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**RESPONSE TO ENVIRONMENTAL PROTECTION  
AGENCY'S INFORMATION REQUEST FOR  
NPDES PERMIT RE-ISSUANCE**

**PSNH SCHILLER STATION  
PORTSMOUTH, NEW HAMPSHIRE**



**Prepared for  
Public Service Company of New Hampshire**

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## 1 Background, Introduction, and Scope

Public Service Company of New Hampshire's (PSNH's) Schiller Station electrical generating facility in Portsmouth, New Hampshire is seeking a renewal of its existing National Pollutant Discharge Elimination System permit (NPDES Permit NH0001473). To support development of the Station's NPDES permit renewal, the United States Environmental Protection Agency (EPA) issued an information request letter to PSNH under Section 308 of the Clean Water Act (CWA) regarding the Station's compliance with CWA §316(b), 33 U.S.C. §1326(b) (§308 Letter). In the §308 Letter, EPA requested certain technology information from PSNH to support EPA's development of the new permit for Schiller Station. In October 2008, PSNH submitted a response (2008 Response) [Ref. 9.1] prepared by Enercon Services, Inc. (ENERCON) and Normandeau Associates, Inc. (Normandeau).

EPA issued follow-up information requests (IR) to PSNH pertaining to the items listed below:

1. Dimensions of the Unit 4 intake pipe, as well as the dimensions of the two abandoned Unit 3 intake pipes. Please also include an intake velocity calculation at the intake point of the Unit 4 pipe based on maximum design flow.
2. In the October 2008 Response to EPA's CWA (Clean Water Act) §308 letter, PSNH indicates that maintenance costs for Unit 3 intake renovation and the continuous operation of screen option are [REDACTED]. Please confirm that these are yearly figures.
3. Did PSNH contact Gunderboom directly during its evaluation of aquatic microfiltration barriers for the 2008 report in regards to Schiller Station? If so, please provide their direct findings.
4. Please provide further explanation why the installation of multi-disc screens would result in higher through-screen velocities especially when combined with the Unit 3 renovations, since the Unit 3 renovations is reported to reduce intake velocity. EPA notes that for Merrimack Station, PSNH reported that the installation of multi-disc screens would reduce impingement mortality by [REDACTED].
5. Please provide further explanation why the installation of WIP (W Intake Protection) screens would result in smaller screen surface area overall (and higher through-screen velocities) especially when combined with the Unit 3 renovations, since the Unit 3 renovations is reported to reduced intake velocity.
6. Please provide an evaluation of a combined fish return system that connects both screen houses and engineered to transport fish away from the intake structures based on the direction of tidal flow.
7. PSNH determined that dual flow screens were technologically infeasible because the size of the existing intake structure could not accommodate a dual flow retrofit. PSNH also indicated that total replacement or extensive modifications of the intake structures would be required at a cost much higher than the cost of the screens themselves. Please provide further explanation or supporting information to document or explain these assessments.



This report individually reviews each information request, provides clarification of the information provided in the 2008 response [Ref. 9.1], and, where necessary, conducts new analysis or evaluation in support of responding to EPA's information request.

## 2 Intake Pipe Dimensions and Flow Velocities

### 2.1 Information Request

EPA requests additional information regarding the dimensions of the Unit 3 and 4 intake pipes, as well as intake velocities for Unit 4:

*Dimensions of the Unit 4 intake pipe, as well as the dimensions of the two abandoned Unit 3 intake pipes. Please also include intake velocity calculation at the intake point of the Unit 4 pipe based on maximum design flow.*

### 2.2 Information Provided in 2008

The 2008 response provided a description of the two cooling water intake structures (CWISs) for Schiller Station. Screen House #1 contains the CWIS for Unit 3 (now retired) and Unit 4, while Screen House #2 contains the CWIS for Units 5 and 6. [REDACTED]

[REDACTED] These intake structures were described in detail with regard to their physical description, location, and depth of CWIS in the 2008 response.

Section 2.3.1 of the 2008 response provided the inner diameter of the Unit 4 intake pipe, and of the Unit 3 intake pipes [Ref. 9.1]:

*There are three 6.5 ft I.D. pipes available to provide cooling water to Screen House #1 from the offshore submerged intake; the south pipe provides cooling water to Unit 4, while the other two pipes were designed for Unit 3, and are currently offline.*

Additionally, this section also states [REDACTED]

[Ref. 9.1].

The 2008 response also provided the design intake capacity for each of the Units at Schiller Station. The Unit 4 design intake capacity is described in Section 2.3.2.2 [Ref. 9.1]:

#### Unit 4

Under normal power generating operation, the salt water heat exchanger pump, the screen wash pump, and the circulating water (CW) pumps can draw in 29,290 gpm of water from the CWIS, which includes both cooling water and process water as follows:

#### Cooling Water (Up to 29,150)

- Up to 28,200 gpm is used as non-contact cooling water in the condenser;
- Up to 950 gpm is used as non-contact cooling water in the salt water heat exchangers;

#### Process Water (Up to 140 gpm)

- Up to 140 gpm is supplied to the screen wash pump during regular operation.

## 2.3 Engineering Response

The intake velocity at the intake point of the Unit 4 pipe can be determined by dividing the maximum design volumetric flow rate by the cross-sectional area available for flow. As mentioned in Section 2.2 above, the Unit 4 intake pipe has an inner diameter of 6.5 feet. Therefore, the cross-sectional area available for flow is ( $A$  = area,  $r$  = radius):

$$A = \pi r^2 = \pi \left( \frac{6.5 \text{ ft}}{2} \right)^2 = 33.18 \text{ ft}^2$$

From the 2008 response, each of the two Unit 4 CW pumps has a capacity of 14,100 gpm, combining for a total of 28,200 gpm. Additionally, the Unit 4 salt water pump has a capacity of 950 gpm to supply the salt water heat exchangers. And finally, while not cooling water, the Unit 4 screen wash pump has an intake capacity of up to 140 gpm. Assuming that all of these pumps run at their full capacity, the total maximum cooling water intake capacity is 29,290 gpm [Ref. 9.1].

Converting to cubic feet per second, this flow rate becomes ( $Q$  = volumetric flow rate) [Ref. 9.3]:

$$Q = 29,290 \frac{\text{gal}}{\text{min}} \times \frac{1 \text{ ft}^3}{7.48052 \text{ gal}} \times \frac{1 \text{ min}}{60 \text{ sec}} = 65.258 \frac{\text{ft}^3}{\text{sec}}$$

Using the design maximum volumetric flow rate and cross-sectional flow area, the intake velocity at the intake point of the Unit 4 pipe is ( $V$  = velocity) [Ref. 9.3]:

$$V = Q/A = \frac{65.258 \frac{\text{ft}^3}{\text{sec}}}{33.18 \text{ ft}^2} = 1.97 \frac{\text{ft}}{\text{sec}}$$

Based on the above calculation, the velocity at the intake point of the Unit 4 offshore intake pipe based on maximum design flow is approximately 1.97 feet per second. However, the intake velocity quickly dissipates moving away from the intake and into the river. As stated in Section 2.2.2 of the 2008 response, the maximum Station intake rate of 194 cubic feet per second is approximately 0.17% of the peak tidal flow rate [Ref. 9.1]. Thus, the general hydraulic influence of Schiller Station upon the Piscataqua River is deemed negligible.

### 3 Maintenance Cost Figures

#### 3.1 Information Request

EPA requests additional information regarding the maintenance cost figures for the Unit 3 intake renovation and the continuous operation of screen option:

*In the October 2008 Response to EPA's CWA [Clean Water Act] §308 letter, PSNH [Public Service of New Hampshire] indicates that maintenance costs for Unit 3 intake renovation and the continuous operation of screen option [REDACTED] [REDACTED] Please confirm that these are yearly figures.*

#### 3.2 Information Provided in 2008

The maintenance costs for the Unit 3 intake renovation and the continuous operation of screen option were addressed in the Table entitled “Comparative Matrix of Technologies or Operational Measures Utilized for CWA 316(b) Compliance” in Section 7 of the 2008 response [Ref. 9.1]. The third column of this table provides the estimated annual costs for each technology or operational measure.

Item #9 in the table is “Unit 3 intake renovation,” which is shown to have [REDACTED] [REDACTED] Item #10 in the table is “Continuous operation of existing traveling screens,” which is shown to have an [REDACTED]. Note that these figures assume a 100% capacity factor.

#### 3.3 Engineering Response

[REDACTED] are yearly figures. These figures were provided under the “Cost - Annual”, column, for Items #9 and #10, in the Table entitled “Comparative Matrix of Technologies or Operational Measures Utilized for CWA 316(b) Compliance” in the 2008 response [Ref. 9.1].

## **4 Gunderboom Findings**

### **4.1 Information Request**

EPA requests additional information regarding PSNH's evaluation of aquatic microfiltration barriers:

*Did PSNH contact Gunderboom directly during its evaluation of aquatic microfiltration barriers for the 2008 report in regards to Schiller Station? If so, please provide their direct findings.*

### **4.2 Information Provided in 2008**

Aquatic microfiltration barrier systems are barriers that employ a filter fabric designed to allow for passage of water into a CWIS, but to exclude aquatic organisms. These systems are designed to be placed some distance from the CWIS within the source waterbody and to act as a filter for the water that enters the cooling water system. These systems may be floating, flexible, or fixed. Since these systems generally have a large surface area, the velocities that are maintained at the face of the permeable curtain can be made very low. At Schiller, Gunderboom and other microfiltration systems would have sizing and physical limitations as well as the potential to interfere with or prevent other existing uses of the Piscataqua River. With a 20 micron mesh, 100,000 and 200,000 gpm intakes would require filter systems 500 and 100 feet long (assuming 20 feet depth). The source waterbody directly adjacent to the site is approximately 16 feet deep at MLW. Therefore, assuming a linear correlation between flow rate and filter length, the Gunderboom would need to be at least 550 feet long.

In addition, the North Dock - directly in front of Screen House #2 and less than 150 feet from Screen House #1 – would obstruct any potentially effective location of the Gunderboom at the Station. If the dock were to be relocated, the remaining available space would still be less than 550 feet. Therefore, there are significant space limitations at Schiller Station that would preclude the successful deployment of an aquatic microfiltration barrier. Additionally, during winter the Gunderboom could be subject to impact from pieces of ice carried in the currents.

Therefore, an aquatic microfiltration barrier is determined to be technologically infeasible for implementation at Schiller Station.

### **4.3 Engineering Response**

Gunderboom was not contacted directly for the 2008 response to the EPA §308 request for Schiller Station. But, the Gunderboom information presented in the report was based on a comprehensive review of industry available information on the design and implementation of aquatic filtration barriers, including but not limited to the following documents:

1. EPA – Technical Development Document for the Final Regulations Addressing Cooling Water Intake Structures for New Facilities – Chapter 5: Efficacy of Cooling Water Intake Structure Technologies;
2. ENSR Information on Alternative Technologies dated March 2000;
3. Information on the Gunderboom technology from the Gunderboom website;
4. “Gunderboom Fouling Studies in Bowline Pond,” by Pisces Conservation Ltd, July 2001, P.A. Henderson, R.M. Seaby, C. Cailes and J.R. Somes.

Additionally, expertise acquired from other projects was used in the feasibility assessment provided in the 2008 Response, as well as knowledge of site-specific challenges related to the Station and to the Piscataqua River.

## 5 MultiDisc Screen Velocities

### 5.1 Information Request

EPA requests additional information regarding the effects of installing MultiDisc screens:

*Please provide further explanation why the installation of multi-disc screens would result in higher through-screen velocities especially when combined with the Unit 3 renovations, since the Unit 3 renovations is reported to reduce intake velocity. EPA notes that for Merrimack Station, PSNH reported that the installation of multi-disc screens would reduce impingement mortality by [REDACTED]*

### 5.2 Information Provided in 2008

Section 2.3.2.4 of the 2008 response stated that the current through-screen velocity for the Unit 4 traveling water screens is 1.38 feet per second, assuming maximum design intake capacity. This is based on the current intake configuration in Screen House #1, which uses only one intake pipe. Because Unit 3 has been retired, and two of the three intake pipes were originally used for Unit 3, the current Unit 4 intake configuration only uses one of the three available intake channels in Screen House #1.

Section 6 of the 2008 response [Ref. 9.1] discussed potential alternative intake technologies and/or operational measures for reducing impingement and impingement mortality at Schiller Station. One of the alternatives discussed is to open the currently closed channel between the Unit 3 and Unit 4 forebays, allowing the original Unit 3 intake structure to be reused for Unit 4. As stated in Section 6.1 of the 2008 response, new traveling water screens (or other screens) and some structural modifications to Screen House #1 would be required to reuse the currently abandoned Unit 3 intake structure. Assuming that new traditional traveling water screens are similar in size to the previous screens, and that structural modifications would allow the flow area in the channels to remain similar to the Unit 4 intake, renovating the Unit 3 intake would potentially triple the available flow area for Unit 4. As such, Section 6.1 of the 2008 response indicated that the use of the two Unit 3 intake pipes would potentially reduce the through-screen velocity to approximately 0.46 feet per second [Ref. 9.1].

Section 6.1.3.2 of the 2008 response discusses the alternative technology of replacing the existing traveling water screens with MultiDisc screens. These screens utilize circulating sickle-shaped mesh panels that are connected to a frame via a revolving chain. Because these screens would be installed in an orientation similar to the existing through flow screens, only minimal civil modifications would be required to install MultiDisc screens in the operable (Units 4–6) intakes. If MultiDisc screens were installed in tandem with Unit 3 intake renovations, more structural modifications would be required.

Because MultiDisc screens are only available in certain widths, a screen that is smaller than the ideal width would have to be installed. Additionally, MultiDisc screens utilize an oval-shaped opening near the bottom, which would be inscribed inside the existing rectangular intake channel, resulting in a slight reduction in screening area. The net result of these features would be a reduction in available flow area.

The last paragraph of Section 6.1.3.2 in the 2008 response discusses the resultant through-screen velocities for each Unit if MultiDisc screens were to be installed:

*With the expansion of the Unit 4 intake to include the two additional intake pipes in the abandoned Unit 3 intake and the installation of traditional traveling water screens, the through-screen velocity at Unit 4 would be 0.46 fps, as discussed in Section 6.1.1. Per Section 2.3.2.4, the through-screen velocity through the existing traveling water screens at Units 5 and 6 is 0.68 fps. Installing two new MultiDisc screens in the renovated Unit 3 intake and replacing existing screens for Units 4, 5, and 6 with MultiDisc screens would effectively decrease the intake channel width, resulting in a through-screen velocity of 0.55 fps for Unit 4 and 0.82 fps for Units 5 and 6.*

Per EPA's request, the preceding paragraph will be further elaborated upon in the following section.

### **5.3 Engineering Response**

As discussed in the section above, installing MultiDisc screens at Schiller Station will reduce the screening area available for flow. Assuming no other modifications, the through-screen velocity will increase. For Units 5 and 6, installation of MultiDisc screens by themselves would increase the through-screen velocity from approximately 0.68 feet per second to approximately 0.82 feet per second. For Unit 4, installation of MultiDisc screens by themselves would also increase through-screen velocity above the current value of approximately 1.38 fps.

The 2008 response also discussed the alternative of renovating the Unit 3 intake to reduce intake velocities for Unit 4. Since the flow area would be increased by approximately a factor of three, the through-screen velocities for Unit 4 would be reduced from approximately 1.38 feet per second to approximately 0.46 feet per second, assuming no other modifications.

The quote from the 2008 response in Section 5.2 discusses the possibility of doing both modifications in tandem: renovating the Unit 3 intake and installing MultiDisc screens. Since installing MultiDisc screens increases through-screen velocity, and because renovating the Unit 3 intake reduces through-screen velocity, it is helpful to consider the net result of these two competing effects. Renovation of the Unit 3 intake by itself would reduce the through-screen velocity to approximately 0.46 feet per second as mentioned above. Combining that with installation of MultiDisc screens, the through-screen velocity would increase to approximately 0.55 feet per second.

For Units 5 and 6, the Unit 3 intake renovations have no effect on the through-screen velocities. This is because the Unit 5 and 6 intakes are located in Screen House #2, making them completely independent of the abandoned Unit 3 intake. Therefore, installation of MultiDisc screens here increases the through-screen velocity to approximately 0.82 feet per second, regardless of the Unit 3 modifications.

Insofar as studies conducted by Normandeau at Merrimack Station indicating impingement reductions of [REDACTED] for MultiDisc screens, the site-specific conditions which formed the basis of those conclusions are not applicable to Schiller Station.

## 6 W Intake Protection Screens

### 6.1 Information Request

EPA requests additional information regarding the effects of installing WIP screens:

*Please provide further explanation why the installation of WIP [W Intake Protection] screens would result in smaller screen surface area overall (and higher through-screen velocities) especially when combined with the Unit 3 renovations, since the Unit 3 renovations is reported to reduce intake velocity.*

### 6.2 Information Provided in 2008

One of the alternative technologies discussed in the 2008 response for reducing impingement and impingement mortality was the use of Beaudrey USA WIP screens to replace the current traveling water screens. WIP screens are modified revolving disc screens, which consist of a flat disc covered with a screening material that rotates about a horizontal axis. Both fish and debris are removed from the screen surface below the waterline by a fish safe pump and suction scoop. WIP screens eliminate the possibility of debris carryover, because the screens do not rotate over into the downstream flow.

One of the primary disadvantages of WIP screens is that they have a much smaller screening area than similar screens for the same intake. This fact was highlighted several times in the 2008 response (Section 6.1.3.3):

*However, compared to traditional through flow traveling water screens, the WIP system does not utilize the entire available screen area, as shown in Figure 6.6. This decreased active screen area results in an increased through-screen velocity...*

*... It should be noted that since the screen area of the WIP screen is circular, the amount of available through-screen area is limited to the circular screen. Hence, the same volume of water currently passing through the width and height of the water level would pass through a smaller area, resulting in higher through-screen velocities.*

Additionally, the 2008 response discussed that the WIP screens would create higher through-screen velocities compared to other similar technologies:

*Installing two new WIP screens in the renovated Unit 3 intake and replacing existing screens for Units 4, 5, and 6 with WIP screens would effectively decrease the available screen area, resulting in increased through-screen velocities.*

### 6.3 Engineering Response

As stated previously, the WIP screens utilize a rotating circular disc that is located beneath a large wall plate (see Figure 6.6 of Reference 9.1). Only the rotating circular disc provides screening area through which the flow can pass. The wall plate occupies the remainder of the intake channel and does not allow flow to pass through. Therefore, the screening area of a WIP screen is necessarily smaller than that of a traditional traveling water screen, Ristroph screen, or even MultiDisc screen. Other things being equal, the through-screen velocity of an intake configuration will be increased by the installation of WIP screens in lieu of other

screening technologies. Specific to Schiller Station, if the current traveling water screens were replaced with WIP screens, the through-screen velocity would increase. If the Unit 3 renovations were to take place, installing WIP screens would result in higher through-screen velocities over other comparable screening technologies.

## 7 Evaluation of Combined Fish Return System

### 7.1 Information Request

EPA requests an evaluation of a combined fish return system that connects both screen houses:

*Please provide an evaluation of a combined fish return system that connects both screen houses and engineered to transport fish away from the intake structures based on the direction of tidal flow.*

### 7.2 Information Provided in 2008

The 2008 response provided information on the existing fish handling and return system at Schiller Station. The intake for Unit 4 has one traveling water screen, while Units 5 and 6 each have two traveling water screens. The screens contain basket/panel segments, which ascend on the upstream side of the traveling water screen. The panels collect debris and are lifted out of the flow towards the spray nozzles. The nozzles, which are rated at 40 psi, spray the entire width of the panel to remove debris and fish that have accumulated on the screen segment. The spray wash water and fish and/or debris are collected in a rectangular fish return trough. Currently, the system is only operated intermittently.

For Screen House #1, the trough varies from 18 to 24 inches wide and from 10 to 18 inches deep. The debris/fish trough runs along the length of CWIS before exiting near the southeast corner of Screen House #1 and transitioning into a 14-inch diameter round pipe. The 14-inch pipe slopes downward as it heads southeast towards the Piscataqua River. The pipe extends out over the river, before eventually discharging at an elevation of 4 feet above MSL.

For Screen House #2, the trough is 24 inches wide and varies from a 12 to 18 inch depth. The debris/fish trough runs along the length of the CWIS and discharges directly through the side of the northwest wall and into the Piscataqua River. The Screen House #2 discharge occurs about 8 feet above MSL.

Section 6.1.2.1 of the 2008 response also discussed operating the traveling water screens and fish return system continuously, as screenwash interval has been shown to be a major factor in influencing impingement survival [Ref. 9.4]. Two additional screen wash pumps would be required for all three Units to operate their fish return systems simultaneously.

Additionally, Section 6.1.2.2 of the 2008 response discussed upgrading the fish return trough. The main objective of a fish return trough is to provide a discharge location for fish once they are removed from the screening device, and to transport them gently and quickly back to the source waterbody. An ideal fish return trough is designed to maintain a water velocity of 3 to 5 feet per second, and a minimum water depth of 4 to 6 inches [Ref. 9.1]. The fish return trough should avoid sharp turns or drops if at all possible, and should discharge slightly above the low water level. Additionally, the fish return trough itself should slope gently downward to avoid additional stress caused by flow turbulence. The 2008 response concluded that a slope of  $\frac{1}{4}$  was reasonable considering the proximity of Screen Houses #1 and #2, and would require an overall trough length of approximately 45 feet. An evaluation of re-impingement

would be required to identify the best return sluice discharge locations relative to the tidal flow.

### **7.3 Engineering Response**

EPA has requested that PSNH provide an evaluation of a combined fish handling and return system that will connect both screen houses, and transport fish away from the Units 4, 5, and 6 intake structures based on the direction of tidal flow. From this point forward, this will be referred to as a “combined fish return system.”

The current fish return systems at Schiller Station discharge the debris/fish sluice in between Screen Houses #1 and #2. The return trough for Unit 4 originates from the southeast corner of Screen House #1 and is carried approximately 48 feet towards Screen House #2 before discharging about 4 feet above MSL near the north corner of Screen House #2 [Ref. 9.5]. The return trough for Units 5 and 6 discharges directly from the side of Screen House #2 near the north corner of the building at an elevation of 8 feet above MSL. The proximity of these two discharge locations does not allow for a smooth connection between them because they are at different elevations.

The Unit 5 and 6 fish return system could be modified to follow some elongated path (such as a downward spiral or helix) to decrease the elevation of the discharge gently with the purpose of joining the Unit 4 fish return discharge at its current discharge location. However, this would place the union of these two troughs out over the Piscataqua River. Since EPA has requested two separate discharge paths to ensure that re-impingement is minimized during both ebb and flood tide conditions, some method for switching between the two flow paths would be required: a flow diverter, baffle, or valve. From a maintenance and/or operational perspective, it would be challenging to have such a device located out over open water, in between the two screen houses. Therefore, implementation of a combined fish handling and return system that will connect both screen houses and transport fish away from the intakes based on the direction of tidal flow will require a complete re-design of the fish handling and return system.

It is outside the scope of this response to provide a completely new design for the fish handling and return system at Schiller Station, particularly since such an effort would be contingent upon acquiring additional data and evaluation of that data. The remainder of this section will discuss the information that is needed and currently unknown, and will develop a list of considerations for designing a combined fish return system.

The first item to be addressed prior to the design of a combined fish return system is the assumption that Schiller Station has a significant re-impingement rate. As mentioned above, implementing a combined fish return system with two discharges will require a complete redesign of the current system. The current re-impingement rate for each tidal condition should be well-understood prior to commencing design work on a new fish return system. This may necessitate hydraulic modeling (such as computational fluid dynamics, or similar) to fully understand the flow behavior near the intake to determine the optimal location. A more detailed knowledge of the flow behavior in front of the intakes would aid in determining whether two discharge locations, or a new location at all, are necessary. The span between the intake for Unit 4 and the intake for Units 5 & 6 is approximately 125 feet [Ref. 9.6]; therefore,

significant piping and associated structural support will be required in the design of a combined fish return system featuring two discharge locations. If two locations are determined to be necessary, the following list provides considerations and/or evaluations that would be required in the design of a combined fish return system as described by EPA.

1. Civil/structural design requirements, including hydrodynamic forces, ice/debris/wind loading, and geology:

The pipe(s) and/or trough(s) would have to span to an offshore location that will reduce re-impingement. Various supports would be designed to support the piping throughout their spans. These supports would be designed considering several loads including hydrodynamic forces, ice/debris impact loading, and wind loading. The size of the supports would also vary based on the river bathymetry and riverbed geology. Considerations to facilitate support and pipe construction and installation would also be assessed in the design.

2. Pipe and/or trough sizing, layout, routing, and material selection to maximize impingement survival:

The piping and/or trough layout would be designed to gently return fish to the source body of water. It would also need to facilitate switchover between debris/fish discharge locations by plant Operators, based on tidal flow, to prevent re-impingement. The pipe routing would need to be an appropriate length and slope considering the intake structure and discharge location and elevation. The layout would also need to be routed to avoid possible navigational interference and to limit debris accumulation within the pipe. The piping material would need to be selected to allow for minimal maintenance caused by corrosion, biofouling, and weathering. The piping size would be selected to handle the possible applied forces such as differential water pressures, and impact loading.

3. Determination of applicable state and federal permitting restrictions:

The applicable permitting restrictions would need to be identified, including but not limited to: U.S. Army Corps of Engineers, U.S. Coast Guard, U.S. Fish and Wildlife Service, New Hampshire Department of Environmental Services, New Hampshire Division of Ports and Harbors, New Hampshire Fish and Game Department, and New Hampshire Department of Transportation, etc. Additionally, the combined fish return system would create new outfalls for the Station.

4. Evaluation of biological efficacy and re-impingement reduction:

The impingement survival rate and re-impingement rate (both before and after modification) will need to be determined. Where necessary, this analysis may necessitate design changes to the combined fish return system. Given that a complete redesign of the fish return system would be required, the re-impingement rate in the current configuration will need to be quantified to justify a combined fish return system.

5. Evaluation of required modifications to traveling water screens to increase impingement survival:

Modifications may be required to the existing traveling water screens to increase impingement survivability. This may necessitate relocating the trough to the downstream side of the screens, or adding screenwash pumps.

6. Evaluation of environmental impacts of both construction and final configuration:

The impacts of both construction and of new permanent structures to the local environment would need to be determined. Additionally, the impact of removing permanent structures would need to be evaluated.

7. Hydraulic considerations, including improvements to screenwash system:

The system would need to be designed such that the flow velocity and water depth are all sufficient to increase impingement survival. The addition of a low pressure spray to the screens may also need to be evaluated.

8. Evaluation of constructability limitations, including construction process, and duration:

A review of the site property boundaries, easements, etc. would be required to determine the physical limitations of construction. The construction process would need to occur during favorable weather and minimize navigational interference. Construction activities that can be done in parallel would be planned as such to limit construction duration. To prevent schedule delays, major interferences would be evaluated during design and reviewed prior to construction start. Feasibility of material and equipment transportation would be determined prior to construction start.

9. Considerations for seasonal operation only:

A combined fish return system that operates only seasonally would be considered in light of the monthly impingement data for Units 4, 5, and 6. It may only be necessary to operate the fish return system during months of significant impingement, reducing operating costs.

## 8 Dual Flow Traveling Screens

### 8.1 Information Request

EPA requests additional information regarding the feasibility of dual flow screens at Schiller Station:

*EPA also requests additional information about the feasibility of dual flow screens at Schiller Station. PSNH determined that dual flow screens were technologically infeasible because the size of the existing intake structure could not accommodate a dual flow retrofit. PSNH also indicated that total replacement or extensive modifications of the intake structures would be required at a cost much higher than the cost of the screens themselves. Please provide further explanation or supporting information to document or explain these assessments.*

### 8.2 Information Provided in 2008

The 2008 response provided information regarding the operation of dual flow traveling water screens, and how they differ from traditional through flow traveling water screens. A dual flow traveling water screen operates similarly to a through flow screen, however, its orientation differs, as it is rotated by ninety degrees.

Dual flow screens are oriented such that the general direction of incoming water flow is parallel to the screening surface. A plate is installed in the front of the dual flow screen, in between the two screening surfaces and perpendicular to the general direction of incoming flow. This plate forces the flow to either the ascending or descending side of the screen. Because dual flow screens have two sides through which the flow can enter, these screens can provide approximately twice the screening area of a through flow screen of equivalent width. An inlet opening on the downstream side of the screens allows screened water to pass through to the pumps.

Retrofitting a through flow screen with a dual flow screen can have the following advantages:

- There is potential to decrease the through screen velocity with dual flow screens. The flow pattern of a dual flow screen allows the entire screen surface to be an active screen area. This means that a dual flow screen of a given width would pass approximately twice as much water at the same velocity as a through flow screen of the same width. Alternatively, a dual flow screen can pass through the same flow at approximately half the flow velocity as a through flow screen of the same width. However, this assumes that there is adequate space within the CWIS to accommodate the conversion.
- The possibility of debris carryover is eliminated with dual flow screens. Traditional through flow screens rotate over into the direction of the downstream flow. Any fish and/or debris that are not washed off the screen basket are washed off into the screened water, which is drawn into the plant cooling system. Because dual flow screens do not rotate over into the downstream flow of screened water, and all flow

must pass through the screen before entering the screenwell and plant cooling systems, the potential for debris carryover is eliminated.

### 8.3 Engineering Response

During preparation of the 2008 response, EIMCO Water Technologies (EIMCO), a leading manufacturer of water screening technologies and devices, was contacted. Site specific conditions, constraints, and dimensions related to Schiller Station were communicated to EIMCO. EIMCO provided a budget proposal based on this information, which was used as one of the bases for the 2008 response.

As discussed above in Section 8.2, the through screen velocity is reduced in a dual flow screen because of the increased screening area. However, dual flow screens create higher flow velocities as the flow approaches the screen. Because of the plate and gull wings that are installed to divert the flow to either side of the dual flow screen, there is less flow area in the region after the flow splits. This creates higher approach velocities as the flow passes around the plate and turns in towards the screening surface. Note that the plate is necessary to prevent unscreened flow from passing through the middle of the screen, and the gull wings are necessary to direct the flow towards the screening surface.

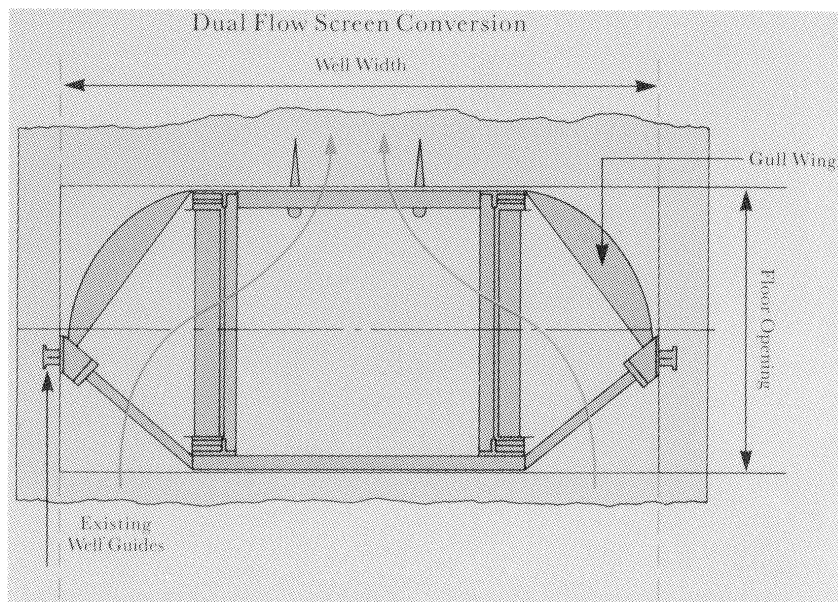


Figure 1: Illustration of Dual Flow Screen [Ref. 9.11]

These components cause the approach velocity (defined here as the flow velocity just before the flow enters the screen) to be considerably higher than the through screen velocity. For a through flow screen, the approach velocity is typically slightly less than the through screen velocity due to the reduction in open area within the screen, and lack of other flow restrictions in front of the screen such as a plate. In the budgetary proposal, EIMCO stated that the through screen velocity for the dual flow screen would be 0.5 feet per second, but also that the velocity through the side entrance openings would be 1.27 feet per second [Ref. 9.9].

In EPA's "Proposed Regulations to Establish Requirements for Cooling Water Intake Structures at Existing Facilities – Fact Sheet," EPA describes the proposed regulation as it would apply to Schiller Station [Ref. 9.7]:

*First, existing facilities . . . would determine which technology would be best suited to meeting this limit. Alternately, the facility could reduce their intake velocity to 0.5 feet per second. At this rate, most of the fish can swim away from the cooling water intake of the facility.*

Installation of dual flow screens would reduce the through screen velocity to 0.5 feet per second, as noted above in the EIMCO proposal. Per EPA's statement in Reference 9.7, most fish would be able to swim away from the screen. However, the approach velocity around the plate and through the side entrance openings would be 1.27 feet per second [Ref. 9.9]. This exceeds the 0.5 feet per second criterion stated by EPA above, and could prevent some fish from swimming away [Ref. 9.7]. Therefore, fish entering into the region between the plate and screens might not be able to swim away and could become trapped and possibly impinged.

To reduce this velocity, the available space on either side of the wall plate would need to be increased. For Screen House #2, which was used as input to EIMCO, the intake channel width is 6' – 8" [Ref. 9.8]. Because the overall dual flow screen breadth would be 3' – 11" [Ref. 9.9], clearances of approximately 1' – 4 ½" remain on either side of the plate through which flow can pass. In order to reduce the side entrance velocity from 1.27 feet per second to 0.5 feet per second, this gap would need to be increased from 1' – 4 ½" to approximately 3' – 6" on either side. If this were to be achieved by widening the intake channel, the channel would need to be widened from 6' – 8" to approximately 10' – 11", an increase of 4' – 3" in width. From drawings of this Screen House [Ref. 9.10], the thickness of concrete separating each of the intake channels at water elevation ranges from 3 – 4 feet. Expanding the intake channel to achieve a side entrance velocity of 0.5 feet per second around the dual flow screens requires more space than is available and therefore is not feasible. Expanding the depth of the intake channel to achieve this velocity is also infeasible, given that the depth would have to increase by a factor of approximately 2.5.

## 9 References

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- 9.5 Public Service Company of New Hampshire, Drawing R-6521-35-1, Rev. 0, Sht. 2, “Plan – Unit 4 Screenwash Discharge Chute, Schiller Station Portsmouth, NH.”
- 9.6 Public Service Company of New Hampshire, Drawing PP021501, Rev. 05, “Integrated Contingency Plan – Site Plan and Storage Locations, Schiller Station Portsmouth, NH.”
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- 9.8 Public Service Company of New Hampshire, Drawing 55600-B-5, Rev. 0, “Screenwell Substructure – Completion – Unit No. 6.”
- 9.9 EIMCO Budget Proposal BP08-128 for Fish Handling Dual Flow Conversion Screens. Dated July 23, 2008.
- 9.10 Public Service Company of New Hampshire, Drawing 175-B-6, Rev. 04, “Screen Well Substructure Sections – Sheet 2.”
- 9.11 Pankratz, Tom, P, Screening Equipment Handbook, Technomic Publishing Company, Inc, Copyright 1995.