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August 18, 2014

VIA ELECTRONIC MAIL

Ms. Sharon DeMeo
U.S. Environmental Protection Agency – Region 1
5 Post Office Square, Suite 100 (OEP06-1)
Boston, MA 02109-3912

Comments of the Utility Water Act Group
on Revised Draft Permit for the Merrimack Station
NPDES Permit No. NH 0001465
April 2014 Revised Draft Permit

Dear Ms. DeMeo:

Attached are the Comments of the Utility Water Act Group on Revised Draft Permit for the Merrimack Station. UWAG appreciates this opportunity to comment. If you have any questions, please call me at (804) 788-8549.

Sincerely,

-s-

Elizabeth E. Aldridge

Attachments

cc: Mr. Mark Stein
Mr. Thomas Burack

COMMENTS OF
THE UTILITY WATER ACT GROUP
ON REVISED DRAFT PERMIT FOR THE MERRIMACK STATION
NPDES Permit No. NH 0001465
April 2014 Revised Draft Permit

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COMMENTS OF
THE UTILITY WATER ACT GROUP
ON REVISED DRAFT PERMIT FOR THE MERRIMACK STATION
NPDES Permit No. NH 0001465
April 2014 Revised Draft Permit

These are the comments of the Utility Water Act Group (UWAG)[1] on EPA Region I's revised draft NPDES permit of April 2014 for Public Service of New Hampshire's Merrimack Station at Bow, New Hampshire. http://www.epa.gov/region1/npdes/merrimackstation/. UWAG also filed comments on an earlier draft of the Merrimack permit on February 28, 2012. Merrimack Administrative Record Document (Merrimack No.) No. 841.

UWAG's members, who operate power generating stations with NPDES permits throughout the country, have a keen interest in the Merrimack permit. Because EPA has not finished its rulemaking to revise the effluent limitations guidelines for the steam electric industry, the draft Merrimack permit represents EPA Region I's "best professional judgment" of what a permit should require as best available technology (BAT) for flue gas desulfurization (scrubber) wastewater. Because this permit may be seen as precedent for other permits, it is important to correct any mistakes.

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[1] UWAG is a voluntary, *ad hoc*, non-profit, unincorporated group of 191 individual energy companies and three national trade associations of energy companies: the Edison Electric Institute, the National Rural Electric Cooperative Association, and the American Public Power Association. The individual energy companies operate power plants and other facilities that generate, transmit, and distribute electricity to residential, commercial, industrial, and institutional customers. The Edison Electric Institute is the association of U.S. shareholder-owned energy companies, international affiliates, and industry associates. The National Rural Electric Cooperative Association is the association of nonprofit energy cooperatives supplying central station service through generation, transmission, and distribution of electricity to rural areas of the United States. The American Public Power Association is the national trade association that represents publicly-owned (units of state and local government) energy utilities in 49 states representing 16 percent of the market. UWAG's purpose is to participate on behalf of its members in EPA's rulemakings under the CWA and in litigation arising from those rulemakings.

The Merrimack decision *should not* be precedent for any other plant, as the Fact Sheet recognizes:

> This is a site-specific, case-by-case determination based on the facts at Merrimack Station and this determination neither applies to nor establishes that this technology is that BAT at any other facility or group of facilities.

Fact Sheet at p. 6. UWAG agrees with this statement.

However, EPA customarily says that a single case, even from a pilot plant study or a different industry, can establish BAT for an entire industry:

> The Agency retains considerable discretion in assigning the weight to be accorded these factors. *Weyerhaeuser Co. v. Costle*, 590 F.2d 1011, 1045 (D.C. Cir. 1978). Generally, EPA determines economic achievability on the basis of the effect of the cost of compliance with BAT limitations on overall industry and subcategory financial conditions. BAT may reflect the highest performance in the industry and may reflect a higher level of performance than is currently being achieved based on technology transferred from a different subcategory or category, bench scale or pilot plant studies, or foreign plants. *American Paper Inst. v. Train*, 543 F.2d 328, 353 (D.C. Cir. 1976); *American Frozen Food Inst. v. Train*, 539 F.2d 107, 132 (D.C. Cir. 1976). BAT may be based upon process changes or internal controls, even when these technologies are not common industry practice. *See American Frozen Foods*, 539 F.2d at 132, 140; *Reynolds Metals Co. v. EPA*, 760 F.2d 549, 562 (4th Cir. 1985); *California & Hawaiian Sugar Co. v. EPA*, 553 F.2d 280, 285–88 (2nd Cir. 1977).

78 Fed. Reg. 34,432, 34,438 col. 2 (June 7, 2013); Technical Development Document for the Proposed Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category, EPA-821-R-13-002 (April 2013) at 1-3 to 1-4.

Hence a decision to require a brine concentrator and two crystallizers in addition to a physical/chemical precipitation treatment system for FGD wastewater at Merrimack could be taken as showing what technology is "best," apart from cost. And if the cost at Merrimack is

greater than $404 per TWPE, as it assuredly is, this decision will set a new high-water mark for what EPA regards as "cost-effective."

For this reopened comment period Region I proposes to require, instead of biological treatment, a brine concentrator and two crystallizers that are already at the plant (Fact Sheet at p. 5). Supposedly based on this existing technology, the Region also proposes to prohibit the discharge of any FGD wastewater.

For the reasons given below, UWAG submits that the draft permit requires more than is required by Clean Water Act § 301 and is inconsistent with EPA's past practice in setting technology-based effluent limitations and national effluent limitations guidelines.

I. History of Merrimack's FGD System and NPDES Permit Proceedings

Merrimack Station, responding to a new state law requiring wet FGD scrubbers for coal plants, completed construction of an FGD scrubber in September 2011. Merrimack planned to discharge the wastewater from the scrubber and therefore filed a supplement to its pending NPDES renewal application in 2010. The supplement requested authorization for the discharge. Merrimack planned to treat the FGD wastewater using a physical/chemical precipitation system before discharging it. That system, which includes an Enhanced Mercury and Arsenic Reduction Filtration system (EMARS), was completed in late 2011.

While Merrimack focused on having technologies to reduce environmental impacts, it did not neglect its compliance obligations. After it filed the 2010 supplement to its NPDES permit application, PSNH officials tried to coordinate with Region I to secure a final revised permit. However, despite the concerted efforts of PSNH since 2010, Region I did not take action on the requested NPDES permit revisions. In September 2011 – about the same time PSNH finished constructing the scrubber – Region I issued a draft permit in which it proposed a "best

professional judgment" (BPJ) determination for FGD wastewater that would have required not only physical/chemical precipitation but also a biological treatment system.

But without a final, revised permit, PSNH in the meantime was forced to consider other methods of compliance. Since the scrubber began operating, PSNH has contrived a means of compliance based primarily on shipping FGD wastewater offsite. To make offsite shipment at all feasible, PSNH investigated technologies to reduce the volume of wastewater needing to be shipped. As a result of those investigations, PSNH eventually decided to install a brine concentrator and crystallizer system as additions to its existing FGD wastewater treatment system. First PSNH installed a brine concentrator plus crystallizer system that came online in February 2012. That system was then modified to add a second crystallizer in June 2012.

Adding the brine concentrator and crystallizers did not transform the FGD system into a "zero liquid discharge" system. Merrimack's brine concentrator/crystallizer design always contemplated a purge stream, and it operates with a purge stream to this day.

The terminology of FGD technologies can be confusing. A primary treatment system like the one at Merrimack can be called a "physical-chemical" treatment system or a "physical-chemical precipitation" system. A few plants have added a "biological" treatment system, optimized to remove one or a small number of pollutants, to their existing physical-chemical treatment systems. An even smaller number of plants have a physical-chemical system followed by a brine concentrator (also known as a vapor-compression evaporation system or VCE). Merrimack has the only VCE-plus-crystallization system used for FGD wastewater in the United States. Several other VCE-plus-crystallization systems operate in Italy.

Using the terminology "zero liquid discharge" or "ZLD" for Merrimack is misleading. In a very few instances, brine concentrator and crystallizer systems are designed to be completely

dry with no liquid discharge. But in most cases – including Merrimack's – VCE-plus-crystallization systems are designed with purge streams. In those cases, the purge stream must be disposed of or otherwise managed.

In a span of just a few years, Merrimack installed an air scrubber and very advanced technologies to treat wastewater from the scrubber. There is no doubt that the environment benefitted from Merrimack's quick work, which resulted in significantly reduced air and water emissions. Whether Merrimack also benefitted from incentives related to construction of the scrubber is irrelevant to the health of the environment. But rather than reward Merrimack's efforts, Region I has determined to eliminate the small purge stream from the FGD system and proposes to deny Merrimack any flexibility in its handling. This is an unjust, arbitrary and capricious decision, as discussed below.

II. Region I's BPJ Approach Is Unwarranted

A. Where Existing ELGs Apply, BPJ Determinations Are Inappropriate

As UWAG has commented before, once EPA has adopted effluent limitations guidelines (ELGs) for an industry category, the authority of permit writers to set additional limits is limited. EPA has adopted national effluent limitation guidelines for steam electric plants in 40 C.F.R. Part 423. In particular, "wastewaters from wet scrubber air pollution control systems" are regulated as "low volume waste sources" (40 C.F.R. § 423.11(b)), and low volume wastes have new source performance standards for total suspended solids, oil and grease, pH, and PCBs (40 C.F.R. §§ 423.15(a)-(c)).

Section 402(a)(1) of the Clean Water Act authorizes BPJ limits "*prior to* the taking of necessary implementing actions relating to all such requirements…." 33 U.S.C. § 1342(a)(1) (emphasis added). By its terms, this authorizes – and does not compel – EPA to set BPJ limits

only as "necessary" and only "prior to the taking of necessary implementing actions." 33 U.S.C. § 1342(a)(1).

Ordinarily this means before industrywide guidelines have been promulgated. *See Catskill Mts. Chapter of Trout Unlimited, Inc. v. City of New York*, 451 F.3d 77, 85 (2d Cir. 2006), *cert. denied*, 549 U.S. 1252 (2007); *NRDC v. EPA*, 863 F.2d 1420, 1424 (9th Cir. 1988) (EPA may establish BPJ limits where "industry-wide guidelines have not yet been promulgated"); *NRDC v. EPA*, 859 F.2d 156 (D.C. Cir. 1988); *Citizens Coal Council v. EPA*, 447 F.3d 879, 891 n.11 (6th Cir. 2006) (BPJ applies "where the EPA has not promulgated an applicable guideline"); *Am. Mining Cong. v. EPA*, 965 F.2d 759, 762 n.3 (9th Cir. 1992) (EPA is authorized to develop BPJ limits when it has "not yet issued national effluent guidelines for a category of point sources"); *NRDC v. EPA*, 822 F.2d 104, 111 (D.C. Cir. 1987) (the permit writer is authorized to use BPJ if "no national standards" have been promulgated for a particular category of point sources).

EPA Region I appears to read § 402(a)(1) of the Act as giving it discretion to impose additional requirements on a wastestream already regulated by the national guidelines. But this is not what is authorized by the Act or EPA's implementing regulations (40 C.F.R. §§ 125.3(c)(2), (3)).

B. The Hanlon Guidance Does Not Mandate a BPJ Approach

Region I's decision to propose FGD limits appears to rely on EPA documents that are not law but merely "guidance." *See, e.g.*, Fact Sheet at pp. 14-15 (citing to the 2011 Fact Sheet, Attachment E, which relies heavily on the so-called "Hanlon Memorandum," as further described below).

As of about June 17, 2010, EPA published on its website a memorandum from James A. Hanlon to EPA Water Division Directors for the Regions. Memorandum, James A. Hanlon to

Water Division Directors, Regions 1-10, "National Pollutant Discharge Elimination System (NPDES) Permitting of Wastewater Discharges from Flue Gas Desulfurization (FGD) and Coal Combustion Residuals (CCR) Impoundments at Steam Electric Power Plants" (June 7, 2010). But the Hanlon Memorandum is not legally binding, and says so on its face. It is basic textbook law that agency "guidance" is not binding, and Attachments A and B to the Hanlon Memorandum have a "disclaimer" saying they are not legally enforceable and do not impose legal obligations.

An agency pronouncement, whether it is called "policy" or "interpretation" or "guidance," cannot be used as a "binding norm" (have "binding effect") unless it has been promulgated with notice-and-comment rulemaking procedures (which the Hanlon Memorandum has not). *McLouth Steel Products Corp. v. Thomas*, 838 F.2d 1317, 1320-23 (D.C. Cir. 1988); *Cement Kiln Recycling Coal. v. EPA*, 493 F.3d 207, 226-27 (D.C. Cir. 2007) (three-factor test for when a guidance is a "rulemaking"); *S. Org. Comm. for Econ. & Soc. Justice v. EPA*, 333 F.3d 1288 (11th Cir. 2003); *Appalachian Power Co. v. EPA*, 208 F.3d 1015, 1020 (D.C. Cir. 2000) (criticizing lawmaking by "guidance" documents); *Mortgage Bankers Ass'n v. Harris*, 720 F.3d 966 (D.C. Cir. 2013) (agency cannot change a "definitive interpretation" without notice-and-comment rulemaking), *cert. granted sub nom. Perez v. Mortgage Bankers Ass'n*, 2014 U.S. LEXIS 4728 (U.S. July 21, 2014).

In *NRDC v. EPA*, 643 F.3d 311 (D.C. Cir. 2011), the D.C. Circuit held that EPA violated the Administrative Procedure Act by relying on interpretive guidance, rather than a regulation, to allow states to propose alternatives to required fees for ozone non-attainment areas. Whether a guidance memorandum is an impermissible attempt to make a "legislative rule" or an allowable "policy statement" depends partly on whether it uses mandatory terms and partly on whether it

has been applied as if binding. *See Nat'l Mining Ass'n v. McCarthy*, 2014 U.S. App. LEXIS 13156 *22-26 (D.C. Cir. July 11, 2014).

The Hanlon Memorandum, by these tests, is an impermissible attempt to make a binding rule. In particular, it says that States "must include technology-based effluent limitations … for pollutants not addressed by the effluent guidelines for that industry" (Hanlon Memorandum, Att. A, p. 2). This creates a new requirement and changes the previous law of effluent limitations guidelines. Moreover, the Memorandum is being applied to the Merrimack Station as though it were a requirement.

As the D.C. Circuit says, when an agency applies a policy statement ("guidance"), it must be prepared to support the policy just as if the policy statement had never been issued. *Nat'l Mining Ass'n v. McCarthy*, 2014 U.S. App. LEXIS 13156 *25. Here, in contrast, Region I treats the Hanlon Memorandum as if it were obligatory. For that reason alone the proposed BPJ determination needs to be reconsidered.

III. The Secondary Treatment System at Merrimack Is *Not* Designed to Be "Zero Discharge"

The Merrimack FGD secondary wastewater treatment system, though using crystallizers, was designed with a purge stream. Having the purge stream means there is still wastewater that needs to be handled at the end of the treatment system. As such, it is not a "zero liquid discharge" system. Furthermore, it is clear from the record that Merrimack never intended to operate its system as a zero liquid discharge system. If it had, it would not have continued to press for a revised NPDES permit.

The Merrimack secondary treatment system was designed with a purge stream as an integral part of the design. Indeed, we understand that the manufacturer Aquatech anticipates such a purge stream in its written operating procedures.

There are several reasons why purging the system is necessary:

1. When the plant burns coal with high chloride, the chloride level in the absorber rises. Effluent from the absorber goes to the physical-chemical treatment system, where most of the chlorides are converted from calcium chloride to sodium chloride. This stream then goes to the brine concentrator and then to the crystallizers. The chlorides must be precipitated as crystals and removed as salt cake or purged. If there is more chloride in the fuel than the salt press can remove, it must be purged.

2. Crystallizer 2 must be periodically purged to remove calcium chloride, magnesium chloride, sodium sulfates, and nitrates. If not purged, the build-up of these highly soluble constituents in the second-stage crystallizer raises the actual boiling point, causing Boiling Point Elevation or BPE. BPE in turn causes shutdown of the first-stage crystallizer due to elevated temperature and pressure.

3. Because magnesium chloride and calcium chloride have higher solubilities than sodium chloride, chloride levels can increase higher than design. High chloride concentrations cause crystallizer corrosion, which can cause a vessel to fail.

4. Sodium sulfate is more soluble than sodium chloride, and so sodium sulfate can build up in crystallizer 2 if it is not purged. Sodium sulfate can form complexes like glauberite ($Na_2Ca(SO_4)_2$) that decrease efficiency and plug flow paths. Glauberite is a sticky solid that sticks to heat transfer surfaces, reducing both flow area and effluent circulation. On two occasions in February and March 2013 accumulations of sticky solids plugged all the flow surfaces in crystallizer 2 at Merrimack. This plugging required, among other things, waterblasting of all crystallizer 2 components. Since the two crystallizers are linked, while crystallizer 2 is being cleaned only the brine concentrator can operate, and about 10 gpm of purge is required with no salts going to salt cake. Also, glauberite decreases heat transfer efficiency and requires higher effluent temperatures, which put higher pressure on crystallizer 1 and can require the system to be shut down to protect the crystallizer 1 vessel.

5. Chemicals other than sodium chloride that do not precipitate build up in crystallizer 2. When pH is low, halogens can be released from crystallizer 2 as gases. These gases can build up pressure in the vessels or expose personnel and become a safety concern. Other chemicals in crystallizer 2 can form acids. If they accumulate, they lower the pH in crystallizer 2 and cause the off-gasing of halogens mentioned above. The solution to the problem is to purge some effluent from crystallizer 2.

As the Fact Sheet makes clear, Merrimack has had to arrange for offsite disposal of its FGD wastewater on a regular basis. The Fact Sheet documents 21 FGD wastewater disposal shipments from June 2012 (start-up of the second crystallizer) to March 2014. Fact Sheet at pp. 23-25. Thus the existing treatment system is not a true ZLD system.

IV. Using the FGD Purge to Condition Ash Is Not Feasible for Merrimack

Region I suggests that Merrimack could use the purge stream to condition ash before landfilling it:

> In the future, Merrimack Station could potentially use this multi-faceted approach to comply with the proposed NPDES permit conditions precluding the Facility from directly discharging its FGD wastewater to the Merrimack River. Under all of the three scenarios – (1) operating the SWWTS as a true ZLD system that eliminates wastewater discharges by enabling reuse of the distillate in the FGD scrubbers, (2) hauling wastewater for disposal at municipal wastewater treatment plants, or (3) using treated FGD wastewater for ash conditioning prior to landfilling – Merrimack Station would have no direct discharges of FGD wastewater to the Merrimack River.

Fact Sheet at p. 50 (footnote omitted); *see also id.* at p. 49.

In fact, this will not work, because the quantity of purge water cannot be counted on to match the quantity of ash that needs conditioning. The volume of the purge stream depends on the chloride content of the coal, which varies widely. Also, the volume of the purge stream increases when one or more of the secondary treatment components are shut down for cleaning. The quantity of ash, on the other hand, depends on the ash content of the coal and on how much ash is fly ash and how much bottom ash. There is virtually no correlation between the volume of fly ash and the volume of the purge water at Merrimack. Merrimack's wet bottom cyclone boiler produces about 20% fly ash and 80% bottom ash. There is not enough fly ash to use all the purge water for fly ash conditioning.

Region I cites Kansas City Power and Light's Iatan facility and Duke Energy's Mayo facility as examples of plants that have installed, or plan to install, a brine concentrator (*i.e.*, a VCE system) and use the purge water to condition fly ash. *See* Fact Sheet at pp. 17-18. But Merrimack is easily distinguishable from those plants because of the relatively small amount of

fly ash it produces. Iatan and Mayo are in no way precedents for Merrimack because the Merrimack cyclone boiler produces much less fly ash.

Moreover, to optimize the disposal of coal ash, the plant's goal is always to increase the quantity of bottom ash relative to fly ash. Relying on fly ash to manage FGD purge water works contrary to this goal.

Changing the generation of fly ash or the amount of purge water to suit the needs of the other system, when there is no operational link between the two, would be poor engineering and could well harm the overall system.

Additionally, as Region I notes, disposing of fly ash conditioned with purge water in a landfill may give rise to other hurdles (*see* Fact Sheet at p. 49), including securing permits and managing landfill leachate. For all these reasons, using FGD purge water for fly ash conditioning is not a viable option for Merrimack.

V. Continuing to Truck Purge Water Offsite Is Not a Feasible Solution

It is clear Region I would like for Merrimack to continue operating its VCE-plus-crystallization system. But Region I cannot simply ignore the purge water. The purge stream cannot be used to condition fly ash, for the reasons cited above, and it is not feasible to haul the purge water offsite indefinitely. Public Service of New Hampshire never intended offsite disposal of FGD purge water to be a long-term solution; in terms of operations and maintenance costs, PSNH anticipated that the expense of hauling the purge water and paying for its disposal at POTWs would be short-term and would cease once the company obtained a new NPDES permit. Since the primary (physical-chemical) treatment system alone removes the great majority of pollutants in the FGD wastewater stream, Merrimack reasonably believed it would be able to secure a permit to discharge the purge water.

Unless Merrimack is able to secure an NPDES permit that will allow discharge of the purge stream, it will have to continue trucking off the purge water. This is not inconsistent with statements PSNH has made about continuing to operate its VCE-plus-crystallization system "on a permanent basis to complement the primary treatment system." *See* Fact Sheet at p. 26 (quoting William H. Smagula, PSNH Director of Generation). As we have said repeatedly, the VCE-plus-crystallization system was designed to produce a purge stream.

Having to rely on offsite disposal creates great uncertainty for Merrimack. As Region I has noted, it remains concerned about the discharge of the purge water at offsite locations. Fact Sheet at p. 49. If Merrimack's permit prohibits FGD wastewater discharges, then Merrimack will have no choice but to continue with offsite disposal. If the current disposal sites become unavailable, then continued operation of the FGD wastewater system will be impossible.

VI. The Costs of FGD Wastewater Treatment, Except Physical-Chemical Precipitation, Are Excessive

EPA's NPDES rules provide that, when setting BPJ limits, the permit writer must consider the same things EPA must consider when EPA sets national guidelines:

> The permit writer shall apply the appropriate factors listed in § 125.3(d) [listing the Clean Water Act statutory factors for each type of ELG] and shall consider:
>
> (i) The appropriate technology for the category or class of point sources of which the applicant is a member, based upon all available information; and
>
> (ii) any unique factors relating to the applicant.

40 C.F.R. § 125.3(c)(2). For BAT requirements, the statute and the regulation specifically require the permit writer to consider the "cost of achieving such effluent reduction" as well as the age of equipment and facilities involved, the processes employed, the engineering aspects of various controls, process changes, and non-water quality environmental impacts including

energy requirements. CWA § 304(b)(2)(B); 40 C.F.R. § 125.3(d)(3). *See also* EPA NPDES Permit Writers' Manual (2010) pp. 5-46 to 5-47.

For decades, EPA has used cost-effectiveness as a primary factor in establishing national ELGs.[2] Cost-effectiveness, in this context, is the dollar cost of treatment divided by the number of pounds of pollutants removed, where the pounds of pollutant are expressed as toxic weighted pound-equivalents, or TWPEs. In EPA's proposed revisions to the steam electric effluent guidelines, EPA reaffirmed its commitment to its traditional cost-effectiveness analysis and again used this method to compare the effectiveness of candidate technologies in removing pollutants to the overall costs of implementing those technologies. 78 Fed. Reg. at 34,503. When UWAG used EPA's methods to examine the cost-effectiveness of the Merrimack candidate technologies, the results definitively demonstrated that Merrimack's VCE-plus-crystallization system was not cost-effective in terms of dollars per TWPE.

[2] Region I says that it "may" – but does not have to – consider the relative cost-effectiveness of available technology options. Fact Sheet at p. 28. However, Region I subsequently decides that it need not consider costs in detail because it claims to be basing the proposed permit requirements on Merrimack's existing treatment system, which it describes as the "existing primary FGD wastewater treatment system (which includes physical/chemical treatment components and the EMARS system) combined with its existing secondary FGD wastewater treatment (which includes the two-stage evaporation system which can be operated to achieve ZLD)." Fact Sheet at pp. 40-41. As we have explained, Region I's assumption that the existing system can achieve ZLD is erroneous. Therefore, Region I has failed to consider the actual costs of achieving ZLD at Merrimack. Further, a cost-effectiveness analysis is appropriate in this case because Region I's proposed ZLD requirement is beyond what can be achieved with the existing technology.

A. Dollars per TWPE for Merrimack

When setting technology-based effluent limits, EPA is obligated to consider "cost." UWAG performed its own $/TWPE calculations and found that the cost of the Merrimack secondary system is enormous,[3] compared to what EPA has required in the past:

UWAG Calculation of $/TWPE for Merrimack Station

Treatment	**$/TWPE $1981**
CP Removal	$370
Biological Removal	$21,698
VCE plus Crystallizer Incremental Removal (Capital and O&M Costs)	$4,490
VCE plus Crystallizer Incremental (O&M Costs Only)	$1,767

See Attachment 1 to these comments (UWAG calculation of $/TWPE).

These excessive costs disqualify the VCE-plus-crystallization system from being BAT based on EPA's own metric for determining cost-effectiveness.

B. EPA Precedent on Cost-Effectiveness

In national ELG rulemakings, EPA's Office of Water has never required facilities to spend more than $404 per TWPE. EPA itself, in the ELG rulemaking for the steam electric industry, cited the highest cost per TWPE as $404 in 1981 dollars:

> A review of approximately 25 of the most recently promulgated or revised BAT limitations shows BAT cost-effectiveness ranging from less than $1/lb-eq (Inorganic Chemicals) to $404/lb-eq (Electrical and Electronic Components), in 1981 dollars.

[3] In its February 2012 comments on the first draft Merrimack permit, UWAG generated preliminary cost-per-TWPE numbers. At that time UWAG used preliminary Merrimack metals data and technology costs from other sites. Since submitting those comments UWAG has collected better information on Merrimack pollutant loadings and its actual capital and operations and maintenance costs for the existing chemical precipitation, EMARS, brine concentrator, and crystallizers. Therefore, the cost-per-TWPE calculations in these comments supersede and replace those in our earlier comments.

78 Fed. Reg. at 34,504 col. 1-2. Typically the cost has been less than $200. 68 Fed. Reg. 25,686, 25,701 col. 3 (May 13, 2003).

In past ELG rulemakings EPA published a table of cost-effectiveness estimates by industry category. Four cost-effectiveness analyses, dated 1996-2000, showed the highest cost per equivalent pound (that is, pound of pollutant adjusted for toxicity) to be $404 in 1981 dollars.[4] *See* Attachment 2.

In the rulemaking for Metal Products and Machinery (MP&M), EPA determined that a technology was not BAT when it had a cost of $1000/PE because this was "substantially greater" than what EPA had typically imposed for BAT technology in other industries, generally less than $200/PE. 68 Fed. Reg. at 25,701 col. 3; *see also id.* at 25,702 col. 2. In the same rulemaking, EPA said that $455/PE was "very expensive per pound removed." EPA's "Development Document for the Final Effluent Limitations Guidelines and Standards for the Metal Products and Machinery Point Source Category," EPA-821-B-03-001 (Feb. 2003) (MP&M Development Document) at 9-21 to -22. A cost of $420/PE was "quite expensive." *Id.* at 9-13.

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[4] *See* EPA, "Cost Effectiveness Analysis of Final Effluent Limitations Guidelines and Standards for the Coastal Subcategory of the Oil and Gas Extraction Point Source Category," EPA-821-R-96-021 (October 1996), Table 5-1 at 5-2 to 5-3, available at http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=200035QV.txt; EPA, "Economic Analysis and Cost- Effectiveness Analysis of Proposed Effluent Limitations Guidelines and Standards for Industrial Waste Combustors" [for proposed rule], EPA 821-B-97-010 (January 1998), Tables 4-1 and 4-2 at C-E 4-2 and C-E 4-3, available at http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=20002HH8.txt; EPA, "Cost-Effectiveness Analysis of Proposed Effluent Limitations Guidelines and Standards for the Metal Products and Machinery Industry" [for proposed rule], EPA-821-B-00-007 (December 2000), Table 7 at 10, available at http://water.epa.gov/scitech/wastetech/guide/mpm/upload/2001_01_10_guide_mpm_proposal_mpm_ce.pdf; EPA, "Cost-Effectiveness Analysis of Effluent Limitation Guidelines and Standards for the Centralized Waste Treatment Industry" (undated but listed in support of final rule of December 2000), Table 4-2 at 4-3, available at http://water.epa.gov/scitech/wastetech/guide/cwt/index.cfm; *see also* EPA, "Cost-Effectiveness Analysis of Effluent Limitations and Standards for the Nonferrous Metals Forming and Metal Powders Industry," PB93158970 (August 1985), Table 3.7 at 3-15.

UWAG's own review of the historic record agrees with EPA's. In the UWAG comments in the steam electric rulemaking, UWAG agreed with EPA that EPA has typically imposed costs of less than $200/TWPE and no more than $404 (in 1981 dollars). Indeed, UWAG submitted a report by the National Economic Research Associates (NERA) showing that the mean cost has been only $47/TWPE and the median $15/TWPE. NERA Economic Consulting, "Cost-Effectiveness Analyses of EPA's Proposed Effluent Limitations Guidelines and Standards for Steam Electric Power Plants (September 2013), Attachment 14 of UWAG Comments on EPA's Proposed Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category, EPA-HW-OW-2009-0819-4655-Att. 14, p. 3.

In summary, EPA's own precedents for what is "cost-effective" are as follows:

EPA Determination	**$/TWPE ($1981)**	**EPA Characterization**
Not BAT	$1000	Too costly to be BAT
	$455	Very expensive
	$420	Quite expensive
BAT	$404	Highest cost determined to be BAT
	<$200	Generally for BAT

C. Region I Apparently Conducted a Cost-Effectiveness Analysis but Did not Put the Results on the Record

In short, there is long-established precedent for cost-effectiveness analysis in developing ELGs. Region I is well aware of this precedent, and the record discloses that Region I took steps toward a cost-effectiveness analysis.[5] Merrimack No. 1057 is titled "Pollutant Reduction Data and Calculations (Merrimack)," dated March 27, 2014, and, according to the index, was authored

[5] For the draft 2011 Merrimack permit, Region I relied on pollutant reductions and cost-per-pound-removed figures developed by EPA headquarters. *See* Merrimack No. 118 (Memo from R. Jordan to S. DeMeo, dated Sept. 13, 2011). UWAG's February 2012 comments explained in detail why EPA's estimates were not likely to be accurate.

by EPA. The document provides pollutant-by-pollutant reduction calculations for a "baseline" condition as well as for several different technology configurations: chemical precipitation, biological treatment, and "evaporation." The last page contains the following information:

Merrimack Station Estimated Pollutant Removals/Technology Option

	[Sums of loadings for each technology option, as indicated on preceding pages]	**TWPE/year [Removals]**
Baseline	5098	
Chemical Precipitation	2208	2890
Biological	639	4459
Evaporation	49	5049

Apparently this document represents Region I's attempt to calculate and compare pollutant reductions from the candidate FGD technologies. But Region I has not used the best available data for its analysis. Although the heading of the last page of the document is "Merrimack Station Estimated Pollutant Removals/Technology Option," most – if not all – of the pollutant loadings appear to be EPA Headquarters' values developed for the proposed ELG rule. EPA derived these values using characterization data from a variety of plants. For example, the "baseline" loadings used by Region I can be found in Table 10-3 of EPA's Incremental Costs and Pollutant Removals for the Proposed Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category (EPA ICPR) (EPA-HQ-OW-2009-0819-2256). Most of the other pollutant loadings also come from the EPA ICPR. *See* EPA ICPR Tables 10-6 (chemical precipitation), 10-7 (biological), and 10-8 (vapor-compression evaporation). Therefore, Region I's attempt to derive pollutant loadings is not specific to Merrimack and thus not as accurate as UWAG's.[6]

[6] Also, EPA Headquarters' pollutant loadings from the ICPR have been shown by UWAG to be incorrect due to inappropriate use of data points from different plants (*i.e.*,

The next steps in any cost-effectiveness analysis would be to (1) calculate the cost of each technology and then (2) divide the cost of each technology by the total pounds of pollutants removed by the technology to arrive at the cost per TWPE. While there are some documents that contain information about costs of technologies in the record (*see* Fact Sheet at pp. 41-42), there does not appear to be any documentation of cost per TWPE, which is the basic metric that EPA uses for evaluating technologies for national-level ELGs.

Region I does not explain why it computed pollutant loadings for the individual technologies but did not take the remaining few steps to arrive at a cost per TWPE. If Region I estimated the costs per TWPE for the technologies at issue, that information should be put in the record. Without Region I's assessment of cost-effectiveness, the record of its consideration of costs (a statutory factor that must be evaluated in any BPJ decision) is incomplete.

D. UWAG's Cost-Effectiveness Analysis Demonstrates that the Existing FGD Treatment System Is Not BAT

To evaluate the technology choices for Merrimack, UWAG estimated the cost effectiveness of Merrimack's existing chemical precipitation system with its EMARS system add-on, incremental biological treatment, and incremental VCE plus crystallization. *See* Attachment 1. UWAG used the following inputs for its analysis:

1. For FGD influent data, UWAG used the average of five days of sampling documented in the *ACG Performance Test Report for FGD Wastewater Treatment System of Units 1 and 2 at PSNH Merrimack Station* (June 1, 2012), and the average of non-softening data of Stream A, Merrimack Station, for ammonia, nitrate, cyanide, boron, calcium, cobalt, sodium, molybdenum, tin, titanium, and vanadium. *See* Attachment 3, Table 7, p. 14.

2. For physical/chemical effluent data, UWAG used the average of five data points of Stream A (without softening), collected at Merrimack Station in 2012. *See* Attachment 4. For magnesium, we used the physical/chemical effluent data in the

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calculation of artificial removals due to mismatched data). *See* UWAG Comments on EPA's Proposed Steam Electric ELG Rule (EPA-HQ-OW-2009-0819-5450) pp. 132-37.

ACG Performance Test Report for FGD Wastewater Treatment System of Units 1 and 2 at PSNH Merrimack Station (June 1, 2012). *Id. See* Attachment 3.

3. For biological treatment effluent, UWAG used data from Table 10-7, *EPA's Technical Development Document for the Proposed Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category*, EPA-821-R-13-002 (April 2013). We assumed biological treatment removals consistent with Duke's Belews Creek and Allen biological treatment systems. Constituents with removals greater than 20% at both plants were assumed to be removed.

4. For data below the method detection limit (MDL), the actual MDL value was used to estimate the concentration of the constituent.

5. UWAG conservatively assumed there was no purge from the VCE/crystallizer system, even though the actual purge flow is, on average, 3 gpm. Also, UWAG assumed that the distillate/condensate would be reused in the plant and not discharged or managed separately for disposal.

6. UWAG used a 40% capacity factor, which represents the average capacity factor for Merrimack during 2012. The 2012 capacity factor is appropriate to use because the influent and effluent data used in the analysis were collected during 2012.

7. UWAG based its annual costs on a 15-year service life and 7% rate of interest.

8. UWAG based its capital costs on the actual Merrimack costs for its primary and secondary FGD treatment systems. The biological capital cost is based on EPRI's model, using a 50-99 gpm maximum design flow, as documented in EPRI's comments on the proposed ELG rule (EPA-OW-HQ-2009-0819-4499). The capital costs are as follows:

Treatment System	**Capital Costs (in $M, 2011)**
Physical/chemical + EMARS	19.3
Biological (estimated from EPRI model)	9.0
Softening, VCE/Crystallizer	35.3

9. For operation and maintenance costs, UWAG used actual costs provided by Merrimack for the primary and secondary treatment systems. For the biological treatment system estimate, we based O&M costs on the EPRI model, and used a 38 gpm average flow rate. The O&M costs per system were as follows:

Treatment System	**O&M Costs ($M, 2011)**
Chemical precipitation + EMARS	1.84
Biological (estimated from EPRI model)	0.53
Softening, VCE/Crystallizer	2.52

10. To calculate Merrimack's energy penalty for the VCE-plus-crystallization system, UWAG used the New England ISO average wholesale electricity price for December 2013 through March 2014. The resulting energy penalty for the system is included in the O&M costs in the table above.

11. Total annualized costs were converted to 1981 dollars to compare cost-effectiveness (in terms of $/TWPE) to EPA's most recent 25 BAT determinations in national effluent guidelines rulemakings across various industrial categories. The conversion factor was obtained from Engineering News Record, Construction Cost Index, http://enr.construction.com/economics/historical_indices/construction_cost_index_history.asp

Based on these factors and assumptions, UWAG calculated TWPEs removed and cost per TWPE:

System	**TWPEs Removed**	**$/TWPEs ($1981)**
Chemical Precipitation + EMARs Removal	4,168	$370
Incremental Biological Removal	27	$21,698
Incremental VCE plus Crystallizer Removal	555	$4,490
Incremental VCE plus Crystallizer Removal (O&M costs only)	555	$1,767

As is evident, only chemical precipitation (plus EMARS) is within the bounds of what EPA considers to be cost effective (*i.e.*, $404 or less in 1981 dollars). Both incremental biological treatment and incremental treatment by a VCE and crystallizer are well outside the upper bound of cost effectiveness. When we consider *only the recurring operations and maintenance costs for the brine concentrator and crystallizer part of the treatment system,* we find that the O&M alone is $1,767 per TWPE, *more than four times EPA's upper limit* for cost-effectiveness. Thus the actual costs that Merrimack *continues to incur* for operations and maintenance for just one part of the FGD treatment system is so high that it renders the system not cost-effective in terms of dollars per TWPE. Since the chemical precipitation portion of the system removes, conservatively, about 88% of the total pollutant loading, it is not surprising that the cost of removing the remaining load is very high on a per-pound basis.

Region I should have finished its cost-effectiveness analysis and presented it for review by the public. Since it has not, UWAG's cost-effectiveness analysis – which closely tracks EPA's methods of measuring cost-effectiveness for ELGs and uses Merrimack-specific data – is the best evidence of the various technologies' cost-effectiveness, and it indicates that the VCE plus crystallizer portion of the system is *not* cost-effective. It also shows that adding a biological treatment system to Merrimack's current system would not be cost-effective.

Region I is required by law to engage in reasoned decisionmaking, and yet it purports to base its decision on cost estimates wildly out of line with precedent, based on UWAG's analysis. If Region I continues to endorse the VCE plus crystallizer as BAT for Merrimack, it would be tantamount to setting a new upper limit for "acceptable" costs per TWPE. For these reasons Region I's choice of the VCE plus crystallizer as "BAT" technology is arbitrary and capricious and not in accordance with law.

VII. Region I's Proposed Decision Is Based on a Fait Accompli rather than by the Traditional Factors for BAT

It is clear from the Region's explanation in the Fact Sheet and the Region's rationale for prohibiting the discharge of FGD wastewater that the permittee has already installed a VCE-plus-crystallization system. But as we have explained, it was Region I's unwillingness to set NPDES limits in a timely way that forced the permittee to install advanced treatment or else stop operating the plant.

Hence Region I's decision can be defended only as a unique circumstance where EPA is making a requirement only of what is already installed. In such a case the decision causes no harm (or so Region I imagines) because the money has been spent and the incremental cost of the requirement should be close to zero.

But the facts are different. The proposed permit does not accept the already-installed system as it is but demands that it be "zero discharge" without a purge stream. The permit ¶ 4 (p. 6) says simply that "the permittee is *not* authorized to discharge treated effluent from the Flue Gas Desulfurization System Waste Treatment Plant." But the assumption that the existing system is "zero discharge" is contrary to fact, as we have explained. As a result, the zero-discharge requirement imposes costs the Region has not even begun to consider. Those costs include ongoing expensive operations and maintenance costs and the continued cost of offsite disposal of the purge water.

VIII. Region I's Reliance on Other Plants as Precedent Is Misplaced

Region I cites as precedents several power plants that use some portion of a VCE system, but those facilities, by and large, are readily distinguishable from Merrimack. Furthermore, UWAG agrees with Region I that a BPJ approach requires a site-specific analysis. *See* Fact Sheet at p. 31. The whole purpose of a BPJ approach is to address what is BAT for the individual facility, not for the industry as a whole. The following is a brief catalog of the differences between Merrimack and the other cited plants.

First, Region I agrees that Iatan differs from Merrimack in three important ways:

> Region I acknowledges that there are several differences between the Iatan VCE system and the system installed at Merrimack Station. Iatan has 1) a brine concentrator, but no crystallizers, 2) fly ash that is conditioned with concentrated brine solution and disposed of in an on-site landfill, and 3) a different primary coal source.

Fact Sheet at p. 31.

But Region I concludes that "despite these differences, the most salient fact is that both the Iatan and Merrimack Station facilities have been able to apply VCE technology in a particular way to their respective FGD wastewaters." *Id.* UWAG disagrees that mere

application of VCE technology – without a more rigorous analysis – is the important fact. Region I waves away significant differences. As we have already shown, it is significant that Merrimack is unable to use its purge water to condition fly ash, as Iatan does. That difference has led to the short-term solution of hauling the purge water offsite, which increases costs to Merrimack and complicates operation of the site through increased truck traffic. Moreover, Kansas City Power and Light has called its VCE system a "work in progress" that is "technologically challenging." KCP&L's Comments on EPA's Proposed Steam Electric ELG Rule (EPA-HQ-OW-2009-0819-5406) pp. 5-6. KCP&L states:

> The complex chemistry involved has made keeping the system on-line challenging even for the small bleed system that is being treated at KCP&L's Iatan Generating Station. Costs of this treatment technology have been significant and continue to grow to achieve the necessary system reliability. Given the high costs and reliability issues, ZLD should not be considered Best Available Technology for FGD wastewater at this time.

Id. at 6.

Like Iatan, Mayo also plans to use its brine concentrator purge water to condition fly ash. But unlike Merrimack, Mayo has a pulverized coal boiler and plans to burn eastern bituminous coal which generates approximately 80% fly ash and 20% bottom ash. Therefore, Mayo is not a precedent for Merrimack since Merrimack produces much less fly ash. Additionally, Mayo is not yet operating its new system and therefore there is no way to judge whether the technologies will function appropriately.

While other United States facilities, such as the Cayuga power plant, the Centralia Big Hanaford Plant, and Millikin Station, operated ZLD systems for FGD wastewater *in the past*, all previous VCE systems for FGD wastewater have been abandoned or shut down. The City of Springfield, Illinois, purchased an Aquatech brine concentrator for its Dallman Generating Station but never installed it.

In short, UWAG knows of no U.S. power plant with a wet FGD scrubber that is achieving true "zero liquid discharge" of FGD wastewater using the VCE-plus-crystallization system installed at Merrimack. Therefore, there is no precedent for what Region I is asking Merrimack to accomplish.

Even considering power plants worldwide, there is no adequate precedent. The single Chinese plant identified as having a VCE actually has a completely different system, one without a brine concentrator. Nebrig et al. 2011 (Merrimack No. 890).

As for the six Italian plants with VCE systems, there are numerous differences – ones that are easily dismissed by the vendors that installed them but are pertinent nonetheless. First and most notably, not all six plants operate their VCE systems regularly. Second, the Italian plants burn different types of coals, and therefore their FGD wastewaters are not necessarily the same as Merrimack's. For example, Brindisi's coal comes from South Africa, Columbia, Indonesia, or the U.S. (Eastern Research Group, Inc., "Site Visit Notes and Sampling Episode Report, Enel's Power Plants, Italy, Sampling Episode 6576" (Aug. 8, 2012) (EPA-HQ-OW-2009-0819-1790) p. 2-1). It is generally low-sulfur coal, though the plant burns bituminous coal occasionally (*id.*). The other Italian plants also burn coals that are much different from Merrimack's feedstock. Third, some of the Italian plants bag the solids from the crystallizer and ship it to Germany for disposal as mine refill. (Nebrig et al. 2011) (Merrimack No. 890). This method of disposal is not available to Merrimack. The solids that Merrimack produces must be suitable for landfilling in a regular solid waste landfill.

Notably, PSNH has examined the permits of the Italian plants and has found that the Italian plants are allowed to discharge FGD wastewater during upset or emergency conditions. Thus, the Italian plants have much greater flexibility in operation than Region I proposes for

Merrimack. Also, PSNH has found that the Italian plants discharge the distillate/condensate produced by their VCE-plus-crystallization systems. Therefore they are not truly "zero liquid discharge" systems.

IX. Vapor Compression-Evaporation Technologies Were Not Proposed as BAT in EPA's ELG Rulemaking

It would be anomalous if EPA Region I were to require the Merrimack system as BAT at the same time that EPA Headquarters, in its ELG rulemaking for the steam electric industry, has so far *not* selected VCE as BAT.

In the proposed ELG Rule, EPA considered a zero liquid discharge system composed of physical/chemical treatment combined with VCE (see Option 5 at 78 Fed. Reg. at 34,458). EPA went to considerable effort to examine VCE systems during the rulemaking (including a trip to Italy to visit several VCE facilities and a trip to Kansas City Power and Light's Iatan facility). Notwithstanding this careful consideration, EPA did not select VCE systems as a "preferred" option among the proposals for FGD wastewater.

X. Significant Operational Issues at Merrimack

It is clear from the record that the Merrimack VCE-plus-crystallization system has presented significant operational issues. Roy and Scroggin (2013) document several major problems, including significant pH excursions of the falling film evaporator, which created a "volcanic" foam permeating the equipment attached to the brine concentrator and multiple challenges involving salt cake quality and quantity. Merrimack No. 893. Although Roy and Scroggin claim success in overcoming these operational challenges, it is also clear that the system remains vulnerable to upsets; Aquatech, the vendor for the system, told Region I the system will "not fully ever [be] optimized." Merrimack No. 1079.

Merrimack's issues with its system included problems with salt cake quality and quantity. Softening targets played a critical role in the quality of the salt cake. Merrimack No. 893. High calcium concentrations in the feed to the vapor compression system (resulting from low-soda ash feed) produced salt cake of poor quality. Low levels of calcium (high soda ash feed) generated compounds that agglomerated in the VCE equipment.

In short, making a VCE system work at all at Merrimack required overcoming many challenges and required joint efforts by the operator, engineer, and equipment supplier. It is not the sort of "one size fits all" technology that can be applied to power plants generally.

XI. VCE Systems Are Not Fully Demonstrated

Assuming, for the sake of argument, that Merrimack has solved its significant operational issues, that nonetheless does not mean that VCE systems are feasible BAT technologies for the industry as a whole. As already discussed, Merrimack is the only U.S. plant attempting to operate a VCE-plus-crystallization system for FGD wastewater. And Merrimack would not have chosen the system it installed without being caught in the untenable position of having constructed a scrubber and facing years of delay in securing a revised NPDES permit to accommodate discharge of the scrubber wastewater. While there is a growing amount of research into VCE systems, they are not fully demonstrated for FGD wastewater. There are many operational issues associated with brine concentrators/evaporators when used to treat FGD wastewater, as discussed below.

XII. VCE Systems Require Extensive Vigilance and Maintenance

Even when a VCE system is operating without major upsets, it will require extensive and continual maintenance. As Nebrig et al. (Merrimack No. 890) note:

> Both the brine concentrator and the crystallizer will scale. Calcium sulfate formation on the evaporation tubes in the brine concentrator is the primary scale in the brine concentrator. The

> formation of the scale reduces heat transfer and results in loss of capacity in the unit. . . . Most vendors recommend cleaning the brine concentrator at least once a year. More frequent cleaning may be necessary, but the down time will reduce the amount of water that can be processed.

Pp. 11-12. This is occurring at Merrimack, where Roy and Scroggin report that running the system required "diligent, ever tightening, plant-wide (coal pile to salt cake) process control." Merrimack No. 893. In other words, to keep the VCE system functioning, every other aspect of Merrimack requires extra diligence and control, a clear case of the "tail wagging the dog."

This means that Merrimack has limited flexibility to make changes in other parts of its process (*e.g.*, changing the coal blend) unless it wants to risk an upset at the VCE stage. The need for extensive vigilance and maintenance of the VCE-plus-crystallization system, and its overall inflexibility, indicates that other plants would not be able to operate it with any assurance of long-term success.

A. Maintaining Crystallizers Is Difficult Due to Operational Variables

Crystallizers take the brine blowdown from the brine concentrator, add heat from a heat exchanger using plant steam, and form crystals that are dewatered and sent to a landfill. Scrubber waste crystallization is a relatively new process. Flow variations, chemical or constituent variation, the amount of heat added to the system, circulation rates, and numerous mechanical elements such as tank size, finish on the tank, internals, and the types of pumps in the system can and will have serious impacts on the success of this final step.

Thus, maintaining the crystallizer, considering the number of variables that change constantly, is challenging.

1. VCE-Plus-Crystallization Systems Have a Large Parasitic Load

The crystallizer is the largest user of energy in the FGD wastewater treatment process because it must evaporate the brine concentrate from a concentrated solution to produce a slurry

that can be dewatered. Nebrig et al. 2011 at 3. A VCE project designed to concentrate 60 gpm of wastewater with 95% recovery has been reported to require a 350 hp mechanical vapor compressor for operations. One of UWAG's members estimated a power requirement for its brine concentrator/crystallizer of 320 kW/100 gallons of treated scrubber blowdown. This company also reported that the equipment will increase carbon emissions per unit energy output and that the cost of station service will lead to lost annual revenue of $1 million.

2. Solid Waste Disposal Problems

VCE system wastes can be challenging to manage for disposal at some sites. *See generally* Ellison (2013), Merrimack No. 981. For instance, some VCE system designs produce a hygroscopic salt that is mainly calcium chloride and magnesium chloride hydrate (Nebrig et al. 2011 at 7-8). Because these salts are hygroscopic, they tend to melt down in a short time (minutes to hours) and, if they are landfilled, the chlorides and other substances may end up in the landfill leachate and runoff. *Id.* While Merrimack apparently avoids the solids stability issues through a full softening step, it is not clear that all plants would be able to stabilize solids through adding softening.

Due to the softening process, the salts produced from the crystallizer are primarily sodium chloride which are also hygroscopic. Some of the salt cake will be made up of calcium chloride due to incomplete softening, as well as other salts such as magnesium chloride and nitrates. These salts have the potential to liquefy in landfills due to rainfall, potentially releasing any of the pollutants in the salts, such as selenium and mercury. Also, high ionic strength leachates could potentially pose risks to clays in existing landfill liners and jeopardize the integrity of the landfill. VCE-plus-crystallization systems do not chemically precipitate constituents like other wastewater treatment technologies. These thermal systems are strictly a volume reduction process. As a result, the constituents entering the system will still be present in

the materials exiting the system in the same form but more concentrated. Very little pollutants are removed with the salts.

Containing the salt-laden leachate may necessitate special equipment or procedures at landfills receiving these wastes. Even with special equipment or procedures, the ability to stabilize chloride salts in a landfill for the long term is questionable. We understand that the VCE wastes generated at the Brindisi and Monfalcone plants in Italy have to be transported to Germany for disposal in a hazardous waste facility.

Assuming that the material can be cost-effectively transported and placed in a landfill, when considering disposal of VCE wastes, the largest unanswered question is the long-term fate of the material. There are few data on whether the VCE solids will remain in place or leach out. This potential environmental impact deserves proper consideration whenever a regulator considers VCE plus crystallizer technology.

3. Vapor Compression-Evaporation Systems Need Large Amounts of Chemicals

As the FGD blowdown slurry stream reaches the first section of the physical-chemical equipment, system operators add large amounts of chemicals to begin precipitation, conditioning, and concentration of the blowdown stream. This step is essential for reducing the levels of calcium, magnesium, and other hardness-producing ions and to lower the scaling potential of the wastewater prior to higher temperature processing.

Each reaction in the physical-chemical part of the treatment system is sensitive to the process parameters of the system. Changes in temperature, concentrations, and flow rate pose difficult challenges to physical-chemical performance. Variability of the parameters affects the primary step in the treatment system. This effect cascades through the physical-chemical system, changing the pH and the quantity of coagulants and polymers used to capture the metals.

The process to soften the FGD wastewater consumes a large amount of lime and soda ash (Nebrig et al. 2011 at 6). In a study evaluating a system capable of treating 410 gpm FGD wastewater with 40,000 ppm chloride in the water, it was estimated that 40 tons of lime and 80 tons of soda ash per day were needed to be fed to the system. *Id.* The chemical cost was estimated to be approximately $8.5 million per year. Based on calculations by a UWAG member for its own 410-gpm system, 40 tons of lime (at about $130/ton) and 80 tons of soda ash per day (about $230/ton) are required to desaturate and soften the FGD wastewater prior to evaporation. This is equivalent to about five to six trucks of lime and soda ash per day, assuming 25 tons per truckload.

4. VCE-Plus-Crystallization Systems Produce Large Amounts of Sludge

Adding lime and soda ash to treat FGD wastewater produces a large amount of byproduct sludge to be dewatered and disposed of offsite. A UWAG member estimated that the amount of sludge produced by the desaturation and softening process is 105 tons per day (at an approximate disposal cost of $3/ton). This company also estimated that the number of daily truckloads will exceed five truckloads per day at 20 tons per truckload. This not only requires additional manpower onsite but also adds to traffic congestion at the site.

5. VCE-PlusCrystallization Systems Have High Capital and O&M Costs

Earlier in these comments UWAG demonstrated that a VCE-plus-crystallization system is not cost-effective (on a dollars per TWPE basis) for Merrimack, based solely on the recurring operations and maintenance costs. *See* Attachment 1. In this section, we explain *why* the systems have such high capital and operations and maintenance costs.

The need to use expensive metals and alloys in the concentrators, evaporators, and crystallizers drives up the capital cost of the VCE-plus crystallizer option. Materials such as titanium, CD4Mcu, and Hastelloy C help reduce scaling and plugging of vessel internals as well

as corrosion. Due to the expected frequent outages, process redundancy will also be required, which will add significantly to the overall capital costs.

For thermal vapor compression systems, the concentrations of calcium and magnesium in the wastewater must be reduced to lower the scaling potential of the water at high temperature. Again using a 410-gpm system as an example, we estimate that chemicals for the hardness-reduction step will cost $8,500,000/year. In addition to the cost of the chemicals themselves, unloading the chemicals will add manpower requirements and increase the plant's traffic congestion.

As the problems at Merrimack demonstrate, a VCE-plus-crystallization system cannot be managed solely by technicians. Each plant will need a systems expert to work with the general operations and maintenance staff. Most system experts will need to be chemical engineers or chemists familiar with the technologies.

Merrimack hired an Aquatech supervisor who previously worked at the ENEL facilities in Italy to help it keep its system functioning. According to PSNH, the current operating contract allows for 12 Aquatech personnel onsite, including the supervisor and 10 technicians. The technicians work in two-man shifts around the clock. Also, a PSNH engineer is on call at all times to adjust the chemistry of the system if needed. This is a very expensive, ongoing cost of operating the VCE-plus-crystallization system.

Also, PSNH's current electrical load cycle allows for maintenance periods every Spring and Fall. During these periods, PSNH continues to work on optimization of the wastewater treatment process. Higher capacity factors at other facilities, or at Merrimack, would make these adjustments more difficult and more costly.

In addition to direct costs of the VCE-plus-crystallization system, the O&M costs of the generating facility itself will be affected. All power plant systems will have to be cycled much more often than originally designed due to the unreliability of the VCE-plus-crystallization system. This will greatly increase plant O&M costs.

Every time the operator must start or stop a power facility, the equipment suffers fatigue. The heating and cooling process is damaging to many of the high temperature systems, especially the boiler. Boilers that are designed for baseload operation but that are then cycled on and off suffer accelerated damage to the boiler tubes, which must be frequently repaired or replaced. Region I should have considered all increased operations and maintenance costs that derive from the choice of the VCE plus crystallizer technology.

6. Some VCE/Crystallizer Equipment Is Difficult to Maintain

The salts produced by the crystallizer are sent to a filter press for dewatering and then to a landfill for disposal. There are many types of filter presses. Some use a vacuum to remove the final moisture, and others use centrifugal force to accomplish the drying. In either case, these pieces of equipment are in a harsh environment and experience constant maintenance issues.

Also, many of the instruments that are used for general makeup water for demineralizers or wastewater plants are not reliable in the extremely corrosive environments of scrubber blowdown waste and hot and cold slurries. This lack of automatic control means the operator must be vigilant. Each operator must interpret data, make adjustments, and then process the changes to ensure the changes are correcting the operational issue. These factors add to O&M costs.

7. VCE/Crystallizer Process for FGD Wastewater Is Not a Proven, Mature Technology

In virtually every complex mechanical system, the initial versions prove to be maintenance-intensive and expensive. For use of ZLD technology for FGD wastewater, the equipment vendors claim a mature technology, but the data do not support the claim.

Given the specifications for types of pumps, piping arrangements, strainers, volume of control tanks, heat transfer surfaces, and metallurgy among vendors of vapor compression equipment, it is clear that each system is unique to its vendor. With the many variables these systems must deal with, it would be a very poor decision for a regulatory agency to require an industry to install a system that is not mature, robust, and reliable.

XIII. The Permit Requirements for Cooling Water Intake Should Conform to EPA's New § 316(b) Rule

Although this is the second draft permit that Region I has issued for Merrimack, there needs to be a third one. EPA released its final rule to regulate cooling water intake structures at "existing" facilities on May 19, 2014. The Merrimack draft permit must now be revised to comply with the new rule, and the revisions should be made available for comment.

XIV. Conclusion

The FGD wastewater provisions in Region I's proposed draft permit for Merrimack Station are arbitrary and capricious and not only unsupported by the record, but even contrary to evidence on the record. Merrimack continues to ship wastewater offsite, as documented in the Fact Sheet. The FGD system is not the "zero liquid discharge" system that Region I claims it is. Merrimack's system greatly reduces the volume of FGD wastewater, but it does not eliminate it. For this reason, Region I should not prohibit the discharge of FGD wastewater at Merrimack. Instead, it should allow Merrimack appropriate flexibility to discharge or otherwise manage the FGD purge stream.

Merrimack worked diligently to install improved air emission and water discharge controls. Those controls have made a significant difference to the environment. It would be egregious public policy to demand that Merrimack Station, having installed wastewater technologies well beyond the industry norm, do even more. Such an action would signal that voluntary actions to improve environmental conditions will not reduce regulatory uncertainty or increase the chances of a reasonable permit proceeding. This is not in the public's interest.

ATTACHMENT 1

Summary of the Cost-Effectiveness Analysis for Merrimack

Treatment System	TWPE/year Removed	Total Capital Cost, 2011M$	Service Life (Years)	Annual O&M Cost 2011$	Annual Capital + O&M Cost $2011	Annual Capital + O&M Cost $1981	$/TWPE $2011	$/TWPE $1981
CP Removal	4,168	$ 19.3	15	$ 1,840,000	$3,959,036	$ 1,544,024	$950	$ 370
Incremental Biological	27	$ 9.0	15	$ 530,000	$1,518,152	$ 592,079	$55,637	$ 21,698
Incremental VCE/Crystallization	555	$ 35.3	15	$ 2,516,000	$6,391,750	$ 2,492,783	$11,513	$ 4,490
Incremental VCE/Crystallization - O&M only	555	$ -	15	$ 2,516,000	$2,516,000	$ 981,240	$4,532	$ 1,767

Capital Costs	2011 M$
CP	17
EMARS	2.3
Bio (est)	9
VCE+Cry	32
Softening	3.3

O&M Costs	M$
CP+EMARS	1.84
Bio (est)	0.53
VCE+Cry	2.1
VCE+Cry (Energy)	0.416

Merrimack Data

SP-1 CP Influent - See Assumption 1 for description of data set.
SP-2 CP + EMARS Effluent - See Assumption 2 for description of data set.
SP-3 CP + Biological Effluent - See Assumption 3 for description of data set.
SP-4 Crystallization Effluent - Assume zero discharge to be conservative.

Capacity Factor: **40%**

		SP-1	SP-2	SP-3	SP-4
		Total	Total	Total	Total
		P/C Influent	CP, EMARS Eff	Bio Eff	Cryst Eff
Classicals Concentration (ppm)					
Ammonia	**NH3 as N**	1.1	1.1	1.1	0
Nitrate as N	**NO3 as N**	77.7	77.7	0.079	0
Nitrogen, Total Kjeldahl	**TKN**				
BOD	**BOD**				
COD	**COD**				
Chloride	**Cl-**	10020	10200	10200	0
Sulfate	**SO4**	2900	1200	1200	0
Cyanide, Total	**CN**	0.015	0.015	0.015	0
TDS	**TDS**	25400	21333	21333	0
TSS	**TSS**	4540	7.3	7.3	0
Phosphorus, Total	**Total P**	0.01	0.01	0.01	0
Metals Concentration (ppb)					
Aluminum	**Al**	197760	135	135	0
Antimony	**Sb**	15.1	0.943	0.943	0
Arsenic	**As**	223.2	8.452	8.452	0
Barium	**Ba**	505.2	250	250	0
Beryllium	**Be**	10.1	1.57	1.57	0
Boron	**B**	668500	668500	668500	0
Cadmium	**Cd**	19.4	0.639	0.639	0
Calcium	**Ca**	5050000	5050000	5050000	0
Chromium	**Cr**	637	2.9	2.9	0
Cobalt	**Co**	5	5	5	0
Copper	**Cu**	325.8	3.13	3.13	0
Iron	**Fe**	120000	238	238	0
Lead	**Pb**	1660	1.16	1.16	0
Magnesium	**Mg**	953000	769000	769000	0
Manganese	**Mn**	23820	751	751	0
Mercury	**Hg**	258	0.01936	0.01936	0
Molybdenum	**Mo**	247	247	247	0
Nickel	**Ni**	1060	12.5	2.6	0
Selenium	**Se**	2740	98.0	5.0	0
Sodium	**Na**	277000	277000	277000	0
Thallium	**Tl**	20	6.38	6.38	0
Tin	**Sn**	0	0	0	
Titanium	**Ti**	0	0	0	
Vanadium	**V**	5	5	5	0
Zinc	**Zn**	4290	5.8	5.8	0

<MDL

Lbs/Year

	Total lbs in Influent	Total lbs in PC Effluent	Total lbs in Bio Effluent	Total lbs in Cryst Effluent
Flow (gpm)	44	44	44	0
Hrs/Day	24	24	24	0
Days/Year	146	146	146	0
NH3 as N	85	85	85	0
NO3 as N	5995	5992	6	0
TKN	0	0	0	0
BOD	0	0	0	0
COD	0	0	0	0
Cl-	773040	786927	786927	0
SO4	223734	92580	92580	0
CN	1	1	1	0
TDS	1959602	1645860	1645860	0
TSS	350260	566	566	0
Total P	1	1	1	0
Al	15257	10	10	0
Sb	1	0	0	0
As	17	1	1	0
Ba	39	19	19	0
Be	1	0	0	0
B	51575	51575	51575	0
Cd	1	0	0	0
Ca	389606	389606	389606	0
Cr	49	0	0	0
Co	0	0	0	0
Cu	25	0	0	0
Fe	9258	18	18	0
Pb	128	0	0	0
Mg	73524	59328	59328	0
Mn	1838	58	58	0
Hg	20	0	0	0
Mo	19	19	19	0
Ni	82	1	0	0
Se	211	8	0	0
Na	21370	21370	21370	0
Tl	2	0	0	0
Sn	0	0	0	0
Ti	0	0	0	0
V	0	0	0	0
Zn	331	0	0	0
Total	**563,355**	**522,016**	**522,008**	**0**

TWPE

		TWPE in Influent	TWPE in PC Effluent	TWPE in Bio Effluent	TWPE in Cryst Effluent
Flow (gpm)		44	44	44	0
Hrs/Day		24	24	24	0
Days/Year		146	146	146	0
	TWF				
NH3 as N	0.001	0	0	0	0
NO3 as N	0.003	19	19	0	0
TKN	0.002	0	0	0	0
BOD		0	0	0	0
COD		0	0	0	0
Cl-	2E-05	19	19	19	0
SO4	6E-06	1	1	1	0
CN	1.117	1	1	1	0
TDS		0	0	0	0
TSS		0	0	0	0
Total P		0	0	0	0
Al	0.065	987	1	1	0
Sb	0.012	0	0	0	0
As	4.041	70	3	3	0
Ba	0.002	0	0	0	0
Be	1.057	1	0	0	0
B	0.008	430	430	430	0
Cd	23.12	35	1	1	0
Ca	3E-05	11	11	11	0
Cr	0.076	4	0	0	0
Co	0.114	0	0	0	0
Cu	0.635	16	0	0	0
Fe	0.006	52	0	0	0
Pb	2.24	287	0	0	0
Mg	9E-04	64	51	51	0
Mn	0.07	129	4	4	0
Hg	117.1	2331	0	0	0
Mo	0.201	4	4	4	0
Ni	0.109	9	0	0	0
Se	1.121	237	8	0	0
Na	5E-06	0	0	0	0
Tl	1.027	2	1	1	0
Sn	0.301	0	0	0	0
Ti	0.029	0	0	0	0
V	0.035	0	0	0	0
Zn	0.047	16	0	0	0
Total		**4,724**	**555**	**528**	**0**

Removals in TWPE

	PC Removal	Bio Removal	VCE + Cryst Removal
Flow (gpm)	44	44	0
Hrs/Day	24	24	0
Days/Year	146	146	0
NH3 as N	0	0	0
NO3 as N	0	19	19
TKN	0	0	0
BOD	0	0	0
COD	0	0	0
Cl-	0	0	19
SO4	1	0	1
CN	0	0	1
TDS	0	0	0
TSS	0	0	0
Total P	0	0	0
Al	986	0	1
Sb	0	0	0
As	67	0	3
Ba	0	0	0
Be	1	0	0
B	0	0	430
Cd	33	0	1
Ca	0	0	11
Cr	4	0	0
Co	0	0	0
Cu	16	0	0
Fe	52	0	0
Pb	287	0	0
Mg	12	0	51
Mn	125	0	4
Hg	2331	0	0
Mo	0	0	4
Ni	9	0	0
Se	229	8	8
Na	0	0	0
Tl	1	0	1
Sn	0	0	0
Ti	0	0	0
V	0	0	0
Zn	15	0	0
Total	**4,168**	**27**	**555**

ATTACHMENT 2

United States Environmental Protection Agency
Office of Water 4303
EPA-821-R-96-021
October 1996

EPA

Cost Effectiveness Analysis of Final Effluent Limitations Guidelines and Standards for the Coastal Subcategory of the Oil and Gas Extraction Point Source Category

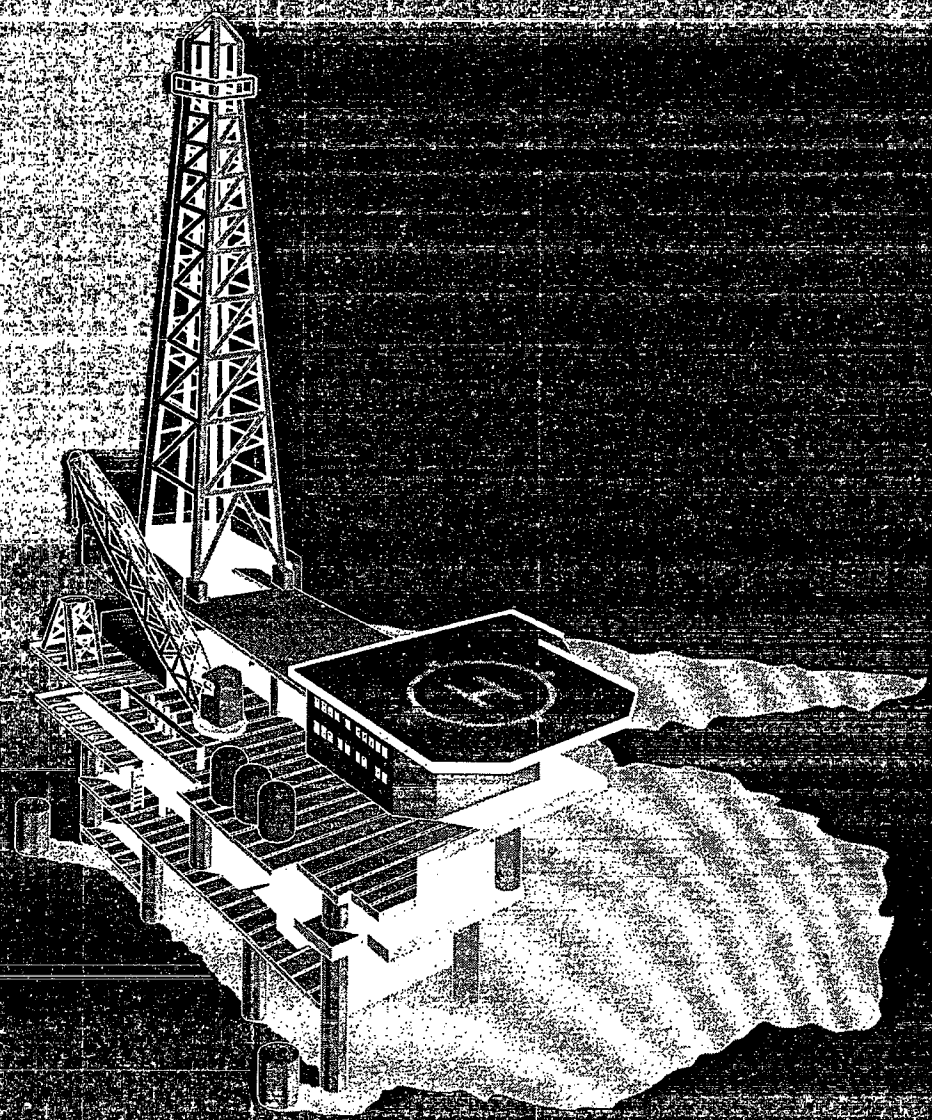


TABLE 5-1

INDUSTRY COMPARISON OF BAT COST-EFFECTIVENESS FOR DIRECT DISCHARGERS
(Toxic and Nonconventional Pollutants Only; Copper-Based Weights[a]; 1981 $)

Industry		PE Currently Discharged (thousands)	PE Remaining at Selected Option (thousands)	Cost-Effectiveness of Selected Option(s) ($/PE removed)
Aluminum Forming		1,340	90	121
Battery Manufacturing		4,126	5	2
Canmaking		12	0.2	10
Coal Mining		BAT=BPT	BAT=BPT	BAT=BPT
Coastal Oil and Gas Produced Water/TWC[b] Drilling Waste		951 BAT=Current Practice	239 BAT=Current Practice	35 BAT=Current Practice
Coil Coating		2,289	9	49
Copper Forming		70	8	27
Electronics I		9	3	404
Electronics II		NA	NA	NA
Foundries		2,308	39	84
Inorganic Chemicals I		32,503	1,290	<1
Inorganic Chemicals II		605	27	6
Iron and Steel		40,746	1,040	2
Leather Tanning		259	112	BAT=BPT
Metal Finishing		3,305	3,268	12
Nonferrous Metals Forming		34	2	69
Nonferrous Metals Manufacturing I		6,653	313	4
Nonferrous Metals Manufacturing II		1,004	12	6
Offshore Oil and Gas		3,628	2,218	34[c]
OCSPSF[d]		54,225	9,735	5
Pesticides		2,461	371	15
Petroleum Refining		BAT=BPT	BAT=BPT	BAT=BPT
Pharmaceuticals[e]	A/C	897	47	47
	B/D	90	0.5	96
Plastics Molding and Forming		44	41	BAT=BPT

TABLE 5-1 (continued)

Industry	PE Currently Discharged (thousands)	PE Remaining at Selected Option (thousands)	Cost-Effectiveness of Selected Option(s) ($/PE removed)
Porcelain Enameling	1,086	63	6
Pulp and Paper[f]	1,330	748	18
Textile Mills	BAT=BPT	BAT=BPT	BAT=BPT

[a]Although toxic weighing factors for priority pollutants varied across these rules, this table reflects the cost-effectiveness at the time of regulation.

[b]TWC loadings and reductions are for Gulf of Mexico only. Produced water loadings and reductions include TWC discharges in Cook Inlet.

[c]For produced water only; for produced sand and drilling fluids and drill cuttings under Offshore Oil and Gas, BAT=NSPS.

[d]Reflects costs and removals of both air and water pollutants.

[e]Proposed.

[f]PCB control for Deink subcategory only.

United States
Environmental Protection
Agency

Office of Water
(4303)

EPA 821-B-97-010
January 1998

EPA

Economic Analysis and Cost-Effectiveness Analysis of Proposed Effluent Limitations Guidelines and Standards for Industrial Waste Combustors

Table 4-1. Industry Comparison of Cost-Effectiveness Values for Indirect Dischargers
Toxic and Nonconventional Pollutants Only, Copper Based Weights (1981 Dollars)*

Industry	Pounds Equivalent Currently Discharged (To Surface Waters) (000's)	Pounds Equivalent Remaining at Selected Option (To Surface Waters) (000's)	Cost Effectiveness of Selected Option Beyond BPT ($/lb-eq. removed)
Aluminum Forming	1,602	18	155
Battery Manufacturing	1,152	5	15
Can Making	252	5	38
Coal Mining***	N/A	N/A	N/A**
Coil Coating	2,503	10	10
Copper Forming	934	4	10
Centralized Waste Treatment † (co-proposal)			
- Regulatory Option 1	689	330	70
- Regulatory Option 2	689	328	110
Electronics I	75	35	14
Electronics II	260	24	14
Foundries	2,136	18	116
Industrial Waste Combustors	**6.5**	**0.2**	**85**
Inorganic Chemicals I	3,971	3,004	9
Inorganic Chemicals II	4,760	6	< 1
Iron & Steel	5,599	1,404	6
Leather Tanning	16,830	1,899	111
Metal Finishing	11,680	755	10
Metal Products & Machinery I †	1,115	234	127
Nonferrous Metals Forming	189	5	90
Nonferrous Metals Mfg I	3,187	19	15
Nonferrous Metals Mfg II	38	0.41	12
Organic Chemicals, Plastics...	5,210	72	34
Pesticide Manufacturing (1993)	257	19	18
Pesticide Formulating, Packaging.. †	33,748	< 1	1
Pharmaceuticals †	340	63	1
Plastic. Molding & Forming	N/A	N/A	N/A
Porcelain Enameling	1,565	96	14
Pulp & Paper	9,539	103	65

* Although toxic weighting factors for priority pollutants varied across these rules, this table reflects the cost-effectiveness at the time of regulation.
** N/A: Pretreatment Standards not promulgated, or no incremental costs will be incurred.
*** Reflects costs and removals of both air and water pollutants
† Proposed rule.

Table 4-2. Industry Comparison of Cost-Effectiveness Values for Direct Dischargers
Toxic and Nonconventional Pollutants Only, Copper Based Weights (1981 Dollars)*

Industry	Pounds Equivalent Currently Discharged (To Surface Waters) (000's)	Pounds Equivalent Remaining at Selected Option (To Surface Waters) (000's)	Cost Effectiveness of Selected Option Beyond BPT ($/lb-eq. removed)
Aluminum Forming	1,340	90	121
Battery Manufacturing	4,126	5	2
Can Making	12	0.2	10
Coal Mining	BAT=BPT	BAT=BPT	BAT=BPT
Coastal Oil and Gas †			
- Produced Water	5,998	506	3
- Drilling Waste	7	0	292
- TWC‡	2	0	200
Coil Coating	2,289	9	49
Copper Forming	70	8	27
Centralized Waste Treatment † (co-proposal)			
- Regulatory Option 1	3,372	1,267	5
- Regulatory Option 2	3,372	1,271	7
Electronics I	9	3	404
Electronics II	NA	NA	NA
Foundries	2,308	39	84
Industrial Waste Combustors	**BAT=BPT**	**BAT=BPT**	**BAT=BPT**
Inorganic Chemicals I	32,503	1,290	< 1
Inorganic Chemicals II	605	27	6
Iron & Steel	40,746	1,040	2
Leather Tanning	259	112	BAT=BPT
Metal Finishing	3,305	3,268	12
Metal Products & Machinery I †	140	70	50
Nonferrous Metals Forming	34	2	69
Nonferrous Metals Mfg I	6,653	313	4
Nonferrous Metals Mfg II	1,004	12	6
Offshore Oil and Gas**†	3,808	2,328	33
Organic Chemicals, Plastics...	54,225	9,735	5
Pesticide Manufacturing (1993)	2,461	371	15
Pharmaceuticals †	208	4	1
Plastics Molding & Forming	44	41	BAT=BPT
Porcelain Enameling	1,086	63	6
Petroleum Refining	BAT=BPT	BAT=BPT	BAT=BPT
Pulp & Paper	61,713	2,628	39
Textile Mills	BAT=BPT	BAT=BPT	BAT=BPT

* Although toxic weighting factors for priority pollutants varied across these rules, this table reflects the cost-effectiveness at the time of regulation.
** Produced water only, for produced sand and drilling fluids and drill cuttings, BAT=BPT.
† Proposed rule.
‡ Treatment, workover, and completion fluids.

United States
Environmental Protection
Agency

Office of Water
(4303)

EPA-821-B-00-007
December 2000

EPA

Cost-Effectiveness Analysis of Proposed Effluent Limitations Guidelines and Standards for the Metal Products and Machinery Industry

Table 7: Cost-Effectiveness for Direct Dischargers by Subcategory

Subcategory & Regulatory Option	Incremental Before-Tax Compliance Cost (million 1981$)	Incremental Removals (lbs-eq)	Cost-Effectiveness Ratio (1981$/lb-eq)
Printed Wiring Boards			
Proposed Option	1.42	64,573	22
Option 2/6/10			
Option 4/8	1.14	2,270	501
Metal Finishing Job Shops			
Proposed Option	0.69	14,194	49
Option 2/6/10			
Option 4/8	0.52	265	1,968
General Metals			
Proposed Option	114.54	899,372	127
Option 2/6/10			
Option 4/8	52.20	21,620	2,414
Non-Chromium Anodizing[a]			
Proposed Option	NA	NA	
Option 2/6/10	NA	NA	
Option 4/8	NA	NA	
Oily Wastes			
Option 4/8	31.34	15,703	1,996
Proposed Option[b]	-24.92	366	-68,007
Option 2/6/10	0.00	0	
Railroad Line Maintenance			
Proposed Option	0.67	174	3,831
Option 2/6/10			
Option 4/8	0.05	23	2,181
Shipbuilding Dry Dock			
Proposed Option	1.24	111	11,179
Option 2/6/10			
Option 4/8	-0.91	335	-2,728
Steel Forming & Finishing			
Proposed Option	18.39	339,147	54
Option 2/6/10			
Option 4/8	1.28	8,977	143

a. EPA estimates that there are no direct discharging non-chromium anodizing facilities.
b. The proposed option has a cost-effectiveness value of 399 when compared to the baseline. This is the number that is presented in the preamble.
Source: U.S. EPA analysis.

Cost-Effectiveness Analysis of Effluent Limitation Guidelines and Standards for the Centralized Waste Treatment Industry

William Wheeler
Economic and Statistical Analysis Branch

Engineering and Analysis Division
Office of Science and Technology

U.S. Environmental Protection Agency
Washington, DC 20460

Table 4-2. Industry Comparison of PSES Cost-Effectiveness for Indirect Dischargers

Industry	Pollutants Currently Discharged (10^3 lb. eq.)[a]	Pollutants Remaining at Selected Option (10^3 lb. eq.)[a]	Cost-Effectiveness of Selected Option(s) ($1981/lb. eq.)
Aluminum Forming	1,602	18	155
Battery Manufacturing	1,152	5	15
Canmaking	252	5.0	38
Centralized Waste Treatment			175
Coal Mining	NA	NA	NA
Coil Coating	2,503	10	10
Copper Forming	34	4	10
Electronics I	75	35	14
Electronics II	260	24	14
Foundries	2,136	18	116
Industrial Waste Combustor[b]			
A			85
B			88
Inorganic Chemicals I	3,971	3,004	9
Inorganic Chemicals II	4,760	6	<1
Iron and Steel	5,599	1,404	6
Leather Tanning	16,830	1,899	111
Metal Finishing	11,680	755	10
Metal Products and Machinery[b]	1,115	234	127
Nonferrous Metals Forming	189	5	90
Nonferrous Metals Manufacturing I	3,187	19	15
Nonferrous Metals Manufacturing II	38	0	12
Organic Chemicals	5,210	72	34
Pesticide Manufacturing	257	19	18
Pesticide Formulating	7,746	112	<3
Pharmaceuticals[b]	340	63	1
Plastics Molding and Forming	NA	NA	NA
Porcelain Enameling	1,565	96	14
Pulp and Paper[b]	9,539	103	65
Transportation Equipment Cleaning	38	19	380

[a] TWFs for some priority pollutants have changed across these rules; this table reflects the cost effectiveness at the time of regulation.
[b] Proposed.

PB93158970

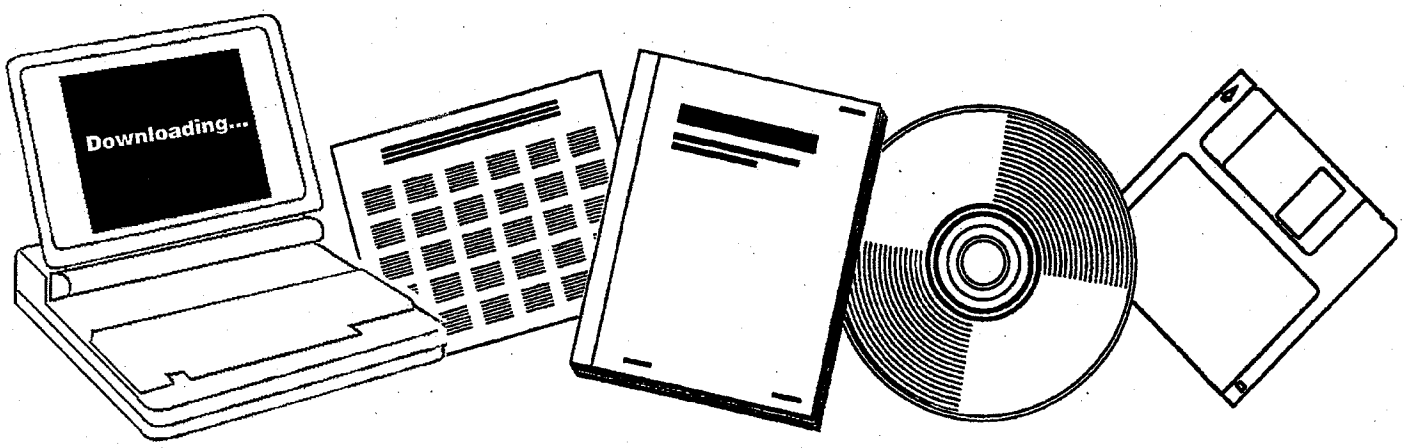
NTIS

One Source. One Search. One Solution.

COST-EFFECTIVENESS ANALYSIS OF EFFLUENT LIMITATIONS AND STANDARDS FOR THE NONFERROUS METALS FORMING AND METAL POWDERS INDUSTRY

ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, DC. OFFICE OF WATER REGULATIONS AND STANDARDS

AUG 1985



U.S. Department of Commerce
National Technical Information Service

TABLE 3.7 INDUSTRY COMPARISON COST-EFFECTIVENESS FOR DIRECT DISCHARGERS
(TOXIC AND NONCONVENTIONAL POLLUTANTS ONLY)
COPPER BASED WEIGHTS
(1981 DOLLARS)

INDUSTRY	POUNDS EQUIVALENT CURRENTLY DISCHARGED (000's)	POUNDS EQUIVALENT REMAINING AT SELECTED OPTION (000's)	COST-EFFECTIVENESS OF SELECTED OPTION(S) ($/POUND EQUIVALENT)
Aluminum Forming	1,340	90	121
Battery Manufacturing	4,126	5	2
Canmaking	12	0.2	10
Coal Mining	BAT=BPT	BAT=BPT	BAT=BPT
Coil Coating	2,289	9	49
Copper Forming	70	8	27
Electronics I	9	3	404
Electronics II	NA	NA	NA
Foundries	2,308	39	84
Inorganic Chemicals I	32,503	1,290	++
Inorganic Chemicals II	605	27	6
Iron and Steel	40,746	1,040	2
Leather Tanning	259	112	BAT=BPT
Metal Finishing	3,305	3,268	12
Nonferrous Metals Forming	34	2	69
Plastic Molding & Forming	44	41	BAT=BPT
Organic Chemicals and Plastics and Synthetics	3,888	433	327
Pesticides	2,461.62	371.33	15
Pharmaceuticals	208	4	1
Nonferrous Metals Manufacturing I	6,653	313	4
Nonferrous Metals Manufacturing II	1,004	12	6
Porcelain Enameling	1,086	63	6
Petroleum Refining	BAT=BPT	BAT=BPT	BAT=BPT
Pulp and Paper*	1,330	748	18
Steam Electric			
Textile Mills	BAT=BPT	BAT=BPT	BAT=BPT
Timber			

++ Less than a dollar.

* PCB control for Deink subcategory only.

ATTACHMENT 3

The Air Compliance Group, LLC (ACG)

5075 Hollins Road
Roanoke, VA 24019
Phone: (540) 265-1987
Fax: (540) 265-0082

Performance Test Report for FGD Wastewater Treatment System of Units 1 and 2 at the PSNH Merrimack Station in Bow, New Hampshire

Prepared for

URS Corporation

Princeton, New Jersey

Test Dates: **December 20-21, 2011**

January 03 - 07, 2012

Report Date: **June 1, 2012**

ACG Contract Numbers V11894

Table 6: Summary of Wastewater Test Results

Constituent	Performance Test Requirements		Total Average Results	
	Influent Design Maximum	Design Effluent Concentration (Total)	Influent	Effluent
Total Suspended Solids	2.0 wt% 20,000 mg/L	3 mg/L	4,540	2*
Total Dissolved Solids, mg/L	36,000	Not Applicable	25,400	19,400
pH, standard units	5.5 to 6.5	6 to 9	6.3	7.2
Chloride, mg/L	18,000	18,000 or slight increase	10,020	10,200
Temperature, degrees F	130	130 (No increase)	108	85
Aluminum, mg/L	800	1.0	198	< 0.02
Antimony, mg/L	0.50	0.5 (No change)	0.02	< 0.0003
Arsenic, mg/L	3.0	0.02	0.22	0.004
Barium, mg/L	5.0	5.0 (No change)	0.51	0.24
Beryllium, mg/L	0.1	0.1 (No change)	0.01	< 0.0007
Cadmium, mg/L	0.5	0.05	0.02	< 0.0001
Chromium III, mg/L	5.0	0.05	< 0.25	< 0.004
Chromium VI, mg/L	0.1	0.1 (No change)	< 0.75	< 0.004
Copper, mg/L	2.0	0.05	0.33	< 0.0007
Iron, mg/L	500	0.1	120	< 0.03
Lead, mg/L	4.0	0.1	1.66	< 0.0001
Magnesium, mg/L	7,000	Not Applicable	953	769
Manganese, mg/L	380	3.0	23.82	0.54
Mercury, mg/L	2.5	0.000014	0.26	0.000009
Nickel, mg/L	6.0	1.0	1.06	0.008
Selenium, mg/L	18	9.0	2.74	0.08
Silver, mg/L	0.30	0.05	< 0.0004	< 0.0002
Sulfate, mg/L	15,500	Not Applicable	2,900	1,280
Thallium, mg/L	0.6	0.6 (No change)	0.02	0.005
Zinc, mg/L	8.0	0.1	4.29	< 0.0004
Oil & Grease, mg/L	None Detected	No Net Increase	< 5	< 5

Secondary Performance Guarantee

Constituent	Performance Test Requirements		Test Result	
Dewatered Filter Cake	Minimum of 45% dry solids, by weight	Pass Paint Filter Liquids Test (PFLT)	60% dry solids, by weight	Passed PFLT

* See discussion in Section 4.2.

TABLE 7

SUMMARY OF WASTE WATER TREATMENT SYSTEM RESULTS

WWT INFLUENT COMPOSITE SAMPLES

PSNH - MERRIMACK STATION

RUN I.D. DATE COLLECTED TIME STARTED TIME ENDED	Day 1 12/20-21/2011 10:30 10:30	Day 2 1/03-04/2012 10:00 10:00	Day 3 1/04-05/2012 10:00 10:00	Day 4 1/05-06/2012 10:00 10:00	Day 5 1/06-07/2012 10:00 10:00	Average
Metals (mg/L)						
Aluminum	65.50	45.20	708.00	85.80	84.30	197.76
Antimony	0.0178	0.0128	0.0145	0.0152	0.0152	0.0151
Arsenic	0.224	0.2060	0.2320	0.2210	0.2330	0.2232
Barium	0.579	0.5820	0.6570	0.4070	0.3010	0.5052
Beryllium	0.00739	0.00978	0.0122	0.0112	0.0101	0.0101
Cadmium	0.0159	0.0198	0.0208	0.0206	0.0201	0.0194
Chromium	0.665	0.5350	0.7180	0.6080	0.6590	0.6370
Chromium (III)	< 0.176	0.3280	< 0.0442	< 0.0442	0.6590	< 0.2503
Chromium (VI)	< 0.176	0.2070	1.3500	1.9100	< 0.0883	< 0.7463
Copper	0.279	0.3140	0.3570	0.3380	0.3410	0.3258
Iron	116	104	137	117	128	120
Lead	1.89	1.65	1.70	1.51	1.56	1.66
Magnesium	870	970	948	1010	968	953
Manganese	22.30	25.50	25.90	22.10	23.30	23.82
Mercury	0.183	0.288	0.303	0.239	0.277	0.258
Nickel	1.03	1.08	1.16	1.03	0.992	1.06
Selenate	0.0852	0.052	0.0583	0.0592	0.0799	0.0669
Selenite	0.0647	0.0663	0.0594	0.0876	0.0728	0.0702
Selenium	2.93	2.71	2.86	2.52	2.68	2.74
Selenocyanate	< 0.022	< 0.022	< 0.022	< 0.022	< 0.022	< 0.022
Silver	0.000781	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0004
Thallium	0.0200	0.0128	0.014	0.0155	0.0178	0.02
Zinc	5.10	3.75	4.56	4.11	3.91	4.29
Suspended Solids (mg/L)	7,800	2,900	3,500	3,200	5,300	4,540
Dissolved Solids (mg/L)	22,000	30,000	25,000	25,000	25,000	25,400
Sulfate (mg/L)	2,200	3,200	2,800	3,200	3,100	2,900
Chloride (mg/L)	9,100	10,000	10,000	10,000	11,000	10,020

Notes:

"<" preceding a value indicates a nondetect in which the reporting limit was used (or average contains one or more of these runs).

TABLE 8

SUMMARY OF WASTE WATER TREATMENT SYSTEM RESULTS

WWT EFFLUENT COMPOSITE SAMPLES

PSNH - MERRIMACK STATION

RUN I.D. DATE COLLECTED TIME STARTED TIME ENDED	Day 1 12/20-21/2011 10:30 10:30	Day 2 1/03-04/2012 10:00 10:00	Day 3 1/04-05/2012 10:00 10:00	Day 4 1/05-06/2012 10:00 10:00	Day 5 1/06-07/2012 10:00 10:00	Average
Metals (mg/L)						
Aluminum	0.0274	< 0.0044	0.0427	< 0.0222	< 0.0222	< 0.0238
Antimony	< 0.000023	0.000338	0.000552	< 0.00023	< 0.00023	< 0.000275
Arsenic	0.0030	0.00375	0.00459	< 0.00255	0.00752	0.0043
Barium	0.141	0.272	0.238	0.256	0.270	0.235
Beryllium	0.0004	< 0.000227	0.000652	< 0.00114	< 0.00114	< 0.0007
Cadmium	< 0.000021	< 0.000042	0.000225	< 0.000208	< 0.000208	< 0.000141
Chromium	< 0.00004	< 0.00009	< 0.00009	< 0.00045	< 0.00045	< 0.00022
Chromium (III)	< 0.00442	< 0.0022	< 0.0011	< 0.0088	< 0.0044	< 0.00418
Chromium (VI)	< 0.0044	< 0.0022	< 0.0011	< 0.0088	< 0.0044	< 0.0042
Copper	0.00246	< 0.0001	< 0.0001	< 0.0005	< 0.0005	< 0.00073
Iron	< 0.0065	< 0.0130	< 0.0130	< 0.0650	< 0.0650	< 0.0325
Lead	< 0.00002	< 0.000039	< 0.000039	< 0.000195	< 0.000195	< 0.00010
Magnesium	605	900	750	824	767	769
Manganese	1.30	0.311	0.243	0.432	0.394	0.536
Nickel	0.00259	0.00778	0.0107	0.00873	0.00948	0.00786
Selenium	0.110	0.0699	0.0846	0.060	0.0703	0.079
Silver	< 0.00003	< 0.00006	< 0.00006	< 0.0003	< 0.00030	< 0.00015
Thallium	0.00274	0.00551	0.00889	< 0.000056	0.00674	0.00479
Zinc	< 0.00008	< 0.00016	< 0.00016	< 0.00082	< 0.00082	< 0.00041
Suspended Solids (mg/L)	3 *	2 **	1 ***	2 **	< 1 ***	< 2
Dissolved Solids (mg/L)	15,000	21,000	20,000	20,000	21,000	19,400
Sulfate (mg/L)	1,200	1,300	1,300	1,300	1,300	1,280
Chloride (mg/L)	8,000	10,000	11,000	11,000	11,000	10,200

Notes:

"<" preceding a value indicates a nondetect in which the reporting limit was used (or average contains one or more of these runs).

* Initial analysis was 8 mg/L. The sample was reanalyzed with a lower detection limit (1 mg/L). The reanalysis result is shown; however, the reanalysis occurred outside of the recommended holding time.

** Initial analysis was < 5 mg/L. The sample was reanalyzed with a lower detection limit (1 mg/L). The reanalysis result is shown. The reanalysis occurred within the recommended holding time.

*** Initial analysis was < 5 mg/L. The sample was reanalyzed with a lower detection limit (1 mg/L). The reanalysis result is shown. The reanalysis occurred outside the recommended holding time.

TABLE 9

SUMMARY OF WASTE WATER TREATMENT SYSTEM RESULTS

GRAB SAMPLES
DAY 1

PSNH - MERRIMACK STATION

RUN I.D. DATE COLLECTED INFLUENT/EFFLUENT TIME COLLECTED	**Grab 1** 12/20/11 12:30 / 11:45	**Grab 2** 12/20/11 19:30 / 15:00 *	**Grab 3** 12/20/11 22:40 / 18:00 **	**Grab 4** 12/21/11 08:15 / 08:30	**AVERAGE**
Influent					
Oil & Grease (mg/L)	N/A	< 5	N/A	N/A	< 5
Temperature (degrees C)	34	34	34.7	33	34
Temperature (degrees F)	93	93	94	91	93
pH (SU)	6.6	6.6	6.6	6.6	6.6
Effluent					
Oil & Grease (mg/L)	N/A	N/A	< 5	N/A	< 5
Temperature (degrees C)	19	20	20	20	20
Temperature (degrees F)	66	68	68	68	68
pH (SU)	7.3	7.3	7.3	7.2	7.3
Mercury (mg/L)	0.00000761	0.00000827	0.00000853	0.00001020	0.00000865

Notes:

"<" preceding a value indicates a nondetect in which the reporting limit was used (or average contains one or more of these runs).

* Because the influent did not have proper flow for collection of a concurrent grab sample, the Effluent Grab 2 sample was taken at 15:00, and the Influent Grab 2 sample was taken at 19:30.

** Due to lack of flow, the Influent Grab 3 sample could not be collected in the same time frame as Effluent Grab 3, which was collected at 18:00. Siemens personnel collected Influent Grab 3 pH and temperature at 22:40.

TABLE 10

SUMMARY OF WASTE WATER TREATMENT SYSTEM RESULTS

GRAB SAMPLES
DAY 2

PSNH - MERRIMACK STATION

RUN I.D.	Grab 1	Grab 2	Grab 3	Grab 4	AVERAGE
DATE COLLECTED	01/03/12	01/03/12	01/03/12	01/04/12	
INFLUENT/EFFLUENT TIME COLLECTED	10:00 / 10:00	13:20 / 13:20 (pH & Temp.) & 14:00 (Hg)	18:00 / 18:00	07:30 / 07:30	
Influent					
Oil & Grease (mg/L)	N/A	N/A	< 5	N/A	< 5
Temperature (degrees C)	45	44	42	41	43
Temperature (degrees F)	113	111	108	106	109
pH (SU)	6.2	6.3	6.3	6.3	6.3
Effluent					
Oil & Grease (mg/L)	N/A	N/A	< 5	N/A	< 5
Temperature (degrees C)	N/A *	34	33	30	32
Temperature (degrees F)	N/A *	93	91	86	90
pH (SU)	7.2	7.2	7.2	7.3	7.2
Mercury (mg/L)	0.00000752	0.00000809	0.00000801	0.00000852	0.00000804

Notes:

"<" preceding a value indicates a nondetect in which the reporting limit was used (or average contains one or more of these runs).

* Temperature could not be measured due to instrument malfunction.

TABLE 11

SUMMARY OF WASTE WATER TREATMENT SYSTEM RESULTS

GRAB SAMPLES
DAY 3

PSNH - MERRIMACK STATION

RUN I.D.	Grab 1	Grab 2	Grab 3	Grab 4	AVERAGE
DATE COLLECTED	01/04/12	01/04/12	01/04/12	01/05/12	
INFLUENT/EFFLUENT TIME COLLECTED	10:00 / 10:00	14:17 (pH & Temp.) & 14:00 (Hg)	18:00 / 18:00	08:00 / 08:00	
Influent					
Oil & Grease (mg/L)	N/A	N/A	< 5	N/A	< 5
Temperature (degrees C)	43	46	44	44	44
Temperature (degrees F)	109	115	111	111	112
pH (SU)	6.2	6.2	6.3	6.2	6.2
Effluent					
Oil & Grease (mg/L)	N/A	N/A	< 5	N/A	< 5
Temperature (degrees C)	31	29	31	30	30
Temperature (degrees F)	88	84	88	86	86
pH (SU)	7.2	7.3	7.2	7.2	7.2
Mercury (mg/L)	0.00000711	0.00000837	0.00000819	0.00000859	0.00000807

Notes:

"<" preceding a value indicates a nondetect in which the reporting limit was used (or average contains one or more of these runs).

ATTACHMENT 4

SUMMARY OF HISTORIC STREAM A ANALYTICAL RESULTS

Public Service Company of New Hampshire
Merrimack Station
Bow, New Hampshire

PARAMETER	STREAM A RESULTS 1/05/2012 EPA 1638 (mg/L)	STREAM A RESULTS 1/05/2012 EPA 200.8MOD (mg/L)	STREAM A RESULTS 01/26/2012 (mg/L)	STREAM A RESULTS 2/2/2012 (mg/L)	STREAM A RESULTS 2/9/2012 (mg/L)	STREAM A RESULTS 3/2/2012 (mg/L)	SOFTENED STREAM A RESULTS 7/19/2012 (mg/L)	SOFTENED STREAM A RESULTS 7/27/20212 (mg/L)	SOFTENED STREAM A RESULTS 1/26/2013 (mg/L)	SOFTENED STREAM A RESULTS 2/07/2013 (mg/L)	SOFTENED STREAM A RESULTS 2/16/2013 (mg/L)
Alkalinity	180	-	-	-	-	-	-	-	-	-	
Aluminum	0.0411	< 0.0800	< 0.080	0.218	< 0.200	-	-	-	-	-	
Ammonia	0.92	-	1.2	1.1	-	-	-	-	-	-	
Antimony	0.000520	0.000408	0.000758	0.00155	-	-	-	-	-	-	
Arsenic	0.00498	0.00851	0.00956	0.0121	< 0.00750	0.00812	<0.0075	-	<0.00150	-	<0.00750
Barium	0.300	0.240	0.208	0.243	-	-	-	-	-	-	
Beryllium	0.000522	< 0.00120	< 0.00120	< 0.00300	-	-	-	-	-	-	
BOD	< 6	-	< 6	< 6	-	< 6	<6	-	<60	<6	
Cadmium	0.000207	< 0.000400	0.000587	< 0.00100	< 0.00100	< 0.000400	<0.000200	-	0.000548	-	
Calcium	5,050.000	5,010.000	-	-	-	-	1,320	2,460.000	-	-	
Chloride	11,000	-	9500	9,300	-	11,000	-	12,000	-	-	
Chlorine (Total Residual)	< 0.05	-	-	-	-	-	-	-	-	-	
Chromium (T)	< 0.00050	< 0.00200	< 0.00200	< 0.00500	< 0.00500	< 0.00200	<0.00500	-	-	-	
COD	130	-	180	140	-	170	-	-	170	-	
Cobalt	-	-	-	-	< 0.00500	-	-	-	-	-	
Copper	< 0.00050	< 0.00200	0.00261	0.00553	< 0.00500	< 0.00200	<0.00500	-	0.00632	-	<0.00500
Cyanide (T)	0.02	-	0.01	< 0.01	-	0.02	-	<0.02	-	-	
Fluoride	10	-	6.2	2.9	-	-	-	-	-	-	
Iron	< 0.050	< 0.200	< 0.200	< 0.500	-	< 0.200	-	-	-	-	
Lead	< 0.000200	< 0.000800	< 0.000800	< 0.00200	< 0.00200	< 0.000800	<0.000400	-	<0.000400	-	
Magnesium	-	-	-	-	-	-	30.200	701.000	-	-	
Manganese	0.293	0.280	0.349	0.631	1.730	-	-	-	-	-	
Mercury	0.0000105	0.0000105	0.0000122	0.0000360	0.0000209	0.0000172	0.0000443	0.0000299	0.0000413	-	
Molybdenum	0.140	0.134	0.373	0.195	0.110	0.419	0.0259	-	0.120	-	0.0552
Nitrate	100	-	68	65	-	-	-	-	-	-	
Nitrate+Nitrite	100	-	-	-	-	-	-	-	-	-	
Nitrogen(T)	106	-	-	-	-	-	-	-	-	-	
Nickel	0.00803	0.00979	0.00776	< 0.00500	0.0126	0.0291	0.0844	-	<0.00100	-	0.00709
O&G (HEM)	< 5	-	< 5	< 5	-	< 5	-	<5	-	-	
pH	7.3	-	7.6	7.4	7.2	7.1	7.61	7.49	7.79	-	7.12
Selenium	0.0740	0.0689	0.104	0.121	0.0822	0.109	0.0446	-	0.0445	-	0.0517

SUMMARY OF HISTORIC STREAM A ANALYTICAL RESULTS

Public Service Company of New Hampshire
Merrimack Station
Bow, New Hampshire

PARAMETER	STREAM A RESULTS 1/05/2012 EPA 1638 (mg/L)	STREAM A RESULTS 1/05/2012 EPA 200.8MOD (mg/L)	STREAM A RESULTS 01/26/2012 (mg/L)	STREAM A RESULTS 2/2/2012 (mg/L)	STREAM A RESULTS 2/9/2012 (mg/L)	STREAM A RESULTS 3/2/2012 (mg/L)	SOFTENED STREAM A RESULTS 7/19/2012 (mg/L)	SOFTENED STREAM A RESULTS 7/27/20212 (mg/L)	SOFTENED STREAM A RESULTS 1/26/2013 (mg/L)	SOFTENED STREAM A RESULTS 2/07/2013 (mg/L)	SOFTENED STREAM A RESULTS 2/16/2013 (mg/L)
Silver	< 0.000100	< 0.000400	< 0.000400	< 0.00100	< 0.00100	< 0.000400	<0.000200	-	<0.000200	-	
Sodium	277.000	259.000	-	-	-	-	5,690.000	4,810.000	7,190.000	-	3,050.000
Sulfate	1,200	-	-	1,200	-	-	-	-	-	-	
Sulfide	< 0.1	-	-	-	-	-	-	-	-	-	
Sulfite	< 2	-	-	-	-	-	-	-	-	-	
TDS	21,000	-	-	19,000	-	24,000	22,000	-	23,000	-	27,000
Thallium	0.00664	0.00556	0.00565	0.00685	-	-	-	-	-	-	
TSS	14	-	-	6	-	2	<5	-	<5	-	<5
TTO	ND (1)	-	ND (1)	-	-	-	-	-	-	-	
Vanadium	-	-	-	-	< 0.00500	-	-	-	-	-	
Zinc	< 0.00100	< 0.004000	< 0.00400	< 0.0100	< 0.0100	< 0.00400	<0.0100	-	-	-	
VOC EPA 624	(2)	-	(2)	-	-	ND (5)	-	ND (5)	-	-	
Semi VOCs 625	ND (3)	-	ND (3)	-	-	-	-	-	-	-	
Phenolic Compounds	< 0.3	-	< 0.5	< 0.5	-	-	-	-	-	-	
TKN	6	-	-	-	-	-	-	-	-	-	
PCBs	ND (4)	-	ND (4)	-	-	-	-	-	-	-	
Boron	980.000	493.000	-	-	357.000	-	-	-	-	-	
Total Phosphorous	0.01	-	-	-	-	-	-	-	-	-	

Note:
1. No TTO compounds were detected above 0.01 mg/L.
2. The following compounds were detected by Method 624: Toluene at 2 µg/L on January 5, 2012; and Toluene at 2 µg/L on 1/26/2012.
3. Semi VOCs were not detected by Method 625 above reporting limits.
4. PCB compounds were analyzed by method 608 and were not detected at concentrations greater than 0.3 µg/L.
5. No VOC compounds were detected by Method 624 above laboratory reporting limits.