brick walls and c) the steel conduits surrounding the ASSS cables at the ceiling level. Since such an eventuality is considered to be highly unlikely, the ASSS cables in the IP-1 control building are not considered susceptible to tornado or high wind induced damage. Thus, the ASSS will be available in the highly improbable event that the IP-2 control building were damaged by a tornado or high wind condition.

Case 3:

The scenario described above for case 3 is similar to previous post-TMI evaluations for reliability of secondary heat sink. The likely structural damage to the condensate storage tank (CST) from a tornado induced high wind condition would be a missile impact rupturing the tank and causing loss of its contents. The high wind condition by itself cannot cause gross failure of the CST due to its design. Given a gross rupture of the CST the city water system provides adequate backup capability for secondary heat sink. The redundant low water level alarm system will alert the operators to manually switch over to the city water system. The city water tank is located at elevation 120' approximately 1/2 mile from the CST, near the Buchanan service center. Sufficient secondary inventory exists to allow the operator time to accomplish switchover from the CST to city water. Upon receipt of the low CST level alarm the operator would trip the running auxiliary feedwater pumps, re-align suction and re-start the pumps. Therefore, even though a tornado generated missile may momentarily interrupt secondary heat sink it is very unlikely to cause a long term loss.

Emergency Plan:

Con Edison's emergency plan procedure IP-1032 (attached) describes the actions to be followed in the event of a tornado watch or warning at the Indian Point site.