# Conceptual Design of the Circulating Water System
# Bell Bend Nuclear Power Plant
# Unistar Nuclear Energy

**Non-Safety-Related**

**Report No. SL-009498**
**Revision 3**

**November 20, 2008**

# APPROVAL PAGE

## Conceptual Design of the Circulating Water System

## Non-Safety-Related

**REVISION SUMMARY**

| | |
|---|---|
| Rev. 0 | For Issue – No Comments Received |
| Rev. 1 | Added Cooling Tower, I&C, and Chemical Treatment information. |
| Rev. 2 | Retention basin discharge flowrate was made consistent with Rev. 1 of S&L Calculation 2008-08550. Fire Protection information revised. Cooling tower information added. Revisions made due to S&L Calculation 2008-09135 pipe routing wetlands avoidance. Diffuser information revised. |
| Rev. 3 | Issue for record. No comments received from OAR. Revision level change only. |

| | | |
|---|---|---|
| Prepared By: | Richard Pospiech | Date: 11/20/08 |
| Reviewed By: | Jeffery Saltarelli | Date: 11/20/08 |
| Approved By: | | Date: 11/20/08 |

Classification: ☐ Safety-Related ☒ Non-Safety-Related

Multi-discipline Signatures: ☒ Applicable ☐ Not Applicable

Mechanical

Preparer: Richard Pospiech [signature] Date: 8/20/08

Reviewer: [signature] L. ANDERSON Date: 8/20/08

Civil

Preparer: Ronald Cook [signature] Date: 06/04/08

Reviewer: DANIEL C. KOCUNIK / [signature] Date: 06/04/08

Structural

Preparer: Julio R. Hernandez / [signature] Date: 08/20/08

Reviewer: N. KLAIC / [signature] Date: 08-20-2008

Electrical

Preparer: SYED M. HUSSAIN [signature] Date: 06/04/08

Reviewer: A.K. Chatterji / [signature] Date: 06/04/08

I&C

Preparer: David L. Kirby [signature] Date: 06/24/08

Reviewer: Joseph W. DeMarco [signature] Date: 06/24/08

HVAC

Preparer: [signature] Weixiang Yang Date: 6-4-08

Reviewer: [signature] RAJ B. TANEJA [signature] Date: 6-4-08

Chemical

Preparer: Diane Martini for Jeri Penrose [signature] Date: 6/26/08

Reviewer: M.D. Rosen [signature] Date: 6/26/08

Note: No disciplines affected in this revision,
new signatures only required on the previous signature page

# TABLE OF CONTENTS

## 1.0 PURPOSE

The purpose of this report is to provide a conceptual design for the Circulating Water System (CWS) of the proposed Bell Bend Nuclear Power Plant. This evaluation will be used in support of the Combined Operating Licensing Application (COLA) and serve as a basis for the detailed design of this system. This system includes:

- The intake structure, which houses the CWS makeup pumps, Raw Water Supply System (RWSS) pumps, traveling screens, and screenwash pumps.
- The CWS pumphouse at the cooling tower basin, which houses the CWS pumps.
- CWS makeup from the intake structure to the CWS cooling tower basin.
- CWS flow from the CWS pumps, located in the CWS pumphouse, to the main condenser and auxiliary cooling water system (ACWS) and back to the CWS cooling towers.
- CWS blowdown from the CWS cooling tower basin to the common retention basin.
- The common retention basin which collects plant wastewater flows and allows any sediment to settle before the water is discharged to the environment.
- Retention basin discharge to the diffuser structure in the Susquehanna River.

The scope of this report includes the following:

- System design bases.
- System general description.
- Pumps, cooling towers, piping, and valves description.
- Structural and geological design considerations for pipe trenches.
- Vacuum priming system.
- Description of the intake structure, including: civil, structural, electrical, I&C, HVAC, and fire protection design considerations.
- Description of CWS pumphouse including: civil, structural, electrical, I&C, HVAC, and fire protection design considerations.
- Description of the common retention basin including: civil, structural, and I&C design considerations.
- Information on the retention basin discharge, including a description of the diffuser structure in the Susquehanna River and structural design considerations.
- System chemical treatment.

## 2.0 ASSUMPTIONS

2.1 The main condenser tubes are assumed to be constructed of 304/316 stainless steel (Ref 6.2) (Unverified).

## 3.0 DESIGN INPUTS

3.1 CWS main headers are 132-inch concrete pipe underground and 132-inch carbon steel above ground per Reference 6.4.
3.2 CWS pumps consist of four 25% vertical shaft pumps per Reference 6.4.
3.3 CWS makeup is 23,808 gpm and CWS blowdown is 7,928 gpm based on 3 cycles of concentration per Reference 6.30 (Attachment T) (Unverified).
3.4 The maximum retention basin discharge flow is 9,356 gpm and an additional 11 gpm is added to the discharge pipe from the liquid radwaste system based on Reference 6.5 (Unverified).
3.5 The maximum temperature of the CWS blowdown is 90°F (Ref. 6.2).
3.6 The maximum temperature of the ESWS blowdown is 95°F (Ref. 6.7).
3.7 The maximum allowable discharge temperature is 87°F based on protection of warm water fishes in Susquehanna River (Ref. 6.2).
3.8 The rise-to-shutoff head of conventional vertical turbine pumps is approximately 150% of the normal operation pressure (Ref. 6.9).

3.9 Unistar will be selecting two natural draft cooling towers with a 720,000 gpm circulating water flowrate described in Report 2008-06824, "Engineering and Economic Evaluation of the Integrated Heat Rejection Cycle" (Ref 6.2).

## 4.0 EVALUATION

### 4.1 DESIGN BASES

The CWS performs no safety-related function and therefore has no nuclear safety-related design basis.

The CWS is designed to meet the following functional criteria:

- Supply cooling water from the normal heat sink to the turbine condensers and auxiliary cooling water system (ACWS).
- Discharge heated water from the turbine condensers and ACWS to the normal heat sink.
- Cool the discharged heated water in the normal heat sink to an acceptable temperature.

### 4.2 GENERAL DESCRIPTION

The CWS is a non-safety-related interface system that provides a continuous supply of cooling water to the turbine condensers and ACWS and rejects heat to the environment via the normal heat sink.

CWS components and equipment are classified Quality Group E and non-seismic (Ref. 6.4).

The CWS consists of CWS pumps, CWS makeup pumps, two natural draft cooling towers, the main condenser, the retention basin, the discharge diffuser, and associated piping, valves and instrumentation. A general flowchart of the CWS is shown in Figure 4.2-1, below:

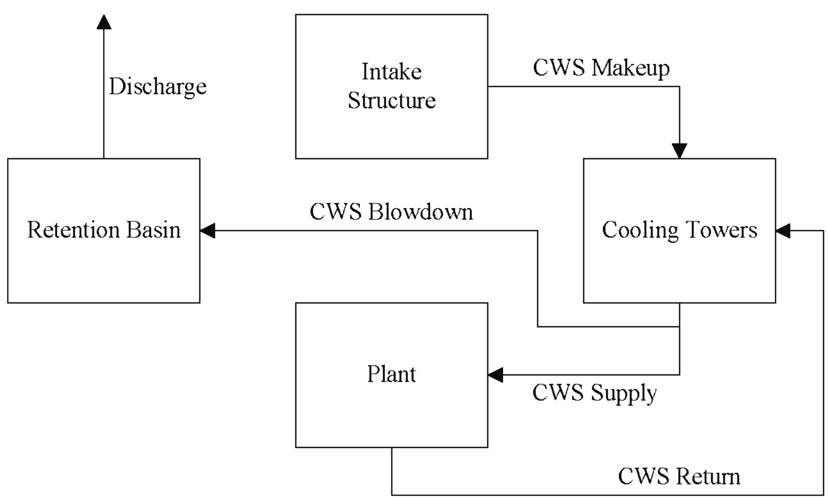



**Figure 4.2-1** CWS Flowchart.

The CWS pumps, housed in the CWS pumphouse (discussed in Section 4.6 of this Report) adjacent to the cooling tower, deliver 720,000 gpm (Design Input 3.9) of circulating water to the turbine building and through the main condenser to remove latent heat from the turbine exhaust steam. The circulating water also flows through the ACWS. The circulating water then returns to the CWS cooling towers and discharges through the spray headers.

The CWS uses two natural draft cooling towers for heat dissipation. The cooling towers are discussed in Section 4.3.1 of this Report.

Evaporation in the cooling towers increases the level of solids in the circulating water. To control solids, a portion of the recirculated water is removed through the CWS blowdown and replaced with water through the CWS makeup. The CWS makeup also replaces the losses from cooling tower evaporation (15,872 gpm, Ref. 6.2) and drift (8 gpm, Ref. 6.2).

The CWS makeup to the cooling tower basin is taken from the Susquehanna River. The makeup pumps are housed in the intake structure and provide a total maximum makeup flowrate of 23,808 gpm (Design Input 3.3). The intake structure is discussed in Section 4.5 of this Report.

The CWS blowdown branches off the discharge headers of the CWS pumps. The maximum blowdown flowrate is 7,928 gpm (Design Input 3.3). The blowdown then enters the common retention basin, along with other plant flows, to provide time for settling of suspended solids and to permit further chemical treatment of the discharge water, if required. The retention basin is discussed in Section 4.7 of this Report.

Discharge from the retention basin is routed to the discharge diffuser in the Susquehanna River. The maximum retention basin discharge flowrate is 9,356 gpm and an additional 11 gpm is added to the discharge pipe from the liquid radwaste system (Design Input 3.4). The discharge diffuser is discussed in Section 4.8 of this Report.

The CWS blowdown with a maximum temperature of 90°F (Design Input 3.5) and the ESWS blowdown with a maximum temperature of 95°F (Design Input 3.6) are the two largest contributors to the retention basin discharge. The maximum allowable discharge temperature is 87°F based on protection of warm water fishes in Susquehanna River (Design Input 3.7); therefore, a heat exchanger will be utilized to reduce the temperature of the CWS blowdown before the flow enters the retention basin and discharges to the diffuser in the Susquehanna River.

## 4.3 PUMPS, COOLING TOWER, PIPING, AND VALVES

### 4.3.1 Circulating Water System

The CWS piping and components shall be designed to withstand the shutoff pressure of the circulating water pumps. This includes the condenser water boxes and tube bundles, butterfly valves and expansion joints.

The CWS pumps are composed of four 25% capacity constant speed, vertical shaft pumps (Design Input 3.2). The pumps are designed to operate under normal plant operating load conditions. The pumps are designed to permit reverse flow. Each pump size is approximately 200,180 gpm at a total developed head of 126 ft (55 psi). The horsepower of each pump is approximately 9,000 HP (Ref. 6.1). The CWS pumps flow capacity includes the blowdown flowrate. These design criteria can be met by the Flowserve VTP vertical turbine, wet-pit pump shown in Attachment J.

The CWS pipelines are concrete underground and carbon steel above ground. The diameter of the CWS pipe is 96 inches at the discharge of the CWS pumps and 132 inches in the two main headers that are routed to the turbine building and back to the cooling tower (Design Input 3.1). The rise-to-shutoff head of conventional vertical turbine pumps is approximately 150% of the normal operation pressure (Design Input 3.8). The rise-to-shutoff head in this system is 189 ft (83 psi); therefore, the CWS piping nominal design pressure is 100 psi.

The two non-plume abated natural draft cooling towers are each approximately 350 ft in diameter and 475 ft tall. The towers have a design range of 27.6°F and a design approach of 17°F to maintain a CW design outlet temperature of 90°F. The towers' design wet bulb temperature and relative humidity are 73°F and 70%, respectively. The heat dissipated by the CWS cooling towers is approximately $1.0 \times 10^{10}$ BTU/hr (Ref. 6.2). The air flow rate through the cooling towers is approximately 54,850,000 cfm (Ref. 6.31). Internal construction materials include polyvinyl chloride (PVC) for piping laterals, polypropylene for spray nozzles,

and PVC for fill material. The noise levels generated by each CWS cooling tower is approximately 67 dBA or less at the distance of approximately 200 ft from the cooling tower (Ref. 6.32). The cooling tower basin is located below the cooling tower structures and serves as the collection point for the CWS cold water after it has fallen through the towers. The basin drains through a flume to the bays of the CWS pumphouse.
An air release valve and a butterfly valve are installed downstream of each circulating water pump. Each cooling tower riser also has a butterfly valve that serves to isolate the cooling tower during maintenance activities. Gate valves will be installed to allow the circulating water to bypass the cooling towers and discharge to the cooling tower basin during cold weather operation. The opening and closing of motor operated valves located at each pump's discharge, on the cooling tower bypass, and at various other points within the process system can be manually operated via valve mounted hand wheels. The valves contained in the CWS are designed to operate under normal plant operating load conditions. Valve opening and closing times are chosen to reduce water hammer effects. The CWS Piping and Instrumentation Diagram (Ref. 6.13) is shown in Attachment A.

Details related to the main condenser are provided in Section 10.4.1 of the U.S. EPR Final Safety Analysis Report.

4.3.2 CWS Makeup

The CWS makeup pumps are composed of three 50% capacity vertical turbine pumps. Each pump size is approximately 13,100 gpm at a total developed head of 421 ft (182 psi). The horsepower of each pump is approximately 1,800 HP (Ref. 6.1). These design criteria can be met by the Flowserve VTP vertical turbine, wet-pit pump shown in Attachment J.

The main CWS makeup header is 30-inch diameter carbon steel (Ref. 6.1). The rise-to-shutoff head of conventional vertical turbine pumps is approximately 150% of the normal operation pressure (Design Input 3.8). The rise-to-shutoff head in this system is 632 ft (273 psi); therefore, the nominal design pressure of the pipe is 275 psi.

A check valve and butterfly valve are installed downstream of each CWS makeup pump. A control valve is installed in the CWS makeup line to control the flow to the CWS cooling tower basin. Isolation valves are installed on either side of the control valve and a bypass line exists for when maintenance is being performed on the control valve. The CWS Piping and Instrumentation Diagram (Ref. 6.13) is shown in Attachment A.

4.3.3 CWS Blowdown

The CWS blowdown is pumped by the CWS pumps as described above.

The CWS blowdown pipeline is 18-inch diameter carbon steel (Ref. 6.1). The rise-to-shutoff head of conventional vertical turbine pumps is approximately 150% of the normal operation pressure (Design Input 3.8). Because the CWS blowdown is pumped by the CWS pumps, the rise-to-shutoff head in this system is 189 ft (83 psi); therefore, the nominal design pressure of the pipe is 100 psi.

A control valve is installed on the blowdown line to control the CWS blowdown flow to the retention basin. Isolation valves are installed on either side of the control valve and a bypass line exists for when maintenance is being performed on the control valve. The CWS Piping and Instrumentation Diagram (Ref. 6.13) is shown in Attachment A.

4.3.4 Retention Basin Discharge

The retention basin discharge flows by gravity. Three pipe materials are analyzed as options for the retention basin discharge line. These options are: 24-inch carbon steel, 24-inch concrete, and 26-inch HDPE (Ref. 6.1). The design pressure of the pipe is 50 psi for all three piping options

A butterfly valve is installed on the retention basin discharge pipeline. A branch off the main header also exists to circulate the retention basin discharge to the intake structure forebay to prevent ice formation on the bar grating and traveling screens. The CWS Piping and Instrumentation Diagram (Ref. 6.13) is shown in Attachment A.

#### 4.3.5 Pipe Trenches

The underground portion of non-safety related piping, discussed above, is placed at the bottom of an open trench excavation and backfilled in accordance with Drawing No. 12198-004-TREN-001 (Ref. 6.10, Attachment E) and Drawing No. 12198-004-TREN-002 (Ref. 6.11, Attachment F) and their details and notes. The notes provide instructions to assist in selecting the depth of the trench and the minimum width of the trench bottom, as well as the selection of bedding and backfill materials. The design for buried piping conforms to design methodology and acceptance criteria provided in S&L Standard SDS-E24, Rev. 1 (Ref. 6.12). The buried piping is designed for internal, soil overburden and surcharge pressure loads. For surcharge pressure, H-20 and Cooper E-80 live loads are considered since some pipes are routed under roads and/or railroad tracks.

The pipelines from the intake structure to the cooling towers and between the cooling towers and the retention basin will generally be founded in the sand and gravel soils. However, some sections of the pipelines will be founded in the bedrock where they are adjacent to structures founded in the bedrock.

Due to acidic soil conditions at the site (Ref 6.22, Attachment R), an external protective coating system and/or cathodic protection will be required for buried carbon steel pipe.

Any flooding exiting the Turbine Building at grade is directed away from structures that house safety-related systems, structures, and/or components (SSCs) by site grading, so external flooding resulting from a failure in the CWS does not adversely affect safety-related SSCs.

### 4.4 VACUUM PRIMING SYSTEM

A vacuum priming system is used to allow the highest tubes in the condenser tube bundle to be filled with water. The connections to the vacuum priming system are at the condenser water boxes. The air from the circulating water is discharged via the vacuum priming system to the water and air separator and from there to the atmosphere.

### 4.5 INTAKE STRUCTURE

The layout of the intake structure is shown on Drawing No. 12198-004-RWSS-004 (Ref. 6.14, Attachment B).

The intake structure is on the bank of the Susquehanna River. It houses the CWS makeup pumps and RWSS pumps. There are three bays for these pumps; each bay contains both a CWS makeup pump and an RWSS pump. Each bay also includes a traveling screen and a screenwash pump.

The bays are sized based on the recommended sump dimensions versus flow specified in the Hydraulic Institute Standards (Ref. 6.23, Attachment H). The bays and pumphouse are also sized to physically contain all of the equipment and to allow access for maintenance. The spacing between pumps in the same bay is also based on the requirements specified in the Hydraulic Institute Standards (Ref. 6.23, Attachment H).

The intake structure utilizes a bar grating, a trash rake, and stop logs. The trash rake is on a track to clean the bar grating. Stop logs can be installed to allow a bay or an intake tunnel to be closed off for maintenance. Installation and removal of the equipment inside the pumphouse is through the roof hatches via a jib crane.

A curtain wall protrudes into the pumphouse bays to prevent any floating debris that passes the bar grating from approaching the pumps. The curtain wall extends below the minimum water level in the forebay.

The inlet area limited by the curtain wall and each bay width is large enough to maintain a flow velocity of less than 0.5 fps during maximum flow through the bay (i.e., all pumps in the bay operating at full capacity).

The dual flow traveling screens shall be designed to have a "through-screen" velocity less than 0.5 fps per EPA Rule 316(b) (Ref. 6.15). Trash basins are installed to collect the debris washed off of the traveling screens. A Siemens traveling water screen is shown in Attachment K.

#### 4.5.1 Civil Design Considerations

The intake structure has a floor elevation of 528 feet. Grade adjacent to the pumphouse is at elevation 525'-6". Twenty feet of flat area is provided on the north and south sides of the building. Eighty feet is provided on the west side of the building to provide space for a crane to sit during initial construction. A 20 foot wide road provides access to the flat pad.

The geologic profile in the vicinity of the intake structure on the Susquehanna River consists of sand and gravel from existing grade at approximately elevation 505 ft down to the bedrock surface. The top of the bedrock surface varies from approximately elevation 462 ft at the river's edge to approximately elevation 480 ft on the back side of the structure (Figures 2.4-41, 2.4-42, 2.4-48, and 2.4-52 from Ref. 6.3). The intake structure will be founded directly on the bedrock at approximately elevation 460 feet. The construction of the pumphouse will require a seepage cutoff structure along the river to provide dry working conditions.

#### 4.5.2 Structural Design Considerations

Flow into the intake structure forebay is by gravity. The area from the river bed to the forebay is designed to allow for gradual transition without excessive turbulence.

The intake structure will be designed for the applicable design basis loads and load combinations that include but are not limited to: dead weight and live loads including wind, soil pressure, ice, and snow, as well as hydrostatic loads due to a flooding condition.

The intake structure is classified as a non-safety-related structure; therefore the following evaluations are not required:

- Seismic evaluation based on site-specific seismic response spectra.
- Dynamic loads from soil and water.
- Tornado winds and tornado generated missiles.
- Impact of high energy line breaks and internally-generated missiles.

The substructure (the portion of the pumphouse between the basemat and main operating floor) is a reinforced concrete structure that consists of three-foot-thick reinforced concrete walls and basemat and two-foot-thick reinforced concrete slab at the grade elevation.

The following design parameters have been utilized for the conceptual design:

- Floor live load of 100 psf (floors without pumps).
- Pump weight of 3 kips per pump.
- Soil dry unit weight of 126 pcf.
- Minimum soil surcharge pressure of 1,000 psf.
- Angle of internal friction of 35°.
- Minimum concrete compressive strength of 4,000 psi.

The design of the substructure concrete walls is governed by:

- The soil lateral pressure and surcharge loading pressure at the exterior walls.
- The hydrostatic loads due to the postulated single interior compartment flooding condition, with adjacent compartments empty.

The shear stress is the governing stress condition for the wall thickness determination.

The design of concrete walls and slabs is in accordance with ACI 318-05 & ACI 318R-05 (Ref. 6.19).
The superstructure above the main floor is a steel-framing structure that consists of steel columns, beams, insulated metal siding, and concrete on metal deck roof. The design of steel columns, beams, and welded and bolted connections is in accordance with AISC (Ref. 6.20).

4.5.3 Electrical Design Considerations

Non-safety-related AC sources are required to power the CWS makeup pumps, valves, and other miscellaneous loads in the pump house.

The CWS makeup pumps are supplied by the 6.9 KV switchgear located in the intake structure. Two pumps are fed from one bus, and the third is fed from the opposite bus for redundancy and to even electrical load distribution. The 6.9 KV switchgear buses are supplied by two 13.8 KV/6.9 KV transformers energized by separate 13.8 KV underground feed cables from the station. The two buses have a cross tie breaker and each transformer is capable of carrying the load of both buses. All 480V loads (such as valves, HVAC, etc.) in the pumphouse are supplied by the 480V MCC located in the pumphouse. The MCC is equipped with a stepdown transformer and a 120V distribution panel to feed process-related 120V loads. The pumphouse indoor and outdoor lights are supplied by the local lighting cabinet. The pumphouse has an independent 250V DC ungrounded system for switchgear control and other DC loads in the pumphouse.

The remote control, indication, and alarms are transmitted by the supervisory panel in the pumphouse.

The intake structure is provided with a grounding system. The electrical equipment and instrument panels are provided with grounding connections in accordance with industry practice. A cathodic protection system is provided to protect buried metal pipes and structures.

Refer to the Intake Structure Electrical One-Line Diagram (Ref. 6.25, Attachment L).

4.5.4 I&C Design Considerations

Local and remote (main control room) monitoring and control of CWS related features located in the intake structure are provided. Local controls are located in the intake structure on a supervisory panel that communicates with the main control room (MCR) monitoring and control equipment. Monitoring and control in the MCR is via a process information and control system.

Cooling tower basin level is displayed locally and in the MCR. Alarms are provided in the MCR for low and high level in the basin. The cooling tower basin level is input to the control for the CWS makeup pumps and CWS makeup control valve. Indication of makeup flow to the cooling tower basin is provided to the MCR by a flow meter located downstream of the makeup control valve.

MCR capability is provided for operational control of each CWS makeup pump and the associated discharge butterfly valve. Each valve is controlled in tandem with the associated pump and sequenced in accordance with pump manufacturer recommendations such that the pump is automatically tripped if the valve is not in the full-open position within a short period after starting the pump. An interlock with the traveling screens is provided such that the screens must be operating for the CWS makeup pump to be placed in operation. Pump operating status and valve position are provided in the MCR.

Discharge pressure for each of the CWS makeup pumps is indicated locally and in the MCR and a low pressure alarm is provided in the MCR.

Operational control of the traveling screens and associated screenwash pumps is provided locally and in the MCR. Screenwash pump operation is based on differential pressure across the traveling screens. An interlock is provided for each traveling screen such that if the associated screenwash pump discharge pressure does not achieve a setpoint within a specified time, an alarm is provided in the MCR. Operating status of the traveling screens and screenwash pumps, and pump discharge pressure are provided in the MCR. Differential pressure across the screens is monitored and alarmed on high pressure in the MCR.

Temperature monitoring is provided in the intake structure forebay. The temperature of the forebay is provided to the MCR.

Available status and alarm indications are provided to the MCR for equipment located in the intake structure, including: valve position, area temperature, power distribution equipment, HVAC, etc.

#### 4.5.5 HVAC Design Considerations

The intake structure Heating and Ventilation (HV) system serves the pumphouse and the battery room. The HV system consists of an outside air intake louver, supply air fan, ductwork, duct accessories, back draft damper exhaust louver, and instrumentation and controls. A temperature controller located downstream of the supply air fan will modulate the outside air control damper and the return air control damper to limit the supply air temperature at a minimum of 50°F. The air supply to the pump house in conjunction with the electric unit heaters will limit the pumphouse temperature to a minimum of 50°F in the winter and a maximum of 122°F in the summer. The excess air that is not recirculated is relieved to the outside via the backdraft damper exhaust louver. A portion of the air is supplied to the battery room where it is exhausted to the outside by its exhaust fan. The exhaust air is slightly more than the supply air so the battery room is always at a slightly negative pressure with respect to the adjacent area (the pumphouse). Air supply to the battery room will limit the room temperature to a maximum of 104°F in the summer, and a battery room thermostat will control the electric duct heater to limit the room temperature to a minimum of 65°F in the winter. Air supplied to the battery room is more than adequate to limit the hydrogen concentration in the battery room below 1% as required by standard NFPA 70.

High and low temperature alarms for the pumphouse and the battery room shall be annunciated in the main control room.

The conceptual design for the intake structure HVAC is shown on the Intake Structure HVAC P&ID (Ref. 6.28, Attachment P).

#### 4.5.6 Fire Protection Design Considerations

Fire Area FA-UPE-01 is the open area on the upper level of the intake structure that contains the electrical control equipment, three CWS makeup pumps, three RWSS pumps, and three screenwash pumps. The adequacy of the fire protection features provided is sufficient to prevent a fire originating within Fire Area FA-UPE-01 from affecting adjacent fire areas. This fire area is not normally occupied during normal plant operations. The egress route from this area is via two exits to the exterior. This fire area utilizes automatic fire detection, manual fire alarms, and portable fire extinguishers. It does not utilize manual fixed fire protection.

Refer to S&L Calculation No. 2008-08861, "Fire Protection Plan for Yard and Outlying Buildings" (Ref. 6.6) for more information on fire protection.

### 4.6 CWS PUMPHOUSE

The layout of the CWS pumphouse is shown in Drawing No. 12198-004-CWS-002 (Ref. 6.16, Attachment C).

The circulating water pumphouse is adjacent to the CWS cooling towers. The bays of the CWS pumphouse are connected to the cooling tower basin via a flume. There is one bay for each of the four CWS pumps. A bar grill and trash rake are installed to prevent any debris from entering the CWS pump bays.

The bays are sized based on the recommended sump dimensions versus flow specified in the Hydraulic Institute Standards (Ref. 6.23, Attachment H). The bays and pumphouse are also sized to physically contain all of the equipment and to allow access for maintenance.

The CWS pumphouse utilizes a bar grating, a trash rake, and stop logs. The trash rake is on a track to clean the bar grating. Stop logs can be installed to allow a bay to be closed off for maintenance. Installation and removal of the equipment inside the pumphouse is through the roof hatches via a jib crane.
A curtain wall protrudes down into the pumphouse bays to prevent any floating debris that passes the bar grating from approaching the pumps. The curtain wall is suspended low enough to be deeper than the minimum water level in the cooling tower basin.

The inlet area limited by the curtain wall and each bay width is large enough to maintain a flow velocity of less than 0.5 fps during maximum flow through the bay (i.e., pumps operating at full capacity).

The chemical treatment room is located inside the CWS pumphouse. Access into the chemical treatment room is from the outside to prevent a chemical leak from affecting other equipment inside the pumphouse.

### 4.6.1 Civil Design Considerations

The grade elevation at the cooling tower and CWS pumphouse is at 694 feet. The CWS pumphouse floor elevation is 695 feet. The area between the CWS pumphouse and the road around the towers is paved. A crane can approach this area and sit during initial construction.

The geologic profile in the vicinity of the cooling towers consists of generally granular soils (silty sand and sandy silt) overlying siltstone and shale bedrock (Ref. 6.8). The top elevation of the bedrock varies from elevation 690 ft to 774 feet. Considering a foundation elevation at approximately elevation 663 ft, the structure will be founded directly on the bedrock.

### 4.6.2 Structural Design Considerations

Flow through the flume is by gravity. The areas from the flume to the bays are designed to allow for gradual transition without excessive turbulence.

The CWS pumphouse structure will be designed for the applicable design basis loads and load combinations that include but are not limited to: dead weight and live loads including soil, wind, ice, and snow loads, as well as hydrostatic loads due to ground water and/or a flooding condition.

The CWS pumphouse structure is classified as a non-safety-related structure; therefore the following evaluations are not required:

- Seismic evaluation based on site-specific seismic-response spectra.
- Dynamic loads from soil and water.
- Tornado winds and tornado generated missiles.
- Impact of high energy line breaks and internally generated missiles.

The subtructure (the portion of the structure between the base mat and main operating floor) is a reinforced concrete structure that consists of two-foot-thick reinforced concrete walls and two-foot-thick reinforced concrete slabs at the base and main operating floor elevations.

The following design parameters have been utilized for the conceptual design:

- Floor live load of 500 psf (floors without pumps).
- Soil dry unit weight of 127.4 pcf (submerged weight of 65 pcf).
- Minimum soil surcharge pressure of 1,000 psf.
- Angle of internal friction of 35°.
- Minimum concrete compressive strength of 4,000 psi.

The design of the substructure concrete walls is governed by:

- The soil lateral pressure and surcharge loading pressure at the exterior walls.
- The hydrostatic loads due to the postulated single interior compartment flooding condition, with adjacent compartments empty.

The shear stress is the governing stress condition for the wall thickness determination.
The design of concrete walls and slabs is in accordance with ACI 318-05 & ACI 318R-05 (Ref. 6.19).

The superstructure above the main floor is a steel-framing structure that consists of steel columns, beams, insulated metal siding, and concrete on metal deck roof. The design of steel columns, beams, and welded and bolted connections is in accordance with AISC (Ref. 6.20).

#### 4.6.3 Electrical Design Considerations

Non-safety-related AC sources are required to power the CWS pumps, valves, and other miscellaneous loads in the pumphouse.

The CWS pumps are supplied from the 13.8 KV station buses: 35BBD and 36BBD. All 480V loads (such as valves, HVAC, etc.) in the pumphouse are supplied by the 480V MCC located in the CWS pumphouse. The MCC is equipped with a stepdown transformer and a 120V distribution panel to feed the process-related 120V loads. The pumphouse indoor and outdoor lights are supplied by the local lighting cabinet.

The remote control, indication, and alarms are transmitted by the supervisory panel in the pumphouse.

The CWS pumphouse is provided with a grounding system. The electrical equipment and instrument panels are provided with grounding connections in accordance with industry practice. A cathodic protection system is provided to protect buried metal pipes and structures.

Refer to the CWS Pumphouse Electrical One-Line Diagram (Ref. 6.24, Attachment M).

The natural draft cooling towers do not have an electrical load.

#### 4.6.4 I&C Design Considerations

Local and remote (main control room) monitoring and control of CWS related features located in the CWS pumphouse are provided. Local controls are located in the CWS pumphouse on a supervisory panel that communicates with the main control room (MCR) monitoring and control equipment. Monitoring and control in the MCR is via a process information and control system.

MCR capability is provided for operational control of each CWS pump and the associated discharge butterfly valve. Each valve is controlled in tandem with the associated pump and sequenced in accordance with pump manufacturer recommendations such that the pump is automatically tripped if the valve is not in the full-open position within a short period after starting the pump. Pump operating status and valve position are provided in the MCR.

Discharge pressure and flow for each of the CWS pumps are indicated locally and in the MCR and low pressure and low flow alarms are provided in the MCR. Motor winding temperature sensors mounted at various locations in the motors along with breaker position provide remote control, indication, and alarm of the CWS pumps.

Temperature monitoring is provided in each CWS pump bay. The temperature for each bay is provided to the MCR.

A means is provided to utilize temporary flow metering equipment on the main circulating water piping.

MCR operation of valves enables bypass of one or both return line flows from the plant to flow directly into the cooling tower basin for operation during cold weather. Position indication for bypass valves is provided in the MCR.

CWS blowdown flow to the retention basin is controlled by the blowdown control valve. The blowdown control valve is modulated using input from the cooling tower basin level instrumentation and MCR input for maintaining the desired water chemistry. CWS blowdown flow is monitored in the MCR. In addition, the CWS blowdown temperature downstream of the blowdown heat exchanger is monitored in the MCR.

Available status and alarm indications are provided to the MCR for equipment located in the CWS pumphouse, including: valve position, area temperature, power distribution equipment, HVAC, etc.

4.6.5 HVAC Design Considerations

The CWS pumphouse has two Heating and Ventilation (HV) systems that serve the pumphouse and the chemical tank room. The Heating and Ventilation (HV) system for the pumphouse consists of two 50% capacity trains. Each train consists of an outside air intake louver, supply air fan, ductwork, duct accessories, back draft damper exhaust louver, and instrumentation and controls. A temperature controller located downstream of the supply air fan will modulate the outside air intake control damper and the return air control damper to limit the supply air temperature to a minimum of 50°F. The air supply to the pump house in conjunction with the electric unit heaters will limit the pumphouse temperature to a minimum of 50 °F in the winter and a maximum of 122°F in the summer. The excess air that is not recirculated is relieved to the outside via the backdraft damper exhaust louver.

The HV system for the chemical tank room consists of an outside air combination fixed and operating louver, exhaust fan, and exhaust louver with backdraft damper. Also, a ductwork with a motor-operated isolation damper is provided in an interior wall of the tank room and the pumphouse. This arrangement allows the transfer of air from the pumphouse to the chemical tank room during winter when the outside air intake louver for the chemical tank room is closed to conserve heat energy. The exhaust air for the system is based on six air changes per hour to keep the toxic gases below the threshold limit and maintain the tank room temperature below 104°F. The exhaust fan operates continuously. At an outside temperature of 70°F the outside air intake louver opens and the transfer air isolation damper closes. When the outside air temperature drops to 50°F, the transfer air isolation damper opens and the outside air intake louver closes. The tank room unit heaters in conjunction with transfer air from the pumphouse will limit the room's minimum temperature to 50°F.

High and low temperature alarms of the pumphouse and the chemical tank room are annunciated in the main control room. Tank room fan failure is also annunciated in the main control room.

The conceptual design for the CWS pumphouse and the chemical tank room HVAC is shown on the CWS Pumphouse HVAC P&ID (Ref. 6.27, Attachment Q).

4.6.6 Fire Protection Design Considerations

Fire Area FA-UQA-01 is the upper floor level of the CWS pumphouse that contains electrical equipment and the four CWS pumps. The adequacy of the fire protection features provided is sufficient to prevent a fire originating within Fire Area FA-UQA-01 from affecting adjacent fire areas. This fire area is occasionally occupied during normal plant operations. The egress route from this area in the event of fire is via four exits to the exterior. This fire area utilizes automatic fire detection, manual fire alarms, and portable fire extinguishers. It does not utilize manual fixed fire protection.

Refer to S&L Calculation No. 2008-08861, "Fire Protection Plan for Yard and Outlying Buildings" (Ref. 6.6) for more information on fire protection.

## 4.7 RETENTION BASIN

The layout of the common retention basin is shown in Drawing No. 12198-004-CWS-003 (Ref. 6.17, Attachment D).

Various plant systems discharge water to the common retention basin. These sources are:

- CWS blowdown.
- ESWS blowdown.
- Wastewater treatment plant effluent.
- Demineralizer reject water.
- Miscellaneous low volume waste.

Liquid radwaste treatment effluent is also injected directly into the retention basin discharge piping.

The maximum flowrate through the basin is 9,356 gpm (Design Input 3.4). To allow sediments to settle, the basin has a surface area of approximately 101,500 $ft^2$ with a length of 451 ft and a width of 225 feet. At 9 ft deep, the volume of the basin is approximately 910,000 $ft^3$ (6,800,000 gal). The weir in the basin has a maximum height of 7.5 ft (Ref. 6.1).

The retention basin discharge drains by gravity at the corner of the retention basin, behind the weir. A prefabricated insulated-siding building will house the retention basin chemical treatment skid.

### 4.7.1 Civil Design Considerations

The top of the retention basin walls are at the 681 ft elevation. Finish grade outside the basin is at the 680 ft elevation. At high water level in the basin, 2.5 ft of interior freeboard is provided. The basin is accessible on all four sides.

The retention basin is located northeast of the nuclear island. The subsurface conditions at this location consist primarily of medium-dense to dense sand and gravel overlying the shale and sandstone bedrock encountered at approximately elevation 636 ft to 641 ft (Ref. 6.8). Considering a final grade elevation at approximately 674’, the bottom of this basin will be founded in the granular soils.

### 4.7.2 Structural Design Considerations

The foundation for the retention basin is a two-foot-thick reinforced concrete slab that is 451 ft long and 225 ft wide. It is designed for 9 ft of hydrostatic water pressure with high water level at elevation 678’-6”. The foundation mat is conceptually evaluated as a beam on the elastic foundation to calculate stresses due to hydrostatic pressure and differential displacements.

The retention basin slab is classified as a non-safety-related structure; therefore the following evaluations are not required:

- Seismic evaluation based on site-specific seismic-response spectra.
- Hydrodynamic loads.
- Impact of externally-generated missiles.

The design of the reinforced concrete slab is in accordance with ACI 318-05 & ACI 318R-05 (Ref. 6.19).

### 4.7.3 I&C Design Considerations

Local and remote (main control room) monitoring and control of features associated with the retention basin are provided. Local controls are located on a supervisory panel that communicates with the main control room (MCR) monitoring and control equipment. The supervisory panel is located in the chemical treatment prefabricated building. Monitoring and control in the MCR are via a process information and control system.

Retention basin level is displayed locally and in the MCR. Alarms are provided in the MCR for low and high level in the basin.

The retention basin discharge is monitored for temperature and flow. A high flow alarm is provided in the MCR to indicate flow exceeding the maximum allowed flow. Similarly, a high temperature alarm is provided in the MCR to indicate exceeding the allowable maximum discharge temperature.

MCR control and position indication of the discharge bypass valve are provided to allow remote alignment of the retention basin discharge to the intake structure for the prevention of ice-formation in the intake structure bays. The bypass flow is indicated in the MCR using a flow meter located downstream of the bypass valve.

## 4.8 DISCHARGE DIFFUSER

The retention basin discharge line is routed to the diffuser structure at the Susquehanna River. The discharge diffuser is shown in Drawing No. 12198-004-CWS-015 Sheet 3 (Ref. 6.18, Attachment N).

The discharge diffuser is essentially the discharge pipe routed along the bottom of the Susquehanna River at approximately 476 ft elevation with 72 four-inch-diameter port holes in it (Ref. 6.29). The port holes are angled 45° from the horizontal in the direction of the river flow and are spaced 1.5 ft apart. A flap gate is installed at the end of the discharge diffuser.

### 4.8.1 Structural Design Considerations

A reinforced concrete pad structure with a saddle-shaped top portion accommodates the discharge pipe and provides adequate bearing surface. The concrete pad is 7 ft wide and 111.5 ft long based on the preliminary layout drawing in Attachment N.

The following design parameters have been utilized for the conceptual design:

- Pipe load at the discharge equal to 10 kips in vertical and lateral direction (preliminary estimate).
- Concrete moist unit weight of 150 pcf (Ref. 6.21).
- Minimum soil surcharge pressure of 1,000 psf.
- Angle of internal friction of 35° (Ref. 6.21).
- Minimum concrete compressive strength of 5,000 psi (Ref. 6.21).

The design of the substructure concrete walls is governed by:

- The soil lateral pressure and surcharge loading pressure.
- The piping loads at the discharge.

The design of concrete pad is in accordance with ACI 318-05 & ACI 318R-05 (Ref. 6.19).

The design of the lateral-angle-type pipe supports and the anchorage will be performed in the detailed design stage based on the stress analysis results.

## 4.9 CHEMICAL TREATMENT

### 4.9.1 Intake Structure

The Susquehanna River is the source of water supplied to the CWS cooling tower and RWSS. This water is characterized as a moderately-hard, alkaline water with a low dissolved solids content averaging 143 mg/l. The composition is shown in Table 4.9.1-1 (Ref. 6.5).

There have been no sightings of zebra mussels along the Susquehanna River as shown in the most recent USGS distribution map updated 1/18/2008 (Ref. 6.26), so no treatment is provided at the intake structure for control of zebra mussels.

Treatment will be required to control microbial growth in the RWSS piping to control biofouling, microbiological deposits, and microbially-induced corrosion, especially in the smaller pipes. An oxidizing biocide was selected. Sodium hypochlorite solution (also referred to as bleach) will be injected intermittently. Facilities for sodium hypochlorite storage and injection will be located near the intake structure and chemical will be injected near the RWSS pumps.

**Table 4.9.1-1** Susquehanna River Composition.

| | | Susquehanna River | |
|---|---|---|---|
| Constituent | Composition | Max | Mean |
| pH | | 8.1 | 7.8 |
| Total dissolved solids | (mg/l) | 201 | 143 |
| Total suspended solids | (mg/l) | 82 | 18 |
| Calcium Hardness | (mg/l as CaCO3) | 97 | 66 |
| Total Hardness | (mg/l as CaCO3) | 132 | 92 |
| M.O. Alkalinity | (mg/l as CaCO3) | 94 | 61 |
| | | | |
| Calcium | (mg/l as Ca) | 38.8 | 26.6 |
| Magnesium | (mg/l as Mg) | 10.6 | 6.3 |
| Sodium | (mg/l as Na) | 24.1 | 15.2 |
| | | | |
| Chloride | (mg/l as Cl) | 39.6 | 25.7 |
| Sulfate | (mg/l as SO4) | 51.2 | 26.6 |
| Ortho-Phosphate | (mg/l as PO4) | 0.7 | 0.2 |
| | | | |
| Silica | (mg/l as SiO2) | 4.8 | 2.8 |
| Iron | (mg/l as Fe) | 0.3 | 0.1 |

### 4.9.2 Cooling Tower

Based on the BBNPP Water Balance Calculation (Ref. 6.5), the CWS cooling tower will normally be operated at 3 cycles of concentration. Localized treatment will be required at the CWS cooling tower to control biofouling, sedimentation, calcium carbonate scaling, and corrosion. The condenser tubes are stainless steel metallurgy (Assumption 2.1) and there are no copper-bearing wetted components, so yellow-metal corrosion control is not required for this system.

Specific treatment chemicals are as follows:

- Acid – Sulfuric acid will be used for pH reduction to aid in calcium carbonate scale control. The pH will be maintained in the alkaline region. Acid feed will be continuous as required to maintain the target pH level.
- Oxidizing biocide – Sodium hypochlorite solution (bleach) will be used to control biofouling. Treatment will be periodic for no more than two hours per day as required by typical NPDES permit requirements.
- Deposit Control Agents – An organic phosphonate such as HEDP plus an acrylate copolymer will be used to control calcium carbonate scaling, to protect against calcium phosphate scaling that might result from reversion of HEDP, and to control silt and iron deposition. These chemicals are available in proprietary formulations and will be fed continuously to maintain target levels.
- Corrosion Inhibitor – A separate corrosion inhibitor is not required. Phosphonates used for deposit control will also provide inhibition of mild steel corrosion in alkaline systems.

The treatment chemicals will be stored onsite in tanks(s) or tote(s) near the CWS cooling tower and will be injected into the circulating water at controlled rates with metering pumps.

Chemical treatment system pumps, valves, tanks, instrumentation, and controls provide the means of monitoring water chemistry. Monitoring will be consistent with chemical vendor recommendations required for chemical dosage and performance. The NPDES permit may require additional environmental compliance monitoring at point sources, such as pump discharges to oil/water separator. Residual chlorine is measured to monitor the effectiveness of biocide treatment. Conductivity and pH are also monitored.

Sample ports are installed at the circulating water supply headers and CWS makeup header. Grab samples are analyzed at the chemistry lab.

### 4.9.3 Retention Basin

Use of sodium hypochlorite as an oxidizing biocide at the CWS and ESWS cooling towers will require dechlorination at the retention basin outlet prior to discharge to the Susquehanna River. Sodium bisulfite solution will be used to react with residual oxidant. Chemical storage and metering facilities located near the retention basin will inject sodium bisulfite into the basin outlet. Because biocide treatment at the cooling towers is periodic, dechlorination will be paced to match the treatment schedules. Downstream monitoring will verify conformance with typical NPDES limitations on residual oxidant.
The discharge from the retention basin will consist primarily of blowdown from the CWS and from the ESWS cooling towers. The combined water composition will depend on the cycles of concentration and on the specific cooling water chemistry control strategy used for deposit control. Using three cycles of concentration per the BBNPP Water Balance (Ref 6.5) and assuming a conservatively high sulfuric acid dosage of 33 ppm, the results in the average composition are shown in Table 4.9.2-1, below. Alternative deposit control strategies using higher pH levels with lower acid dosages and more aggressive deposit control chemical programs would have similar compositions but with higher pH levels, higher alkalinities, and lower sulfate levels.

**Table 4.9.2-1** Retention Basin Discharge Composition.

| | | Retention Basin Discharge |
|---|---|---|
| Constituent | Composition | Mean |
| pH | | 8.0 to 8.5 |
| Total dissolved solids | (mg/l) | 471 |
| Total suspended solids | (mg/l) | |
| Calcium Hardness | (mg/l as CaCO3) | 198 |
| Total Hardness | (mg/l as CaCO3) | 276 |
| M.O. Alkalinity | (mg/l as CaCO3) | 83 |
| | | |
| Calcium | (mg/l as Ca) | 80 |
| Magnesium | (mg/l as Mg) | 19 |
| Sodium | (mg/l as Na) | 46 |
| | | |
| Chloride | (mg/l as Cl) | 77 |
| Sulfate | (mg/l as SO4) | 180 |
| Ortho-Phosphate | (mg/l as PO4) | 0.6 |
| | | |
| Silica | (mg/l as SiO2) | 8.4 |
| Iron | (mg/l as Fe) | 0.3 |

## 5.0 LIMITATIONS

This Conceptual Design Report is prepared to support COL application and shall provide the basis for a detailed design prior to construction. Verification of inputs, assumptions, and limitations shall be performed during the detailed design stage.

Additional limitations are as follows:

5.1 This conceptual design report is based on the Bell Bend Nuclear Power Plant Conceptual Design Calculation of the Circulating Water System, Calculation No. 2008-09135, Rev. 2. Verification of inputs, assumptions, and limitations shall be performed during the detailed design stage.

5.2 Information from vendors is considered preliminary. During the detailed design, equipment specifications will be developed as required.

## 6.0 REFERENCES

6.1 S&L Calculation 2008-09135, Rev. 2, "Conceptual Design Calculation for the Circulating Water System" (Unverified).
6.2 S&L Report No. 2008-06824, Rev. 1, "Engineering and Economic Evaluation of the Integrated Heat Rejection Cycle."
6.3 Susquehanna Steam Electric Station (SSES) FSAR.
6.4 U.S. EPR Final Safety Analysis Report Section 10.4.5, Rev. 0, "Circulating Water System."
6.5 Calculation 2008-08550, Rev. 1, "BBNPP Unit 3 Water Balance" (Unverified).
6.6 S&L Calculation No. 2008-08861, Rev. 2, "Fire Protection Plan for Yard and Outlying Buildings" (Unverified).
6.7 U.S. EPR Final Safety Analysis Report Section 9.2.5, Rev. 0, "Ultimate Heat Sink."
6.8 Boring logs from Paul C. Rizzo Associates, Inc. performed in conjunction with the COLA for the Bell Bend site.
6.9 Ingersoll-Dresser Pumps. Type APKD, APKC, QLQC Vertical, Multistage Can Pump Brochure. (Attachment G).
6.10 S&L Drawing 12198-004-TREN-001, Rev. 0, "Single Line Pipe Trench Detail" (Unverified) (Attachment E)
6.11 S&L Drawing 12198-004-TREN-002, Rev. 0, "Multiple Line Pipe Trench Detail" (Unverified) (Attachment F)
6.12 S&L Standard SDS-E24, Rev. 1, "Buried Pipes."
6.13 S&L Drawing 12198-004-CWS-001, Rev. 5, "Piping and Instrumentation Diagram Circulating Water System" (Unverified) (Attachment A).
6.14 S&L Drawing 12198-004-RWSS-004, Rev. 2, "Conceptual Intake Structure General Arrangement" (Unverified) (Attachment B).
6.15 Environmental Protection Agency (EPA) Rule 316(b). Dated June 16, 2006.
6.16 S&L Drawing 12198-004-CWS-002, Rev. 2, "Conceptual Circulating Water Pumphouse General Arrangement" (Unverified) (Attachment C).
6.17 S&L Drawing 12198-004-CWS-003, Rev. 3, "Conceptual Retention Basin General Arrangement" (Unverified) (Attachment D).
6.18 S&L Drawing 12198-004-CWS-015, Rev. 1, "Conceptual Discharge Detail" (Unverified) (Attachment N).
6.19 ACI 318-05 & ACI 318R-05,"Building Code Requirements for Structural Concrete and Commentary," ACI Committee.
6.20 AISC, 13th Edition, "Steel Construction Manual," American Institute of Steel Construction, Inc.
6.21 Response to RFI No. EPR 08-170 from Paul C Rizzo Associates, Inc, dated 05-08-08 (Attachment S).
6.22 S&L Internal Design Information Transmittal DIT-BBNPP-003, dated 4/28/08, "Water and Soil Chemistry Parameters for Buried Commodities" (Attachment R).
6.23 Hydraulic Institute Standards for Centrifugal, Rotary & Reciprocating Pumps. Twelfth Edition. (Attachment H).
6.24 S&L Drawing 12198-004-CWS-014, Rev. 1, "Conceptual Electrical One-Line Diagram Circ Water Pump House" (Unverified) (Attachment M).
6.25 S&L Drawing 12198-004-RWSS-005, Rev. 2, "Conceptual Electrical One-Line Diagram Intake Structure for CWS and RWSS" (Unverified) (Attachment L).
6.26 Benson, A. J. and D. Raikow. 2008. Dreissena polymorpha. USGS Nonindigenous Aquatic Species Database, Gainesville, FL.
6.27 S&L Drawing 12198-004-HV-002, Rev. 0, "Conceptual Piping & Instrumentation Diagram Circulating Water Pump House Heating and Ventilation" (Unverified) (Attachment Q).
6.28 S&L Drawing 12198-004-HV-001, Rev. 0, "Conceptual Piping & Instrumentation Diagram CWS Makeup & RWS Pump House Heating & Ventilation" (Unverified) (Attachment P).
6.29 Thermal Plume Studies in the Susquehanna River at the Discharge Diffuser of the Susquehanna Steam Electric Station 1986-87. Ecology III, Inc.
6.30 Not used.
6.31 Email from SPX date 5-16-08 regarding cooling tower air flow rates (Unverified) (Attachment T).
6.32 Email from John Dalton (SPX Marley) to Richard Pospiech (S&L), 6/25/2008 (Attachment U).

## 7.0 CONCLUSIONS AND RECOMMENDATIONS

The specifications for pumps and piping in the Circulating Water System are summarized in the table below:

**Table 7.0-1** Summary of CWS Pumps and Piping.

| | Flowrate (each) | Pipe | TDH | HP (each) |
|---|---|---|---|---|
| CWS Pumps (4-25%) | 220,180 gpm | 132-inch Concrete* | 126 ft (55 psi) | 9,000 HP |
| • CWS Blowdown | 8,700 gpm | 18-inch Carbon Steel | - | - |
| CWS Makeup Pumps (3-50%) | 13,100 gpm | 30-inch Carbon Steel | 421 ft (182 psi) | 1,800 HP |
| Retention Basin Discharge | 9,370 gpm | 24-inch Carbon Steel | - | - |
| | | 24-inch Concrete | - | - |
| | | 26-inch HDPE | - | - |

*Note: Two pipelines, concrete below ground, carbon steel above ground.

The intake structure utilizes a bar grating, a trash rake, dual-flow traveling screens, and screenwash pumps. CWS makeup pump operation is automatically controlled with input from the cooling tower basin level.

The CWS pumphouse utilizes a bar grating and a trash rake. The CWS pumps provide both the circulating water and the CWS blowdown. CWS blowdown flow to the retention basin is controlled by the blowdown control valve which is modulated using input from the cooling tower basin level instrumentation and MCR input for maintaining the desired water chemistry.

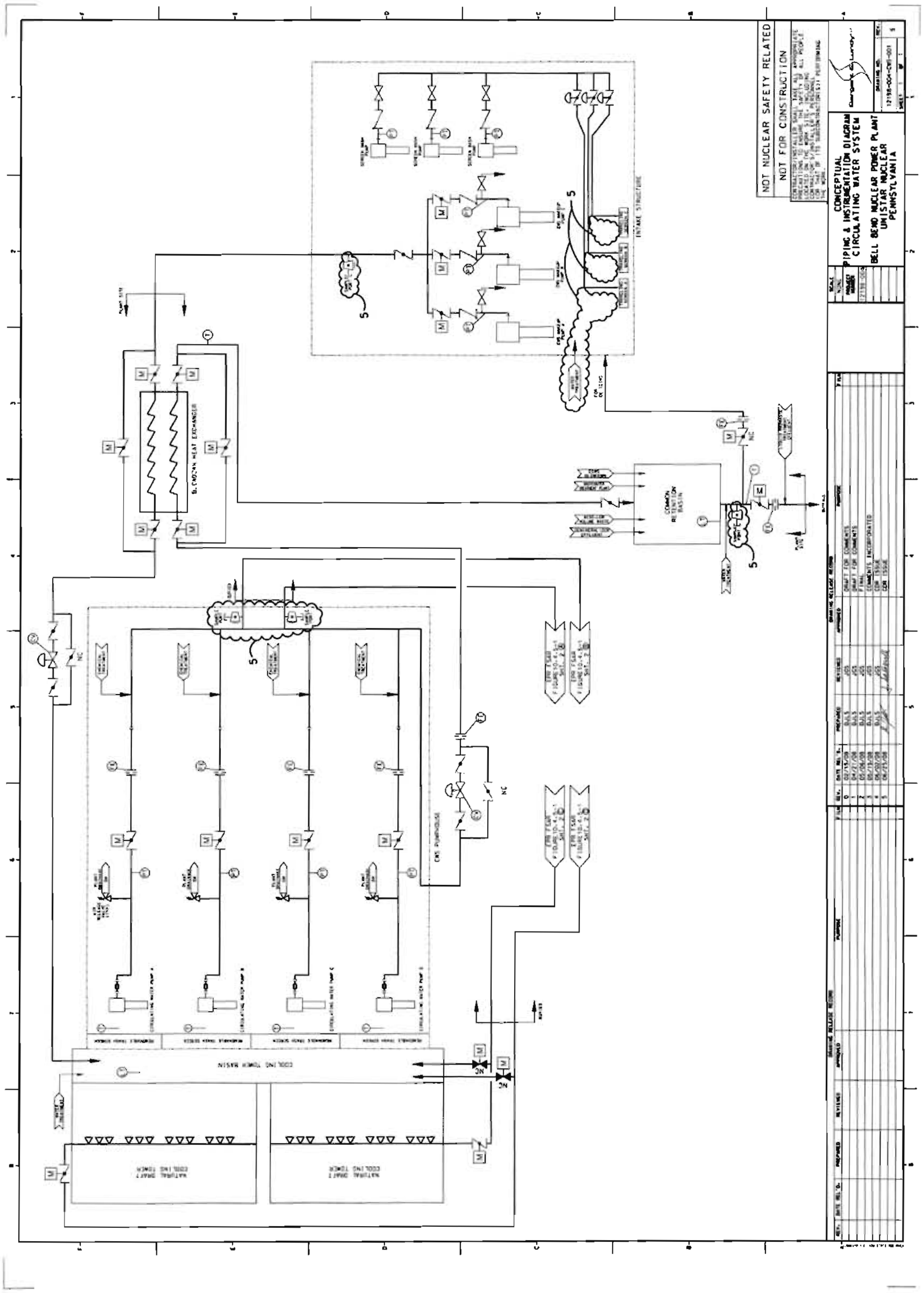
The retention basin is 451’ x 225’ x 9’ and has a volume of approximately 910,000 $ft^3$ (6,800,000 gal).

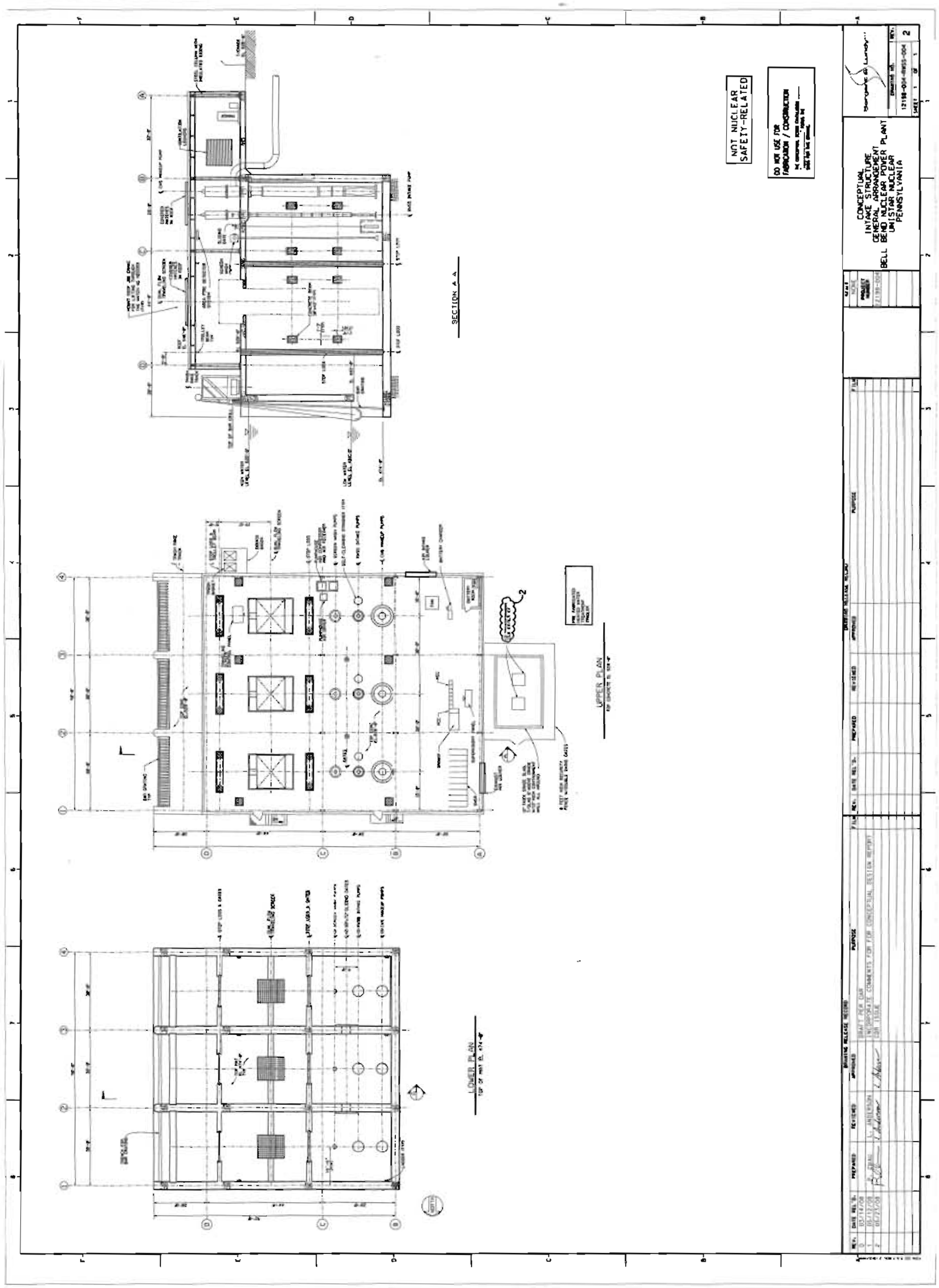
Three potential retention basin discharge pipe options are described above. The final selection shall be made during the detailed design.

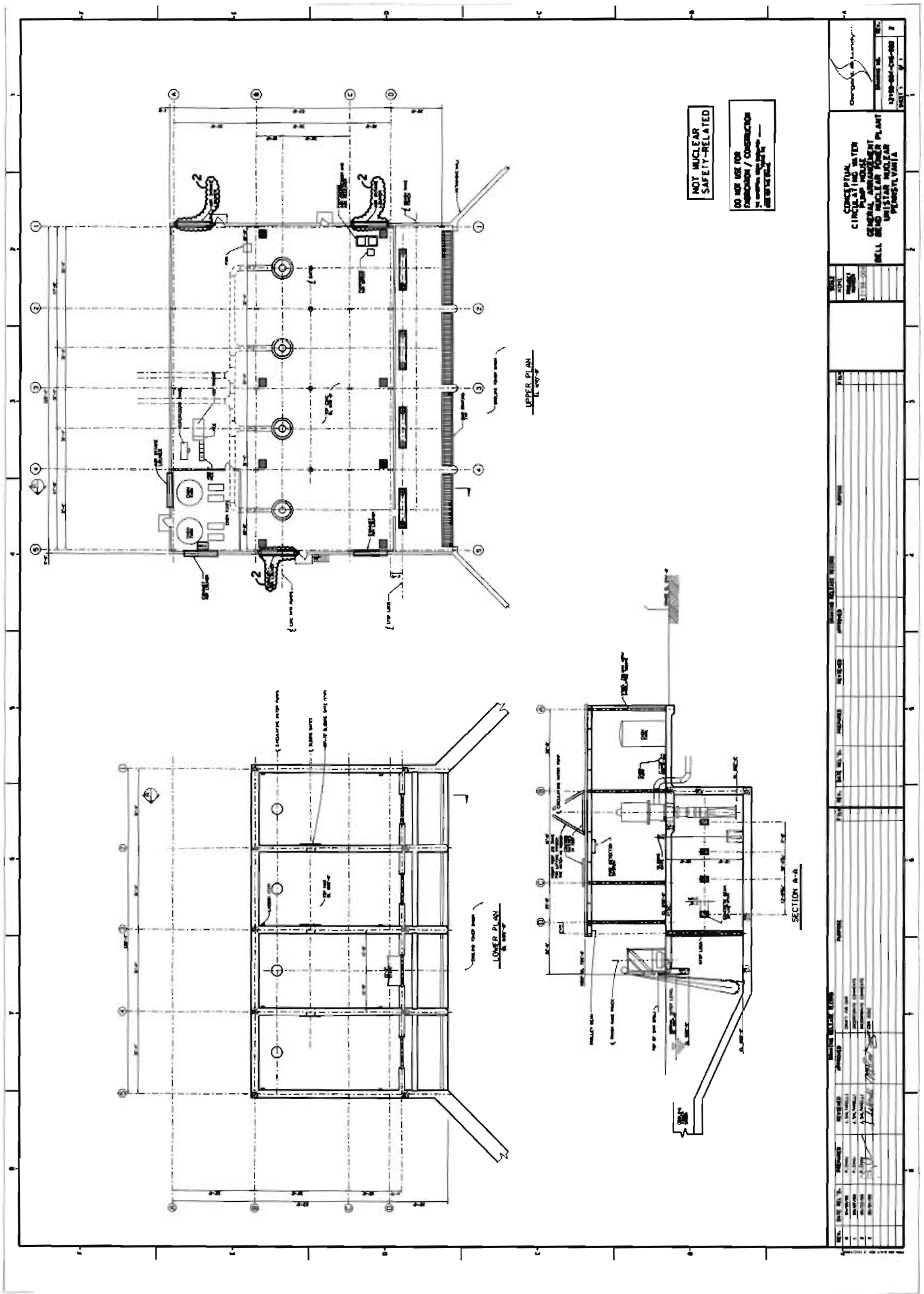
The discharge diffuser creates a large mixing zone in order to meet maximum surface temperature-rise limitations.

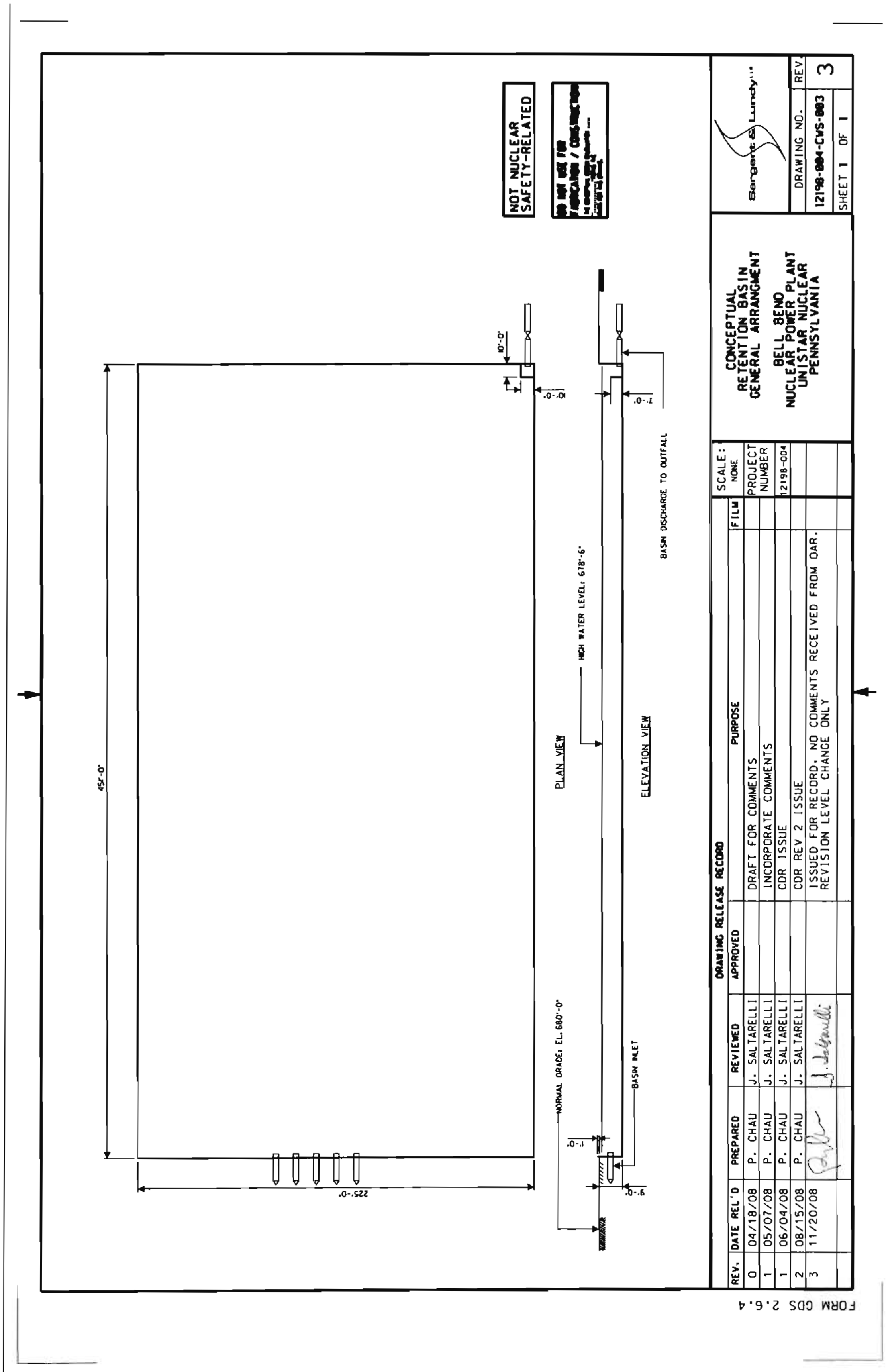
## 8.0 ATTACHMENTS

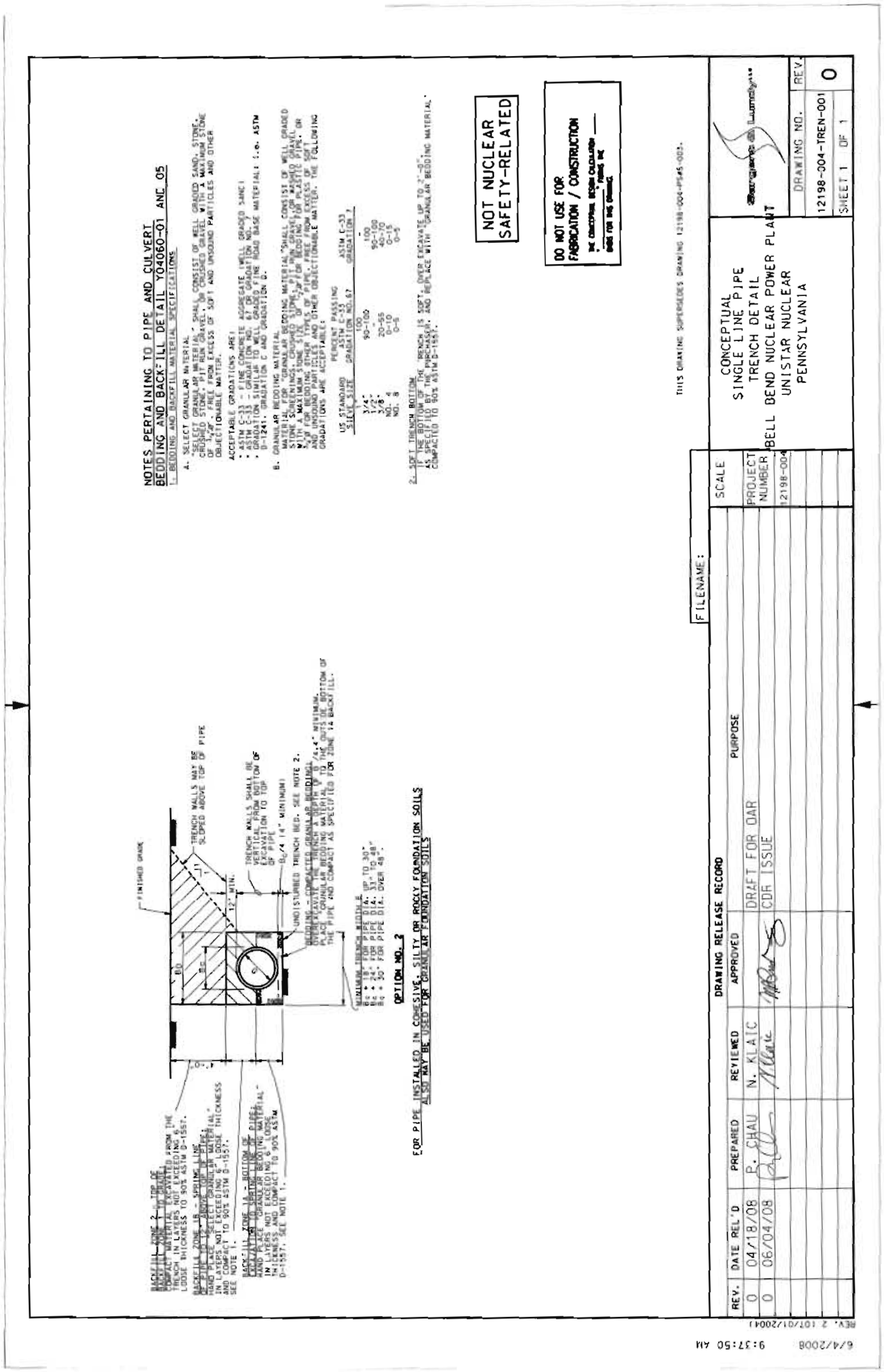
A CWS Piping and Instrumentation Diagram
B Intake Structure Layout
C CWS Pumphouse Layout
D Retention Basin Layout
E Single Pipeline Trench Detail
F Multiple Pipeline Trench Detail
G Ingersoll-Dresser Pump Brochure
H Hydraulic Institute Standards Excerpt
J Flowserve Pump Brochure
K Siemens Traveling Screen Brochure
L Intake Structure Electrical One-Line
M CWS Pumphouse Electrical One-Line
N Discharge Diffuser Layout
P Intake Structure HVAC P&ID
Q CWS Pumphouse HVAC P&ID
R S&L Internal DIT-BBNPP-003
S Response to RFI EPR-08-170
T Air Flow Rate
U Email on Cooling Tower

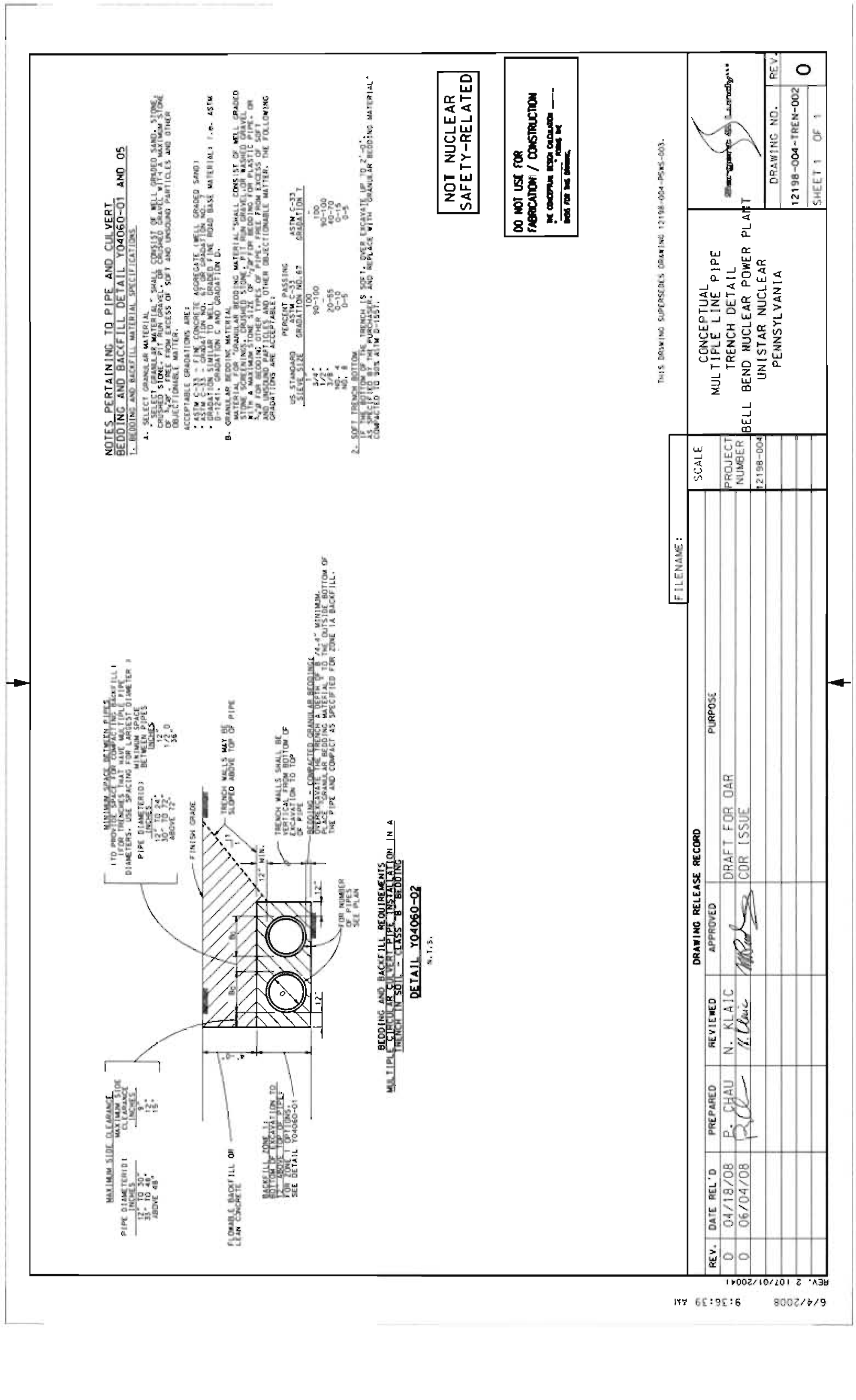

NOT NUCLEAR SAFETY RELATED
NOT FOR CONSTRUCTION
CONCEPTUAL
PIPING & INSTRUMENTATION DIAGRAM
CIRCULATING WATER SYSTEM
BELL BEND NUCLEAR POWER PLANT
UNISTAR NUCLEAR
PENNSYLVANIA
INTAKE STRUCTURE
COMMON RETENTION BASIN
CWS PUMPHOUSE
COOLING TOWER BASIN
NATURAL DRAFT COOLING TOWER


NOT NUCLEAR SAFETY-RELATED
SECTION A-A
UPPER PLAN
LOWER PLAN
CONCEPTUAL
INTAKE STRUCTURE
GENERAL ARRANGEMENT
BELL BEND NUCLEAR POWER PLANT
UNISTAR NUCLEAR
PENNSYLVANIA


NOT NUCLEAR SAFETY-RELATED
DO NOT USE FOR FABRICATION / CONSTRUCTION
UPPER PLAN
LOWER PLAN
SECTION A-A
CONCEPTUAL
CIRCULATING WATER
PUMP HOUSE
GENERAL ARRANGEMENT
BELL BEND NUCLEAR POWER PLANT
UNISTAR NUCLEAR
PENNSYLVANIA


NOT NUCLEAR SAFETY-RELATED
PLAN VIEW
ELEVATION VIEW
45'-0"
225'-0"
10'-0"
10'-0"
7'-0"
1'-0"
9'-0"
HIGH WATER LEVEL: 678'-6"
BASIN DISCHARGE TO OUTFALL
NORMAL GRADE: EL. 680'-0"
BASIN INLET
Sargent & Lundy
CONCEPTUAL RETENTION BASIN GENERAL ARRANGEMENT
BELL BEND NUCLEAR POWER PLANT
UNISTAR NUCLEAR
PENNSYLVANIA
SCALE: NONE
PROJECT NUMBER 12198-004
DRAWING NO. 12198-004-CWS-003
REV. 3
SHEET 1 OF 1
DRAWING RELEASE RECORD
REV. DATE REL'D PREPARED REVIEWED APPROVED PURPOSE FILM
0 04/18/08 P. CHAU J. SALTARELLI DRAFT FOR COMMENTS
1 05/07/08 P. CHAU J. SALTARELLI INCORPORATE COMMENTS
1 06/04/08 P. CHAU J. SALTARELLI CDR ISSUE
2 08/15/08 P. CHAU J. SALTARELLI CDR REV 2 ISSUE
3 11/20/08 ISSUED FOR RECORD. NO COMMENTS RECEIVED FROM OAR. REVISION LEVEL CHANGE ONLY
FORM GDS 2.6.4

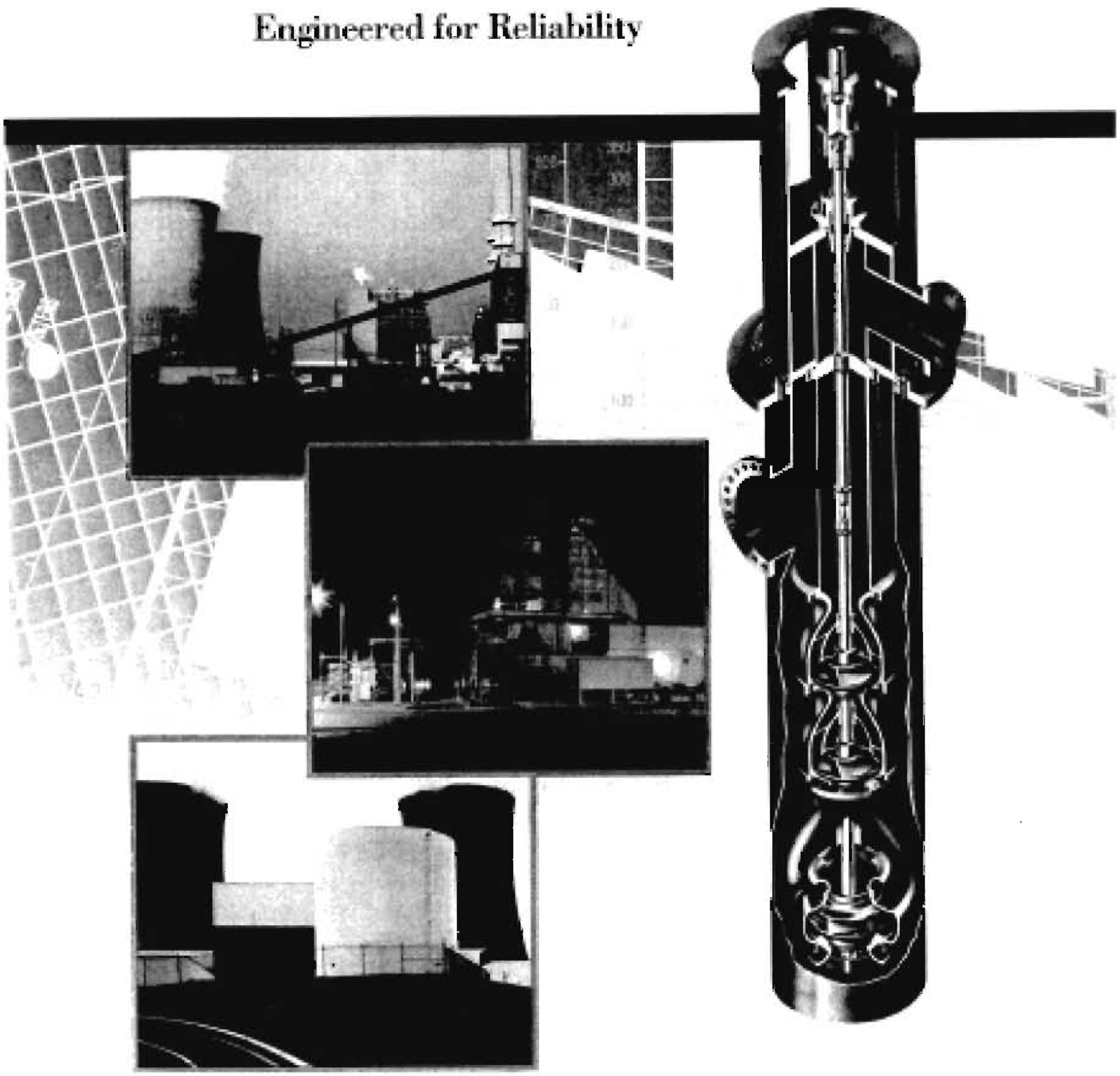

NOT NUCLEAR SAFETY-RELATED
DO NOT USE FOR FABRICATION / CONSTRUCTION
CONCEPTUAL
SINGLE LINE PIPE
TRENCH DETAIL
BELL BEND NUCLEAR POWER PLANT
UNISTAR NUCLEAR
PENNSYLVANIA
DRAWING NO.
12198-004-TREN-001
REV.
0
SHEET 1 OF 1
DRAWING RELEASE RECORD
REV. DATE REL'D PREPARED REVIEWED APPROVED PURPOSE
0 04/18/08 P. CHAU N. KLAIC DRAFT FOR OAR
0 06/04/08 CDR ISSUE
SCALE
PROJECT NUMBER 12198-004
FILENAME:
OPTION NO. 2
NOTES PERTAINING TO PIPE AND CULVERT BEDDING AND BACKFILL DETAIL Y04060-01 AND 05


NOT NUCLEAR SAFETY-RELATED
DO NOT USE FOR FABRICATION / CONSTRUCTION
NOTES PERTAINING TO PIPE AND CULVERT BEDDING AND BACKFILL DETAIL Y04060-01 AND 05
BEDDING AND BACKFILL REQUIREMENTS MULTIPLE CIRCULAR CULVERT PIPE INSTALLATION IN A TRENCH IN SOIL - CLASS "B" BEDDING
DETAIL Y04060-02
N.T.S.
FINISH GRADE
DRAWING RELEASE RECORD
REV. | DATE REL'D | PREPARED | REVIEWED | APPROVED | PURPOSE
0 | 04/18/08 | P. CHAU | N. KLAIC | | DRAFT FOR OAR
0 | 06/04/08 | | | | COR ISSUE
FILENAME:
SCALE
PROJECT NUMBER
12198-004
CONCEPTUAL
MULTIPLE LINE PIPE
TRENCH DETAIL
BELL BEND NUCLEAR POWER PLANT
UNISTAR NUCLEAR
PENNSYLVANIA
DRAWING NO.
12198-004-TREN-002
SHEET 1 OF 1
REV.
0
6/4/2008 9:36:39 AM

Ingersoll-Dresser Pumps

# Type APKD, APKC, QLQC Vertical, Multistage Can Pump

## Engineered for Reliability



# Type APKD, APKC, QLQC —

## Engineered for Reliability... Performance-proven in Demanding Applications

The APKD, APKC, QLQC line is a vertically mounted multistage pump. This line is specifically designed for operation on condenser condensate, heater drain service, or for applications where NPSHA is limited or the installation requirements are best suited to a vertical pump. Both single and double suction first stage designs are available, depending on the specific application.

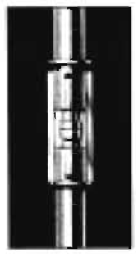
Following are some of the features and benefits of this proven performer.

### Double Suction Impeller

The APKD's and QLQC's first stage is a dual volute, double suction design. This design reduces the NPSH required by the first stage impeller. The double suction design minimizes the length of the pump, providing lower installation costs, and more importantly, an extremely rigid pump design that provides stable, reliable operation over a wide range of flows.

### Impeller Attachment

The intermediate stage impellers are positively locked to the shaft. This design eliminates any undesired movement and insures that torque will be smoothly transmitted from the shaft to the impeller even during thermal cycling and transient suction conditions.

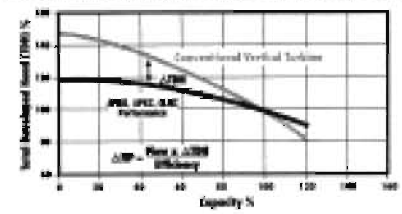


### Lineshaft Coupling Design

The shaft coupling is a solid sleeve type that features a keyed and clamped design. The torque is transmitted through full keyways and thrust is transmitted through split rings. To facilitate assembly and disassembly, no threaded parts are used in the critical coupling areas.

### Curve Shape/Hydraulic Performance

Excessive high head rise to shutoff can cause a waste of power at part load or off peak operating conditions, resulting in higher operating cost of the equipment. The APKD, APKC, QLQC line of pumps can be offered with a head rise to shutoff as low at 120% of the rated head. This compares to 140 – 150% for most vertical turbine designs. The flatter the pump head-capacity curve, the lower the part load horsepower and operating cost of the pump.



### Experience in a Wide Range of Demanding Applications

Ingersoll-Dresser Pumps' APKD, APKC, QLQC is a proven performer, providing reliable service for over 45 years in the most demanding applications-condensate, high/low pressure heater drain, containment spray, residual heat removal, geothermal hot water, brine injection, pipeline booster, and hydrocarbon transfer.

### Intake Design

The function of the intake, whether it be an open channel or a tunnel having 100 per cent wetted perimeter, is to supply an evenly distributed flow of water to the suction bell. An uneven distribution of flow, characterized by strong local currents, favors formation of vortices and with certain low values of submergence, will introduce air into the pump with reduction of capacity, accompanied by noise. Uneven distribution can also increase or decrease the power consumption with a change in total developed head. There can be vortices which do not appear on the surface, and these also may have adverse effects.

Uneven velocity distribution leads to rotation of portions of the mass of water about a centerline called vortex motion. This centerline may also be moving. Uneven distribution of flow is caused by the geometry of the intake and the manner in which water is introduced into the intake from the primary source.

Calculated low *average* velocity is not always a proper basis for judging the excellence of an intake. High *local* velocities in currents and in swirls may be present in intakes which have very low *average* velocity. Indeed, the uneven distribution which they represent occurs less in a higher velocity flow with sufficient turbulence to discourage the gradual build-up of a larger and larger vortex in any region. Numbers of small surface eddies may be present without causing any trouble.

The ideal approach is a straight channel coming directly to the pump. Turns and obstructions are detrimental since they may cause eddy currents and tend to initiate deep-cored vortices.

Water should not flow past one pump to reach the next if this can be avoided. If the pumps must be in line of flow, it may prove necessary to construct an open front cell around each pump or to put turning vanes under the pump to deflect the water upward.

All possible streamlining should be used to reduce the trail of alternating vortices in the wake of the pump or of other obstructions in the stream flow.

Successful proportions of the amount of submergence per se (See Suction Limitations, page 67), will depend greatly on the approaches to the intake and the size of the pump. The pump manufacturer will generally render advice on specific problems while the intake design is still preliminary if he is provided with the necessary intake layout drawings reflecting the physical limitations of the site.

Complete analysis of intake structures is best accomplished by scale model tests (See Model Tests of Intakes page 90).

Subject to the qualifications of the foregoing statements, Figs. 64, 65 & 66 have been constructed for single and simple multiple pump arrangements to show suggestions for basic sump dimensions. They are for pumps normally operating in the capacity range of approximately 3,000 to 300,000 gpm. Since these values are composite averages from a great many pump types and cover the entire range of specific speeds, they must not be thought of as absolute values but rather as basic guides subject to some possible variations. For pumps normally operating at capacities below approximately 3,000 gpm, refer to Sump or Pit Designs (small pumps) page 9[illegible].

All of the dimensions in Figs. 64, 65 & 66 are based on the rated capacity of the pump at the design head. Any increase in capacity above these values should be momentary or very limited in time. If operation at an increased capacity is to be undertaken for considerable periods of time, the maximum capacity should be used for the design value in obtaining sump dimensions.

The Dimension C is an average, based on an analysis of many pumps. Its final value should be specified by the pump manufacturer.

Dimension B is a suggested maximum dimension which may be less depending on actual suction bell or bowl diameters in use by the pump manufacturer. The edge of the bell should be close to the back wall of the sump. When the position of the back wall is determined by the driving equipment or the discharge piping, Dimension B may become excessive and a "false" back wall should be installed.

Dimension S is a minimum for the sump width for a single pump installation. This dimension can be increased, but if it is to be made smaller, the manufacturer should be consulted or a sump model test should be run to determine its adequacy.

Dimension H is a minimum value based on the "normal low water level" at the pump suction bell, taking into consideration friction losses through the inlet screen and approach channel. This dimension can be considerably less momentarily or infrequently without excessive damage to the pump. It should be remembered, however, that this does not represent "submergence." Submergence is normally quoted as dimension "H" minus "C." This represents the physical height of water level above the bottom of the suction inlet. The actual submergence of the pump is something less than this, since the impeller eye is some distance above the bottom of the suction bell, possibly as much as 3 to 4 feet. For the purposes of sump design in connection with this chart, it is understood that the pump has been selected in accordance with specific speed charts, Figs. 54, 55, 56 and 57, the submergence referred to herein having to do only with vortexing and eddy formations.

Dimensions Y and A are recommended minimum values. These dimensions can be as large as desired but should be limited to the restrictions indicated on the curve. If the design does not include a screen, Dimension A should be considerably longer. The screen or gate widths should not be substantially less than S, and heights should not be less than H. If the main stream velocity is more than 2 feet per second, it may be necessary to construct straightening vanes in the approach channel, increase Dimension A, conduct a sump model test of the installation, or work out some combination of these factors.

Dimension S becomes the width of an individual pump cell or the center-to-center distance of two pumps if no division walls are used.

On multiple pump installations, the recommended dimensions in Figs. 64, 65 and 66 also apply as noted above, and the following additional determinants should be considered:

Fig. 67a. Low velocity and straight-line flow to all units simultaneously is the first recommended style of pit. Velocities in pump area should be approximately one foot per second. Some sumps with velocities of 2 feet per second and higher have given good results. This is particularly true where the design resulted from a model study. Not recommended would be an abrupt change in size of inlet pipe to sump or inlet from one side introducing eddying.

Fig. 67b. A number of pumps in the same sump will operate best without separating walls unless all pumps are always in operation at the same time, in which case the use of separating walls may be beneficial. If walls must be used for structural purposes, and pumps will operate intermittently, leave flow space behind each wall from the pit floor up to at least the minimum water level and the wall should not extend upstream beyond the rim of the suction bell. If walls are used, increase dimension "S" by the thickness of the wall for correct centerline spacing. Round or "ogive" ends of walls. NOT recommended is the placement of a number of pumps around the edge of a sump with or without dividing walls.

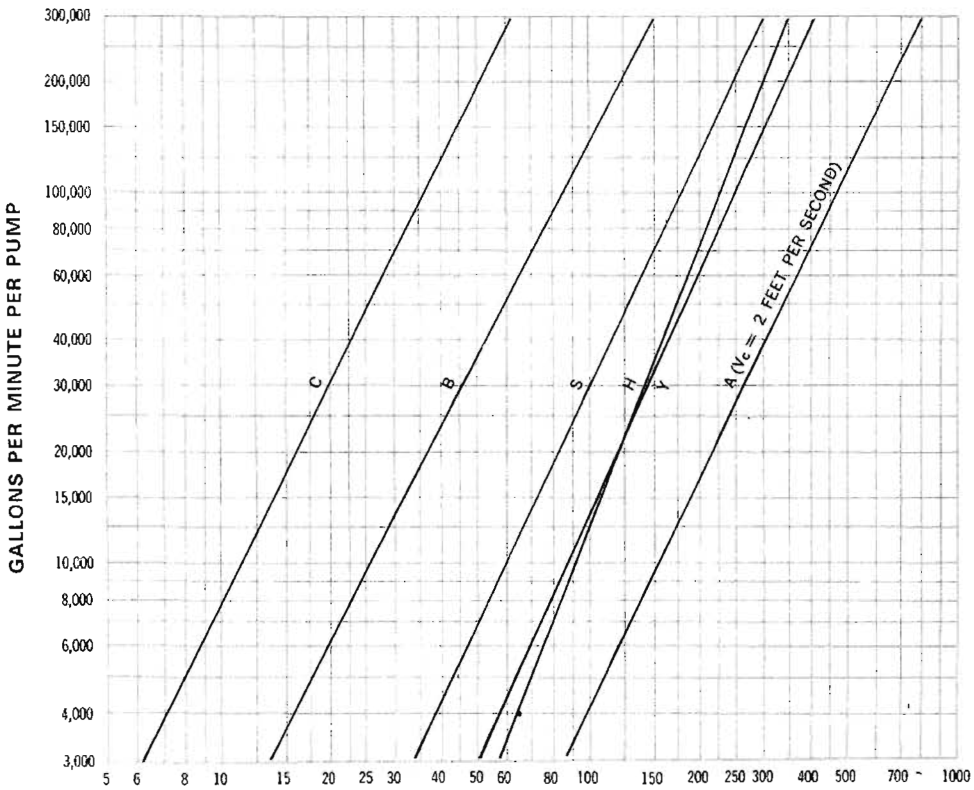
Fig. 67c. Abrupt changes in size from inlet pipe or channel to pump bay are not desirable. A relatively small pipe emptying into a large pump pit should connect to the pit with a gradually increasing taper section. The angle should be as large as possible, preferably not less than 45 degrees. With this arrangement, pit velocities much less than one foot per second are desirable. Especially not recommended is a small pipe directly connected to a large pit with pumps close to the inlet. Flow will have excessive change of direction to get ~~the~~ most of the pumps. Centering pumps in the pit leaves large "vortex areas" behind the pumps which will cause operational trouble.

Fig. 67d. If the pit velocity can be kept low enough (below one foot per second), an abrupt change from inlet pipe to pit can be accommodated if the length equals or exceeds the values shown. It is assumed that as ratio W/P increases, the inlet velocity at "P" will increase up to an allowed maximum of eight feet per second at W/P=10. Pumps "in line" are not recommended unless the ratio of pit to pump size is quite large, and pumps are separated by a generous margin longitudinally. A pit can generally be constructed at much less cost by using a recommended design.

Fig. 67e. It is sometimes desirable to install pumps in tunnels or pipe lines. A drop pipe or false well to house the pump with vaned inlet ell facing upstream will be satisfactory in flows up to eight feet per second. Without the inlet ell, the pump section bell should be positioned at least two pipe (vertical) diameters above the top of the tunnel, not hung into the tunnel flow, especially with tunnel velocities two feet per second or more. There should be no signs of air along the top of tunnel. It may be necessary to lower the scoop or insist on minimum water level in vertical well.

**Note:** The foregoing statements apply to sumps for clear liquid. For fluid-solids mixtures refer to the pump manufacturer.

SUMP DIMENSIONS VERSUS FLOW




RECOMMENDED SUMP DIMENSIONS IN INCHES

See explanatory notes in Text, Pages 85 and 86. Figures apply to sumps for clear liquid. For fluid-solids mixtures refer to the pump manufacture..

Fig. 64

## SUMP DIMENSIONS VERSUS FLOW

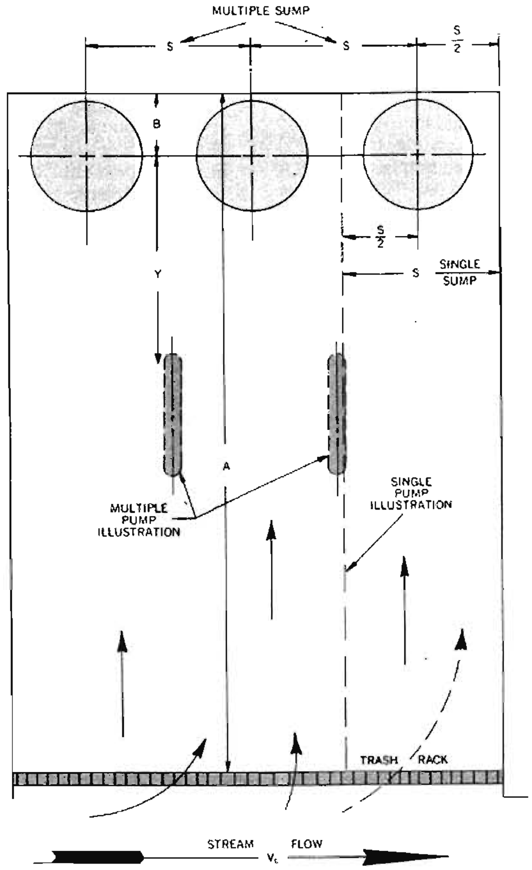



Fig. 65

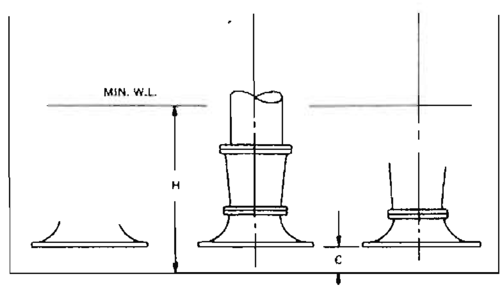
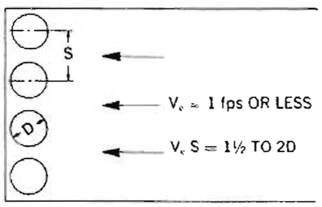



Fig. 66

## MULTIPLE PUMP PITS

RECOMMENDED | NOT RECOMMENDED



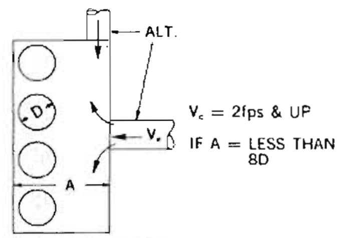
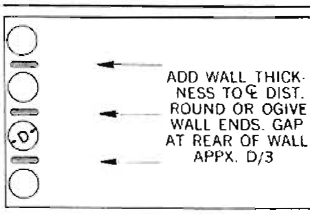




Fig. 67A



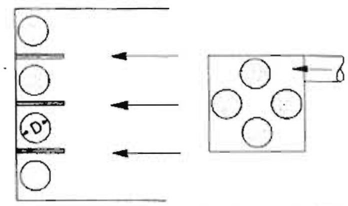
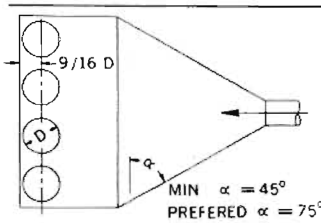




Fig. 67B



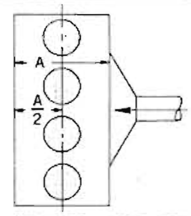
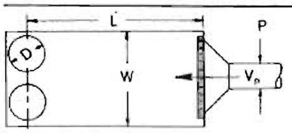
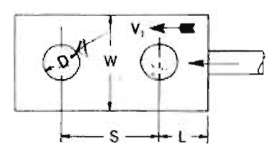




Fig. 67C



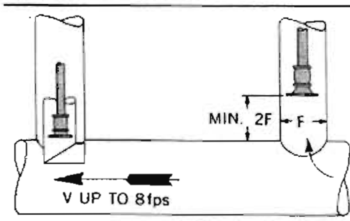

BAFFLES, GRATING OR STRAINER SHOULD BE INTRODUCED ACROSS INLET CHANNEL AT BEGINNING OF MAXIMUM WIDTH SECTION.

| W/P | 1.0 | 1.5 | 2.0 | 4.0 | 10.0 |
|---|---|---|---|---|---|
| L | 3D | 6D | 7D | 10D | 15D |
| $V_c$ | 1 | 2 | 4 | 6 | 8 |




W = 5D OR MORE, OR
$V_1$ = 0.2fps OR LESS AND
L = SAME AS CHART TO LEFT
S = IS GREATER THAN 4D

Fig. 67D



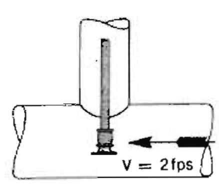




Fig. 67E

The Dimension "D" is generally the diameter of the suction bell measured at the inlet. This dimension may vary depending upon pump design. Refer to the pump manufacturer for specific dimensions.

NOTE: Figures apply to sumps for clear liquid. For fluid-solids mixtures refer to the pump manufacturer.

## VTP Vertical Turbine, Wet Pit Pump

Flowserve's VTP vertical turbine pump is a diffuser type, single or multiple stage design for continuous service in wet pit and deep well applications. With more than 300 bowl and impeller designs, the VTP provides unsurpassed hydraulic coverage to ensure the best pump selection for a wide variety of services.

Click to enlarge
1 image available

**Brands:** Byron Jackson, IDP, Western Land Roller, Worthington
**Applications:** Agriculture, Cooling Water, Circulation, Circulating Water, Cargo Loading and Unloading, Condenser Cooling, Deep Well, Essential Service Water, Flood Protection, General Purpose, Water Cooling, Water Supply, Water Treatment, Irrigation, Marine, Mining, Municipal, Pulp and Paper, Power Generation, Screen Wash, Sewage, Sump Service, Snowmaking, Storm Water, Utility, Wet Pit
**Industries:** Boiling Water Reactors Non-safety, Boiling Water Reactors Safety, Construction, Cooling Systems, Cooling Water - Metals, Desalination, Dewatering & Water Supply, Flood Control, Ground Water Development and Irrigation, Miscellaneous Services, OEM, Products Pipeline, Pressurized Water Reactors - Non-safety, Pressurized Water Reactors - Safety, Snowmaking, Utilities, Water Handling and Treatment, Water Supply and Distribution, Water Treatment
**Standards:**
**Misc:**

**Enclosed and Semi-Open Impellers** are designed for maximum coverage of all applications.

**Suction Bell** is designed to provide efficient liquid flow into the eye of the first stage impeller.

**Bowl Bearings**, with high length to diameter ratio, on either side of the impeller provide rigid support for the bowl shaft.

**Optional Bowl and Enclosed Impeller Wear Rings** provide means to renew clearances and pump efficiency.

**Open Lineshaft Construction, or Enclosed Oil Lubrication** for better lubrication of lineshaft bearings in abrasive services.

**Features:**

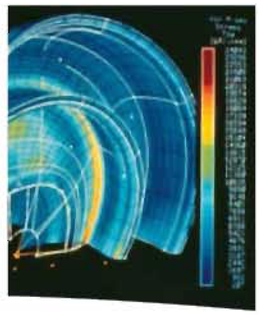
- Engineeered models to 160 000 $m^3/h$ (750 000 gpm)
- Lineshaft bearing lubrication options
  - Product lubrication
  - Oil lubrication (alternative lubricants available)
- Drive options
  - Dry or submersible electric motors
  - Variable speed drive
  - Engines with right angle gears
  - Steam turbines
- Choice of bearing materials
  - Metal
  - Rubber
  - Carbon
  - Composite
- Other configurations
  - VTP double casing with optional API 610 design
  - VTP-WUC double casing to API 610, ASME Code Section VIII and IX, German Pressure Vessel Association (AD) and other international standards
- Operating parameters
  - Pressures to 150 bar (2175 psi)
  - Temperatures from -200°C (-325°F) to 300°C (570°F)
  - Sizes to 1375 mm (55 in)
  - Settings to 365 m (1200 ft)

**VTP Vertical Turbine, Wet Pit Pump Chart**

# VTP
## Vertical Turbine, Wet-Pit Pump

FLOWSERVE






# Pump Supplier To The World

*Flowserve is the driving force in the global industrial pump marketplace. No other pump company in the world has the depth or breadth of expertise in the successful application of pre-engineered, engineered and special purpose pumps and systems.*

## Life Cycle Cost Solutions

Flowserve is providing pumping solutions which permit customers to reduce total life cycle costs and improve productivity, profitability and pumping system reliability.

## Market Focused Customer Support

Product and industry specialists develop effective proposals and solutions directed toward market and customer preferences. They offer technical advice and assistance throughout each stage of the product life cycle, beginning with the inquiry.

## Broad Product Lines

Flowserve offers a wide range of complementary pump types, from pre-engineered process pumps, to highly engineered and special purpose pumps and systems. Pumps are built to recognized global standards and customer specifications.

Pump designs include:
- Single stage process
- Between bearing single stage
- Between bearing multistage
- Vertical
- Submersible motor
- Rotary
- Reciprocating
- Nuclear
- Specialty

## Product Brands of Distinction

*ACEC™ Centrifugal Pumps*

*Aldrich® Pumps*

*Byron Jackson® Pumps*

*Cameron® Pumps*

*Durco® Pumps*

*Flowserve® Pumps*

*IDP® Pumps*

*Jeumont-Schneider™ Pumps*

*Pacific® Pumps*

*Pleuger® Pumps*

*Scienco® Pumps*

*Sier-Bath® Rotary Pumps*

*TKL™ Pumps*

*United® Centrifugal Pumps*

*Western Land Roller® Irrigation Pumps*

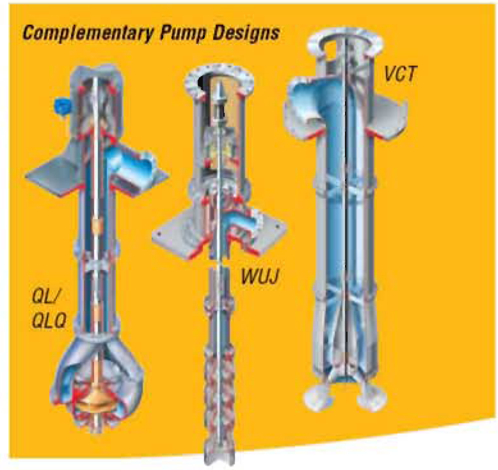
*Wilson-Snyder® Pumps*

*Worthington® Pumps*

*Worthington Simpson® Pumps*

flowserve.com

**VTP**
**Vertical Turbine, Wet-Pit Pump**




## Unequaled Hydraulic Coverage and Design Flexibility

*The Flowserve VTP is a single casing, diffuser type vertical turbine pump. Flowserve VTP pumps are installed in wet-pit or deep well applications where NPSH available is ample. Flowserve manufactures one of the world's most comprehensive lines of mixed flow vertical turbine pumps to ensure the best pump selection for a wide variety of services.*

### Engineered Flexibility

VTP pumps are available in a wide variety of configurations, constructions and materials to suit application requirements. Among the options are:

- Open or enclosed lineshaft construction
- Enclosed or semi-open impellers, keyed or collet mounted
- Bowl and enclosed impeller wear rings
- Cast iron or fabricated steel discharge heads
- Sealing configurations for open lineshaft construction
  - Packed box with flexible graphite packing
  - Single or dual mechanical seal
- Sealing configurations for enclosed lineshaft construction
  - Enclosing tube tension assembly for oil lubrication
  - Water injection packing assembly
- Above ground or below ground discharge flanges
- Multiple drivers
  - Electric motors, solid or hollow shaft
  - Engines with right angle gear drives
  - Steam turbines
- Separate axial thrust bearing assembly
- Standard and ISO 13709/API 610 (VS1), latest edition configurations

### Applications

- Municipal water
- Irrigation
- General industrial
- Snow making
- Power generation
- Oil and gas production
- Hydrocarbon processing
- Mining
- Storm water
- Sump service

### Rebowl Services

Flowserve can revitalize the performance of aged VTPs and reduce total operating costs. Whether for competitor or Flowserve pumps, upgrades will reduce power consumption, downtime and maintenance costs while extending the pump life.

### Complementary Pumps

Flowserve also offers these complementary pumps:

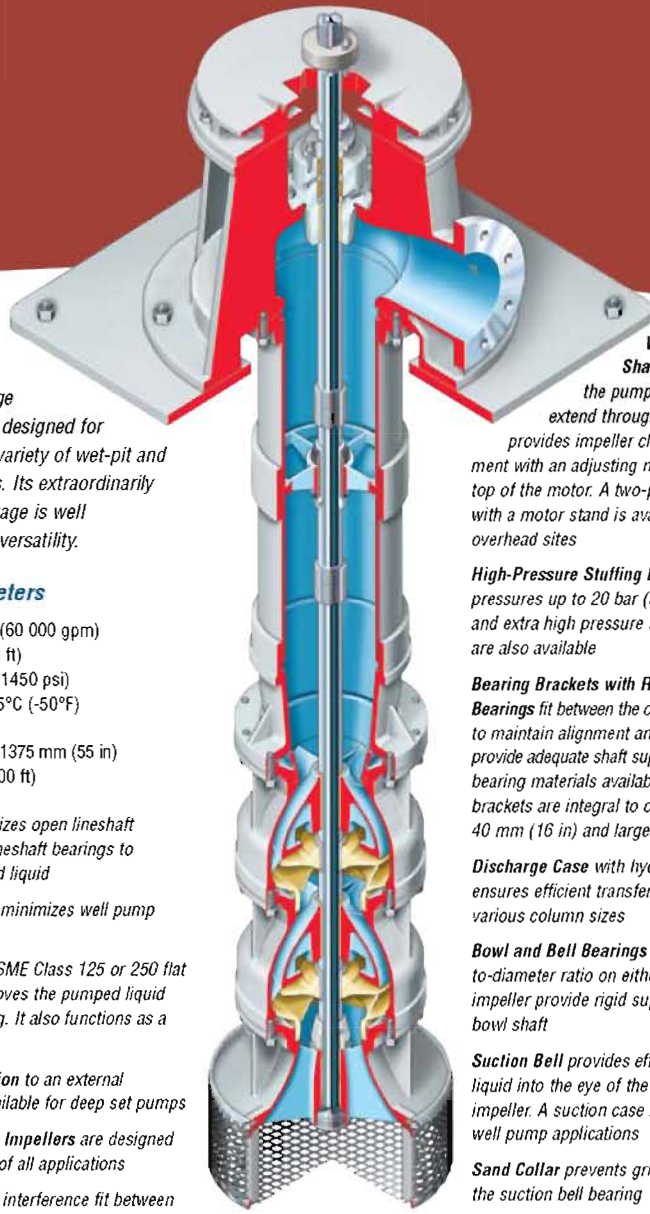
- VCT vertical mixed flow pumps
- QL and QLQ single casing, double suction, twin volute pumps
- WUJ ISO 13709/API 610 (VS1) vertical, multistage single casing process pump
- AFV vertical axial flow pump
- VPC vertical turbine, double casing pump
- LNN between bearing, axially split, single stage, double suction pump

3

FLOWSERVE

## VTP
## Vertical Turbine, Wet-Pit Pump

### Product Lubrication



*The VTP is a single casing, diffuser type, single or multiple stage vertical turbine pump designed for continuous duty in a variety of wet-pit and deep well applications. Its extraordinarily broad hydraulic coverage is well complemented by its versatility.*

### Operating Parameters

- Flows to 13 600 $m^3/h$ (60 000 gpm)
- Heads to 700 m (2300 ft)
- Pressures to 100 bar (1450 psi)
- Temperatures from -45°C (-50°F) to 200°C (400°F)
- Sizes 150 mm (6 in) to 1375 mm (55 in)
- Settings to 365 m (1200 ft)

***Product Lubrication*** *utilizes open lineshaft construction allowing lineshaft bearings to be lubricated by pumped liquid*

***Threaded Column Pipe*** *minimizes well pump casing diameter*

***Discharge Head*** *with ASME Class 125 or 250 flat face flange smoothly moves the pumped liquid into the discharge piping. It also functions as a driver mounting base*

***Prelubrication Connection*** *to an external lubrication source is available for deep set pumps*

***Enclosed or Semi-open Impellers*** *are designed for maximum coverage of all applications*

***Lock Collets*** *provide an interference fit between the bowl shaft and impeller to hold the impeller securely in place. Keyed impellers are standard for 500 mm (20 in) and larger models and optional on other sizes*

***Vertical Hollow Shaft Motor*** *allows the pump headshaft to extend through the motor and provides impeller clearance adjustment with an adjusting nut located at the top of the motor. A two-piece headshaft with a motor stand is available for low overhead sites*

***High-Pressure Stuffing Box*** *for working pressures up to 20 bar (300 psi). Low and extra high pressure stuffing boxes are also available*

***Bearing Brackets with Rubber Lineshaft Bearings*** *fit between the column sections to maintain alignment and are spaced to provide adequate shaft support. Alternative bearing materials available. Bearing brackets are integral to column pipes 40 mm (16 in) and larger*

***Discharge Case*** *with hydraulic adapter ensures efficient transfer of flow to various column sizes*

***Bowl and Bell Bearings*** *with high length-to-diameter ratio on either side of the impeller provide rigid support for the bowl shaft*

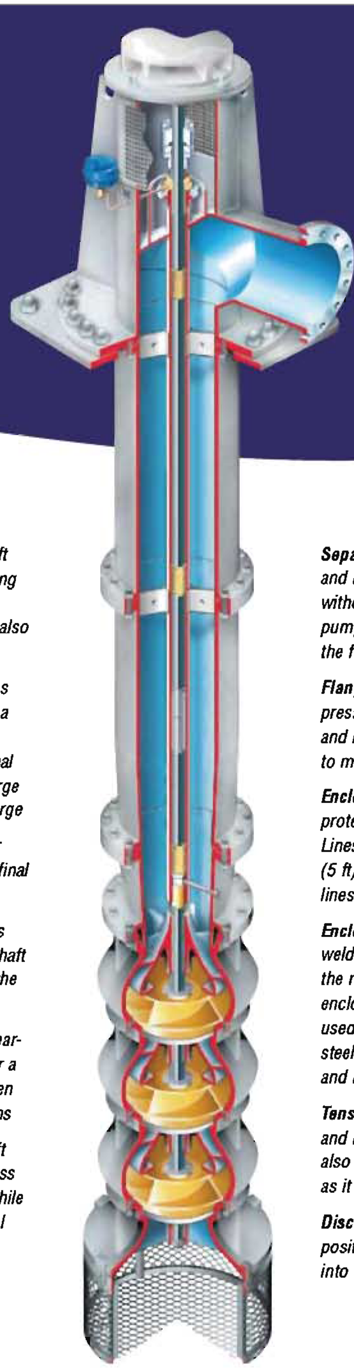
***Suction Bell*** *provides efficient flow of liquid into the eye of the first stage impeller. A suction case is provided for well pump applications*

***Sand Collar*** *prevents grit from entering the suction bell bearing*

***Basket Strainer*** *exceeds Hydraulics Institute parameters. Cone strainers are provided for deep well installations*

## VTP
## Vertical Turbine, Wet-Pit Pump

### Enclosed Oil Lubrication



***Enclosed Oil Lubrication*** *isolates the lineshaft and bearings from the pumped liquid minimizing maintenance in abrasive services. Alternative lubricants such as clean water or grease can also be used with enclosed lineshaft construction*

***Heavy-Duty Discharge Head*** *with ASME Class 150, 300 or 600 raised face flanges provides a rigid and stable support for high horsepower drivers. The mitered elbow reduces the internal friction loss and turbulence. Cast iron discharge heads are available to 500 mm (20 in) discharge*

***Alignment Screws*** *allow positioning of larger frame size motors on the discharge head for final alignment of the pump and motor shafts*

***Rigid, Adjustable Flanged Coupling*** *provides accurate impeller clearance adjustment and shaft stability. A spacer coupling allows access to the mechanical seal without removing the motor*

***Enclosed Impeller*** *provides close running clearance with the bowl to maintain efficiency over a broad operating range. Full range of semi-open impellers is available for particular applications*

***Keyed Impellers*** *positively locked to the shaft eliminate shaft to impeller movement. Stainless steel slotted keys prevent radial movement while the stainless steel split-ring keys prevent axial movement. Collet mounting is standard for impellers up to 460 mm (18 in)*

***Separate Steel Soleplate*** *allows grouting and leveling of the pump discharge head without permanently anchoring it. The pump can be removed without disturbing the foundation*

***Flanged Column Pipe*** *contains the pressure being generated by the pump and has a rabbet fit between the flanges to maintain alignment*

***Enclosing Tube*** *provides lineshaft protection from the pumped liquid. Lineshaft bearings are spaced at 1.5 m (5 ft) intervals to provide adequate lineshaft support*

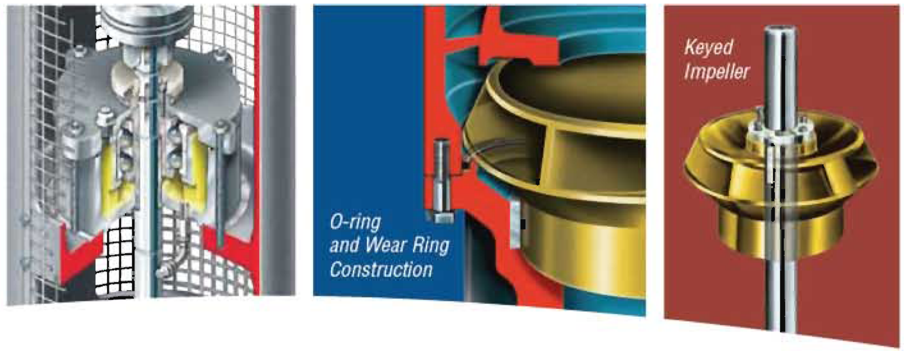
***Enclosing Tube Stabilizer*** *is integrally welded to the column pipe to maintain the rigidity and the alignment of the enclosing tube. Rubber stabilizers are used on column sizes to 355 mm (14 in); steel stabilizers for 400 mm (16 in) and larger*

***Tension Bearing*** *holds the enclosing tube and lineshaft bearings in alignment. It also provides a chamber for the lubricant as it enters the enclosing tube*

***Discharge Case With Bypass Port*** *allows positive flow of lineshaft bearing lubricant into the enclosing tube*

FLOWSERVE

# Options and Technical Data




## Integral Axial Thrust Bearing Assembly

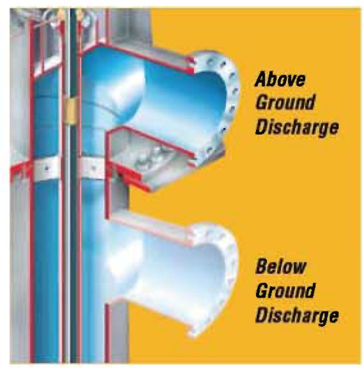
The axial thrust bearing assembly withstands the total hydraulic thrust as well as the rotor weight. Self-lubricating anti-friction bearings are utilized for standard applications. The integral axial thrust bearing assembly is available on VPC pumps with IEC motors.

## API 610 Compliant Features

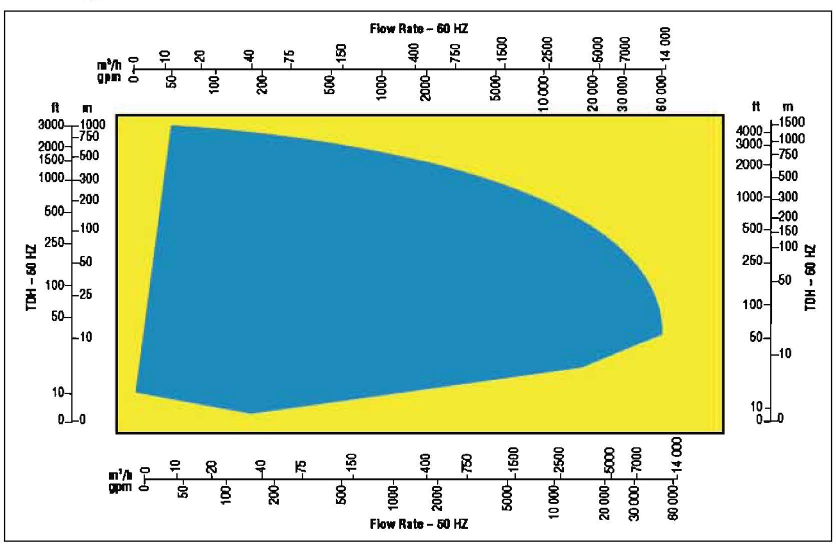
- Weld neck flanges
- Precision, rigid adjustable flanged spacer coupling
- Seal chamber with jackscrews
- Studs and nuts
- O-ring construction
- One-piece pump shaft up to 6 m (20 ft)
- Dynamically balanced, keyed enclosed impellers
- Pinned wear rings
- API 610 forces and moments

## Discharge Configurations

When using a fabricated discharge design, VTP pumps are available with above or below ground discharge flanges to suit site conditions.



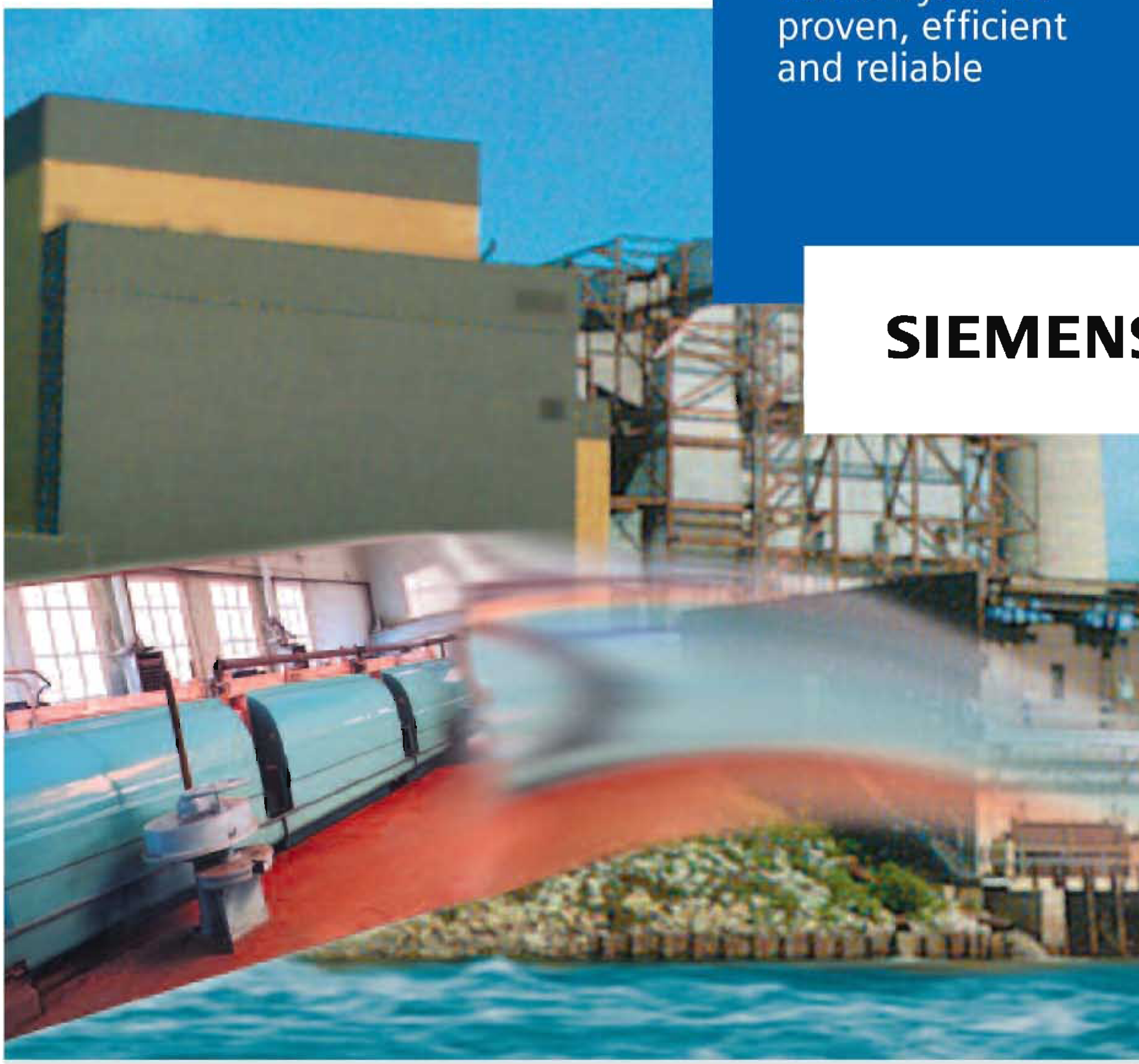

## VTP Range Chart



Water Technologies

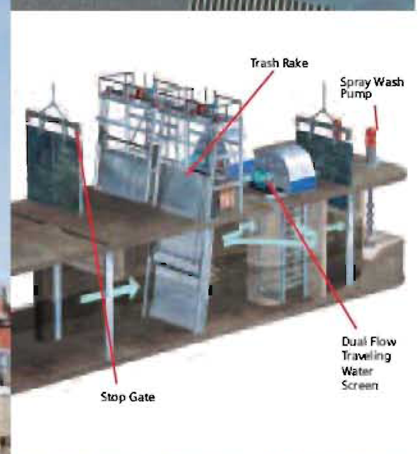
# Rex® and Link-Belt® Intake Systems: proven, efficient and reliable

SIEMENS



# Unrivaled experience in providing dependable, efficient screening

Trash rake removes heavy debris.




We have decades of experience solving high volume water intake problems under varying site conditions.

### Rex® and Link-Belt® intake systems lead the industry

With thousands of our traveling water screens supplied to power generators, municipalities and other industries over the past century, we are the recognized leader in the water intake industry. Our intake screening systems provide clean, debris-free raw water while minimizing ecological impacts, reducing maintenance problems, and extending service life.

### A complete system from stop gates through controls

Stop logs/gates prevent water from entering the channel during down-stream maintenance. Bar racks capture rough and larger debris to prevent it from reaching the finer mesh of the traveling water screen. These racks are cleaned by trash rakes, either stationary or traversing.

Choose from several types of traveling water screens to capture fine debris. In addition, we offer a dependable, user-friendly control system for complete and closely-calibrated control of the entire screening system.

We also provide all the ancillary equipment, from pumps to auxiliary strainers, trash baskets and stationary screens. And - before we leave your site - we can arrange for training for your operating personnel.

# The leader in solutions for fish-friendly screening

A Rex® fish screen installation designed with the benefit of our full-scale fish laboratory.

New technologies for fish protection such as our unique integral fish buckets are a proven way to minimize the adverse impact on marine life.

**Our Modified Ristroph system meets environmental standards**

Cooling water intake systems are the highly visible object of Section 316(b) of the Clean Water Act. These standards mandate very specific requirements for all areas of intake structure operation.

We've been designing, testing and improving fish protection systems since the late 1960's; long before the current regulations were conceived.

As a result, our Modified Ristroph fish handling intake screen systems are all able to meet the new rules.

Whether you need to plan a new intake system or a retrofit, you'll benefit from our experience and our support.

# A variety of screen designs for any site condition


Dual Flow Traveling Water Screens | Dual Flow Retrofits | Center Flow Screens

No matter what the site condition or specification, we have the right water screen to meet your needs.

### Through Flow Traveling Water Screens

have submerged screen surfaces perpendicular to the intake flow. They collect and carry debris upward where it is flushed into a debris trough. Screen widths range from 2 to 14 feet (610 to 4267 mm) with vertical centers from 8 to 100+ feet (2440 mm to 30 m). Screen mesh openings are sized according to customer requirements and site conditions.

### Dual Flow Traveling Water Screens

are essentially Through Flow systems turned 90 degrees, putting the screen surfaces parallel to the intake flow. This doubles the effective screening area and reduces possible downstream debris carryover. It also allows the use of finer screen meshes without increasing flow velocity.

### Dual Flow Retrofits

allow an existing Through Flow screen well to be easily converted to Dual Flow operation. Curved flow diverter plates on both sides of the new Dual Flow screen engage the existing embedded guideways and create the "double entry/single exit" flow pattern.

### Center Flow Screens

are similar to Dual Flow traveling screens, but direct the flow from inside to the outside of the screen. Side plates block the flow along the outer edges of the channel and direct it inward to the screen. Debris is lifted to the top and flushed away by water and gravity.

# Superior systems get superior support

Our divers find and fix potential trouble spots.

**Service – the details that make the difference**

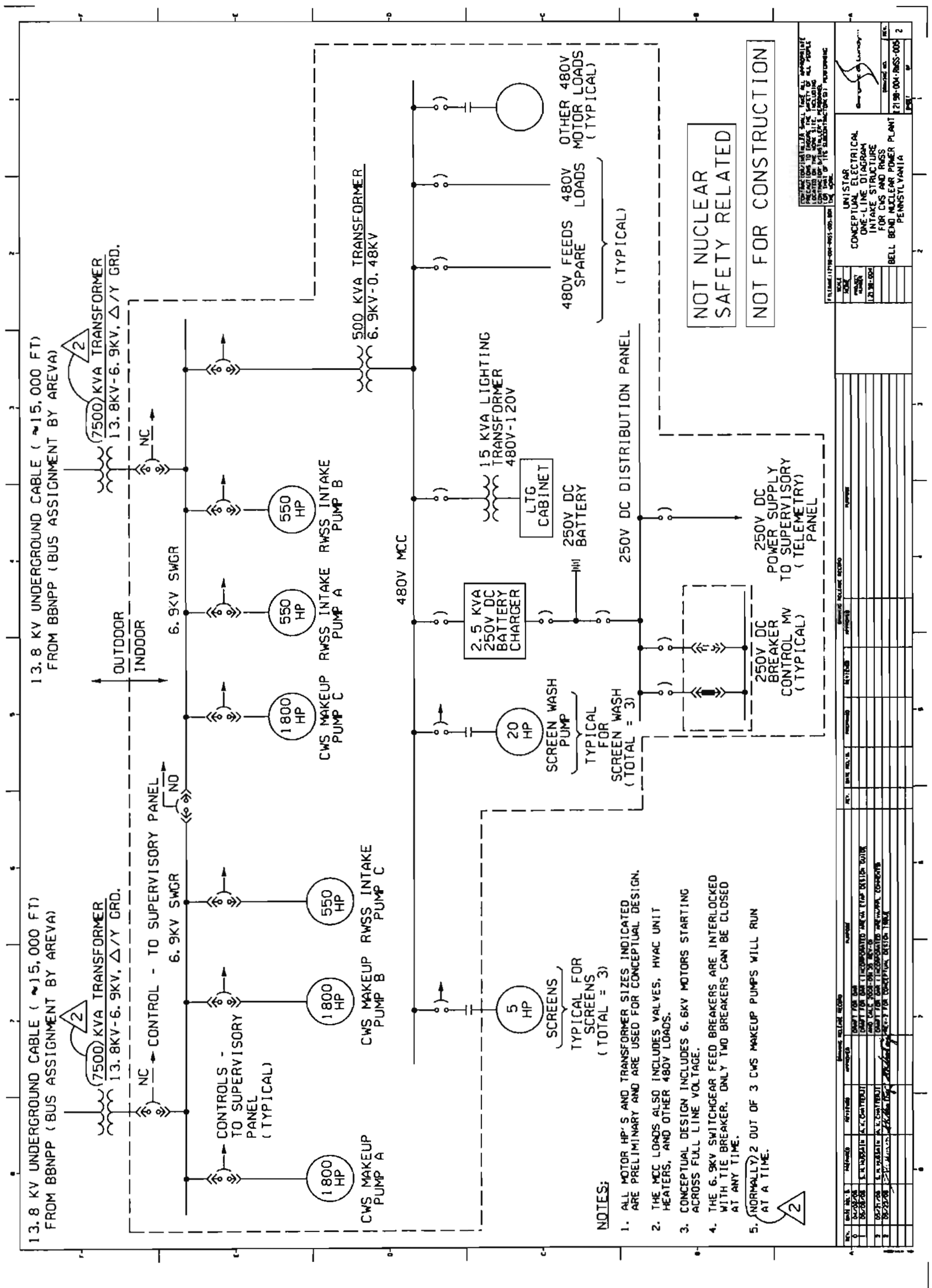
As good as our products are, they work in a tough environment and sooner or later, they need some attention. That's when our advantages become even more obvious. Our service team divers get to the bottom of the problem - literally. Once there, they replace or repair whatever's needed. While on site, our service teams can also inspect the entire installation to detect and prevent problems.

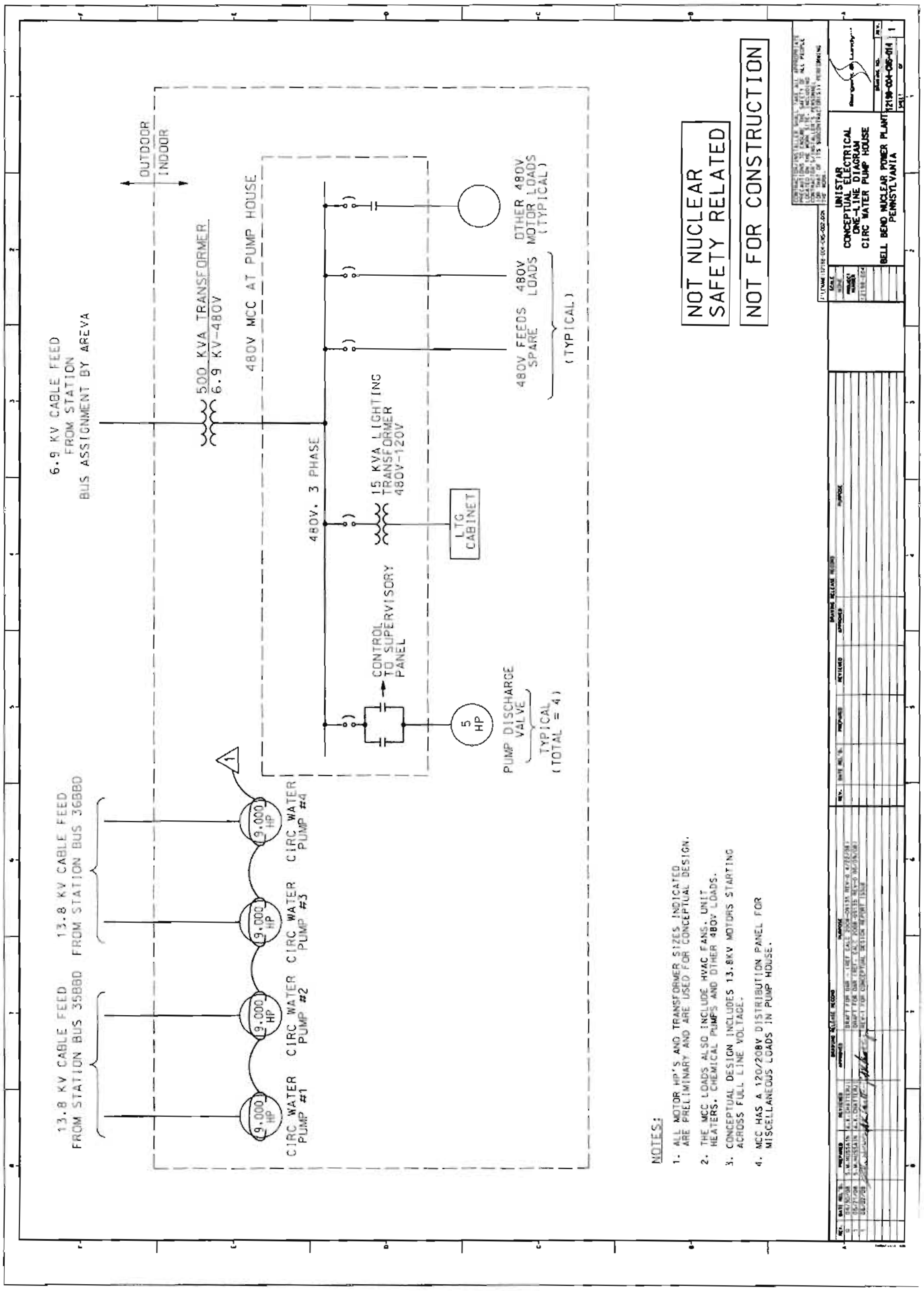
Our aftermarket service team is known for being prepared and responsive. We maintain extensive inventories of parts for our Rex®, Link-Belt® and Royce™ screen brands. These parts – baskets, framework, drive systems, etc. – are the same components that went into your original system and their perfect fit and function will return your system to original condition. Through years of continuing research and development, has also developed and made available other upgrades and improvements to our screening technologies.

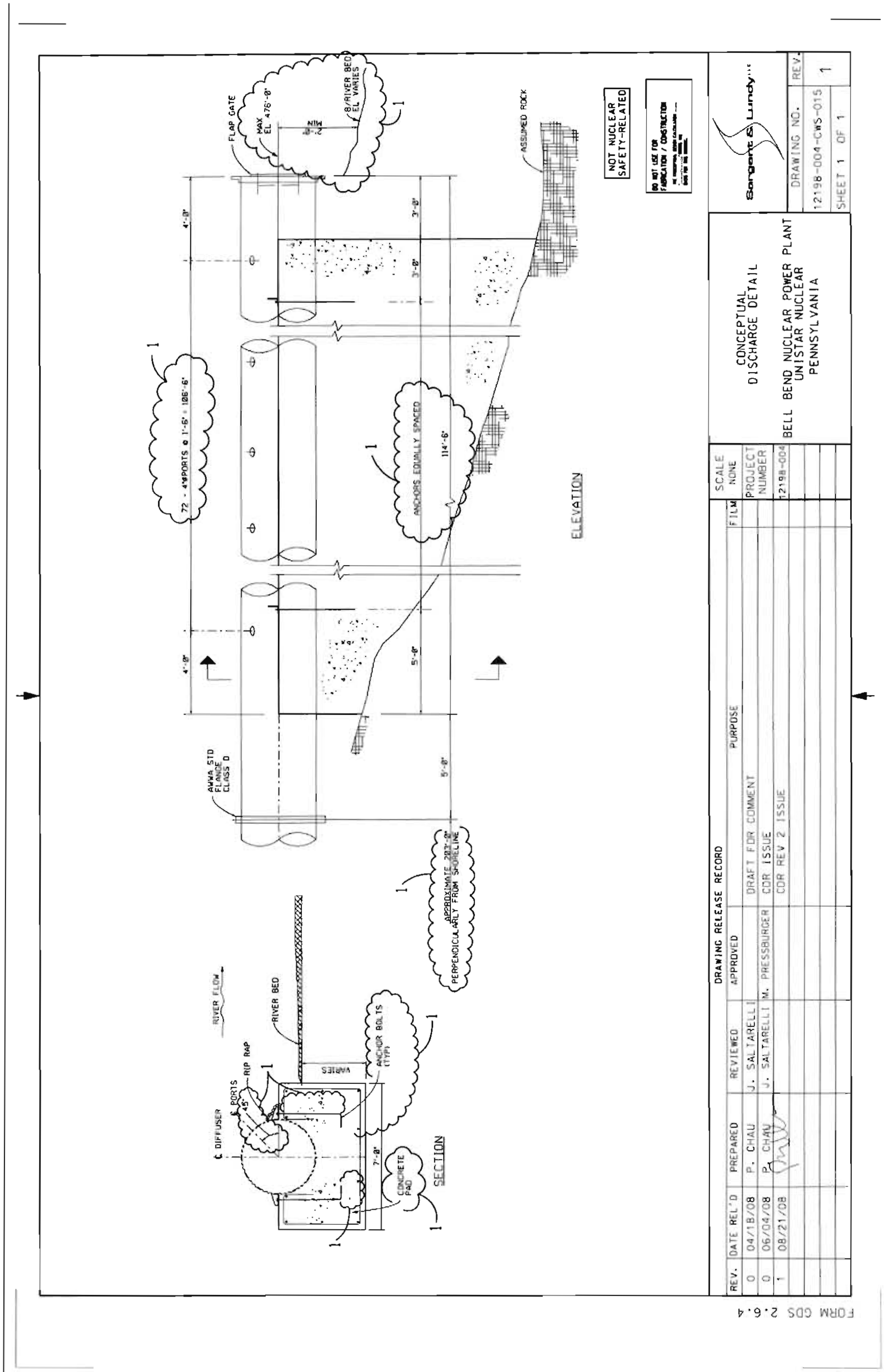
But we're more than rapid-response repair experts. We're also preventative maintenance specialists. We can develop a program tailored to your needs, conduct scheduled maintenance and provide you with the details of every inspection, repair and recommendation.

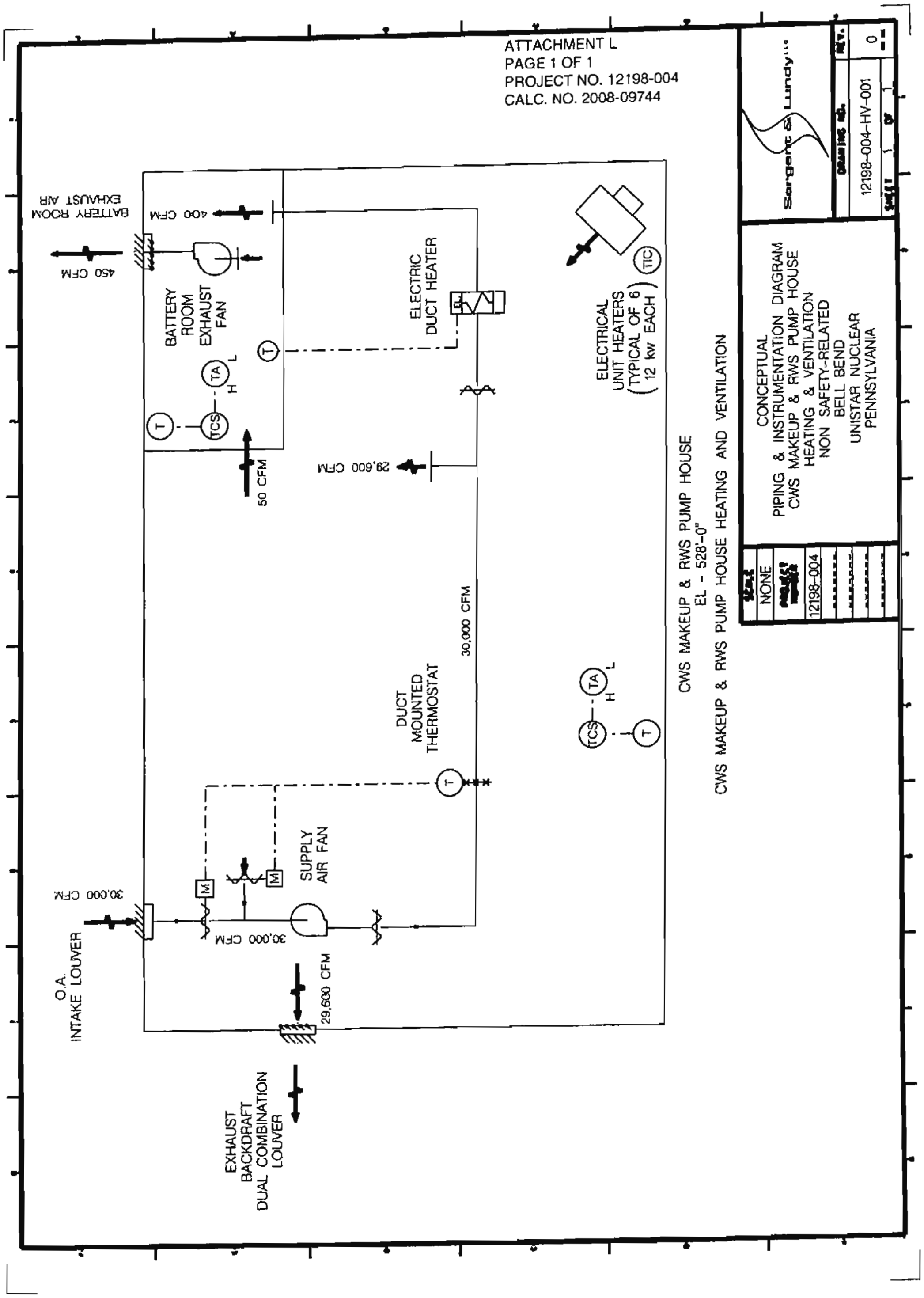
**Field Services**

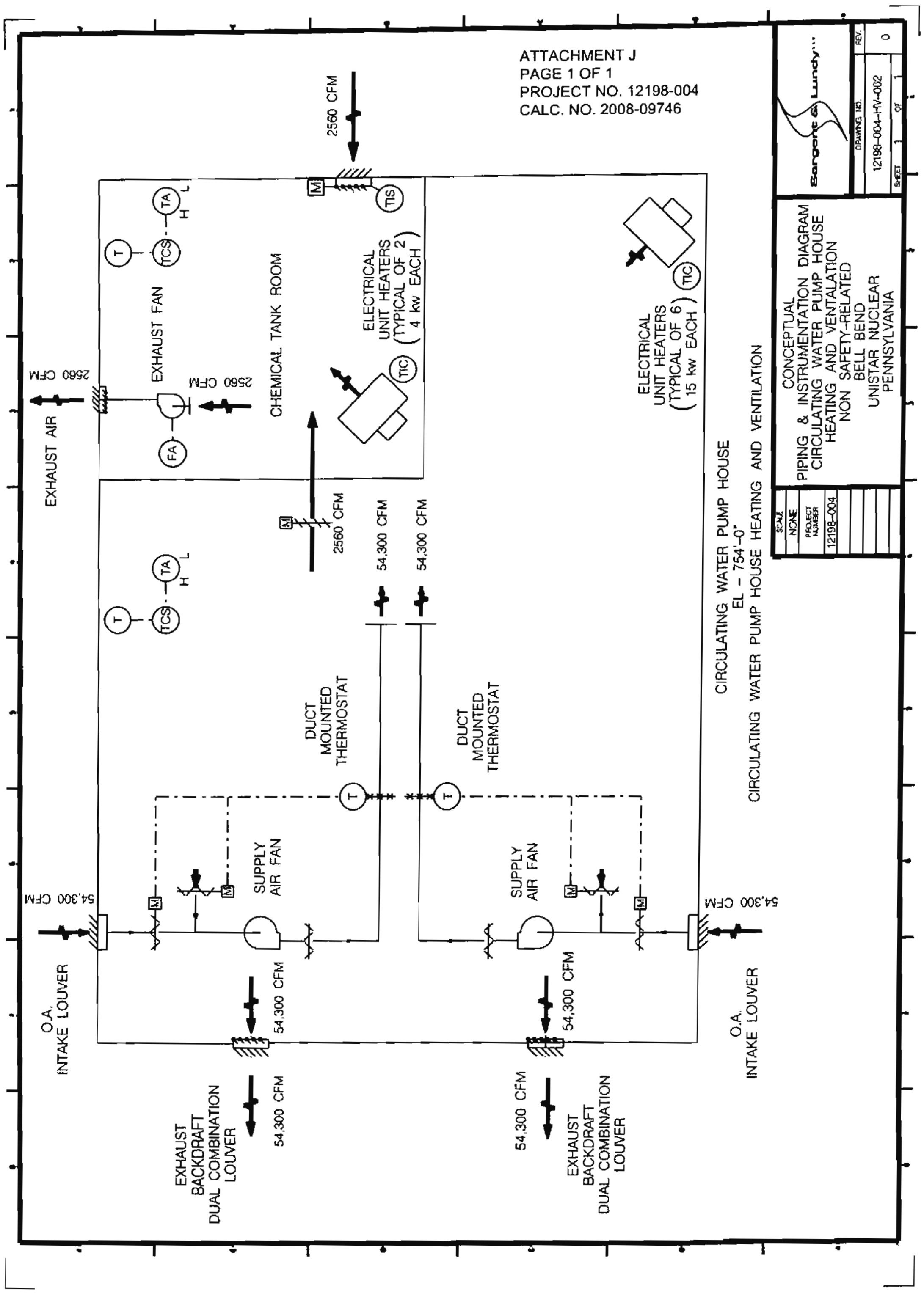
- Diving and topside inspections
- Screen repairs and adjustments, wet or dry
- Screen installing or extracting
- Intake well cleaning
- Bar rack repair
- Implementing annual maintenance contracts


13.8 KV UNDERGROUND CABLE ( ~15,000 FT)
FROM BBNPP (BUS ASSIGNMENT BY AREVA)
7500 KVA TRANSFORMER
13.8KV-6.9KV, Δ/Y GRD.
NC
CONTROL - TO SUPERVISORY PANEL
NO
OUTDOOR
INDOOR
6.9KV SWGR
CONTROLS - TO SUPERVISORY PANEL (TYPICAL)
1800 HP
CWS MAKEUP PUMP A
CWS MAKEUP PUMP B
CWS MAKEUP PUMP C
550 HP
RWSS INTAKE PUMP A
RWSS INTAKE PUMP B
RWSS INTAKE PUMP C
500 KVA TRANSFORMER
6.9KV-0.48KV
480V MCC
5 HP
SCREENS
TYPICAL FOR SCREENS (TOTAL = 3)
20 HP
SCREEN WASH PUMP
TYPICAL FOR SCREEN WASH (TOTAL = 3)
2.5 KVA 250V DC BATTERY CHARGER
250V DC BATTERY
15 KVA LIGHTING TRANSFORMER 480V-120V
LTG CABINET
250V DC DISTRIBUTION PANEL
250V DC BREAKER CONTROL MV (TYPICAL)
250V DC POWER SUPPLY TO SUPERVISORY (TELEMETRY) PANEL
480V FEEDS SPARE
480V LOADS
(TYPICAL)
OTHER 480V MOTOR LOADS (TYPICAL)
NOT NUCLEAR SAFETY RELATED
NOT FOR CONSTRUCTION
NOTES:
1. ALL MOTOR HP'S AND TRANSFORMER SIZES INDICATED ARE PRELIMINARY AND ARE USED FOR CONCEPTUAL DESIGN.
2. THE MCC LOADS ALSO INCLUDES VALVES, HVAC UNIT HEATERS, AND OTHER 480V LOADS.
3. CONCEPTUAL DESIGN INCLUDES 6.6KV MOTORS STARTING ACROSS FULL LINE VOLTAGE.
4. THE 6.9KV SWITCHGEAR FEED BREAKERS ARE INTERLOCKED WITH TIE BREAKER. ONLY TWO BREAKERS CAN BE CLOSED AT ANY TIME.
5. (NORMALLY) 2 OUT OF 3 CWS MAKEUP PUMPS WILL RUN AT A TIME.
UNISTAR
CONCEPTUAL ELECTRICAL ONE-LINE DIAGRAM
INTAKE STRUCTURE FOR CWS AND RWSS
BELL BEND NUCLEAR POWER PLANT
PENNSYLVANIA


6.9 KV CABLE FEED
FROM STATION
BUS ASSIGNMENT BY AREVA
OUTDOOR
INDOOR
500 KVA TRANSFORMER
6.9 KV-480V
480V MCC AT PUMP HOUSE
480V, 3 PHASE
15 KVA LIGHTING
TRANSFORMER
480V-120V
LTG
CABINET
CONTROL
TO SUPERVISORY
PANEL
5
HP
PUMP DISCHARGE
VALVE
TYPICAL
(TOTAL = 4)
480V FEEDS
SPARE
480V
LOADS
(TYPICAL)
OTHER 480V
MOTOR LOADS
(TYPICAL)
13.8 KV CABLE FEED
FROM STATION BUS 35BBD
13.8 KV CABLE FEED
FROM STATION BUS 36BBD
9,000
HP
CIRC WATER
PUMP #1
CIRC WATER
PUMP #2
CIRC WATER
PUMP #3
CIRC WATER
PUMP #4
1
NOTES:
1. ALL MOTOR HP'S AND TRANSFORMER SIZES INDICATED ARE PRELIMINARY AND ARE USED FOR CONCEPTUAL DESIGN.
2. THE MCC LOADS ALSO INCLUDE HVAC FANS, UNIT HEATERS, CHEMICAL PUMPS AND OTHER 480V LOADS.
3. CONCEPTUAL DESIGN INCLUDES 13.8KV MOTORS STARTING ACROSS FULL LINE VOLTAGE.
4. MCC HAS A 120/208V DISTRIBUTION PANEL FOR MISCELLANEOUS LOADS IN PUMP HOUSE.
NOT NUCLEAR
SAFETY RELATED
NOT FOR CONSTRUCTION
UNISTAR
CONCEPTUAL ELECTRICAL
ONE-LINE DIAGRAM
CIRC WATER PUMP HOUSE
BELL BEND NUCLEAR POWER PLANT
PENNSYLVANIA
12198-004-CWS-014
1


ELEVATION
SECTION
FLAP GATE
MAX EL 476'-0"
8/RIVER BED EL VARIES
ASSUMED ROCK
NOT NUCLEAR SAFETY-RELATED
72 - 4"ØPORTS @ 1'-6" = 106'-6"
ANCHORS EQUALLY SPACED
114'-6"
AWWA STD FLANGE CLASS D
APPROXIMATE 203'-0" PERPENDICULARLY FROM SHORELINE
RIVER FLOW
RIVER BED
RIP RAP
ANCHOR BOLTS (TYP)
VARIES
℄ DIFFUSER
℄ PORTS
CONCRETE PAD
7'-0"
CONCEPTUAL DISCHARGE DETAIL
BELL BEND NUCLEAR POWER PLANT
UNISTAR NUCLEAR
PENNSYLVANIA
Sargent & Lundy
DRAWING NO. 12198-004-CWS-015
SHEET 1 OF 1
REV. 1
SCALE NONE
PROJECT NUMBER 12198-004
DRAWING RELEASE RECORD
REV. DATE REL'D PREPARED REVIEWED APPROVED PURPOSE
0 04/18/08 P. CHAU J. SALTARELLI DRAFT FOR COMMENT
0 06/04/08 P. CHAU J. SALTARELLI M. PRESSBURGER CDR ISSUE
1 08/21/08 CDR REV 2 ISSUE
FORM GDS 2.6.4


ATTACHMENT L
PAGE 1 OF 1
PROJECT NO. 12198-004
CALC. NO. 2008-09744
BATTERY ROOM EXHAUST AIR
450 CFM
400 CFM
BATTERY ROOM EXHAUST FAN
ELECTRIC DUCT HEATER
ELECTRICAL UNIT HEATERS (TYPICAL OF 6) 12 kw EACH
TIC
50 CFM
29,600 CFM
30,000 CFM
DUCT MOUNTED THERMOSTAT
SUPPLY AIR FAN
O.A. INTAKE LOUVER
30,000 CFM
30,000 CFM
29,600 CFM
EXHAUST BACKDRAFT DUAL COMBINATION LOUVER
CWS MAKEUP & RWS PUMP HOUSE
EL - 528'-0"
CWS MAKEUP & RWS PUMP HOUSE HEATING AND VENTILATION
CONCEPTUAL
PIPING & INSTRUMENTATION DIAGRAM
CWS MAKEUP & RWS PUMP HOUSE
HEATING & VENTILATION
NON SAFETY-RELATED
BELL BEND
UNISTAR NUCLEAR
PENNSYLVANIA
Sargent & Lundy
NONE
12198-004
12198-004-HV-001
0


ATTACHMENT J
PAGE 1 OF 1
PROJECT NO. 12198-004
CALC. NO. 2008-09746
2560 CFM
EXHAUST AIR
2560 CFM
EXHAUST FAN
2560 CFM
CHEMICAL TANK ROOM
ELECTRICAL UNIT HEATERS (TYPICAL OF 2) (4 kw EACH)
ELECTRICAL UNIT HEATERS (TYPICAL OF 6) (15 kw EACH)
2560 CFM
54,300 CFM
54,300 CFM
DUCT MOUNTED THERMOSTAT
DUCT MOUNTED THERMOSTAT
SUPPLY AIR FAN
SUPPLY AIR FAN
54,300 CFM
54,300 CFM
O.A. INTAKE LOUVER
O.A. INTAKE LOUVER
54,300 CFM
54,300 CFM
54,300 CFM
54,300 CFM
EXHAUST BACKDRAFT DUAL COMBINATION LOUVER
EXHAUST BACKDRAFT DUAL COMBINATION LOUVER
CIRCULATING WATER PUMP HOUSE
EL - 754'-0"
CIRCULATING WATER PUMP HOUSE HEATING AND VENTILATION
CONCEPTUAL
PIPING & INSTRUMENTATION DIAGRAM
CIRCULATING WATER PUMP HOUSE
HEATING AND VENTALATION
NON SAFETY-RELATED
BELL BEND
UNISTAR NUCLEAR
PENNSYLVANIA
Sargent & Lundy
12198-004-HV-002
0
SCALE NONE
PROJECT NUMBER 12198-004

UniStar NUCLEAR

**DESIGN INFORMATION TRANSMITTAL (DIT)**

DIT Form, Part 1

| | | |
|---|---|---|
| ☒ SAFETY-RELATED<br>☐ NON-SAFETY-RELATED | **Originating Organization**<br>☐ S&L ☒ S&L Internal<br>☐ Unistar ☐ Other (specify) | DIT No DIT-BBNPP-003 |
| Plant: ☐ NMP ☒ BBNPP Unit: 3<br><br>System Designation: CIRCULATING WATER, RAW WATER, AND POTABLE WATER LINES AND BURIED EELCTRICAL CONDUITS AND DUCT BANKS | | Page 1 of 2<br><br>To |

Subject: WATER AND SOIL CHEMISTRY PARAMETERS FOR BURIED COMMODITIES

| | | | |
|---|---|---|---|
| D. C. KOCUNIK | GEOTECH. MANAGER | Daniel C. Kocunik | 4/28/2008 |
| Preparer | Position | Preparer's Signature | Date |
| E.S. MOTAN | SENIOR ASSOCIATE | E. Sabri Motan | 4/28/2008 |
| Reviewer | Position | Reviewer's Signature | Date |
| D. C. KOCUNIK | GEOTECH. MANAGER | Daniel C. Kocunik | 4/28/2008 |
| Approver | Position | Approver's Signature | Date |

Status of Information: ☒ Approved for Use ☐ Unverified

Method and Schedule of Verification for Unverified DITs: NA

Holds Associated with Unverified DITs: NA

Description of Information: Information is provided to document various chemical parameters present in the groundwater at the Bell Bend site.

Purpose of Issuance (Including any Precautions or Limitations): Information for evaluation of need for protective coatings and type of cement for buried pipes and concrete duct banks.

Source of Information: Data from Paul C. Rizzo Associates (attached) and the "Natural Resources Conservation Service – National Cooperative Soil Survey, Luzerne County, Pennsylvania" (Web Survey Information obtained on 3/7/2008.

Engineering Judgement Used? ☒ Yes ☐ No

Controlled Reference / Document No.: NA

Uncontrolled Reference / Document No.: NA

Distribution: Copy to Requestor: R. Hameetman, M. Pressburger, H. Taylor, J. Saltarelli, R. Pospiech, J. Devgun, L. Anderson, N. Klaic, A.K. Chatterji, D. Kocunik

Copy to Project File

UniStar NUCLEAR

**DESIGN INFORMATION TRANSMITTAL (DIT)**

DIT Form, Part 2

| Design Information Transmittal | DIT No. DIT BBNPP 003 |
|---|---|
| | Page 2 of 2 |

The following is a summary of properties for the water chemistry for the surface water and groundwater obtained from Paul C. Rizzo Associates (PCR). It is a copy of the field data obtained by PCR as part of the COLA. The data is attached for a more detailed review.

SUMMARY:

Groundwater in soil:

- pH ranges from 5.55 to 7.34 with a general range from 5.6 to 6.5.
- chlorides range from 0.75 to 13 mg/l.
- Sulfates range from 11 to 57 mg/l.
- Specific Conductance ranges from 0.048 to .469 mS/cm with a general range from 0.15 to 0.2.

Water in Bedrock:

- pH ranges from 7.28 to 11.18 with a general range from 7.5 to 9.
- Specific Conductance ranges from 0.133 to 0.544 mS/cm with a general range from 0.2 to 0.4.

Surface water:

- chlorides range from 3.9 to 27 mg/l.
- Sulfates range from 9.4 to 58 mg/l.

These chemical properties are based on water samples and not soil/rock samples. Since this water will be in contact with the buried commodities, the values presented will be representative of the materials around the buried commodities.

Data from the Natural Resources Conservation Service indicates similar trends for the upper soils present at the site.

This information was provided by PCR as draft information. It can be used for evaluating the need for cathodic protection and corrosion protection for buried commodities. No major change in these values are anticipated when test results on soil and rock samples are provided.

See attached page 1 of 1 for Sulfates and chlorides and pages 1 through 7 for the pH and other values.

1 OF 1

fEBRUARY 2008 GROUNDWATER QUALITY DATA (PRELIMINARY, DO NOT CITE)

| Client Sample ID | Collection Date | Analyte | Result | Unit | Flag |
|---|---|---|---|---|---|
| BB-MW304A-1 | 2/28/2008 9:00 | Chloride | 0.75 | mg/L | J |
| BB-MW304A-1 | 2/28/2008 9:00 | Sulfate | 11 | mg/L | |
| BB-MW304A-1 | 2/28/2008 9:00 | Chloride | 10.4 | mg/L | |
| BB-MW304A-1 | 2/28/2008 9:00 | Sulfate | 20.7 | mg/L | |
| BB-MW304A-1 | 2/28/2008 9:00 | Chloride | 10.1 | mg/L | |
| BB-MW304A-1 | 2/28/2008 9:00 | Sulfate | 20.3 | mg/L | |
| BB-G3-1 | 2/28/2008 12:15 | Chloride | 13 | mg/L | |
| BB-G3-1 | 2/28/2008 12:15 | Sulfate | 12 | mg/L | |
| BB-G5-1 | 2/28/2008 14:30 | Chloride | 7.3 | mg/L | |
| BB-G5-1 | 2/28/2008 14:30 | Sulfate | 15 | mg/L | |
| BB-MW305B-1 | 2/28/2008 14:00 | Chloride | 3.9 | mg/L | J |
| BB-MW305B-1 | 2/28/2008 14:00 | Sulfate | 26 | mg/L | |
| BB-MW301A-1 | 2/28/2008 12:00 | Chloride | 2 | mg/L | J |
| BB-MW301A-1 | 2/28/2008 12:00 | Sulfate | 29 | mg/L | |
| BB-MW304B-1 | 2/28/2008 10:50 | Chloride | 6.3 | mg/L | |
| BB-MW304B-1 | 2/28/2008 10:50 | Sulfate | 57 | mg/L | |
| BB-MW305A1-1 | 2/28/2008 13:30 | Chloride | 13 | mg/L | |
| BB-MW305A1-1 | 2/28/2008 13:30 | Sulfate | 22 | mg/L | |
| BB-DUP-1 | 2/28/2008 9:00 | Chloride | 3.9 | mg/L | |
| BB-DUP-1 | 2/28/2008 9:00 | Sulfate | 58 | mg/L | |
| BB-G1-1 | 2/28/2008 13:15 | Chloride | 8.3 | mg/L | |
| BB-G1-1 | 2/28/2008 13:15 | Sulfate | 9.4 | mg/L | |
| BB-SR01-1 | 2/28/2008 7:17 | Chloride | 27 | mg/L | |
| BB-SR01-1 | 2/28/2008 7:17 | Sulfate | 17 | mg/L | |
| BB-G2-1 | 2/28/2008 13:45 | Chloride | 10 | mg/L | |
| BB-G2-1 | 2/28/2008 13:45 | Sulfate | 13 | mg/L | |
| BB-SR02-1 | 2/28/2008 8:03 | Chloride | 27 | mg/L | |
| BB-SR02-1 | 2/28/2008 8:03 | Sulfate | 17 | mg/L | |

Handwritten annotations: rows BB-MW304A-1 bracketed "WELL WATER DATA"; rows BB-G3-1 through BB-G5-1 boxed "SURFACE WATER DATA"; rows BB-MW305B-1 through BB-MW305A1-1 bracketed "WELL WATER DATA"; rows BB-DUP-1 through BB-SR02-1 boxed "SURFACE WATER DATA".

1 of 7

**Table 2.4.12-14 Bell Bend NPP Unit 1 Groundwater Quality Data**
**(Page 1 of 7)**

| Location | Date | pH | Specific Conductance (mS/cm) | Turbidity (NTU) | Dissolved Oxygen (mg/L)[1] | Temperature (° Celsius) | ORP (mV) | Salinity (ppt) | TDS (mg/L) |
|---|---|---|---|---|---|---|---|---|---|
| **Glacial Overburden Wells** | | | | | | | | | |
| MW301A | 10/30/2007 | 5.76 | 0.173 | 0.4 | 1.34 | 12.92 | 189.3 | 0.08 | 0.113 |
| | 1/26/2008 | 5.81 | 0.149 | 0.0 | 5.98 | 10.66 | 221.6 | 0.07 | 0.097 |
| | 2/27/2008 | 5.68 | 0.129 | 2.4 | 7.52 | 9.16 | 206.6 | 0.06 | 0.084 |
| | 4/14/2008 | 5.70 | 0.136 | 0.0 | 7.30 | 8.43 | 201.1 | 0.06 | 0.088 |
| MW302A1 | 10/30/2007 | 5.66 | 0.177 | 2.0 | -0.14 | 13.01 | 127.3 | 0.08 | 0.115 |
| | 1/26/2008 | 5.81 | 0.188 | 0.8 | 0.69 | 10.46 | 70.4 | 0.09 | 0.122 |
| | 2/29/2008 | 5.58 | 0.171 | 0.0 | 1.30 | 9.36 | 113.0 | 0.08 | 0.111 |
| | 4/16/2008 | 5.74 | 0.153 | 0.0 | 0.79 | 8.83 | 84.6 | 0.07 | 0.099 |
| MW302A2 | 10/30/2007 | 5.58 | 0.165 | 2.1 | 1.40 | 12.92 | 160.3 | 0.08 | 0.107 |
| | 1/26/2008 | 5.76 | 0.186 | 1.0 | 0.68 | 10.52 | 79.3 | 0.09 | 0.121 |
| | 3/2/2008 | 5.74 | 0.189 | 0.0 | 0.00 | 16.86 | 67.0 | 0.09 | 0.123 |
| | 4/18/08 | 5.84 | 0.172 | 0.0 | 1.04 | 13.00 | 67.4 | 0.08 | 0.113 |
| MW302A3 | 10/30/2007 | 5.55 | 0.159 | 6.7 | 3.31 | 12.73 | 177.8 | 0.08 | 0.104 |
| | 1/26/2008 | 5.67 | 0.179 | 11.3 | 0.85 | 10.62 | 114.4 | 0.08 | 0.116 |
| | 3/2/2008 | 5.70 | 0.187 | 0.0 | 0.45 | 14.08 | 107.3 | 0.09 | 0.122 |
| | 4/18/2008 | 5.76 | 0.182 | 0.0 | 1.89 | 11.27 | 100.6 | 0.08 | 0.109 |

2 of 7

Table 2.4.12-14 Bell Bend NPP Unit 1 Groundwater Quality Data
(Page 2 of 7)

| Location | Date | pH | Specific Conductance (mS/cm) | Turbidity (NTU) | Dissolved Oxygen (mg/L)[1] | Temperature (° Celsius) | ORP (mV) | Salinity (ppt) | TDS (mg/L) |
|---|---|---|---|---|---|---|---|---|---|
| MW302A4 | 10/30/2007 | 5.65 | 0.165 | 1.7 | 4.75 | 12.66 | 196.3 | 0.08 | 0.107 |
| | 1/27/2008 | 5.75 | 0.174 | 0.0 | 4.33 | 10.37 | 114.1 | 0.08 | 0.113 |
| | 3/2/2008 | 5.62 | 0.161 | 0.3 | 4.32 | 14.98 | 164.5 | 0.08 | 0.105 |
| | 4/18/2008 | 5.65 | 0.048 | 0.0 | 6.25 | 12.76 | 156.9 | 0.02 | 0.031 |
| | | | | | | | | | |
| MW303A | 10/31/2007 | 6.40 | 0.179 | 17.1 | 2.99 | 13.14 | 124.9 | 0.08 | 0.116 |
| | 1/29/2008 | 7.04 | 0.200 | 45.1 | 0.22 | 9.42 | -21.7 | 0.10 | 0.130 |
| | 3/2/2008 | 6.94 | 0.203 | 62.8 | 4.01 | 4.71 | -2.0 | 0.10 | 0.132 |
| | 4/19/2008 | 7.23 | 0.202 | 68.1 | 7.30 | 13.40 | 10.1 | 0.10 | 0.131 |
| | | | | | | | | | |
| MW304A | 10/31/2007 | 6.18 | 0.254 | 11.3 | 4.60 | 11.89 | 109.3 | 0.12 | 0.165 |
| | 1/28/2008 | 6.12 | 0.265 | 0.1 | 2.35 | 11.11 | 140.9 | 0.13 | 0.172 |
| | 2/27/2008 | 6.10 | 0.220 | 5.8 | 1.74 | 10.16 | 124.9 | 0.11 | 0.143 |
| | 4/15/2008 | 6.14 | 0.213 | 0.0 | 0.81 | 10.55 | 110.8 | 0.10 | 0.139 |
| | | | | | | | | | |
| MW305A1 | 10/31/2007 | 6.35 | 0.204 | 30.2 | 1.51 | 13.61 | 146.7 | 0.10 | 0.133 |
| | 1/30/2008 | 6.14 | 0.186 | 9.3 | 1.22 | 10.84 | 162.3 | 0.09 | 0.121 |
| | 2/27/2008 | 5.97 | 0.159 | 3.0 | 2.65 | 10.43 | 172.4 | 0.08 | 0.103 |
| | 4/15/2008 | 6.21 | 0.169 | 0.0 | 1.78 | 10.65 | 153.0 | 0.08 | 0.110 |
| | | | | | | | | | |
| MW305A2 | 10/31/2007 | 6.89 | 0.267 | 34.2 | -0.17 | 12.78 | 8.3 | 0.13 | 0.174 |

3 of 7

**Table 2.4.12-14 Bell Bend NPP Unit 1 Groundwater Quality Data (Page 3 of 7)**

| Location | Date | pH | Specific Conductance (mS/cm) | Turbidity (NTU) | Dissolved Oxygen (mg/L)[1] | Temperature (° Celsius) | ORP (mV) | Salinity (ppt) | TDS (mg/L) |
|---|---|---|---|---|---|---|---|---|---|
| | 1/30/2008 | 6.82 | 0.241 | 0.0 | 0.00 | 11.19 | -47.0 | 0.12 | 0.157 |
| | 3/2/2008 | 6.77 | 0.236 | 0.0 | 0.00 | 14.97 | -41.7 | 0.11 | 0.153 |
| | 4/18/2008 | 6.69 | 0.235 | 0.0 | 0.00 | 12.67 | -23.1 | 0.11 | 0.149 |
| | | | | | | | | | |
| MW306A | 10/31/2007 | 6.28 | 0.189 | 6.5 | 5.24 | 13.02 | 168.0 | 0.09 | 0.123 |
| | 1/27/2008 | 6.23 | 0.178 | 0.8 | 5.72 | 12.10 | 130.7 | 0.08 | 0.116 |
| | 2/29/2008 | 6.07 | 0.167 | 0.0 | 6.52 | 11.50 | 204.8 | 0.08 | 0.108 |
| | 4/16/2008 | 6.18 | 0.172 | 0.0 | 6.67 | 11.35 | 153.5 | 0.08 | 0.112 |
| | | | | | | | | | |
| MW307A | 10/30/2007 | 7.27 | 0.294 | 139.6 | 3.96 | 13.36 | 41.8 | 0.14 | 0.191 |
| | 1/27/2008 | 7.34 | 0.300 | 10.8 | 2.54 | 9.56 | 7.9 | 0.14 | 0.194 |
| | 2/26/2008 | 7.20 | 0.294 | 49.9 | 4.11 | 11.28 | 31.2 | 0.14 | 0.191 |
| | 4/17/2008 | 7.14 | 0.279 | 36.3 | 4.99 | 12.32 | 122.0 | 0.13 | 0.180 |
| | | | | | | | | | |
| MW308A | 10/30/2007 | 5.95 | 0.138 | 15.5 | 3.90 | 11.96 | 134.6 | 0.07 | 0.090 |
| | 1/27/2008 | 5.91 | 0.147 | 0.0 | 0.89 | 10.98 | 214.0 | 0.07 | 0.096 |
| | 2/26/2008 | 5.78 | 0.142 | 0.4 | 0.59 | 9.63 | 239.6 | 0.07 | 0.092 |
| | 4/17/2008 | 5.72 | 0.143 | 0.0 | 0.35 | 12.21 | 157.5 | 0.07 | 0.093 |
| | | | | | | | | | |
| MW309A | 10/31/2007 | 6.49 | 0.348 | 3.8 | 4.59 | 14.22 | 155.8 | 0.17 | 0.227 |
| | 1/28/2008 | 6.29 | 0.469 | 0.0 | 5.71 | 9.30 | 151.1 | 0.23 | 0.304 |

4 of 7

**Table 2.4.12-14 Bell Bend NPP Unit 1 Groundwater Quality Data (Page 4 of 7)**

| Location | Date | pH | Specific Conductance (mS/cm) | Turbidity (NTU) | Dissolved Oxygen (mg/L)[1] | Temperature (° Celsius) | ORP (mV) | Salinity (ppt) | TDS (mg/L) |
|---|---|---|---|---|---|---|---|---|---|
| | 3/1/2008 | 6.13 | 0.414 | 0.0 | 4.77 | 15.20 | 150.9 | 0.20 | 0.269 |
| | 4/19/2008 | 6.15 | 0.429 | 0.0 | 5.23 | 9.48 | 245.4 | 0.21 | 0.279 |
| | | | | | | | | | |
| MW310A | 10/30/2007 | 7.18 | 0.079 | 1093.3 | 8.30 | 13.29 | 76.5 | 0.04 | 0.051 |
| | 1/26/2008 | 6.58 | 0.122 | 132.7 | 3.83 | 9.47 | 153.5 | 0.06 | 0.079 |
| | 2/26/2008 | 6.41 | 0.130 | 12.4 | 3.91 | 7.28 | 141.6 | 0.06 | 0.084 |
| | 4/17/2008 | 6.12 | 0.123 | 0.0 | 5.27 | 10.05 | 139.6 | 0.06 | 0.080 |
| | | | | | | | | | |
| **Shallow Bedrock Wells** | | | | | | | | | |
| MW301B1 | 10/30/2007 | 9.42 | 0.210 | 8.8 | 1.75 | 12.74 | -137.5 | 0.10 | 0.136 |
| | 1/26/2008 | 10.11 | 0.154 | 0.0 | 0.00 | 11.15 | -191.5 | 0.07 | 0.100 |
| | 2/29/2008 | 10.13 | 0.156 | 0.0 | 0.00 | 10.21 | -166.4 | 0.07 | 0.101 |
| | 4/14/2008 | 9.63 | 0.133 | 0.0 | 0.00 | 10.80 | -186.5 | 0.06 | 0.086 |
| | | | | | | | | | |
| MW302B | 10/30/2007 | 9.19 | 0.256 | 15.7 | 0.22 | 12.28 | -190.7 | 0.12 | 0.167 |
| | 1/26/2008 | 9.18 | 0.298 | 26.0 | 0.01 | 10.17 | -317.5 | 0.14 | 0.194 |
| | 3/2/2008 | 9.19 | 0.283 | 11.9 | 0.54 | 13.41 | -232.0 | 0.14 | 0.184 |
| | 4/18/2008 | 9.17 | 0.294 | 0.0 | 0.09 | 12.19 | -204.4 | 0.14 | 0.191 |
| | | | | | | | | | |
| MW303B | 10/31/2007 | 7.68 | 0.162 | 2.0 | 0.35 | 12.25 | -7.5 | 0.08 | 0.105 |
| | 1/29/2008 | 7.54 | 0.176 | 0.0 | 0.00 | 11.12 | -127.8 | 0.08 | 0.114 |

5 of 7

Table 2.4.12-14 Bell Bend NPP Unit 1 Groundwater Quality Data
(Page 5 of 7)

| Location | Date | pH | Specific Conductance (mS/cm) | Turbidity (NTU) | Dissolved Oxygen (mg/L)[1] | Temperature (° Celsius) | ORP (mV) | Salinity (ppt) | TDS (mg/L) |
|---|---|---|---|---|---|---|---|---|---|
| | 3/2/2008 | 7.47 | 0.191 | 0.0 | 0.06 | 10.34 | -56.4 | 0.09 | 124 |
| | 4/19/2008 | 7.62 | 0.191 | 0.0 | 0.00 | 13.19 | -86.4 | 0.09 | 0.124 |
| | | | | | | | | | |
| MW304B | 10/31/2007 | 9.86 | 0.332 | 10.0 | 5.27 | 12.17 | -69.7 | 0.16 | 0.216 |
| | 1/29/2008 | 11.18 | 0.518 | 0.0 | 0.00 | 11.62 | -178.5 | 0.26 | 0.336 |
| | 2/27/2008 | 10.71 | 0.418 | 1.5 | 0.00 | 10.82 | -138.6 | 0.20 | 0.272 |
| | 4/15/2008 | 11.10 | 0.544 | 0.0 | 0.00 | 11.39 | -151.3 | 0.26 | 0.347 |
| | | | | | | | | | |
| MW305B | 10/31/2007 | 7.32 | 0.264 | 2.5 | 2.60 | 12.97 | 57.3 | 0.13 | 0.172 |
| | 1/30/2008 | 7.43 | 0.272 | 0.0 | 0.00 | 11.49 | -151.5 | 0.13 | 0.177 |
| | 2/27/2008 | 7.37 | 0.251 | 2.4 | 0.00 | 10.78 | -109.3 | 0.12 | 0.163 |
| | 4/15/2008 | 7.32 | 0.266 | 0.0 | 0.00 | 11.39 | -118.6 | 0.13 | 0.173 |
| | | | | | | | | | |
| MW307B | 10/30/2007 | 8.78 | 0.250 | 3.9 | 5.95 | 12.80 | -24.6 | 0.11 | 0.158 |
| | 1/27/2008 | 8.73 | 0.248 | 0.0 | -0.12 | 11.75 | -197.2 | 0.12 | 0.161 |
| | 2/26/2008 | 8.45 | 0.248 | 0.0 | 0.01 | 12.15 | -158.3 | 0.12 | 0.161 |
| | 4/17/08 | 8.70 | 0.246 | 0.0 | 0.00 | 13.68 | -89.4 | 0.12 | 0.160 |
| | | | | | | | | | |
| MW308B | 10/30/2008 | 7.79 | 0.210 | 934.4 | 10.17 | 13.17 | 48.3 | 0.10 | 0.137 |
| | 1/27/2008 | 7.70 | 0.430 | 969.0 | 0.42 | 11.83 | -68.3 | 0.21 | 0.279 |
| | 2/26/2008 | 7.41 | 0.412 | 1067.0 | 1.85 | 14.28 | 8.5 | 0.19 | 0.261 |

6 of 7

**Table 2.4.12-14 Bell Bend NPP Unit 1 Groundwater Quality Data**
**(Page 6 of 7)**

| Location | Date | pH | Specific Conductance (mS/cm) | Turbidity (NTU) | Dissolved Oxygen (mg/L)[1] | Temperature (° Celsius) | ORP (mV) | Salinity (ppt) | TDS (mg/L) |
|---|---|---|---|---|---|---|---|---|---|
| | 4/17/2008 | 7.45 | 0.454 | 1115.9 | 3.43 | 11.70 | 77.7 | 0.22 | 0.294 |
| | | | | | | | | | |
| MW309B | 10/31/2007 | 7.29 | 0.459 | 6.3 | 1.30 | 11.50 | -1.2 | 0.22 | 0.298 |
| | 1/28/2008 | 7.32 | 0.465 | 0.0 | -0.10 | 11.11 | -99.1 | 0.23 | 0.302 |
| | 3/1/2008 | 7.28 | 0.456 | 0.0 | 0.00 | 14.95 | -102.0 | 0.22 | 0.296 |
| | 4/19/2008 | 7.36 | 0.452 | 0.0 | 0.00 | 13.78 | -68.0 | 0.22 | 0.293 |
| | | | | | | | | | |
| MW310B | 10/30/2007 | 7.78 | 0.196 | 3.4 | -0.25 | 12.44 | -63.4 | 0.09 | 0.127 |
| | 1/26/2008 | 7.64 | 0.194 | 0.0 | -0.08 | 11.24 | -143.4 | 0.09 | 0.126 |
| | 2/26/2008 | 7.61 | 0.192 | 0.0 | 0.82 | 9.71 | -67.2 | 0.09 | 0.125 |
| | 4/17/2008 | 7.52 | 0.196 | 0.0 | 0.00 | 13.04 | -130.4 | 0.09 | 0.137 |
| | | | | | | | | | |
| **Deep Bedrock Wells** | | | | | | | | | |
| MW303C | 10/31/2007 | 7.97 | 0.173 | 6.0 | 5.45 | 12.76 | 58.7 | 0.08 | 0.113 |
| | 1/29/2008 | 7.98 | 0.171 | 0.0 | 0.00 | 11.38 | 10.5 | 0.08 | 0.111 |
| | 3/2/2008 | 7.94 | 0.169 | 0.0 | 0.02 | 14.75 | -121.0 | 0.08 | 0.110 |
| | 4/19/2008 | 8.14 | 0.171 | 0.0 | 0.00 | 13.21 | -166.4 | 0.08 | 0.111 |
| | | | | | | | | | |
| MW304C | | | | | | | | | |
| | 1/29/2008 | 9.58 | 0.552 | 182.1 | 0.24 | 11.83 | -34.2 | 0.27 | 0.359 |
| | 3/1/2008 | 9.46 | 0.411 | 296.1 | 0.13 | 14.24 | -173.4 | 0.20 | 0.267 |

Bell Bend NPP Unit 1 FSAR Draft

Rev. 0

**Table 2.4.12-14 Bell Bend NPP Unit 1 Groundwater Quality Data (Page 7 of 7)**

| Location | Date | pH | Specific Conductance (mS/cm) | Turbidity (NTU) | Dissolved Oxygen (mg/L)[1] | Temperature (° Celsius) | ORP (mV) | Salinity (ppt) | TDS (mg/L) |
|---|---|---|---|---|---|---|---|---|---|
| | 4/15/2008 | 9.31 | 0.361 | 84.2 | 0.10 | 12.12 | -161.5 | 0.17 | 0.235 |
| | | | | | | | | | |
| MW306C | 10/31/2007 | 8.59 | 0.197 | 16.6 | -0.10 | 12.48 | -264.8 | 0.09 | 0.128 |
| | 1/27/2008 | 9.23 | 0.492 | 17.4 | 0.27 | 11.15 | -27.4 | 0.24 | 0.320 |
| | 3/2/2008 | 8.97 | 0.517 | 3.9 | 0.02 | 16.09 | -131.6 | 0.25 | 0.336 |
| | 4/18/2008 | 9.24 | 0.512 | 40.3 | 0.01 | 13.95 | -41.3 | 0.25 | 0.335 |
| | | | | | | | | | |

[1]Small negative DO values indicate near zero and values are within the calibration tolerance. In subsequent rounds these values were recorded as 0.0 on the field form.

UniStar NUCLEAR ENERGY

May 13, 2008

Lannis Selz
AREVA NP, Inc
3315 Old Forest Road
PO Box 10935
Lynchburg, VA 24506-0935

RFI #08-141

Subject: Response to RFI EPR-08-170, from Lannis Selz to George Wrobel, dated January 31, 2008.

Attached is a copy of the subject RFIs, as well as the Paul C. Rizzo Associates response.

Sincerely,

G. van Noordennen

Gerry van Noordennen

xc: J. Price, w/o
B. Perdue
R. Hameetman, S&L
T. Barnett, S&L

ENGINEERS & CONSULTANTS

**CORPORATE HEADQUARTERS - PITTSBURGH**
ExpoMart, Suite 270-E • 105 Mall Boulevard • Monroeville, PA 15146-2288
Phone (412) 856-9700 • Fax (412) 856-9749
www.rizzoassoc.com

May 8, 2008
Project No. 07-3891

Mr. Michael Cain
c/o Heather Scholtes
PPL Nuclear Development
38 Bomboy Lane, Suite 2
Berwick, PA 18603

**TRANSMITTAL**
**RESPONSE TO RFI EPR 08-170**
**BERWICK NUCLEAR POWER PLANT**

Dear Mr. Cain:

Please find enclosed geotechnical data in response to RFI EPR 08-170.

If you have any questions or need additional copies, please do not hesitate to call me at (412) 856-9700, extension 1039, or e-mail me at Antonio.fernandez@rizzoassoc.com.

Thank you for your assistance.

Sincerely,
***Paul C. Rizzo Associates, Inc.***

Antonio Fernandez, Ph.D., P.E.
Project Manager

AF/dcf

Enclosures

L19 073891/08

AREVA

# REQUEST FOR INFORMATION

| | | |
|---|---|---|
| **RFI Number: RFI-EPR-08-170** | **Date of Request: 1/31/2008** | **Sheet 1 of 2** |
| **To: George Wrobel, CGG** | | |
| **Subject:** COLA Geotechnical Site Characteristic Data | | |
| **Contract No.: A0000832** | **Project or Plant: Pennsylvania Power and Light (PPL) (Berwick, U.S. EPR)** | |
| **Reference Documents: See Below** | | |

**Information Requested (Indicate Intended Use):**

For preparation of the Berwick COLA, it is necessary to reconcile the U S EPR design with the Berwick site In support of this, certain Geotechnical information is required. It is AREVA's understanding that this information has been obtained through a geological/geotechnical survey of the Berwick site

The following list is a summary of the data required by AREVA to perform this reconciliation. If the data is provided from other source documents please provide the document title and revision number If the information is not final, please provide a date when final information will be available to tie to current schedule activity PL230285005 that will provide this information

Because this information will be used by AREVA to perform the required reconciliation of the U S EPR design for the Berwick site, the following requested design input must be provided from an approved QA source.
For each layer of the Berwick soil profile please provide:

1. Thickness

2. Unit weight

3 Shear wave velocity - Strain-compatible S-wave velocities for three soil conditions, i.e , best estimate, lower bound and upper bound

4. S-wave damping ratio - Strain-computable S-wave damping ratios for three soil conditions, i.e., best estimate, lower bound and upper bound

5 P-wave damping ratio - P-wave clamping ratio is usually taken as 1/3 of the corresponding strain comparable S-wave clamping ratio Confirmation that this is acceptable for this soil profile

6 Poisson's ratio and/or compression wave velocity If compression wave velocity is to be provided, please provide the strain-compatible P-wave velocities for three soil conditions, i.e , best estimate, lower bound and upper bound

7 Shear modulus reduction curve - This information will not be needed if the strain-compatible S-wave velocity and damping ratio are provided

8 Friction angle

9 Cohesion

10 At rest, active and passive earth pressure coefficients

11. Recommended bearing capacity/settlement estimates

12. Groundwater elevation

13 Groundwater/Soil Acid content, sulfate content & Chloride content

14. Confirmation of horizontal soil uniformity by geotechnical engineer.

15. For any borrow fill sources provide the information identified in Nos 1-14 of the RFI, as applicable

| | | |
|---|---|---|
| **RFI Classification:** | ☐ **Document Request**<br>☒ **Design Input Request**<br>☐ **Document Clarification**<br>☐ **Other:** | **Verification Required:** ☒ **Yes** ☐ **No**<br>**Date Response Required: February 22, 2008** |

<table>
<tr><td>Requested By:</td><td>Signature:<br>B.D. Hovis</td><td>Title/Organization:<br>Principal Engineer/New Plants Engr</td><td>Date: 2/8/08</td></tr>
<tr><td>Approved By:</td><td>Signature:<br>J.B Wheeler</td><td>Title/Organization:<br>Engr. Manager/New Plants Deployment</td><td>Date: 2/8/08</td></tr>
<tr><td colspan="4">RFI Response (Include Any conditions or Restrictions for Use):<br>See PC Rizzo response dated May 8, 2008 (attached)<br>UniStar 5-13-08</td></tr>
<tr><td>Response By:</td><td>Signature:<br>Antonio Fernandez</td><td>Title/Organization: Project Manager<br>RIZZO</td><td>Date: 5/5/08</td></tr>
<tr><td>Verified By:</td><td>Signature:<br>Jeff Schubert</td><td>Title/Organization: Senior Hydrogeologist<br>Project Associate</td><td>Date: 5/5/08</td></tr>
<tr><td>Approved By:</td><td>Signature:</td><td>Title/Organization:</td><td>Date: 5/5/08</td></tr>
</table>

DCR ENGINEERS & CONSULTANTS

EPR 08-170

| By: | AF | Date: | 5/8/2008 | Subject: | Response to RFI EPR-08-170 | Sheet No. | 1 of 8 |
|---|---|---|---|---|---|---|---|
| | | | | | | Project No. | 07-3891.03 |

The following list provides the response to each of the 15 items listed by the RFI:

## 1. Thickness

The thickness of the existing soils is provided by ***Table 2.5.4-29***.

**TABLE 2.5.4-29**
**RECOMMENDED VALUES FOR DYNAMIC ELASTIC PROPERTIES**
**(Page 1 of 1, English units)**

| | Unit | Depth [ft] (*) | | $V_s$ [fps] | $V_p$ [fps] | $\rho$ [$p_{cf}$] | $\nu$ | $G_{max}$ [ksf] | $E_{max}$ [ksf] | $DS_o$ [%] | Observations |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SOILS | Galcial Overburden 1 | 0.0 | 20.0 | 1160 | 2550 | 126 | 0.37 | 5180 | 14220 | 1.00 | $G_{max} = \rho V_s^2$<br>$E_{max} = 2(1+\nu)G_s$ |
| | Glacial Overburden 2 | 20.0 | 40.0 | 2300 | 7000 | 126 | 0.44 | 20700 | 59590 | 1.00 | |
| ROCK FORMATIONS | Mahantango Formation Layer 1 | 40.0 | 60.0 | 6800 | 12900 | 170 | 0.31 | 244120 | 638430 | 0.80 | - Velocities determined from best estimate soil profile<br>- Poisson's Ration determined from velocity ratio squared<br>- Initial Shear Damping (DSo) determined from "Free-Free" Testing for Rocks, and RCTS Tesing for Overburden and Graydon Chert Conglomerate<br>- (*) Depth of in-situ layers provided at Nuclear Island Location |
| | Mahantango Formation Layer 2 | 60.0 | 100.0 | 7150 | 15300 | 170 | 0.36 | 269900 | 734290 | 0.80 | |
| | Mahantango Formation Layer 3 | 100.0 | 155.0 | 7600 | 16100 | 170 | 0.36 | 304940 | 827380 | 0.70 | |
| | Mahantango Formation Layer 4 | 155.0 | 220.0 | 8600 | 16100 | 170 | 0.31 | 381440 | 996910 | 0.70 | |
| | Mahantango Formation Layer 5 | 220.0 | 270.0 | 8950 | 16750 | 170 | 0.30 | 422900 | 1099710 | 0.70 | |
| | Mahantango Formation Layer 6 | 270.0 | - | 9600 | 16850 | 170 | 0.26 | 486560 | 1225840 | 0.70 | |
| FILLS | Category 1 Granular Fill/Backfill | 0.0 | 10.0 | 600 | 1250 | 140 | 0.35 | 1570 | 4240 | 1.00 | NA: Not Applicable |
| | | 10.0 | 20.0 | 800 | 1670 | 140 | 0.35 | 2780 | 7510 | 1.00 | |
| | | > 20.0 | | 1000 | 2100 | 140 | 0.35 | 4360 | 11770 | 1.00 | |
| | Concrete | NA | NA | 7240 | 12900 | 150 | 0.20 | 244180 | 586030 | 0.80 | |

Table 2.5.4-29 provides the in-situ soil profile below the center line of the reactor. Please refer to the Response to RFI EPR-08-436 for strain compatible soil profiles

## 2. Unit Weight

The unit weight is provided by ***Table 2.5.4-23*** bellow. The fill material will replace the overburden soils around the facilities.

DCR
ENGINEERS & CONSULTANTS

EPR 08-170

By: AF Date: 5/8/2008 Subject: Response to RFI EPR-08-170 Sheet No. 2 of 8
Project No. 07-3891.03

**TABLE 2.5.4-23**
**RECOMMENDED VALUES OF INDEX PROPERTIES**
**(Page 1 of 1, English units)**

| Unit | USCS or URCS | Water Content [%] | Liquid Limit [%] | Plastic Index [%] | Unit Weight [pcf] Dry | Unit Weight [pcf] Moist | Unit Weight [pcf] Sat | Observations |
|---|---|---|---|---|---|---|---|---|
| Glacial Overburden | SW | 20 | NP | NP | 105 | 126 | 131 | -URCS Classification: (Weathering, Strength, Discontinuity, Weight) NA: Not Applicable NP: Non Plastic (*) See grain size curves |
| Mahantango Formation | AAAA | 0.5 | NP | NP | 169 | 170 | 170 | |
| Category 1 Granular Fill | SW | 6 | NP | NP | 133 | 141 | 144 | |
| Category 1 Granular Backfill | SW | 6 | NP | NP | 126 | 134 | 140 | |
| Concrete Fill | NA | NA | NA | NA | NA | 150 | NA | |

3. **Shear Wave Velocity – Strain Compatible S-Wave Velocity for three soil conditions, i.e., best estimate, lower bound, and upper bound.**

   Please refer to the Response to RFI EPR-08-436.

4. **S-wave damping ratio – Strain compatible S-wave damping ratios for three soil conditions, i.e., best estimate, lower bound, and upper bound.**

   Please refer to the Response to RFI EPR-08-436.

5. **P-Wave damping ratio is usually taken as 1/3 of the corresponding strain compatible S-wave damping ratio.**

   Soil amplification analysis is performed for vertically propagated shear wave. Vertical ground motion is obtained by following Reg Guide 1.208. Compressional damping does not affect the site amplification results. The 1/3 ratio proposal is acceptable

6. **Poisson's ratio and/or compression wave velocity. If compression wave velocity is to be provided, please provide the strain-compatible P-wave velocities for three soil conditions, i.e., best estimate, lower bound, and upper bound.**

   The Poisson ratio is provided in ***Table 2.5.4-29***. This value should be used to estimate the strain compatible P-Wave velocities for the three soil conditions

7. **Shear modulus reduction curve – This information will not be needed if the strain-compatible S-wave velocity and damping ratio are provided**

   Strain-compatible S-wave velocity and damping ratio are provided (Items 3 and 4)

8. **Friction Angle**

Table 2.5.4-25 provides the recommended strength parameter values.

**TABLE 2.5.4-25**
**RECOMMENDED VALUES FOR STRENGTH PROPERTIES**
**(Page 1 of 1, English units)**

| Formation | SPT | c [ksf] | φ [°] | $s_u$ [ksf] | $q_u$ [ksf] | Observations |
|---|---|---|---|---|---|---|
| Glacial Overburden | 35 | 0 | 35.0 | NA | NA | - Friction obtained from SPT Correlation for Dense Sands and Gravels (Peck, 1974)<br>- Unconfined Compressive Test for qu<br>- Equivalent cohesion and friction (RMR)<br>- Concrete strength consistent with Vs = 6800 fps<br>- NM: Not Measured<br>- NA: Not Applicable |
| Mahantango Formation | NA | 7.3 | 40.0 | NA | 1050 | |
| Category 1 Granular Fill | NM | 0.0 | 35.0 | NA | NA | |
| Category 1 Granular Backfill | NM | 0.0 | 35.0 | NA | NA | |
| Concrete Fill | fc = 5000 [psi] | | | | | |

## 9. Cohesion

Recommended cohesion is provided by ***Table 2.5.4-25***.

## 10. At Rest, Active, and Passive Earth Pressure Coefficients

The coefficients are provided by ***Table 2.5.4-33***. Note that the overburden soils will be replaced by engineered backfill around the facilities. The earth pressure coefficients of the backfill are the applicable ones. The overburden values are provided for reference purposes.

**TABLE 2.5.4-33**
**EARTH PRESSURE COEFFICIENTS**
**(Page 1 of 1)**

| Formation | φ [°] | $k_a$ | $k_p$ | $k_o$ | $k_{AE}$ | $k_{PE}$ | Observations |
|---|---|---|---|---|---|---|---|
| Glacial Overburden | 35 | 0.27 | 3.69 | 0.43 | 0.58 | 8.12 | NA - Not Applicable<br>$k_a$ - Active Earth Pressure Coefficient<br>$k_p$ - Passive Earth Pressure Coefficient<br>$k_o$ - At Rest Earth Pressure Coefficient |
| Mahantango Formation | NA | NA | NA | NA | NA | NA | |
| Granular Fill/Backfill | 35 | 0.27 | 3.69 | 0.43 | 0.58 | 8.12 | |
| Concrete Fill | NA | NA | NA | NA | NA | NA | |

DCR ENGINEERS & CONSULTANTS

EPR 08-170

By: AF Date: 5/8/2008 Subject: Response to RFI EPR-08-170 Sheet No. 4 of 8
Project No. 07-3891.03

## 11. Recommended bearing capacity/settlement estimates

Allowable bearing Capacities are in the excess of 40 ksf for buildings placed over engineered fills. For the case of the Nuclear Island placed on top of concrete and the Mahantango formation, the allowable bearing capacity is higher than 100 ksf. Settlements are below the 2 inch threshold for facilities placed on top of engineered fill and negligible for the Nuclear Island.

## 12. Groundwater Elevation

Normal groundwater:

The seasonal variation of Normal Groundwater Elevation below the center line of the containment:

| Oct | Nov | Dec | Jan | Feb | Mar | Apr |
|---|---|---|---|---|---|---|
| 655.7 | 657.7 | 657.5 | 657.7 | 658.8 | 659.3 | 658.1 |

Maximum groundwater: El. 671 msl

## 13. Chemical Properties of soil and water

Available Chemical Testing of Water:

**CHEMICAL TEST RESULTS OF GROUNDWATER WATER SAMPLES AT MW-301 (NUCLEAR ISLAND)**
**(Page 1 of 1, English and SI Units)**

| Location | Date | pH | Sulfates [ mg/l ]* | Chlorides [ mg/l ]* |
|---|---|---|---|---|
| MW-301 (Nuclear Island) | 10/30/2007 | 5.76 | | |
| | 1/26/2008 | 5.81 | | |
| | 2/27/2008 | 5.68 | 29 | 2 |
| | 4/14/2008 | 5.7 | OI-TBC | OI-TBC |
| | 7/7/08 | OI-TBC | OI-TBC | OI-TBC |
| | 9/29/08 | OI-TBC | OI-TBC | OI-TBC |

(*) Winter monitoring program
OI-TBC: Open Item, To be Completed

Available Chemical Testing of Soil (Plan view given for boring location):

**Fw: Nine Mile Point**
PAWEL KUT to: RICHARD P POSPIECH 06/23/2008 10:12 AM

History: This message has been replied to.

Air Flowrates

Pawel

----- Forwarded by PAWEL KUT/Sargentlundy on 06/23/2008 10:11 AM -----

From: Bill.Schott@ct.spx.com
To: PAWEL.KUT@sargentlundy.com
Cc: Paul.Secen@ct.spx.com, Kent.Martens@ct.spx.com, rblomquist@rmbsales.com
Date: 05/16/2008 04:15 PM
Subject: Nine Mile Point

Pawel,

Here is the data I think you are asking for..

| | Exit Air Flow, cfm |
|---|---|
| Natural Draft Towers | 54,848,028 |
| Round Towers | 58,860,000 |
| Rectangular Towers | 55,566,000 |

The conditions were 800,000 gpm at 114.76/90/74.
Regards,

Bill Schott, PE
Proposal Engineer
SPX Cooling Technologies
7401 W 129 Street
Overland Park, KS 66213 USA
913-664-7809 office phone
913-693-9406 office fax

<JOHN.DALTON@ct.spx.com
>

06/25/2008 08:57 PM

To RICHARD.P.POSPIECH@Sargentlundy.com
cc Paul.Secen@ct.spx.com, Kent.Martens@ct.spx.com
bcc
Subject BELL BEND - Data and Information

History: This message has been replied to and forwarded.

Richard,

As requested, your undimensioned drawing and answers follow below. Thank you & all the best,

1a) Drawing: (See attached file: Bell Bend - undimensioned.pdf)
1b) Dimensions: 475' high x 350' base diameter per Richard Pospiech 6/24/08 e-mail.

2) No. Fan assisted natural drafts and fan assisted plume abated natural drafts (hybrid) are available, but are quite different towers.

3) Yes. The basin can be sized, within reason, to handle any water volume required by the customer by changing the diameter and/or depth.

4) Airflow - we did not do the design. 35,000,000-60,000,000 cfm??

5a) Reinforced concrete shell, plinth, and basin.
5b) Distribution system: Concrete flume or RTR headers, PVC laterals, polypropylene spray arms and nozzles.
5c) Bottom supported PVC film fill and PVC eliminators
5d) Fiberglass fill and eliminator support
5e) Stainless hardware

6) Sound:

(Embedded image moved to file: pic25724.jpg)

Information needed on cooling tower:
1. Dimensions (height, diameter), and drawing.
2. Does tower have structural features that will permit the installation of dry cooling fans, heat exchangers, sound attenuation equipment, and hot air distribution ducting?
3. Will basin be sized to provide sufficient volume to allow draindown of the circulating water system without overflow with the basin initially at maximum operating water level?
4. Air flow rate
5. Internal construction materials, including:
a. Material for piping laterals
b. Material for spray nozzles
c. Fill material
6. Noise levels? At what distance away?

John Dalton
Proposal Engineer
Field Erected Products
Tel: 913.664.7482

Fax: 913.664.7993
John.Dalton@CT.SPX.com
SPX Cooling Technologies
7401 W. 129th St.
Overland Park, KS 66213



Bell Bend - undimensioned.pdf pic25724.jpg

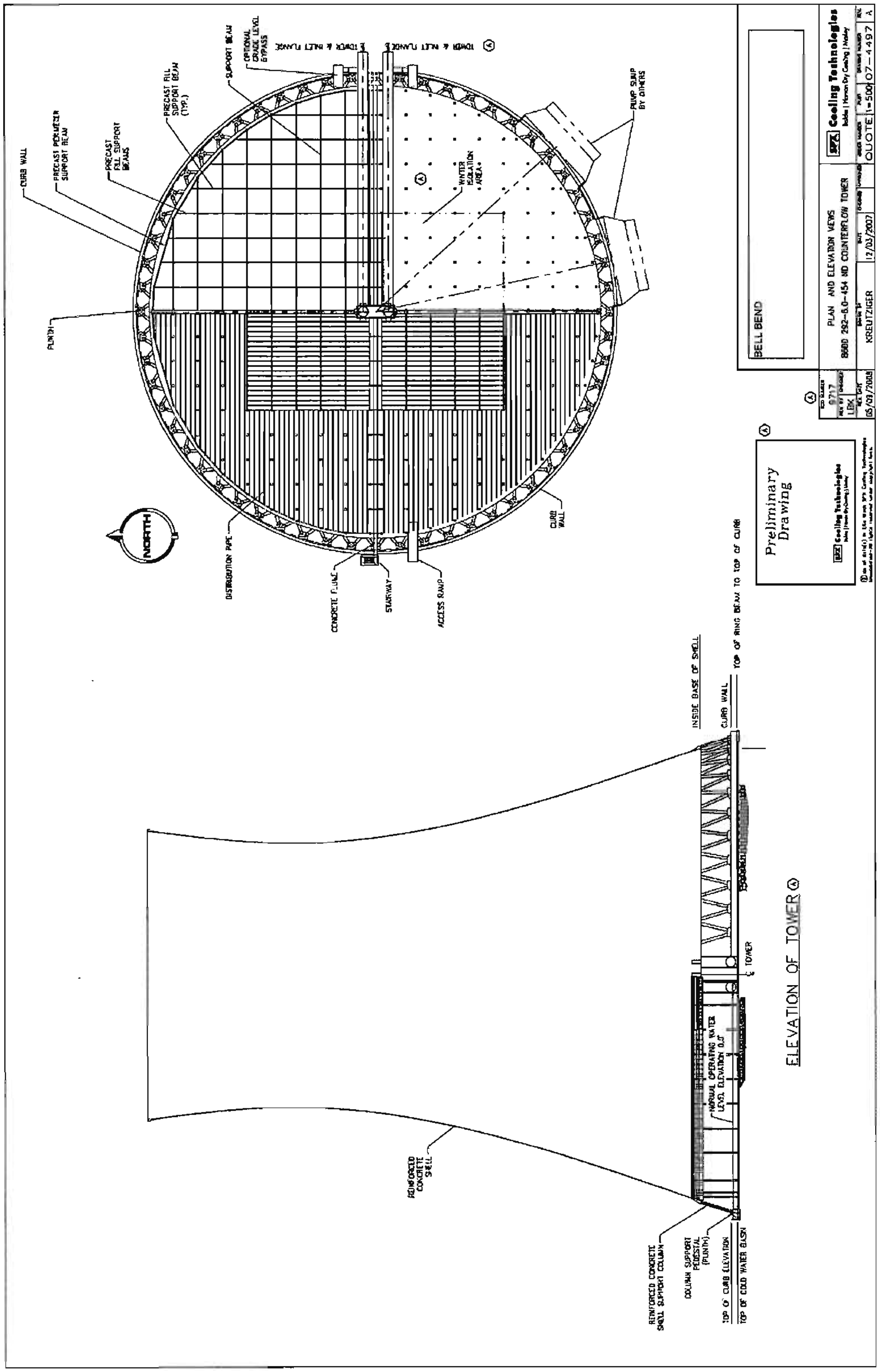
**BELL BEND**

JDD
25-Jun-08

SPX COOLING TECHNOLOGIES

Sound data for a free and unobstructed environment per CTI ATC-128
Sound Pressure Level (SPL) expressed in dB (re: 20E-6 Pa).

| SPL | | 31.5 | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 | dBA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | From Curb | | 60 | 60 | 64 | 72 | 74 | 72 | 77 | 77 | 82 |
| 50 | From Curb | | 61 | 59 | 60 | 68 | 71 | 70 | 73 | 72 | 78 |
| 100 | From Curb | | 59 | 60 | 57 | 63 | 66 | 64 | 66 | 66 | 72 |
| 200 | From Curb | | 58 | 59 | 56 | 57 | 61 | 60 | 61 | 60 | 67 |


ELEVATION OF TOWER
Preliminary Drawing
BELL BEND
PLAN AND ELEVATION VIEWS
NORTH
DISTRIBUTION PIPE
CONCRETE FLUME
STAIRWAY
ACCESS RAMP
CURB WALL
REINFORCED CONCRETE SHELL
PUMP SUMP BY OTHERS