Determination of Technology-Based Effluent Limits for the Flue Gas Desulfurization Wastewater at Merrimack Station in Bow, New Hampshire

EPA - Region 1
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The analysis presented in this document was developed by the Environmental Protection Agency (EPA) – Region 1 in support of the reissuance of a National Pollutant Discharge Elimination Systems (NPDES) permit for Merrimack Station (Permit No. NH0001465). EPA is the permitting authority in this case, since the NPDES program has not been delegated to the state of New Hampshire.

1.0 Background

1.1 Merrimack Station's FGD System

Merrimack Station, owned and operated by Public Service of New Hampshire (referred to hereafter as PSNH or the Permittee), consists of two coal fired, steam electric generating units. The coal combustion process generates a variety of air pollutants that are emitted from the facility's smoke stacks. Currently, the flue gas from each of these two units passes through air pollution control equipment that includes selective catalytic reduction systems to reduce nitrogen oxides emissions and two electrostatic precipitators to reduce particulate matter emissions.

In 2006, the New Hampshire legislature enacted RSA 125-0:11-18, which requires PSNH to install and operate a wet flue gas desulfurization (FGD) system at Merrimack Station to reduce air emissions of mercury and other pollutants.[1] RSA 125-O:11(I), (II) and (III); RSA 125-O:12(V); RSA 125-O:13(I) and (II). The state law calls for the facility to, among other things, reduce mercury emissions by at least 80 percent. RSA 125-O:11(I) and (III); 125-O:13(I) and (II). *But see also* RSA 125-O:13(V), (VII) and (VIII); RSA 125-O:17(II) (variances).

PSNH is required to have the FGD system fully operational by July 1, 2013, "*contingent upon obtaining all necessary permits and approvals* from federal, state, and local regulatory agencies and bodies." RSA 125-O:13(I) (emphasis added). *But see also* RSA 125-O:17(I) (variances). With regard to such permits and approvals, the statute requires PSNH to "make appropriate initial filings with the [New Hampshire] department [of environmental services] … within one year of the effective date of this section, and with any other applicable regulatory agency or body in a timely manner." RSA 125-O:13(I). The legislation also expresses the state's desire to realize the air quality benefits of an FGD system at Merrimack Station sooner than the July 2013 date to the extent practicable, and it creates incentives to encourage Merrimack Station to better that date. RSA 125-O:11(IV); RSA 125-O:13(III); RSA 125-O:16.

The New Hampshire statute expressly requires PSNH to install a "wet" FGD

[1] Title X Public Health Chapter 125-O Multiple Pollutant Reduction Program, sections 125-O:11 through 18. *See* http://www.gencourt.state.nh.us/rsa/html/x/125-o/125-o-mrg.htm

system at Merrimack Station. According to the statute, the New Hampshire Department of Environmental Services (NHDES) "determined that the best known commercially available technology [for reducing the facility's air emissions] is a wet flue gas desulphurization (sic) system, hereafter 'scrubber technology,' as it best balances the procurement, installation, operation, and plant efficiency costs with the projected reductions in mercury and other pollutants from the flue gas streams of Merrimack Units 1 and 2." RSA 125-O:11(II).

While wet FGD scrubbers are one of the available means of reducing air pollutant emissions from coal-burning power plants like Merrimack Station, the contaminants removed from the flue gas become part of a wastewater stream from the scrubbers. "In wet FGD scrubbers, the flue gas stream comes in contact with a liquid stream containing a sorbent, which is used to effect the mass transfer of pollutants from the flue gas to the liquid stream." EPA, Steam Electric Power Generating Point Source Category: Detailed Study Report, EPA 821-R-09-008, October 2009, p. 3-16 (hereinafter "EPA's 2009 Detailed Study Report"). In other words, the wet FGD system generates a wastewater purge stream containing the pollutants removed from the flue gas, thus, exchanging air pollution for water pollution.

PSNH is installing a limestone forced oxidation scrubber system and intends to produce a saleable gypsum byproduct (e.g., wallboard). While this will reduce the quantity of solid waste requiring disposal, the gypsum cake typically must be rinsed to reduce the level of chlorides in the final product. This generates additional wastewater requiring treatment prior to reuse or discharge.

1.2 Wastewater from FGD Systems

Coal combustion generates a host of air pollutants which enter the flue gas stream and are emitted to the air unless an air emissions control system is put in place. The wet FGD scrubber system works by contacting the flue gas stream with a liquid slurry stream containing a sorbent (typically lime or limestone). The contact between the streams allows for a mass transfer of contaminants from the flue gas stream to the slurry stream.

Coal combustion generates acidic gases, such as sulfate, which become part of the flue gas stream. Not only will the liquid slurry absorb sulfur dioxide and other sulfur compounds from the flue gas, but it will also absorb other contaminants from the flue gas, including particulates, chlorides, volatile metals - including arsenic (a metalloid), mercury, selenium, boron, cadmium, and zinc – total dissolved solids (TDS), nitrogen compounds and organics. Furthermore, the liquid slurry will also readily absorb hydrochloric acid, which is formed as a result of chlorides in the coal. The limestone in the slurry also contributes iron and aluminum (from clay minerals) to the FGD wastewater. The chloride concentration and clay inert fines of the FGD slurry must be controlled through a routine wastewater purge to minimize corrosion of the absorber vessel materials. Depending upon the pollutant, the type of solids separation process and the solids dewatering process used, the pollutants may partition to either the solid phase (i.e., FGD solids) or the aqueous phase.

Many of the pollutants found in FGD wastewater can cause serious environmental harm and present potential human health risks. These pollutants can occur in quantities (i.e., total mass released) and/or concentrations that cause or contribute to in-stream excursions of EPA-recommended water quality criteria for the protection of aquatic life and/or human health. In addition, some pollutants in the FGD wastewater present a particular ecological threat due to their tendency to persist in the environment and bioaccumulate in organisms. For example, arsenic, mercury and selenium readily bioaccumulate in exposed biota.

1.3 NPDES Permitting of FGD Wastewater Discharges

Polluted wastewater from FGD scrubber systems cannot be discharged to waters of the United States, such as the Merrimack River, unless in compliance with the requirements of the federal Clean Water Act, 33 U.S.C. §§ 1251 *et seq.* (CWA), and applicable state laws. More specifically, any such discharges must comply with the requirements of a NPDES permit.

As will be discussed in detail below, discharges of wastewater from a FGD scrubber system to a water of the United States must satisfy federal technology-based treatment requirements as well as any more stringent state water quality-based requirements that may apply. While EPA has promulgated National Effluent Limitation Guidelines (NELGs) which set technology-based limits for the discharge of certain pollutants by facilities in the Steam Electric Power Generating Point Source Category, *see* 40 C.F.R. Part 423, these NELGs do not yet include best available technology (BAT) limits for wastewater from FGD systems. In the absence of national standards for FGD wastewater, technology-based limits are developed by EPA (or state permitting authorities administering the NPDES permit program) on a Best Professional Judgment (BPJ), case-by-case basis. *See generally* 40 C.F.R. § 125.3.

During October 2009, EPA completed a national study of wastewater discharges from the steam electric power generating industry. *See* EPA's 2009 Detailed Study Report. Based on this study, among other things, EPA decided to work toward developing NELGs to address a variety of wastewater streams and pollutants discharged by this industry but not yet addressed by the existing NELGs. The wastewater from wet FGD scrubbers was identified as one of the waste streams to be addressed by the new standards. EPA has indicated that it currently expects to complete the rulemaking process and promulgate revised NELGs by early 2014.

In a letter dated June 7, 2010, EPA's Office of Wastewater Management provided EPA and state permitting authorities information about establishing technology-based NPDES permit limits for discharges from FGD wastewater treatment systems (WWTSs) at steam electric power plants between now and the effective date of the revised NELGs. This letter underscores the CWA's requirement that until NELG's for FGD WWTS discharges become effective, technology-based effluent limits for such discharges will continue to be based on BPJ.

1.4 NPDES Permitting Process for FGD Wastewater Discharges at Merrimack Station

In response to the 2006 state legislation requiring use of a wet FGD scrubber system at Merrimack Station, PSNH contracted with Siemens Water Technologies (Siemens) to design and construct a WWTS for the FGD wastewater. The company received additional engineering/design support from URS Corporation. PSNH's plan ultimately called for the treated wastewater to be discharged to the Merrimack River.

In 2009, PSNH began work on an antidegradation analysis, under the direction of NHDES, to determine whether the new discharges would satisfy state water quality standards. *See* Merrimack Station Fact Sheet, section 5.6.3.1 and NHDES draft antidegradation review document. Based on the requirements of Env-Wq 1708, NHDES required PSNH to perform sampling and analysis of a number of pollutants of concern. These analyses led to the development of certain water quality-based effluent limits, as discussed in greater detail in the Fact Sheet. *Id.*

It was not until May 5, 2010, that PSNH submitted to EPA an addendum to its previously filed NPDES permit application for Merrimack Station in order to identify the company's plan for discharging treated FGD effluent to the Merrimack River. New pollutant discharges to waters of the United States, such as PSNH's proposed discharges of FGD wastewater to the Merrimack River, are prohibited unless and until authorized by a new NPDES permit. Therefore, in response to PSNH's new plan, EPA must determine both the technology-based and, coordinating with NHDES, the water quality-based effluent limits that would apply to the new discharge.

Unfortunately, the permit application addendum submitted by PSNH did not provide all the information necessary to enable EPA to determine the applicable technology-based and water quality-based requirements for the FGD wastewater. Therefore, EPA began coordinating with NHDES on the water quality standards analysis. Furthermore, EPA informally suggested to PSNH that it might wish to submit its own evaluation of whether its proposed discharge would satisfy applicable technology-based requirements. In response, PSNH submitted a document dated October 8, 2010, and entitled, "Public Service of New Hampshire, Merrimack Station, Bow, New Hampshire, Response to Informal EPA Request for Supplemental Information about Planned State-of-the-Art Flue Gas Desulfurization ("FGD") Wastewater Treatment System" (hereinafter "PSNH's October 2010 Report"). In response to this submission, EPA sent PSNH a letter with a number of follow-up questions. The company responded with a letter dated December 3, 2010, with the heading, "Public Service of New Hampshire, Merrimack Station, Bow, New Hampshire, NPDES Permit No. NH0001465 Response to Information Request about Planned State-of-the-Art Flue Gas Desulfurization Wastewater Treatment System" (hereinafter "PSNH's December 2010 Report").

The information submitted (thus far) indicates that PSNH, at the recommendation of Siemens, has selected a physical/chemical treatment system for the FGD purge stream. Generally, a physical/chemical WWTS consists of chemical precipitation, coagulation/flocculation, clarification, filtration and sludge dewatering. The new WWTS at Merrimack Station will be supplemented with proprietary adsorbent media (or "polishing step") for further removal of mercury from the effluent. As of September 2011, construction of the FGD system and its WWTS is almost complete. PSNH is currently performing pre-operational testing of the various components of the FGD system.

PSNH designed, financed and, for the most part, constructed the Merrimack Station FGD WWTS system without first discussing with EPA whether this WWTS would satisfy technology-based and water quality-based standards. To be sure, PSNH was not required by regulation either to consult with EPA or to gain EPA approval before constructing a WWTS for the FGD scrubber system at Merrimack Station. By the same token, however, EPA is not required to determine that the new WWTS satisfies the applicable CWA requirements because PSNH has already built it. Rather, EPA must set discharge limits based on the applicable requirements of federal and state law and Merrimack Station will have to meet them. EPA's determination of the appropriate effluent limitations for the FGD wastewater is set forth below.

2.0 Legal Requirements and Context

2.1 Setting Effluent Discharge Limits

As the United States Supreme Court has explained:

> [t]he Federal Water Pollution Control Act, commonly known as the Clean Water Act, 86 Stat. 816, as amended, 33 U.S.C. § 1251 et seq., is a comprehensive water quality statute designed to "restore and maintain the chemical, physical, and biological integrity of the

> Nation's waters." § 1251(a). The Act also seeks to attain "water quality which provides for the protection and propagation of fish, shellfish, and wildlife." § 1251(a)(2).

PUD No. 1 of Jefferson County v. Washington Dept. of Ecology, 511 U.S. 700, 704 (1994). The CWA should be construed and interpreted with these overarching statutory purposes in mind. To accomplish these purposes, the CWA prohibits point source discharges of pollutants to waters of the United States unless authorized by a NPDES permit (or a specific provision of the statute). The NPDES permit is the mechanism used to implement NELGs, state water quality standards, and monitoring and reporting requirements on a facility-specific basis. When developing pollutant discharge limits for a NPDES permit, the CWA directs permit writers to impose limits based on (a) specified levels of pollution reduction technology (technology-based limits), and (b) any more stringent requirements needed to satisfy state water quality standards (water quality-based limits).

2.2 Technology-Based Discharge Limits

The CWA requires all discharges of pollutants to meet, at a minimum, applicable technology-based requirements. The statute creates several different narrative technology standards, each of which applies to a different type of pollutant or class of facility. EPA develops NELGs based on the application of these technology standards to entire industrial categories or sub-categories.

Although technology-based effluent limitations are based on the pollution reduction capabilities of particular wastewater treatment technologies or operational practices, the CWA does not dictate that the dischargers subject to the limitations must use the particular technologies or practices identified by EPA. Rather, dischargers are permitted to use any lawful means of meeting the limits. In this way, the CWA allows facilities to develop different, and potentially innovative, approaches to satisfying applicable technology-based requirements.[2]

As befits the "technology-forcing" scheme of the CWA, Congress provided for the statute's technology-based requirements to become increasingly stringent over time. Of relevance here, industrial dischargers were required by March 31, 1989, to comply with effluent limits for toxic and non-conventional pollutants that reflect the best available technology economically achievable ("BAT").[3] *See* 33 U.S.C. §§

[2] Water quality-based requirements are not based on particular technologies or practices. Thus, they also leave room for different approaches to complying with permit limits.

[3] In addition, CWA § 301(b)(1)(A) requires industrial dischargers, by July 1, 1977, to have satisfied limits based on the application of the best practicable control technology currently available (BPT). *See* 33 U.S.C. §1311(b)(1)(A). *See also* 40 C.F.R. § 125.3(a)(2)(i). Furthermore, CWA § 306, 33 U.S.C. § 1316, requires new sources to meet performance standards based on the best available demonstrated control technology (BADT).

1311(b)(2)(A) and (F); 40 C.F.R. § 125.3(a)(2)(iii) – (v). Of further relevance, industrial dischargers are also required by the same date to meet limits for conventional pollutants based on the best conventional pollutant control technology ("BCT"). *See* 33 U.S.C. §1311 (b)(2)(E); 40 C.F.R. § 125.3(a)(2)(ii). The BAT and BCT standards are discussed in more detail below.

2.3 Setting Technology-Based Limits on a BPJ Basis

As mentioned above, EPA has developed NELGs for certain pollutants discharged by facilities within the steam-electric power generating point source category – an industrial category that includes Merrimack Station – but has not promulgated BAT or BCT NELGs for FGD scrubber system wastewater. *See* 40 C.F.R. Part 423. As a result, EPA (or a state permitting authority, as appropriate) must develop technology-based limits for Merrimack Station's FGD wastewater on a case-by-case, BPJ basis pursuant to CWA § 402(a)(1)(B), 33 U.S.C. § 1342(a)(1)(B), and 40 C.F.R. § 125.3(c)(2) and (3).

When developing technology-based limits using BPJ under CWA § 402(a)(1), the permit writer considers a number of factors that are spelled out in the statute and regulations. The BAT factors are set forth in CWA § 304(b)(2)(B) and 40 C.F.R. § 125.3(d)(3), while the BCT factors are set forth in CWA § 304(b)(4)(B) and 40 C.F.R. § 125.3(d)(2). The regulations reiterate the statutory factors, *see* 40 C.F.R. § 125.3(d), and also specify that permit writers must consider the "appropriate technology for the category of point sources of which the applicant is a member, based on all available information," as well as "any unique factors relating to the applicant." 40 C.F.R. § 125.3(c)(2).

As one court has explained, BPJ limits represent case-specific determinations of the appropriate technology-based limits for a particular point source. *Natural Resources Defense Council v. U.S. Envtl. Prot. Agency*, 859 F.2d 156, 199 (D.C. Cir. 1988). The court expounded as follows:

> [i]n what EPA characterizes as a "mini-guideline" process, the permit writer, after full consideration of the factors set forth in section 304(b), 33 U.S.C. § 1314(b), (which are the same factors used in establishing effluent guidelines), establishes the permit conditions "necessary to carry out the provisions of [the CWA]." § 1342(a)(1). These conditions include the appropriate . . . [technology-based] effluent limitations for the particular point source. . . . [T]he resultant BPJ limitations are as correct and as statutorily supported as permit limits based upon an effluent limitations guideline.

Id. See also Texas Oil & Gas Ass'n v. U.S. Envtl. Prot. Agency, 161 F.3d 923, 929 (5th Cir. 1998) ("Individual judgments thus take the place of uniform national guidelines, but the technology-based standard remains the same"). EPA's "Permit Writers' Manual" instructs permit writers that they can derive BPJ-based limits after considering a variety of sources (e.g., other NPDES permits; effluent guidelines development and planning information). *See Permit Writers' Manual* at section 5.2.3.3 (September 2010).

2.4 The BAT Standard

The BAT standard is set forth in CWA § 301(b)(2)(A), 33 U.S.C. § 1311(b)(2)(A), and applies to many of the pollutants in Merrimack Station's FGD wastewater, which include both toxics (e.g., mercury, arsenic, selenium) and non-conventional pollutants (e.g., nitrogen). *See* 33 U.S.C. § 1311(b)(2)(A) & (F); 40 C.F.R. §§ 125.3(a)(2)(iii) – (v). *See also* 33 U.S.C. § 1314(b)(2). The BAT standard requires achievement of:

> effluent limitations . . . which . . . shall require application of *the best available technology economically achievable . . ., which will result in reasonable further progress toward the national goal of eliminating the discharge of all pollutants*, as determined in accordance with regulations issued by the [EPA] Administrator pursuant to section 1314(b)(2) of this title, which such effluent limitations shall require the elimination of discharges of all pollutants if the Administrator finds, on the basis of information available to him . . . that such elimination is technologically and economically achievable . . . as determined in accordance with regulations issued by the [EPA] Administrator pursuant to section 1314(b)(2) of this title . . ..

33 U.S.C. § 1311(b)(2)(A) (emphasis added). In other words, EPA must set effluent discharge limits corresponding to the use of the best pollution control technologies that are technologically and economically achievable and will result in reasonable progress toward eliminating discharges of the pollutant(s) in question. In a given case, this might or might not result in limits prohibiting the discharge of certain pollutants.

According to the CWA's legislative history, the starting point for identifying the "best available technology" refers to the "single best performing plant in an industrial field" in terms of its capacity to reduce pollutant discharges. *Chemical Manufacturers. Ass'n v. U.S. Envtl. Prot. Agency*, 870 F.2d 177, 239 (5th Cir. 1989) (*citing* Congressional Research Service, *A Legislative History of the Water Pollution Control Act Amendments of 1972* at 170 (1973) (hereinafter "1972 Legislative History") at 170).[4] Thus, EPA need not set BAT limits at levels that are being met

[4] *See also Texas Oil*, 161 F.3d at 928, *quoting Chemical Manufacturers.*, 870 F.2d at 226; *Kennecott v. U.S. Envtl. Prot. Agency*, 780 F.2d 445, 448 (4th Cir. 1985) ("In setting BAT, EPA uses not the average plant, but the optimally operating plant, the pilot plant which acts as a beacon to

by most or all the dischargers in a particular point source category, as long as at least one demonstrates that the limits are achievable. *Id.* at 239, 240. This comports with Congressional intent that EPA "use the latest scientific research and technology in setting effluent limits, pushing industries toward the goal of zero discharge as quickly as possible." *Kennecott*, 780 F.2d 445, 448 (4th Cir. 1984), *citing* 1972 Legislative History at 798. *See also Natural Resources Defense Council*, 863 F.2d at 1431 ("The BAT standard must establish effluent limitations that utilize the latest technology."). While EPA must consider the degree of pollutant reduction achieved by the available technological alternatives, the Agency is not required to consider the extent of water quality improvement that will result from such reduction.[5]

Available technologies may also include viable "transfer technologies" – that is, a technology from another industry that could be transferred to the industry in question – as well as technologies that have been shown to be viable in research even if not yet implemented at a full-scale facility.[6] When EPA bases BAT limits on such "model" technologies, it is not required to "consider the temporal availability of the model technology to individual plants," because the BAT factors do not include consideration of an individual plant's lead time for obtaining and installing a technology. *See Chemical Manufacturers*, 870 F.2d at 243; *American Meat Inst. v. U.S. Envtl. Prot. Agency*, 526 F.2d 442, 451 (7th Cir. 1975).

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show what is possible."); *American Meat*, 526 F.2d at 463 (BAT "should, at a minimum, be established with reference to the best performer in any industrial category"). According to one court:

> [t]he legislative history of the 1983 regulations indicates that regulations establishing BATEA [i.e., best available technology economically achievable, or BAT] can be based on statistics from a single plant. The House Report states:
>
>> It will be sufficient for the purposes of setting the level of control under available technology, that there be one operating facility which demonstrates that the level can be achieved or that there is sufficient information and data from a relevant pilot plant or semi-works plant to provide the needed economic and technical justification for such new source.

Ass'n of Pacific Fisheries v. U.S. Envtl. Prot. Agency, 615 F.2d 794, 816-17 (9th Cir. 1980) (*quoting* 1972 Legislative History at 170).

[5] *See, e.g.*, *American Petroleum*, 858 F.2d at 265–66 ("Because the basic requirement for BAT effluent limitations is only that they be technologically and economically achievable, the impact of a particular discharge upon the receiving water is not an issue to be considered in setting technology-based limitations.").

[6] These determinations, arising out of the CWA's legislative history, have repeatedly been upheld by the courts. *E.g., American Petroleum Inst. v. U.S. Envtl. Prot. Agency*, 858 F.2d 261, 264–65 (5th Cir. 1988); *Pacific Fisheries*, 615 F.2d at 816–17; *BASF Wyandotte Corp. v. Costle*, 614 F.2d 21, 22 (1st Cir. 1980); *American Iron*, 526 F.2d at 1061; *American Meat*, 526 F.2d at 462.

While EPA must articulate the reasons for its determination that the technology it has identified as BAT is technologically achievable, courts have construed the CWA not to require EPA to identify the precise technology or technologies a plant must install to meet BAT limits. *See Chemical Manufacturers.*, 870 F.2d at 241. The Agency must, however, demonstrate at least that the technology used to estimate BAT limits and costs is a "reasonable approximation of the type and cost of technology that must be used to meet the limitations." *Id.* It may do this by several methods, including by relying on a study that demonstrates the effectiveness of the required technology. *BP Exploration & Oil, Inc. v. U.S. Envtl. Prot. Agency*, 66 F.3d 784, 794 (6th Cir. 1995) (upholding BAT limits because EPA relied on "empirical data" presented in studies demonstrating that improved gas flotation is effective for removing dissolved as well as dispersed oil from produced water). S*ee also Ass'n of Pacific Fisheries v. U.S. Envtl. Prot. Agency*, 615 F.2d 794, 819 (9th Cir. 1980) (regulations remanded because the BAT limit was based on a study that did not demonstrate the effectiveness of the technology selected as BAT).

Beyond looking at the best performing pollution reduction technologies, the statute also specifies the following factors that EPA must "take into account" in determining the BAT:

> . . . the age of equipment and facilities involved, the process employed, the engineering aspects of the application of various types of control techniques, process changes, the cost of achieving such effluent reduction, non-water quality environmental impact (including energy requirements), and such other factors as the Administrator deems appropriate.

33 U.S.C. § 1314(b)(2)(B). *See also* 40 C.F.R. § 125.3(d)(3). As elucidated by the case law, the statute sets up a loose framework for EPA's taking account of these factors in setting BAT limits. As one court explained:

> [i]n enacting the CWA, 'Congress did not mandate any particular structure or weight for the many consideration factors. Rather, it left EPA with discretion to decide how to account for the consideration factors, and how much weight to give each factor.'

BP Exploration, 66 F.3d at 796, *citing Weyerhauser v. Costle*, 590 F.2d 1011, 1045 (D.C. Cir. 1978) (citing Senator Muskie's remarks about CWA § 304(b)(1) during debate). Comparison between the factors is not required, merely their consideration. *Weyerhauser*, 590 F.2d at 1045 (explaining that CWA § 304(b)(2) lists factors for EPA "consideration" in setting BAT limits, in contrast to § 304(b)(1)'s requirement that EPA *compare* "total cost versus effluent reduction benefits" in setting *BPT* limits).[7]

Ultimately, when setting BAT limits, EPA is governed by a standard of reasonableness in its consideration of the required factors. *BP Exploration*, 66 F.3d at 796, *citing American Iron & Steel Inst. v. Envtl. Prot. Agency*, 526 F.2d 1027, 1051 (3d Cir. 1975), *modified in other part*, 560 F.2d 589 (3d Cir. 1977), *cert. denied*, 435 U.S. 914 (1978). Each factor must be considered, but the Agency has "considerable discretion in evaluating the relevant factors and determining the weight to be accorded to each in reaching its ultimate BAT determination." *Texas Oil*, 161 F.3d at 928, *citing Natural Resources Defense Council*, 863 F.2d at 1426. *See also Weyerhauser*, 590 F.2d at 1045 (stating that in assessing BAT factors, "[s]o long as EPA pays some attention to the congressionally specified factors, [CWA § 304(b)(2),] on its face lets EPA relate the various factors as it deems necessary"). One court succinctly summarized the standard for reviewing EPA's consideration of the BAT factors in setting limits as follows: "[s]o long as the required technology reduces the discharge of pollutants, our inquiry will be limited to whether the Agency considered the cost of technology, along with other statutory factors, and whether its conclusion is reasonable." *Pacific Fisheries*, 615 F.2d at 818. *See also Chemical Manufacturers*, 870 F.2d at 250 n. 320 (*citing* 1972 Legislative History (in determining BAT, "'[t]he Administrator will be bound by a test of reasonableness.'")).

The BAT Factors

As detailed above, the CWA requires EPA to consider a number of factors in developing BAT limits. Certain of these factors relate to technological concerns related to the industry and treatment technology in question. For example, EPA takes into account (1) the engineering aspects of the application of various types of control techniques, (2) the process or processes employed by the point source category (or individual discharger) for which the BAT limits are being developed, (3) process changes that might be necessitated by using new technology, and (4) the extent to which the age of equipment and facilities involved might affect the introduction of new technology, its cost and its performance.

EPA also considers the cost of implementing a treatment technology when determining BAT. CWA §§ 301(b)(2) and 304(b)(2) require "EPA to set discharge limits reflecting the amount of pollutant that would be discharged by a point source employing the best available technology that the EPA determines to be *economically feasible* . . .." *Texas Oil*, 161 F.3d at 928 (emphasis added). *See also* 33 U.S.C. §§ 1311(b)(2) and 1314(b)(2) (when determining BAT, EPA must consider the "cost of

[7] *See also U.S. Envtl. Prot. Agency v. Nat'l Crushed Stone Ass'n*, 449 U.S. 64, 74 (1980) (noting that "[s]imilar directions [as those for setting BPT limits] are given the Administrator for determining effluent reductions attainable from the BAT except that in assessing BAT total cost is no longer to be considered in comparison to effluent reduction benefits").

achieving such effluent reduction"); 40 C.F.R. § 125.3(d)(3) (same). The United States Supreme Court has stated that treatment technology that satisfies the CWA's BAT standard must "represent 'a commitment of the maximum resources economically possible to the ultimate goal of eliminating all polluting discharges." *EPA v. Nat'l Crushed Stone Ass'n*, 449 U.S. 64, 74 (1980). *See also BP Exploration*, 66 F.3d at 790 ("BAT represents, at a minimum, the best economically achievable performance in the industrial category or subcategory."), *citing NRDC v. EPA*, 863 F.2d 1420, 1426 (9th Cir. 1988).

The Act gives EPA "considerable discretion" in determining what is economically achievable. *Natural Resources Defense Council*, 863 F.2d at 1426, *citing American Iron*, 526 F.2d at 1052. It does not require a precise calculation of the costs of complying with BAT limits.[8] EPA "need make only a reasonable cost estimate in setting BAT," meaning that it must "develop no more than a rough idea of the costs the industry would incur." *Id. See also Rybachek v. U.S. Envtl. Prot. Agency*, 904 F.2d 1276, 1290–91 (9th Cir. 1990); *Chemical Manufacturers.*, 870 F.2d at 237–38.

Moreover, CWA § 301(b)(2) does not specify any particular method of evaluating the cost of compliance with BAT limits or state how those costs should be considered in relation to the other BAT factors; it only directs EPA to consider whether the costs associated with pollutant discharge reduction are "economically achievable." *Chemical Manufacturers.*, 870 F.2d at 250, *citing* 33 U.S.C. § 1311(b)(2)(A). Similarly, CWA § 304(b)(2)(B) requires only that EPA "take into account" cost along with the other BAT factors. *See Pacific Fisheries*, 615 F.2d at 818 (in setting BAT limits, "the EPA must 'take into account . . . the cost of achieving such effluent reduction,' along with various other factors"), *citing* CWA § 304(b)(2)(B).

In the context of considering cost, EPA may also consider the relative "cost-effectiveness" of the available technology options. The term "cost-effectiveness" is used in multiple ways. From one perspective, the most cost-effective option is the least expensive way of getting to the same (or nearly the same) performance goal. From another perspective, cost-effectiveness refers to a comparative assessment of the cost per unit of performance by different options. In its discretion, EPA might decide that either or both of these approaches to cost-effectiveness analysis would be useful in determining the BAT in a particular case. Alternatively, EPA might reasonably decide that neither was useful. For example, the former approach would not be helpful in a case in which only one technology even comes close to reaching a particular performance goal. Moreover, the latter approach would not be helpful where a meaningful cost-per-unit-of-performance metric cannot be developed, or

[8] In *BP Exploration*, the court stated that, "[a]ccording to EPA, the CWA not only gives the agency broad discretion in determining BAT, the Act merely requires the agency to consider whether the cost of the technology is reasonable. EPA is correct that the CWA does not require a precise calculation of BAT costs." 66 F.3d at 803, *citing Natural Resources Defense Council*, 863 F.2d at 1426.

where there are wide disparities in the performance of alternative technologies and those with lower costs-per-unit-of-performance fail to reach some threshold of necessary performance. The courts, including the United States Supreme Court, have consistently read the statute and its legislative history to indicate that while Congress intended EPA to consider cost in setting BAT limits, it did not require the Agency to perform some type of cost-benefit balancing.[9]

Finally, in determining the BAT, EPA also considers the non-water quality environmental effects (and energy effects) of using the technologies in question. *See* 33 U.S.C. § 1314(b)(2)(B); 40 C.F.R. § 125.3(d)(3). Again, the CWA gives EPA broad discretion in deciding how to evaluate these non-water quality effects and weigh them against the other BAT factors. *Rybachek*, 904 F.2d at 1297, *citing Weyerhauser*, 590 F.2d at 1049–53. In addition, the statute authorizes EPA to consider any other factors that it deems appropriate. 33 U.S.C. § 1314(b)(2)(B).

2.5 The BCT Standard

Discharges of conventional pollutants by existing sources are subject to effluent limitations based on the "best conventional pollutant control technology" (BCT). 33 U.S.C. §§ 1311(b)(2)(E) and 1314(b)(4)(A); 40 C.F.R. § 125.3(a)(2)(ii). *See also* 33 U.S.C. § 1314(a)(4) and 40 C.F.R. § 401.16 (conventional pollutants include biochemical oxygen demand (BOD), total suspended solids (TSS) (nonfilterable), pH, fecal coliform and oil and grease). BCT is the next step above BPT for conventional pollutants. As a result, effluent limitations based on BCT may not be less stringent than limitations based on BPT would be. In other words, BPT effluent limitation guidelines set the "floor" for BCT effluent limitations.

EPA is discussing the BCT standard here because of the possibility that Merrimack Station's FGD wastewater could include elevated BOD levels and non-neutral pH. These are conventional pollutants subject to the BCT standard. As explained above, any BCT limits for these pollutants would need to be determined based on a BPJ basis because EPA has not promulgated BCT NELGs for FGD wastewater. The factors to be considered in setting BCT limits are specified in the Clean Water Act and EPA regulations. *See* 33 U.S.C. § 1314(b)(4)(B); 40 C.F.R. § 125.3(d)(2).

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[9] *E.g., Nat'l Crushed Stone*, 449 U.S. at 71 ("Similar directions [to those for assessing BPT under CWA § 304(b)(1)(B)] are given the Administrator for determining effluent reductions attainable from the BAT except that in assessing BAT total cost is no longer to be considered in comparison to effluent reduction benefits.") (footnote omitted); *Texas Oil*, 161 F.3d at 936 n.9 (petitioners asked court "to reverse years of precedent and to hold that the clear language of the CWA (specifically, 33 U.S.C. § 1314(b)(2)(B)) requires the EPA to perform a cost-benefit analysis in determining BAT. We find nothing in the language or history of the CWA that compels such a result"); *Reynolds Metals*, 760 F.2d at 565. *Reynolds Metals Co. v. U.S. Environmental Protection Agency*, 760 F.2d 549, 565 (4th Cir. 1985) (in setting BAT limits, "no balancing is required – only that costs be considered along with the other factors discussed previously"), *citing Nat'l Ass'n Metal Finishers v. U.S. Environmental Protection Agency*, 719 F.2d 624, 662–63 (3rd Cir. 1983).

EPA has determined, however, that based on current facts, developing BCT limits for Merrimack Station's Draft Permit would be inappropriate at this time. This decision is discussed further in section 3.5.

3.0 Technological Alternatives Evaluated

PSNH's October 2010 and December 2010 Reports explain why the various FGD wastewater treatment technologies discussed below, except physical/chemical treatment, were not chosen for Merrimack Station. EPA describes PSNH's reasons for rejecting each of these technologies and comments on the company's explanations. The technologies analyzed include:

Discharge to a POTW
Evaporation ponds
Flue gas injection
Fixation
Deep well injection
FGD WWTS effluent reuse/recycle
Settling ponds
Treatment by the existing WWTS
Vapor-compression evaporation
Physical/chemical treatment
Physical/chemical with added biological stage

3.1 Discharge to a POTW

PSNH evaluated discharging Merrimack Station's FGD wastewater to a local publicly owned treatment works (POTW) as a treatment alterative. Specifically, PSNH evaluated "[d]ischarging the FGD Wastewater to the POTW closest to Merrimack Station - the Hall Street Wastewater Treatment Facility in Concord, New Hampshire – [but the company concluded that it would be] … technically infeasible because there currently is no physical connection between the Station and the POTW by which to convey the FGD Wastewater … [and] the POTW is not designed to manage wastewater with the pollutant characterization of the FGD Wastewater." PSNH's October 2010 Report, p. 8.

In EPA's view, it would be unreasonable in this case to require PSNH to install a connection of over five miles to a POTW that might not be capable of treating the FGD system wastewater. Therefore, EPA concurs with PSNH that this option does not represent a long-term BAT option for Merrimack Station.

3.2 Evaporation Ponds

PSNH also evaluated evaporation ponds as a treatment alterative for the FGD wastewater from Merrimack Station but reached the following conclusions:

> [u]sing evaporation ponds at Merrimack Station to treat the FGD Wastewater is technically infeasible because the New Hampshire climate is not sufficiently warm and dry year-round to enable evaporation ponds at the Station to achieve an evaporation rate that would be equal to or greater than the flow of FGD Wastewater …. If PSNH were to rely solely on evaporation ponds to remove FGD-related pollutants from the FGD Wastewater, it would only be able to operate the FGD WWTS - and thus the FGD System - during the summer months.

Id. at 9. EPA concurs with PSNH that use of evaporation ponds, a technology predominantly used in the south and southwest, would be impracticable in New Hampshire's climate. Therefore, EPA does not consider this technology to be a possible BAT at Merrimack Station.

3.3 Flue Gas Injection

PSNH also evaluated the use of flue gas injection as a treatment alternative for the FGD wastewater from Merrimack Station, explaining that "[t]his treatment technology option would involve injecting part or all of the FGD [w]astewater into the Station's flue gas upstream of the electrostatic precipitators ("ESPs") and relying on the hot flue gas to evaporate the liquid component of the FGD [w]astewater and the ESPs to capture the remaining metals and chlorides." *Id.* at 9-10. PSNH rejected this option, however, explaining as follows:

> PSNH is not aware of any flue gas injection system currently in operation at any power plant in the U.S. to treat FGD wastewater. Further, after evaluating this option for use at Merrimack Station, PSNH has concluded that the lack of such systems is due to the numerous technical, operation and maintenance ("O&M") and potential worker safety issues they could pose. First, there is a reasonable risk that the highly corrosive dissolved chlorides remaining after the evaporation of the injected FGD wastewater's liquid component would not be fully captured by the ESPs, with the result that over time, they would concentrate in the FGD system's scrubber and other components, posing a serious risk of equipment corrosion and FGD system failure. This in turn would give rise to burdensome long-term O&M issues and costs that, while potentially manageable in theory, could in fact render operation of the flue gas injection system impracticable. In addition, metals that commingle and become concentrated with fly ash in the boilers and elsewhere could pose a potential health risk to employees.

Id. at 10. EPA agrees with PSNH that this technology has not been demonstrated to be available for treating FGD wastewater and that remaining technical issues would need to be resolved before EPA could consider determining it to be the BAT at Merrimack Station.

3.4 Fixation

PSNH also evaluated the use of "fixation" as a treatment alternative for the FGD wastewater from Merrimack Station. PSNH explained this technology as follows:

> Fixation would involve the mixing of lime, fly ash and FGD Wastewater with the gypsum solids separated from the purged slurry to form a concrete-like substrate. Through the pozzolanic reactions that result, dissolved solids, metals and chlorides in the FGD Wastewater would be bound up in the concrete-like substrate, which would be disposed of by landfilling.
>
> However, fixation generally is not used to manage the gypsum solids by-product generated by forced-oxidation FGD systems like the Station's FGD System, which are designed and operated to "recycle" these solids into wallboard-quality gypsum. Rather, fixation historically has been used to manage the unusable calcium sulfite by-product generated by inhibited oxidation FGD systems and the calcium sulfite/calcium sulfate by-product generated by natural oxidation FGD systems.

Id. Under state law, PSNH is required to install a wet flue gas desulfurization system at Merrimack Station. Further, PSNH concluded that a limestone forced oxidation system is the best technology match for the wet scrubber to be installed at Merrimack Station. PSNH has further commented that fixation "was historically used at plants with natural or inhibited oxidation FGD systems, both of which produce an unusable calcium sulfide byproduct that requires management and disposal." PSNH's December 2010 Report, p. 6. Although the fixation process is viable for the type of FGD system at Merrimack Station (i.e., the FGD gypsum solids could be combined with the FGD wastewater, lime and fly ash to create the pozzolanic solids), the process would render the gypsum solids unmarketable. EPA concurs that fixation does not represent BAT for this facility.

3.5 Deep Well Injection

PSNH evaluated and rejected deep well injection as a treatment alterative for the FGD wastewater from Merrimack Station. The company explained its decision as follows:

> [d]eep well injection is not a viable treatment alternative for the FGD Wastewater for several reasons. First, PSNH does not currently have any

> deep wells at any of its facilities. Second, there would be significant local opposition - from the Town of Bow, residents in the area around Merrimack Station, and interested environmental groups - to its installation of a deep well at Merrimack Station due to potentially adverse drinking water aquifer impacts. Third, we believe it would be difficult to the point of impossible to obtain the necessary state permits, especially in light of the New Hampshire legislature's focus on groundwater quality management and use over the past few years.

Id. at 5. While PSNH's reasoning does not persuade EPA that deep well injection would be infeasible, EPA does for other reasons conclude that this technology is not the BAT for controlling FGD wastewater discharges at Merrimack Station at this time.

Although PSNH correctly points out that Merrimack Station does not currently have a deep injection well, it appears that it would be technologically feasible to install deep well injection equipment at the site. PSNH's additional reasons for rejecting this technology seem largely based on speculation about political reactions to the technology, rather than its technical merits. The question should not turn on speculation about whether local residents, environmental groups or New Hampshire legislators might tend to be opposed to the technology due to the importance of protecting local drinking water aquifers. EPA shares the state and local priority for protecting groundwater quality, but the question should be whether the technology will be environmentally protective and capable of meeting applicable groundwater quality standards. Furthermore, proper use of deep well injection would not be expected to impact local water supplies as, in general, a correctly designed injection well "extends from the surface to below the base of the deepest potable water aquifer, and is cemented along its full length." Herbert, Earle A., "The Regulation of Deep-Well Injection: A Changing Environment Beneath the Surface," Pace Environmental Law Review, Volume 14, Issue 1, *Fall 1996,* Article 16, 9-1-1996, p. 174.[10]

Still, it is unclear whether deep well injection is an available technology for potential use at Merrimack Station. This is because "[u]nderground injection uses porous rock strata, which is commonly found in oil producing states" (*Id*. at 178), but EPA is unaware of data indicating whether or not suitable hydrogeologic conditions exist at Merrimack Station. For this reason, EPA has decided that it cannot currently find deep well injection to be the BAT at Merrimack Station. At the same time, PSNH has not provided sufficient technical information to rule out the possibility that deep well injection could in the future be determined to be the BAT at Merrimack Station. As a result, EPA may revisit this option going forward

[10] Also at http://digitalcommons.pace.edu/pelr/vol14/iss1/16/ or http://digitalcommons.pace.edu/cgi/viewcontent.cgi?article=1375&context=pelr&seiredir=1#search="http://+digitalcommons.pace.edu/pelr/vol14/iss1/16", p.6.

depending on the available information.

3.6 FGD WWTS Effluent Reuse/Recycle

On October 29, 2010, EPA sent PSNH an information request letter under CWA §308(a), in which the Agency specifically requested that PSNH, "[p]lease explain why the wastewater generated from the proposed Merrimack Station FGD WWTS is not being proposed for reuse and or recycle within the Station (e.g., for coal dust suppression or scrubber make-up water)." EPA, "Information Request for NPDES Permit Re-issuance, NPDES Permit No: NH0001465," October 29, 2010, p. 4. The purpose of EPA's request was to garner information to help the Agency decide if recycling some or *all* of the FGD WWTS effluent might be part of the BAT for Merrimack Station.

PSNH responded that it was indeed planning to recycle *some* of the treated effluent from the FGD WWTS to the FGD system. The FGD wet scrubber system's make-up water needs are projected to be approximately 750 gpm (1.08 MGD), while the volume of the FGD WWTS effluent discharge is projected to be substantially less, at 35-50 gpm (0.07 MGD). PSNH plans to discharge the treated FGD wastewater from the FGD WWTS to the slag settling pond, which also receives various other wastewaters from the facility, and then to withdraw water from the slag settling pond for the FGD wet scrubber system's make-up water. Since the FGD WWTS effluent is to be commingled with the slag settling pond water, PSNH concludes that some of the FGD wastewater should be considered to be recycled back to the FGD scrubber system. However, in light of the piping layout shown in the company's site diagram and the volume of the various flows entering and exiting the pond, EPA believes that a *de minimis* amount, if any, of the treated FGD effluent is actually likely to be recycled back to the scrubber from the slag settling pond. Therefore, such recycling/reuse of the FGD wastewater will not be considered part of the BAT for Merrimack Station, at this time.

Aside from stating that some of the FGD effluent would be recycled for scrubber makeup water, PSNH's submissions to EPA fail to address whether or not some or all of the remaining FGD WWTS effluent could also be reused within some aspect of plant operations (e.g., for coal dust suppression). Therefore, PSNH has not provided sufficient technical information to rule out the possibility that additional recycle/reuse could be achievable at Merrimack Station. As a result, EPA may revisit this option in the future depending on the available information.

3.7 Settling Ponds

PSNH evaluated the use of settling ponds as a treatment alterative for the FGD wastewater from Merrimack Station as follows:

> The use of on-site settling ponds dedicated solely to treating the FGD Wastewater is technically infeasible at Merrimack Station because there is not enough usable open space at the Station to construct a settling pond system of adequate dimensions to achieve proper treatment. To be effective, a settling pond must retain wastewater for a sufficient period of time to allow particulates to fall out of suspension before the wastewater is discharged....
>
> In addition, settling ponds are designed to remove suspended particulates from wastewater by means of simple gravity separation, and do not include the process control features that are intrinsic to modern clarifiers, allowing operator control over treatment factors such as settling rate, removal and recirculation.

PSNH's October 2010 Report, p. 8-9. EPA does not necessarily agree that Merrimack Station does not have sufficient area to construct settling ponds. There are areas, such as those on the northern boundary of the Merrimack Station property, or on PSNH owned property across River Road, which might provide sufficient space to build settling ponds.

Treatment by physical/chemical treatment followed by biological treatment, however, is more effective than settling ponds. EPA has explained that its evaluation of the industry indicates that "settling ponds are the most commonly used treatment system for managing FGD wastewater … [and] can be effective at removing suspended solids and those metals present in the particulate phase from FGD wastewater; however, they are not effective at removing dissolved metals." EPA's 2009 Detailed Study Report, p. xii- xiii. As a result, EPA does not consider settling ponds to be the BAT for FGD wastewater at Merrimack Station.

3.8 Treatment by the Existing WWTS

PSNH evaluated the use of Merrimack Station's existing wastewater treatment system (WWTS) as an alternative for treating the FGD wastewater. PSNH's analysis stated as follows:

> Merrimack Station has an existing on-site WWTS that it uses to treat the wastewater streams from its current operations before discharging them, via the Station's treatment pond … This WWTS consists primarily of three large, rectangular concrete settling basins with chemical feed systems and basic mixing capability (using compressed air) … [The existing WWTS] would not provide optimal treatment, especially compared to the significant reductions in FGD-related pollutant concentrations that the FGD WWTS is projected to achieve. The existing WWTS' limitations as a treatment system for the FGD Wastewater stem directly from the fact that the characteristics of the FGD Wastewater and the Station's other wastewaters, and thus

> their respective treatment requirements, are appreciably different.... [the] purpose of the Station's existing WWTS is to remove suspended solids from large batches of Station wastewater. However, the FGD-related pollutants in the FGD Wastewater will be present primarily as dissolved solids … [and the FGD WWTS influent] will have higher concentrations of dissolved metals and chlorides than any of the Station's other wastewaters and will be supersaturated with dissolved gypsum, which the Station's other wastewaters are not. For this reason, effective treatment of the FGD Wastewater will require certain conditioning steps ….. to precipitate and flocculate the dissolved metals and gypsum prior to clarification. These conditioning steps are most favorably performed as they will be in the FGD WWTS: in a continuous, not a batch, process using reaction tanks.

PSNH's October 2010 Report, p. 7-8. EPA agrees that Merrimack Station's existing WWTS, currently used for metal cleaning and low volume wastes, would require redesign/rebuilding to enable it to treat the FGD wastewater. Therefore, EPA rejects use of the existing WWTS as a potential BAT for treating FGD wastewater at Merrimack Station.

3.9 Vapor-Compression Evaporation

EPA has reported that "evaporators in combination with a final drying process can significantly reduce the quantity of wastewater discharged from certain process operations at various types of industrial plants, including power plants, oil refineries, and chemical plants." EPA's 2009 Detailed Study Report, p. 4-33. In some cases, plants have been able to achieve "zero liquid discharge" with this technology. *Id.*

In its submissions to date, PSNH evaluated the use of vapor-compression evaporation at Merrimack Station as follows:

> [p]ower plants have used vapor-compression evaporator systems - typically consisting of brine concentrators in combination with forced-circulation crystallizers - to treat cooling tower blowdown since the 1970s. Nonetheless, FGD wastewater chemistry and cooling tower blowdown chemistry are very different, with the result that the power industry's design and operational experience with treating cooling tower blowdown using evaporation systems is not directly transferable to the use of evaporation systems to treat FGD wastewater. In fact, there are currently no power plants in the United States that are operating vapor-compression evaporator (i.e., brine concentrator and crystallizer) systems to treat FGD wastewater….
>
> In treating FGD wastewater with a vapor-compression evaporator system, there is a high potential for scaling and corrosion. In fact, using a crystallizer

> to treat FGD wastewater requires pretreatment, upstream of the brine concentrator, to "soften" the wastewater by removing calcium chloride and magnesium chloride salts that could result in a very high scaling potential within the brine concentrator and crystallizer. This softening process consumes large quantities of lime and soda ash and produces large quantities of sludge that must be dewatered, usually by filter press, for landfill disposal. … Until recently, RCC Ionics was the only supplier that had installed a vapor-compression evaporator system using a brine concentrator and crystallizer for FGD wastewater treatment in the United States; however, none of the five units that it has installed are currently operational. Aquatech had designed and manufactured vapor-compression evaporator system components for the Dallman Power Station in Springfield, Illinois, but this system was never installed. At present, another Aquatech vapor-compression evaporator system is currently in start-up in the United States, at Kansas City Power & Light's Iatan Station in Weston, Missouri; however, to date there has been no published information regarding its start-up or operation. Aquatech has also installed five vapor-compression evaporator systems at ENEL power plants in Italy, but not all of these systems are in operation, and performance data has not been published....

PSNH's October 2010 Report, p. 10-11. EPA agrees with PSNH that the operation of vapor-compression evaporation requires proper control of wastewater chemistry and process operations and may require pretreatment steps tailored to the specific facility operation.[11]

EPA has reported that "one U.S. coal-fired plant and six coal-fired power plants in Italy are treating FGD wastewater with vapor-compression evaporator systems." EPA's 2009 Detailed Study Report, p. 4-33. This information suggests that this technology *may* be available for use at Merrimack Station. In fact, EPA has recently received information that PSNH is currently evaluating the potential use of this technology for Merrimack Station. PSNH has not, however, submitted an amended permit application proposing to use vapor compression evaporation, or providing information concerning the suitability of the technology for use at Merrimack Station.

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[11] For example, the design currently operating on FGD wastewater requires pretreatment of the wastewater in a clarifier/softener for TSS and hardness reduction followed by concentration in a brine concentrator and a crystallizer. One equipment vendor has developed an alternative design that would avoid the need for pre-softening. Shaw, William A., *Low Temperature Crystallization Process is the Key to ZLD Without Chemical Conditioning*, Paper Number IWC-10-39 presented at The International Water Conference®, 71st Annual Meeting, October 24-28, 2010. One such system is currently being installed to treat coal gasification wastewater and such systems have been used for years in other industries, but no systems of this alternative design are currently used to treat FGD wastewater.

In light of all of the above, EPA has concluded that it cannot based on current information determine this technology to be the BAT for treating FGD wastewater at Merrimack Station. It simply is not clear at the present time whether or not this technology is feasible for application at Merrimack Station. EPA is continuing to review information characterizing operational factors and pollutant removal efficacy for vapor compression evaporation and depending on the results of further evaluation of this technology, EPA could potentially find it to be part of the BAT for Merrimack Station for the final NPDES permit.

EPA has also considered the BAT factors in evaluating the possibility of using vapor compression evaporation technology at Merrimack Station. Specifically, EPA has considered engineering and process concerns related to the potential use of vapor compression technology, and whether it might necessitate any changes in Merrimack Station's primary production process or other pollution control processes. While effective vapor compression evaporation will require control of water chemistry and may necessitate pretreatment of the wastewater, EPA finds that use of vapor compression evaporation would not interfere with, or require changes to, the facility's other pollution control processes or its primary process for generating electricity. EPA also concludes that vapor compression evaporation technology can be utilized together with physical/chemical treatment. Moreover, EPA finds that the age of Merrimack Station would neither preclude nor create special problems with using vapor compression evaporation technology. With regard to the potential non-water environmental effects of using vapor compression evaporation, EPA notes that energy demands of this type of treatment technology may not be insignificant. In addition, vapor compression evaporation treatment would produce a solid waste that would require proper management.

Finally, EPA has also considered the cost of the technology and finds that it would add significant cost. Specifically, EPA has estimated that utilizing physical/chemical treatment together with vapor compression evaporation at Merrimack Station would cost approximately $4,162,000 per year (based on capital costs of approximately $27,949,000, and annual operating and maintenance costs of approximately $1,524,000). *See* 9/13/11 (07:56 AM) Email from Ronald Jordan, EPA Headquarters, to Sharon DeMeo, EPA Region 1, "Estimated costs & pollutant reductions for treatment options at Merrimack Station."

3.10 Physical/Chemical Treatment

Physical/chemical treatment (i.e., chemical precipitation) is a common treatment method used to remove metal compounds from wastewater. With this treatment technology, "chemicals are added to the wastewater in a series of reaction tanks to convert soluble metals to insoluble metal hydroxide or metal sulfide compounds, which precipitate from solution and are removed along with other suspended solids." *See* Memorandum from James A. Hanlon of EPA's Office of Water to EPA Water Division Directors, dated June 7, 2010 (hereafter "EPA's June 7, 2010 Guidance Memorandum"), Attachment A, p. 3-4. For example, an alkali, such as hydrated lime, may be added to adjust the pH of the wastewater to the point where the metals precipitate out as metal hydroxides. Coagulants and flocculants are also often added to facilitate the settling and removal of the newly-formed solids.

Plants striving to maximize removals of mercury and other metals will also often include sulfide addition (e.g., organosulfide) as part of the process. Adding sulfide chemicals in addition to the alkali can provide even greater reductions of heavy metals due to the very low solubility of metal sulfide compounds, relative to metal hydroxides.

> Sulfide precipitation has been widely used in Europe and is being installed at multiple locations in the United States. Approximately thirty U.S. power plants include physical/chemical treatment as part of the FGD wastewater treatment system; about half of these plants employ both hydroxide and sulfide precipitation in the process. This technology is capable of achieving low effluent concentrations of various metals and the sulfide addition is particularly important for removing mercury….

EPA's June 7, 2010 Guidance Memorandum, Attachment A, p. 4.

In an effort to control its air pollutant emissions as required by New Hampshire state law, Merrimack Station recently completed the installation of a limestone forced-oxidation, wet flue gas desulfurization (FGD) scrubber system, as described in section 1.0 above. Moreover, conscious of the need to treat the wastewater generated from the FGD system prior to discharge to the Merrimack River, PSNH decided to install, and is currently in the process of completing the construction of, a physical/chemical treatment system. The treatment system at Merrimack Station consists of the following operations in sequence: equalization; reaction tank #1 (includes the addition of hydrated lime for pH adjustment, recycled sludge and organosulfide); reaction tank #2 where ferric chloride will be added; polymer addition; clarification; gravity filtration; and a series of proprietary filter cartridges containing adsorbent media targeted specifically for the removal of mercury i.e., "polishing step".

3.11 Physical/Chemical with added Biological Treatment

While physical/chemical treatment can be very effective for removing some metals, it is ineffective for removing certain forms of selenium and nitrogen compounds, and certain other metals that can contribute to high concentrations of TDS in FGD wastewater (e.g., calcium, magnesium, sodium). "Seven power plants in the U.S.

are operating or constructing treatment systems that follow physical/chemical treatment with a biological treatment stage to supplement the metals removals with substantial additional reductions of nitrogen compounds and/or selenium." *Id.* Like mercury and other contaminants found in FGD wastewater that originate from the process of coal combustion, selenium is a toxic pollutant that can pose serious risk to aquatic ecosystems (*see* Table 5.1, *supra*). Nitrogen compounds, in turn, can contribute to a variety of water quality problems (*see* Table 5.1, *supra*).
As EPA has explained:

> … biological wastewater treatment systems use microorganisms to consume biodegradable soluble organic contaminants and bind much of the less soluble fractions into floc. Pollutants may be reduced aerobically, anaerobically, and/or by using anoxic zones. Based on the information EPA collected during the detailed study, two main types of biological treatment systems are currently used (or planned) to treat FGD wastewater: aerobic systems to remove BOD5 and anoxic/anaerobic systems to remove metals and nutrients. These systems can use fixed film or suspended growth bioreactors, and operate as conventional flow-through or as sequencing batch reactors (SBRs).

EPA's 2009 Detailed Study Report, p. 4-30. Of the seven power plants mentioned in EPA's June 7, 2010 Guidance Memorandum, three plants operate physical/chemical treatment along with a fixed-film anoxic/anaerobic bioreactor optimized to remove selenium from the wastewater.[12] "Selenate, the selenium form most commonly found in forced oxidation FGD wastewaters and the specie that is more difficult to treat using chemical processes, is found [to] be readily remediated using anaerobic biological reactors as is selenite." EPRI, Treatment Technology Summary for Critical Pollutants of Concern in Power Plant Wastewaters, January 2007, p. 4-2. The bioreactor reduces selenate and selenite to elemental selenium, which is then captured by the biomass and retained in treatment system residuals. The conditions in the bioreactor are also conducive to forming metal sulfide complexes to facilitate the additional removal of mercury, arsenic, and other metals.

Consideration of PSNH's Reasons for Rejecting Biological Treatment

PSNH provided several reasons why it did not propose biological treatment

[12] There are two additional power plants (not included in those mentioned above) that operate fixed-film anoxic/anaerobic bioreactors to remove selenium from their wastewater. These two plants precede the bioreactors with settling ponds instead of physical/chemical treatment. The other four plants mentioned in EPA's June 7, 2010 Guidance Memorandum operate sequencing batch reactors (SBR) that are operated to optimize removal of ammonia and other nitrogen compounds; the effectiveness of these SBRs at removing selenium compounds has not been demonstrated.

technology for selenium removal at Merrimack Station, but EPA does not find these reasons to be persuasive. First, PSNH states that its consultant URS's anti-degradation analysis to determine compliance with New Hampshire water quality standards concluded that the FGD wastewater would contribute "an insignificant loading of selenium to the Merrimack River, in part due to the anticipated performance of the FGD WWTS' physical-chemical treatment …." EPA's determination of technology-based effluent limits under the BAT standard is not, however, governed by a determination of the selenium discharge limits needed to satisfy state water quality standards. Selenium is a toxic pollutant subject to the BAT technology standard under the CWA. Dischargers must comply with federal technology-based standards *at a minimum*, as well as any more stringent state water quality requirements that may apply.

Second, PSNH states that selenium in FGD wastewater is primarily present in the elemental form, which is easily removed in the treatment process. The company also states that "… analyses during recent FGD scrubber startups have shown that the largest percentage of the selenium present in FGD wastewater is present in the elemental form and as selenite." PSNH's December 2010 Report, p. 7. PSNH provides no references in support of these statements, however. Moreover, as indicated above, EPA's research has found (a) that "FGD wastewater entering a treatment system contains significant concentrations of several pollutants in the dissolved phase, including … selenium," EPA's 2009 Detailed Study Report, p. 4-31, and (b) that "[m]odern forced-oxidation FGD system wastewater contains selenium, predominately in the selenate form …, [and that although] selenite can be somewhat removed by iron co-precipitation, selenate is soluble and is not removed in the [physical/chemical] treatment processes mentioned earlier." Power-Gen Worldwide, "FGD Wastewater Treatment Still Has a Ways to Go" (Jan 1, 2008).

If selenium will be present in the FGD wastewater in the elemental form and easily removed in Merrimack Station's WWTS, as PSNH suggests, then one would expect much lower levels of selenium in the effluent than projected by PSNH. PSNH reports that the FGD wastewater at Merrimack Station could be treated to achieve a level of 9,000 ug/L. Yet, this level of selenium is within the range of levels seen <u>prior to treatment</u>. See EPA's 2009 Detailed Study Report, p. 4-25, Table 4-6: FGD Scrubber Purge Self-Monitoring Data.

Finally, PSNH opines that the four biological treatment systems for selenium that it is aware of "have not been in service for a sufficiently long time to establish them as proven technology." PSNH's December 2010 Report, p. 7. In that report, PSNH suggests that five years of operations are required in order to establish that a treatment technology is proven. EPA does not concur with PSNH's use of its proposed five-year-of-operation criterion to rule out biological treatment for selenium removal as unproven. With that said, anoxic/anaerobic technology has been around longer than five years, albeit for other wastes or in pilot scale for FGD wastewater. As previously mentioned, available technologies may also include viable "transfer technologies" – that is, a technology from another industry that could be transferred to the industry in question – as well as technologies that have been shown to be viable in research even if not yet implemented at a full-scale facility.

Furthermore, as discussed above, EPA's research indicates that a number of power plants have coupled biological treatment with physical/chemical treatment to enhance selenium removal. For example, a two-unit 1,120 MW coal-fired generating facility in the eastern United States installed physical/chemical treatment coupled with anoxic/anaerobic biological treatment to reduce the concentration of selenium in its effluent. According to one analysis, "[t]he entire system has exceeded expectations and is meeting the discharge requirements." M. Riffe et. al., "Wastewater Treatment for FGD Purge Streams," presented at MEGA Symposium 2008.[13] On a broader level, a 2006 article in Power-Gen Worldwide stated the following:

> [m]uch of the coal mined and used in the eastern United States is high in selenium. This requires many power producers to include selenium removal as part of their FGD wastewater treatment systems to protect the environment. Recommended water quality criteria for selenium can be below 0.020 parts per million (ppm)…"

Power-Gen Worldwide, "Using Biology to Treat Selenium" (Nov. 1, 2006). As quoted above, EPA has also found that "some coal-fired power plants are moving towards using anoxic/anaerobic biological systems to achieve better reductions of certain pollutants (e.g., selenium, mercury, nitrates) than has been possible with other treatment processes used at power plants." EPA's 2009 Detailed Study Report, p. 4-31. In addition, EPA explained that while "… chemical precipitation is an effective means for removing many metals from the FGD wastewater …[, b]iological treatment, specifically fixed-film anoxic/anaerobic bioreactors when paired with a chemical precipitation pretreatment stage, is very effective at removing additional pollutants such as selenium and nitrogen compounds (e.g., nitrates, nitrites)." *Id.* at 4-50. Thus, EPA regards biological treatment – more particularly, biological treatment coupled with physical/chemical treatment – to be an adequately proven technology to be a candidate for being designated as the BAT for treating Merrimack Station's FGD wastewater.

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[13] The authors of this paper, which included two employees of Siemens Water Technology Corp., report that "[a]bout eight biological systems have been installed or planned for installation since 2004." EPA acknowledges that not all of these systems were installed specifically for selenium removal, since biological treatment can also be used to reduce COD/BOD and ammonia or other nitrogen compounds. Nevertheless, these installations demonstrate the viability of biological technology for treating a variety of pollutants in FGD wastewater, and currently there are five biological systems that are specifically optimized for removing selenium from FGD wastewater.

4.0 BAT for FGD Wastewater at Merrimack Station

EPA is not aware of, and PSNH has not identified, any reason that physical/chemical treatment or biological treatment would be precluded from being the BAT (or part of the BAT) for the FGD wastewater in this case. In evaluating these treatment methods, EPA has considered the BAT factors on a site-specific basis for Merrimack Station. This consideration is discussed below.

(i) Age of the equipment and facilities involved

In determining the BAT for Merrimack Station, EPA accounted for the age of equipment and the facilities involved. As mentioned previously, PSNH is already in the process of completing construction of a physical/chemical treatment system to treat the wastewater generated from the Station's new FGD scrubber system. Moreover, there is nothing about the age of the equipment and facilities involved that would preclude the addition of biological treatment technology. In other words, Merrimack Station's new physical/chemical treatment system could be retrofitted with additional new biological treatment technology, albeit at some expense. Therefore, the age of the facility by itself poses no bar to compliance.

(ii) Process employed and process changes

In determining the BAT for Merrimack Station, EPA considered the process employed at the facility. Merrimack Station is a 520 MW, fossil fuel-burning, steam-electric power plant with the primary purpose of generating electrical energy. Adding physical/chemical treatment and biological treatment for the FGD wastewater will not interfere with the Permittee's primary process for generating electricity. In addition, biological treatment would not interfere with the physical/chemical treatment process; it would complement it. Biological treatment typically consists of a bioreactor tank(s)/chamber(s), nutrient storage, a possible heat exchanger, a solids removal device, pumps and associated equipment. To add biological treatment to the FGD wastewater treatment system, Merrimack Station would need to install additional treatment tanks and process equipment and connect it with the physical/chemical treatment system.

(iii) Engineering aspects of the application of various types of control techniques

As discussed above, physical/chemical treatment is frequently used to treat FGD wastewater and PSNH has chosen it for Merrimack Station. In addition, biological technology optimized for treating nitrates and selenium in FGD wastewater, while also removing other pollutants, is used at five existing coal fired steam-electric power plants around the country.[14] According to EPA's research:

> [s]even power plants in the U.S. are operating or constructing treatment systems that follow physical/chemical treatment with a biological treatment stage to supplement the metals removals with substantial additional reductions of nitrogen compounds and/or selenium. Three of these systems use a fixed film anoxic/anaerobic bioreactor optimized to remove selenium from the wastewater. . . . Two other power plants (in addition to the seven biological treatment systems) operate treatment systems that incorporate similar biological treatment stages, but with the biological stage preceded by settling ponds instead of a physical/chemical treatment stage. Although the primary treatment provided by such settling ponds at these plants is less effective at removing metals than physical/chemical treatment, these plants nonetheless further demonstrate the availability of the biological treatment system and its effectiveness at removing selenium and nitrates.

EPA's June 7, 2010 Guidance Memorandum, Attachment A, p. 4. EPA also reported that "some coal-fired power plants are moving towards using anoxic/anaerobic biological systems to achieve better reductions of certain pollutants (e.g., selenium, mercury, nitrates) than has been possible with other treatment processes used at power plants." EPA's 2009 Detailed Study Report, p. 4-31.

(iv) Cost of achieving effluent reductions

PSNH chose to install, and has largely completed installation of, a physical/chemical treatment system at Merrimack Station. This demonstrates that the cost of this system was not prohibitive. While PSNH did not provide EPA with its predicted (or actual) costs for its physical/chemical FGD WWTS, EPA estimates the annualized costs for such a system (*not including* the polishing step for added mercury removal)[15] to be approximately $889,000 (based on approximately $4,869,000 in capital costs and approximately $430,000 in yearly operating and

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[14] Five power plants operate biological systems optimized to remove selenium; three plants do so in conjunction with physical/chemical treatment and two do so in conjunction with a settling pond (nitrates are also removed in the process of biologically removing selenium). Four other power plants operate biological systems (i.e., sequencing batch reactors) that are optimized to remove ammonia and other nitrogen compounds; the effectiveness of these SBRs at removing selenium has not been quantified. In part, these two different types of biological systems optimize removal of their target pollutants (i.e., selenium versus ammonia and other nitrogen compounds) by controlling the oxidation/reduction potential (ORP) within zones or stages of the bioreactors. Nitrogen compounds and selenium are removed at different ORPs. Thus the manner in which a bioreactor is operated will influence which pollutants it removes and the degree to which they are removed. In addition, removing ammonia biologically requires including an oxidation step within the bioreactor.

[15] PSNH did not provide estimated or actual costs for the polishing step and EPA does not presently have sufficient information to generate a reasonable estimate of these costs.

maintenance costs). *See* 9/13/11 (07:56 AM) Email from Ronald Jordan, EPA Headquarters, to Sharon DeMeo, EPA Region 1, "Estimated costs & pollutant reductions for treatment options at Merrimack Station." In addition, EPA estimates that the additional annualized costs of adding biological treatment at Merrimack Station would be approximately $765,000 (based on additional costs of approximately $4,954,000 in capital costs and approximately $297,000 in yearly operating and maintenance costs). *Id.* EPA also found additional information supporting the reasonableness of these cost estimates.[16] Thus, EPA estimates that the total FGD WWTS, including biological treatment would be approximately $1,654,000 (based on approximately $9,823,000 in capital costs and approximately $727,000 in yearly operating and maintenance costs). *Id.* EPA notes that data collected from power plants currently operating fixed-film anoxic/anaerobic biological treatment systems show that operating costs are relatively small because electrical consumption is low and relatively little treatment sludge is generated in comparison to physical-chemical treatment.[17] Costs on this order of magnitude can reasonably be borne by PSNH. PSNH has been a profitable company and should be able to afford to install biological treatment equipment if it is determined to be part of the BAT for Merrimack Station. For comparison, PSNH Merrimack has reported the total cost of the FGD system, including wastewater treatment, at $430 million. The additional cost for adding biological treatment would represent a small fraction of this total.[18]

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[16] One biological system currently in operation is sized to handle approximately 30 times the flow of Merrimack's FGD wastewater treatment system (70,000 gpd) and cost approximately $35 million, including construction of a settling pond and related equipment, such as piping and feed pumps. Another biological system designed to handle wastewater flows almost 5 times greater than Merrimack cost approximately $20 million (including construction of a settling pond and related equipment), while another system 10 times larger than Merrimack Station's treatment system cost less than $27 million (for the bioreactor stage and other facility improvements not related to the bioreactor). Industry responses to the U.S. Environmental Protection Agency "Questionnaire for the Steam Electric Power Generating Effluent Guidelines." (confidential business information (CBI)) *Also see* Sonstegard, J. et al, "ABMet: Setting the Standard for Selenium Removal." Presented at the International Water Conference, October 2010.

[17] Published values in the literature for operating and maintenance costs are on the order of $0.35 to $0.46 per 1,000 gallons of water treated (excluding labor). Three plants, with FGD wastewater flow rates ranging from 0.25 to 2 MGD, have reported annual O&M costs of $152,000 to $400,000 (including labor, and in some cases also including costs for activities not associated with the biological treatment system). Industry responses to the U.S. Environmental Protection Agency "Questionnaire for the Steam Electric Power Generating Effluent Guidelines." (CBI) *Also see* Sonstegard, J. et al, "ABMet: Setting the Standard for Selenium Removal." Presented at the International Water Conference, October 2010.

[18] EPA has also considered information suggesting that physical/chemical treatment coupled with biological treatment is likely to be more cost-effective than physical/chemical treatment alone in terms of cost per pound of pollutant discharge reduced. *Id.* (data in table indicates a cost per pound of pollutant discharge reduced of $52.60 (based on annualized costs of $889,000/16,900 lbs. of pollutant discharge removed per year) for physical/chemical treatment alone, and of $2.59 (based on

(v) Non-water quality environmental impacts (including energy requirements)

Finally, EPA considered the secondary, non-water quality environmental impacts and energy effects associated with the physical/chemical treatment together with biological treatment, including air emissions, noise, and visual effects at Merrimack Station. To EPA's current knowledge, there is nothing about either physical/chemical treatment or biological treatment that is likely to generate any significant adverse non-water quality environmental effects at Merrimack Station.

Physical/chemical treatment is estimated to generate 1,976 tons of solids per year, and require 339,017 kW-hr of electricity. *See* 9/16/11 (09:57 AM) Email from Ronald Jordan, EPA Headquarters, to Sharon DeMeo, EPA Region 1, "Non-water quality environmental impacts for FGD wastewater treatment options." "The technology option of chemical precipitation in conjunction with biological treatment is estimated to generate a total of 1,986 tons of solids per year (0.5 percent more than the chemical precipitation technology), and require 354,085 kW-hr of electricity (4.4 percent increase relative to chemical precipitation)." *Id.*

There will be some indirect air emissions associated with the energy needed to operate the treatment system. The incremental increases in energy demand and air emissions will be insignificant relative to Merrimack Station's existing energy production and air emissions.

5.0 BPJ-Based BAT Effluent Limits

5.1 Introduction

As previously discussed, for pollutants not addressed by the NELGs for a particular class or category of industrial dischargers, permitting authorities develop technology-based effluent limits for NPDES permits on the basis of BPJ. In the text above, EPA evaluated technological alternatives and determined that physical/chemical treatment, coupled with biological treatment, constitutes the BAT for limiting the discharge of certain FGD wastewater pollutants at Merrimack Station.[19]

Yet, specifying treatment technology does not by itself determine the precise discharge limits that should be included in the permit for pollutants in the FGD

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annualized costs of $1,654,000/639,900 lbs. of pollutant discharge removed per year) for physical/chemical and biological treatment).

[19] As explained farther below, EPA has determined based on current facts that it should not develop BCT limits at this time (see discussion of BOD and pH, below). *Also see* section 5.4 below.

wastewater. For example, EPA's research into facilities using physical/chemical and biological treatment reveals that different facilities display a range of concentrations for various pollutants in the untreated FGD wastewater.

The variation in pollutant concentrations at each facility likely results from the interaction of a number of different factors. These may include variables such as the quality of the coal burned at the facility, the type and amount of air pollutants generated in the combustion process, the efficiency with which the scrubbers remove pollutants from the flue gas and transfer it to the wastewater stream, and the degree to which the physical/chemical and biological treatment systems can remove pollutants from the wastewater. The latter factor may, in turn, be affected by the design and operation of the wastewater treatment system (e.g., the types and dosages of chemicals used for precipitation and coagulation; equalization capacity and residence time in the reaction tanks and clarifiers; and operational conditions such as pH set-points in the reaction tanks, sludge recycle frequency/rates, and clarifier sludge levels).

EPA's task in setting BAT limits is to set the most stringent pollutant discharge limits that are technologically and economically available (or feasible), and are not otherwise rejected in light of considering the "BAT factors." Neither Merrimack Station's wet FGD scrubber system nor its proposed FGD WWTS is yet operational. As a result, EPA does not have actual data for characterizing the untreated FGD purge from Merrimack Station operations. Nevertheless, EPA has reviewed the available data for a number of FGD systems collected during EPA's detailed study of the industry (described in EPA's 2009 Detailed Study Report) and during EPA's current rulemaking to revise the effluent guidelines. These data include samples of untreated and treated wastewater collected during EPA sampling episodes and self-monitoring data collected by power plants. In determining effluent limits for Merrimack Station, EPA used the best available information to specify permit limits that, consistent with the BAT standard, are appropriately stringent but not infeasible.

For the new Merrimack Station NPDES permit, EPA developed BAT-based effluent limits to address wastewater discharges from the FGD WWTS after consulting multiple sources, including EPA's 2009 Detailed Study Report[20] and EPA's June 7, 2010 Guidance Memorandum. EPA's 2009 Detailed Study Report summarizes information recently collected by the Agency to inform a determination of whether to revise the current Steam Electric Power Generating NELGs promulgated at 40 C.F.R. Part 423. EPA's June 7, 2010, Guidance Memorandum offers assistance to

[20] As part of the data collection activities presented in EPA's 2009 Detailed Study Report, EPA compiled sampling self-monitoring data from a number of power plants. As described below, EPA considered this data, along with other information, in its BPJ determination of BAT-based permit limits for certain pollutants for Merrimack Station.

NPDES permitting authorities working to establish, on a BPJ basis, BAT-based effluent limits for wastewater discharges from FGD systems at steam electric power generating facilities prior to revisions to the NELGs.

In addition, EPA relied on an August 11, 2011, report by EPA's Office of Water, Engineering and Analysis Division, titled "Determination of Effluent Limits for Flue Gas Desulfurization (FGD) Wastewater at PSNH Merrimack Station Based on Performance of Physical-Chemical Treatment Followed by Biological Treatment" (hereafter "EPA's 2011 Effluent Limits Report"). This report "presents the results of statistical analyses performed on treatment system performance data to calculate effluent limitations for inclusion in Merrimack Station's NPDES permit." August 11, 2011 Memorandum from EPA's Office of Water to EPA Region 1 accompanying EPA's 2011 Effluent Limits Report. Based on the sufficiency of available data, effluent limits were determined for the following parameters: arsenic, chromium, copper, mercury, selenium, and zinc. These limits were based on statistical analyses of self-monitoring data collected by plant staff at Duke Energy's Allen and Belews Creek Stations to evaluate FGD treatment system operations, as well as certain data collected during a study of the Belews Creek treatment system conducted by the Electric Power Research Institute (EPRI) (hereafter "Duke Energy data"). This data reflects performance over several years at these two Duke Energy plants. In EPA's view, this data is the best available reflection of what is possible with the use of physical/chemical and biological treatment for FGD wastewater.

Duke Energy's Allen Station and Belews Creek Station are similar to Merrimack Station in that they are coal-fired power plants that burn bituminous coal to generate electricity and "operate limestone forced oxidation wet flue gas desulfurization (FGD) systems to reduce sulfur dioxide (SO2) emissions, producing a commercial-grade gypsum byproduct." EPA's 2011 Effluent Limits Report, p. 3. In addition, PSNH has installed a similar physical/chemical FGD treatment system at Merrimack Station to those at the Duke Energy stations, consisting of one-stage chemical precipitation/iron co-precipitation. Allen and Belews Creek treatment systems, however, also include an anoxic/anerobic biological treatment stage, designed to optimize the removal of selenium.[21] "The bioreactor portion of the treatment train consists of bioreactor cells containing activated carbon media and microbes which reduce selenium to its elemental form and precipitate other metals as sulfide complexes. The microbes also reduce the concentration of nitrogen present in the wastewater." *Id.*

The data presented in EPA's 2011 Effluent Limits Report was collected over several years of operation, with samples collected at various intervals during the following periods: March 2009 to May 2011 for Allen Station; and February 2008 to May 2011

[21] As mentioned above, *see* section 3.10, EPA also recognizes that PSNH's proposed treatment system also includes a "polishing step" intended to further reduce mercury levels. *See also* sections 5.4 and 5.5.11, below.

for Belews Creek. *See* EPA's 2011 Effluent Limits Report, p. 6-7 for specifics. Furthermore, the data used to determine effluent limits were generated using sufficiently sensitive analytical methods. EPA believes that this data set is appropriate to use in developing BPJ-based BAT limits for Merrimack Station because it represents long-term performance that reflects variability in the systems. Appropriate analytical and statistical methods were applied to the data to derive daily maximum and monthly average effluent limits for this Draft Permit.

The Duke Energy data was thoroughly reviewed and certain values were excluded prior to calculating limits. EPA excluded or corrected data: (1) associated with the treatment system commissioning period; (2) collected during treatment system upsets; (3) not representative of a typical well-operated treatment system; (4) generated using insufficiently sensitive analytical methods; and (5) determined to be extreme values or "outliers". In addition, EPA corrected certain data errors (e.g., data entry errors) to differentiate from the excluded data. EPA's 2011 Effluent Limits Report provides more information about the data points excluded.

A modified delta-lognormal distribution was selected to model the pollutant data sets for each plant, except for chromium, and to calculate long-term averages, daily variability factors and monthly variability factors. The long-term averages and variability factors for each pollutant from both plants were then combined (i.e., median of long-term averages and mean of each variability factor). Generally, daily maximum and monthly average limits were determined by taking the product of the combined long-term average and the combined daily or monthly variability factor. EPA's 2011 Effluent Limits Report provides more information about the effluent limits determinations.

In addition to the sources described above, EPA also considered information presented by the permittee. Specifically, in PSNH's December 3, 2010 Report, in response an EPA's information request under CWA § 308(a), PSNH identified the concentrations of pollutants that it predicted would be present in the discharge from the new Merrimack Station FGD wastewater treatment system. Yet, EPA generally considers the multi-year data from actual operations at the Duke Energy plants to provide a superior basis for setting permit limits than the facility's projections given that (1) EPA is determining limits reflecting the BAT, not merely the limits that reflect the performance of Merrimack Station's WWTS, (2) PSNH's projected values do not reflect actual operations, and (3) Merrimack Station may have an incentive to understate, rather than overstate, the pollutant removal capabilities of its proposed treatment technologies in order to receive less stringent permit limits. That said, for certain pollutants not limited using the Duke Energy data, EPA did rely more directly upon the company's projections.

Based on the above considerations, EPA's approach to setting permit limits for specific pollutants in the wastewater from Merrimack Station's FGD WWTS is described below.

> (1) For arsenic, chromium, copper, mercury, selenium, and zinc, EPA calculated limits based on analysis of the Duke Energy data, as presented in EPA's 2011 Effluent Limits Report.
>
> (2) With regard to the remaining pollutants that might be present in the FGD wastewater, EPA determined for some that it would be appropriate to base limits on the levels that PSNH projected could be achieved by its new FGD WWTS, while for others EPA determined that it would not be appropriate to develop a BPJ-based BAT or, as appropriate, BCT limit at this time.[22]

The new NPDES permit will also require effluent monitoring to produce actual discharge data to support an assessment of whether permit limits should be made more or less stringent in the future.

5.2 Compliance Location

EPA has developed effluent limits for Merrimack Station's FGD WWTS to be applied at internal outfall 003C. This location is appropriate for technology-based limits because the FGD WWTS effluent will be diluted by, and include interferences from, other waste streams prior to discharge to the Merrimack River. *See* 40 C.F.R. §§ 122.45(h) and 125.3(f). These aspects would make monitoring and analysis impracticable downstream from this location.

According to PSNH, Merrimack Station's FGD wastewater will be directed to the slag settling pond (internal outfall 003A) that currently receives the following waste streams: slag (bottom ash) transport wastewater, overflow from slag tanks and storm water from miscellaneous yard drains, boiler blow-down, treated chemical metal cleaning effluent through internal outfall 003B, and other miscellaneous and low volume wastes such as flow from demineralizer regeneration, chemical drains, equipment and floor drains, miscellaneous tank maintenance drains, the yard service building floor drain sump, as well as wastewater consisting of pipe trench storm water, and ash landfill leachate. The FGD wastewater flow will be an average 0.07 MGD compared to the flow into the pond from the other sources, which is approximately 5.3 MGD (average) to 13 MGD (maximum). The magnitude of the dilution, along with the commingling of sources that contain similar pollutants, would make it difficult or impracticable to measure compliance of the FGD wastewater with technology-based limits at the pond sampling location (outfall 003A). Therefore, to ensure the effective control of the pollutants in Merrimack

[22] Generally, EPA believes that the application of the wastewater treatment to achieve compliance with the BAT limits specified in the Draft Permit will also inevitably result in the removal of other pollutants not limited in the permit.

Station's FGD WWTS effluent, the new Draft Permit imposes the effluent limits, and requires compliance monitoring, at internal outfall 003C, prior to the FGD wastewater being mixed with other waste streams.

5.3 Pollutants of Concern in FGD Wastewater

EPA began the process of establishing BPJ-based BAT limits by considering those constituents identified in EPA's 2009 Detailed Study Report, at p. 6-3, as "the most frequently cited pollutants in coal combustion wastewater associated with environmental impacts." This list also includes many of the pollutants that were evaluated under the NHDES anti-degradation review.

In addition, as part of the next permit reissuance proceeding, EPA expects to assess whether permit limits should be added for additional specific pollutants or whether limits for certain pollutants could be dropped. EPA expects that this assessment will be based on a review of effluent data collected at the facility and any relevant new NELGs that may have been promulgated and supporting information that may have been developed. Table 5-1, reproduced from the EPA's 2009 Detailed Study Report, discusses the potential for environmental harm from each pollutant compound "depending on the mass pollutant load, wastewater concentration, and how organisms are exposed to them in the environment." EPA's 2009 Detailed Study Report, p. 6-3.

Table 5-1 Selected Coal Combustion Wastewater Pollutants

Compound	Potential Environmental Concern
Arsenic	Frequently observed in high concentrations in coal combustion wastewater; causes poisoning of the liver in fish and developmental abnormalities; is associated with an increased risk of cancer in humans in the liver and bladder.
BOD	Can cause fish kills because of a lack of available oxygen; increases the toxicity of other pollutants, such as mercury. Has been associated with FGD wastewaters that use organic acids for enhanced SO2 removal in the scrubber.
Boron	Frequently observed in high concentrations in coal combustion wastewater; leachate into groundwater has exceeded state drinking water standards; human exposure to high concentrations can cause nausea, vomiting, and diarrhea. Can be toxic to vegetation.
Cadmium	Elevated levels are characteristic of coal combustion wastewater-impacted systems; organisms with elevated levels have exhibited tissue damage and organ abnormalities.
Chlorides	Sometimes observed at high concentrations in coal combustion wastewater (dependent on FGD system practices); elevated levels observed in fish with liver and blood abnormalities.
Chromium	Elevated levels have been observed in groundwater receiving coal combustion wastewater leachate; invertebrates with elevated levels require more energy to

	support their metabolism and therefore exhibit diminished growth.
Copper	Coal combustion wastewater can contain high levels; invertebrates with elevated levels require more energy to support their metabolism and therefore exhibit diminished growth.
Iron	Leachate from impoundments has caused elevated concentrations in nearby surface water; biota with elevated levels have exhibited sublethal effects including metabolic changes and abnormalities of the liver and kidneys.
Lead	Concentrations in coal combustion wastewater are elevated initially, but lead settles out quickly; leachate has caused groundwater to exceed state drinking water standards. Human exposure to high concentrations of lead in drinking water can cause serious damage to the brain, kidneys, nervous system, and red blood cells. Manganese Coal combustion wastewater leachate has caused elevated concentrations in nearby groundwater and surface water; biota with elevated levels have exhibited sublethal effects including metabolic changes and abnormalities of the liver and kidneys.
Mercury	Biota with elevated levels have exhibited sublethal effects including metabolic changes and abnormalities of the liver and kidneys; can convert into methylmercury, increasing the potential for bioaccumulation; human exposure at levels above the MCL for relatively short periods of time can result in kidney damage.
Nitrogen	Frequently observed at elevated levels in coal combustion wastewater; may cause eutrophication of aquatic environments.
pH	Acidic conditions are often observed in coal combustion wastewater; acidic conditions may cause other coal combustion wastewater constituents to dissolve, increasing the fate and transport potential of pollutants and increasing the potential for bioaccumulation in aquatic organisms.
Phosphorus	Frequently observed at elevated levels in coal combustion wastewater; may cause eutrophication of aquatic environments.
Selenium	Frequently observed at high concentrations in coal combustion wastewater; readily bioaccumulates; elevated concentrations have caused fish kills and numerous sublethal effects (e.g., increased metabolic rates, decreased growth rates, reproductive failure) to aquatic and terrestrial organisms. Short term exposure at levels above the MCL can cause hair and fingernail changes; damage to the peripheral nervous system; fatigue and irritability in humans. Long term exposure can result in damage to the kidney, liver, and nervous and circulatory systems.
Total dissolved solids	High levels are frequently observed in coal combustion wastewater; elevated levels can be a stress on aquatic organisms with potential toxic effects; elevated levels can have impacts on agriculture & wetlands.
Zinc	Frequently observed at elevated concentrations in coal combustion wastewater; biota with elevated levels have exhibited sublethal effects such as requiring more energy to support their metabolism and therefore exhibiting diminished growth, and abnormalities of the liver and kidneys.

5.4 The BAT for Controlling Merrimack Station's FGD Wastewater

PSNH has installed a wet FGD system utilizing a limestone forced oxidation scrubber (LSFO). Most plants that utilize this type of scrubber system produce a commercial-grade gypsum by-product and a wastewater stream. Such wastewater streams require treatment for the removal of solids and pollutants prior to discharge. As explained previously:

> [t]he FGD system works by contacting the flue gas stream with a slurry stream containing a sorbent. The contact between the streams allows for a mass transfer of sulfur dioxide as it is absorbed into the slurry stream. Other pollutants in the flue gas (e.g., metals, nitrogen compounds, chloride) are also transferred to the scrubber slurry and leave the FGD system via the scrubber blowdown (i.e., the slurry stream exiting the FGD scrubber that is not immediately recycled back to the spray/tray levels).

See EPA's 2009 Detailed Study Report, p. 4-15. PSNH plans to purge the scrubber slurry from the FGD on a regular, periodic (i.e., not continuously) basis to maintain suitable scrubber chemistry (70,000 gpd average).[23] Hydroclones (a centrifugal device) will be used to separate the solid gypsum from the liquid component of the scrubber slurry. This liquid component will be directed to the FGD WWTS and will contain chlorides, heavy metals, dissolved gypsum and other inert suspended solids.

As previously described, PSNH is installing a physical/chemical precipitation treatment system to remove pollutants from the wastewater prior to discharging the effluent to the Merrimack River. EPA reviewed physical/chemical treatment (i.e., chemical precipitation) as a technology and compared the systems described in EPA's 2009 Detailed Study Report and EPA's June 7, 2010 Guidance Memorandum with the system being installed at Merrimack Station. All of these systems have a series of reaction tanks in which precipitation and coagulation take place and in which insoluble metal hydroxides and metal sulfides are formed. This is followed by solids settling and physical removal. This treatment method is used at approximately 30 power plants in the U.S. *See* EPA's June 7, 2010 Guidance Memorandum, Attachment A, p. 4. Approximately half of these plants – as well as Merrimack Station's FGD WWTS – also add sulfide precipitation to the treatment process for more efficient removal of mercury and other metals.

In addition to physical/chemical treatment, three plants in the U.S. incorporate a biological treatment stage, added after chemical precipitation and solids removal,

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[23] PSNH has indicated that the scrubber purge rate may need to be increased, depending on actual operating characteristics of the scrubber system. According to PSNH, the discharge flow may increase to 100,000 gpd. Such an increase would not, however, affect the technology-based and water quality-based permitting evaluations.

specifically for reducing levels of dissolved selenium. Two additional U.S. plants operate biological treatment for removing selenium, but these plants use settling ponds instead of physical/chemical treatment prior to the biological treatment step. There are another four plants that incorporate a biological treatment stage following chemical precipitation and solids removal, but the biological stage at these four plants is a sequencing batch reactor that is operated at ORP levels that optimize the removal of nitrogen compounds instead of selenium. *See* EPA's June 7, 2010 Guidance Memorandum, Attachment A, p. 4.

The evidence reviewed by EPA indicates that physical/chemical treatment with biological treatment will remove selenium, additional dissolved metals and other pollutants from the FGD wastewater, beyond the level of removal achieved by physical/chemical treatment alone, and that adding a biological treatment stage is an available, cost-effective technological option.[24] In addition, EPA's evaluation concluded that additional removals of mercury could be attained through the use of the proprietary adsorbent media (or "polishing step"), which PSNH is installing on the "backside" of the new physical/chemical treatment system. Therefore, EPA has determined that the combination of physical/chemical treatment with biological treatment and the polishing step (for removal of mercury) are components of BAT for the control of FGD wastewater at Merrimack Station. EPA's determination that these technologies are components of BAT for the facility is also supported by EPA's above-described consideration of the BAT factors specified in the statute and regulations. Therefore, statistical analysis was performed on the data from the effluent of the physical/chemical and biological treatment systems at Belews Creek and Allen Stations to calculate limits for certain pollutants in the Merrimack Station Draft Permit, as described in this document. With regard to mercury, as also discussed below, the Draft Permit limit is based on use of the polishing medium in the physical/chemical treatment system.

Finally, for chlorides and total dissolved solids (TDS), EPA has determined that the BAT for Merrimack Station's FGD wastewater is not based on treatment/removal of these compounds. Instead, the BAT for these constituents is based on the operating characteristics of the FGD scrubber. As described below, the chloride and TDS levels in the discharge will be determined by the FGD scrubber purge rate, which is an operational set-point that will be established by the plant. A scrubber's set-point is determined largely by the maximum amount of chlorides (one component of TDS) allowable in the FGD system without causing corrosion of the equipment. Thus, it is based on the most vulnerable materials of construction.

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[24] In fact, in 2003, at "The 19th Annual International Conference on Soils, Sediments and Water", representatives from Applied Biosciences Corporation reported that "Applied Biosciences has developed the ABMet™ microbial bioprocess for the removal of metals and inorganics from industrial and other waters. …and has demonstrated removal of As, Se, Cu, Ni, Zn, Hg, Cd, Cr, Te, NO3, CN, and NH3." See http://scholarworks.umass.edu/soils_conf_abstracts/2Conference Co-Direct.

While EPA has based these BAT technology-based effluent limits on either an available treatment train consisting of 1) physical/chemical treatment, 2) the PSNH polishing step, and 3) biological treatment, or the operational conditions of the scrubber, PSNH may meet these limits using any means legally available.

5.5 Effluent Limits

5.5.1 Arsenic

Although PSNH projects that Merrimack Station's physical/chemical treatment system will be able to achieve a level of 20 ug/L for total arsenic, EPA has determined that physical/chemical treatment (with or without the biological treatment stage) can achieve lower arsenic levels. Therefore, the new Draft Permit includes BAT limits of 15 ug/L (daily maximum) and 8 ug/ L (monthly average) for total arsenic at internal outfall 003C. These limits are primarily based on the analysis in EPA's 2011 Effluent Limits Report.

5.5.2 BOD

Although EPA's October 29, 2010, information request directed PSNH to identify what it regarded to be an achievable BOD concentration limit for its FGD wastewater, the company failed to identify an attainable level.

In EPA's 2009 Detailed Study Report, p. 5, the Agency explained that:

> [b]iochemical oxygen demand (BOD) is a measure of the quantity of oxygen used by microorganisms (e.g., aerobic bacteria) in the oxidation of organic matter. The primary source of BOD in coal combustion wastewater is the addition of organic acid buffers to the FGD scrubbers.

Organic acids are added to some FGD scrubbers to improve the SO_2 removal efficiency of the systems. Merrimack Station does not, however, plan to add organic acid buffers to its newly installed FGD system, obviating any concern about high BOD levels in the wastewater. In addition, there is presently little data available concerning BOD levels in FGD wastewater from which to determine effluent limits. *See* Duke Energy data and EPA's 2009 Detailed Study Report.

In light of the above considerations, EPA has determined that including a BPJ-based BCT limit for BOD is not appropriate at this time. However, the Draft Permit requires the permittee to sample and report BOD_5 levels in the FGD effluent to support consideration of whether or not BOD limits might be needed in the future.

The Draft Permit requires weekly sampling. After weekly sampling data has been collected for at least six months, after an initial startup period of six months, the permittee may request a reduction in monitoring for BOD at this location. The permittee may submit a written request to EPA seeking a review of the BOD test results. EPA will review the test results and other pertinent information to make a determination of whether a reduction in testing is justified. The frequency of BOD testing may be reduced to no less than one test per year. The permittee is required to continue testing at the frequency specified in the permit until the permit is either formally modified or until the permittee receives a certified letter from the EPA indicating a change in the permit conditions.

As part of the next permit reissuance proceeding, EPA plans to reassess whether a BOD permit limit should be added to the permit based on consideration of any new NELGs that may have been promulgated and a review of monitoring data and any other relevant new information. As always, new information could also potentially support future permit modifications during the term of the new permit.

5.5.3 Boron

Although EPA's October 29, 2010 information request directed PSNH to identify what it regarded to be an achievable boron concentration limit for its FGD wastewater, the company did not identify an attainable level.

EPA's research indicates that FGD wastewaters contain a wide range of total boron levels. This highly variable range is seen in the power plant self-monitoring data submitted to EPA and presented in EPA's 2009 Detailed Study Report[25], as well as in the Allen Station and Belews Creek data that was recently submitted to EPA upon request. It is presently unclear whether and at what level boron may be found in Merrimack Station's FGD wastewater.

Boron is one of several pollutants that are almost exclusively present in the dissolved phase. In addition, boron is not easily removed by physical/chemical treatment with or without the biological treatment stage. *See* EPA's 2009 Detailed Study Report p. 4-18. *Also see* EPA's June 7, 2010 Guidance Memorandum, Attachment A, p.4. Therefore, EPA has determined that it cannot reasonably set a BPJ-based BAT limit for boron at this time. Consequently, the Draft Permit requires the permittee to sample and report boron levels in the FGD waste stream but does not propose a technology-based effluent limit.

As part of the next permit reissuance proceeding, EPA currently plans to assess

[25] A range of 17,000 to 474,000 ug/L of total boron was reported for two plants utilizing physical/chemical treatment, and from 7,820 to 666,000 ug/L of total boron for two plants that use biological treatment. EPA's 2009 Detailed Study Report, pp. 4-65 and 4-67.

whether a boron permit limit should be added based on consideration of any new NELGs that may have been promulgated and a review of monitoring data and any other relevant new information. As always, new information could also potentially support future permit modifications during the term of the new permit.

5.5.4 Cadmium

PSNH projects that Merrimack Station's physical/chemical treatment system will be able to achieve a level of 50 ug/L for total cadmium. Although there is evidence that some plants have discharged FGD wastewater with lower cadmium levels,[26] there is insufficient information at this time upon which to prescribe a cadmium limit lower than that proposed by PSNH.[27] Therefore, EPA is basing the Draft Permit limit on PSNH's projected level of 50 ug/L. As part of the next permit reissuance proceeding, EPA expects to assess whether this cadmium permit limit should be adjusted based on consideration of any new NELGs that may have been promulgated and a review of monitoring data and any other relevant new information. As always, new information could also potentially support future permit modifications during the term of the new permit.

5.5.5 Chlorides

EPA has found no evidence to suggest that physical/chemical treatment with or without the biological treatment stage is effective in removing chlorides. The chloride level in the discharge will be determined by the FGD scrubber purge rate, which is an operational set-point that will be established by the plant. A scrubber's set-point is determined largely by the maximum amount of chlorides allowable for preventing corrosion of the equipment, thus it is based on the most vulnerable materials of construction. PSNH proposed that the FGD WWTS at Merrimack Station would discharge up to 18,000 mg/L chlorides.[28] Therefore, this value is chosen as the BAT-based Draft Permit limit for Merrimack Station. As part of the

[26] Self-monitoring cadmium data from three plants utilizing physical/chemical treatment ranged from 0.07 – 21.9 ug/L (18 samples) and from one plant using biological treatment ranged from ND (0.5) – 3.57 ug/L (37 samples). EPA's 2009 Detailed Study Report, pp. 4-65 and 4-67. An anoxic/anaerobic biological treatment system can reduce metals such as selenium, arsenic, cadmium, and mercury, by forming metal sulfides within the system. *Id.* at 4-32. *See also* Duke Energy data from Allen and Belews Creek Stations.

[27] An anoxic/anaerobic biological treatment system can reduce metals such as selenium, arsenic, cadmium, and mercury, by forming metal sulfides within the system. EPA's 2009 Detailed Study Report, p.4-32. EPA's 2009 Detailed Study Report shows that self-monitoring cadmium data from three plants utilizing physical/chemical treatment ranged from 0.07 – 21.9 ug/L (18 samples) and from one plant using biological treatment ranged from ND (0.5) – 3.57 ug/L (37 samples). *See also* Duke Energy data from Allen and Belews Creek Stations.

[28] Self-monitoring chloride data from two plants utilizing physical/chemical treatment ranged from 4,700 – 20,500 mg/L (21 samples). EPA's 2009 Detailed Study Report, p. 66.

next permit reissuance, EPA plans to assess whether this chloride permit limit should be adjusted based on consideration of any new NELGs that may have been promulgated and a review of monitoring data and any other relevant new information. As always, new information could also potentially support future permit modifications during the term of the new permit.

5.5.6 Chromium

PSNH did not report an achievable concentration of total chromium as requested by EPA's October 29, 2010, information request. However, PSNH did report projected levels of 50 ug/L and 100 ug/L for trivalent and hexavalent chromium, respectively. Chromium is more likely found in the particulate, rather than the dissolved, phase in scrubber blowdown. Therefore, it is more easily removed in the treatment process. In the Draft Permit, EPA is proposing a daily maximum limit of 10 ug/L for total chromium at internal outfall 003C based primarily on the analysis presented in EPA's 2011 Effluent Limits Report. Based on data restrictions for chromium from the Duke Energy plants, no monthly average limit was calculated. *See* EPA's 2011 Effluent Limits Report. EPA expects to reconsider whether a monthly average limit should be added to the permit during the next permit reissuance proceeding based on consideration of any new NELGs that may have been promulgated and a review of monitoring data and any other relevant new information. As always, new information could also potentially support future permit modifications during the term of the new permit.

5.5.7 Copper

PSNH projects that Merrimack Station's physical/chemical treatment system will be able to achieve a level of 50 ug/L for total copper. EPA has determined, however, that physical/chemical treatment with or without the biological treatment stage can achieve lower copper levels. In particular, EPA is proposing in the Draft Permit a daily maximum limit of 16 ug/L and a monthly average limit of 8 ug/L for total copper at internal outfall 003C based primarily on the analysis presented in EPA's 2011 Effluent Limits Report.

5.5.8 Iron

Although PSNH projects that Merrimack Station's treatment system will be able to achieve a discharge concentration of 100 ug/L for iron, EPA has determined on a BPJ basis that BAT limits for iron are not appropriate at this time. Ferric chloride will be added in the FGD physical/chemical treatment process at Merrimack Station to co-precipitate a variety of heavy metals in the wastestream and further promote the coagulation of suspended solids. Generally, EPA does not set effluent limits for parameters that are associated with wastewater treatment chemicals, assuming that system and site controls demonstrate good operation of the treatment technology.[29]

Consequently, the Draft Permit requires the permittee to sample and report iron levels in the FGD waste stream but does not propose a technology-based effluent limit. As part of the next permit reissuance proceeding, EPA expects to reassess whether an iron limit would be appropriate based on consideration of any new NELGs that may have been promulgated and a review of monitoring data and any other relevant new information. As always, new information could also potentially support future permit modifications during the term of the new permit.

5.5.9 Lead

Lead can be effectively removed by physical/chemical treatment, such as the system installed at Merrimack Station, and PSNH predicts that the FGD WWTS installed at Merrimack Station will be able to achieve a total lead discharge concentration of 100 ug/L. This value is within the range of self-monitoring lead data collected in response to EPA's 2009 Detailed Study Report.[30] EPA is basing the Draft Permit limit on PSNH's projected value of 100 ug/L because the Agency does not have sufficient data from which to calculate an alternative BAT-based lead limit for Merrimack's FGD WWTS at this time. As part of the next permit reissuance proceeding, EPA expects to assess whether this permit limit for lead should be adjusted based on consideration of any new NELGs that may have been promulgated and a review of monitoring data and any other relevant new information. As always, new information could also potentially support future permit modifications during the term of the new permit.

[29] For example, the Development Document for the December 2000 Centralized Waste Treatment Final Rule, page 7-1, states that "EPA excluded all pollutants which may serve as treatment chemicals: aluminum, boron, calcium, chloride, fluoride, iron, magnesium, manganese, phosphorus, potassium, sodium, and sulfur. EPA eliminated these pollutants because regulation of these pollutants could interfere with their beneficial use as wastewater treatment additives." (http://water.epa.gov/scitech/wastetech/guide/treatment/upload/2000_10_19_guide_cwt_fina_develop_ch7.pdf) Similarly, the Development Document for the October 2002 Iron and Steel Manufacturing Point Source Category Final Rule, page 12-1, states that "EPA excluded all pollutants that may serve as treatment chemicals: aluminum, boron, fluoride, iron, magnesium, manganese, and sulfate (several other pollutants are commonly used as treatment chemicals but were already excluded as POCs). EPA eliminated these pollutants because regulation of these pollutants could interfere with their beneficial use as wastewater treatment additives." (http://water.epa.gov/scitech/wastetech/guide/ironsteel/upload/2003_05_27_guide_ironsteel_reg_tdd_sections12-17.pdf)

[30] Self-monitoring data for lead from four plants using physical/chemical treatment ranged from ND (0.07) to 11 ug/L (47 samples). In addition, one plant using biological treatment reported lead ranging from ND(1.9) to 291 ug/L (37samples). EPA's 2009 Detailed Study Report, pp 4-65 and 4-67.

5.5.10 Manganese

PSNH projects that Merrimack Station's treatment system can achieve a manganese level of 3000 ug/L. This is within the wide range of values that EPA collected during the development of EPA's 2009 Detailed Study Report (*see* pages 4-65 and 4-67).

Although manganese is one of several pollutants entering treatment systems almost entirely in the dissolved phase (*see* EPA's 2009 Detailed Study Report, pp. 4-18 and 4-26), there is some evidence suggesting that physical/chemical treatment can achieve some removal of manganese from FGD system wastewater. *See* FGD Flue Gas (FGD) Wastewater Characterization and Management: 2007 Update, 1014073, Final Report, March 2008 (EPRI Project Manager P. Chu). At the same time, however, EPA presently has only a very limited data pool for manganese in FGD system wastewater. As a result, the Agency has determined based on BPJ that the BAT limit for manganese is the level projected by PSNH and this level has been included as a limit in the Draft Permit.

As part of the next permit reissuance proceeding, EPA expects to assess whether this permit limit for manganese should be adjusted based on consideration of any new NELGs that may have been promulgated and a review of monitoring data and any other relevant new information. As always, new information could also potentially support future permit modifications during the term of the new permit.

5.5.11 Mercury

Mercury is one of several metals that may potentially be removed more effectively by biological treatment than physical/chemical treatment alone. Based on the analysis presented in EPA's 2011 Effluent Limits Report, EPA would prescribe BAT limits for total mercury discharges from Merrimack Station's FGD WWTS of 0.055 ug/L (daily maximum) and 0.022 ug/L (monthly average). Merrimack Station projects even better performance, however, from its physical/chemical treatment system with the addition of the previously mentioned "polishing step." This polishing step involves the use of two sets of proprietary adsorbent media targeted specifically for mercury. In particular, PSNH projects that its proposed treatment system can achieve a limit of 0.014 ug/L. Therefore, EPA has included a technology-based limit of 0.014 ug/L (daily maximum) in the Draft Permit to control the discharge of mercury in the effluent from Merrimack Station's FGD WWTS based on the company's newly installed physical/chemical treatment system with the added polishing step.

5.5.12 Nitrogen

While biological treatment systems can remove both selenium and nitrogen compounds, the treatment systems currently operating have not been optimized for the removal of both types of contaminants. Instead, these treatment systems have been optimized for the removal of one or the other.

> Seven power plants in the U.S. are operating or constructing treatment systems that follow physical/chemical treatment with a biological treatment stage.... Three of these systems use a fixed film anoxic/anaerobic bioreactor optimized to remove selenium from the wastewater.... Four power plants operate the treatment system with the biological stage optimized for nitrogen removal by using a sequencing batch reactor to nitrify and denitrify the wastewater and produce very low concentrations of both ammonia and nitrates.

EPA's June 7, 2010 Guidance Memorandum, Attachment A, p. 4. Although biological treatment systems remove nitrates in the process of removing selenium,[31] it is unclear to what extent, if any, biological treatment affects ammonia-nitrogen and other nitrogen compounds, unless a process such as nitrification is added.

In determining the BAT for Merrimack Station, EPA has decided that the biological treatment system should be optimized for selenium removal due to the toxicity and bioaccumulation potential of that contaminant. (EPA discusses the Draft Permit's selenium limits further below.) Although PSNH predicts that the newly installed FGD WWTS – without biological treatment – can achieve discharge levels of <350 mg/L of ammonia-nitrogen (NH3-N) and <350 mg/L for nitrates/nitrites (NO3/NO2-N), EPA cannot reasonably set a total nitrogen limit at this time because the level of total nitrogen likely to remain in Merrimack Station's FGD WWTS effluent after biological treatment that has been optimized for selenium removal is uncertain. The added biological treatment stage will likely remove some nitrogen, but EPA is unable to quantify likely discharge levels at this time.

The Draft Permit does require the permittee to sample and report nitrogen levels in the FGD wastewater stream. As part of the next permit reissuance, EPA plans to assess whether a nitrogen permit limit should be added based on consideration of any new NELGs that may have been promulgated and a review of monitoring data and any other relevant new information. As always, new information could also potentially support future permit modifications during the term of the new permit.

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[31] Both Allen and Belews Creek Stations employ anoxic/anaerobic biological treatment of their FGD wastewater, optimized for the removal of selenium compounds. EPA's 2011 Effluent Limits Report, page 4, indicates that for each plant, "[t]he bioreactor portion of the treatment train consists of bioreactor cells containing activated carbon media and microbes which reduce selenium to its elemental form and precipitate other metals as sulfide complexes. The microbes also reduce the concentration of nitrogen present in the wastewater." *See also* Duke Energy data.

5.5.13 pH

As previously discussed, Merrimack's FGD wastewater will be directed to the slag settling pond that currently receives numerous waste streams including bottom ash transport water, metal cleaning effluent, low volume wastes, and stormwater. The FGD wastewater flow (70,000 gpd) will be diluted by the other waste streams in the pond (5.3 MGD (average) to-13 MGD (maximum)). EPA has determined that monitoring for pH is not necessary at internal outfall 003C. EPA's March 21, 1986, Memorandum from Charles Kaplan, EPA, to Regional Permit Branch Chiefs and State Directors, explains that using dilution to accomplish the neutralization of pH is preferable to adding chemicals when commingling low volume waste with once through cooling water. EPA is using this same approach in this case and has determined that including a BPJ-based, BCT limit for pH is not necessary or appropriate at this time. *See* Merrimack Station Fact Sheet for the explanation of the water quality-based pH limit at outfall 003A (slag settling pond).

5.5.14 Phosphorus

PSNH did not project a particular concentration of phosphorus that could be achieved by Merrimack Station's new FGD WWTS, as was requested by EPA's October 29, 2010 information request.

Similar to iron, phosphorus may be added (or used) in the FGD wastewater treatment process. Anoxic/anaerobic biological treatment systems remove selenium and other compounds using suspended growth or fixed film reactors comprised of a bed of activated carbon (or other supporting medium) on which microorganisms (i.e., site-specific bacteria cultures) live. A common food source used consists of a molasses-based nutrient mixture that contains carbon, nitrogen, and phosphorus.[32] As discussed above, EPA generally does not set technology-based effluent limits for parameters that are associated with wastewater treatment chemicals. *See* footnote 29 of this document. Therefore, EPA has determined, using BPJ, that BAT limits for phosphorus are not appropriate at this time. Consequently, the Draft Permit requires the permittee to sample and report phosphorus levels in the FGD waste stream but does not propose technology-based effluent limits. EPA expects to reconsider whether a phosphorus limit would be appropriate during the next permit reissuance proceeding based on consideration of any new NELGs that may have been promulgated and a review of monitoring data and any other relevant new information. As always, new information could also potentially support future permit modifications during the term of the new permit.

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[32] United States Patent, Sep. 7, 2010, No. 7,790,034 B2, *Apparatus and Method for Treating FGD Blowdown or Similar Liquids*, p. 11. This patent, assigned to Zenon Technology Partnership indicates that the wastewater flow through the system "may already contain sufficient phosphorus and so there may be no need for phosphorus in the nutrient solution." (http://data.ipthoughts.com/publication/09102010/US7790034)

5.5.15 Selenium

PSNH reported that FGD wastewater at Merrimack Station could be treated to achieve 9,000 ug/L total selenium using physical/chemical processes. However, EPA has determined that physical/chemical treatment with an added biological treatment stage results in much lower selenium levels. "Biological treatment, specifically fixed-film anoxic/anaerobic bioreactors when paired with a chemical precipitation pretreatment stage, is very effective at removing additional pollutants such as selenium and nitrogen compounds (e.g., nitrate, nitrites)." EPA's 2009 Detailed Study Report, p. 4-50. EPA is proposing a daily maximum limit of 19 ug/L and a monthly average limit of 10 ug/L for total selenium at internal outfall 003C based primarily on the analysis presented in EPA's 2011 Effluent Limits Report.

5.5.16 Total Dissolved Solids

PSNH projects that the FGD WWTS at Merrimack Station will be able to achieve a level of total dissolved solids (TDS) of 35,000 mg/L, which is well above the range of data reported in EPA's 2009 Detailed Study Report.[33] At the same time, however, EPA finds no current evidence to suggest that physical/chemical treatment (with or without the biological treatment stage) effectively removes TDS.[34] The chlorides level in the discharge will be determined by how the FGD scrubber purge is managed and represents a substantial component of the TDS. Thus, the controlling factors for the TDS effluent concentration are similar to those described for chlorides. Therefore, the BAT limit is based on how the company manages its scrubber and not on the actual treatment system for the blowdown. The Draft Permit limit in this case is PSNH's projected value of 35,000 mg/L. In addition, as part of the next permit reissuance proceeding, EPA plans to assess whether this TDS permit limit should be adjusted based on consideration of any new NELGs that may have been promulgated and a review of monitoring data and any other relevant new information. As always, new information could also potentially support future permit modifications during the term of the new permit.

5.5.17 Zinc

PSNH projects that Merrimack Station's physical/chemical treatment system can achieve a level of 100 ug/L. However, other plants evaluated by EPA show that lower limits can consistently be achieved using this technology. EPA is proposing a daily maximum limit of 15 ug/L and monthly average limit of 12 ug/L for total zinc

[33] Self-monitoring data from one plant (16 samples) using physical/chemical treatment ranged from 12,000 – 23,000 mg/L. In addition, the range from two plants (52 samples) with biological treatment is 2,500 – 23,000 mg/L. EPA's 2009 Detailed Study Report, pp. 4-66 and 4-67.

[34] EPA reported that "…the figures [2008 monitoring data from Belews Creek and Roxboro stations] show that TDS is not significantly removed by the settling pond, the chemical precipitation system, or the biological treatment system." EPA's 2009 Detailed Study Report, p. 4-51.

at internal outfall 003C based primarily on the analysis presented in EPA's 2011 Effluent Limits Report.

5.6 Summary of Effluent Limits

The following table summarizes the Draft Permit limits for outfall location 003C – FGD WWTS and the rationale for each of the BPJ-based BAT limits:

Table 5-2 Draft Permit Limits for Outfall 003C

Compound/ Units	Maximum Daily Limit	Monthly Average Limit	BAT Limit Based On
Flow	Report	Report	---
Arsenic (ug/L)	15	8	EPA calculations
Boron (ug/L)	Report	Report	no BAT numerical effluent limit at this time
Cadmium (ug/L)	50	Report	PSNH projected value
Chromium (ug/L)	10	Report	EPA calculations
Copper (ug/L)	16	8	EPA calculations
Iron (ug/L)	---	Report	no BAT numerical effluent limit at this time
Lead (ug/L)	100	Report	PSNH projected value
Manganese (ug/L)	3,000	Report	PSNH projected value
Mercury (ug/L)	0.014	Report	PSNH projected value (physical/chemical w/ polishing step)
Selenium (ug/L)	19	10	EPA calculations
Zinc (ug/L)	15	12	EPA calculations
BOD (mg/L)	Report	Report	no BCT numerical effluent limit at this time
Chlorides (mg/L)	18,000	Report	PSNH projected value
Nitrogen (mg/L)	Report	Report	no BAT numerical effluent limit at this time
pH	---	---	water quality-based range

			at outfall 003A
Phosphorus (mg/L)	---	Report	no BAT numerical effluent limit at this time
TDS (mg/L)	35,000	Report	PSNH projected value

5.7 Sufficiently Sensitive Analytical Methods

To prevent undetected exceedances of these permit limits, EPA's Draft Permit requires sufficiently sensitive analytical methods to be used for compliance monitoring purposes. EPA recommends that "for purposes of permit applications and compliance monitoring, a method is 'sufficiently sensitive' when (1) the method quantitation level is at or below the level of the applicable water quality criterion for the pollutant, or (2) the method quantitation level is above the applicable water quality criterion, but the amount of pollutant in a facility's discharge is high enough that the method detects and quantifies the level of pollutant in the discharge." EPA's June 7, 2010 Guidance Memorandum, Attachment A, p. 6. Therefore, the Merrimack Draft Permit includes a provision for outfall location 003C that the permittee is required to use EPA approved methods that are sufficiently sensitive to measure each FGD pollutant at concentrations low enough to determine compliance.

Furthermore, as currently indicated on EPA's Steam Electric Power Generating website page:

> [w]astewater from flue gas desulfurization (FGD) systems can contain constituents that may interfere with certain laboratory analyses, due to high concentrations of total dissolved solids (TDS) or the presence of elements known to cause matrix interferences. EPA has observed that, during inductively coupled plasma – mass spectrometry (ICP-MS) analysis of FGD wastewater, certain elements commonly present in the wastewater may cause polyatomic interferences that bias the detection and/or quantitation of certain elements of interest. These potential interferences may become significant when measuring trace elements, such as arsenic and selenium, at concentrations in the low parts-per-billion range.
>
> As part of a recent sampling effort for the steam electric power generating effluent guidelines rulemaking, EPA developed a standard operating procedure (SOP) that was used in conjunction with EPA Method 200.8 to conduct ICP-MS analyses of FGD wastewater. The SOP describes critical

> technical and quality assurance procedures that were implemented to mitigate anticipated interferences and generate reliable data for FGD wastewater. EPA regulations at 40 CFR 136.6 already allow the analytical community flexibility to modify approved methods to lower the costs of measurements, overcome matrix interferences, or otherwise improve the analysis. The draft SOP developed for FGD wastewater takes a proactive approach toward looking for and taking steps to mitigate matrix interferences, including using specialized interference check solutions (i.e., a synthetic FGD wastewater matrix).

http://water.epa.gov/scitech/wastetech/guide/steam_index.cfm. EPA's draft "FGD ICP/MS Standard Operating Procedure: Inductively Coupled Plasma/Mass Spectrometry for Trace Element Analysis in Flue Gas Desulfurization Wastewaters," dated May 2011 is available at this website page or directly at http://water.epa.gov/scitech/wastetech/guide/upload/steam_draft_sop.pdf. PSNH is encouraged to make this document available to its contract laboratory as an alternative approach to mitigate matrix interferences during the analysis of Merrimack Station's FGD wastewater.