STATE OF NEW HAMPSHIRE

PUBLIC UTILITIES COMMISSION

DE 10-261

2010 Least Cost Integrated Resource Plan (LCIRP)

EXPERT REPORT

OF

DR. RANAJIT (RON) SAHU

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ON BEHALF OF NEW HAMPSHIRE SIERRA CLUB

JUNE 30, 2011

I. BACKGROUND AND EXPERIENCE

I, Ranajit Sahu, have over twenty years of experience in the fields of environmental, mechanical, and chemical engineering including: program and project management services; design and specification of pollution control equipment; soils and groundwater remediation; combustion engineering evaluations; energy studies; multimedia environmental regulatory compliance (involving statutes and regulations such as the Federal CAA and its Amendments, Clean Water Act, TSCA, RCRA, CERCLA, SARA, OSHA, NEPA as well as various related state statutes); transportation air quality impact analysis; multimedia compliance audits; multimedia permitting (including air quality NSR/PSD permitting, Title V permitting, NPDES permitting for industrial and storm water discharges, RCRA permitting, etc.), multimedia/multi-pathway human health risk assessments for toxics; air dispersion modeling; and regulatory strategy development and support including negotiation of consent agreements and orders.

I have a B.S., M.S., and Ph.D. in Mechanical Engineering, the first from the Indian Institute of Technology (Kharagpur, India) and the latter two from the California Institute of Technology (Caltech) in Pasadena, California. My research specialization was in the combustion of coal and, among other things, understanding air pollution aspects of coal combustion in power plants.

I have over eighteen years of project management experience and have successfully managed and executed numerous projects in this time period. This includes basic and applied research projects, design projects, regulatory compliance projects, permitting projects, energy studies, risk assessment projects, and projects involving the communication of environmental data and information to the public.

I have provided consulting services to numerous private sector, public sector and public interest group clients. My major clients over the past eighteen years include various steel mills, petroleum refineries, cement companies, aerospace companies, power generation

facilities, lawn and garden equipment manufacturers, spa manufacturers, chemical distribution facilities, and various entities in the public sector including EPA, the states of New York, New Jersey, New Mexico, the US Dept. of Justice, California DTSC, various municipalities, etc.). I have performed projects in 48 US states, numerous local jurisdictions and internationally.

In addition to consulting, I have taught and continue to teach numerous courses in several Southern California universities including UCLA (air pollution), UC Riverside (air pollution, process hazard analysis), and Loyola Marymount University (air pollution, risk assessment, hazardous waste management) for the past seventeen years. In this time period I have also taught at Caltech, my alma mater, at USC (air pollution) and at Cal State Fullerton (transportation and air quality).

I have and continue to provide expert witness services in a number of environmental areas discussed above in both state and Federal courts as well as before administrative bodies.

Additional details regarding my background and experience can be found in my resume provided in Attachment A and in the list of publications and presentations provided in Attachment B.

The opinions expressed in the report are my own and are based on the data and facts available to me at the time of writing. Should additional relevant or pertinent information become available, I reserve the right to supplement the discussion and opinions provided in this report.

II. INTRODUCTION AND PURPOSE OF THIS REPORT

Public Service of New Hampshire (PSNH) operates a coal-fired thermal steam electric power plant called the Merrimack station, located near Bow, New Hampshire. The station consists of two coal-fired boilers (Units 1 and 2) and associated turbines, generators and other support facilities. Unit 1 is rated at 113 MW and Unit 2 is rated at 320 MW. In addition, the station also consists of two combustion turbines, collectively rated at around 40 MW. The boilers, designed to burn specific types of coal, currently burn coal from US coal mines located in Pennsylvania, Virginia, and West Virginia as well as from Venezuela and other countries. The station withdraws and discharges once-through cooling water from a freshwater hydropower impoundment called Hooksett Pool on the Merrimack River near Bow. The boilers at the station use certain air pollution control devices to reduce (but not eliminate) emissions of certain air pollutants that would otherwise be emitted in greater quantities. It has particulate control devices, it has a selective catalytic reduction (SCR) unit for reducing emissions of oxides of nitrogen, and it is in the process of installing a wet scrubber which is expected to reduce emissions of mercury and oxides of sulfur and fine particulate matter. The scrubber is expected to come on line in 2013.

It is assumed that the readers of this report are familiar with the basic processes by which a coal-fired power plant produces electricity. It is also assumed that readers are aware that producing electricity from coal in a thermal power plant, using technology at Merrimack, will produce various air pollutants (such as particulate matter of various sizes and types, oxides of nitrogen, oxides of sulfur, carbon monoxide, various organic volatile/semi-volatile compounds, metals, cyanides, dioxins, and other pollutants such as greenhouse gases like carbon dioxide, methane, and others), pollutants that can affect water bodies (such as from the wet scrubber effluent and from ash-handling activities and from storm water, etc.), and wastes such as boiler bottom ash, fly ash, etc.

Since coal-fired thermal power plants like the Merrimack Station produce various pollutants and contaminants to media such as ambient air, water bodies, etc. as noted above, and are

consequently subject to New Hampshire and Federal environmental regulations, derived from statutes to protect such media. As a result, they must operate within the constraints of various permits, issued by regulatory agencies, which contain applicable current regulatory requirements. Under current statutes and regulations, proper public notice and public review of permits issued to such power plants is an important aspect of issuance of such permits.

Merrimack Station will be subject to additional new and upcoming Federal environmental regulations in the near- and medium-term future. The Public Utilities Commission Order of Notice issued November 3, 2010, requires an assessment of PSNH's planning compliance with the Clean Air Act Amendments of 1990 and an assessment of the LCIRP's long and short term environmental, economic, and energy price and supply impact on the state.

My expert report is intended to address the Commission mandate.

It is not the purpose of this report to discuss all of the currently applicable requirements at the station nor assess Merrimack's current state of compliance with these regulations.

Rather, the purpose of this report is to discuss pending regulations and requirements. Of necessity, this discussion is general at this point since not all of the upcoming regulations have been finalized at the time of this writing. Also, their exact impact on Merrimack cannot be fully analyzed for several reasons. First, not all of the regulations not final, as noted. Second, and critically important to a proper examination of the PSNH planning compliance with the Clean Air Act Amendments of 1990, the analytical framework which can be used to analyze the impacts of certain upcoming regulations, to the extent that may have been completed by PSNH, is not available for public review[1] For example, current air dispersion modeling, using proper protocols to assess the impacts of emissions from the station on ambient air quality has either not been completed or is not available for public review. Discussions with staff at the New Hampshire DES indicate that recent modeling may not have been completed or, at any rate, has not been submitted to the agency. Second, the necessary current background values for ambient

[1] For example, I advised the New Hampshire Sierra Club to file Data Requests for technical information regarding the costs at Merrimack Station to comply with the Regional Haze program, a Clean Air Act program that will be part of the New Hampshire State Implementation plan [SIP] this year. PSNH refused to provide the information.

air quality, for the appropriate averaging time periods, do not appear to be available. Such monitoring, at appropriate locations, is critical to a proper assessment of source impacts on ambient air quality.[2] Third, design information on current and proposed controls, such as the SCR present at units 1 and 2 for NOx control, and the new scrubber under construction, are not available. In spite of repeated requests to provide such information, such that a proper assessment can be done or independently verified, no such information was provided by PSNH. Indeed, even the Commission's posture in obtaining this information from PSNH was not helpful. How can a proper evaluation of emissions control for a range of pollutants be conducted without a basic understanding of the design capabilities of the very controls that are supposed to reduce emissions of such pollutants? Just relying on unsupported assertions of PSNH in this regard is not proper.

It is important to note that compliance with these upcoming and future regulations will likely require additional, significant, capital costs and operating costs at the Merrimack station, above and beyond costs associated with current operations, even assuming operation of the scrubber under operation. However, a detailed cost analysis is not possible at this time with the information available. In order to complete proper cost assessments, the items discussed above should be available – i.e., information on design bases and capabilities of current and proposed air pollution controls; dispersion air modeling; ambient background data; etc.

[2] I am aware that currently some ambient air monitoring is conducted at the Pembroke monitoring station, located along the Merrimack river, and to the south of the station. However, it appears that this monitoring location only monitors SO2 and PM but no other pollutants, including NOx, ozone, mercury, or other air toxic compounds that are emitted from the station. See "The New Hampshire Ambient Air Monitoring Program – 2011/2012 Annual Network Review and Plan," June 2011, p. 8. While the DES seems to have plans for continuously monitoring real-time hourly PM, that is subject to future funding (see p. 11). I also note that the 1-hr SO2 standard was 258% of the relevant ambient air standard in 2010 at Pembroke (see Table 1.4). While ambient levels will likely come down after the scrubber is operational after 2013, that still leaves many more months of exceedances. More importantly, without knowing how the scrubber will be operated and at what capacity factors, it is impossible to know if the 1-hour ambient standard for SO2 will continue to be violated at Pembroke.

III. NEW/UPCOMING FEDERAL REGULATIONS

The following is a list of new and upcoming Federal regulations that is likely to affect the operation of coal-fired power plants such as Units 1 and 2 at Merrimack. In each case, I have also provided the citation to the EPA docket (or other sources) where additional information and rule-making materials are available. All EPA dockets are available at www.regulations.gov.

The timing for some of these regulations is more certain than others. But regardless of day-to-day or week-to-week political factors that may affect timing, it is my opinion that a prudent power plant operator such as PSNH should be carefully analyzing the potential impacts of all of these regulations (and, perhaps, others at the state level[3]) that may affect operations at Merrimack.

A few caveats. First, I have not listed nor analyzed the impact of accidents and resultant risks at Merrimack. This is not only an issue at the plant itself but also extends to liabilities relating to its operations extend throughout its supply chain, such as accidents and liabilities associated with its coal supply/mining and transportation (i.e., rail car accidents etc. and resulting contamination); and liabilities associated with its disposal/sale of waste materials such as ash. Second, EPA is evaluating the safety of ash ponds and impoundments at various coal-fired power plants due to recent, well-publicized failures of such impoundments. It is my understanding that this may not be applicable at Merrimack because the station does not include such impoundments. Third, I will not discuss efforts underway relating to requirements that may apply at the Merrimack station pursuant to regional haze and related regulations – involving further reductions in nitrogen oxides, SO2, and particulate matter emissions because of the PSNH refusal to provide information [see footnote 1].

Second, I note that while the short-term aspects of any future carbon-related legislation are uncertain at the present, the long-term need to reduce carbon emissions from coal-fired power plants is still an issue. Costs associated with this have been subject to numerous previous studies

[3] Including, for example, the June 28, 2011, NHDES-Air Resources Division, Final Determination of the Baseline Mercury Input.

and I will not discuss this further other than noting that typical carbon cost assumptions range from $20-$50/ton.

The following is the list of new/proposed/likely regulations that currently apply or will apply at the station.

[A] National Ambient Air Quality Standards for Nitrogen Dioxide (published February 9, 2010), Docket number: EPA-HQ.OAR-2006-0922. This rule is currently effective.

[B] National Ambient Air Quality Standards for Sulfur Dioxide (published June 22, 2010), Docket number: EPA-HQ-OAR-2007-0352. This rule is currently effective.

[C] Prevention of Significant Deterioration (PSD) for Particulate Matter Less Than 2.5 Micrometers (PM2.5) (published October 20, 2010), Docket number: EPA-HQ-OAR-2006-0605. This rule is currently effective.

[D] Clean Air Act Permitting for Greenhouse Gas Emissions (published June 3, 2010), Docket number: EPA-HQ-OAR-2009-0517. This rule is currently effective.

[E] Coal Combustion Residuals rule (proposed June 21, 2010), Docket number: EPA-HQ-RCRA-2009-0640.

[F] Clean Air Transport Rule to replace the Clean Air Interstate Rule (proposed August 2, 2010, final rule expected July 2011). Docket number: EPA-HQ-OAR-2009-0491.

[G] Reconsideration of National Ambient Air Quality Standards for Ground-Level Ozone (proposed January 19, 2010, final rule expected August 2011), Docket number: EPA-HQ-OAR-2005-0172.

[H] MACT Standards for Hazardous Air Pollutants and NSPS for Utilities – Utility Air Toxics Rule (proposed March 16, 20 II, final rule expected November 16, 2011). Docket number: EPA-HQ-OAR-2009-0234, EPA-HQ-OAR-2011-0044. Compliance with this rule is likely within 3-5 years after it is finalized.

[I] New Source Performance Standards for Greenhouse Gas Emissions from Electric Generating Units (proposed rule expected July 26, 2011, final rule expected May 26, 2012). *Settlement Agreements to Address Greenhouse Gas Emissions From Electric Generating Units And Refineries: Fact Sheet.* Available at: http: //www.epa.gov/airquality/pdfslsettlementfactsheet.pdf.

[J] Section 316(b) Cooling Water Intake Existing Facilities Rule (proposed rule April 20, 2011) Docket number: EPA-HQ-OW-2008-0667.

[K] Steam Electric Effluent Limitations Guidelines (proposed rule expected July 2012), Docket number: EPA-HQ-OW-2009-0819.

[L] New Particulate Matter National Ambient Air Quality Standards (proposed rule expected sometime in 2011).

As can be seen from the above, the new rules (i.e., those already promulgated), proposed ruled that are not yet final, and some rules yet to be proposed cover air emissions, water effluent limitations, and aspects relating to cooling water intake. In the following pages, I will provide a brief summary/discussion of the regulations listed above and their potential impact on the Merrimack station. The last is based on available information that is necessarily incomplete at this point. The reason why information is incomplete is a combination of available information that was not provided upon request, as noted earlier in footnote 1 and also the fact that several analytical holes remain, as discussed previously. I will reference my subsequent discussion based on the alphabetical letters pertaining to the specific regulations above within square brackets.

Regulations [A] and [B], currently effective, are related to new National Ambient Air Quality Standards (NAAQS) for the NOx and SO2. Most importantly EPA has promulgated new NAAQS that apply on a short term 1-hour basis. These regulations as well as regulation [G] apply to ambient air and not specifically to any particular source, such as Merrimack. However, emissions of NOx and SO2 from large sources such as Merrimack can and will affect ambient air concentrations of these pollutants, including ozone, for which NOx is a precursor.

At this time, the impact of these NAAQS on Merrimack is not clear. While SO2 emissions are expected to be reduced due to the scrubber, the impact of NOx emissions (for which Merrimack has the SCR control, but which is significantly old at this point in terms of NOx reductions) could be more problematic, both for compliance with regulation [A] and [G]. The scrubber will not reduce NOx emissions. A thorough assessment of the impact of these emissions would require: (i) the proper placement of ambient monitors to collection ambient concentration data for these pollutants; (ii) collection, followed by a thorough evaluation of the ambient air quality data; (iii) and assessment of Merrimack's impacts on ambient air quality using predictive air quality dispersion modeling. None of these has been properly addressed or evaluated at this time. For example, it does not appear that PSNH has completed any dispersion modeling using appropriate protocols to assess its emission impacts with these standards.

It is my opinion that the new scrubber[4] notwithstanding, PSNH could face additional reductions of NOx and SO2 emissions from the boilers. If additional NOx reductions are required, the current SCR would need to be modified or a new SCR installed. If additional SO2 reductions are required, they could be accommodated via operation of the new scrubber if it is properly sized for SO2 reductions. But this is not clear since the SO2 reduction sizing (i.e., to what degree it can reduce uncontrolled SO2 emissions beyond the 90% required by New Hampshire law) of the scrubber is not certain. Also, the effluent treatment system for the scrubber could be affected as well. All of these potential impacts would require additional capital and operating costs.

[4] I note that the goal of the scrubber installation was to meet a 2006 New Hampshire law requiring 80% reduction of mercury by2013 and that any SO2 reduction is a co-benefit. It is not clear to what extent the design or the operation of the new scrubber will target specific SO2 reductions beyond the 90% required by New Hampshire law.

Regulation [C] deals with fine particulate matter emissions, 2.5 microns or less in aerodynamic diameter, including both filterable and condensable components. This is a fine regulation, effective at this time. Here again, the ability of Merrimack's existing particulate controls and its proposed new scrubber in controlling this size-class of particulate matter is unknown. The only test data on particulate matter I was able to review was conducted in 2000 and it did not address PM2.5. It is not clear to what extent the new scrubber will control condensable PM2.5. Thus, the ability to forecast PM2.5 impacts from the station is limited. Particulate matter emissions and the station's compliance with ambient PM standards will be further impacted by any revisions to the ambient standards that may result due to proposed regulation [L].

I should also note that a large portion of condensable PM2.5 is sulfuric acid mist, which ultimately derives from the sulfur present in the coal. It is not clear to what degree the new scrubber is designed to or will be able to reduce sulfuric acid mist. Typically, other types of controls such as dry scrubbers or wet electrostatic precipitators (not the dry, cold-side precipitators currently used for removal of coarser particulate) are used to remove sulfuric acud mist and condensable particulate matter.

All of the above deals with particulate matter emissions that are directly emitted by the boilers. This is sometimes known as primary particulate matter. In addition, the NOx and SO2 emitted by the boilers can also convert, in the atmosphere, to fine particulate matter known as secondary PM, which can impact visibility and regional haze.

Regulation [D], sometimes known as the "tailoring rule" requires a source to consider greenhouse gases during permitting activities if projects are contemplated and reporting of greenhouse gas emissions from all emitting sources at the station. This rule is applicable when underlying permitting is triggered.

This final rule sets thresholds for greenhouse gas (GHG) emissions that define when permits under the New Source Review Prevention of Significant Deterioration (PSD) and title V Operating Permit programs are required for new and existing industrial facilities.[5]

As such, the reporting requirement should not require any significant additional costs at this point. As to permitting, if the appropriate criteria are met, then increased emissions of greenhouse gases will require the installation of Best Available Control Technology (BACT) for such gases. The specific controls or work practices that will be BACT depends on the case-by-case BACT analysis that will need to be completed but it is quite likely that capital and operating costs will increase as a result.

Relating to the same set of pollutants, regulation [I] will establish New Source Performance Standards for greenhouse gases, which will need to be met, when NSPS is triggered due to any potential projects I the future. As such, it is difficult to assess impacts on the station due to this rule due to its lack of specificity at the present time and its conditional nature (i.e., applicable when triggered).

[5] See Factsheet at http://www.epa.gov/NSR/actions.html

In regulation [E] EPA is proposing to regulate for the first time coal ash to address the risks from the disposal of the wastes generated by electric utilities and independent power producers. Timing? EPA is considering two possible options for the management of coal ash for public comment. Both options fall under the Resource Conservation and Recovery Act (RCRA). Under the first proposal, EPA would list these residuals as special wastes subject to regulation under subtitle C of RCRA, when destined for disposal in landfills or surface impoundments. Under the second proposal, EPA would regulate coal ash under subtitle D of RCRA, the section for non-hazardous wastes. The Agency considers each proposal to have its advantages and disadvantages, and includes benefits which should be considered in the public comment period.[6]

This regulation may not apply at the station based on my understanding that the station currently disposes off its combustion residuals (i.e., slag and ash) by sale to others[7] but should this change in the future,[8] impacts of this rule need to be assessed at the station.

[6] http://www.epa.gov/osw/nonhaz/industrial/special/fossil/ccr-rule/index.htm

[7] See http://yesvy.blogspot.com/2010/02/all-around-coal-boiler.html. This article notes that "The plant doesn't need ash ponds, but instead has relatively small ash hoppers...." It also notes that "All the slag is ground coarsely and sold as roofing material. The small amount of ash is sold as an additive for concrete."

[8] It is my understanding that prior testing of activated carbon injection at the station (for mercury reduction) resulted in adverse impacts to ash sales. Should such injection be necessary in the future to control mercury above that provided by the scrubber (see later discussion relating to the utility MACT rule, regulation [H]), then ash sales may be affected.

Regulation [F] is essentially a revised version of the prior Clear Air Interstate Rule, requiring the station to meet allocations of NOx and SO2. Specifically, this proposal would require significant reductions in SO_2 and NO_x emissions that cross state lines.

EPA notes that "Additional emission reductions will be needed for the nation to attain the existing ozone standard and any upcoming 2010 ozone standards. The Agency plans to propose a transport rule to address that standard in 2011 and finalize it in 2012. Each time EPA changes national ambient air quality standards, EPA will evaluate whether new emission reductions will be required from upwind states."[9]

Thus, compliance with this regulation and subsequent revisions will be an on-going affair, impacting emissions of NOx and SO2. As such, it is my assumption that this rule, by itself, should not pose any significant compliance challenges at the station at the current time but may require further reductions in NOx and SO2 emissions in the future.

[9] See factsheet at www.epa.gov/airtransport/pdfs/FactsheetTR7-6-10.pdf

Regulation [H] deals with the emissions of hazardous air pollutants from the boilers at the station. The final rule is expected to be published before the end of 2011 and sources would be 3-5 years to come into compliance. Typically, over 50 different such pollutants are emitted from coal-fired boilers including mercury, other metals including selenium, various acid gases including HCl, HF, and cyanides, dioxins, and a number of volatile and semi-volatile organic compounds. EPA has recently proposed Maximum Achievable Control Technology Standards (MACT) for electric utilities such as Merrimack.[10] MACT is a two step process. First, all existing sources have to comply with the MACT "Floor" which is a standard based in units of lb/MMBtu or equivalent as set by EPA. Sources are then supposed to undertake a "beyond the Floor" analysis, considering cost and other impacts and determine if they can meet even lower standards. EPA has proposed MACT "Floors" for existing and new sources for a number of these pollutants including certain "surrogates" that will stand in for other pollutants. While the final standards may change from what is proposed, based on comments received during rule making, it is likely that the station cannot comply with these standards, as currently proposed. The table below shows test data that I was able to obtain and a comparison to the proposed MACT standards for mercury. Even assuming that the scrubber reduces mercury emissions by the desired 80%, it appears that the two units would not be able to meet the currently proposed MACT Floor for mercury. Of course, if the standard were to be lowered, then the situation becomes even more dire.

[10] It is worth noting that EPA's proposal sets technology-based MACT emissions limitation standards for mercury and other toxic air pollutants, reflecting levels achieved by the best-performing sources currently in operation. Unfortunately, in spite of its claim to be one of the cleanest power plants in the country, the Merrimack station did not qualify as the best performing source of any of the pollutants for which data is available. Thus, such statements, unsupported by any data, should be set aside.

Summary of Previous Compliance Tests at Merrimack Units 1 and 2								
[Source: Table 11, Permit Application Review Summary, by G. Milbury, dated 3/6/2009								
Unit	Pollutant	Test Date	Result		After Scrubber[a]	Proposed MACT		Test/MACT
MK1	Mercury	1/20/2007	0.0000149	lb/MMBtu	0.00000298	0.0000012	lb/MMBtu	2.48
		2/6/2007	0.00000842	lb/MMBtu	0.000001684	0.0000012	lb/MMBtu	1.40
		2/22/2007	0.00001038	lb/MMBtu	0.000002076	0.0000012	lb/MMBtu	1.73
		4/11/2007	0.00000533	lb/MMBtu	0.000001066	0.0000012	lb/MMBtu	0.89
		5/31/2007	0.00000516	lb/MMBtu	0.000001032	0.0000012	lb/MMBtu	0.86
		3/14/2008	0.00000448	lb/MMBtu	0.000000896	0.0000012	lb/MMBtu	0.75
		8/7/2008	0.00000448	lb/MMBtu	0.000000896	0.0000012	lb/MMBtu	0.75
MK2	Mercury	1/31/2007	0.00001124	lb/MMBtu	0.000002248	0.0000012	lb/MMBtu	1.87
		2/21/2007	0.00000981	lb/MMBtu	0.000001962	0.0000012	lb/MMBtu	1.64
		4/10/2007	0.00000876	lb/MMBtu	0.000001752	0.0000012	lb/MMBtu	1.46
		6/4/2007	0.00000751	lb/MMBtu	0.000001502	0.0000012	lb/MMBtu	1.25
		6/5/2007	0.00000778	lb/MMBtu	0.000001556	0.0000012	lb/MMBtu	1.30
		3/12/2008	0.00000628	lb/MMBtu	0.000001256	0.0000012	lb/MMBtu	1.05
		8/8/2008	0.00000602	lb/MMBtu	0.000001204	0.0000012	lb/MMBtu	1.00

[a] Assumes that mercury is reduced by 80% from baseline testing values

Compliance with the acid gas HAPs could not be assess due to lack of data from the two units at this time. Although some reduction of these gases (HCl and HF, not HCN) is expected due to the scrubber, previous data indicate that reduction of these pollutants in a scrubber can vary significantly based on scrubber operating parameters. At this time, there is literally no information available with regards to the design capability of the proposed scrubber to remove any of these acid gases. Nor is any test data of current emissions of these acid gases at the station available. So, a proper evaluation is not possible at this time.

It is worth noting that in this regulation, EPA's proposal sets technology-based MACT emissions limitation standards for mercury and other toxic air pollutants, reflecting levels achieved by the best-performing sources currently in operation. Unfortunately, in spite of its claim to be one of the cleanest power plants in the country,[11] the Merrimack station did not qualify as the best performing source of any of the pollutants for which data is available. Thus, such statements, unsupported by any data, should be set aside.

The bottom line is that additional capital (for potential scrubber upgrades, installation of additional controls such as dry sorbent and activated carbon injection) and associated operating

[11] See http://www.allbusiness.com/energy-utilities/utilities-industry-electric-power-power/11803460-1.html

costs are likely for compliance with the MACT standards at the station, when this rule is finalized.

Regulation [J] deals with cooling water issues.[12]

This proposed rule would establish requirements under section 316(b) of the Clean Water Act (CWA) for all existing power generating facilities and existing manufacturing and industrial facilities that withdraw more than 2 million gallons per day (MGD) of water from waters of the U.S. and use at least twenty-five (25) percent of the water they withdraw exclusively for cooling purposes. The proposed national requirements, which would be implemented through National Pollutant Discharge Elimination System (NPDES) permits, would establish national requirements applicable to the location, design, construction, and capacity of cooling water intake structures at these facilities by setting requirements that reflect the best technology available (BTA) for minimizing adverse environmental impact.[13]

EPA anticipates this proposed rule would help protect ecosystems affected by cooling water intake structures and preserve aquatic organisms and the ecosystems they inhabit in waters used by cooling water intake structures at existing facilities.[14]

EPA's proposal would require a sites-specific determination of BTA. BTA decisions will result in one of two outcomes at any facility: BTA is an entrainment mortality technology beyond what the facility has already installed (this may include closed cycle cooling or other technologies, or BTA requires no additional controls for entrainment mortality.

Based on the above, this regulation could have significant impacts at the station because it will require a closed-loop cooling system as opposed to the current, once-through system at the station.[15] PSNH should be required to provide cost information in its planning process.

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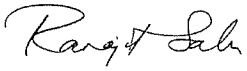
[12] See http://yosemite.epa.gov/opei/rulegate.nsf/byRIN/2040-AE95#4.
[13] Fed. Reg. 76, 22174, April 20, 2011.
[14] Ibid.
[15] It is my understanding that the station withdraws and discharges once-through cooling water from a freshwater hydropower impoundment called Hooksett Pool on the Merrimack River. It is also my understanding that the station operates its cooling water system under a NPDES permit which was last issued by Region 1 of the USEPA in 1992. The proposed regulation indicates EPA's intent to propose new thermal criteria that are more stringent than the §316(a) variance-based alternative thermal criteria presently contained in the station's NPDES permit.

Regulation [K] deals with waste water discharges. While the station current has a requisite NPDES permit, it is likely that the permit limitations will be significantly changed as a result of this regulation. I note that the regulation seeks to update standards that are almost three decades old at this time.[16] If new or more stringent standards are mandated, then the waste water system being constructed to handle scrubber effluent,[17] for example, will need to be appropriately modified. This could result in additional costs, both capital and operating.

Respectfully submitted.



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[16] ".....The current regulations, which were last updated in 1982, do not adequately address the pollutants being discharged and have not kept pace with changes that have occurred in the electric power industry over the last three decades...." See http://water.epa.gov/scitech/wastetech/guide/steam_factsheet.cfm

[17] See http://waterwastemanagement.cleantechnology-business-review.com/news/siemens_water_to_provide_wastewater_treatment_system_for_psnh_merrimack_generating_station_090316

ATTACHMENT A – RESUME FOR RANAJIT SAHU

RANAJIT (RON) SAHU, Ph.D, QEP, REA I, CEM (Nevada), CPP (SCAQMD)
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EXPERIENCE SUMMARY

Dr. Sahu has over twenty years of experience in the fields of environmental, mechanical, and chemical engineering including: program and project management services; design and specification of pollution control equipment; soils and groundwater remediation; combustion engineering evaluations; energy studies; multimedia environmental regulatory compliance (involving statutes and regulations such as the Federal CAA and its Amendments, Clean Water Act, TSCA, RCRA, CERCLA, SARA, OSHA, NEPA as well as various related state statutes); transportation air quality impact analysis; multimedia compliance audits; multimedia permitting (including air quality NSR/PSD permitting, Title V permitting, NPDES permitting for industrial and storm water discharges, RCRA permitting, etc.), multimedia/multi-pathway human health risk assessments for toxics; air dispersion modeling; and regulatory strategy development and support including negotiation of consent agreements and orders.

He has over eighteen years of project management experience and has successfully managed and executed numerous projects in this time period. This includes basic and applied research projects, design projects, regulatory compliance projects, permitting projects, energy studies, risk assessment projects, and projects involving the communication of environmental data and information to the public. Notably, he has successfully managed a complex soils and groundwater remediation project with a value of over $140 million involving soils characterization, development and implementation of the remediation strategy, regulatory and public interactions and other challenges.

He has provided consulting services to numerous private sector, public sector and public interest group clients. His major clients over the past seventeen years include various steel mills, petroleum refineries, cement companies, aerospace companies, power generation facilities, lawn and garden equipment manufacturers, spa manufacturers, chemical distribution facilities, and various entities in the public sector including EPA, the US Dept. of Justice, California DTSC, various municipalities, etc.). Dr. Sahu has performed projects in over 44 states, numerous local jurisdictions and internationally.

Dr. Sahu's experience includes various projects in relation to industrial waste water as well as storm water pollution compliance include obtaining appropriate permits (such as point source NPDES permits) as well development of plans, assessment of remediation technologies, development of monitoring reports, and regulatory interactions.

In addition to consulting, Dr. Sahu has taught and continues to teach numerous courses in several Southern California universities including UCLA (air pollution), UC Riverside (air pollution, process hazard analysis), and Loyola Marymount University (air pollution, risk assessment, hazardous waste management) for the past seventeen years. In this time period he has also taught at Caltech, his alma mater and at USC (air pollution) and Cal State Fullerton (transportation and air quality).

EXPERIENCE RECORD

2000-present **Independent Consultant.** Providing a variety of private sector (industrial companies, land development companies, law firms, etc.) public sector (such as the US Department of Justice) and public interest group clients with project management, air quality consulting, waste remediation and management consulting, as well as regulatory and engineering support consulting services.

1995-2000 Parsons ES, **Associate, Senior Project Manager and Department Manager for** Air Quality/Geosciences/Hazardous Waste Groups, Pasadena. Responsible for the management of a group of approximately 24 air quality and environmental professionals, 15 geoscience, and 10 hazardous waste professionals providing full-service consulting, project management, regulatory compliance and A/E design assistance in all areas.

Parsons ES, **Manager for Air Source Testing Services**. Responsible for the management of 8 individuals in the area of air source testing and air regulatory permitting projects located in Bakersfield, California.

1992-1995 Engineering-Science, Inc. **Principal Engineer and Senior Project Manager** in the air quality department. Responsibilities included multimedia regulatory compliance and permitting (including hazardous and nuclear materials), air pollution engineering (emissions from stationary and mobile sources, control of criteria and air toxics, dispersion modeling, risk assessment, visibility analysis, odor analysis), supervisory functions and project management.

1990-1992 Engineering-Science, Inc. **Principal Engineer and Project Manager** in the air quality department. Responsibilities included permitting, tracking regulatory issues, technical analysis, and supervisory functions on numerous air, water, and hazardous waste projects. Responsibilities also include client and agency interfacing, project cost and schedule control, and reporting to internal and external upper management regarding project status.

1989-1990 Kinetics Technology International, Corp. **Development Engineer.** Involved in thermal engineering R&D and project work related to low-NOx ceramic radiant burners, fired heater NOx reduction, SCR design, and fired heater retrofitting.

1988-1989 Heat Transfer Research, Inc. **Research Engineer**. Involved in the design of fired heaters, heat exchangers, air coolers, and other non-fired equipment. Also did research in the area of heat exchanger tube vibrations.

EDUCATION

1984-1988 Ph.D., Mechanical Engineering, California Institute of Technology (Caltech), Pasadena, CA.

1984 M. S., Mechanical Engineering, Caltech, Pasadena, CA.

1978-1983 B. Tech (Honors), Mechanical Engineering, Indian Institute of Technology (IIT) Kharagpur, India

TEACHING EXPERIENCE

Caltech

"Thermodynamics," Teaching Assistant, California Institute of Technology, 1983, 1987.

"Air Pollution Control," Teaching Assistant, California Institute of Technology, 1985.

"Caltech Secondary and High School Saturday Program," - taught various mathematics (algebra through calculus) and science (physics and chemistry) courses to high school students, 1983-1989.

"Heat Transfer," - taught this course in the Fall and Winter terms of 1994-1995 in the Division of Engineering and Applied Science.

"Thermodynamics and Heat Transfer," Fall and Winter Terms of 1996-1997.

U.C. Riverside, Extension

"Toxic and Hazardous Air Contaminants," University of California Extension Program, Riverside, California. Various years since 1992.

"Prevention and Management of Accidental Air Emissions," University of California Extension Program, Riverside, California. Various years since 1992.

"Air Pollution Control Systems and Strategies," University of California Extension Program, Riverside, California, Summer 1992-93, Summer 1993-1994.

"Air Pollution Calculations," University of California Extension Program, Riverside, California, Fall 1993-94, Winter 1993-94, Fall 1994-95.

"Process Safety Management," University of California Extension Program, Riverside, California. Various years since 1992.

"Process Safety Management," University of California Extension Program, Riverside, California, at SCAQMD, Spring 1993-94.

"Advanced Hazard Analysis - A Special Course for LEPCs," University of California Extension Program, Riverside, California, taught at San Diego, California, Spring 1993-1994.

"Advanced Hazardous Waste Management" University of California Extension Program, Riverside, California. 2005.

Loyola Marymount University

"Fundamentals of Air Pollution - Regulations, Controls and Engineering," Loyola Marymount University, Dept. of Civil Engineering. Various years since 1993.

"Air Pollution Control," Loyola Marymount University, Dept. of Civil Engineering, Fall 1994.

"Environmental Risk Assessment," Loyola Marymount University, Dept. of Civil Engineering. Various years since 1998.

"Hazardous Waste Remediation" Loyola Marymount University, Dept. of Civil Engineering. Various years since 2006.

University of Southern California

"Air Pollution Controls," University of Southern California, Dept. of Civil Engineering, Fall 1993, Fall 1994.

"Air Pollution Fundamentals," University of Southern California, Dept. of Civil Engineering, Winter 1994.

University of California, Los Angeles

"Air Pollution Fundamentals," University of California, Los Angeles, Dept. of Civil and Environmental Engineering, Spring 1994, Spring 1999, Spring 2000, Spring 2003, Spring 2006, Spring 2007, Spring 2008, Spring 2009.

International Programs

"Environmental Planning and Management," 5 week program for visiting Chinese delegation, 1994.

"Environmental Planning and Management," 1 day program for visiting Russian delegation, 1995.

"Air Pollution Planning and Management," IEP, UCR, Spring 1996.

"Environmental Issues and Air Pollution," IEP, UCR, October 1996.

PROFESSIONAL AFFILIATIONS AND HONORS

President of India Gold Medal, IIT Kharagpur, India, 1983.

Member of the Alternatives Assessment Committee of the Grand Canyon Visibility Transport Commission, established by the Clean Air Act Amendments of 1990, 1992-present.

American Society of Mechanical Engineers: Los Angeles Section Executive Committee, Heat Transfer Division, and Fuels and Combustion Technology Division, 1987-present.

Air and Waste Management Association, West Coast Section, 1989-present.

PROFESSIONAL CERTIFICATIONS

EIT, California (# XE088305), 1993.

REA I, California (#07438), 2000.

Certified Permitting Professional, South Coast AQMD (#C8320), since 1993.

QEP, Institute of Professional Environmental Practice, since 2000.

CEM, State of Nevada (#EM-1699). Expiration 10/07/2011.

ATTACHMENT B – LIST OF PUBLICATIONS AND PRESENTATIONS

PUBLICATIONS

"Physical Properties and Oxidation Rates of Chars from Bituminous Coals," with Y.A. Levendis, R.C. Flagan and G.R. Gavalas, *Fuel*, **67**, 275-283 (1988).

"Char Combustion: Measurement and Analysis of Particle Temperature Histories," with R.C. Flagan, G.R. Gavalas and P.S. Northrop, *Comb. Sci. Tech.* **60**, 215-230 (1988).

"On the Combustion of Bituminous Coal Chars," PhD Thesis, California Institute of Technology (1988).

"Optical Pyrometry: A Powerful Tool for Coal Combustion Diagnostics," *J. Coal Quality*, **8**, 17-22 (1989).

"Post-Ignition Transients in the Combustion of Single Char Particles," with Y.A. Levendis, R.C.Flagan and G.R. Gavalas, *Fuel*, **68**, 849-855 (1989).

"A Model for Single Particle Combustion of Bituminous Coal Char." Proc. ASME National Heat Transfer Conference, Philadelphia, **HTD-Vol. 106**, 505-513 (1989).

"Discrete Simulation of Cenospheric Coal-Char Combustion," with R.C. Flagan and G.R.Gavalas, *Combust. Flame*, **77**, 337-346 (1989).

"Particle Measurements in Coal Combustion," with R.C. Flagan, in "**Combustion Measurements**" (ed. N. Chigier), Hemisphere Publishing Corp. (1991).

"Cross Linking in Pore Structures and Its Effect on Reactivity," with G.R. Gavalas in preparation.

"Natural Frequencies and Mode Shapes of Straight Tubes," Proprietary Report for Heat Transfer Research Institute, Alhambra, CA (1990).

"Optimal Tube Layouts for Kamui SL-Series Exchangers," with K. Ishihara, Proprietary Report for Kamui Company Limited, Tokyo, Japan (1990).

"HTRI Process Heater Conceptual Design," Proprietary Report for Heat Transfer Research Institute, Alhambra, CA (1990).

"Asymptotic Theory of Transonic Wind Tunnel Wall Interference," with N.D. Malmuth and others, Arnold Engineering Development Center, Air Force Systems Command, USAF (1990).

"Gas Radiation in a Fired Heater Convection Section," Proprietary Report for Heat Transfer Research Institute, College Station, TX (1990).

"Heat Transfer and Pressure Drop in NTIW Heat Exchangers," Proprietary Report for Heat Transfer Research Institute, College Station, TX (1991).

"NOx Control and Thermal Design," Thermal Engineering Tech Briefs, (1994).

PRESENTATIONS

"Pore Structure and Combustion Kinetics - Interpretation of Single Particle Temperature-Time Histories," with P.S. Northrop, R.C. Flagan and G.R. Gavalas, presented at the AIChE Annual Meeting, New York (1987).

"Measurement of Temperature-Time Histories of Burning Single Coal Char Particles," with R.C. Flagan, presented at the American Flame Research Committee Fall International Symposium, Pittsburgh, (1988).

"Physical Characterization of a Cenospheric Coal Char Burned at High Temperatures," with R.C. Flagan and G.R. Gavalas, presented at the Fall Meeting of the Western States Section of the Combustion Institute, Laguna Beach, California (1988).

"Control of Nitrogen Oxide Emissions in Gas Fired Heaters - The Retrofit Experience," with G. P. Croce and R. Patel, presented at the International Conference on Environmental Control of Combustion Processes (Jointly

sponsored by the American Flame Research Committee and the Japan Flame Research Committee), Honolulu, Hawaii (1991).

"Air Toxics - Past, Present and the Future," presented at the Joint AIChE/AAEE Breakfast Meeting at the AIChE 1991 Annual Meeting, Los Angeles, California, November 17-22 (1991).

"Air Toxics Emissions and Risk Impacts from Automobiles Using Reformulated Gasolines," presented at the Third Annual Current Issues in Air Toxics Conference, Sacramento, California, November 9-10 (1992).

"Air Toxics from Mobile Sources," presented at the Environmental Health Sciences (ESE) Seminar Series, UCLA, Los Angeles, California, November 12, (1992).

"Kilns, Ovens, and Dryers - Present and Future," presented at the Gas Company Air Quality Permit Assistance Seminar, Industry Hills Sheraton, California, November 20, (1992).

"The Design and Implementation of Vehicle Scrapping Programs," presented at the 86th Annual Meeting of the Air and Waste Management Association, Denver, Colorado, June 12, 1993.

"Air Quality Planning and Control in Beijing, China," presented at the 87th Annual Meeting of the Air and Waste Management Association, Cincinnati, Ohio, June 19-24, 1994.