From: <eddie.grant@exeloncorp.com>
To: <jps1@nrc.gov>
Date: 4/26/05 3:38PM
Subject: DSER OI Response

John Segala
Attached is your copy of the response to the remaining DSER Open Items that is being mailed today.

Thanks,
Eddie R. Grant
Early Site Permit Project
610.765.5001 voice
610.765.5755 fax
850.598.9801 cell

CC: <thomas.mundy@exeloncorp.com>

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Subject: DSER OI Response
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Created By: eddie.grant@exeloncorp.com

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thomas.mundy CC

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52.17

April 26, 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: Response to Draft Safety Evaluation Report (DSER) Items

Re: 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 4, 2005, Partial Response to Draft Safety Evaluation Report (DSER) Items

Enclosed, as requested in the referenced letter, are responses to the open items identified in the subject DSER for the Exelon Generation Company, LLC (EGC) ESP. Many responses were previously provided in Reference 2. The first enclosure to this letter provides the remaining responses. Also provided in the enclosures is information related to the proposed permit conditions, the proposed action items that would need to be addressed in a combined license (COL) application that references the ESP, and the proposed site characteristics. In general, EGC requests the NRC to establish objective criteria as a basis for these items and utilize the criteria during reconsideration of the proposed permit conditions, COL action items, and site characteristics. EGC would be pleased to work with the NRC staff in the development of such appropriate criteria.

Please contact Eddie Grant of my staff at 610-765-5001 if you have any questions regarding this submittal.

Sincerely yours,

Marilyn C. Kray
Vice President, Project Development

TPM/erg

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

Enclosures

AFFIDAVIT OF MARILYN C. KRAY

State of Pennsylvania

County of Chester

The foregoing document was acknowledged before me, in and for the County and State aforesaid, by Marilyn C. Kray, who is Vice President, Project Development, of Exelon Generation Company, LLC. She has affirmed before me that she 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 her knowledge and belief.

Acknowledged and affirmed before me this 26th day of April, 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

This letter provides responses to the following DSER Open Items.

DSER Open Item 2.1-1

DSER Open Item 2.3-2

DSER Open Item 2.4-1

DSER Open Item 2.4-2(a)

DSER Open Item 2.4-2(b)

DSER Open Item 2.4-9

DSER Open Item 2.4-11

DSER Open Item 2.4-14

DSER Open Item 2.4-15

DSER Open Item 2.4-16

DSER Open Item 2.4-17

DSER Open Item 2.4-19

DSER Open Item 13.3-3

DSER Open Item 13.3-5

DSER Open Item 13.3-6

NRC Letter Dated: 02/10/2005

NRC DSER Open Item 2.1-1

Demonstrate that the applicant has the legal right to control the exclusion area, or has an irrevocable right to obtain such control.

EGC RAI ID: SOI1-1

EGC RESPONSE:

The NRC indicates, in DSER Section 2.1.2.3, that "To meet the exclusion area control requirements of 10 CFR 100.21(a), "Non-Seismic Site Criteria," and 10 CFR 100.3, the applicant does not need to demonstrate total control of the property before issuance of the ESP. However, the applicant must provide reasonable assurance that it can acquire the land (i.e., that it has the legal right to obtain control of the exclusion area). The applicant should demonstrate that it has the legal right to control the exclusion area or has irrevocable right to obtain such control. Specifically, the applicant should provide a detailed explanation of the corporate relationship between Exelon (the parent company) and AmerGen (the subsidiary).

As indicated in the Administrative Information document included in the EGC ESP application, AmerGen is the licensed owner and operator of Clinton Power Station. AmerGen is a wholly-owned subsidiary of the applicant, Exelon Generation Company, LLC (EGC). EGC is a wholly-owned subsidiary of Exelon Ventures Company, LLC, which in turn is a wholly-owned subsidiary of Exelon Corporation.

Additionally, the AmerGen Management Committee, which has the authority to manage AmerGen, authorized AmerGen's officers to negotiate all necessary agreements to support EGC with its ESP application, which may include, without limitation, a long-term interest in the real estate that is the subject of the ESP application and an exclusion area agreement. A copy of the AmerGen resolution is provided as Attachment OI 2.1-1A.

Finally, it should be recognized that there is a pending merger of Exelon Corporation (the ultimate parent company of both AmerGen and EGC) and Public Service Enterprise Group (PSEG) and the subsequent restructuring of the merged companies. Under the merger agreement, the two companies will combine to create Exelon Electric & Gas Corporation (EEG). As a result of the merger, AmerGen will remain a wholly-owned subsidiary of EGC; EGC will remain a wholly-owned subsidiary of Exelon Ventures; and Exelon Ventures will become a wholly-owned subsidiary of EEG. AmerGen will continue to be the owner of the Clinton Power Station and the associated property. The relationship of AmerGen and EGC will not be affected by the merger, and the authorization of the AmerGen officers to support the EGC ESP application will also not be affected.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

1. Revise Administrative Information, Chapter 1, Section 1.1, third paragraph, fourth sentence, from:

In December of 1999, the CPS was sold by the Illinois Power Company to AmerGen Energy Company, (AmerGen), LLC, a joint venture of EGC (as assignee of PECO Energy Company [PECO]) and British Energy, of Edinburgh, Scotland).

To read:

In December of 1999, the CPS was sold by the Illinois Power Company to AmerGen Energy Company, (AmerGen), LLC, of which EGC is now (2005) the sole owner.

2. Revise Administrative Information, Chapter 3, Section 3.3, second paragraph, last sentence, from:

AmerGen is a joint venture of EGC (as assignee of PECO) and British Energy, of Edinburgh, Scotland.

To read:

AmerGen was created in 1997 as an equally owned venture of EGC (as assignee of PECO) and British Energy, of Edinburgh, Scotland. In December 2003, EGC purchased British Energy's fifty percent interest and became the sole owner of AmerGen.

3. Revise Administrative Information, Chapter 3, Section 3.4.2, to add a new second paragraph, which reads:

There is a pending (2005) merger of Exelon Corporation (the ultimate parent company of both AmerGen and EGC) and Public Service Enterprise Group (PSEG) and the subsequent restructuring of the merged companies. Under the merger agreement, the two companies will combine to create Exelon Electric & Gas Corporation (EEG). As a result of the merger, AmerGen will remain a wholly-owned subsidiary of EGC; EGC will remain a wholly-owned subsidiary of Exelon Ventures; and Exelon Ventures will become a wholly-owned subsidiary of EEG. AmerGen will continue to be the owner of the Clinton Power Station and the associated property. The relationship of AmerGen and EGC will not be affected by the merger, and the authorization of the AmerGen officers to support the EGC ESP application will also not be affected.

4. Revise Administrative Information, Chapter 3, Section 3.4.6, third paragraph, from:

Finally, the EGC will acquire whatever other rights, control and access necessary to effectuate the objectives of this ESP application, including access to riparian, transmission, and other rights as deemed necessary pursuant to an ESP granted in furtherance of this application.

To read:

The AmerGen Management Committee, which has the authority to manage AmerGen, authorized AmerGen's officers to negotiate all necessary agreements to support EGC with its ESP application, which may include, without limitation, a long-term interest in the real estate that is the subject of the ESP application and an exclusion area agreement.

Finally, the EGC will acquire whatever other rights, control and access necessary to effectuate the objectives of this ESP application, including access to riparian, transmission, and other rights as deemed necessary pursuant to an ESP granted in furtherance of this application.

ATTACHMENTS:

OI 2.1-1A (AmerGen Resolution)

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:

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 1065 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 1065 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 Chapter 1, Tables 1.4-1, to include the following new section:

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

2. Revise SSAR 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 2.4-1

Define the extent of the vertical disturbance and the bounding elevations of all structures, systems, and components (SSCs). Additionally, SSAR Figure 1.2-4 does not identify either the elevations or the areal locations of the safety-related piping corridors. Since the intake pumps for the ESP facility UHS makeup water are safety-related structures, the applicant must state whether it covers these through the site grade specified in the PPE or proposes separate criteria for these structures.

EGC RAI ID: SOI1-5

EGC RESPONSE:

The NRC indicates, in DSER Section 2.4.1.3, that “the applicant… provided no information on the elevations required to define the bounding volume of the disturbed subsurface material. Therefore, the applicant should define the extent of the vertical disturbance and the bounding elevations of all SSCs. Additionally, SSAR Figure 1.2-4 does not identify either the elevations or the areal locations of the safety-related piping corridors. Since the intake pumps for the ESP facility UHS makeup water are safety-related structures, the applicant should state whether it covers these through the site grade specified in the PPE or proposes separate criteria for these structures.”

The bounding foundation embedment (i.e., vertical disturbance) is 140 ft below grade (see SSAR Table 1.4-1, PPE section 1.1.2). Specific vertical disturbance and elevations for each SSC are dependent on the reactor design and thus, have not yet been determined. However, at 140 ft below grade the foundation basemat is a dense Illinoian glacial till. This material is considered very good foundation material and any further excavation would not be significant (e.g., as necessary for leveling). Additionally, the bounding elevation for structures within the power block is 234 ft above grade (see SSAR Table 1.4-1, PPE section 1.1.1). The tallest structure for the EGC ESP Facility would be a natural draft cooling tower(s) with a bounding elevation of 550 ft above grade if one is utilized (see SSAR Table 1.4-1, PPE section 2.5.8).

The UHS piping has not been designed since it is dependent on the reactor type selected and neither a UHS nor the piping is required for reactor plants using passive systems for cooling. The response to RAI 2.4.1-1 provided a general description of the location, and since the UHS makeup piping is routed above the CPS Shutdown Service Water discharge piping, which has a minimum elevation of 675 ft, the pipe would be installed between this elevation and the plant grade of 735 ft. Separation between the safety related CPS piping and the EGC SEP Facility piping will be determined by the COL applicant and the management of the existing CPS.

The ESP facility UHS makeup water structure (if one is needed) will be built at the edge of the lake (normal pool elevation 690 ft msl) approximately 65 ft south of the existing CPS intake facility structure. Therefore, the site grade of 735 ft msl identified in SSAR Section 2.4.1.1 is not pertinent for this structure. The response to RAI 2.4.7-3 provides a general description of the intake structure noting that the bottom of the intake basemat is expected to be located at elevation 657 ft-6 in. with the final elevation dependent upon the submergence required by the makeup pump, and an inlet from 670 ft to 697 ft msl. As indicated in the revised wording for SSAR Section 2.4.10 previously included with the response to RAI 2.4.3-8, at these elevations the ESP Facility UHS intake structure could be affected by the PMF and thus, will be designed to consider flood protection of the safety-related equipment located in the intake structure.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/10/2005

NRC DSER Open Item 2.4-2(a)

(a) Provide a schematic representation of the complete UHS system for a future facility on the ESP site, including the intake, piping, any potential storage basins, the UHS cooling loop, and the cooling tower(s), clearly showing all components and water flow including discharges through these components.

EGC RAI ID: SOI1-6

EGC RESPONSE:

The NRC indicates, in DSER Section 2.4.1.3, that "the applicant needs to provide a schematic representation of the complete UHS system for any future facility on the ESP site, including the intake, piping, any potential storage basins, the UHS cooling loop, and the cooling tower(s), clearly showing all components and water flow including discharges through these components."

SSAR Figure 3.2-1 is a schematic representation of the UHS system (if one is required) showing the major components and the direction of water flow (with the exception of blowdown). The design of the UHS is directly dependent on the reactor design to be built. The conceptual design identified in the EGC ESP SSAR was chosen to provide a bounding value for possible UHS makeup water needs. The associated intake structure is described in the response to DSER Open Item 2.4-10. As shown in the figure, each mechanical draft cooling tower will have a basin which provides the suction source to the ESW pumps. The basin depth will be based on the NPSH requirements for the ESW pumps. While the basin capacity will include sufficient water for initial operation, no credit has been assumed for the basin volume in calculating the required volume of makeup water for 30 days of operation. No additional basins are considered in this calculation.

The UHS cooling loop is shown schematically with the heat exchangers representing the equipment in the reactor supplier's specific design that requires cooling water from the UHS. The ESW flow (26,125 gpm normal, 52,250 gpm max) is given in the SSAR, Chapter 3, Section 3.2.2.2 and Table 1.4-1, Section 3.3.12. While the cooling tower blowdown is not shown on the schematic, the blowdown flow would be taken from the ESW pump discharge and is given as 144 gpm normal and 700 gpm max in the SSAR, Chapter 3, Section 3.2.2.2 and Table 1.4-1, Section 3.3.13. The makeup flow is 555 gpm during normal operation and 1400 gpm max (see Table 1.4-1, Section 3.3.9). The maximum makeup is associated with the maximum blowdown rate which is used only during periods when it is necessary to correct excursions in water chemistry, such as would occur when the blowdown is isolated for maintenance. The maximum values are not appropriate for determining the 30-day makeup requirements.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/10/2005

NRC DSER Open Item 2.4-2(b)

(b) Demonstrate that PPE make-up flow rate, an average of 555 gpm and a maximum of 1400 gpm, at the maximum inlet temperature of 95°F, is sufficient to remove all waste heat from the UHS cooling tower(s) and that there are no limits on plant operation due to limited water supply or due to elevated water temperatures at the UHS intake for any facility constructed on the ESP site.

EGC RAI ID: SOI1-7

EGC RESPONSE:

The NRC indicates, in DSER Section 2.4.1.3, that "the applicant needs to demonstrate that PPE makeup flow rate, an average of 555 gpm and a maximum of 1400 gpm, at the maximum inlet temperature of 95°F, is sufficient to remove all waste heat from the UHS cooling tower(s) and that there are no limits on plant operation due to limited water supply or due to elevated water temperatures at the UHS intake for any facility constructed on the ESP site."

The reactor suppliers provide the makeup flow rates (the bounding value is shown in the SSAR Table 1.4-1, Section 3.3.9), along with its components of evaporation from the cooling tower (SSAR Table 1.4-1, Section 3.3.7), which is the primary heat removal mechanism, and blowdown (SSAR Table 1.4-1, Section 3.3.4), which is used to control the cycles of concentration of impurities in the water. The PPE makeup flow value identified (1400 gpm) is associated with the maximum blowdown rate which is used only during periods when it is necessary to correct excursions in water chemistry, such as would occur when the blowdown is isolated for maintenance. This maximum value of 1400 gpm is not appropriate for determining the 30-day makeup requirements.

SSAR Section 2.4.8.1.5 and Table 1.4-1, Section 3.2.1, identify the CPS UHS maximum temperature is 95ºF. Therefore, the makeup to the EGC ESP UHS cooling tower will not exceed the required UHS cold-water temperature. The makeup is added to the water flowing over the fill, and therefore, since the makeup would be cooled in the UHS cooling tower (no credit is taken for this cooling), the proposed design is conservative.

The capability of the flow rate to remove the waste heat is a design issue that will be appropriately reviewed at the COL stage. The above-identified bounding PPE values were identified for the UHS as indicated in SSAR Section 3.2.2.2. The results of the evaluation of UHS makeup water volume need are based on these values and included in the UHS water availability tabulation provided in response to DSER Open Item 2.4-16.

During the review of this item, SSAR Sections 2.4.11.5 and 2.4.11.6 were determined to require revision as identified below.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

1. Revise SSAR Chapter 2, Section 2.4.11.5, last paragraph, from:

The Ultimate Heat Sink cooling function for the EGC ESP Facility is provided by the Essential Service Water Cooling Tower(s). The cooling tower(s) require makeup from Lake Clinton to replace the water lost due to the evaporative cooling process that takes place in the tower(s). The make up water requirements range from 250 gpm during normal operation up to a maximum of 700 gpm during a normal shutdown. The total makeup water requirements for post accident shutdown and cooldown for a 30 day period are approximately 2,860,000 cubic feet (21,392,800 gallons) which is a average makeup requirement of approximately 495.2 gpm over the 30 day period.

To read:

The Ultimate Heat Sink cooling function for the EGC ESP Facility is provided by the Essential Service Water Cooling Tower(s). The cooling tower(s) require makeup from Lake Clinton to replace the water lost due to the evaporative cooling process that takes place in the tower(s). The make up water requirements, for evaporation, range from 250 gpm during normal operation up to a maximum of 700 gpm during a normal shutdown. The total makeup water requirements for post accident shutdown and cooldown for a 30 day period are based on the evaporation rate (411 gpm per Table 1.4-1, PPE section 3.3.7) increased by 33% for blowdown and a 20% margin added, as described in SSAR section 2.4.8.1.5, which results in a make-up water quantity of 28,337,300 gallons for 30 days. This 30 day water requirement converts to 87 ac-ft which is an average makeup requirement of approximately 655.9 gpm over the 30 day period.

2. Revise SSAR Chapter 2, Section 2.4.11.6, second paragraph, from:

The existing CPS UHS pond is a submerged pond within Clinton Lake formed by the construction of a submerged dam across the North Fork channel. The existing CPS UHS pond is adjacent to the EGC ESP Facility intake structure where the make-up water pumps for the Essential Service Water (ESW) safety-related cooling tower(s), if required, will be located. The return (cold) water temperature from the safety related cooling tower(s) is a maximum of 94.7 °F based on a 10°F approach and a maximum wet bulb temperature of 84.7 °F. The blowdown from the safety-related cooling tower(s) is discharged to the existing discharge flume for the CPS Facility and no credit has been taken for the return of blowdown to the CPS UHS pond in determining its capability to supply water to the EGC ESP Facility.

To read:

The existing CPS UHS pond is a submerged pond within Clinton Lake formed by the construction of a submerged dam across the North Fork channel. The existing CPS UHS pond is adjacent to the EGC ESP Facility intake structure where the make-up water pumps for the Essential Service Water (ESW) safety-related cooling tower(s), if required, will be located. The return (cold) water temperature from the safety related cooling tower(s) is a maximum of 95 °F (SSAR Section 2.3.1.2.4). The blowdown from the safety-related cooling tower(s) is discharged to the existing discharge flume for the CPS

Facility and no credit has been taken for the return of blowdown to the CPS UHS pond in determining its capability to supply water to the EGC ESP Facility.

3. Revise SSAR Chapter 2, Section 2.4.11.6, sixth paragraph, from:

The amount of makeup water required to the EGC ESP Facility safety related Ultimate Heat Sink cooling tower(s) for a 30 day period was determined based on the reactor plant with the bounding Ultimate Heat Sink heat load for shutdown. The amount of water that will be evaporated to provide post accident shutdown cooling is 2,860,000 ft^3 of water. This water quantity was conservatively increased by 1/3 to provide an allowance for blowdown to limit the concentration of impurities in the cooling tower basin to four times the concentration in the Lake. This number is conservative since it would be expected that blowdown would be terminated during an accident and that normal operation would be at a higher concentration ratio than the assumed ratio of four.

To read:

The amount of makeup water required to the EGC ESP Facility safety related Ultimate Heat Sink cooling tower(s) for a 30 day period, 28,337,300 gallons, is defined in SSAR section 2.4.11.5 including blowdown equal to 0.33% of the evaporation which provides for operation with four cycles of concentration for the impurities in the makeup. This number is conservative since it would be expected that blowdown would be terminated during an accident and that normal operation would be at a higher concentration ratio than the assumed ratio of four.

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:

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. Details of these activities, including 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, are presented in Attachment PC 2.4-9A.

The evaluation established an expected maximum ice thickness of 24.8 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 1,065 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). 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 NRC Staff appears to have used a hypothetical starting date for ice accumulation that was a reasonable approximation, but not as accurate as the recorded data for a similar lake considerably north of Clinton Lake. The NRC Staff also 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, Chapter 2, Section 2.4.7, second paragraph (as revised in response to RAI 2.47-2), from:

Ice thickness calculations were completed for Clinton Lake for 26-years extending back from the 2003-2004 winter. The average thickness of sheet-ice calculated over that period is 14.2-inches. The maximum thickness calculated was in the 1978-1979 winter of 22.2-inches. The calculations did not consider the influence of heat discharge from the power plant. The thickness was estimated using the standard method from the U.S. Army Corps of Engineers (USACOE, 2002). The coefficient of ice cover condition used in the calculation was 0.80 with freezing degree days calculated for each year from temperature data from Decatur, Illinois (MRCC, 2004).

To read:

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).

2. Revise SSAR, Chapter 2, Section 2.4 References, to include the following new references:

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.

ATTACHMENTS:

OI 2.4-9A (Details of Ice Thickness Calculations)

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:

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 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). 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 a smaller excess capacity than if the ice were 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 2.4-14

Provide the volume requirements of the UHS for the CPS taking into consideration the latest power uprate.

EGC RAI ID: SOI1-19

EGC RESPONSE:

The NRC indicates, in DSER Section 2.4.8.3, that the "applicant needs to provide the volume requirements of the UHS for the CPS taking into consideration the latest power uprate."

The required capacity of the single uprated 1138.5 MWe Clinton Power Station is calculated to be 586 acre-ft. This is based on a heat load of 99,973 million BTUs as provided in SSAR Section 2.4.11.6 and 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
Total	586 ac-ft

CPS shutdown cooling value of 327 ac-ft is based on a best estimate of single unit needs after uprate. This value is obtained by multiplying the 590 ac-ft needed for both units to shutdown by the ratio of the shutdown heat load for one unit and the shutdown heat load for the two units (99,973 BTU / 180,455 BTU).

ASSOCIATED EGC ESP APPLICATION REVISIONS:

1. Revise SSAR, Chapter 2, Section 2.4.8.1.5, fifth paragraph, last sentence (as revised in response to RAI 2.4.8-2), from:

The minimum UHS volume of 849 acre-feet of water, based on the 30-day emergency shut down of the two 992 MWe units is more than sufficient for the existing single uprated 1138.5 MWe CPS Facility.

To read:

The minimum UHS volume of 849 acre-feet of water, based on the 30-day emergency shut down of the two 992 MWe units is more than sufficient for the existing single uprated 1138.5 MWe CPS Facility and any ESP Facility UHS makeup requirements. See Section 2.4.11.6 for additional details.

2. The associated SSAR revisions for Section 2.4.11.6 are included with the response to DSER Open Item 2.4-16.

ATTACHMENTS:

None

NRC Letter Dated: 02/10/2005

NRC DSER Open Item 2.4-15

Address the staff's conclusion that the applicant has not adequately established the rationale for using the 5-year drought duration as opposed to a shorter duration drought with a significantly lower inflow estimate.

EGC RAI ID: SOI1-20

EGC RESPONSE:

The NRC indicates, in DSER Section 2.4.8.3, that "the applicant described an analysis of changes in pool elevation resulting from droughts of 5-year duration with a recurrence period of 50 and 100 years. The applicant did not provide a basis for selecting the 5-year duration drought over a shorter drought duration which would provide much lower inflow, albeit for a shorter duration. The staff, based on an independent reading of the report from an earlier study conducted by the Illinois State Water Survey that the applicant used as the basis for the assumed low-flow conditions, concluded that a drought period of shorter duration with the same recurrence period could result in considerably more challenging conditions for lake level. For instance, based on data in the report for the Rowell gauge on Salt Creek, using a recurrence interval of 40 years, the inflows (expressed as area averaged runoff) for the 1-year drought and 5-year drought are approximately 1 in. and 23 in., respectively. The applicant relied on the CPS USAR as the basis for its values of natural evaporation and precipitation. It performed the analysis using a spreadsheet calculation and provided the spreadsheet as Attachment C with its responses to RAIs 5.2-1 and 5.2-2 generated from the staff's review of the applicant's ER. The staff reviewed the applicant's narrative response to RAI 2.4.8-3, the associated spreadsheet calculations, and the Illinois State Water Survey report on low flows of Illinois streams. The staff concluded that the applicant needs to provide a rationale for using the 5-year drought duration as opposed to a shorter duration drought with a significantly lower inflow estimate."

The 5-year duration was used to evaluate the Clinton Lake in the original lake study and the more recent evaluation for the uprated plant. For consistency, the same duration was used for the current ESP application. Review of the duration indicates that it continues to be an appropriate duration for the Clinton Lake watershed rather than a shorter duration drought with a significantly lower inflow estimate.

The storage volume in Clinton Lake is large enough that short duration droughts of one to two years do not create a critical situation. For example, a simple mass-balance calculation has shown that with zero inflow (a situation that has never occurred) applied continuously, the lake will take approximately 20 months to drop from an initial water surface elevation of 690 feet to the minimum level of 677 feet. If we assume an extreme short term low inflow or drought value of 0.04-inches of runoff apply uniformly for every month of the year, the lake can support normal plant operation for 29 months.

Review of the inflow values associated with the current 5-year duration indicates that shorter duration droughts are embedded in the 5-year duration drought used in the analysis. CPS USAR Table 2.4-24 shows the 5-year duration 50-year drought that was used for the current ESP application. The first 1-year of the 5-year analysis has a cumulative runoff volume of 0.85 inches. This is very close to the 45-year recurrence interval volume of 0.91 inches shown on Table 4 of the Stall document (Stall, 1964). Thus, the 1-year duration 50-year recurrence interval drought has been accounted for or embedded in the first year of the five-year duration 50-year recurrence interval drought. Similarly it can be seen that the first 2-years of the 5-year analysis has a cumulative runoff volume of 4.90 inches in the CPS USAR table compared to 4.94 inches in the Stall document. Thus, it can be seen that the shorter 1-year and 2-year durations are embedded in the 5-year duration 50-year recurrence interval drought. Finally, the total 5-year duration of the analysis has a cumulative runoff volume of 24 inches in the CPS USAR table compared to 23-inches in the Stall document. The same comparisons and conclusion are valid for the 100-year recurrence interval drought that was also used in the ESP drought analysis.

Regarding the 1-inch and 23-inch values referred to in DSER Section 2.4.8.3, it appears that the NRC reviewer was referring to the same flow values that the applicant used from Table 4 of the Stall document but the reviewer did not consider that these are cumulative flow values for the "given flow period" of 1-year and 5-years respectively. The cumulative annual inflows (expressed as area averaged runoff) for the 1-year duration and 5-year duration droughts are approximately 1 in. and 4.6-inches, respectively.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

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:

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##	300 ac-ft
- Available for sediment accumulation	421 ac-ft

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

This value is actually greater than the estimated excess capacity without ice cover.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

1. Revise SSAR, Chapter 2, to add new Section 2.4.7.2, Impact on UHS Volume:

2.4.7.2, Impact on UHS Volume

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.

2. Revise SSAR, 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, 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, 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

NRC Letter Dated: 02/10/2005

NRC DSER Open Item 2.4-17

Establish the monitoring and dredging needs for the UHS pond for the combined operation of the CPS facility and a future facility consistent with the PPE parameter for maximum thermal discharge.

EGC RAI ID: SOI1-22

EGC RESPONSE:

The NRC indicates, in DSER Section 2.4.8.3, that the "applicant stated that it monitors the CPS UHS for sediment accumulation periodically and after a major flood passes through the submerged UHS pond. The applicant committed to perform necessary dredging to prevent the accumulation of sediment from exceeding the capacity provided for sediment storage in the design. The staff will evaluate the applicant's response to open items listed in this section to consider the adequacy of submerged UHS pond monitoring and dredging. The pond monitoring and dredging frequencies may need to be included as a permit condition. The applicant needs to establish the monitoring and dredging needs for the UHS pond for the combined operation of the CPS facility and a future facility consistent with the PPE parameter for maximum thermal discharge."

The NRC staff appears to have confused the actions of the ESP applicant and those of the CPS operators. The applicant does not monitor the CPS UHS for sediment accumulation, but the CPS operators do. Further, the applicant did not commit to dredging the CPS UHS. The ESP stage is inappropriate for establishing operational requirements since the UHS volume may not even be needed for the ESP Facility (as some designs under consideration do not require a water cooled UHS).

Further, the monitoring reports from 1991 to 2004 show a nominal reduction of 63 acre-ft (1054 – 991) of storage capacity in the UHS over the 13-year period. This is a loss rate of approximately 4.85 acre-ft per year. With a single uprated 1138.5 MWe plant (requiring 586 acre-ft) and a new EGC ESP Facility added (requiring 87 acre-ft), the design storage capacity provides 394 acre-ft for sediment accumulation (see response to DSER Open Item 2.4-16). With this excess capacity and the same sediment rate of 4.85 acre-ft per year, the UHS would require dredging every 81 yrs. Thus, no specific frequency is proposed. Rather the need for dredging will be evaluated at the COL stage based on the final design of the ESP Facility and the results of the CPS UHS sedimentation monitoring reports.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

The associated SSAR revisions for Section 2.4.11.6 are included with the response to DSER Open Item 2.4-16.

ATTACHMENTS:

None

NRC Letter Dated: 02/10/2005

NRC DSER Open Item 2.4-19

Explain why the limited data used to estimate the three values required to calculate the average ground water velocity represent a basis for a velocity estimate. Provide values for the hydraulic gradient, saturated hydraulic conductivity, and effective porosity measured at the ESP site.

EGC RAI ID: SOI1-24

EGC RESPONSE:

The NRC indicates, in DSER Section 2.4.12.3, that "the applicant estimated the average ground water velocity as follows:

Velocity = Hydraulic Gradient x Saturated Hydraulic Conductivity / Effective Porosity

While the staff agrees that the equation is technically accurate, the applicant used very limited data to estimate the three values required to estimate the velocity. Based on one of two field permeability tests, the applicant selected the higher of the two values, $2.6x10^{-6}$ ft/d. For the porosity value, only one value (25 percent) was available for the Wisconsinan Till. The hydraulic gradient value (0.086) was based on the maximum head loss from the site to the floodplain of the North Fork of Salt Creek. The applicant should explain why such limited data represent a basis for a velocity estimate. In addition, the applicant should provide values for the hydraulic gradient, saturated hydraulic conductivity, and effective porosity measured at the ESP site."

A geotechnical investigation was conducted in July and August 2002 within the footprint of the EGC ESP Facility (see SSAR, Appendix A, Chapter 5). As discussed in Section 2.4 (see Sections 2.4.13.1.3 and 2.4.13.2.3) and Section 2.5 (see Sections 2.5.1.2, 2.5.4.2, and 2.5.4.3), the results of this investigation indicated that the general stratigraphic sequence, groundwater elevations, and geotechnical conditions (i.e., the soil properties) were consistent with those reported for the previous CPS investigations. Thus, the CPS data are considered representative of site conditions.

The estimated groundwater velocity calculated in Section 2.4.13.2.3 is based on the maximum hydraulic gradient on 0.086 ft/ft and the maximum measured hydraulic conductivity for the Wisconsian till of $2.6x10^{-6}$ cm/s (see Table 2.4-19). The values utilized represent the highest values of the gradient and hydraulic conductivity reported in the CPS USAR and were selected to provide a conservatively high velocity for the groundwater system that would represent the worst-case for potential releases to Clinton Lake. The investigations for the CPS, as summarized in the CPS USAR, indicate that the magnitude of the hydraulic gradient at the plant site is approximately 0.086 ft/ft (or 454 ft/mi). The gradient was based upon a maximum head loss of 55 ft over a minimum distance of 640 ft from the site to the edge of the floodplain of North Fork of Salt Creek. The impoundment increased the base level from the North Fork of Salt Creek to the pool elevation of 690 feet msl, causing the groundwater-surface water interface to shift to the southeast toward the plant. The establishment of the higher base level closer to the plant also resulted in a reduced hydraulic gradient (CPS, 2002).

In addition, the piezometer measurements before and after the impoundment (see USAR Figures 2.4-39 through 2.4-43 and 2.4-48 through 2.4-50), show that the lake filling did not cause substantial readjustment of the groundwater water levels upstream of the dam (CPS 2002). Because the impoundment of the lake did not significantly impact the water levels, the maximum head loss reported in the CPS USAR would result in the highest groundwater velocity from the facility to Clinton Lake.

The calculation of groundwater velocity also utilized the physical aquifer properties (hydraulic conductivity of 2.6×10^{-6} cm/s and an effective porosity of 0.25) collected during the CPS investigations (see SSAR Table 2.4-19). Although the data for the Wisconsinan till are limited to a few measurements, the values used were relatively consistent with the field and laboratory measurements for the other till samples (Illinoian Tills) collected during the CPS investigations, and thus, are considered to be representative of the site.

As required by 10 CFR 100.20(c)(3), the above site measured factors were utilized to determine the velocity of 2.5×10^{-3} ft/d as identified in SSAR section 2.4.13.2.3.

$$2.5\times10^{-3} \text{ ft/d} = 0.086 \text{ ft/ft} \times (2.6\times10^{-6} \text{ cm/s}^{*} \times 2835 \text{ ft/day/cm/s}) / 0.25$$

Note * (The units for a hydraulic conductivity of 2.6×10^{-6} are cm/s, not ft/d as identified in the DSER. This value converts roughly to 0.01 ft/d.)

Additional hydrogeologic data (i.e., water level data) will also be collected as part of the COL pre-construction monitoring program and used to verify the hydraulic gradient, flow directions, and groundwater velocity (if these parameters are needed for COL evaluations).

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/10/2005

NRC DSER Open Item 13.3-3

Address the adequacy of the OSC, TSC, and EOF, and related equipment, in support of emergency response, and address with specificity such facility and equipment areas as location, size, structure, function, habitability, communications, staffing and training, radiological monitoring, instrumentation, data system equipment, power supplies, technical data and data systems, and record availability and management.

EGC RAI ID: SOI1-30

EGC RESPONSE:

The NRC indicates, in DSER Section 13.3.3.9.3, that "the applicant provides general descriptions of the OSC, TSC, and EOF and equipment. With regard to RAI 13.3-12, in order for the staff to determine whether major feature H is acceptable, the applicant needs to address the adequacy of the facilities and related equipment in support of emergency response, and to address with specificity, such facility and equipment areas as location, size, structure, function, habitability, communications, staffing and training, radiological monitoring, instrumentation, data system equipment, power supplies, technical data and data systems, and record availability and management."

As indicated in our response to RAI 13.3-12, the EGC ESP addresses Evaluation Criterion V.H.1 of Supplement 2 to NUREG-0654/FEMA-REP-1 in Section 8.1 of the Emergency Plan (EP) and provides the EGC ESP discussion of the major features of the TSC and OSC. Because the Combined License (COL) Application is expected to reference a certified design that has already addressed the details of the design of these facilities, the ESP does not include these details. The specific designs vary and thus, providing these details in the ESP could result in discrepancies with the to-be-selected certified design. The COL application will address any details not included in the combined to-be-referenced ESP and Design Certification Document.

Similarly, Section 8.2 of the Emergency Plan provides the EGC ESP discussion of the major features of the EOF to address Evaluation Criterion V.H.2 of Supplement 2 to NUREG-0654/FEMA-REP-1. As indicated in Section 8.2, the EGC ESP facility intends to use the existing common EOF currently located in the Exelon Cantera Facility in Warrenville, IL. This facility supports the existing Clinton unit as well as other existing units in Illinois and has been previously approved as an acceptable centralized EOF as addressed in SECY-02-0033 and its associated Commission Staff Requirements Memorandum. Since the EOF is already established to support numerous nuclear facilities, the only impact is incorporating the appropriate documents and any necessary communication inputs. Thus, including the EGC ESP facility in the existing EOF is expected to have minimal impact. Completion of the activities associated with these impacts will occur at the COL stage and these and other NUREG-0696 criteria can be readily confirmed by inspection at that time (consistent with the process utilized for the previously licensed facilities).

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/10/2005

NRC DSER Open Item 13.3-5

Provide information related to protective measures in State and local emergency plans and address the review of the draft ETE submitted by State and local organizations involved in emergency response for the site.

EGC RAI ID: SOI1-32

EGC RESPONSE:

The NRC indicates, in DSER Section 13.3.3.11.3, that the staff needs for information related to protective measures in State and local emergency plans includes "a description of the State and local governments' concepts for using the traffic capacities of evacuation routes for implementing protective measures, a description of the State and local organizations' concepts for using ETEs when considering the evacuation of various sectors and distances, and a description of the IDNS SOPs that relate to the basis for choosing a recommended protective action for the plume exposure pathway."

The highway traffic capacities identified in the ETE are considered a tool for developing the State and local plans and procedures, but it is not a critical consideration during protective-action decision-making. The state's Protective Action Recommendations (PARs) to localities are based primarily on reactor conditions and predictive modeling with the aim of implementing pre-emptive protective actions before any radioactive release occurs. Thus, the projected timeframe (i.e., the ETE) for a given scenario is of less concern than the actual environmental conditions that might exist at the time of the emergency. Evacuation routes are pre-designated in the plans and public information materials, taking into account the various scenarios for wind direction and sub-area designations.

There are provisions for adjusting the evacuation routes during an actual emergency or an exercise. For example, IPRA, Volume VIII, Chapter 2, Section J, indicates that the specific evacuation routes are determined through coordination of the DeWitt County EOC and IEMA, and local officials then arrange the traffic and access control posts (see subsection J.3.b and J.3.d). Under actual (and exercise) emergency conditions, the state and localities adjust the available and desirable routes to the current circumstances, using traffic and access control points to divert evacuees to the appropriate routes so as to avoid traffic moving within and across the plume path, and to avoid impediments. These techniques are demonstrated during FEMA-evaluated exercises. There are no specific directions or procedures for these techniques because the conditions under which the action would be taken are dictated by circumstances and the knowledge of the local officials of the road networks in their communities.

The original response to NRC RAI No. 13.3-14 (submitted October 7, 2004) indicated that "each comment resulting in an adaptation of the ETE was appropriately included in the final version of the ETE." This was intended to reflect that the draft ETE was provided to the State organizations involved in emergency response for the site for comment, that the State provided comments on the draft ETE, and that these comments were appropriately incorporated into the final ETE delivered to the State.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/10/2005

NRC DSER Open Item 13.3-6

Provide a description of State and local organizations' means for radiological decontamination of emergency personnel wounds, supplies, instruments, and equipment.

EGC RAI ID: SOI1-33

EGC RESPONSE:

The NRC indicates, in DSER Section 13.3.3.12.3, that the staff needs for information related to "how the State will acquire and distribute dosimeters, both direct-reading and permanent record devices. Also, the staff needs additional information related to the State and local organization-specific action levels for determining the need for decontamination of emergency workers, equipment and vehicles, and the general public and their possessions. The staff also needs a description of State and local organizations' means for radiological decontamination of emergency personnel wounds, supplies, instruments, and equipment."

The State (IEMA) maintains a statewide inventory of approximately 9,000 direct-read dosimeters and approximately 9,000 LDs (for permanent record). Over ninety per cent of this inventory is pre-positioned (pre-distributed) with the response organizations identified in the plan for distribution to emergency workers when an emergency is declared. For example, dosimetry control actions for various groups are described under the "Parallel Actions" discussions in the IPRA, Volume VIII, Sections D.1, D.2, D.3, D.4, D.5, and O.1. Included with the dosimetry is an individual 14-day supply of potassium iodide (KI). The dosimetry is field tested and calibrated in accordance with FEMA guidance, and replaced when necessary. IEMA has the capability to "read' the LDs in the field and in-house for an initial dose determination, and a contract with the supplier to read the devices for a certified record.

The contamination "Action Level" is defined in IEMA procedures as "twice-background". The State reserves the right to make case-by-case determinations on whether equipment, vehicles, and personal possessions can be released with contamination levels above the twice-background threshold, e.g., critical emergency equipment, fixed contamination, etc.

The "means" for radiological decontamination are also embodied in IEMA's operational procedures and are part of the process associated with monitoring evacuees and emergency workers. Evacuees are directed to Reception Centers where monitoring occurs either by or under the supervision of trained IEMA staff. These dedicated facilities have decontamination showers and designated areas outside for the decontamination of vehicles and other equipment. These same facilities would be available for use by emergency workers. (NOTE: The Radiological Accident Field Teams (RAFT) personnel dispatched to take plume measurements and collect environmental samples return to their independent operations center for monitoring and, if necessary, decontamination.)

The reference to "wounds" in the staff question relates to an of the availability of medical services. The standing procedures provide that anyone (evacuee or emergency worker) injured and potentially contaminated would be directed to a designed hospital for treatment and their “wounds” handled in accordance with accepted contamination control protocols. If the patient originates at a Reception Center, IEMA would provide monitoring personnel to accompany the individual to the treatment facility. In any instance where a patient self-presents and the hospital is concerned about contamination issues, assistance can be requested from IEMA.

The IEMA functional instructions for establishing and operating an evacuee and emergency worker monitoring and decontamination center and for dealing with potentially contaminated vehicles and other equipment are provided in Department of Nuclear Safety Standard Operating Procedures 4-SOP-29 and 4-SOP-30.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/10/2005

NRC DSER Permit Condition 2.4-1

Maintain a minimum horizontal clearance between the existing CPS piping and the new ESP facility piping of 50 feet.

EGC RAI ID: SPC1-1

EGC RESPONSE:

The need for clearance between the piping of the existing CPS unit and the new ESP Facility is not a site consideration that needs to be determined at the ESP stage. This would not be a condition applicable to the ESP holder, but it may be applicable to the COL holder during the design and construction of the new facility. The EGC position is that Permit Conditions should be limited to actions required of the ESP holder. Actions required by the COL holder should be addressed by COL Action Items, but only if they are not already required to be addressed by the regulations and associated guidance.

Notwithstanding the foregoing, a minimum horizontal clearance of fifty feet cannot be maintained between EGC ESP Facility piping and safety related CPS piping located below grade. As shown on the attached Figure 2.4-1, these two sets of piping are expected to cross.

Additionally, DSER Section 2.4.1.1 indicates the ESP Facility will have a UHS blowdown discharge similar to the CPS UHS which discharges to the CPS UHS. As shown in the attached figure, the ESP Facility discharges only to the normal outlet canal, not to the CPS UHS.

Based on the above, this is not an appropriate siting permit condition.

Based on the above, this is also not an appropriate COL Action Item.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

PC 2.4-1A (Cooling System Piping Figure)

NRC Letter Dated: 02/10/2005

NRC DSER Permit Condition 2.4-2

Maintain a minimum vertical clearance between the existing CPS piping and the new ESP facility piping of 6.6 feet or 3 times the diameter of the pipes, whichever is larger.

EGC RAI ID: SPC1-2

EGC RESPONSE:

The need for clearance between the piping of the existing CPS unit and the new ESP Facility is not a site consideration that needs to be determined at the ESP stage. This would not be a condition applicable to the ESP holder, but it may be applicable to the COL holder during the design and construction of the new facility. The EGC position is that Permit Conditions should be limited to actions required of the ESP holder. Actions required by the COL holder should be addressed by COL Action Items, but only if they are not already required to be addressed by the regulations and associated guidance.

This item is already addressed by the regulations. For the operating unit, any safety concern would be addressed by the appropriate safety evaluation (e.g., 50.59) prior to beginning construction. Additionally, 10 CFR 52.79(b) and 10 CFR 50.34(b)(6)(vii) require the COL application *"for operating licenses for nuclear powerplants to be operated on multiunit sites shall include an evaluation of the potential hazards to the structures, systems, and components important to safety of operating units resulting from construction activities, as well as a description of the managerial and administrative controls to be used to provide assurance that the limiting conditions for operation are not exceeded as a result of construction activities at the multiunit sites."* Thus, as required by regulations, pipe routing clearances will be addressed both by the COL applicant and by the existing facility operator.

Based on the above, this is not an appropriate siting permit condition.

Based on the above, this is also not an appropriate COL Action Item.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/10/2005

NRC DSER Permit Condition 2.4-3

Design the ESP facility's intake structures to withstand the combined effects of PMF, coincident wind wave activity, and wind setup, as discussed in Section 2.4.3 of this SER.

EGC RAI ID: SPC1-3

EGC RESPONSE:

The design of the ESP intake structure for the new facility is not a site consideration that needs to be determined at the ESP stage. This would not be a condition applicable to the ESP holder, but it may be applicable to the COL holder during the design of the new facility. The EGC position is that Permit Conditions should be limited to actions required of the ESP holder. Actions required by the COL holder should be addressed by COL Action Items, but only if they are not already required to be addressed by the regulations and associated guidance.

Notwithstanding the foregoing, the ESP facility intake structure may not be safety related if the chosen reactor facility design does not require a UHS or if the UHS can be designed with the necessary 30-day capacity. Thus, imposing specific design requirements is not appropriate at this stage.

Based on the above, this is not an appropriate siting permit condition.

Further, this item is already addressed by the regulations. 10 CFR 52.79(a)(1) requires that *"if the application references an early site permit, the application… must contain, in addition to the information and analyses otherwise required, information sufficient to demonstrate that the design of the facility falls within the parameters specified in the early site permit."* Thus, if a safety related intake is required, it's design will be addressed by the COL applicant to show compliance with the site characteristic of probable maximum flood effects, including coincident wind wave activity and wind setup, as identified in SSAR Section 2.4.

Based on the above, this is also not an appropriate COL Action Item.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/10/2005

NRC DSER Permit Condition 2.4-4

Demonstrate that the ESP site can discharge site drainage from local intense precipitation at the ESP site to Clinton Lake without relying on any active drainage systems that may be blocked during this event.

EGC RAI ID: SPC1-4

EGC RESPONSE:

The design of the ESP Facility drainage is not a site consideration that needs to be determined at the ESP stage. This would not be a condition applicable to the ESP holder, but it may be applicable to the COL holder during the design and construction of the new facility. The EGC position is that Permit Conditions should be limited to actions required of the ESP holder. Actions required by the COL holder should be addressed by COL Action Items, but only if they are not already required to be addressed by the regulations and associated guidance.

Notwithstanding the foregoing, while the local intense precipitation can be determined at the ESP stage, the site drainage capacity will be dependent on the design and layout of the facility and thus cannot be determined until the COL stage.

Based on the above, this is not an appropriate siting permit condition.

Further, this item is already addressed by the regulations. 10 CFR 52.79(a)(1) requires that *"if the application references an early site permit, the application… must contain, in addition to the information and analyses otherwise required, information sufficient to demonstrate that the design of the facility falls within the parameters specified in the early site permit."* Thus, site drainage will be addressed by the COL applicant to show compliance with the site characteristic of maximum rainfall rate identified in SSAR Section 2.4 (see response to DSER Open Item 2.4-8).

Based on the above, this is also not an appropriate COL Action Item.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/10/2005

NRC DSER Permit Condition 2.4-5

Demonstrate that the intake structure can withstand the effects of ice sheet crushing, bending, buckling, and splitting, or a combination of these modes.

EGC RAI ID: SPC1-5

EGC RESPONSE:

The design of the ESP intake structure for the new facility is not a site consideration that needs to be determined at the ESP stage. This would not be a condition applicable to the ESP holder, but it may be applicable to the COL holder during the design of the new facility. The EGC position is that Permit Conditions should be limited to actions required of the ESP holder. Actions required by the COL holder should be addressed by COL Action Items, but only if they are not already required to be addressed by the regulations and associated guidance.

Notwithstanding the foregoing, the ESP facility intake structure may not be safety related if the chosen reactor facility design does not require a UHS or if the UHS can be designed with the necessary 30-day capacity. Thus, imposing specific design requirements is not appropriate at this stage.

Based on the above, this is not an appropriate siting permit condition.

Further, this item is already addressed by the regulations. 10 CFR 52.79(a)(1) requires that *"if the application references an early site permit, the application… must contain, in addition to the information and analyses otherwise required, information sufficient to demonstrate that the design of the facility falls within the parameters specified in the early site permit."* Thus, if a safety related intake is required, it's design will be addressed by the COL applicant to show compliance with the site characteristic of the potential for ice identified in SSAR Section 2.4.

Based on the above, this is also not an appropriate COL Action Item.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/10/2005

NRC DSER Permit Condition 2.4-6

Maintain a minimum water temperature of 40°F at all times to preclude formation of frazil and anchor ice on the intake inlet.

EGC RAI ID: SPC1-6

EGC RESPONSE:

Operating restrictions for the ESP intake structure for the new facility is not a site consideration that needs to be determined at the ESP stage. This would not be a condition applicable to the ESP holder, but it may be applicable to the COL holder during the design of the new facility. The EGC position is that Permit Conditions should be limited to actions required of the ESP holder. Actions required by the COL holder should be addressed by COL Action Items, but only if they are not already required to be addressed by the regulations and associated guidance.

Notwithstanding the foregoing, the ESP facility intake structure may not be safety related if the chosen reactor facility design does not require a UHS or if the UHS can be designed with the necessary 30-day capacity. Thus, imposing specific design and operating requirements is not appropriate at this stage.

Based on the above, this is not an appropriate siting permit condition.

Further, this item is already addressed by the regulations. 10 CFR 52.79(a)(1) requires that *"if the application references an early site permit, the application… must contain, in addition to the information and analyses otherwise required, information sufficient to demonstrate that the design of the facility falls within the parameters specified in the early site permit."* Thus, if a safety related intake is required, it's design will be addressed by the COL applicant to show compliance with the site characteristic of the potential for frazil and anchor ice identified in SSAR Section 2.4.7.1 (see response to RAI 2.4.7-4).

Based on the above, this is also not an appropriate COL Action Item.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/10/2005

NRC DSER Permit Condition 2.4-7

Ensure that the UHS intake is located at an elevation of 668 feet MSL.

EGC RAI ID: SPC1-7

EGC RESPONSE:

The design of the ESP intake structure for the new facility is not a site consideration that needs to be determined at the ESP stage. This would not be a condition applicable to the ESP holder, but it may be applicable to the COL holder during the design of the new facility. The EGC position is that Permit Conditions should be limited to actions required of the ESP holder. Actions required by the COL holder should be addressed by COL Action Items, but only if they are not already required to be addressed by the regulations and associated guidance.

Notwithstanding the foregoing, the ESP facility intake structure may not be safety related if the chosen reactor facility design does not require a UHS or if the UHS can be designed with the necessary 30-day capacity. Thus, imposing specific design requirements is not appropriate at this stage.

Based on the above, this is not an appropriate siting permit condition.

Further, this item is already addressed by the regulations. 10 CFR 52.79(a)(1) requires that *"if the application references an early site permit, the application… must contain, in addition to the information and analyses otherwise required, information sufficient to demonstrate that the design of the facility falls within the parameters specified in the early site permit."* Thus, if a safety related intake is required, it's design will be addressed by the COL applicant to show compliance with the site characteristic of the lake minimum water level identified in SSAR Section 2.4.

Based on the above, this is also not an appropriate COL Action Item.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/10/2005

NRC DSER Permit Condition 2.4-8

Ensure that ground water is not used for either normal or safety-related plant operations.

EGC RAI ID: SPC1-8

EGC RESPONSE:

As indicated in the SAR Section 2.4.13.1.1, groundwater use is not planned for either normal or safety-related plant operations of the EGC ESP Facility. However, groundwater use is not a site consideration that needs to be determined at the ESP stage. This would not be a condition applicable to the ESP holder, but it may be applicable to the COL holder during the design of the new facility. The EGC position is that Permit Conditions should be limited to actions required of the ESP holder. Actions required by the COL holder should be addressed by COL Action Items, but only if they are not already required to be addressed by the regulations and associated guidance.

Notwithstanding the foregoing, there is no apparent reason to restrict groundwater use for all designs. Some designs, e.g., gas reactors, have very little if any potential for liquid releases and will not be dependent on site groundwater for release prevention. Other designs may be very deep and substantial groundwater level change could be accommodated without impacting the necessary gradient. Therefore, the basis for a permit condition with an operating restriction on groundwater use is not appropriate at this stage.

Based on the above, this is not an appropriate siting permit condition.

Further, this item is already addressed by the regulations. 10 CFR 52.79(a)(1) requires that *"if the application references an early site permit, the application… must contain, in addition to the information and analyses otherwise required, information sufficient to demonstrate that the design of the facility falls within the parameters specified in the early site permit."* Thus, the ESP Facility design will be addressed by the COL applicant to show compliance with the site characteristic of groundwater identified in SSAR Section 2.4.

Based on the above, this is also not an appropriate COL Action Item.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/10/2005

NRC DSER Permit Condition 2.4-9

Establish a monitoring plan to ensure maintenance of an inward-directed gradient for all credible water table conditions.

EGC RAI ID: SPC1-9

EGC RESPONSE:

The establishment of a groundwater-monitoring plan for the new facility is not a site consideration that needs to be determined at the ESP stage. This would not be a condition applicable to the ESP holder, but it may be applicable to the COL holder during the operation of the new facility. The EGC position is that Permit Conditions should be limited to actions required of the ESP holder. Actions required by the COL holder should be addressed by COL Action Items, but only if they are not already required to be addressed by the regulations and associated guidance.

First, a monitoring plan does not "ensure maintenance of an inward-directed gradient."

Second, the monitoring programs to be established to monitor groundwater levels are described in Section 2.4.13.4. However, intent to implement these programs should be confirmed by the COL applicant.

Notwithstanding the foregoing, there is no apparent reason to require monitoring for all designs. Some designs, e.g., gas reactors, have very little if any potential for liquid releases and will not be dependent on site groundwater for release prevention. Other designs may be very deep and substantial groundwater level change could be accommodated without impacting the necessary gradient. Therefore, the basis for a permit condition with an operating requirement for groundwater monitoring is not appropriate at this stage.

Based on the above, this is not an appropriate siting permit condition.

Further, this item is already addressed by the regulations. 10 CFR 52.79(a)(1) requires that *"if the application references an early site permit, the application… must contain, in addition to the information and analyses otherwise required, information sufficient to demonstrate that the design of the facility falls within the parameters specified in the early site permit."* Thus, the ESP Facility design will be addressed by the COL applicant to show compliance with the site characteristic of groundwater identified in SSAR Section 2.4.

Based on the above, this is also not an appropriate COL Action Item.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/10/2005

NRC DSER Permit Condition 2.4-10

Utilize a design in which radioactive liquid waste releases would not occur at any elevation greater than the minimum design water table elevation outside the facility.

EGC RAI ID: SPC1-10

EGC RESPONSE:

The design of the ESP facility is not a site consideration that needs to be determined at the ESP stage. This would not be a condition applicable to the ESP holder, but it may be applicable to the COL holder during the design, construction and operation of the new facility. The EGC position is that Permit Conditions should be limited to actions required of the ESP holder. Actions required by the COL holder should be addressed by COL Action Items, but only if they are not already required to be addressed by the regulations and associated guidance.

Notwithstanding the foregoing, there is no apparent reason to require this condition for all designs. Some designs, e.g., gas reactors, have very little if any potential for liquid releases and will not be dependent on site groundwater for release prevention. Therefore, the basis for a permit condition with an operating requirement for groundwater monitoring is not appropriate at this stage.

Based on the above, this is not an appropriate siting permit condition.

Further, this item is already addressed by the regulations. 10 CFR 52.79(a)(1) requires that *"if the application references an early site permit, the application… must contain, in addition to the information and analyses otherwise required, information sufficient to demonstrate that the design of the facility falls within the parameters specified in the early site permit."* Thus, the ESP Facility design will be addressed by the COL applicant to show compliance with the site characteristic of groundwater identified in SSAR Section 2.4.

Based on the above, this is also not an appropriate COL Action Item.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/10/2005

NRC DSER Permit Condition 3.2-1

Ensure that the maximum NPHS heat load during normal operation is $15.08x10^9$ Btu/hr.

EGC RAI ID: SPC1-11

EGC RESPONSE:

The value of $15.08x10^9$ Btu/hr is provided as the maximum NPHS heat load during normal operation in SSAR Table 1.4-1, PPE Section 2.3.2 and in SSAR Section 3.2.1.2. However, this value is for the normal heat sink, not the ultimate heat sink, and does not affect the safety analysis. Further, this value is identified in DSER Section 3.2.1.1 but no discussion is provided as to its significance with regard to the siting evaluation that might make it appropriate for a permit condition. The only discussions in the technical evaluation section are related to water level, not facility heat load, and the parameter does not appear to be limited by the site. Thus, this value is not appropriate for a siting permit condition.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/10/2005

NRC DSER Permit Condition 3.2-2

Ensure that the maximum NPHS discharge temperature during normal operation is 100ºF.

EGC RAI ID: SPC1-12

EGC RESPONSE:

The value of 100ºF is provided as the maximum NPHS discharge temperature during normal operation in SSAR Table 1.4-1, PPE Section 2.4.5 and in SSAR Section 3.2.1.2. However, this value is for the normal heat sink, not the ultimate heat sink, and does not affect the safety analysis. Further, this value is identified in DSER Section 3.2.1.1 but no discussion is provided as to its significance with regard to the siting evaluation that might make it appropriate for a permit condition. The only discussions in the technical evaluation section are related to water level, not temperature, and the parameter does not appear to be limited by the site. Thus, this value is not appropriate for a siting permit condition.

While reviewing this item, EGC identified the need for an update of this information in SSAR 3.2.1.2 that was inadvertently omitted from the response to RAI 2.4.1-8. This update of the maximum temperature (now 101ºF) is provided in the revisions identified below.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

Revise SSAR, Chapter 3, Section 3.2.1.2, third paragraph, from:

The discharge from cooling tower blowdown is normally 12,000 gpm with a maximum flow of 49,000 gpm. The temperature of the blowdown discharge to the existing CPS Facility discharge flume is 100°F maximum. The 100°F discharge temperature is based on a maximum wet bulb temperature of 85°F and a maximum cooling tower design approach of 15°F. The maximum wet bulb temperature that is exceeded less than 1% of the time is 77.2°F and the maximum wet bulb temperature based on weather data will be 84.7°F with corresponding blowdown temperatures of 92.2°F and 99.7°F with the maximum cooling tower approach of 15°F. The blowdown constituents and concentrations expected are listed below:

To read:

The discharge from cooling tower blowdown is normally 12,000 gpm with a maximum flow of 49,000 gpm. The temperature of the blowdown discharge to the existing CPS Facility discharge flume is 101ºF maximum. The 101ºF discharge temperature is based on a maximum wet bulb temperature of 86ºF and a maximum cooling tower design approach of 15ºF. The maximum wet bulb temperature that is exceeded less than 1% of the time is 78ºF and the maximum wet bulb temperature based on weather data will be 86ºF with corresponding blowdown temperatures of 93ºF and 101ºF with the maximum cooling tower approach of 15ºF. The blowdown constituents and concentrations expected are listed below:

ATTACHMENTS:

None

NRC Letter Dated: 02/10/2005

NRC DSER Permit Condition 3.2-3

Ensure that the maximum UHS load during normal operation is 411.4×10^6 Btu/hr.

EGC RAI ID: SPC1-13

EGC RESPONSE:

The value of 411.4×10^6 Btu/hr is provided as the maximum UHS heat load during shutdown operation in SSAR Table 1.4-1, PPE Section 3.2.2 and in SSAR Section 3.2.2.2. However, since any limitations on this parameter are determined by plant design and not by the site limitations, this value is not appropriate for a siting permit condition.

Further, this item is already addressed by the regulations. 10 CFR 52.79(a)(1) requires that *"if the application references an early site permit, the application… must contain, in addition to the information and analyses otherwise required, information sufficient to demonstrate that the design of the facility falls within the parameters specified in the early site permit."* Thus, the ESP Facility design will be addressed by the COL applicant to show compliance with the site characteristic of available UHS makeup water identified in SSAR Section 2.4.

Based on the above, this is also not an appropriate COL Action Item.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/10/2005

NRC DSER Permit Condition 3.2-4

Ensure that the maximum UHS discharge temperature during normal operation is 95 F.

EGC RAI ID: SPC1-14

EGC RESPONSE:

The value of 95ºF is provided as the maximum UHS discharge temperature in SSAR Table 1.4-1, PPE Section 3.3.5 and in SSAR Section 3.2.2.2. However, since any limitations on this parameter are determined by plant design and not by the site limitations, this value is not appropriate for a siting permit condition.

Further, this item is already addressed by the regulations. 10 CFR 52.79(a)(1) requires that *"if the application references an early site permit, the application… must contain, in addition to the information and analyses otherwise required, information sufficient to demonstrate that the design of the facility falls within the parameters specified in the early site permit."* Thus, the ESP Facility design will be addressed by the COL applicant to show compliance with the site characteristic of available UHS makeup water identified in SSAR Section 2.4.

Based on the above, this is also not an appropriate COL Action Item.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/16/2005

NRC DSER COL Action Item 2.1-1

Provide Universal Transverse Mercator coordinates for new unit(s) on the EGC ESP site.

Reason For Deferral – Exact UTM coordinates for new unit(s) will depend on specific reactor technology selected for deployment

EGC RAI ID: SAI1-1

EGC RESPONSE:

The COL application is already required by the regulations to address this action item. 10 CFR 52.79(b) requires *"the application must contain the technically relevant information required of applicants for an operating license by 10 CFR 50.34."* The Universal Transverse Mercator coordinates are typically required to be provided in the FSAR, as identified by Regulatory Guide 1.70 and the Standard Review Plan, NUREG-0800.

Based on the above, this is not an appropriate COL Action Item.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/16/2005

NRC DSER COL Action Item 2.1-2

Make arrangements with the appropriate local, State, Federal, or other public agencies to provide control of the portion of Clinton Lake that is within the exclusion area. These public agencies, together with the ESP holder, will need authority over these bodies of water sufficient to allow for the exclusion and ready removal, in an emergency, of any persons present on them.

Reason For Deferral – Such arrangements not required at ESP stage.

EGC RAI ID: SAI1-2

EGC RESPONSE:

The COL application is already required by the regulations to address this action item. 10 CFR 52.79(b) requires *"the application must contain the technically relevant information required of applicants for an operating license by 10 CFR 50.34."* The arrangements for control of the exclusion area are typically required to be provided in the FSAR, as identified by Regulatory Guide 1.70 and the Standard Review Plan, NUREG-0800.

Based on the above, this is not an appropriate COL Action Item.

However, should this Action Item be retained, the wording indicates that the public agencies, together with the ESP holder, will need the authority. Since the ESP holder will never actually need this authority, the COL Action Item should indicate that the public agencies, together with the COL holder, will need the authority.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/16/2005

NRC DSER COL Action Item 2.2-1

Evaluate design-specific interactions between the existing unit and new unit(s).

Reason For Deferral – New unit design and specific location not known at ESP stage

EGC RAI ID: SAI1-3

EGC RESPONSE:

Evaluation of the design-specific interaction of the existing unit on the new unit(s) will be provided in a COL application as necessary pursuant to 10 CFR 52.79(b) and 50.34(b). However, there are several concerns associated with this COL Action Item.

First, DSER §2.2.3.3 states: "Although the applicant cited the USAR's inventory of toxic chemicals, such quantities cannot be determined at the ESP stage without a precise set of plant-design parameters. Therefore, the staff cannot evaluate the potential effects of accidents on control room habitability at this time." While EGC agrees the potential effects of control room habitability cannot be evaluated at this time, the quantities in use at the existing unit that determines the hazard were identified and otherwise evaluated in SSAR sections 2.2.2.2 and 2.2.3.1. This set of hazards is not dependent on the ESP facility design parameters and the review of the identification of the hazards does not need to be delayed.

Second, it is unnecessary to identify this as a COL Action Item since it duplicates the COL application content expectations associated with the requirements of 10 CFR 52.79(b) and 50.34(b) as identified in the Standard Review Plan, NUREG-0800, Sections 2.2.3 and 6.4.

Finally, the evaluation of the design-specific interaction of the new unit(s) on the existing unit is the responsibility of the owner/operator of the existing unit. Since the COL applicant may not be the owner or operator of the existing unit, it is inappropriate to request the evaluation of the impact on the existing unit in a COL application. This evaluation would be conducted by the owner/operator of the existing unit, as necessary, pursuant to 10 CFR 50.59 and identified to the NRC under 10 CFR 50.71(e) or 50.90, as appropriate.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/16/2005

NRC DSER COL Action Item 2.3-1

Determine the 3-second gust wind speed based on the current applicable design standard.

Reason For Deferral – Applicant preference to define this characteristic based on standards in effect at time of COL application.

EGC RAI ID: SAI1-4

EGC RESPONSE:

The 3-second gust wind speed that represents a 100-year return period for the Clinton early site permit (ESP) site was identified in response to RAI 2.3.1-2 as 96 mph. EGC elects to identify this site characteristic value for the ESP stage rather than at the COL stage because the National Weather Service has phased out the measurement of fastest-mile wind speeds. The 3-second gust wind speed is based on the Structural Engineering Institute/American Society of Civil Engineers (SEI/ASCE) 7-98, "Minimum Design Loads for Buildings and Other Structures" (ASCE, 2000). Specifically, this design information was obtained from Figure 6-1 "Basic Wind Speed" from that reference. The wind speed obtained from Figure 6-1 for the Clinton ESP site area is 90 mph and is representative of the nominal design 50-year return 3-second gust at 10 meters above the ground. A correction of this value is provided in Table C6-3 "Conversion Factors for Other Mean Recurrence Intervals". The conversion factor for a 100-year return period is 1.07, resulting in a nominal design 3-second gust wind speed of 96 mph.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

1. Revise SSAR, Chapter 1, Table 1.4-1, from:

1.7.1	Basic Wind Speed	Note 1	75 mph	SSAR

To read:

1.7.1	Basic Wind Speed	Note 1	75 mph	SSAR
	OR			
	3-second Gust	Note 1	96 mph	SSAR

2. Revise SSAR, Chapter 1, Table 1.4-9, from:

1.7.1	Basic Wind Speed	mph	The design wind, or "fastest mile of wind" with a 100-year return period (NUREG-0800, Sections 2.3.1 and 3.3.1) for which the facility is designed.	Minimum

To read:

1.7.1	Basic Wind Speed	mph	The design wind, or "fastest mile of wind" with a 100-year return period (NUREG-0800, Sections 2.3.1 and 3.3.1) for which the facility is designed.	Minimum
	OR 3-second Gust	mph	The 3-second gust wind velocity per SEI/ASCE 7-98, associated with a 100-year return period, at 33 feet (10 m) above the ground level in the site area	Minimum

3. Revise SSAR, Chapter 2, Section 2.3.1.2.2, last paragraph, from:

A site characteristic wind velocity of 75 mph is established for the EGC ESP Site based on the peak wind speed observed at either Peoria or Springfield, IL as identified in Table 2.3-1. An importance factor of 1.11 is applied to this wind speed in the design of safety related structures.

To read:

A site characteristic wind velocity of 75 mph is established for the EGC ESP Site based on the peak wind speed observed at either Peoria or Springfield, IL as identified in Table 2.3-1. An importance factor of 1.11 is applied to this wind speed in the design of safety related structures. In addition, a site characteristic 3-second gust wind speed that represents a 100-year return period for the Clinton early site permit (ESP) site is established as 96 mph because the National Weather Service has phased out the measurement of "fastest-mile" wind speeds. The 3-second gust wind speed is based on the Structural Engineering Institute/American Society of Civil Engineers (SEI/ASCE) 7-98, "Minimum Design Loads for Buildings and Other Structures" (ASCE, 2000). Specifically, this design information was obtained from Figure 6-1 "Basic Wind Speed" from that reference. The wind speed obtained from Figure 6-1 for the Clinton ESP site area is 90 mph and is representative of the nominal design 50-year return 3-second gust at 10 meters above the ground. A correction of this value is provided in Table C6-3 "Conversion Factors for Other Mean Recurrence Intervals." The conversion factor for a 100-year return period is 1.07, resulting in a nominal design 3-second gust wind speed of 96 mph.

ATTACHMENTS:

None

NRC Letter Dated: 02/16/2005

NRC DSER COL Action Item 2.3-2

Address how potential increases in atmospheric moisture and icing during winter months due to the use of natural draft cooling towers or mechanical draft cooling towers or both will impact plant design and operation.

Reason For Deferral – ESP facility's cooling system configuration and design parameters not defined at ESP stage.

EGC RAI ID: SAI1-5

EGC RESPONSE:

The COL application is already required by the regulations to address this action item. 10 CFR 52.79(b) requires *"the application must contain the technically relevant information required of applicants for an operating license by 10 CFR 50.34."* The evaluation of the possible impact plant design and operation of potential increases in atmospheric moisture and icing during winter months due to the use of natural draft cooling towers or mechanical draft cooling towers is typically required to be provided in the FSAR, as identified by Regulatory Guide 1.70 and the Standard Review Plan, NUREG-0800.

Based on the above, this is not an appropriate COL Action Item.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/16/2005

NRC DSER COL Action Item 2.3-3

Evaluate dispersion of airborne radioactive materials to the control room.

Reason For Deferral – Control room location and design features not known at ESP stage.

EGC RAI ID: SAI1-6

EGC RESPONSE:

The COL application is already required by the regulations to address this action item. 10 CFR 52.79(b) requires *"the application must contain the technically relevant information required of applicants for an operating license by 10 CFR 50.34."* The evaluation of the dispersion of airborne radioactive materials to the control room are typically required to be provided in the FSAR, as identified by Regulatory Guide 1.70 and the Standard Review Plan, NUREG-0800.

Based on the above, this is not an appropriate COL Action Item.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/16/2005

NRC DSER COL Action Item 2.3-4

Confirm specific release point characteristics and locations of potential receptors for routine release dose computations.

Reason For Deferral – Exact release points and receptor locations not known at ESP stage

EGC RAI ID: SAI1-7

EGC RESPONSE:

The COL application is already required by the regulations to address this action item. 10 CFR 52.79(b) requires *"the application must contain the technically relevant information required of applicants for an operating license by 10 CFR 50.34."* The Specific release point characteristics and locations of potential receptors for routine release dose computations are typically required to be provided in the FSAR, as identified by Regulatory Guide 1.70 and the Standard Review Plan, NUREG-0800.

Based on the above, this is not an appropriate COL Action Item.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/16/2005

NRC DSER COL Action Item 3.1-1

Verify that calculated radiological doses to members of the public from radioactive gaseous and liquid effluents for ESP facility are bounded by the radiological doses included in the SSAR for the ESP application and reviewed by the NRC staff.

Reason For Deferral – Specific details of how ESP facility will control, monitor, and maintain radioactive gaseous and liquid effluents not known at ESP stage.

EGC RAI ID: SAI1-8

EGC RESPONSE:

The COL application is already required by the regulations to address this action item. 10 CFR 52.79(a)(1) requires that *"if the application references an early site permit, the application… must contain, in addition to the information and analyses otherwise required, information sufficient to demonstrate that the design of the facility falls within the parameters specified in the early site permit."* Thus, the verification that the COL facility calculated radiological doses to members of the public from radioactive gaseous and liquid effluents are bounded by the radiological doses included in the ESP SSAR will be provided in a COL application.

Based on the above, this is not an appropriate COL Action Item.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/16/2005

NRC DSER COL Action Item 3.4.1.6-1

Provide specific designs for protected area barriers.

Reason For Deferral – Specific design information is not known at the ESP stage.

EGC RAI ID: SAI1-9

EGC RESPONSE:

The COL application is already required by the regulations to address this action item. 10 CFR 52.79(b) requires *"the application must contain the technically relevant information required of applicants for an operating license by 10 CFR 50.34."* The specific designs for protected area boundaries will be provided in a COL application, as identified by 10 CFR 50.34(c) and 10 CFR Part 73 with regard to the required content of a COL application.

Based on the above, this is not an appropriate COL Action Item.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

NRC Letter Dated: 02/16/2005

NRC DSER Proposed Site Characteristics

Several areas of the Draft Safety Evaluation Report (DSER) identify proposed Site Characteristics for the EGC ESP site. Some of these are discussed below.

DSER Section 2.3.5.3 identifies, in **Table 2.3.5-2**, numerous Staff proposed site characteristics (SCs) related to the long-term (routine release) atmospheric dispersion.

Of these, the proposed SCs related to the Exclusion Area Boundary (EAB) are acceptable since the EAB is an established, material parameter for the evaluation of the acceptability of the site and any change to the parameter requires specific action by the permit holder. However, the proposed SCs related to the location of the nearest milk cow, the nearest milk goat, the nearest garden, the nearest meat animal, and the nearest resident are not established by nature or the applicant, and thus, should not be considered as SCs. EGC agrees that these are interesting parameters for evaluating the expected impacts of operation of the ESP Facility, but does not agree that these should be identified as site characteristics.

DSER Section 2.4.14 identifies, in **Table 2.4.14-1**, numerous Staff proposed SCs related to hydrology.

Proposed Facility Boundary is identified as a proposed SC. The proposed facility boundary, as identified in Open Item 2.4-1 (i.e., vertical disturbance and bounding elevations), is established by the choice of facility design and not by the site. Thus, the Facility Boundary should be identified as a design related parameter rather than a site characteristic.

Site Grade = 735 ft msl is identified as a proposed SC. This is controllable parameter that is dependent on design of the site drainage system, and thus, should be considered a design related parameter rather than a site characteristic.

Low Water Elevation is identified as a proposed SC. Per Confirmatory Item 2.4-1, this is used to determine the available UHS water volume. Once determined, the Available UHS Volume would be a more appropriate SC since it is actually the limiting parameter for facility design.

Snow Load = 35 lb/ft^2 is identified as a proposed SC and discussed in DSER Section 2.4.3.1. This value was revised to 40 lb/ft^2 in response to RAI 2.3.1-6.

Lake Surface Icing is identified as a proposed SC. As indicated in the response to DSER Open Item 2.4-9, the proposed SC for determining Lake Surface Icing is the number of Freezing Degree(F)-Days.

Distance to Closest Surface Water is identified as a proposed SC and identified as related to Open Item 2.4-1. The identified open item does not discuss this topic and the distance to the closest surface water was not used by EGC in determining site suitability. Thus, this item should not be identified as a site characteristic.

Location of Aquifers Used by Large Population is identified as a proposed SC. This parameter is not established by nature or the applicant, and was not used by EGC in determining site suitability. While this item is an appropriate parameter for evaluating the expected impacts of operation of the ESP Facility, for the reasons identified above, it should be identified as a site characteristic.

Hydraulic Conductivity, Hydraulic Gradient and Porosity are identified as proposed SCs. However, these parameters were not used by EGC in determining site suitability and should not be identified as a site characteristic.

Absorption and Retention Coefficients for Rad Materials are identified as proposed SCs. However, these parameters were not used by EGC in determining site suitability and should not be identified as a site characteristic. Further, it is not clear how these are related to the Open Items 2.4-20 and 2.4-21 as indicated in DSER Table 2.4.14-1.

DSER Section 3.3.3.4 identifies that the Staff intends to include the source terms in the ESP. It is not clear if these are proposed as SCs or as some other Permit Condition. However, since the source terms are only one parameter used in determining the acceptability of the overall dose consequences, it would be more appropriate to identify the resulting dose consequences as the parameter that would need to be met at the COL stage.

ATTACHMENTS

Attachment OI 2.1-1A (AmerGen Resolution) [2 pages]

Attachment OI 2.4-9A (Details of Ice Thickness Calculations) [13+ pages]

Attachment PC 2.4-1A (Cooling System Piping Figure) [1 page]

AMERGEN ENERGY COMPANY, LLC

SECRETARY'S CERTIFICATE

I, KEVIN D. STEPANUK, Assistant Secretary of AmerGen Energy Company, LLC (the "Company"), a limited liability company organized and existing under the laws of the State of Delaware, HEREBY CERTIFY that the following is a true and correct copy of resolutions adopted by the Management Committee of the Company at its meeting held on December 22, 2003:

CLINTON STATION – EARLY SITE PERMIT

RESOLVED, that the appropriate officers of the Company are authorized and directed to negotiate all necessary agreements to support Exelon Generation Company, LLC with its Early Site Permit application and to protect the interests of the Company including, without limitation, a long-term interest up to 99 years in the real estate that is the subject of the ESP application and an exclusion area agreement.

WITNESS my hand, this 26th day of April, 2005.

KEVIN D. STEPANUK
Assistant Secretary

P226588

Estimation of Ice Thickness at Clinton Lake

PREPARED FOR: Joe Stuber/MKE

PREPARED BY: Ken Lilly/SEA

COPIES:

DATE: April 25, 2005

Introduction

An estimate was made of the ice thickness for Clinton Lake, Illinois for the winters 1896 through 2003 using the methodologies in U. S. Army Corps of Engineers (USACOE, 2002) and (USACOE, 2004) and observed ice conditions for Lake Monona, Wisconsin. In addition, a statistical evaluation was completed using probability distributions to an input data set of computed annual maximum ice thicknesses over the period of record. It is noted that there were no data for observed ice conditions on Clinton Lake available for the present analysis, so comparison of calculated ice thicknesses with observed values could not be done. The ice thickness estimates derived from the present study were compared to the estimated ice thickness from a draft NRC review document of February, 2005 using the methodology established by Assur, 1956**.**

Basic Principles of Lake Ice Formation

Lake ice formation is a complicated phenomenon involving water phase changes, heat transfer, and physical and mechanical processes. For example, the presence of snow on the ice may influence the heat transfer rate from the surface of the ice to the atmosphere. The weight of the snow may be sufficient to depress the ice cover, forming cracks that allow water to saturate the snow. Saturated snow freezes rapidly, forming snow ice. The methodology used in the present analysis assumes that the ice is a homogenous horizontal layer and does not include “snow ice thickness”. Additionally, the method assumes that the loss of heat from the surface of the ice to the atmosphere is a linear function of the temperature difference between the ice surface and the air.

The calculated ice thickness was determined using EQ. 1 below, which is from USACOE (2002). This equation is derived in USACOE (2002) from a more complex form called the “standard model”. In deriving EQ.1, it was assumed that heat conduction through the ice cover controls the rate of energy flux. The Corps of Engineers points out that to go beyond this methodology requires extensive data collection, and there has been no indication so far that the additional effort would result in more accurate results.

$h_j = \alpha(U_j)^{0.5}$ (EQ. 1)

where

h_j = Ice thickness on day *j*, inches

α = Coefficient of ice cover condition (Table 1)

TABLE 1
Coefficient of Ice Cover Condition

Ice Cover Condition	α
Windy lake with no snow cover	0.80
Average lake with snow	0.50-0.70

U_j = Accumulated Freezing Degree Days recorded between the onset of freeze up up (day 1) and the day of interest (day *j*)

A freezing degree day is determined using EQ.2 from USACOE (2004) for each day.

$FDD = 32 - T_{avg}$ (EQ. 2)

where

FDD = Freezing degree day

T_{avg} = Average daily air temperature, °F

The average daily air temperature is determined by averaging the maximum daily temperature in a 24-hour period, T_{max}, and the minimum daily air temperature, T_{min}. As an example, if T_{max} = 30°F and T_{min} = 22°F, the average daily temperature is 26°F, and FDD = 6. For the winter season, if $T_{avg} \geq 32$°F, a negative value is assigned for that day's FDD.

The accumulated FDD (AFDD) used in EQ. 1 is the maximum net cumulative sum of the daily FDDs (both positive and negative values) from the date of freeze up to the date of maximum value, which is typically in February or early March for Decatur, Illinois.

Ice Thickness Calculations

Two methods were used to estimate ice thickness using EQ. 1. The first method was based on the history of freeze up at Lake Monona in southern Wisconsin, and the second method assumed that freeze up started on December 1 in every year on Clinton Lake. Finally a statistical analysis of the annual maximum ice thickness values established in the first method is presented (Method 3) that establishes bounding values for a range of recurrence intervals.

Method 1-Ice Thickness Using Monona Lake Freeze up History and the USACOE 2002 Equation

Since there are no records of freeze up for Clinton Lake, an approximate date was determined using the *observed* freeze up dates for Lake Monona in Madison, Wisconsin approximately 180 miles north of Clinton Lake. The freeze up dates for Lake Monona were from the Wisconsin State Climatology Office, which has annual records for freeze up and opening dates from the winter of 1851to the present time.

Lake Monona covers approximately 3,277 acres, with a mean depth of 27 feet and average storage capacity of 88,500 acre-feet. It is 3.2 miles long and 1.8 miles wide at its greatest width. Clinton Lake covers approximately 4,900 acres with an average storage capacity of 74,200 acre-feet and average depth of 15 feet at normal pool elevation 690 feet-MSL. The two lakes are similar in volume but not in shape or depth (Attachment 1). Lake Monona is more or less oval, and Clinton Lake is long and narrow. The thermal characteristics of Clinton Lake for the ice-free months are typically warmer with pre CPS operation average monthly surface water temperatures of typically 51ºF (April), 60ºF (May), 72ºF (June), 79ºF (July), 78ºF (August), 72ºF (September), 60ºF (October) and 47ºF (November). Surface water temperatures for Lake Monona at mid-month are typically 4 to 8 degrees lower, with 46ºF (April), 54ºF (May), 68ºF (June), 75ºF (July), 73ºF (August), 68ºF (September), 54ºF (October) and 39ºF (November). It is likely that Clinton Lake reaches higher temperatures in summer because it is in a warmer climate and is not as deep as Lake Monona.

The winter climate is cooler in Madison compared to that for Decatur, Illinois, as shown in Attachment 2. The maximum net AFDDs for Decatur and Madison for each winter season 1896 through 2003 are shown. The maximum net AFDD for Madison was determined starting the day of observed freeze up at Lake Monona. For Decatur, the maximum net AFDD started at the estimated date of freeze up for Clinton Lake, as explained below. The winter of 1977/1978 was the coldest on record for Decatur, with a maximum net AFDD of 963 on March 10, 1978. At Madison, this winter was only the ninth coldest on record, with a maximum net AFDD of 1,653 on March 18, 1978.

Attachment 3 illustrates the 1977/1978 winter season for Decatur. The daily FDDs, both positive and negative are shown as the gray curve along the X-axis. Note that the FDDs are predominately positive starting about day 55, which corresponds to November 24th. Freeze up was estimated to have occurred on December 27th. Starting on this date, the AFDDs are shown and accumulate rapidly until the peak accumulation of 963 is reached on March 10th. Note that just past this date, the daily FDD curve trends negatively, indicating that average air temperatures are above freezing.

For a given winter season, the estimated date for the start of freeze up at Clinton Lake was based on the cumulative *positive* FDDs from November 1st through the day before the *observed* freeze up date at Lake Monona. The date of freeze up for Clinton Lake then was assumed to be the day with the same (or nearly same) positive FDDs.This assumption appears to be conservative because Clinton Lake is warmer during ice-free periods and it is linear in shape with higher velocity and greater mixing. Monona Lake is however, deeper with greater volume and smaller surface area which may tend to partially offset the warmer temperature and mixing factors.

Winter seasons 1896 through 2003 were used in the analysis and covered the coldest winters on record. The FDDs were determined using daily air temperature data from the National Climatic Data Center for Madison Dane County Regional Airport located 3 miles north of Lake Monona and the National Weather Service values for the city of Madison, Wisconsin. City data were used 1896-1955, and airport data from 1956-2003.

Table 2 (see Attachment 4) shows the cumulative positive FDDs prior to freeze up at Lake Monona for each winter season 1896 through 2003. A high of 406 FDDs in 1966 and a low of 80 FDDs in 1913 were required to freeze the lake. This variability is expected due to other variable meteorological factors that influence water temperature such as solar radiation, wind, precipitation and lake inflow, and antecedent summer air temperature and humidity. The table also shows the winter season maximum net AFDDs for both Lake Monona and Clinton Lake. The AFDDs accumulate starting the date of freeze up. This method assumes that the cumulative positive FDDs required for freeze up at Clinton Lake were the same as those for freeze up at Lake Monona, and the freeze up date for Clinton Lake was calculated accordingly. In some of the milder winters, 1982-1983 for example, the data suggest that Lake Clinton may not have frozen. In that winter season, 351 cumulative positive FDDs were required for Lake Monona to freeze, but there were only 259 cumulative positive FDDs for the entire winter season for Clinton Lake.

For estimating maximum ice thickness, a conservative approach was taken in which α = 0.80 was used in EQ 1. Ice thickness on Clinton Lake is estimated to range from 0.0 to a maximum of 24.8 inches (1977/1978 winter), with an average thickness of 12.6 inches for years in which the lake freezes. Lake Monona had estimated ice thicknesses of 12.8 to 34.7 inches, with an average thickness of 25.1 inches.

The Center for Limnology at the University of Wisconsin has made intermittent ice thickness measurements on Lake Monona in winters 1995 through 2003, but these likely do not correspond to maximum ice thicknesses for the season, as shown in Table 3. This may be seen by comparing the discrete thicknesses in Table 3 with the calculated values in Table 2 for the corresponding winter seasons.

TABLE 3
Lake Monona, WI – Observed Ice Thickness

Winter	Freeze up Date	Observation Date	Ice Thickness (inches)	Opened Date
1995-1996	10 December 1995	6 February 1996	15.0	24 March 1996
1996-1997	20 December 1996	14 January 1997	11.8	26 March 1997
1996-1997	20 December 1996.	17 February 1997	16.6	26 March 1997.
1998-1999	30 December 1998	27 January 1999	10.2	10 March 1999
1998-1999	30 December 1998.	23 February 1999	7.5	10 March 1999.
1999-2000	14 January 2000	25 January 2000	7.5	6 March 2000
2000-2001	13 December 2000	15 January 2001	10.6	31 March 2001
2002-2003	4 January 2003	13 February 2003	15.8	22 March 2003
2003-2004	6 January 2004	17 February 2004	12.8	20 March 2004

Method 2-Ice Thickness Using Freeze up Day of December 1st , the USCOE 2002 Equation and the Assur 1956 Equation

In this method, it was assumed that freeze up on Clinton Lake occurred on December 1st each year regardless of the number of FDDs preceding the freeze up. This procedure is highly conservative compared to the assumptions in the method above. In Table 2, it is clear that Lake Monona only had 3 freeze ups on or before December 1st in the period 1896 to 2003 and that at least 80 cumulative positive FDDs were needed prior to freeze up occurring. From this it may easily be concluded that December 1st is not a good assumption for the warmer Clinton Lake freeze up. There were some years, such as in 1902, in which there were no FDDs prior to December 1st at Decatur. The number of FDDs in November for Decatur is shown in Attachment 5.

The ice thickness was estimated based on the method from USACOE (2002) described earlier and from Assur's method described in Chow (1964), which was from a paper by Assur (1956). Assur's method is the procedure used in excerpts from NRC Draft SER of February 2005 and is shown below. Note that the Assur method is similar to the USACOE's method, but that the coefficient of snow cover and local conditions is larger, and there is also a multiplier of 1.06 in the equation. Both of these items contribute additional conservatism to the ice thickness calculations.

$h_i = \alpha\ [1.06\ (S)^{0.5}]$ (EQ. 3)

where

h_i = Ice thickness, inches

α = Coefficient of snow cover and local conditions (Table 4)

S = Accumulated freezing degree days since freeze up based on ^{o}F.

TABLE 4
Coefficient of Ice Cover Condition (Assur's Method)

Ice Cover Condition	α
Theoretical maximum (never reached under natural conditions)	1.00
Maximum for ice not covered with snow	0.85-0.90
Medium-size lakes with moderate snow cover	0.65-0.75

Table 5 shows that the maximum ice thickness based on USACOE (2002) is 26.1 inches and 31.1 inches based on Assur's method. These maxima occurred in the winter of 1977/1978 for both methods.

TABLE 5

CLINTON LAKE ICE THICKNESS USING USACOE AND ASSUR METHODS (1896-2003)

Winter Season		Assumed Clinton Lk Freezeup	Max Net AFDD from Freezeup	USACOE Ice Thick. α = 0.80 (in)	ASSUR Ice Thick. α = 0.90 (in)	Winter Season		Assumed Clinton Lk Freezeup	Max Net AFDD from Freezeup	USACOE Ice Thick. α = 0.80 (in)	ASSUR Ice Thick. α = 0.90 (in)
1896	1897	1-Dec	98	7.9	9.4	1951	1952	1-Dec	90	7.6	9.1
1897	1898	1-Dec	169	10.4	12.4	1952	1953	1-Dec	9	2.4	2.9
1898	1899	1-Dec	606	19.7	23.5	1953	1954	1-Dec	20	3.6	4.3
1899	1900	1-Dec	264	13.0	15.5	1954	1955	1-Dec	79	7.1	8.5
1900	1901	1-Dec	240	12.4	14.8	1955	1956	1-Dec	198	11.3	13.4
1901	1902	1-Dec	723	21.5	25.7	1956	1957	1-Dec	126	9.0	10.7
1902	1903	1-Dec	414	16.3	19.4	1957	1958	1-Dec	176	10.6	12.7
1903	1904	1-Dec	812	22.8	27.2	1958	1959	1-Dec	493	17.8	21.2
1904	1905	1-Dec	712	21.3	25.5	1959	1960	1-Dec	227	12.1	14.4
1905	1906	1-Dec	139	9.4	11.2	1960	1961	1-Dec	394	15.9	18.9
1906	1907	1-Dec	174	10.6	12.6	1961	1962	1-Dec	445	16.9	20.1
1907	1908	1-Dec	110	8.4	10.0	1962	1963	1-Dec	796	22.6	26.9
1908	1909	1-Dec	113	8.5	10.1	1963	1964	1-Dec	418	16.4	19.5
1909	1910	1-Dec	678	20.8	24.8	1964	1965	1-Dec	238	12.3	14.7
1910	1911	1-Dec	366	15.3	18.3	1965	1966	1-Dec	102	8.1	9.6
1911	1912	1-Dec	711	21.3	25.4	1966	1967	1-Dec	107	8.3	9.9
1912	1913	1-Dec	91	7.6	9.1	1967	1968	1-Dec	251	12.7	15.1
1913	1914	1-Dec	110	8.4	10.0	1968	1969	1-Dec	281	13.4	16.0
1914	1915	1-Dec	404	16.1	19.2	1969	1970	1-Dec	552	18.8	22.4
1915	1916	1-Dec	214	11.7	14.0	1970	1971	1-Dec	335	14.6	17.5
1916	1917	1-Dec	478	17.5	20.9	1971	1972	1-Dec	159	10.1	12.0
1917	1918	1-Dec	957	24.7	29.5	1972	1973	1-Dec	239	12.4	14.7
1918	1919	1-Dec	-7	NF[1]	NF[1]	1973	1974	1-Dec	331	14.6	17.4
1919	1920	1-Dec	536	18.5	22.1	1974	1975	1-Dec	39	5.0	6.0
1920	1921	1-Dec	-8	NF[1]	NF[1]	1975	1976	1-Dec	256	12.8	15.3
1921	1922	1-Dec	111	8.4	10.1	1976	1977	1-Dec	990	25.2	30.0
1922	1923	1-Dec	70	6.7	8.0	1977	1978	1-Dec	1065	26.1	31.1
1923	1924	1-Dec	73	6.8	8.2	1978	1979	1-Dec	901	24.0	28.6
1924	1925	1-Dec	341	14.8	17.6	1979	1980	1-Dec	288	13.6	16.2
1925	1926	1-Dec	190	11.0	13.1	1980	1981	1-Dec	343	14.8	17.7
1926	1927	1-Dec	255	12.8	15.2	1981	1982	1-Dec	805	22.7	27.1
1927	1928	1-Dec	208	11.5	13.8	1982	1983	1-Dec	-25	NF[1]	NF[1]
1928	1929	1-Dec	434	16.7	19.9	1983	1984	1-Dec	762	22.1	26.3
1929	1930	1-Dec	379	15.6	18.6	1984	1985	1-Dec	461	17.2	20.5
1930	1931	1-Dec	14	3.0	3.6	1985	1986	1-Dec	0	no data	0.0
1931	1932	1-Dec	-2	NF[1]	NF[1]	1986	1987	1-Dec	168	10.4	12.4
1932	1933	1-Dec	84	7.3	8.7	1987	1988	1-Dec	347	14.9	17.8
1933	1934	1-Dec	-10	NF[1]	NF[1]	1988	1989	1-Dec	202	11.4	13.6
1934	1935	1-Dec	89	7.5	9.0	1989	1990	1-Dec	413	16.3	19.4
1935	1936	1-Dec	916	24.2	28.9	1990	1991	1-Dec	214	11.7	14.0
1936	1937	1-Dec	42	5.2	6.2	1991	1992	1-Dec	36	4.8	5.7
1937	1938	1-Dec	178	10.7	12.7	1992	1993	1-Dec	111	8.4	10.1
1938	1939	1-Dec	-6	NF	NF[1]	1993	1994	1-Dec	337	14.7	17.5
1939	1940	1-Dec	388	15.8	18.8	1994	1995	1-Dec	150	9.8	11.7
1940	1941	1-Dec	25	4.0	4.8	1995	1996	1-Dec	463	17.2	20.5
1941	1942	1-Dec	0	0.0	0.0	1996	1997	1-Dec	285	13.5	16.1
1942	1943	1-Dec	230	12.1	14.5	1997	1998	1-Dec	0	NF[1]	NF[1]
1943	1944	1-Dec	148	9.7	11.6	1998	1999	1-Dec	147	9.7	11.6
1944	1945	1-Dec	483	17.6	21.0	1999	2000	1-Dec	28	4.2	5.0
1945	1946	1-Dec	266	13.0	15.6	2000	2001	1-Dec	568	19.1	22.7
1946	1947	1-Dec	57	6.0	7.2	2001	2002	1-Dec	-11	NF[1]	NF[2]
1947	1948	1-Dec	285	13.5	16.1	2002	2003	1-Dec	279	13.4	15.9
1948	1949	1-Dec	0	0.0	0.0	2003	2004	1-Dec	186	10.9	13.0
1949	1950	1-Dec	-9	NF[1]	NF[1]				**MAX**	26.1	31.1
1950	1951	1-Dec	516	18.2	21.7						

Notes

Method 3-Return Period Ice Thickness for Clinton Lake

A coastal engineering program from the suite of programs in CEDAS (Coastal Engineering Design and Analysis System) "Extremal Significant Wave Height" was used to estimate the 100- year return-period ice thickness. The program contains five probability distribution functions. Although the program is specifically labeled for significant wave height, it may be used for any suitable data set, such as annual maximum wind speeds, water levels, or ice thicknesses.

The annual maximum ice thicknesses from 1896 through 2003 for Clinton Lake used in Method 1 and shown in Table 2 were used as the input data set. Table 6 shows the return-period values at the 95% confidence interval and the upper and lower bounds. The correlation was 0.993 using a Weibull distribution function.

TABLE 6
Clinton Lake, Illinois Return-Period Ice Thicknesses

Return-Period (years)	**Ice Thickness** (in.)	**Lower Bound Ice Thickness** (in.)	**Upper Bound Ice Thickness** (in.)
2	11.5	not computed	not computed
5	16.6	15.4	17.8
10	19.4	18.0	20.9
25	22.6	20.8	24.4
50	24.8	22.8	26.8

Summary

The estimated ice thickness on Clinton Lake determined using the methods above are listed in Table 7. The estimated thickness values range from a low of 24.8 to a high of inches to 31.1 inches. In Method 1 the ice thickness is calculated using the USACOE 2002 equation. The freeze up date for Clinton Lake is estimated based on the number of FDDs leading up to the observed freeze up date on Lake Monona. The FDDs from freeze up on Clinton Lake through 31 March were then used to calculate ice thickness using EQ.1 above. Lake Monona is deeper than Clinton Lake with a smaller surface area, but is located in a cooler climate with significantly colder water temperatures. The effects of a deeper water body and smaller surface area on heat loss and the FDDs required for freeze up may be offset by the fact that Clinton Lake is in a warmer climate and reaches significantly higher summertime water temperatures than does Lake Monona.

In Method 2 the date of ice freeze up is assumed to always occur on December 1st on Clinton Lake. The USACOE (2002) method using EQ. 1 and the method by Assur (1956) in Chow (1964) using EQ. 3 were then applied in making estimates of ice thickness. The USACOE equation is considered a better estimate of ice thickness because it is a refinement of the Assur method based on additional study. Both the USACOE and Assur equations likely overestimate ice thickness because the temperature data shows that in most years there are not enough FDDs leading up to December 1st to support the assumption of freeze up on December 1st.. This suggests that Method 1, which establishes the initial date of ice freezing based on FDD, would provide a more accurate estimate of ice thickness

In Method 3, the annual maximum ice thicknesses from Method 1 were used in a probability distribution to estimate the bounding values for ice thickness for a range of return periods.

TABLE 7
Summary of Maximum Ice Thickness for Clinton Lake, Illinois

Method	Ice Thickness (in.)
1-Calculated freeze up date on Clinton Lake with USACOE, 2002. (max value over 108-year period of record)	24.8
2-Fixed freeze up date (Dec. 1) on Clinton Lake with USACOE, 2002. (max value over 108-year period of record)	26.1
2-Fixed freeze up date (Dec. 1) on Clinton Lake with Assur, 1956. (max value over 108-year period of record)	31.1
3-Extremal Statistical Analysis of Method 1. (50-year recurrence interval value)	24.8
(upper and lower bounds at 95 percent confidence interval)	22.8-26.8

Based on the results of the ice thickness evaluation and the discussion above, it is recommended that the maximum ice thickness be established based on the USACOE 2002 equation and the calculated date of initial ice freeze up using Monona Lake FDDs as a conservative indicator of initial ice freeze up. It is further recommended that the worst case value of ice thickness over the 108-years of record be used as the design value for the ESP safety analysis report. This value is 24.8inches and is within the bounding limits for a 95 percent confidence interval for the 50-year return period.

References

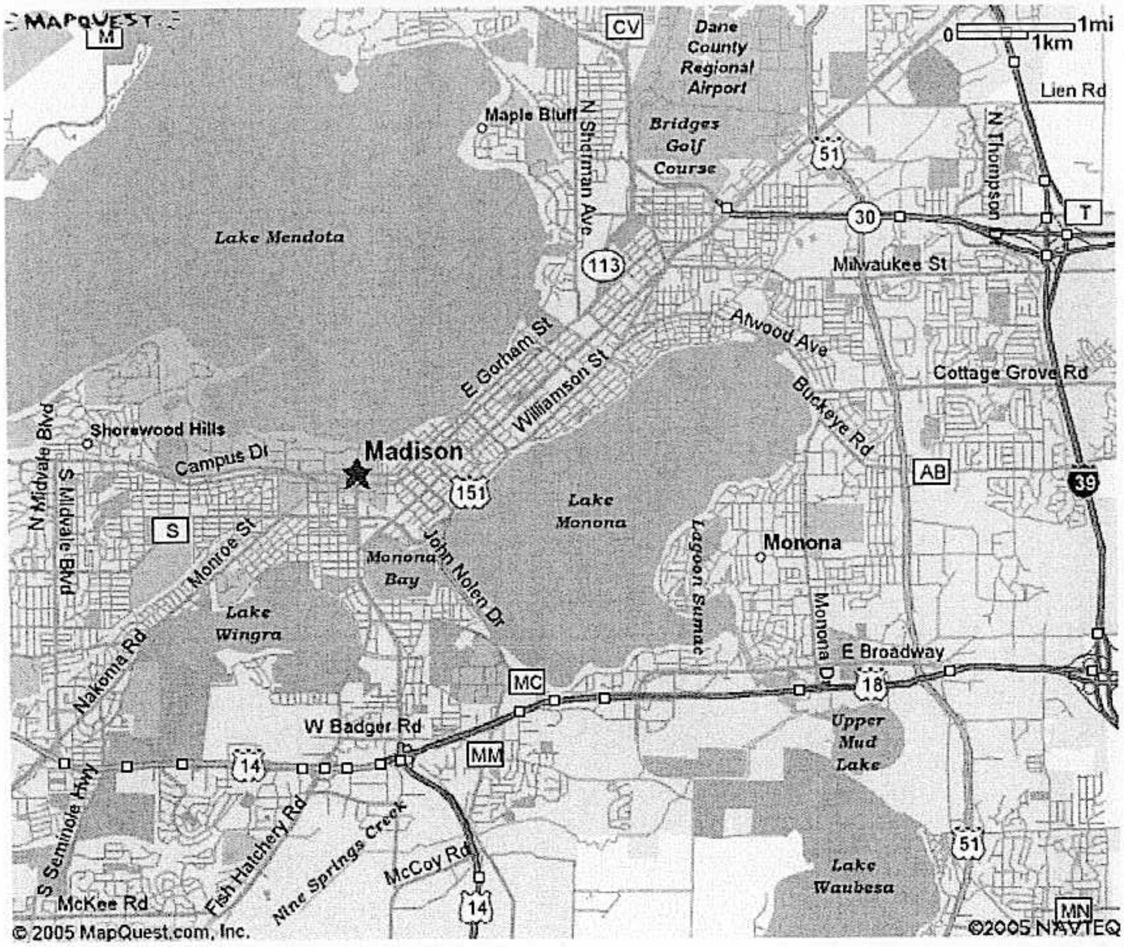
Assur, A. “Airfields on Floating Ice Sheets for Routine and Emergency Operations”. *U.S. Army Corps Engrs., Snow, Ice, Permafrost Res. Estab., Rept. 5, pt. 1.* Wilmette, Illinois. 1954.

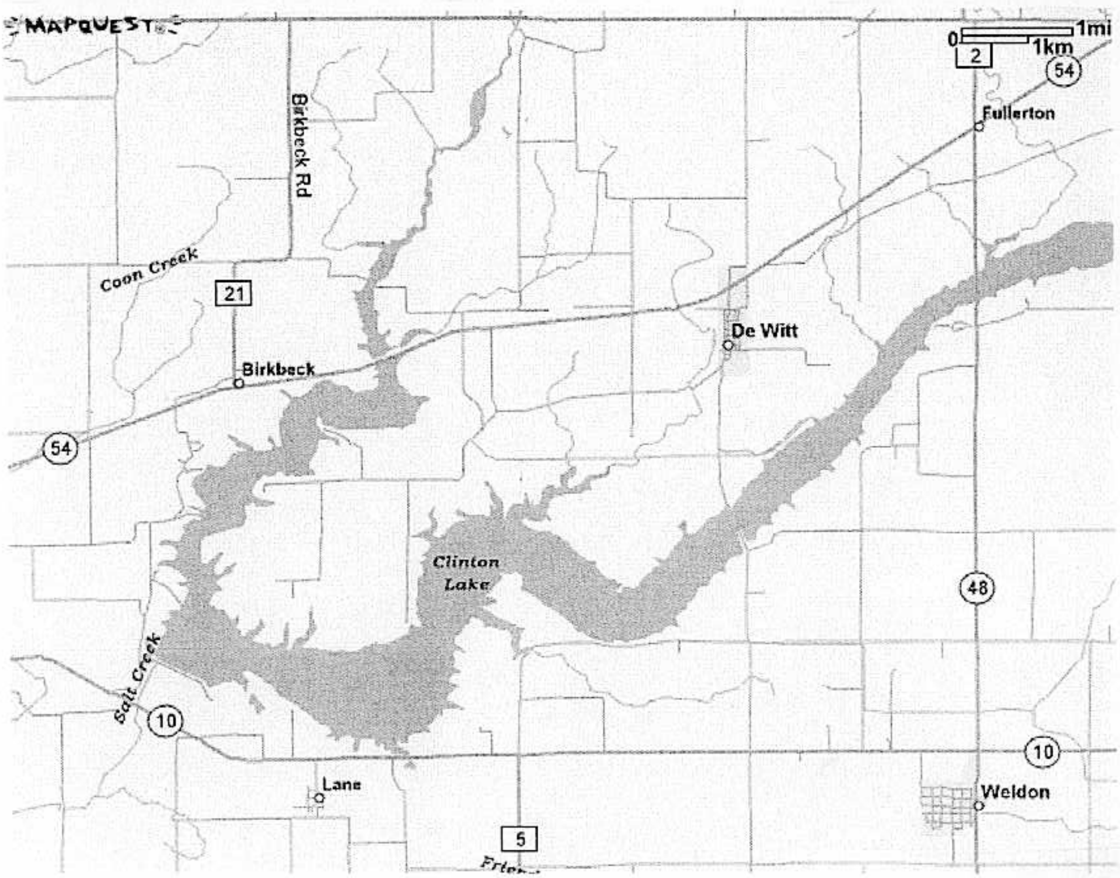
Chow, Ven Te (ed.). *Handbook of Applied Hydrology*. McGraw-Hill Book Co., NY, NY. 1964.

Leenknecht, David a., A. Szuwalski, and A. Sherlock. *Automated Coastal Engineering System (Version 1.07).* Corps of Engineers, Waterways Experiment Station. Vicksburg, MS. 1992.

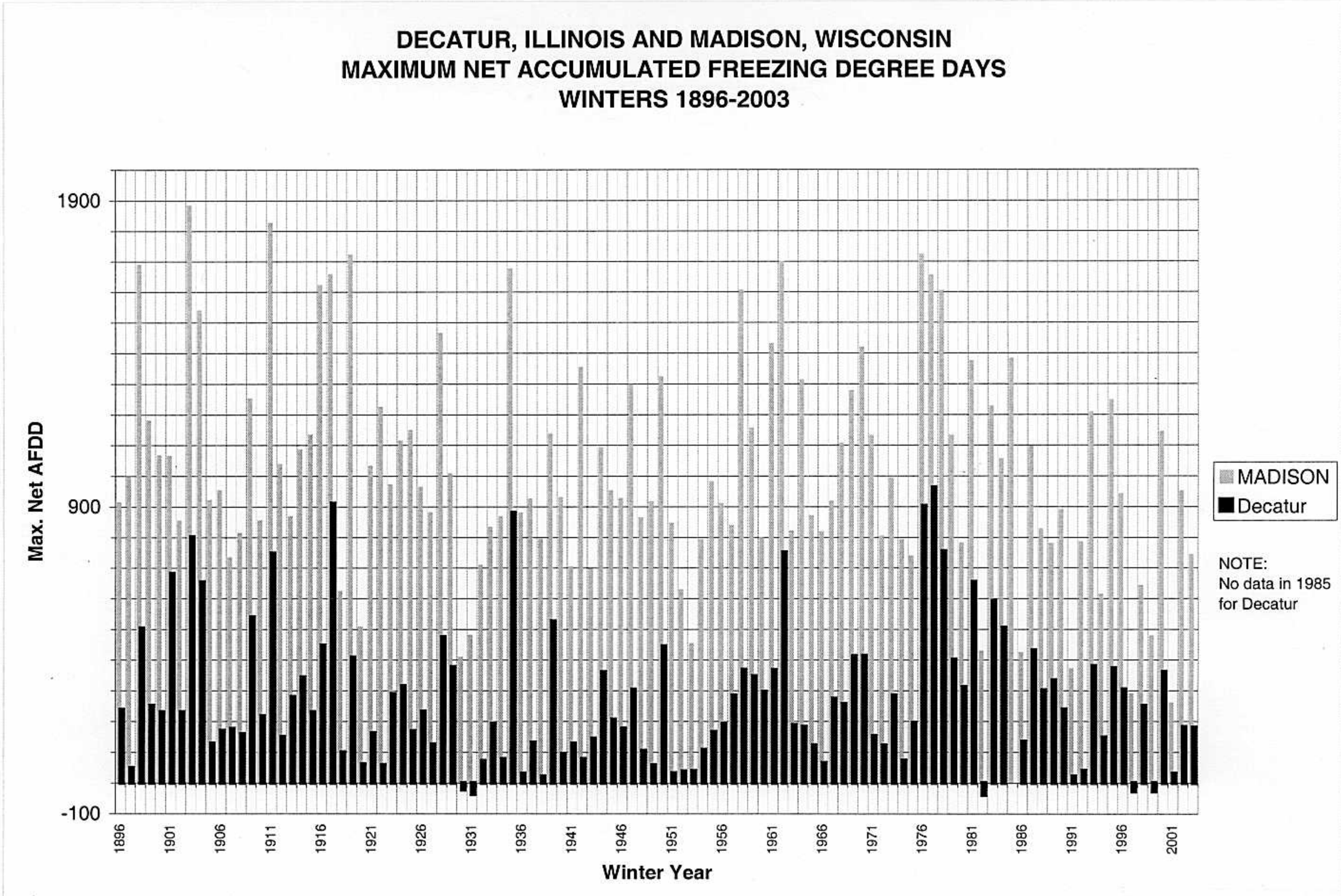
USACOE. “Ice Engineering (ERDC/CRREL Technical Note 04-3)”. Dept. of the Army. Corps of Engineers. Engineer Research and Development Center/Cold Regions Research and Engineering Laboratory. Hanover, New Hampshire. 2004.

USACOE. *Engineering and Design-Ice Engineering (EM1110-2-1612).* Dept. of the Army. Corps of Engineers. Washington, D.C. 2002.



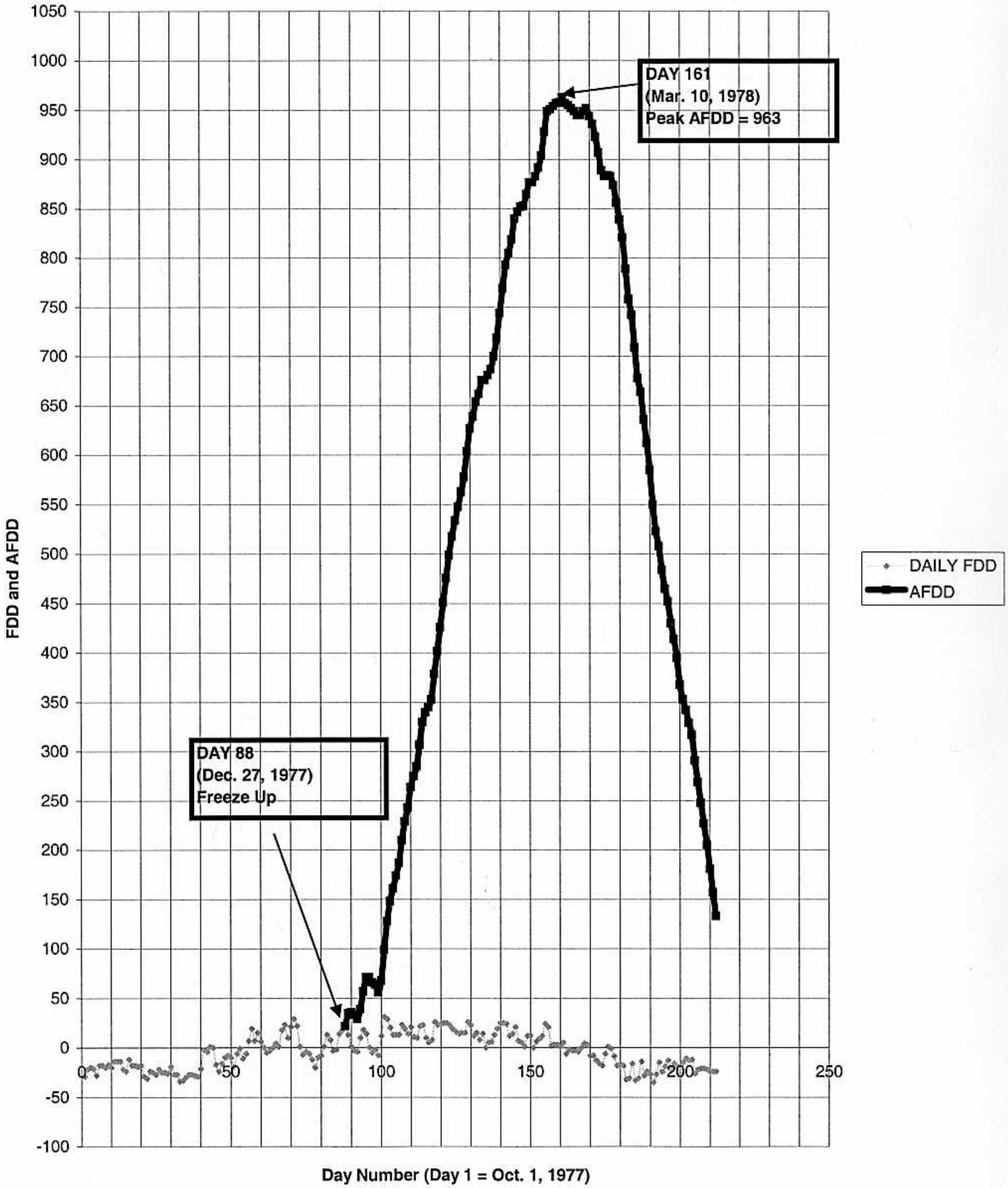


ATTACHMENT 1



ATTACHMENT 2

DECATUR, ILLINOIS WINTER 1977/1978
Daily FDD and AFDD from Date of Freeze Up



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ATTACHMENT 3

TABLE 2

FREEZE UP DATE AND ICE THICKNESS FOR LAKE MONONA AND CLINTON LAKE

Winter Season		Observed Lk Monona Freeze Up	FDD to Freeze Up	Max Net AFDD from Freeze Up	Ice Thick (in)	Estimated Clinton Lk Freeze Up	Max Net AFDD from Freeze Up	Ice Thick (in)
1896	**1897**	3 Dec 1896	189	912	24.2	23 Jan 1897	238	12.3
1897	**1898**	15 Dec 1897	230	996	25.2	2 Jan 1898	49	5.6
1898	**1899**	7 Dec 1898	217	1688	32.9	28 Dec 1898	504	18.0
1899	**1900**	25 Dec 1899	139	1179	27.5	29 Dec 1899	251	12.7
1900	**1901**	14-Dec-1900	159	1066	26.1	2-Jan-1901	231	12.2
1901	**1902**	14-Dec-1901	140	1063	26.1	17-Dec-1901	682	20.9
1902	**1903**	26-Dec-1902	255	852	23.4	11-Jan-1903	231	12.2
1903	**1904**	27-Nov-1903	97	1882	34.7	5-Dec-1903	802	22.7
1904	**1905**	13-Dec-1904	168	1537	31.4	8-Jan-1905	654	20.5
1905	**1906**	14-Dec-1905	127	919	24.3	8-Jan-1906	129	9.1
1906	**1907**	8-Dec-1906	94	952	24.7	25-Dec-1906	170	10.4
1907	**1908**	11-Dec-1907	93	732	21.6	16-Jan-1908	176	10.6
1908	**1909**	9-Dec-1908	163	812	22.8	7-Jan-1909	159	10.1
1909	**1910**	18-Dec-1909	234	1251	28.3	21-Dec-1909	539	18.6
1910	**1911**	8-Dec-1910	179	852	23.4	24-Dec-1910	218	11.8
1911	**1912**	18-Dec-1911	184	1825	34.2	5-Jan-1912	748	21.9
1912	**1913**	19-Dec-1912	122	1036	25.7	12-Jan-1913	150	9.8
1913	**1914**	27-Dec-1913	80	867	23.6	13-Jan-1914	280	13.4
1914	**1915**	15-Dec-1914	176	1084	26.3	22-Dec-1914	344	14.8
1915	**1916**	15-Dec-1915	107	1133	26.9	6-Jan-1916	231	12.2
1916	**1917**	16-Dec-1916	213	1621	32.2	22-Dec-1916	447	16.9
1917	**1918**	8-Dec-1917	113	1656	32.6	10-Dec-1917	911	24.1
1918	**1919**	27-Dec-1918	97	621	19.9	3-Jan-1919	100	8.0
1919	**1920**	3-Dec-1919	162	1720	33.2	15-Dec-1919	409	16.2
1920	**1921**	21-Dec-1920	150	505	18.0	12-Jan-1921	61	6.2
1921	**1922**	19-Dec-1921	147	1030	25.7	19-Jan-1922	161	10.2
1922	**1923**	13-Dec-1922	120	1223	28.0	21-Dec-1922	59	6.1
1923	**1924**	1-Jan-1924	89	970	24.9	5-Jan-1924	289	13.6
1924	**1925**	14-Dec-1924	145	1113	26.7	24-Dec-1924	315	14.2
1925	**1926**	10-Dec-1925	132	1147	27.1	27-Dec-1925	169	10.4
1926	**1927**	5-Dec-1926	139	962	24.8	18-Dec-1926	232	12.2
1927	**1928**	9-Dec-1927	157	879	23.7	23-Dec-1927	126	9.0
1928	**1929**	21-Dec-1928	155	1463	30.6	7-Jan-1929	474	17.4
1929	**1930**	3-Dec-1929	201	1006	25.4	21-Dec-1929	378	15.6
1930	**1931**	16-Dec-1930	185	407	16.1	NF[1]	-21	NF[1]
1931	**1932**	30-Jan-1932	216	479	17.5	NF[1]	-36	NF[1]
1932	**1933**	10-Dec-1932	183	708	21.3	16-Dec-32	72	6.8
1933	**1934**	13-Dec-1933	162	831	23.1	29-Jan-1934	192	11.1
1934	**1935**	20-Dec-1934	203	866	23.5	23-Jan-1935	78	7.1
1935	**1936**	11-Dec-1935	127	1673	32.7	24-Dec-35	880	23.7
1936	**1937**	5-Jan-1937	342	878	23.7	24-Feb-1937	31	4.5
1937	**1938**	1-Dec-1937	136	924	24.3	8-Dec-1937	131	9.2
1938	**1939**	19-Dec-1938	147	793	22.5	27-Jan-1939	22	3.8
1939	**1940**	31-Dec-1939	98	1136	27.0	1-Jan-1940	526	18.3
1940	**1941**	3-Dec-1940	168	929	24.4	28-Jan-1941	95	7.8
1941	**1942**	29-Dec-1941	149	702	21.2	6-Jan-1942	128	9.1
1942	**1943**	7-Dec-1942	175	1352	29.4	16-Dec-1942	78	7.1
1943	**1944**	14-Dec-1943	104	695	21.1	17-Dec-1943	144	9.6
1944	**1945**	18-Dec-1944	152	1091	26.4	25-Dec-1944	360	15.2
1945	**1946**	12-Dec-1945	144	951	24.7	17-Dec-1945	206	11.5
1946	**1947**	18-Dec-1946	126	925	24.3	4-Jan-1947	177	10.6
1947	**1948**	9-Dec-1947	186	1296	28.8	18-Jan-1948	304	13.9

Notes

[1]NF = no freeze up for the winter season.

ATTACHMENT 4

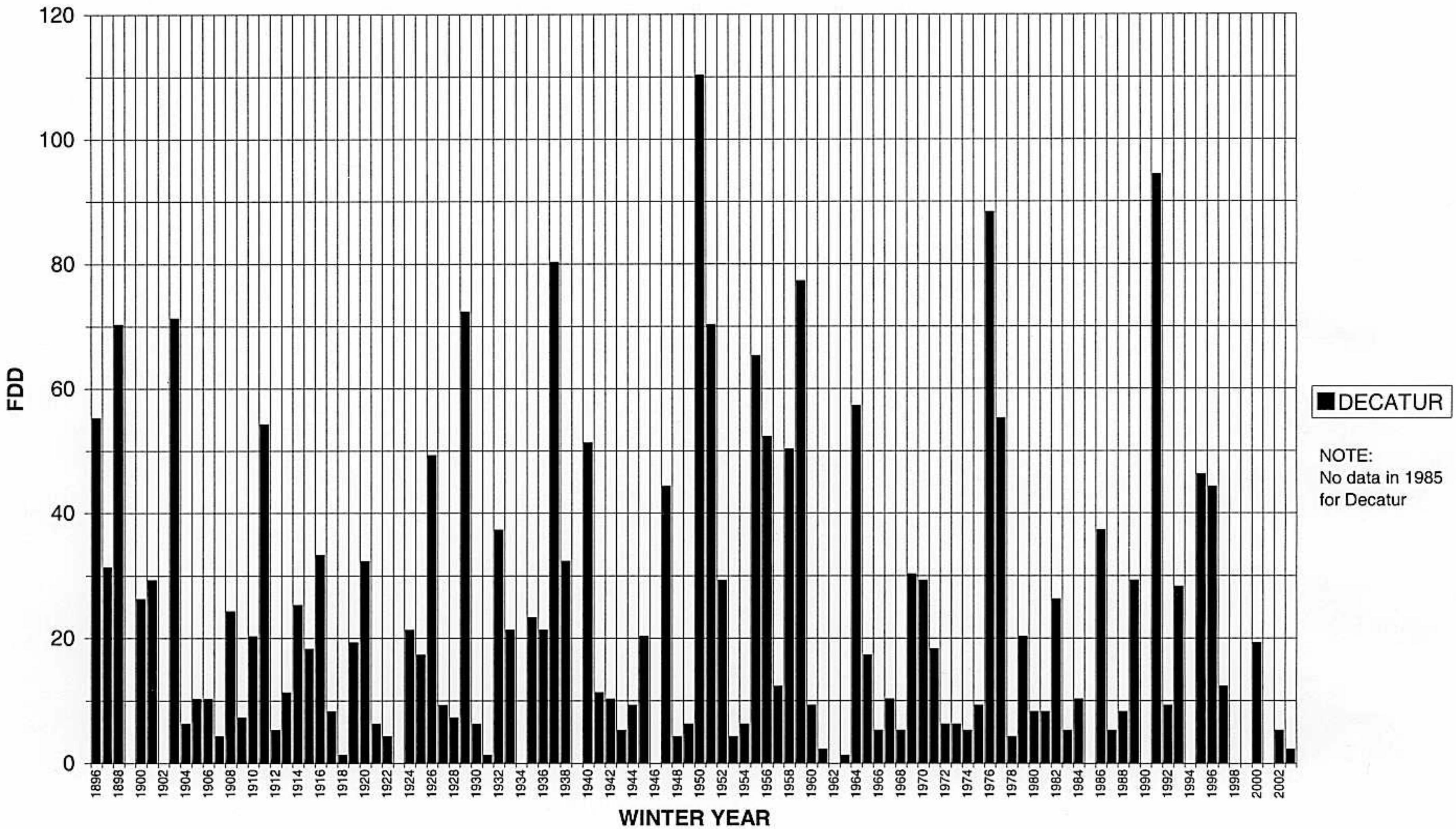
TABLE 2
FREEZE UP DATE AND ICE THICKNESS FOR LAKE MONONA AND CLINTON LAKE

Winter Season		Observed Lk Monona Freeze Up	FDD to Freeze Up	Max Net AFDD from Freeze Up	Ice Thick (in)	Estimated Clinton Lk Freeze Up	Max Net AFDD from Freeze Up	Ice Thick (in)
1948	**1949**	24-Dec-1948	148	862	23.5	22-Jan-1949	105	8.2
1949	**1950**	15-Dec-1949	149	915	24.2	30-Jan-1950	57	6.0
1950	**1951**	11-Dec-1950	218	1321	29.1	15-Dec-1950	445	16.9
1951	**1952**	16-Dec-1951	285	844	23.2	27-Dec-1951	32	4.5
1952	**1953**	17-Dec-1952	115	627	20.0	6-Jan-1953	38	4.9
1953	**1954**	30-Dec-1953	201	451	17.0	17-Jan-1954	39	5.0
1954	**1955**	31-Dec-1954	202	791	22.5	30-Jan-1955	108	8.3
1955	**1956**	6-Dec-1955	143	980	25.0	16-Dec-1955	166	10.3
1956	**1957**	13-Dec-1956	183	909	24.1	14-Jan-1957	192	11.1
1957	**1958**	12-Dec-1957	140	837	23.1	8-Jan-1958	284	13.5
1958	**1959**	8-Dec-1958	185	1604	32.0	13-Dec-1958	369	15.4
1959	**1960**	29-Dec-1959	298	1154	27.2	20-Feb-1960	347	14.9
1960	**1961**	19-Dec-1960	179	798	22.6	23-Dec-1960	296	13.8
1961	**1962**	15-Dec-1961	197	1429	30.2	7-Jan-1962	368	15.3
1962	**1963**	12-Dec-1962	122	1697	33.0	14-Dec-1962	751	21.9
1963	**1964**	18-Dec-1963	283	819	22.9	22-Dec-1963	188	11.0
1964	**1965**	15-Dec-1964	295	1311	29.0	18-Jan-1965	182	10.8
1965	**1966**	11-Jan-1966	310	868	23.6	30-Jan-1966	123	8.9
1966	**1967**	5-Jan-1967	406	817	22.9	24-Feb-1967	65	6.4
1967	**1968**	24-Dec-1967	155	916	24.2	1-Jan-1968	274	13.2
1968	**1969**	15-Dec-1968	111	1105	26.6	26-Dec-1968	256	12.8
1969	**1970**	16-Dec-1969	209	1276	28.6	5-Jan-1970	413	16.3
1970	**1971**	15-Dec-1970	119	1417	30.1	30-Dec-1970	414	16.3
1971	**1972**	4-Jan-1972	318	1130	26.9	31-Jan-1972	152	9.9
1972	**1973**	7-Dec-1972	167	803	22.7	17-Dec-1972	122	8.8
1973	**1974**	20-Dec-1973	155	991	25.2	22-Dec-1973	285	13.5
1974	**1975**	2-Jan-1975	212	791	22.5	9-Feb-1975	73	6.8
1975	**1976**	21-Dec-1975	228	737	21.7	14-Jan-1976	195	11.2
1976	**1977**	1-Dec-1976	177	1721	33.2	9-Dec-1976	903	24.0
1977	**1978**	7-Dec-1977	245	1653	32.5	27-Dec-1977	963	24.8
1978	**1979**	9-Dec-1978	237	1602	32.0	7-Jan-1979	755	22.0
1979	**1980**	17-Dec-1979	154	1130	26.9	23-Jan-1980	402	16.0
1980	**1981**	20-Dec-1980	194	780	22.3	7-Jan-1981	312	14.1
1981	**1982**	20-Dec-1981	240	1373	29.6	7-Jan-1982	654	20.5
1982	**1983**	9-Jan-1983	351	427	16.5	NF[1]	-38	NF[1]
1983	**1984**	18-Dec-1983	233	1226	28.0	23-Dec-1983	592	19.5
1984	**1985**	24-Dec-1984	205	1054	26.0	16-Jan-1985	505	18.0
1985	**1986**	6-Dec-1985	219	1381	29.7	no data	no data	no data
1986	**1987**	13-Dec-1986	213	422	16.4	23-Jan-1987	134	9.3
1987	**1988**	25-Dec-1987	105	1058	26.0	1-Jan-1988	432	16.6
1988	**1989**	29-Dec-1988	237	826	23.0	4-Feb-1989	302	13.9
1989	**1990**	7-Dec-1989	144	778	22.3	15-Dec-1989	335	14.6
1990	**1991**	23-Dec-1990	142	888	23.8	30-Dec-1990	239	12.4
1991	**1992**	16-Dec-1991	265	370	15.4	8-Feb-1992	22	3.8
1992	**1993**	24-Dec-1992	190	783	22.4	17-Jan-1993	40	5.1
1993	**1994**	26-Dec-1993	144	1207	27.8	30-Dec-1993	381	15.6
1994	**1995**	5-Jan-1995	257	612	19.8	30-Jan-1995	148	9.7
1995	**1996**	10-Dec-1995	232	1246	28.2	2-Jan-1996	373	15.5
1996	**1997**	20-Dec-1996	279	940	24.5	12-Jan-1997	305	14.0
1997	**1998**	11-Jan-1998	257	288	13.6	NF[1]	-27	NF[1]
1998	**1999**	30-Dec-1998	128	641	20.3	1-Jan-1999	250	12.6
1999	**2000**	14-Jan-2000	358	477	17.5	NF[1]	-27	NF[1]
2000	**2001**	13-Dec-2000	255	1142	27.0	22-Dec-2000	362	15.2
2001	**2002**	1-Jan-2002	167	258	12.8	1-Mar-2002	31	4.5
2002	**2003**	4-Jan-2003	268	949	24.6	24-Jan-2003	182	10.8
2003	**2004**	6-Jan-2004	237	741	21.8	29-Jan-2004	180	10.7
				AVG	25.1		AVG	12.6
				MAX	34.7		MAX	24.8

Notes
[1]NF = no freeze up for the winter season.

ATTACHMENT 4

DEACATUR, ILLINOIS -- CUMULATIVE POSITIVE FREEZING DEGREE DAYS IN NOVEMBER FOR WINTERS 1896-2003



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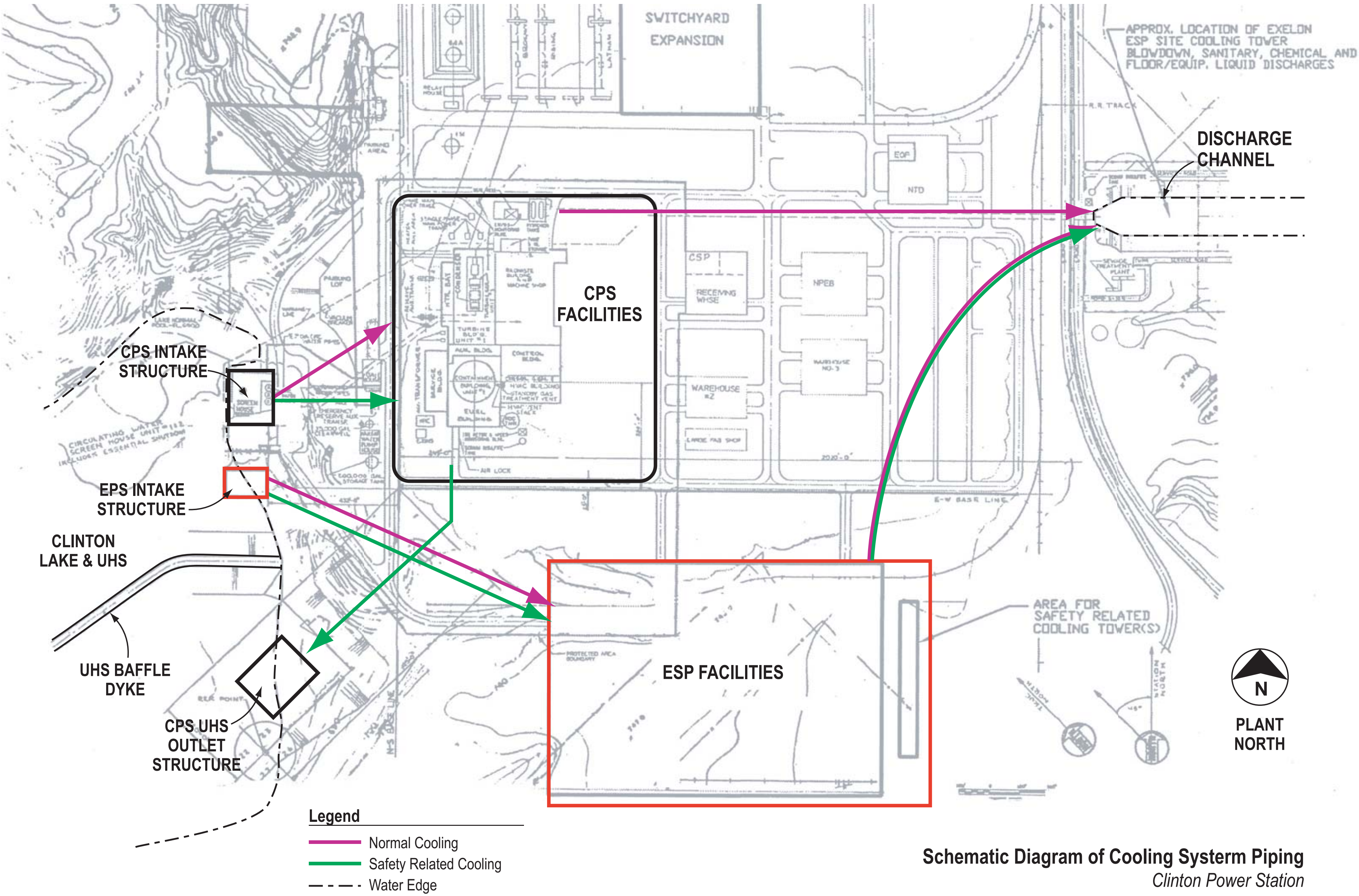
ATTACHMENT 5



Schematic Diagram of Cooling Systerm Piping

Clinton Power Station

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