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ComEd

United States Nuclear Regulatory Commission
ATTN: Document Control Desk
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Braidwood Station, Units 1 and 2
Facility Operating License Nos. NPF-72 and NPF-77
NRC Docket Nos. STN 50-456 and STN 50-457

Byron Station, Units 1 and 2
Facility Operating License Nos. NPF-37 and NPF-66
NRC Docket Nos. STN 50-454 and STN 50-455

Subject: Analysis Regarding a Potential Rack Drop Accident During Installation of New Spent Fuel Pool Storage Racks at Byron and Braidwood Stations

Reference: Teleconference Between Representatives of Commonwealth Edison Company and the Nuclear Regulatory Commission on March 23, 2000, Regarding Analysis of a Potential Rack Drop Accident During Installation of New Spent Fuel Pool Storage Racks at Byron and Braidwood Stations

In the referenced teleconference, the Nuclear Regulatory Commission (NRC) raised questions regarding assumptions made in the analysis for a potential rack drop accident during installation of the new spent fuel pool (SFP) storage racks at Byron and Braidwood Stations. Attachment 1 to this letter provides the requested information.

In summary, the analysis demonstrates that in the unlikely event of a SFP rack drop, the resultant potential SFP leak rate and associated SFP structural damage do not present a significant safety issue.

Should you have any questions or concerns regarding this information, please contact Mr. J. A. Bauer at (630) 663-7287.

Respectfully,

R M Krich

R. M. Krich
Vice President – Regulatory Services

Attachment: Attachment 1, "Braidwood and Byron Stations, Spent Fuel Pool Rerack Project Rack Drop Accident Analysis"

cc: Regional Administrator – NRC Region III
NRC Senior Resident Inspector – Braidwood Station
NRC Senior Resident Inspector – Byron Station

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ATTACHMENT 1

Braidwood and Byron Stations
Spent Fuel Pool Rerack Project
Rack Drop Accident Analysis

In the unlikely event of a rack drop accident during installation of the new spent fuel pool (SFP) racks, adequate mitigation capability exists such that the consequences of a hypothetical rack drop does not pose a significant safety issue. The following assumptions and discussion is applicable to both the Byron Station SFP and the Braidwood Station SFP as the physical layout of the SFPs at each station are nearly identical. For convenience, only Byron Station procedures are referenced by name in the discussion, however, each procedure has a Braidwood Station counterpart.

Assumptions and Analysis

<u>Dropped Rack Weight</u>

The weight of the rack assumed to drop is 25,889 lbs., (i.e., the weight of the heaviest rack).

<u>Liner Tear Size</u>

If a rack drop accident occurs, the rack will fall freely through a stratum of water before it impacts the SFP liner. A drop height of 40 feet is assumed. Because of the fluid drag forces, it is improbable that the rack will remain in a perfectly upright orientation at the time of impact. Realistically, the rack will become skewed during the fall, which will produce an initial impact between the rack and the liner at a single rack support pedestal location. Therefore, it is assumed that only one rack support pedestal penetrates the SFP liner plate and creates a single liner hole five inches in diameter, (i.e., the size of the rack support pedestal). Secondary impacts involving the other rack support pedestals are less likely to puncture the liner. Note that a rack is never carried over spent fuel assemblies.

<u>Structural Damage</u>

Holtec analysis previously performed on the Millstone Unit 3 SFP, which has an elevated concrete SFP slab foundation, indicated that damage to the concrete was confined to a local area which measured approximately three inches in depth assuming a rack drop height of 40 feet. There was no quantifiable leakage though the concrete slab. The Byron and Braidwood Stations' SFP concrete slabs are six feet thick. Since an elevated slab configuration is more limiting than the Byron and Braidwood Stations' SFPs, which are founded on bedrock and soil respectively, the structural damage to the Byron Station or Braidwood Station SFP, due to a rack drop, would be comparable, (i.e., no more severe) than the Millstone Unit 3 results.

Leak Rate Model

The SFP leak chase system is routed to four drain lines; one from each corner of the SFP. Even though only one five inch diameter hole is assumed to be created by a rack drop, the maximum possible leak rate through all four drain lines will be assumed in the below analysis. This leak rate is larger than the leak rate possible through a single five inch hole.

The maximum liner leak rate will be limited by the size of the piping between the SFP leakchase system and leak detection isolation valves; and not the size of the SFP liner tear. Piping to the isolation valves is 1-1/2". The shortest run of the 1-1/2" leak detection drain lines from the SFP was conservatively modeled. This drain line was on the Unit 2 side of the SFP. We also assumed that the 1-1/2" line comes directly off the bottom of the pool neglecting the flow restriction though the leakchase channels.

The 1-1/2" pipe travels vertically from the bottom of the SFP at the 385' elevation down to approximately the 368' elevation, and horizontally about 34 feet, where the isolation valve and sight glass are located. Although thirty-nine and one half feet (i.e., 39'-6") of water is normally above the SFP floor elevation of 385', thirty-nine feet 9-1/2 inches (i.e., 39' 9-1/2") of water head is assumed. This corresponds to the Byron Spent Fuel Pool High Level alarm setpoint at the 424' 9-1/2" elevation. Conservatively, no valves or fittings were assumed to exist in the line. Just below the SFP leak off sight glass, which gives a visual indication of a SFP liner leak, the Unit 2 side SFP leak detection lines tie into a 3" header. The piping below the header is all 3" or larger. This piping was assumed not to exist; however, the head loss associated with the piping from the header down to the Auxiliary Building sump was conservatively added to the head associated with the level of water in the SFP.

The results of the calculation indicated a flow rate of 179 gpm for the shortest drain line. This value was multiplied by four to obtain the maximum possible leak rate of 716 gpm for all four drain lines. This maximum leak rate is considered to be extremely conservative and improbable for the following reasons.

1. While the liner tear is expected to be a five inch diameter hole, the rack support pedestal will most likely remain in the hole, creating a "self-plugging" situation, which will act to restrict flow.

2. The calculation is based on the liner tear being open to the leak detection channel. The most probable event would be a tear in the liner some distance away from a leak detection channel. This will result in the water flowing through the narrow gap between the bottom of the liner and the top of the SFP concrete slab grout until it reaches a leak detection channel and flows to the leak detection piping. This narrow gap will severely limit the leakage flow. In all probability, flow would not be maximized through all four drain lines.

3. Should the rack tear the liner directly above a leak detection channel, the resulting flow area would effectively be the equivalent of two channels (i.e., the channel cross-section emanating from each side of the hole). The largest channel cross-section is just slightly larger than a leak detection drain line cross-section. Based on engineering judgement, considering the resistance of flow through the leak channels from the tear location to the leak detection flow pipes, flow in a channel will be

approximately equal to the flow in one leak detection drain line. Therefore, the flow through the two leak detection channels would equal the maximum flow which could be passed by two drain lines (i.e., 179 gpm x 2 = 358 gpm).

Leakchase Channel Isolation Capability

The worst case leak of 716 gpm is approximately 95.7 ft^3/min. The SFP surface area is 1869 ft^2. Therefore, it would take approximately 19.5 minutes to drop the SFP level one foot at a leak rate of 716 gpm. Again, as stated above, this leak rate is considered to be extremely conservative.

The SFP operating floor is on the 426' elevation. The leakchase isolation valves are located on the 368' elevation and are normally left in the open position. Should a rack drop occur and the isolation valves need to be checked and isolated, it would take no more than five minutes, including 20-30 seconds in the personnel radiation detection monitor, to reach the leakchase isolation valves from the SFP operating floor. Even at the maximum calculated leak rate, the SFP level would drop only 3-1/8" in this five minutes. The normal SFP level is 424'6"; therefore, there is approximately 26 feet of water above the active fuel in the SFP. The SFP low level alarm is set at 424'2"; therefore, the leak would be isolated before the low-level alarm would sound. The leakchase isolation valves have been and will be cycled monthly throughout the SFP rerack replacement project to ensure valve operability.

If the SFP level were to drop to the SFP low level alarm setpoint of 424'2", the loss of SFP level is annunciated in the Main Control Room on Annunciator 1-1-C1, "Spent Fuel Pit Level High Low." The annunciator response procedure directs the operators to suspend all fuel movement and go to Byron Operating Abnormal (BOA) Procedure REFUEL-2, "Refueling Cavity or Spent Fuel Pool Level Loss Unit 1/2," for any uncontrolled level loss. BOA REFUEL-2 directs the following actions to be performed.

- Evacuation of non-essential personnel
- Securing of fuel in a safe location
- Shutdown of Refueling Cavity cleanup system
- Closure of the Fuel Transfer tube
- Closure of the Spent fuel pool sluice gates
- Isolation of Spent Fuel Pool Cleanup system
- Check of sluice gate seal pressures
- Verification of no siphon source
- Check of SFP leak detection system
- Fill Spent Fuel Pool with borated water

SFP Makeup Capability

SFP makeup is governed by the following procedures that identify the various makeup sources and associated makeup rates.

a) Borated Water per Byron Operating Procedure (BOP) Fuel Pool Cooling and Cleanup (FC)-11, "Spent Fuel Pool Make-Up & Refueling Cavity Make-Up"
   - Normal makeup from the Refueling Water Storage Tank (RWST) via either of two Refueling Water Purification Pumps rated at 150 gpm and 250 gpm, respectively

b) Borated Water per BOP FC-14, "Boron Addition to the Spent Fuel Pool or Transfer Canal," (i.e., when the Chemical and Volume Control System (CVCS) Blender is aligned to SFP)
   - Blended flow from the CVCS blender, via a hose, to the SFP; flow rate is 75-120 gpm depending on boron concentration selected

If borated water is not available, the SFP can be supplied with unborated water.

a) Unborated Primary Water per BOP FC-11, "Spent Fuel Pool Make-Up & Refueling Cavity Make-Up"
   - Makeup flow rate from the Primary Water System is 120 gpm

b) Unborated Demineralized Water per BOA REFUEL 2
   - Demineralized Water flow rate from local hose drop is approximately 340 gpm

c) Fire Protection water (i.e., unborated water) from local Safety Category I hose stations
   - Fire Protection water flow rate from these two hose stations is approximately 191 gpm each

The minimum makeup capability from the above sources totals to 1067 gpm, which is greater than the maximum, most conservative leak rate possible due to a rack drop event.

SFP Potential Boron Dilution

In the extremely unlikely event that a rack is dropped in the SFP and water make-up is provided from an unborated water source, the margin to criticality in the SFP may be affected. A review was performed to evaluate the potential effects on SFP criticality.

During installation of the new Holtec spent fuel pool storage racks, both Holtec and the existing Joseph Oat spent fuel pool storage racks will be in the spent fuel pool at the same time. The criticality analysis for the Joseph Oat spent fuel pool storage racks states that should a spent fuel pool water temperature change accident or a fuel assembly misload accident occur in the Region 1, Region 2, or failed fuel storage cells, k_{eff} will be maintained ≤ 0.95 due to the presence of at least 550 ppm (i.e., no fuel handling) or 1650 ppm (i.e., during fuel handling) of soluble boron in the spent fuel pool water. These assumptions are more conservative than the requirements stated in the criticality analysis for the Holtec spent fuel pool storage racks which only requires 220 ppm boron to maintain $k_{eff} \leq 0.95$ during the worst case fuel assembly misload accident. The new Holtec racks have a superior neutron attenuation capability due to their improved design.

The Technical Specifications (TS) boron concentration requirement for Joseph Oat spent fuel pool storage racks is $\geq$ 2000 ppm. The TS boron concentration requirement for Holtec spent fuel pool storage racks is $\geq$ 300 ppm. A boron concentration of $\geq$ 2000 ppm boron will be maintained in the SFP during the entire rack change out process, thereby ensuring that k_{eff} will remain ≤ 0.95.

The SFP boron concentration is administratively maintained at approximately 2350 ppm. Based on the methodology from an existing calculation, it would take approximately 58,000 gallons of unborated water to reduce the SFP boron concentration from 2350 ppm to the TS limit of 2000 ppm. As noted earlier, given the extremely conservative assumption that the SFP leak rate is 716 gpm, in the five minutes it would take for an operator to isolate the associated leakchase isolation valves, only 3580 gallons would have leaked from the SFP. Conservatively, if all of this water was replenished from an unborated water source, the SFP boron concentration would be reduced an insignificant amount. Assuming a leak rate and subsequent makeup rate of 716 gpm, it would take approximately 1 hour and 21 minutes to makeup 58,000 gallons of unborated water and subsequently reduce the SFP boron concentration from 2350 ppm to 2000 ppm.

Conclusions

The above analysis demonstrates that in the unlikely event of a SFP rack drop, the resultant leak rate and associated SFP structural damage are minimal and do not present a significant safety issue.