Technical Support Document for Prevention of Significant Deterioration Permit No. 91-02, Amendment 3 Final Determination

Puget Sound Energy
Encogen Generating Station

September 2020
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Technical Support Document
for Prevention of Significant Deterioration
Permit No. 91-02, Amendment 3

Puget Sound Energy
Encogen Generating Station

Air Quality Program
Washington Department of Ecology
Olympia, Washington
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1. Executive Summary

Puget Sound Energy (PSE) operates three turbines at the existing Encogen Generating Station in Bellingham. The facility is located at 915 Cornwall Avenue, east of the Port of Bellingham's waterfront redevelopment.

PSE has requested to make minor changes to its Prevention of Significant Deterioration (PSD) permit. The changes include:

- Clarify that short-term emission limits for nitrogen oxide (NOx) do not apply during start-up and shutdown.
- Update the sulfur dioxide (SO2) emission limit to be more consistent with the sulfur content in the natural gas that the facility receives.
- Change permit conditions for NOx and CO emissions to be consistent with the New Source Performance Standard (NSPS).

PSE did not propose any physical and operational change to the turbines.

After reviewing PSE’s request and additional information received, Ecology accepted the request. This technical support document shows Ecology’s analysis supporting our decision.
2. Introduction

2.1. The permitting process

PSD permitting requirements in Washington State are established in Washington Administrative Code (WAC) 173-400-700 through 750. Washington State implements its PSD program as a State Implementation Plan (SIP)-approved program. This SIP-approved program became effective May 29, 2015.

Federal and state rules require PSD review of all new or modified air pollution sources that meet certain criteria in an attainment or unclassifiable area with the NAAQS. The objective of the PSD program is to prevent significant adverse environmental impact from emissions into the atmosphere by a proposed new major source, or major modification to an existing major source. The program limits degradation of air quality to that which is not considered “significant.” PSD rules require the utilization of BACT for certain new or modified emission units, which is the most effective air pollution control equipment and procedures that are determined to be available after considering environmental, economic, and energy factors.

The PSD rules must be addressed when a company is adding a new emission unit or modifying an existing emission unit in attainment or unclassifiable area. PSD rules apply to pollutants for which the area is classified as attainment or unclassifiable with the NAAQS. PSD rules are designed to keep an area with “good” air in compliance with the NAAQS. The distinctive requirements of PSD are BACT, air quality analysis (allowable increments and comparison with the NAAQS), and analysis of impacts of the project on visibility, vegetation, and soils.

2.2. PSD permitting schedule


2.3. PSD permitting history

<table>
<thead>
<tr>
<th>Permit No.</th>
<th>Issuance Date</th>
<th>Project Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>91-02</td>
<td>September 26, 1991</td>
<td>Installation and operation of three (3) natural gas fired CCCTs.</td>
</tr>
<tr>
<td>91-02, Amendment 1</td>
<td>December 6, 1993</td>
<td>PSD Permit No.91-02 revision. The revision was to allow for the use of diesel fuel during times of natural gas curtailment and for limited testing.</td>
</tr>
</tbody>
</table>
Technical Support Document for PSD No. 91-02, Amendment 3  
PSE Encogen Generating Station  
Final Determination

<table>
<thead>
<tr>
<th>Permit No.</th>
<th>Issuance Date</th>
<th>Project Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>91-02, Amendment 2</td>
<td>July 23, 1998</td>
<td>PSD Permit No. 91-02, Amendment 1 revision. The revision was to establish higher daily NOx emission levels.</td>
</tr>
</tbody>
</table>

### 2.4. Site description

PSE Encogen Generating Station is located at 915 Cornwall Avenue, Bellingham, Washington, east of the Port of Bellingham's waterfront redevelopment. PSE assumed complete ownership of the facility in November 1999. The plant was originally constructed and operated by the Enserch Development Corporation.

The facility consists of three combustion gas turbine (GE Frame 6, Model MS6001B) generator systems and associated heat recovery steam generators (HRSGs) and exhaust gas treatment, a steam turbine-generator system, fuel oil storage, an electrical switchyard, and equipment for feed water treatment. See the facility’s aerial photograph in Figure 1. The facility is located in a Class II area that is designated as “attainment or unclassifiable” for the purpose of PSD permitting for all pollutants.

![Figure 1: PSE Encogen Generating Station aerial photograph](image-url)
3. Project Description

3.1. Request No. 1

PSE has requested that NOX emissions generated during turbine start-up and shutdown to be excluded from the 7 ppm daily limit.

PSE explained that during start-up/shutdown, the exhaust temperature is insufficient to allow for the utilization of steam injection and the selective catalytic reduction (SCR) for NOX control. Therefore, NOX concentration during start-up/shutdown in some cases exceeds the 7 ppm daily average limit.

Currently, the excess emission occurred during start-up/shutdown event is be considered unavoidable if PSE reports the exceedance.

3.1.1. Ecology’s review

Table 1: NOX Emission Limits for Condition 2 of Permit No. PSD 91-02, Amendment 2

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Fuel</th>
<th>Limit</th>
<th>Apply to</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOx</td>
<td>Natural gas</td>
<td>7.0 ppmvd corrected to 15 percent O2 at ISO conditions on a daily average</td>
<td>Each CCCT</td>
</tr>
<tr>
<td>NOx</td>
<td>Natural gas</td>
<td>1,000 lb/day</td>
<td>All three CCCTs combined</td>
</tr>
<tr>
<td>NOx</td>
<td>Diesel</td>
<td>11.0 ppmvd corrected to 15% O2 at ISO conditions on a daily average</td>
<td>Each CCCT</td>
</tr>
<tr>
<td>NOx</td>
<td>Diesel</td>
<td>1,605 lb/day</td>
<td>All three CCCTs combined</td>
</tr>
<tr>
<td>NOx</td>
<td>All fuels</td>
<td>175 tons per 12 consecutive months</td>
<td>All three CCCTs combined</td>
</tr>
</tbody>
</table>

The short-term 7.0 ppmvd NOX limits reflects the achievable emission performance using the applicable control technology during periods of normal, steady-state turbine operation.

Generally, the emission rates during the start-up and shutdown period are greater than the emissions during steady-state turbine operation and are highly variable. NOX emissions can be significantly higher during start-up/shutdown events for the following reasons.

- The emissions are not controlled by the SCR because the ammonia is not injected in the SCR until the catalyst reaches the appropriate operating temperature for the catalyst. When the
catalyst surface temperatures are low, ammonia will not react completely with the NO\textsubscript{X}, resulting in excess NO\textsubscript{X} emissions or excess ammonia slip.

- The HRSG is not hot enough to provide steam to the steam injection system in order to minimize thermal NO\textsubscript{X} emission.

PSE Encogen Generating Station also subject to NO\textsubscript{X} limit of 1,000 lb/day and 175 tons per 12-month period, which include the emission during start-up and shutdown. Since the emissions during start-up and shutdown periods cannot be further controlled beyond the best operational practices (i.e. less frequent start-up event, shorter start-up duration, etc.), Ecology believes that the existing lb/day and tons/year NO\textsubscript{X} limit in the permit will continue to effectively minimize the NO\textsubscript{X} emission during these events.

The applicant did not request to exclude CO emission limit from start-up and shutdown events. Performance tests were conducted during October 5-7, 2015, and the results showed that the CO emission during start-up for 3-run tests were 2.9 ppmdv, 2.2 ppmdv, and 2.5 ppmdv at 15 percent O\textsubscript{2}, significantly below the emission limit. Therefore, the CO emission limit is achievable during start-up. Performance tests were not conducted during shutdown events, presumably due to difficulties to obtain sufficient data using the standard reference method because of the short shutdown duration.

### 3.2. Request No. 2

PSE proposes to eliminate the 100 lb/day SO\textsubscript{2} emission limit when firing natural gas. PSE explains that the limit is not needed since:

- The sulfur content in the natural gas cannot be controlled.
- The ambient air standard impact analysis was conducted based on the higher SO\textsubscript{2} limit of 1,584 lb/day when firing diesel fuel.

#### 3.2.1. Ecology’s review

Table 2: SO\textsubscript{2} Emission Limits for Condition 3 of PSD Permit No. 91-02, Amendment 2

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Fuel</th>
<th>Limit</th>
<th>Apply to</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO\textsubscript{2}</td>
<td>Natural gas</td>
<td>100 lb/day</td>
<td>All three CCCTs combined</td>
</tr>
<tr>
<td>SO\textsubscript{2}</td>
<td>Diesel</td>
<td>9.0 ppmdv corrected to 15 percent O\textsubscript{2} at ISO conditions on a daily average</td>
<td>Each CCCT</td>
</tr>
<tr>
<td>SO\textsubscript{2}</td>
<td>Diesel</td>
<td>1,584 lb/day</td>
<td>All three CCCTs combined</td>
</tr>
</tbody>
</table>
Ecology finds that the request is acceptable for the following reasons:

- The original PSD permit allowed the units to only use pipeline natural gas as fuel. In Permit Amendment 1, PSE requested to allow the units to burn diesel fuel during gas curtailment and testing. At that time, the SO₂ emission from diesel firing triggered the PSD review. The SO₂ emission from natural gas firing alone is below the significant emission rate threshold of 40 tons/year.

- The modeling input data (from the Permit Amendment 1 application) assumed SO₂ emission rate of 2.77 g/s for each CCCT, equal to approximately 22 lb/hr for each CCCT when firing diesel fuel. The ambient impact analysis was conducted assuming worst-case scenario of burning diesel fuel because of the higher sulfur content in the fuel. Therefore, it does not appear that the SO₂ limit of 100 lb/day is needed for NAAQS protection.

- The original 100 lb SO₂/day emission limit was established by assuming that the sulfur content of natural gas contain is 1.16 gr/100 cf. However, measurement data collected (November 1, 2006 and September 30, 2008) at the Huntington pumping station showed a maximum daily average total sulfur concentration of 1.91 gr/100 cf. The current 100 lb SO₂/day emission limit is not achievable on continuous basis even though the facility is fueled by natural gas as required by the permit.

Additionally, PSE commented on the draft permit (in the email dated September 17, 2018) that the Condition 1 of the permit requiring that the units fueled by pipeline quality natural gas should change to natural gas. PSE’s concern that the term “pipeline quality natural gas” might imply that the gas supplied to Encogen shall meet the requirement of pipeline natural gas as defined in 40 CFR 72.2. The natural gas PSE receives has a higher sulfur content than the pipeline natural gas as defined by 40 CFR 72.2 (0.5 grains or less of total sulfur per 100 standard cubic feet).

Ecology did not find any reference to 40 CFR 72.2 or explanation regarding the use of term “pipeline quality natural gas” in the historical permitting document. The PSD permits previously issued for PSE Encogen predated the time that the facility became subject to the Acid Rain Program during November 1999. Ecology agrees to revise this permit condition as requested by PSE because it does not appear that the permit condition was drafted intended to be consistent with the meaning of pipeline natural gas as defined in 40 CFR 72.2.

### 3.3. Request No. 3

PSE proposes to remove the ISO correction requirement for NOₓ, SO₂, and CO emission from the PSD permit.

For the NOₓ emission limit, PSE explained that New Source Performance Standards (NSPS), Subpart GG – Standards of Performance for Stationary Gas Turbine does not require the ISO correction for:
• Lean premix stationary combustion turbines.
• Unit used in association with HRSG equipped with duct burners.
• Units equipped with add-on emission control devices.

The Encogen turbines are all equipped with SCR as add-on control and ISO correction is not required under NSPS, Subpart GG.

3.3.1. Ecology’s review

Based on the NSPS, Subpart GG’s proposed rule (October 3, 1977), the ISO correction factor was initially developed for NO\textsubscript{X} limit to ensure that NO\textsubscript{X} standards are enforced uniformly because large change in temperature, pressure, humidity can cause the NO\textsubscript{X} emission to vary significantly. At that time, ISO correction was developed based on the diffusion flame units without add-on NO\textsubscript{X} control.

In the NSPS, Subpart GG’s direct final rule (April 14, 2003), EPA determines that the ISO correction equation was not necessary for lean premix stationary combustion turbines, combined cycle system with duct burner and unit equipped with add-on control. In this case, Encogen turbines would be exempted from ISO correction in NSPS.

CO emission is the product of incomplete combustion and generally has an inverse relationship with the NO\textsubscript{X} emission. Since EPA deems ISO correction for NO\textsubscript{X} not necessary, it appears that the CO emission limit should be treated similarly.

SO\textsubscript{2} emission from the turbines depends on the sulfur content of the fuel and nearly 100 percent of the fuel sulfur is converted to SO\textsubscript{2} during the combustion process. Ecology believes that the atmospheric temperature, moisture, and pressure should not affect the exhaust SO\textsubscript{2} concentration. NSPS Subpart GG also does not require the SO\textsubscript{2} limit to be corrected to ISO conditions.

Ecology finds that the request is acceptable and consistent with the EPA’s determination in NSPS, Subpart GG.
4. Ambient Air Quality Analysis

An air quality analysis can include up to three parts: Significant Impact analysis, National Ambient Air Quality Standards (NAAQS) analysis, and PSD Increment analysis. The first step in the air quality analysis is to determine if emissions from the proposed project result in impacts greater than the modeling significance levels (MSLs). Then, for those pollutants and averaging periods that have impacts greater than the MSL, a NAAQS analysis is used to determine if the proposed project will cause or contribute to an exceedance of a NAAQS. The PSD Increment analysis is used to determine if the change in the air quality since the applicable baseline dates is greater than the Class I and Class II PSD Increment Levels.

There is no emission increase proposed for this project. Therefore, this review focuses on the NAAQS analysis of 1-hr nitrogen dioxide (NO2) and 1-hr sulfur dioxide (SO2) NAAQS promulgated during 2010. Prior to promulgation of the new 1-hr NO2 and SO2 standard, the only NAAQS applicable was the annual standard.

4.1. Models, receptor grids, and meteorological data

PSE’s consultant, SLR International Corporation, used the following programs for cumulative impact analysis:

- AERMOD (version 15181)
- AERMAP (version 11103)
- AERMET (version 15181)
- AERMINUTE (version 14337)
- AERSURFACE (version 13016)
- BPIP-PRIME (version 04112)

Five years (2007-2011) of integrated surface hourly data (ISHD) collected at the Bellingham International Airport (BLI) was used in combination with upper air data collected at the Quillayute State Airport (UIL). AERMINUTE (version 14337) is applied to the sub-hourly wind data (DSI-6405 format) provided by the National Weather Service for BLI station.

A wind rose plot from the AERMET output is provided in Figure 2 below.
SLR also utilized the following receptor grids in the modeling:

- “Fence” receptors spaced every 50 meters (m) along the fence line.
- “Fine” grid spaced every 100 m, extending 2 kilometers (km) from the fence line.
- “Medium” grid spaced every 200 m extending from 2 km to 8 km.
4.2. Stack parameter

Table 3: Stack Parameter for the Model Input

<table>
<thead>
<tr>
<th>Description</th>
<th>CCCTG 1 (middle stack)</th>
<th>CCCTG 2 (north-end stack)</th>
<th>CCCTG 3 (south-end stack)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exit temp (K)</td>
<td>400</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>Stack diameter (m)</td>
<td>4.42</td>
<td>4.42</td>
<td>4.42</td>
</tr>
<tr>
<td>Release height (m)</td>
<td>25.6</td>
<td>25.6</td>
<td>25.6</td>
</tr>
</tbody>
</table>

4.3. NO to NO₂ chemical transformation

NOₓ emissions from a stack contain some proportion of NO and NO₂. During ambient dispersion of NOₓ emissions, the NO fraction reacts with ambient ozone to generate NO₂ farther downwind of the source depending on dispersion conditions.

Plume Volume Molar Ratio Method (PVMRM) was used within AERMOD to account for NO₂ chemical transformations in order to address 1-hr NO₂ NAAQS attainment demonstration concerns. In AERMOD, PVMRM accounts for transformation of NOₓ emissions into NO₂ as determined through chemical reactions with available ambient ozone.

The NO₂ concentrations predicted using PVMRM is dependent upon a user-specified NO₂/ NOₓ in-stack ratio, ozone background concentrations, and the ambient NO₂ equilibrium ratio. The CCCTG(s in the NOₓ modeling analysis have an in-stack ratio of 0.1, based on default in-stack ratios suggested by California guidance and Tier 3 NO₂ analyses involving CCCTGs. The NO₂/ NOₓ chemical conversion equilibrium ratio is set to 0.9 based on EPA’s 2011 Memo. The hourly ozone data dataset covers 2007-2011 collected at the Custer Station, located about 20 km north of Bellingham, Washington, was used in the model. The model with a default ozone concentration of 40 ppb (EPA’s 2011 Memo) fills any missing hours.

4.4. Emission input data and model results

SLR used the NOₓ limit of 1,605 lb/day for the 1-hr NO₂ averaging period. This daily NOₓ limit includes the emission from start-up and shutdown. The modeling assumed the emissions are spread equally across each of the turbines, which is about 22.3 lb/hr for each turbine. The daily average emission limit is used because Encogen plant is not a peaking plant and emission from start-up can be considered intermittent according to EPA’s guidance memorandum (March 1, 2011), “Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO₂ National Ambient Air Quality Standard.”
SLR conducted a cumulative impact analysis to demonstrate that CCCTG emissions comply with the NAAQS for 1-hr NO₂. The cumulative impact analysis for 1-hr NO₂ includes and addresses both project emissions and background NO₂ concentrations representative of regional emissions from small point sources, area, and mobile sources. See table below for NO₂ NAAQS model results.

Table 4: NO₂ NAAQS Model Results

<table>
<thead>
<tr>
<th>Averaging Period</th>
<th>Modeled Concentration (µg/m³)</th>
<th>Background Concentration (µg/m³)</th>
<th>Design Value Concentration (µg/m³)</th>
<th>NAAQS (µg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 hour</td>
<td>103</td>
<td>44</td>
<td>147</td>
<td>188</td>
</tr>
</tbody>
</table>

The design value is approximately 78 percent of the NAAQS. Ecology believes that if the emissions including start-ups/shutdowns produce a design concentration that is less than 90 percent of the 1-hr NAAQS, compliance has been satisfied.

PSE’s 2011 submittal (the original version of the application) also consists of 1-hr SO₂ modeling. The model assumed a plant-wide emission rate of 200 lb/day when firing with natural gas and showed that the highest receptor value is predicted to be 43.7 µg/m³. When added to the regional background concentration of 44.5 µg/m³, the total concentration is about 88.2 µg/m³ or 34 ppb. The 1-hr SO₂ NAAQS is 75 ppb (196.5 µg/m³).

However, Ecology believes that it is more conservative to assume emission rate of 1,584 lb/day under the operating scenario where all the CCCTs are firing diesel fuel at the same time. At 1,584 lb/day emission rate, the highest receptor value is 1584/200 x 43.7 µg/m³ = 346.1 µg/m³. When added to the regional background concentration of 44.5 µg/m³, the total concentration is 390.6 µg/m³ > 196.5 µg/m³ 1-hr SO₂ NAAQS.

To estimate SO₂ limit that is needed for NAAQS protection, the highest receptor value should not be more than 196 (standard) – 44.5 (background) = 151.5 µg/m³. SO₂ emission = 151.5/43.7 x 200 lb/day = 693 lb/day.

The 1,584 lb/day SO₂ limit was established based on the diesel fuel sulfur content of 0.05 percent by wt. Today, the ultra-low sulfur diesel (ULSD) fuel is widely available and contains no more than 15 ppm sulfur content, or 0.0015 percent sulfur by wt. By using ULSD and assuming 658 lb SO₂/day emission limit (approximately five percent margin of safety for reasonable assurance), the facility should have the ability to use the diesel when needed without losing operational flexibility and at the same time provide 1-hr SO₂ NAAQS protection.
5. Discussion of Permit Conditions Revision

5.1. Summary of the permit conditions revision

- Initial compliance demonstration language for the emission limit is removed since it is obsolete.
- ISO correction requirement is removed per applicant’s request. After the revision, the permit conditions will be more consistent with NSPS, Subpart GG. See more detail in Section 3 of this support document.
- Adding clarification that the 7 ppmvd NOX limit on a daily average does not apply during start-up and shutdown events.
- Adding start-up/shutdown definitions. Generally, the duration of start-up depends upon the amount of time that the unit has “stood still” or has not been operating since its last period of operation. The longer the standstill time, the longer the subsequent start-up time due to the time necessary to heat up and prepare for normal operation to prevent adverse impacts such as material fatigue, creep (damage caused by high temperatures), and corrosion.
- Remove the language describing that excess emission during start-up and shutdown shall be considered unavoidable provided the source reports the exceedance. This language provides an affirmative defense for excess emissions and appears to bar enforcement by the EPA or citizens for such excess emissions if it remains in the permit.
- Remove 100 pounds per day SO2 emission limit when the unit is fired on natural gas, per applicant request.
- Revise part of Condition 10 in Amendment 2 language as shown below.

> “Excess emissions which represent a potential threat to human health or safety or which ENWLP believes to be unavoidable shall be reported as soon as possible.”

Any excess emission represents a potential threat to human health or safety subject to prompt reporting requirements of WAC 173-401-615 (3)(b), which is included in the facility’s Title V permit, regardless if the exceedance is avoidable or unavoidable. The revised language will be more consistent with WAC 173-401-615 (3)(b).

- Lower the SO2 emission limit from the three CCCTs combined from 1,584 pounds to 658 pounds per day when fired on oil for 1-hr SO2 NAAQS protection.
- Revise the term “pipeline natural gas” to “natural gas” in Condition 1.
- Update the name of Northwest Air Pollution Control Agency (NWAPA) to Northwest Clean Air Agency (NWCAA).
- Revise NOX CEMs language to add more clarification.
6. Environmental Justice Review

Environmental Justice (EJ) is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Ecology conducts an EJ review to ensure no group of people bear a disproportionate share of the negative environmental consequences as the result of the permitting action.

The initial step in this review is to identify of any affected populations, or communities of concern. Ecology used EPA’s EJ screening and mapping tool EJSCREEN for this purpose. Area of map as shown below was selected for the analysis, which occupies total area of 8.35 square miles.

![Figure 3: Selected EJSCREEN area](image)

EJSCREEN American Community Survey (ACS) report estimates that the selected area consists of approximately 20 percent minority population, with approximately two percent of the total population speaking English “less than well.” A copy of the ACS report will be filed as part of the supporting document of the project.

Because the project will not have any emission increase, Ecology did not conduct more extensive review of the potential for disproportionate high and adverse effects on an EJ community, other than the NAAQS analysis conducted.
It also appears that a majority of the population in the selected area can understand and speak English proficiently. Ecology is not expecting a communication barrier and determines that an enhance outreach effort is not needed due to the nature and scope of this project.
7. Public Involvement

This PSD permitting action was subject to a minimum 30-day public comment period under WAC 173-400-740. Ecology posts the public notice on Ecology's web site for a minimum of 30 days. Day one of the public comment period begins on the next calendar day after Ecology posts the public notice. The public comment period started on June 1, 2020, and closed on July 2, 2020, at 5 PM PDT. Ecology did not receive a comment during the comment period.
8. Conclusion

The amendment action will have no significant adverse impact on air quality or air quality-related values. The Washington Department of Ecology finds that the applicant, Puget Sound Energy, has satisfied all requirements for approval of PSD 91-02, Amendment 3.

For additional information, please contact:

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