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January 14, 2011

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Director, Technical Programs
Susquehanna River Basin Commission
1721 N. Front Street
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**BELL BEND NUCLEAR POWER PLANT**
**APPLICATION FOR SURFACE WATER WITHDRAWAL**
**APPLICATION FOR CONSUMPTIVE WATER USE**
**BNP-2011-005 Docket No. 52-039**

By letter of May 13, 2009, PPL Bell Bend LLC (PPL) submitted applications to the Susquehanna River Basin Commission (Commission) for groundwater withdrawal, surface water withdrawal, and consumptive water use at the proposed Bell Bend Nuclear Power Plant (BBNPP). On March 1, 2010 the Commission requested additional information on the applications. Since then, the application for groundwater withdrawal has been withdrawn, and the applications for surface water withdrawal and for consumptive water use have been supplemented.

The May 2009 application for surface water withdrawal requested the Commission's approval to withdraw up to a maximum of 44 million gallons per day (mgd) (peak day) from the Susquehanna River. Based on information that has become available since the initial application, PPL wishes to reduce the requested maximum (peak day) withdrawal to 42 mgd. Enclosure 1 to this letter documents the determination of the 42 mgd in accordance with Commission requirements under 18 CFR 806.14(a)(2) (iii) and (viii) and in response to the Commission's March 1, 210 letter.

The May 2009 application for consumptive water use requested the Commission's approval to consume up to a maximum of 31 mgd (peak day). Based on information that has become available since the initial application, PPL wishes to reduce the requested maximum (peak day) consumptive water use to 28 mgd. Enclosure 2 to this letter documents the determination of the 28 mgd in accordance with Commission requirements under 18 CFR 806.14(a)(2)(iv) and in response to the Commission's March 1, 210 letter. Enclosure 2 accounts for thermal-induced in-river evaporation as required by the Commission. Please note that the previously defined stormwater ponds are no longer a project component.

Final BBNPP system designs are not complete and the procurement of equipment has not begun; consequently, there are no certified cooling tower or pump performance curves. The requested maximum (peak day) 42 mgd surface water withdrawal and requested maximum (peak day) 28 mgd consumptive water use values are based on best available information and believed to be conservative, as explained in Enclosures 1 and 2, respectively. While PPL does not envision a need to do so, it is possible that one or both of the requested values will need to be revised as plant system designs are completed.

Actual water use at BBNPP will be monitored in accordance with an approved Water Monitoring Plan, in compliance with the Commission's regulations. PPL submitted a proposed Water Monitoring Plan to the Commission by letter dated July 8, 2010.

Should you or your staff have any questions, please contact Bradley Wise at 610.774.6508 or bawise@pplweb.com or Gary Petrewski at 610.774.5996 or gpetrewski@pplweb.com.

Respectfully,

TL Harpster

Terry L Harpster

TLH/kw

Enclosures: 1) Determination of Surface Water Withdrawal

2) Determination of Consumptive Water Use

cc: w/ Enclosures

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Enclosure 1

Determination of Surface Water Withdrawal

Contents

PPL Bell Bend, LLC
Bell Bend Nuclear Power Plant
Determination of Surface Water Withdrawal

## 1 Introduction

The initial applications to SRBC (May 2009) requested approval for surface water withdrawal up to a maximum (peak day) of 44 mgd and for consumptive water use up to a maximum (peak day) of 31 mgd. Based on currently available information, PPL Bell Bend has re-determined the surface water withdrawal and consumptive water use values. Consequently, PPL Bell Bend is revising the respective applications to request approval for surface water withdrawal up to a maximum (peak day) of 42 mgd and for consumptive water use up to a maximum (peak day) of 28 mgd.

Enclosure 1 documents determination of the requested maximum (peak day) surface water withdrawal of 42 mgd, as well as other water use values required in the application for surface water withdrawal. With respect to the required water use values, Enclosure 1 supersedes Attachment SW-3 to the initial application.

Abbreviations relating to plant systems used herein are:

- CWS – Circulating Water System
- CWSMWS – Circulating Water System Makeup Water System
- ESWS – Essential Service Water System
- ESWEMS – Essential Service Water Emergency Makeup System
- RWSS – Raw Water Supply System

## 2 General Information

All water necessary for normal and emergency use at BBNPP will be withdrawn from the Susquehanna River except for a relatively minor amount of potable and sanitary water that is expected to be supplied by the local purveyor and not addressed herein. The water withdrawn from the Susquehanna River for emergency use consists of on-site stored capacity, no water is required to be withdrawn from the Susquehanna River during an emergency.

BBNPP will have two systems that withdraw water from the Susquehanna River for BBNPP use, namely the CWSMWS and the RWSS, as depicted on Attachment A.

The CWSMWS will convey river water into a closed cooling system, which will utilize two natural draft counter-flow cooling towers (Main Cooling Towers) to remove heat from the circulating cooling water after passing through the plant's steam condenser. Evaporation is lost in the Main Cooling Towers; this loss increases the level of solids in the circulating water. To control dissolved solids, a portion of the re-circulated water will be removed (blowdown) and discharged to the river. In addition, there is a small loss for drift of the cooling tower spray. The CWSMWS provides makeup to replenish water lost by the Main Cooling Towers through evaporation, blowdown and drift.

The RWSS will supply water to the ESWS, the Demineralized Water Distribution System, the Fire Water Distribution System, Floor Wash Drains, and the RWSS filter backwash. The ESWS will feature four, closed cooling water systems. Each system will utilize a mechanical draft cooling tower with two cells to dissipate heat from the ESWS. Just as in the case of the Main

Cooling Towers, the RWSS provides makeup to ESWS to account for the cooling tower evaporation, blowdown and drift. The RWSS also supplies makeup to the ESWEMS Retention Pond to account for surface evaporative losses from the pond as needed.

In the determinations described below, consideration was given to adding an allowance for monitoring instrument accuracy, as was done in the initial applications. Allowance for monitoring instrument accuracy was intended to result in values of surface water withdrawal or consumptive water use that would not be exceeded, so long as the accuracy of the monitoring instruments remained within the required tolerance required by the Commission. However, PPL is confident that the maximum (peak day) surface water withdrawal of 42 mgd for which approval is being requested amply compensates for monitoring instrument accuracy. Accordingly, specific allowances for instrument accuracy are not included in the determinations below.

Because the amount of surface water withdrawal depends upon some plant consumptive water use, the determination of the relevant consumptive water use values is included below, for convenience. (Determinations of these and other consumptive water use values are presented in Enclosure 2.)

## 3 Determination of Consumptive Water Use Values Relevant to Determination of Surface Water Withdrawal

Three values of plant consumptive water use are required:

- Maximum (peak day) consumptive water use, required to determine maximum (peak day) surface water withdrawal;
- Maximum 30-day average consumptive water use, required to determine maximum 30-day average surface water withdrawal; and
- Average consumptive water use, required to determine average surface water withdrawal.

The maximum values will occur during normal (i.e., non-emergency) plant operation, at full power, during adverse climatic conditions.

There are a total of five (5) paths that consume water during normal plant operation and are relevant to the determination of surface water withdrawal. See Attachment A. These are:

- Main (CWS) Cooling Towers Evaporation
- Main (CWS) Cooling Towers Drift
- ESWS Cooling Towers Evaporation
- ESWS Cooling Towers Drift and
- ESWEMS Retention Pond Evaporation

### 3.1 Maximum (Peak Day) Consumptive Water Use

#### 3.1.1 Main Cooling Towers Evaporation

The maximum (peak day) value determined from a 61-year historical meteorological record is 16,723 gallons per minute (gpm) for two towers combined. See Attachment B.

#### 3.1.2 Main Cooling Towers Drift

The maximum daily value is 8 gpm. [Reference 5.1, Section 5.0] This value will be assumed in all cases for which consumptive water use is determined herein.

3.1.3 ESWS Cooling Towers Evaporation

The ESWS Cooling Towers evaporation that coincides with the maximum (peak day) Main Cooling Towers evaporation determined from 61 years of daily meteorological data is 480 gpm for two towers combined. See Attachment B.

3.1.4 ESWS Cooling Towers Drift

The maximum daily value is 2 gpm. [Reference 5.1, Section 5.0] This value will be assumed in all cases for which consumptive water use is determined herein.

3.1.5 ESWEMS Retention Pond Evaporation

Reference 5.4, Section 7.4 provides a calculation for water evaporation from the ESWEMS Retention Pond for worst-case meteorological conditions over a 30-day period. The result, 198,300 $ft^3$ is converted to gpm by

$$198{,}300\ ft^3/30\ days) \times (7.48\ gal/ft^3) \times (1\ gpm/1{,}440\ gal/day) = 34.3\ gpm$$

This value will be assumed in all cases for which consumptive water use is determined herein.

NOTE: The area of the ESWEMS Retention Pond is 247,900 $ft^2$. [Reference 5.4, Section 7.4] The worst-case 30-day evaporation rate is equivalent to

$$((198{,}300\ ft^3/30\ days)\ /247{,}900\ ft^2) \times 12\ in/ft = 9.6\ inches\ in\ 30\ days.$$

3.2 Maximum 30-Day Average Consumptive Water Use

3.2.1 Main Cooling Towers Evaporation

The maximum 30-day average value determined from a 61-year historical meteorological record is 16,026 gpm for two towers combined. See Attachment B.

3.2.2 Main Cooling Towers Drift

The maximum value of 8 gpm is assumed. [3.1.2]

3.2.3 ESWS Cooling Towers Evaporation

The 30-day average value that coincides with the maximum 30-day average Main Cooling Towers evaporation determined from 61 years of daily meteorological data is 448 gpm. See Attachment B.

3.2.4 ESWS Cooling Towers Drift

The maximum value of 2 gpm is assumed. [3.1.4]

3.2.5 ESWEMS Retention Pond Evaporation

The maximum value of 34.3 gpm is assumed. [3.1.5]

3.3 Average Consumptive Water Use

3.3.1 Main Cooling Towers Evaporation

The average value determined from a 61-year historical meteorological record is 13,360 gpm for two towers combined. See Attachment B.

3.3.2 Main Cooling Towers Drift

The maximum value of 8 gpm is assumed. [3.1.2]

3.3.3 ESWS Cooling Towers Evaporation

The average value that coincides with the average Main Cooling Towers evaporation determined from 61 years of daily meteorological data is 324 gpm. See Attachment B.

3.3.4 ESWS Cooling Towers Drift

The maximum value of 2 gpm is assumed. [3.1.4]

3.3.5 ESWEMS Retention Pond Evaporation

The maximum value of 34.3 gpm is assumed. [3.1.5]

4 Determination of Surface Water Withdrawal

Attachment A is a schematic diagram of the water flow into, within, and from the plant, and shows the flows corresponding to the maximum (peak day) surface water withdrawal.

Four values relating to surface water withdrawal are required:

- Maximum (peak day) surface water withdrawal;
- Maximum 30-day average surface water withdrawal;
- Average surface water withdrawal (demand); and
- Withdrawal systems capability.

The maximum withdrawal for CWSMWS occurs with the plant at 100% power, worst-case meteorological conditions and a blowdown flow to maintain 3.0 cycles of dissolved solids concentration. The maximum withdrawal for RWSS occurs when the plant is shutting down. Because the maximum withdrawal scenarios for each system are mutually exclusive, i.e. 100% power cannot exist during plant shutdown, the maximum surface water withdrawal will be based on CWSMWS supporting the plant at 100% power, worst-case meteorological conditions, a blowdown flow to maintain 3.0 cycles of dissolved solids concentration (Cycles = 3.0), and the RWSS supplying loads that are expected for 100% power operation. The average surface water withdrawal is also calculated assuming continuous normal, non-emergency operation, and 3.0 cycles of dissolved solids concentration.

Blowdown from an evaporative cooling tower is calculated as:

Blowdown = Evaporation/(Cycles-1) - Drift [Reference 5.1, Section 5.0]

The total plant withdrawal is the sum of the respective CSWMWS and RWSS withdrawal values. The CSWMWS Withdrawal is equal to

Main Cooling Tower ( Evaporation + Drift + Blowdown )

The RWSS Withdrawal is equal to

ESWS Cooling Tower ( Evaporation + Drift + Blowdown ) + the following miscellaneous uses shown on Attachment A:

| Use | gpm |
|---|---|
| Makeup to ESWEMS Pond | 24 |
| RWSS Filter Backwash | 91 |
| Demineralizer Makeup | 107 |
| Fire Water Distribution System | 5 |
| Floor Wash Drains | 5 |
| Total of Miscellaneous Uses | 232 |

Miscellaneous uses equal to 232 gpm will be assumed in all cases for which surface water withdrawal is determined herein.

4.1 Maximum (Peak Day) Surface Water Withdrawal

4.1.1 CWSMWS Withdrawal

The maximum (peak day) Main Cooling Towers evaporation is 16,723 gpm. [3.1.1]

The Main Cooling Towers drift is 8 gpm. [3.1.2]

Then, Main Cooling Towers blowdown = 16,723/(3-1) - 8 = 8,354 gpm

CWSMWS Withdrawal = Main Cooling Towers (Evaporation + Blowdown + Drift)
= 16,723 gpm + 8,354 gpm + 8 gpm
= 25,085 gpm

4.1.2 RWSS Withdrawal

The ESWS Cooling Towers evaporation that coincides with the maximum (peak day) Main Cooling Towers evaporation is 480 gpm. [3.1.3]

The ESWS Cooling Towers drift is 2 gpm. [3.1.4]

Then, ESWS Cooling Towers blowdown = 480/(3-1) -2 = 238 gpm

RWSS Withdrawal = ESWS Cooling Towers (Evaporation + Blowdown + Drift) + Miscellaneous Uses
= 480 gpm + 238 gpm + 2 gpm + 232 gpm = 952 gpm
The maximum (peak day) surface water withdrawal is then
25,085 gpm + 952 gpm =26,037 gpm = 37.5 mgd.

## 4.2 Maximum 30-Day Average Surface Water Withdrawal

### 4.2.1 CWSMWS Withdrawal

The maximum 30-day average Main Cooling Towers evaporation is 16,026 gpm. [3.2.1]

The Main Cooling Towers drift is 8 gpm. [3.1.2]

Then, Main Cooling Towers blowdown = 16,026/(3-1) - 8 = 8,005 gpm

CWSMWS Withdrawal = Main Cooling Towers (Evaporation + Blowdown + Drift)
= 16,026 gpm + 8,005 gpm + 8 gpm = 24,039 gpm

### 4.2.2 RWSS Withdrawal

The ESWS Cooling Towers evaporation that coincides with the maximum 30-day average Main Cooling Towers evaporation is 448 gpm. [3.2.3]

The ESWS Cooling Towers drift is 2 gpm. [3.1.4]

Then, ESWS Cooling Towers blowdown = 448/(3-1) -2 = 222 gpm

RWSS Withdrawal = ESWS Cooling Towers (Evaporation + Blowdown + Drift) + Miscellaneous Uses
= 448 gpm + 222 gpm + 2 gpm + 232 gpm = 904 gpm

The maximum 30-day average surface water withdrawal is then:
24,039 gpm + 904 gpm = 24,943 gpm = 35.9 mgd.

## 4.3 Average Surface Water Withdrawal

### 4.3.1 CWSMWS Withdrawal

The average Main Cooling Tower evaporation value determined from a 61-year historical meteorological record is 13,360 gpm for two towers combined. [3.3.1]

The Main Cooling Towers drift is 8 gpm. [3.1.2]

Then, Main Cooling Towers blowdown = 13,360/(3-1) - 8 = 6,672 gpm

CWSMWS Withdrawal = Main Cooling Towers (Evaporation + Blowdown + Drift)
= 13,360 gpm + 6,672 gpm + 8 gpm
= 20,040 gpm

4.3.2 RWSS Withdrawal

The average ESWS Cooling Towers evaporation value determined from a 61-year historical meteorological record is 324 gpm for two towers combined. [3.3.3]

The ESWS Cooling Towers drift is 2 gpm. [3.1.4]

Then, ESWS Cooling Towers blowdown = 324/(3-1) -2 = 160 gpm

RWSS Withdrawal = ESWS Cooling Towers (Evaporation + Blowdown + Drift) + Miscellaneous Uses
= 324 gpm + 160 gpm + 2 gpm + 232 gpm = 718 gpm

The average surface water withdrawal is then:
20,040 gpm + 718 gpm =20,758 gpm = 29.9 mgd.

4.4 Withdrawal Systems Capability

The CWSMWS has three (3) 50% capacity vertical pumps each rated 13,100 gpm @ 182 psi. [Reference 5.2, Section 4.3.2] Expected normal operation is two pumps in service.

The RWSS has three (3) pumps each rated 2,900 gpm @ 552 ft TDH. [Reference 5.3, Section 6] The number of pumps in service will be dependent on the mode of the plant. During normal operation one pump in service will be sufficient to handle the load.

No scenario is envisioned during which simultaneous pump operation would exceed the combined capacity of two CWSMWS pumps and one RWSS pump. Thus, the maximum instantaneous surface water withdrawal is equal to:

2 x 13,100 gpm + 2,900 gpm = 29,100 gpm = 41.9 mgd

Since the maximum instantaneous surface water withdrawal based on maximum pump operation (41.9 mgd) exceeds the calculated maximum (peak day) surface water withdrawal (37.5 mgd), approval for the maximum instantaneous surface water withdrawal rounded up to 42 mgd from 41.9 mgd is being requested.

5 References

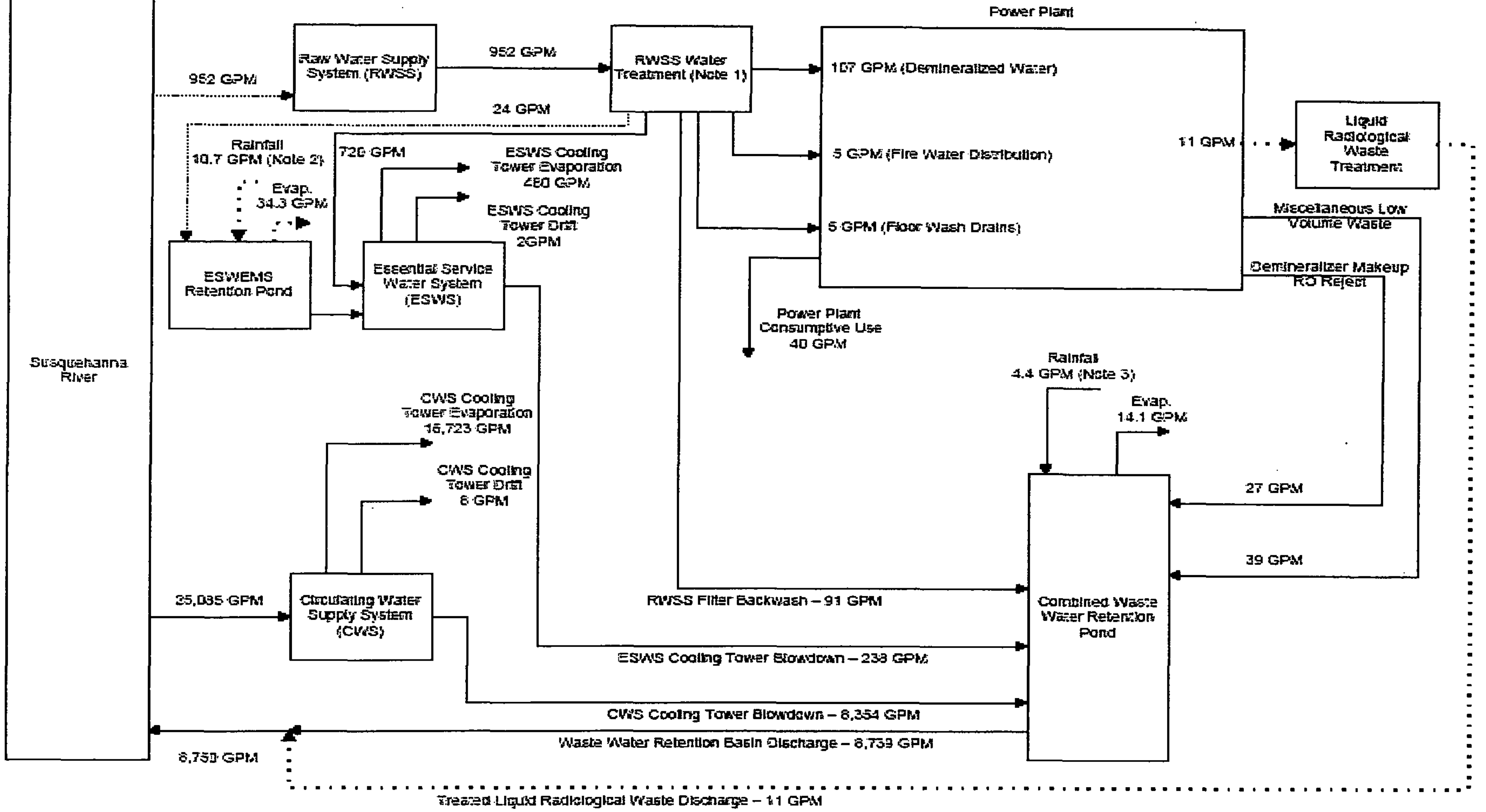
5.1 Sargent & Lundy Calculation 2008-08550, Rev. 3, Bell Bend Water Balance Calculation

5.2 Sargent & Lundy Report No. SL-009498, Rev. 6, Conceptual Design of the CWS Pump and Pipe Sizing Calculation

5.3 Sargent & Lundy Calculation No. 2008-07916, Rev. 6, RWSS Pump and Pipe Sizing

5.4 Black & Veatch Calculation 161642.51.2001, Rev. 1, ESWEMS Retention Pond Sizing

# Attachment A




NOTES:

1. Dual media filtration.
2. Based on an annual precipitation of 36.25 inches (BBNPP ER Table 2.7-50) and pond surface area 246,533 sq.ft. (B&V Calculation 161642.51.2001 Rev. 1, Section 6.3)
3. Base on an annual precipitation of 36.25 inches (BBNPP ER Table 2.7-50) and pond surface area 101,500 sq.ft. (S&L Report SL-009495 Bell Bend Nuclear Power Plant Rev.6)
4. Process flow values are rounded to the nearest whole value.

LEGEND:

Normal Flows
Flow Varies
DBA Shutdown Flow

BELL BEND NUCLEAR POWER PLANT
PEAK DAY WATER USE DIAGRAM

Attachment B

Determination of BBNPP Cooling Tower Evaporation Rates

BBNPP will have two types of evaporative cooling towers. There will be two Circulating Water System (Main) cooling towers and four Essential Service Water System (ESWS) cooling towers. During normal plant operation, both Main cooling towers and two ESWS cooling towers will be in service.

The Main cooling towers will be natural draft towers, each with a design water flow of 360,000 gpm and a design cooling range of 27.56 F degrees. A cooling tower manufacturer has provided a diagram relating expected evaporation rate (per tower) to relative humidity (RH) and wet-bulb temperature (WBT) corresponding to the design water flow and cooling range. The diagram depicts four curves of evaporation rate; the four curves represent RH values of 25, 50, 75 and 100 percent respectively, and each curve spans WBT values ranging from 30 to 90 degrees F.

The ESWS cooling towers will be mechanical draft towers, each with a design water flow of 19,200 gpm and a cooling range of 13.4 F degrees during normal operation. A cooling tower manufacturer has provided several diagrams relating expected evaporation rate (per tower) to cooling range, RH and WBT corresponding to a water flow of 19,000 gpm. (The evaporation rates determined as described below were adjusted to represent the design water flow of 19,200 gpm.) The several diagrams each represent a selected RH value from 28 to 72 percent; each diagram depicts two curves, one for each of two selected cooling ranges, and each curve spans WBT values ranging from 30 to 70 degrees F.

Daily average RH and WBT values for the meteorological station at Wilkes-Barre were obtained for the 61-year period January 1949 through December 2009. (The daily record is approximately 99 percent complete for this period.) Daily in-plant consumptive water use was simulated by an Excel spreadsheet prepared for this purpose; normal, full-load plant operation each day during the simulation period was assumed. The spreadsheet includes algorithms to determine daily Main cooling tower evaporation and daily ESWS cooling tower evaporation as a function of daily average RH and WBT; the algorithms were derived by interpolation and extrapolation from the respective cooling tower evaporation curves provided by the manufacturers.

Table A-1 on the following page presents the cooling tower evaporation rates cited in the Main Report, as determined by the spreadsheet simulation, along with the corresponding dates and average RH and WBT values. It is important to note that the maximum evaporation rates for the Main and the ESWS cooling towers do not occur at the same RH and WBT conditions. Maximum in-plant consumptive use coincides with maximum Main cooling tower evaporation; accordingly, the ESWS cooling tower evaporation rates for the peak day and maximum 30-day average as presented in Table A-1 are slightly less than the corresponding maximum rates for the ESWS cooling towers alone.

Table A-1. BBNPP Cooling Tower Evaporation Rates Cited in Enclosure 1

| Condition | | Date(s) | RH (%) | WBT (deg F) | Cooling Tower | Evaporation Rate (gpm, total two towers) |
|---|---|---|---|---|---|---|
| 1 | Peak Day | July 15, 1995 | 66.2 | 77.8 | Main | 16,723 |
| | | | | | ESWS | 480 |
| 2 | Maximum 30-day average | July 8 through August 6, 1955 | 62.2 [1] | 67.1 [1] | Main | 16,026 |
| | | | | | ESWS | 448 |
| 3 | Daily Average | January 1949 through December 2009 | 69.3 [1] | 44.4 [1] | Main | 13,360 |
| | | | | | ESWS | 324 |

[Note 1] The average RH and WBT values for the maximum 30-day average and 61-year average conditions are presented for reference. The evaporation rates presented in the table are the averages of the simulated daily evaporation rates during the respective periods rather than the evaporation rates corresponding to the average RH and WBT values during the period.

# Enclosure 2

## Determination of Consumptive Water Use

Contents

PPL Bell Bend, LLC
Bell Bend Nuclear Power Plant
Determination of Consumptive Water Use

## 1 Introduction

The initial applications to SRBC (May 2009) requested approval for surface water withdrawal up to a maximum (peak day) of 44 mgd and for consumptive water use up to a maximum (peak day) of 31 mgd. Based on currently available information, PPL Bell Bend has re-determined the surface water withdrawal and consumptive water use values. Consequently, PPL Bell Bend is revising the respective applications to request approval for surface water withdrawal up to a maximum (peak day) of 42 mgd and for consumptive water use up to a maximum (peak day) of 28 mgd.

Enclosure 2 documents determination of the requested maximum (peak day) consumptive water use of 28 mgd, as well as other water use values required in the application for consumptive water use. With respect to the required water use values, Enclosure 2 supersedes Attachment CU-3 to the initial application.

Abbreviations relating to plant systems used herein are:

- CWS – Circulating Water System
- CWSMWS – Circulating Water System Makeup Water System
- ESWS – Essential Service Water System
- ESWEMS – Essential Service Water Emergency Makeup System
- RWSS – Raw Water Supply System

## 2 General Information

All water necessary for normal and emergency use at BBNPP will be withdrawn from the Susquehanna River except for a relatively minor amount of potable and sanitary water that is expected to be supplied by the local purveyor and not addressed herein. The water withdrawn from the Susquehanna River for emergency use consists of on-site stored capacity, no water is required to be withdrawn from the Susquehanna River during an emergency.

BBNPP will have two systems that withdraw water from the Susquehanna River for BBNPP use, namely the CWSMWS and the RWSS, as depicted on Attachment A.

The CWSMWS will convey river water into a closed cooling system, which will utilize two natural draft counter-flow cooling towers (Main Cooling Towers) to remove heat from the circulating cooling water after passing through the plant's steam condenser. Evaporation is lost in the Main Cooling Towers; this loss increases the level of solids in the circulating water. To control dissolved solids, a portion of the re-circulated water will be removed (blowdown) and discharged to the river. In addition, there is a small loss for drift of the cooling tower spray. The CWSMWS provides makeup to replenish water lost by the Main Cooling Towers through evaporation, blowdown and drift.

The RWSS will supply water to the ESWS, the Demineralized Water Distribution System, the Fire Water Distribution System, Floor Wash Drains, and the RWSS filter backwash. The ESWS will feature four, closed cooling water systems. Each system will utilize a mechanical draft cooling tower with two cells to dissipate heat from the ESWS. Just as in the case of the Main

Cooling Towers, the RWSS provides makeup to ESWS to account for the cooling tower evaporation, blowdown and drift. The RWSS also supplies makeup to the ESWEMS Retention Pond to account for surface evaporative losses from the pond as needed.

In the determinations described below, consideration was given to adding an allowance for monitoring instrument accuracy, as was done in the initial applications. Allowance for monitoring instrument accuracy was intended to result in values of surface water withdrawal or consumptive water use that would not be exceeded, so long as the accuracy of the monitoring instruments remained within the required tolerance required by the Commission. However, PPL is confident that the maximum (peak day) consumptive water use of 28 mgd for which approval is being requested amply compensate for monitoring instrument accuracy. Accordingly, specific allowances for instrument accuracy are not included in the determinations below.

## 3 Determination of Consumptive Water Use

Two values of plant consumptive water use are required: maximum (peak day) consumptive water use; and maximum 30-day average consumptive water use. These maximum values will occur during normal (i.e., non-emergency) plant operation, at full power, during adverse climatic conditions.

There are a total of seven (7) paths that consume water during normal plant operation. See Attachment A. These are:

- Main (CWS) Cooling Towers Evaporation
- Main (CWS) Cooling Towers Drift
- ESWS Cooling Towers Evaporation
- ESWS Cooling Towers Drift
- ESWEMS Retention Pond Evaporation
- Combined Waste Water Retention Basin Evaporation and
- Power Plant Consumptive Use

In addition to the above values an allowance will be added for in-river evaporation from the BBNPP blowdown discharge at the river diffuser.

The maximum daily value for each path and allowance for in-river evaporation are provided below either by reference or by calculation, and then the values are summed to determine a maximum daily consumptive use.

### 3.1 Maximum (Peak Day) Consumptive Water Use

#### 3.1.1 Main Cooling Towers Evaporation

The maximum (peak day) value determined from a 61-year historical meteorological record is 16,723 gallons per minute (gpm) for two towers combined. See Attachment B.

#### 3.1.2 Main Cooling Towers Drift

The maximum daily value is 8 gpm. [Reference 5.2, Section 5.0] This value will be assumed in all cases for which consumptive water use is determined herein.

3.1.3 ESWS Cooling Towers Evaporation

The ESWS Cooling Towers evaporation that coincides with the maximum (peak day) Main Cooling Towers evaporation determined from 61 years of daily meteorological data is 480 gpm for two towers combined. See Attachment B.

3.1.4 ESWS Cooling Towers Drift

The maximum daily value is 2 gpm. [Reference 5.2, Section 5.0] This value will be assumed in all cases for which consumptive water use is determined herein.

3.1.5 ESWEMS Retention Pond Evaporation

Reference 5.5, Section 7.4 provides a calculation for water evaporation from the ESWEMS Retention Pond for worst-case meteorological conditions over a 30-day period. The result, 198,300 $ft^3$ is converted to gpm by

$$198{,}300\ ft^3/30\ days) \times (7.48\ gal/ft^3) \times (1\ gpm/1440\ gal/day) = 34.3\ gpm$$

This value will be assumed in all cases for which consumptive water use is determined herein.

NOTE: The area of the ESWEMS Retention Pond is 247,900 $ft^2$. [Reference 5.5, Section 7.4] The worst-case 30-day evaporation rate is equivalent to

$$((198{,}300\ ft^3/30\ days)\ /247{,}900\ ft^2) \times 12\ in/ft = 9.6\ inches\ in\ 30\ days.$$

3.1.6 Combined Waste Water Retention Basin Evaporation

Evaporation for this basin can be determined from the ESWEMS Retention Pond evaporation rate above based on the ratio of surface areas. The surface area for the Combined Waste Water Retention Basin is 102,000 $ft^2$. [Reference 5.3, Section 4.7] The evaporative loss from the Combined Waste Water Retention Basin is then

$$(102{,}000\ ft^2/247{,}900\ ft^2) \times 34.3\ gpm = 14.1\ gpm$$

This value will be assumed in all cases for which consumptive water use is determined herein.

3.1.7 Power Plant Consumptive Use

Maximum daily value is 40 gpm. [Reference 5.1, Figure 3.3-1] This value will be assumed in all cases for which consumptive water use is determined herein.

3.1.8 Allowance for In-River Evaporation

Attachment D [replicated from Reference 5.6] presents the calculation of in-river evaporation at BBNPP; the methodology used is explained in Attachment C [replicated from Reference 5.6]. The calculated maximum monthly in-river evaporation in Attachment D is 88,000 gallons per day, or 61.1 gpm. Although in-river evaporation at a rate of 61.1 gpm is unlikely to coincide with maximum plant consumptive water use, this value will be assumed in all cases for which consumptive water use is determined herein.

The calculated maximum (peak day) consumptive water use is thus 17,363 gpm without allowance for monitoring instrument accuracy, as follows:

| Path/Allowance | gpm |
|---|---|
| Main Cooling Tower Evaporation | 16,723 |
| Main Cooling Tower Drift | 8 |
| ESWS Cooling Towers Evaporation | 480 |
| ESWS Cooling Towers Drift | 2 |
| ESWEMS Retention Pond Evaporation | 34.3 |
| Combined Waste Water Retention Pond Evaporation | 14.1 |
| Power Plant Consumptive Use | 40 |
| In-River Evaporation | 61.1 |
| TOTAL | 17, 363 |

The calculated maximum consumptive water use of 17,363 gpm is equal to 25.0 mgd. PPL is applying for approval of consumptive water use up to 28 mgd to provide an adequate margin for monitoring instrument accuracy or any other unforeseen condition that could result in monitored consumptive water use exceeding the calculated maximum of 25.0 mgd.

3.2 Maximum 30-Day Average Consumptive Water Use

3.2.1 Main Cooling Towers Evaporation

The maximum 30-day average value determined from a 61-year historical meteorological record is 16,026 gpm for two towers combined. See Attachment B.

3.2.2 Main Cooling Towers Drift

The maximum value of 8 gpm is assumed. [3.1.2]

3.2.3 ESWS Cooling Towers Evaporation

The 30-day average value that coincides with the maximum 30-day average Main Cooling Towers evaporation determined from 61 years of daily meteorological data is 448 gpm. See Attachment B.

3.2.4 ESWS Cooling Towers Drift

The maximum value of 2 gpm is assumed. [3.1.4]

3.2.5 ESWEMS Retention Pond Evaporation

The maximum value of 34.3 gpm is assumed. [3.1.5]

3.2.6 Combined Waste Water Retention Basin Evaporation

The maximum value of 14.1 gpm is assumed. [3.1.6]

3.2.7 Power Plant Consumptive Use

The maximum value of 40 gpm is assumed. [3.1.7]

3.2.8 Allowance for In-River Evaporation

The maximum value of 61.1 gpm is assumed. [3.1.8]

The calculated maximum 30-day average consumptive water use is thus 16,634 gpm without allowance for monitoring instrument accuracy, as follows:

| Path/Allowance | gpm |
|---|---|
| Main Cooling Tower Evaporation | 16,026 |
| Main Cooling Tower Drift | 8 |
| ESWS Cooling Towers Evaporation | 448 |
| ESWS Cooling Towers Drift | 2 |
| ESWEMS Retention Pond Evaporation | 34.3 |
| Combined Waste Water Retention Pond Evaporation | 14.1 |
| Power Plant Consumptive Use | 40 |
| In-river Evaporation | 61.1 |
| TOTAL | 16,634 |

The calculated maximum 30-day average consumptive water use of 16,634 gpm is equal to 24.0 mgd.

4 Maximum Daily Total Withdrawal

The maximum surface water withdrawal being requested is based upon the capability of the withdrawal systems. CWSMWS has three (3) 50% capacity vertical pumps each rated 13,100 gpm @ 182 psi. [Reference 5.2, Section 4.3.2] Expected normal operation is two pumps in service.

The RWSS has three (3) pumps each rated 2,900 gpm @ 552 ft TDH. [Reference 5.3, Section 6] The number of pumps in service will be dependent on the mode of the plant. During normal operation one pump in service will be sufficient to handle the load.

No scenario is envisioned during which simultaneous pump operation would exceed the combined capacity of two CWSMWS pumps and one RWSS pump. Thus, the maximum daily surface water withdrawal is equal to:

$$2 \times 13{,}100 \text{ gpm} + 2{,}900 \text{ gpm} = 29{,}100 \text{ gpm} = 41.9 \text{ mgd}$$

Approval for a maximum instantaneous surface water withdrawal rounded up to 42 mgd from 41.9 mgd is being requested.

## 5 References


5.1 BBNPP Environmental Report, Revision 2

5.2 Sargent & Lundy Calculation 2008-08550, Rev. 3, Bell Bend Water Balance Calculation

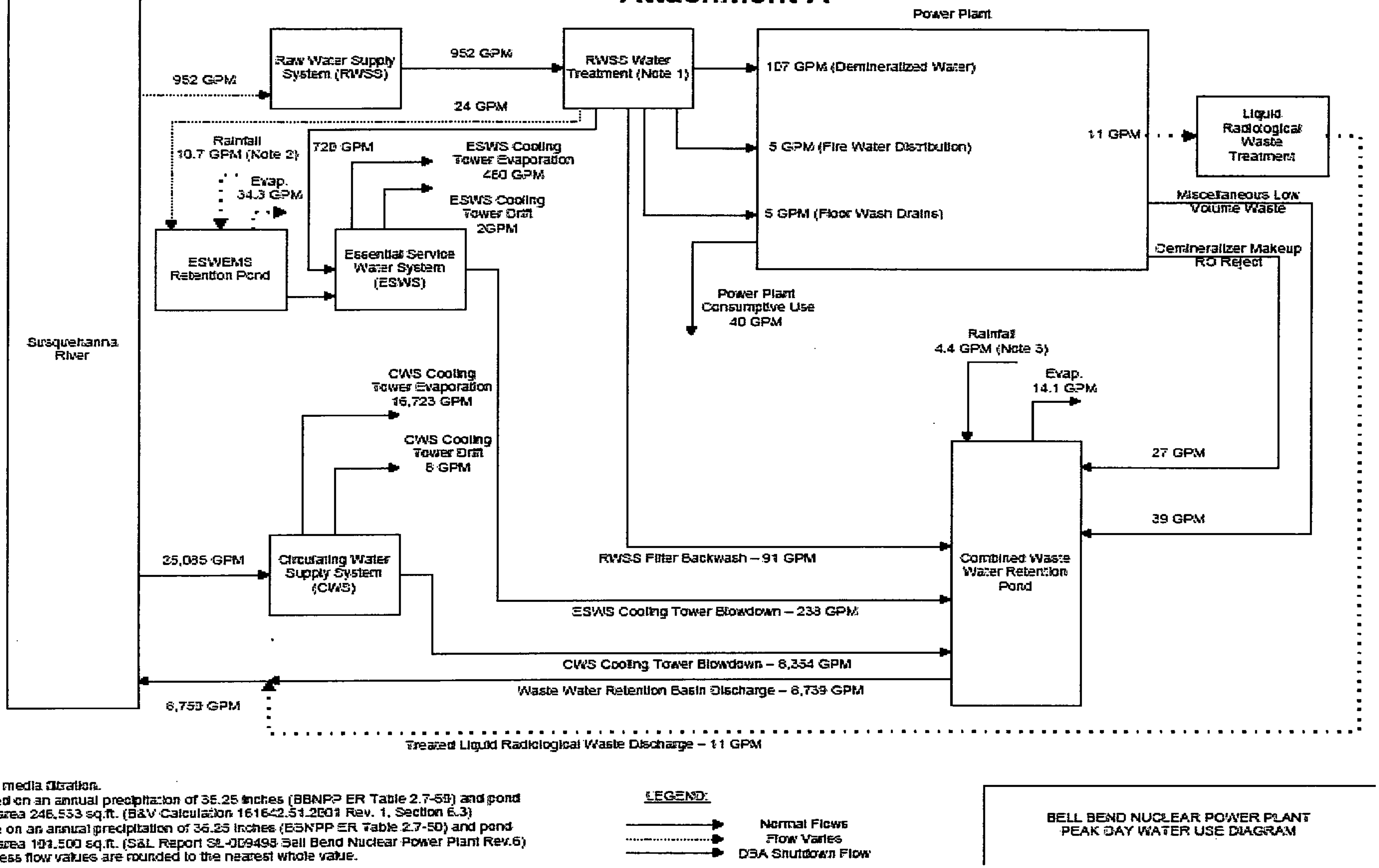
5.3 Sargent & Lundy Report No. SL-009498, Rev. 6, Conceptual Design of the CWS Pump and Pipe Sizing Calculation

5.4 Sargent & Lundy Calculation No. 2008-07916, Rev. 6, RWSS Pump and Pipe Sizing

5.5 Black & Veatch Calculation 161642.51.2001, Rev. 1, ESWEMS Retention Pond Sizing

5.6 Water Monitoring Plan for Bell Bend Nuclear Power Plant submitted by letter BNP-2010-164 to the SRBC July 8, 2010.

# Attachment A




NOTES:
1. Dual media filtration.
2. Based on an annual precipitation of 36.25 inches (BBNPP ER Table 2.7-50) and pond surface area 246,533 sq.ft. (B&V Calculation 161642.51.2001 Rev. 1, Section 6.3)
3. Base on an annual precipitation of 36.25 inches (BBNPP ER Table 2.7-50) and pond surface area 101,500 sq.ft. (S&L Report SL-009498 Bell Bend Nuclear Power Plant Rev.6)
4. Process flow values are rounded to the nearest whole value.

Attachment B

Determination of BBNPP Cooling Tower Evaporation Rates

BBNPP will have two types of evaporative cooling towers. There will be two Circulating Water System (Main) cooling towers and four Essential Service Water System (ESWS) cooling towers. During normal plant operation, both Main cooling towers and two ESWS cooling towers will be in service.

The Main cooling towers will be natural draft towers, each with a design water flow of 360,000 gpm and a design cooling range of 27.56 F degrees. A cooling tower manufacturer has provided a diagram relating expected evaporation rate (per tower) to relative humidity (RH) and wet-bulb temperature (WBT) corresponding to the design water flow and cooling range. The diagram depicts four curves of evaporation rate; the four curves represent RH values of 25, 50, 75 and 100 percent respectively, and each curve spans WBT values ranging from 30 to 90 degrees F.

The ESWS cooling towers will be mechanical draft towers, each with a design water flow of 19,200 gpm and a cooling range of 13.4 F degrees during normal operation. A cooling tower manufacturer has provided several diagrams relating expected evaporation rate (per tower) to cooling range, RH and WBT corresponding to a water flow of 19,000 gpm. (The evaporation rates determined as described below were adjusted to represent the design water flow of 19,200 gpm.) The several diagrams each represent a selected RH value from 28 to 72 percent; each diagram depicts two curves, one for each of two selected cooling ranges, and each curve spans WBT values ranging from 30 to 70 degrees F.

Daily average RH and WBT values for the meteorological station at Wilkes-Barre were obtained for the 61-year period January 1949 through December 2009. (The daily record is approximately 99 percent complete for this period.) Daily in-plant consumptive water use was simulated by an Excel spreadsheet prepared for this purpose; normal, full-load plant operation each day during the simulation period was assumed. The spreadsheet includes algorithms to determine daily Main cooling tower evaporation and daily ESWS cooling tower evaporation as a function of daily average RH and WBT; the algorithms were derived by interpolation and extrapolation from the respective cooling tower evaporation curves provided by the manufacturers.

Table A-1 on the following page presents the cooling tower evaporation rates cited in the Main Report, as determined by the spreadsheet simulation, along with the corresponding dates and average RH and WBT values. It is important to note that the maximum evaporation rates for the Main and the ESWS cooling towers do not occur at the same RH and WBT conditions. Maximum in-plant consumptive use coincides with maximum Main cooling tower evaporation; accordingly, the ESWS cooling tower evaporation rates for the peak day and maximum 30-day average as presented in Table A-1 are slightly less than the corresponding maximum rates for the ESWS cooling towers alone.

Table A-1. BBNPP Cooling Tower Evaporation Rates Cited in Enclosure 1

| Condition | | Date(s) | RH (%) | WBT (deg F) | Cooling Tower | Evaporation Rate (gpm, total two towers) |
|---|---|---|---|---|---|---|
| 1 | Peak Day | July 15, 1995 | 66.2 | 77.8 | Main | 16,723 |
| | | | | | ESWS | 480 |
| 2 | Maximum 30-day average | July 8 through August 6, 1955 | 62.2 [1] | 67.1 [1] | Main | 16,026 |
| | | | | | ESWS | 448 |
| 3 | Daily Average | January 1949 through December 2009 | 69.3 [1] | 44.4 [1] | Main | 13,360 |
| | | | | | ESWS | 324 |

[Note 1] The average RH and WBT values for the maximum 30-day average and 61-year average conditions are presented for reference. The evaporation rates presented in the table are the averages of the simulated daily evaporation rates during the respective periods rather than the evaporation rates corresponding to the average RH and WBT values during the period.

Attachment C

Methodology to Calculate In-River Evaporation

[Attachment C replicates Attachment 3 to the Water Monitoring Plan for Bell Bend Nuclear Power Plant submitted to the Commission on July 8, 2010]

The owners of electric generating facilities in the Delaware and Susquehanna river basins have estimated in-stream evaporation induced by thermal discharge using a method developed in the 1960s by Edinger and Geyer. [1 2 3] The "Edinger-Geyer Method" is employed to determine a coefficient of evaporation ("C") in cfs (alternatively, MGD) per billion Btu/hr of heat rejected by the plant or unit. The ambient parameters used in the method are the temperature of the receiving water body, the dew point temperature and the wind speed. Typically, long-term average monthly values for these parameters are used to determine a value of "C" for each month of the year. The average evaporation for each month is determined as the product of the plant/unit full-load heat rejection rate, the plant/unit capacity factor for the month, and the monthly "C" value.

The method is as follows, where:

C - consumptive water use (cfs per $10^9$ Btu/hr)

$T_d$ - dew point temperature (°F)

$T_s$ - background temperature of receiving stream (°F, assumed surface)

U - wind speed (miles per hr)

L - latent heat of vaporization of water at $T_s$ (Btu per lb)

B - slope of saturated water vapor pressure curve between $T_d$ and $T_s$ (mmHg per °F)

K - surface heat exchange coefficient (Btu ft $^{-2}$ day $^{-1}$ °F $^{-1}$)

Monthly average values of $T_d$, $T_s$ and U are obtained from long-term data.

L depends upon $T_s$ and may be determined from a table of water properties or approximated as $L = 1093.9 - 0.566T_s$

B, K and C are calculated as:

$B= 0.255 - 0.0085T + 0.000204T^2$ (mmHg per °F)

where $T = (T_s + T_d)/2$ (°F)

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1 Edinger, J.E. and J.C. Geyer, "Heat Exchange in the Environment," Edison Electric Institute, Publication NO. 65-902, 1965

2 Helwig, D.R., "An Overview of Heat Rejection from Electric Generating Facilities," presentation to the SRBC on behalf of Susquehanna River Basin Electric Utilities Group, 1975

3 Technical Support Document - Calculation of Evaporative Water Loss from Steam Electric Plants Located in the Delaware River Basin," Delaware River Basin Electric Utilities Group, 1986

$K = 15.7 + (B+0.26) \times f(W)$ (Btu $ft^{-2}$ $day^{-1}$ $°F^{-1}$)

where $f(W) = 70 + 0.7U^2$ (Btu $ft^{-2}$ $day^{-1}$ $mmHg^{-1}$)

$C = (4450/L) \times B \times (K-15.7)/((0.26 + B) \times K)$ (cfs per $10^9$ Btu/hr)

Alternatively, $C = (2880/L) \times B \times (K-15.7)/((0.26 + B) \times K)$ (MGD per $10^9$ Btu/hr)

Attachment D

Calculation of In-River Evaporation at BBNPP

[Attachment D replicates Attachment 4 to the Water Monitoring Plan for Bell Bend Nuclear Power Plant submitted to the Commission on July 8, 2010]

Ambient Data
Available monthly average ambient meteorological and river water temperature data tabulated below were used in the calculation.

| Parameter | Available each month during 1977 through 2007 except as noted | Data site |
|---|---|---|
| Wet-bulb temperature | excludes Jul-Sep 1988 | Wilkes-Barre weather station |
| Relative humidity | excludes Jul-Sep 1988 | Wilkes-Barre weather station |
| River water temperature | excludes Aug 2003-Jan 2004 and Aug 2007-Dec 2007 | Susquehanna SES |
| Dew point temperature | excludes Oct-Dec 2007 | Wilkes-Barre weather station |
| Wind speed | excludes Oct-Dec 2007 | Wilkes-Barre weather station |

These data allowed estimated in-river evaporation to be calculated for ambient conditions during each month of the following periods: January 1977 through June 1988; October 1988 through July 2003; and February 2004 through July 2007.

Circulating Water System (CWS) Cooling Tower Blowdown Flow Rate (gpm)
The monthly average CWS full-power cooling tower blowdown flow was estimated as follows:

1. CWS cooling tower evaporation rate (gpm) was derived from manufacturer evaporation curves[4] according to monthly average wet-bulb temperature (WBT) and relative humidity (RH). The evaporation curves were replicated mathematically in a spreadsheet to facilitate derivation of the evaporation rates.
2. Blowdown flow rate (gpm) was calculated as evaporation rate divided by the difference between assumed cycles of concentration (CC) and unity. CC was assumed in all months to be 3.0. The result for each month:

   Monthly average blowdown flow rate = monthly average evaporation rate / 2

Total Plant Blowdown Flow Rate (gpm)
The total plant blowdown flow rate (gpm) was considered to be the estimated CWS cooling tower blowdown flow rate plus a constant additional flow rate of 724 gpm. The 724 gpm is the estimated normal operations peak day flow rate from other plant systems:

- Essential Service Water System cooling tower blowdown (567 gpm)
- Raw Water Supply System water treatment filter backwash (91 gpm)
- Miscellaneous Low Volume Waste flow (39 gpm)
- Demineralizer Makeup Reverse Osmosis reject flow (27 gpm)

Intermittent water treatment flow (11 gpm) is not included.

CWS Cooling Tower Blowdown Temperature (deg F)

[4] SPX Cooling Tower Co., "TRACS Version 18-SEP-08, Cooling Tower Model 8500 202-5.3-324," 100% design flow rate, April 2, 2010.

1. CWS cold-water temperature was derived from manufacturer cold-water temperature curves[5] according to monthly average WBT and RH. The cold-water temperature curves were replicated mathematically in a spreadsheet to facilitate derivation of the cold-water temperatures. The curves are linear and correspond to WBT ranging from 60 deg F to 80 deg F; the curves were assumed to extend linearly in both directions outside that WBT range.
2. CWS blowdown temperature was assumed to be equal to the cold-water temperature.

Total Plant Blowdown Temperature (deg F)
The CWS cooling tower blowdown temperature was assumed to be the temperature of the total plant blowdown to the river.

Heat Rejection Rate (billion Btu per hour)
The heat rejection rate to the river (HRR, $10^9$ Btu/hr) was calculated as the product of (a) the total plant blowdown flow rate and (b) the difference between the total plant blowdown temperature and the river water temperature, adjusted for units:

HRR ($10^9$ Btu/hr) = 8.34 x blowdown flow rate (gpm) x 60
x (blowdown temperature – river water temperature) (deg F) / $10^9$, or
HRR ($10^9$ Btu/hr) = 0.0000005 x blowdown flow rate (gpm)
x (blowdown temperature – river water temperature) (deg F)

HRR was assumed equal to zero when river water temperature exceeded blowdown temperature.

In-River Evaporation Rate (gpd)
The estimated monthly average in-river evaporation rate was calculated in accordance with the methodology in Attachment 3, corresponding to monthly average ambient river water temperature, dew point temperature and wind speed.

Back-up In-River Evaporation Rates (gpd)
The estimated in-river evaporation rates corresponding to full-power operation for ambient conditions of 1977 through 2007 are tabulated on the following page. The back-up in-river evaporation rates in Attachment 2 are the maximum monthly rates shown in the table, for each month.

Conservatism of Estimated Amounts
The estimated in-river evaporation rates are considered to be conservative (high) for the following reasons:

- 3.0 cycles of concentration (CC) were assumed in calculating the CWS cooling tower blowdown flow rate. Average CC values over periods as long as one month are always expected to exceed 3.0, resulting in reduced blowdown flow rates compared to the calculated rates.
- The assumed additional blowdown flow from non-CWS systems is a peak-day flow.
- The small effect of CWS cooling tower drift in reducing derived blowdown flow was disregarded.
- The effect of river water make-up temperature in reducing CWS cooling tower blowdown temperature was disregarded.
- The loss of heat in the blowdown flow in transit from the plant via the Waste Water Retention Pond to the river was disregarded.

[5] SPX Cooling Tower Co., "TRACS Version 18-SEP-08, Cooling Tower Model 8500 202-5.3-324," 100% design flow rate, November 24, 2008.

Table to Attachment 4. Estimated monthly maximum, average and minimum in-river evaporation (gpd) for ambient meteorological data and river water temperatures from 1977 through 2007.

| Month | Maximum Month | Average Month | Minimum Month | Years | Notes |
|---|---|---|---|---|---|
| Jan | 69,000 | 47,000 | 26,000 | 30 | excludes 2004 |
| Feb | 70,000 | 50,000 | 28,000 | 31 | |
| Mar | 68,000 | 60,000 | 48,000 | 31 | |
| Apr | 88,000 | 64,000 | 44,000 | 31 | |
| May | 75,000 | 52,000 | 33,000 | 31 | |
| Jun | 66,000 | 32,000 | 0 | 31 | |
| Jul | 42,000 | 17,000 | 0 | 30 | excludes 1988 |
| Aug | 42,000 | 16,000 | 0 | 28 | excludes 1988, 2003, 2007 |
| Sep | 44,000 | 31,000 | 14,000 | 28 | excludes 1988, 2003, 2007 |
| Oct | 60,000 | 48,000 | 28,000 | 29 | excludes 2003, 2007 |
| Nov | 67,000 | 57,000 | 46,000 | 29 | excludes 2003, 2007 |
| Dec | 62,000 | 51,000 | 32,000 | 29 | excludes 2003, 2007 |