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December 21, 2005

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Early Site Permit (ESP) Application for the Clinton ESP Site
Docket No. 52-007

Subject: Revised Response to Draft Safety Evaluation Report Open Items

Ref: 1) Letter, U.S. Nuclear Regulatory Commission (W. D. Beckner) to Exelon Generation Company, LLC, (M. Kray), dated February 10, 2005, *Draft Safety Evaluation Report for the Exelon Early Site Permit Application*

2) Letter, Exelon Generation Company, LLC (M. Kray), to U.S. Nuclear Regulatory Commission dated April 26, 2005, *Response to Draft Safety Evaluation Report (DSER) Items*

Reference 1 identified certain open items pertaining to Exelon Generation Company (EGC) LLC's assessment of ice formation on Clinton Lake during winter months. EGC responded to these open items via the correspondence of reference 2. The enclosed information is provided in response to subsequent discussions with the NRC regarding EGC's methodology for determining ice thickness. Change bars in the margin identify the revised portion of each response. These changes will be reflected in Revision 2 of EGC's ESP application, which is expected to be submitted to the NRC no later than January 12, 2006. Please contact Eddie Grant of my staff at 850-598-9801 if you have any questions regarding this submittal.

Sincerely yours,

Thomas P. Mundy

Thomas P. Mundy
Director, Project Development

D073

TPM/erg

cc: U.S. NRC Regional Office (w/ enclosures)
Mr. John P. Segala (w/ enclosures)

Enclosures

AFFIDAVIT OF THOMAS P. MUNDY

State of Pennsylvania

County of Chester

The foregoing document was acknowledged before me, in and for the County and State aforesaid, by Thomas P. Mundy, who is Director, Project Development, of Exelon Generation Company, LLC. He has affirmed before me that he is duly authorized to execute and file the foregoing document on behalf of Exelon Generation Company, LLC, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged and affirmed before me this 21st day of December, 2005.

My commission expires 10-6-07.

Vivia V. Gallimore

Notary Public

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Vivia V. Gallimore, Notary Public
Kennett Square Boro, Chester County
My Commission Expires Oct. 6, 2007
Member, Pennsylvania Association Of Notaries

NRC Letter Dated: 02/10/2005

NRC DSER Open Item 2.3-2

Identify an additional UHS design basis site characteristic for use in evaluating the potential for water freezing in the UHS water storage facility.

EGC RAI ID: SOI1-3

EGC RESPONSE (revised):

The NRC indicates, in DSER Section 2.3.1.3, "the applicant needs to identify an additional UHS design-basis site characteristic for use in evaluating the potential for water freezing in the UHS water storage facility (e.g., Clinton Lake), a phenomenon that would reduce the amount of water available for use by the UHS. The lowest 7-day average air temperature recorded in the site region may be a reasonably conservative site characteristic for evaluating the potential for water freezing in the UHS water storage facility."

EGC has selected, as an appropriate site characteristic for use in evaluating the potential for water freezing in the UHS water storage facility (if one is required), the maximum cumulative degree (°F)-days below freezing over a winter. This site characteristic of 1141.5 degree-days below freezing was determined based on historical temperature data obtained from the National Climatic Data Center for Decatur, IL. This value is used in the maximum ice thickness accumulation determination provided in response to DSER 2.4-9.

The value of 1141.5 freezing degree-days will be added to SSAR Table 1.4-1 as a site characteristic. Additional revisions related to ice formation are included in the response to DSER Open Item 2.4-9.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

1. Revise SSAR (Rev. 1) Chapter 1, Tables 1.4-1, from:

3.1.10	Maximum Cumulative Degree-Days Below Freezing	Note 1	1065 degree-days	SSAR

To read:

3.1.10	Maximum Cumulative Degree-Days Below Freezing	Note 1	1141.5 degree-days	SSAR

2. Revise SSAR (Rev. 0) Chapter 1, Table 1.4-9, to include the following new sections:

3.1.10	Maximum Cumulative Degree Days Below Freezing	degree (°F)-days	Mean number of degrees Fahrenheit below freezing each day accumulated over a winter	Minimum

ATTACHMENTS:

None

NRC Letter Dated: 02/10/2005

NRC DSER Open Item 2.4-9

Provide more details regarding the method and air temperature data set used in estimating the thickness of an ice sheet that may form on the surface of Clinton Lake and demonstrate that the ice thickness estimate is adequate.

EGC RAI ID: SOI1-14

EGC RESPONSE (revised):

The NRC indicates, in DSER Section 2.4.7.3, that the "staff's estimate of ice sheet thickness is significantly greater than that of the applicant. Therefore, the applicant needs to provide more details regarding the method and air temperature data set used in estimating the thickness of an ice sheet that may form on the surface of Clinton Lake and demonstrate that the ice thickness estimate is adequate."

During our consideration of this concern, EGC has obtained additional data, evaluated the differences in the EGC and NRC calculation methodologies, and revised our estimate of probable ice thickness on Clinton Lake.

The evaluation established an expected maximum ice thickness of 27.03 in for use in calculating the water available in the Clinton Power Station UHS that could be used for makeup of the ESP Facility UHS if one is needed. This expected maximum ice thickness is based on the worst-case available data from a year where there were 1,141.5 accumulated freezing degree (F)-days. The temperature data was obtained from the National Climatic Data Center for Decatur, IL, and the ice thickness was calculated using procedures established in USACOE Engineering and Design-Ice Engineering Manual (EM1110-2-1612). The NRC Staff appears to have used a method that does not consider recent advances in the available data correlations.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

1. Revise SSAR (Rev. 1), Chapter 2, Section 2.4.7, second paragraph, from:

Ice thickness calculations were completed for Clinton Lake for 108-years extending back from the 2003-2004 winter. The average thickness of sheet-ice calculated over that period is 12.6-inches for the winters in which the lake froze. The maximum thickness calculated was in the 1978-1979 winter of 24.8-inches. The ice thickness was calculated using procedures established in U. S. Army Corps of Engineers Engineering and Design-Ice Engineering Manual (USACOE, 2002) and Technical Note 04-3 (USACOE, 2004). A similar mid-western lake located 180 miles north of Clinton Lake was conservatively selected to assist in establishing the initial point of lake freezing. This is a particularly important step in the evaluation, as ice thickness increases from that point through the winter with accumulating freezing degree-days. The calculations did not consider the influence of heat discharge from the power plant. The coefficient of ice cover condition used in the calculation was 0.80 with a maximum of 1065 accumulated freezing degree (F)-days calculated from temperature data for Decatur, Illinois (MRCC, 2004).

The inlet to a screen house at elevation 670 ft above msl, is 5 ft below the design water level of the ultimate heat sink, giving a water depth of 12.3 ft for station operation during lake low water level conditions. The occurrence of a maximum ice thickness of 22.2 in in the intake area when the water level is at elevation 675 ft above msl would not block the flow into the screen house. Thus, the availability of EGC ESP facility cooling water will not be affected by ice formation in the screen house area. Ice formation or ice jams causing low flow conditions in the streams would not affect the performance of the ultimate heat sink due to its submerged condition. The ultimate heat sink is full and will be maintained (CPS, 2002).

The only EGC ESP Facility structure exposed to the effect of ice on Clinton Lake is the new intake structure. The new intake structure will be similar to the existing CPS intake structure except it will be smaller. The intake opening(s) to the ESP intake structure will extend vertically from elevation 690 feet, or higher, down to approximately elevation 669 feet. The formation of ice on Clinton Lake would potentially block only a small portion of the intake opening since the separation distance between the surface ice and the bottom of the intake is significant. The separation between the surface ice and the bottom intake is significant. Ice jams at bridge crossings are not an issue because of the low velocity situations at the two impoundment crossings at Route 48 across the Salt Creek stream valley and Route 54 across the north Branch stream valley. Upstream and downstream ice jams will not impact ESP Facility operations.

Since there is a potential for ice sheet effects on the ESP intake structure, the final intake structure design at the COL stage will include the effects of the applicable ice forces. The force resulting when a moving ice sheet and a structure interact is limited to the magnitude of force necessary to fail the ice sheet in crushing, bending, buckling, splitting, or a combination of these modes. The total force on the entire structure is important for designing foundations to resist sliding and overturning. Contact forces over small areas, or local contact pressures, are important for designing internal structural members and the external skin of a structure.

To read:

Ice thickness calculations were completed for Clinton Lake for a period from 1902 through 2001. The average thickness of sheet-ice calculated over that period is 16.2 in. The maximum thickness calculated was in the 1977-1978 winter of 27.0 in. The ice thickness was calculated using procedures established in U. S. Army Corps of Engineers Engineering ERDC/CRREL Technical Note 04-3 (USACOE, 2004). The calculations did not consider the influence of waste heat discharge from the power plant. The coefficient of ice cover condition used in the calculation was 0.80. The average number of net accumulated freezing degree (F)–days (AFDD) is 409.9 with a maximum of 1141.5 AFDD calculated from temperature data for Decatur, Illinois (MRCC, 2004; USACOE, 2005).

Ice jams at bridge crossings are not an issue because of the low velocity situations at the two impoundment crossings at Route 48 across the Salt Creek stream valley and Route 54 across the north branch stream valley. Upstream and downstream ice jams will not impact ESP Facility operations.

The only EGC ESP Facility structure exposed to the effect of ice on Clinton Lake is the new intake structure. The new intake structure will be similar to the existing CPS intake structure except it will be smaller. The intake opening(s) to the ESP intake structure will extend vertically from the normal lake elevation of 690 ft, or higher, down to an inlet elevation of approximately 669 ft, providing a vertical opening of about 21 ft. The maximum estimated formation of ice on Clinton Lake (about 27.0 in or 2.25 ft) would potentially block only a small portion of the intake opening leaving 18.75 ft of vertical opening for water intake which is more than adequate for the intake requirements of the plants. At the minimum lake level of 277 ft msl, the intake opening would be reduced to about 5.75 ft which when combined with a nominal horizontal dimension is still more than adequate for the intake requirements of the plants.

Since there is a potential for ice sheet effects on the ESP intake structure, the final intake structure design at the COL stage will include the effects of the applicable ice forces. The force resulting when a moving ice sheet and a structure interact is limited to the magnitude of force necessary to fail the ice sheet in crushing, bending, buckling, splitting, or a combination of these modes. The total force on the entire structure is important for designing foundations to resist sliding and overturning. Contact forces over small areas, or local contact pressures, are important for designing internal structural members and the external skin of a structure.

2. Revise SSAR (Rev. 1), Chapter 2, Section 2.4 References, from:

U.S. Army Corps of Engineers (USACOE). Engineering and Design - Ice Engineering Manual (EM1110-2-1612). Chapter 15, Ice Forecasting. October 30, 2002.

U.S. Army Corps of Engineers (USACOE). "Ice Engineering (ERDC/CRREL Technical Note 04-3)." Engineer Research and Development Center/Cold Regions Research and Engineering Laboratory. Hanover, NH. 2004.

To read:

U.S. Army Corps of Engineers (USACOE). "Ice Engineering (ERDC/CRREL Technical Note 04-3)." Engineer Research and Development Center/Cold Regions Research and Engineering Laboratory. Hanover, NH. June 2004.

U.S. Army Corps of Engineers (USACOE). "Annual Net AFDDs for the Decatur Station." Engineer Research and Development Center/Cold Regions Research and Engineering Laboratory (ERDC/CRREL). Hanover, NH. December 2005.

ATTACHMENTS:

None

NRC Letter Dated: 02/10/2005

NRC DSER Open Item 2.4-11

Quantify the reduction in water storage capacity of the submerged UHS pond in the event of a complete loss of Clinton Dam coincident with the presence of surface ice.

EGC RAI ID: SOI1-16

EGC RESPONSE (revised):

The NRC indicates, in DSER Section 2.4.7.3, that the "applicant should quantify the reduction in water storage capacity of the submerged UHS pond in the event of a complete loss of Clinton Dam coincident with the presence of surface ice."

With a catastrophic failure of the main lake impoundment during a period of maximum ice thickness (see response to DSER Open Item 2.4-9), and with the ice cover remaining in place and settling down on the ultimate heat sink (in spite of the water gradient toward the dam), the ice is expected to displace approximately 326 acre ft (obtained from 158 ac x (27.0 in/12 in/ft) x 0.917 = 326.3 ac-ft) of water (density of ice/density of water = 0.917). This volume of displaced water is also used in the response to DSER Open Item 2.4-16).

The NRC states that the applicant's assumption regarding the disposition of ice with failure of the main dam is not conservative. The assumption that the ice would float away was made by the applicant while describing a scenario with both the CPS and the EGC ESP Facility in operation. While EGC did not state that the "no ice" assumption was conservative, the "no ice" scenario is calculated to have approximately the same excess capacity as the scenario in which the ice is in place (because the ice cover would result in near zero evaporative loss). Excess volume under both scenarios (with and without the ice) is reported in the response to DSER Open Items 2.4-14 and 2.4-16.

Regarding the response to RAI 2.4.7-2 not being consistent, the NRC does not appear to have considered that the basis of the discussion is that both the CPS and the EGC ESP Facility are in operation. The heat of fusion of ice was related to the CPS shutdown cooling operation and not the makeup water of the EGC ESP Facility.

If the assumed failure is during a time when CPS is not operating, then the UHS water normally reserved for a CPS shutdown would also be available for use by the ESP facility, i.e., the entire CPS UHS volume would be available to the ESP Facility.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

The associated SSAR revisions for Section 2.4.7 are included with the response to DSER Open Item 2.4-9.

ATTACHMENTS:

None

NRC Letter Dated: 02/10/2005

NRC DSER Open Item 2.4-16

Establish that the submerged UHS pond has adequate capacity to provide makeup water to the ESP facility UHS.

EGC RAI ID: SOI1-21

EGC RESPONSE (revised):

The NRC indicates, in DSER Section 2.4.8.3, that "The staff's estimate of ice sheet formation in Clinton Lake indicated that the maximum ice thickness could reach 31.4 in. Under these icing conditions, if the main dam failed, or the water surface elevation in Clinton Lake fell to 675 ft MSL, it is likely that there would be some loss in the storage capacity of the submerged UHS pond because the ice sheet would settle down into the pond behind the submerged UHS dam. The staff conservatively estimated this loss in capacity by multiplying the surface area of the submerged UHS pond at elevation 675 ft MSL by the maximum thickness of the ice sheet. The staff estimated that the loss in submerged UHS pond capacity because of icing would be 413 ac-ft. Based on this estimate and the issue described in Open Item 2.4-12, the staff concludes that the applicant needs to establish that the submerged UHS pond has adequate capacity to provide makeup water to the ESP facility UHS."

The required capacity of the UHS was established based on maximum evaporative loss from the facilities and temperature limitations of 95 degrees F at the plant intake.

UHS Design Capacity*	1067 ac-ft
- CPS needs (30-days)**	586 ac-ft
- ESP Facility UHS makeup needs (30-days)#	87 ac-ft
- Available for sediment accumulation	394 ac-ft

* Water surface at 675 ft msl – surface area = 158 ac (CPS USAR Rev. 10, §2.4.8.1.5).

** CPS needs include shutdown cooling evaporative loss (327 ac-ft), fire protection (3 ac-ft), 100-yr flood sediment (35 ac-ft), and sediment inflow from liquefaction (221 ac-ft). See response to DSER Open Item 2.4-14.

Includes 20% margin. See response to RAI 2.4.8-1 and DSER Open Item 2.4-12

Generally, the maximum loss is determined during warm weather conditions when atmospheric cooling is limited. With the existing uprated CPS facility and EGC ESP Facility in operation and under the conditions that the reviewer describes in DSER Open Item 2.4-9 (total ice cover), the evaporative loss in the UHS would be limited and near zero. Additionally, the ice cover and melting would maintain a very low intake temperature and provide cooling benefits for both the CPS and the ESP Facility. With near zero evaporative loss the remaining losses to be covered include:

UHS Design Capacity	1067 ac-ft
- CPS needs (30-days w/ zero evaporation)	259 ac-ft
- ESP Facility UHS makeup needs (30-days)	87 ac-ft
- Loss to ice buildup##	326 ac-ft
- Available for sediment accumulation	395 ac-ft

See responses to DSER Open Items 2.4-9 and 2.4-11

This value is approximately equivalent to the estimated excess capacity without ice cover.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

1. Revise SSAR (Rev. 1), Chapter 2, Section 2.4.7.2, from:

The ultimate heat sink for the EGC ESP facility will be safety related cooling towers if the selected reactor type does not use passive cooling methods. Clinton Lake will be used as a make-up water source for the ESP cooling towers, but not as the ESP Facility heat sink. If Clinton Dam is lost, the ice would be expected to be lost also since it would float on the surface. If it is postulated that the ice drops to the CPS UHS heat sink surface following the loss of Clinton Dam there would be a decrease in the water mass available as a heat sink for CPS. This loss would be expected to be more than offset by the additional heat removal capacity for shutdown of the CPS gained by having the latent heat of fusion of the ice available for heat removal. Adequate water volume for make-up to the ESP cooling towers would be available since the required shutdown of CPS after a dam failure would supply heat to convert the ice back into water.

With the ice cover remaining in place and settling down on the ultimate heat sink (in spite of the water gradient toward the dam), the ice would be expected to displace approximately 300 acre ft (obtained from 158 ac x (24.8 in/12 in/ft) x 0.917 = 300 ac-ft) of water (density of ice/density of water = 0.917). However, while the ice cover would displace some water, it would not be expected to reduce the actual available volume of water in the CPS UHS.

The normal CPS UHS capacity available for shutdown of both the single, uprated CPS and the ESP Facility (provided in Section 2.4.11.6) is determined using warm weather conditions when atmospheric cooling is limited. With the existing uprated CPS facility and EGC ESP Facility in operation and the CPS UHS under total ice cover, the evaporative loss in the UHS would be limited and near zero. Additionally, the ice cover and melting would maintain a very low intake temperature and provide cooling benefits for both the CPS and the ESP Facility. With near zero evaporative loss, the CPS needs are calculated to be reduced to only 259 ac-ft. As discussed in Section 2.4.7, the initial loss of capacity due to ice buildup is calculated to be 300 ac-ft. Therefore, a UHS design capacity of 1067 ac-ft would provide approximately 421 ac-ft for sediment accumulation and any minimal loss due to evaporation. This is actually more available volume than during the no ice cover conditions identified in Section 2.4.11.6.

If the assumed failure is during a time when CPS is not operating, then the UHS water normally reserved for a CPS shutdown would also be available for use by the ESP facility, i.e., the entire CPS UHS volume would be available to the ESP Facility for UHS makeup.

To read:

The ultimate heat sink for the EGC ESP facility will be safety related cooling towers if the selected reactor type does not use passive cooling methods. Clinton Lake will be used as a make-up water source for the EGC ESP cooling towers, but not as the primary EGC ESP Facility heat sink. If Clinton Dam is lost, the ice is expected to float off the CPS UHS and toward the lake outlet leaving an open water surface on the CPS UHS. If it is postulated that with failure of the Clinton Lake dam, the ice does not float off the CPS UHS but drops with the water surface to the CPS UHS there would be a decrease in the liquid water volume available as a heat sink for CPS and as makeup water for the EGC ESP facility. This loss would be expected to be more than offset by the additional heat removal capacity gained by having the latent heat of fusion of the ice available for heat removal. Adequate water volume for make-up to the EGC ESP cooling towers would be available since the required shutdown of CPS after a dam failure would supply heat to convert the ice back into water. In addition, the ice cover, when present, will reduce the evaporative component of the CPS UHS water balance which is the most significant loss component.

With the ice cover remaining in place and settling down on the ultimate heat sink (in spite of the water gradient toward the dam), the ice would be expected to displace approximately 326 ac-ft (obtained from 158 ac x (27.0 in/12 in/ft) x 0.917 = 326 ac-ft) of water (density of ice/density of water = 0.917).

The normal CPS UHS capacity available for shutdown of both the single, uprated CPS and the EGC ESP Facility (provided in Section 2.4.11.6) is determined using warm weather conditions when atmospheric cooling is limited. During this condition the maximum cooling requirement with both the uprated CPS and EGC ESP in operation is 673 ac-ft. The total available capacity of the CPS UHS is 1,067 ac-ft. This leaves an excess capacity of 395 ac-ft. With total ice cover the available liquid water volume is reduced by the volume of water displaced by the ice (326 ac-ft) and increased by the loss of the evaporative component of the cooling process (327 ac-ft). The net change results in essentially the same excess capacity as that identified for warm weather conditions in Section 2.4.11.6.

If the assumed failure is during a time when CPS is not operating, then the UHS water normally reserved for a CPS shutdown would also be available for use by the EGC ESP facility, i.e., the entire CPS UHS volume would be available to the EGC ESP Facility for UHS makeup.

2. Revise SSAR (Rev. 0) Chapter 2, Section 2.4.11.6, to delete the 4th paragraph which reads:

The capacity of the CPS UHS pond will be sufficient for providing make-up to the ESW cooling tower(s) for the safe shutdown of the EGC ESP Facility and to provide safe shutdown cooling for the CPS Facility. A reduction in the allowable accumulated sediment volume in the CPS UHS pond may be required to provide adequate additional capacity make-up to the EGC ESP Facility ESW cooling tower(s).

3. Revise SSAR (Rev. 0) Chapter 2, Section 2.4.11.6, latter portion of sixth last paragraph, from:

The original design of the Ultimate Heat Sink pond for the CPS was based on the heat load from the shutdown of one unit under LOCA and one unit under LOOP with a total integrated heat load of 180,455 x 10^6 btu for 30 days. The heat load for the single CPS unit constructed, with Power Uprate, is 99,973 x 10^6 btu for 30 days under LOCA or LOOP conditions. This value is approximately 55 percent of the CPS UHS Pond design heat load and indicates considerable margin is available. The design analysis for the original CPS UHS pond were reviewed and it was determined that the withdrawal of water to provide makeup to the Exelon ESP facility would have only a small effect on heat transfer from the CPS UHS pond and is insignificant when the actual CPS heat load, which is 55 percent of the design heat load, is considered.

To read:

The original design of the Ultimate Heat Sink pond for the CPS was based on the heat load from the shutdown of one unit under LOCA and one unit under LOOP with a total integrated heat load of 180,455 x 10^6 btu for 30 days. This heat load required a total of approximately 590 ac-ft of UHS water volume. The total CPS UHS requirement of 849 ac-ft also included 3 ac-ft for fire protection, 35 ac-ft for sedimentation due to a 100-yr flood and 221 ac-ft for sediment inflow during a Safe Shutdown Earthquake liquefaction event. The heat load for the single CPS unit constructed, with Power Uprate, is 99,973 x 10^6 btu for 30 days under LOCA or LOOP conditions. This value is approximately 55 percent of the CPS UHS Pond design heat load and requires only approximately 327 ac-ft of UHS water. Thus, the required capacity of the single uprated 1138.5 MWe Clinton Power Station is calculated to be 586 acre-ft. This includes the following:

CPS shutdown cooling (LOCA or LOOP) (lost to evaporation)	327 ac-ft
Fire protection	3 ac-ft
Sedimentation due to 100-yr flood	35 ac-ft
Sediment inflow during SSE liquefaction	221 ac-ft

Therefore, with 87 ac-ft required for shutdown of the ESP Facility, the CPS UHS has 394 ac-ft available for sediment accumulation. Recent (1991 through 2004) sediment accumulation reports indicate a general accumulation of approximately 4.85 ac-ft per year, which would allow many years of operation before dredging would be required.

4. Revise SSAR (Rev. 0) Chapter 2, Section 2.4.11.6, last paragraph, from:

The CPS UHS pond is monitored for sediment accumulation periodically and after a major flood passes through the cooling lake (CPS, 2002). After the EGC ESP Facility is constructed, the allowable sedimentation accumulation in the CPS UHS pond may be decreased. For example, an allowable post-1991 dredging sedimentation accumulation of approximately 118 ac-ft would continue to support the largest anticipated additional capacity requirements.

To read:

The CPS UHS pond is monitored for sediment accumulation periodically and after a major flood passes through the cooling lake (CPS, 2002). Sediment will be removed as necessary during operation of the ESP Facility to maintain an adequate volume of cooling water.

ATTACHMENTS:

None