

October 22, 2020

Michael Boynton
Town Of Medway
155 Village Street
Medway, MA 02053

Re: Third-Party Review of the Notice of Project Change for Exelon West Medway II

Dear Mr. Boynton:

Tech Environmental, Inc. (Tech) has completed a third-party review of the Notice of Project Change (NOPC) materials submitted to the Energy Facilities Siting Board (EFSB) on August 31, 2020, by Exelon West Medway, LLC and Exelon West Medway II, LLC, and related underlying construction and permit approvals issued to Exelon in EFSB 15-1/D.P.U. 15-25 and EFSB 17-01, for the 200-MW simple-cycle turbine generating plant (the Facility) in Medway. The Facility consists of two GE LMS-100-PA+ turbine generators, designated as Units J4 and J5.

The following documents were reviewed for this report:

- Host Community Agreement (HCA) between the Town and Exelon, October 14, 2015, and the First Amendment to the HCA, April 7, 2017.
- EFSB 15-01 Final Decision, November 16, 2016; EFSB 17-01 Final Decision, August 4, 2017.
- Notice of Project Change/Request to Modify Certificate Regarding Use of Ultra Low Sulfur Kerosene and Opacity Levels, including Exhibits A through F, August 31, 2020.
- Final Air Quality Plan Approval X265409, Exelon West Medway, LLC and Exelon West Medway II, LLC, December 19, 2016.
- Final Air Quality Plan Approval X269143, NRG Canal 3 Development, LLC, August 4, 2017.

Tech has provided air quality permitting and impact analysis of energy facilities since 1984, for clients in both the electric generating sector and government. Tech's staff of scientists and engineers have extensive experience with health-based air quality standards, air dispersion modeling, air quality monitoring, and regulatory analysis. Tech has provided peer review service to many local and State regulatory agencies.

This report considers seven air quality impact issues related to the NOPC. These issues are discussed below, following two introductory sections.

Existing and Proposed Air Permit Conditions

The existing *Air Plan Approval* allows the Facility to use Ultra Low Sulfur Distillate (ULSD) fuel oil as back-up fuel for a maximum of 720 hours (equivalent to 30 days) between October and April under certain conditions, and it contains limitations on the opacity (a measure of non-transparency) of the flue gas emanating from the Facility's stack. Specifically, the *Air Plan Approval* contains an opacity emissions limit of less than 5% (1-minute block average), except for two minutes during any one hour when the limit increases to less than 10%.¹ The NOPC requests the EFSB approve the following changes to the *Air Plan Approval* conditions incorporated into the EFSB *Certificate*:

- (a) adjust the opacity limits as follows: (i) excluding startup/shutdown: less than 15% on a two-minute block average basis, except less than 20% for up to 2 minutes during any one hour, (ii) during startup/shutdown: less than 20%, except less than 40% for up to 6 minutes during any one hour;
- (b) add Ultra Low Sulfur Kerosene (ULSK) as a back-up fuel with the proviso that the Facility can also use ULSD only if Exelon demonstrates to MassDEP that the Facility can meet the opacity limits set forth in (a) above when operating on ULSD.

Particulate Matter (PM) and Opacity

Particulate Matter (PM) is the term for a mixture of solid particles and liquid droplets found in the air. Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using an electron microscope. U.S. EPA has set air quality standards to protect public health for PM₁₀ and PM_{2.5}. PM₁₀, also called inhalable PM, is included in total PM and generally consists of particles with a diameter of 10 micrometers or smaller. PM_{2.5}, also called fine inhalable PM, generally consists of particles with a diameters of 2.5 micrometers or smaller. As part of the original permitting process, Exelon demonstrated, through dispersion modeling, that PM emissions from the West Medway II, in conjunction with other nearby PM sources, would maintain acceptable air quality levels for PM₁₀ and PM_{2.5}. The *Air Plan Approval* includes two PM emission rate limits, designed to ensure the Facility is in compliance with the PM health standards, when it is firing the back-up fuel ULSD. Those limits are 30.69 lb PM/hour and 0.032 lb PM/million Btu heat input.¹

Opacity is a measure of the amount of light attenuated by PM in the stack emissions. The percentage of visible light attenuated is defined as the opacity of the emissions. Transparent stack emissions that do not attenuate light have an opacity of 0 percent. Opaque stack emissions that attenuate all of the visible

¹ MassDEP, *Air Plan Approval X265409*, Table 13, December 19, 2016.

light have an opacity of 100 percent. Opacity is obviously a measure of visual impact, and while it is sometimes used as a surrogate for PM emissions, there are no health-based or safety limits for opacity, as it only measures plume visibility, an aesthetic concern. A plume with an opacity of 5% or less is considered essentially invisible.

Opacity provides only qualitative information on the performance of the combustion process. For a clean liquid fuel, such as ULSD, opacity is relatively low, and opacity readings are affected by PM composition, particle size, physical conditions (e.g., coagulation of particles), and by water vapor. As a consequence, opacity readings for ULSD combustion may not correlate well with actual PM mass emissions. One side benefit of the Continuous Opacity Monitoring System (COMS) in this situation is in providing real-time data on the combustion process, similar to that provided by the Continuous Emissions Monitoring System (CEMS) for carbon monoxide (CO). Thus, a significant increase in either CO or opacity levels above previously measured baseline values flags possible problems in the combustion device.

Stack tests were done in 2019 on Units J4 and J5 when operating on back-up fuel ULSD, to confirm compliance with the 5% opacity limit. As reported in a letter of November 14, 2019 from Exelon's consultant Epsilon to MassDEP,² both turbines unexpectedly produced opacity levels above the 5% limit when operating at 100% load (nominally 100 MW) and burning ULSD.³ The PM emission rates measured in those tests, however, confirm compliance with the PM mass emission limits, and the average PM emissions at design load were very low and only 1/3 of the permit limits (10.92 lb PM/hour and 0.011 lb PM/million Btu heat input).² Thus, while opacity levels were higher than 5% when the turbines operated on the back-up fuel ULSD, actual emissions of regulated pollutants easily complied with permit limits and showed no adverse impact on public health.

In February 2020, Exelon's consultant Epsilon provided 6-minute average opacity data from the 2019 stack tests for the full load condition (100-111 MW) to MassDEP, at the request of the Department. Those data show that when firing ULSD, Unit J4 exceeded 15%-opacity 15% of the time (with a maximum 6-minute opacity of 23.8%), and Unit J5 exceeded 15%-opacity 9% of the time (with a maximum 6-minute opacity of 9.5%).⁴

At the suggestion of MassDEP, Exelon performed a short opacity test on Unit J4 (the one with the highest opacity levels on ULSD) at full load using Ultra Low Sulfur Kerosene (ULSK).⁵ The results demonstrated that, while 6-minute opacity levels were still greater than the 5% limit set forth in the *Air Plan Approval*, they were less than the levels measured using ULSD. Specifically, when firing ULSK, Unit J4 never exceeded 15% opacity for a 6-minute period.⁶

² Letter from Dale Raczyński, P.E. to MassDEP Central Regional Office, "West Medway Opacity," November 14, 2019.

³ Opacity is generally not an issue with combustion turbines burning clean fuels (natural gas and ULSD). The two turbines at West Medway II (GE LMS-100 PA+) are the newest generation machines from GE, designed for very high efficiency, and are unique in their application with dual fuel firing.

⁴ Letter from Dale Raczyński, P.E. to MassDEP Central Regional Office, February 12, 2020.

⁵ DEP did not require the total PM testing done for ULSD to be repeated during the ULSK test because the two back-up fuels are very similar, and if anything ULSK would be expected to produce slightly lower PM emissions.

⁶ Letter from Dale Raczyński, P.E. to MassDEP Central Regional Office, April 15, 2020.

Using the ULSK test run results, and following MassDEP's stated preference for any revised opacity limits to be based on 2-minute averaging, the proposed opacity condition listed on page one of this letter was crafted by Exelon for consideration by EFSB.

The following sections discuss seven air quality impact issues related to the NOPC. Each issue is introduced in the form of a question.

Question 1 – Is there a scientific reason for claiming ULSK produces less opacity than ULSD?

Both kerosene and distillate oil are considered light-grade fuel oils, and are often used interchangeably. Kerosene is also known as No. 1 fuel oil, while distillate goes by the designation No. 2 fuel oil. Both oils are made up of a mixture of hydrocarbons.

The distribution of hydrocarbon length in each mixture is designated by the number of carbon atoms in the component molecules. For kerosene, the predominant hydrocarbons are in the C11 to C16 range, while distillate oil has hydrocarbons in the C11 to C20 range. Thus, kerosene is a slightly lighter fuel oil than distillate. Generally, fuels with a lower number of carbon atoms produce less PM (elemental carbon) when burned. The cleanest-burning hydrocarbon fuel, methane (CH₄), is a C1 compound.

Units J4 and J5 are required to burn methane (natural gas) except under certain conditions when back-up fuel oil may be used. Whereas, opacity is a surrogate for PM emissions, the differences in chemical composition between kerosene and distillate suggest that, yes, kerosene may produce slightly less opacity (a less visible plume) than distillate oil.

Question 2 – Does Gradient's 2020 Human Health Risk Assessment Addendum demonstrate the proposed change will not cause any adverse health effect?

In 2015, Gradient issued a Human Health Risk Assessment (HHRA) for the project, which evaluated potential public health impacts of criteria air pollutant and air toxic emissions from the combustion turbines. The HHRA concluded that facility emissions, including fine inhalable particulate matter (PM_{2.5}) "would not be expected to contribute to significant health risks among potentially affected communities."⁷ The HHRA Addendum published by Gradient concludes "that increasing the opacity limit during the usage of the kerosene back-up fuel would not be expected to create public health risks of concern in the communities around the Facility, including Medway as well as nearby environmental justice communities in Milford and Franklin."⁸ While Gradient presents six separate lines of evidence to support their conclusion, there are two principal arguments.

In the first argument, Exelon states the facility is not requesting any change to the PM emission limits, and it is PM emissions, not opacity, that determine potential health effects of air pollution. The increase in the opacity limit for back-up fuel oil use, by itself, does not change potential health effects tied to PM emissions. Those are true statements.

⁷ Gradient Corporation, *Updated Human Health Risk Assessment for Exelon's Proposed West Medway Project*, 2015.

⁸ Gradient Corporation, *2020 Human Health Risk Assessment Addendum for Exelon's New West Medway Facility*, July 2020.

The original HHRA calculated health risk assuming the projected worst case PM_{2.5} levels in the air (facility plus background) associated with the estimated maximum emission rate for a combination of natural gas and back-up fuel oil. The *Air Plan Approval* PM emission limits are tied to that same worst case scenario. Gradient argues correctly that since the stack testing on back-up fuel oil revealed actual PM emissions are well below the PM emission limits during the higher-than-5% opacity events, there is no change to the calculated health risk.

In the second argument, Exelon notes that the conservative health-based evaluation of PM_{2.5} emissions from the facility was not tied to an assumption that backup fuel was specifically ULSD or ULSK, but instead assumed that all facility PM_{2.5} emissions have similar toxicological properties to diesel exhaust particulate matter, one of the forms of fine PM with the greatest potential health risk. This is a very conservative assumption in the risk analysis, and the requested change to opacity limits does not affect the risk calculations.

In summary, since the change to the opacity permit condition does not affect the PM emission limits, and it is the latter which were used in the calculation of potential health risks with other very conservative assumptions, then yes, the Gradient HHRA Addendum demonstrates the proposed change will not cause any adverse health effect.

Question 3 – Does an analysis of the oil-firing test results support Epsilon’s claim that emission rates for all pollutants remain below permit limits even while opacity exceeded the 5% limit?

Stack test data for the tests made on Units J4 and J5 when firing back-up fuel oil, conducted between June 25, 2019 and April 1, 2020, were reviewed.^{9,10} For most of these tests, stack opacity exceeded 5% (two-minute average). The tests measured the pollutants CO, and NO_x with Continuous Emission Monitoring Systems (CEMS) and measured Opacity with Continuous Opacity Monitoring Systems (COMS), with generator output ranging from 53 to 108 MW.

Stack CO levels, corrected to 15% O₂, ranged from 0.23 to 0.94 ppm, and all measured values were below the permit limit of 5.0 ppm. Stack NO_x levels, corrected to 15% O₂, ranged from 1.8 to 4.8 ppm, and all measured values were below the permit limit of 5.0 ppm. Separate PM compliance tests were done using published EPA Methods at 100% load on October 7-9, 2019 for Unit J4, and on October 5-6, 2019 on Unit J5. The EPA Methods average the results of multiple tests to obtain the compliance test value. The test results for Units J4 and J5, operating at 100% load, were 10.81 lb/hour and 0.011 lb/MMBtu (Unit J4), and 10.92 lb/hour and 0.011 lb/MMBtu (Unit J5).⁹ All test results are approximately 1/3 of the PM permit limits.

⁹ Letter from Dale Raczyński, P.E. to MassDEP Central Regional Office with accompanying table of individual ULSD test results, February 12, 2020.

¹⁰ Letter from Dale Raczyński, P.E. to MassDEP Central Regional Office, April 15, 2020.

In summary, the back-up fuel oil test results reveal that the emission rates for all tested pollutants complied with permit limits.¹¹

Question 4 – Are the proposed changes to opacity limits (stated in terms of % opacity, averaging time, and duration of special events) for normal operation and startup/shutdown reasonable, and will they likely ensure continuous compliance when the facility must use ULSK as a fuel?

There are two parts to the proposed opacity permit condition, the details of which were negotiated with MassDEP. Part (i) pertains to steady-state turbine operation and limits opacity to 15% on a two-minute basis, except for two minutes in any hour when a limit of 20% is allowed. The data from the ULSK firing test done on April 1, 2020, reported as two-minute values, show all measured values below 15% with a small portion of the periods having opacity between 12.5% and 15%.¹² Given the fact only one test on ULSK has been done to-date, on only one turbine (Unit J4), and the test was of limited duration (approximately 40 minutes), the proposed contingency limit of 20% for up to two minutes in any hour is very reasonable. Further support for the contingency 20% limit is provided by the fact the larger data set of tests for ULSD fuel oil showed significant variability. It is also reasonable to expect some deterioration in turbine performance over time.

Part (ii) of the proposed opacity condition pertains to start-up and shutdown of the turbines on back-up fuel oil. The 20% limit, with a contingency 40% limit for up to six minutes in any hour, is needed because incomplete combustion of fuel, and therefore higher plume opacity, is unavoidable during start-up and shutdown events. The proposed startup/shutdown-specific limits are commensurate with opacity levels previously observed during startups on ULSD fuel oil. The highest 1-minute opacity that was measured at the facility (approximately 35%) occurred during startup on ULSD, and there were multiple other startups on ULSD that included at least one minute with opacity between 20% and 40%.

The proposed startup and shutdown opacity limits are consistent with MassDEP's statewide opacity limits for combustion units, as specified in 310 CMR 7.06, which recognize brief periods of up to 40% opacity occur when a cold start occurs for oil-fired combustion equipment. The proposed startup and shutdown limits are also consistent with Exelon West Medway's existing *Air Plan Approval*, which already specifies distinct, and higher, startup/shutdown limits for CO, VOC and NO_x. Finally, it should be noted that these limits are consistent with the *Air Plan Approval* for Canal Station's Unit No. 10, a simple-cycle dual-fueled combustion turbine permitted by MassDEP more recently than Exelon West Medway II, which uses the MassDEP 310 CMR 7.06 opacity limits for oil-fired startup and shutdown.¹³ As noted in the introduction, there are no health-based or safety limits for opacity, as it only regulates the aesthetic concern of plume visibility.

In summary, the proposed opacity limits are reasonable and should ensure continuous compliance when the facility must use ULSK as a back-up fuel.

¹¹ Other pollutants regulated by limits in the *Air Plan Approval* are covered by separate compliance tests, the results of which can be found in the DEP file for West Medway II.

¹² Email from Dale Raczyński, P.E. to Tom Hannah, MassDEP Central Regional Office, July 20, 2020.

¹³ MassDEP, *Air Plan Approval X269143*, Table 9, August 4, 2017.

Question 5 – (A) Is opacity measured using optical light beams for the purpose of measuring particle emissions in power plant stacks? (B) Is it correct that lower opacity usually means there is a higher particle count which could translate two ways: (1) that there are more particles going up the stack; and (2) that the particles exiting the stack are bigger? (C) Could lower opacity and the associated higher particle count mean higher levels of particle emissions are coming out of the Exelon stack than expected? (D) If so, given the State’s desire to lower fuel emissions from vehicles how does the higher opacity relate?

(Part A) Yes, the facility’s Continuous Opacity Monitoring System (COMS) measures the attenuation of a light beam passing through the stack flue gas to determine plume opacity.

(Part B) No, just the opposite is true – lower opacity (less light attenuation) means there is a lower concentration of PM in the flue gas.

(Part C) No, the stack test data for back-up fuel oil firing show that even though opacity was unexpectedly above 5%, the total PM emissions were always well below the PM emission limits in the DEP permit.

(Part D) The requested change to the opacity condition does not include a change to the emission limit for total PM or any other regulated pollutant. There is no link between the requested change to the opacity limit for West Medway II and motor vehicle emissions.

Question 6 – Is there any inherent safety impact on the switch from diesel to kerosene?

No. Kerosene has been used as a household fuel for lamps, cooking and heating since the mid-19th Century, though today it is primarily used only in developing countries lacking electrification. Both kerosene and distillate oil are non-corrosive fuels and are safe to store for an extended period of time.


Question 7 – Should we be concerned for public health and safety with regard to opacity levels at start up, especially if the opacity levels approach 40%?

No. The proposed startup and shutdown opacity limits are consistent with MassDEP’s statewide opacity limits for combustion units, as specified in 310 CMR 7.06, which recognize brief periods of up to 40% opacity occur when a cold start occurs for oil-fired combustion equipment. Opacity only measures plume visibility, an aesthetic concern.

Thank you for the opportunity to provide this third-party review of the requested West Medway II NOPC for the Town of Medway.

Sincerely yours,

TECH ENVIRONMENTAL, INC.

A handwritten signature in black ink that reads "Peter H. Guldberg". The signature is written in a cursive style with a large, looped initial "P" and a stylized "G" at the end.

Peter H. Guldberg, INCE, CCM
Senior Consultant
4602/Letter Report Oct 22 2020