UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Washington, DC 20460

OFFICE OF AIR AND RADIATION

June 26th, 2025

Mr. Kevin Counts
Designated Representative
Palomar Energy Center
2300 Harveson Place
Escondido, CA 92029

Re: Petition for monitoring alternatives for hydrogen combustion at San Diego Gas & Electric's Palomar Energy Center (ORIS 55985)

Dear Mr. Counts:

The United States Environmental Protection Agency (EPA) has reviewed the June 4, 2024, petition and supporting emails submitted under 40 CFR 75.66 by York Engineering, LLC on behalf of San Diego Gas & Electric Company (SDG&E) for the Palomar Energy Center (PEC). SDG&E requests EPA's approval of (1) a waiver of fuel sampling and analysis requirements that would otherwise apply to hydrogen fuel combusted by PEC in blends with pipeline natural gas (PNG); (2) default values for sulfur content, gross calorific value (GCV), F-factor, and F_c-factor to use for the hydrogen fuel; and (3) application of the procedures in section 3.3.6.4 of appendix F to 40 CFR part 75 to determine prorated F-factor values for the PNG-hydrogen fuel blends combusted in each hour. The hydrogen fuel would be produced on-site by electrolysis of water, and the combusted quantities would be monitored separately from the combusted quantities of PNG. EPA approves the petition in part, with conditions, as discussed below.

Background

SDG&E owns and operates PEC, which is located in Escondido, California. Units CTG1 and CTG2 are combustion turbines equipped with heat recovery steam generators that serve a single steam turbine electrical generator in a "2-on-1" combined cycle configuration. Each of the combustion turbines has a nominal gross capacity of 165 MW and the steam turbine electrical generator has a nominal gross capacity of 229 MW, yielding a total nominal gross generating capacity of 559 MW for the overall plant. The combustion turbines have historically combusted exclusively PNG.

According to SDG&E, units CTG1 and CTG2 are subject to the Acid Rain program. SDG&E is therefore required to monitor and report sulfur dioxide (SO_2) and carbon dioxide (CO_2) mass emissions, nitrogen oxides (NO_X) emission rate, and heat input for each unit in accordance with 40 CFR part 75. To meet the requirements relating to NO_X emission rate, SDG&E has installed and certified a NO_X-diluent continuous emission monitoring system on the stack for each unit, with oxygen (O_2) as the monitored

diluent gas. To meet the requirements relating to SO_2 mass emissions and heat input, SDG&E has chosen to use the excepted monitoring methodology in appendix D to part 75 and has installed and certified fuel flowmeters to continuously monitor the quantities of PNG combusted in each unit. To meet the requirements relating to CO_2 mass emissions, SDG&E uses the procedures in section 2.3 of appendix G to part 75.

The methodologies SDG&E follows to determine PEC's hourly NO_X emission rate and hourly CO_2 mass emissions require the use of F-factors and F_c-factors, respectively. As used in part 75, an F-factor is a factor representing the volume of dry combustion gases produced by combustion of a given quantity of heat input from a given fuel or fuel blend,[1] while an F_c-factor is a factor representing the volume of CO_2 produced by combustion of a given quantity of heat input from a given fuel or fuel blend. For the most common fuels, Table 1 in section 3.3.5 of appendix F to part 75 lists default values for F-factors and F_c-factors, and sections 3.3.6 through 3.3.6.2 provide a methodology for computing optional site-specific values for F-factors and F_c-factors for the listed fuels based on analyses of fuel samples. Further, where a unit combusts a blend of listed fuels, section 3.3.6.4 provides a methodology to determine prorated values of F-factors or F_c-factors for any given blend proportions, and section 3.3.6.5 provides a "worst-case" option to use the highest F-factor or F_c-factor for any listed fuel combusted at the unit as the F-factor or F_c-factor for all fuel blends combusted at the unit. However, if a unit combusts a fuel not listed in Table 1 or a fuel blend that includes an unlisted fuel, section 3.3.6.3 requires the unit's owner or operator to obtain EPA approval for site-specific values of F-factors and/or F_c-factors for the fuel or fuel blend through a petition under § 75.66.

The methodologies SDG&E follows to determine PEC's reported SO_2 mass emissions and heat input require the use of values for the sulfur content and GCV of each fuel combusted. In the case of sulfur content, default SO_2 emission rates determined without fuel sampling and analysis may be used for fuels that meet the definitions of "pipeline natural gas" or "natural gas" in 40 CFR 72.2, but for all other fuels the sulfur content values (in sulfur per unit of fuel mass or volume) are determined through periodic sampling and analysis, sometimes in conjunction with provisions of the relevant fuel contract. Depending on the fuel characteristics and/or delivery method, the required minimum sampling frequencies for sulfur content can range from annual to hourly, or sampling can be required for each delivery lot. In the case of GCV, the values for all fuels (in Btus per unit of fuel mass or fuel volume) are determined through periodic sampling and analysis, sometimes in conjunction with provisions of the relevant fuel contract, and the required minimum sampling frequencies can range from monthly to daily or by delivery lot. Exceptions to the fuel sampling and analysis requirements and the sulfur content and GCV determination procedures set forth in appendix D require EPA approval through a petition under § 75.66.

[1] In other contexts, the dry-basis F-factors used in part 75 may be termed F_d-factors to distinguish them from wet-basis F-factors (F_w-factors). An F_w-factor is a factor representing the volume of all combustion gases, including water vapor, produced by combustion of a given quantity of heat input from a given fuel or fuel blend.

In the June 2024 petition, SDG&E describes a plan to combust hydrogen fuel at PEC in blends with PNG.[2] According to SDG&E, all the hydrogen fuel combusted at PEC would be produced on-site through electrolysis of water. After production, the hydrogen fuel would be compressed and stored on-site until use. The quantities of hydrogen fuel combusted would be monitored with a fuel flowmeter separate from the fuel flowmeter used to monitor the quantities of PNG combusted, and the two separately monitored fuel streams would be blended immediately before the fuel blend is fed to the combustion turbine.

Because Table 1 in section 3.3.5 of appendix F does not include hydrogen as a listed fuel, EPA approval is needed for the values of the F-factors that will be used to determine reported hourly NO_X emission rate from the PNG-hydrogen fuel blends and for the F_c-factor that will be used to determine reported hourly CO_2 mass emission rate from the hydrogen fuel portion of the fuel blend in hours when a PNG-hydrogen fuel blend is combusted. No petition would ordinarily be needed for the determination of sulfur content and GCV of the hydrogen fuel because appendix D to part 75 sets out sampling and analysis procedures that can be applied to any gaseous fuel. However, given the expected high purity of hydrogen gas produced through electrolysis, SDG&E believes that periodic sampling and analysis of the hydrogen fuel combusted at PEC would be unnecessary, because the chemical composition and GCV of pure hydrogen gas are known physical properties of the gas. SDG&E therefore requests approval to use default values for sulfur content and for GCV per unit of volume combusted at PEC based on the physical properties of pure hydrogen gas, without any requirement for periodic sampling and analysis of the hydrogen fuel. SDG&E likewise requests approval of default values for an F-factor and an F_c-factor for the hydrogen fuel calculated from formulas in the part 75 regulations using inputs based on the physical properties of pure hydrogen gas, again without any requirement for periodic sampling and analysis of the hydrogen fuel. Finally, SDG&E requests approval to compute the hourly values of the F-factors for the PNG-hydrogen fuel blends by applying the prorating procedure in section 3.3.6.4 of appendix F, using the F-factors for the PNG and hydrogen fuels as inputs.[3]

SDG&E requests approval for the following specific default values for the hydrogen fuel combusted at PEC. With respect to sulfur content, SDG&E requests approval of a default value of 0.00 gr/100 scf, equivalent to a default SO_2 emission rate of 0 lb /mmBtu. With respect to GCV, SDG&E requests approval of a default value of 31,870 Btu/100 scf, which is the result SDG&E calculated by applying a temperature correction adjustment to a value of 32,360 Btu/100 scf (which is a value SDG&E obtained from a reference document). With respect to F-factor, SDG&E requests approval of a default value of 5,966 dscf/mmBtu, which SDG&E calculated by applying equation F-7a in section 3.3.6 of appendix F to a fuel consisting of 100% hydrogen with a GCV of 61,013 Btu/lb (which is a value SDG&E obtained from

[2] Although thus far SDG&E has obtained a permit modification from the California Public Utilities Commission allowing the use of blends containing up to 2% hydrogen fuel by volume, SDG&E asks EPA to approve this petition without any specific maximum hydrogen fuel percentage so that no additional petition would be needed in the future in the event that SDG&E seeks to raise the allowed maximum hydrogen fuel percentage above 2%.

[3] SDG&E does not need to compute prorated F_c-factors for PEC because the methodology used to determine SDG&E's reported CO_2 mass emissions uses an F_c-factor for each individual fuel included in the fuel blend combusted in an hour, not a prorated F_c-factor for the fuel blend, and the methodology used to determine SDG&E's reported NO_X emission rate uses only F-factors, not F_c-factors.

a different reference document). With respect to Fc-factor, SDG&E requests approval of a default value of 0 scf CO2/mmBtu, which is the result obtained by applying equation F-7b in section 3.3.6 to a fuel with 0% carbon.

SDG&E supports its request with an analysis of nine samples of the hydrogen fuel produced at PEC. Gas composition was measured in accordance with ASTM D1946-90, total sulfur was measured in accordance with ASTM D5504, and heating value was calculated according to ASTM 3888-98. The average F-factor calculated from the nine samples was 5,967 dscf/mmBtu, within 0.02% of the requested default value of 5,966 dscf/mmBtu. The average GCV calculated from the nine samples was 31,733 Btu/100 scf, within 0.5% of the requested default value of 31,870 Btu/100 scf. The average sulfur content calculated from the nine samples was 0.00 gr/100 scf, matching the requested default value. SDG&E also calculated the standard deviations of sulfur content and GCV across the nine samples. Despite the relatively small number of samples, the standard deviations were below the levels that (with much larger numbers of samples) would allow a gaseous fuel to qualify for reduced sampling frequencies under sections 2.3.5(c) and 2.3.6(d) of appendix D to 40 CFR part 75.

EPA's Determination

EPA has evaluated SDG&E's proposed approach for monitoring emissions in hours when PEC is combusting PNG-hydrogen fuel blends. As described above, SDG&E will produce the hydrogen fuel on-site through electrolysis of water, then compress and store the hydrogen fuel on-site, and finally monitor the quantities of hydrogen fuel separately from the quantities of PNG before the fuel streams are blended and combusted. Unlike alternative processes for producing hydrogen (e.g., steam reforming of natural gas), electrolysis of water produces essentially pure hydrogen as a matter of process design. Because the hydrogen fuel combusted at PEC will be produced on-site through electrolysis of water and also stored on-site until use, and because its quantities would be monitored separately from the quantities of PNG prior to blending and combustion, the configuration of the SDG&E hydrogen fuel supply and monitoring system would ensure that the hydrogen component of the PNG-hydrogen fuel blends would constitute essentially pure hydrogen gas through the point at which the monitored quantities are fed to the blending apparatus. In these circumstances, EPA finds that it is reasonable to use default values of sulfur content, GCV, F-factor, and F_c-factor based on the physical properties of hydrogen gas, without the need to analyze samples of the hydrogen fuel in the future.

With respect to sulfur content and F_c-factor, EPA approves SDG&E's requested default values of 0 lb SO_2/mmBtu for sulfur content and 0 scf CO_2/mmBtu for F_c-factor for the hydrogen fuel combusted at PEC, because pure hydrogen gas produced through electrolysis of water contains no sulfur or carbon.

With respect to GCV and F-factor, as just noted, EPA agrees that it is reasonable to use default values based on the physical properties of pure hydrogen gas for the hydrogen fuel combusted at PEC. However, SDG&E's requested default values of 31,870 Btu/100 scf for GCV and 5,966 dscf/mmBtu for F-factor differ slightly from the default values of 31,890 Btu/100 scf and 5,970 dscf/mmBtu that EPA previously approved for a similarly situated facility. EPA considers it appropriate that all facilities using default values for hydrogen fuel for part 75 purposes based on the physical properties of hydrogen gas should use the same default values. Accordingly, EPA approves a default value of 31,890 Btu/100 scf

for GCV[4] and a default value of 5,970 dscf/mmBtu for F-factor[5] for the hydrogen fuel combusted at PEC. EPA notes that the differences between the approved values and SDG&E's requested values are less than 0.1% in both cases.[6] EPA also approves SDG&E's proposal to determine the hourly F-factors for the PNG-hydrogen fuel blends by applying the prorating procedure in section 3.3.6.4 of appendix F and using the F-factors for PNG and hydrogen fuel as inputs.

EPA's approval of the requested waiver of sampling and analysis requirements for the hydrogen fuel combusted at PEC and the use of the default values identified above is subject to the following conditions:

1. The quantities of hydrogen fuel combusted in each hour must be monitored separately from the quantities of PNG combusted before blending and combustion, and the fuel flowmeter used to monitor the quantities of hydrogen fuel combusted must be certified and quality-assured in accordance with the requirements in appendix D to part 75.

2. The hydrogen fuel must be produced exclusively through electrolysis of water and must not be commingled with hydrogen fuel produced by other means or with any other substances prior to monitoring of the quantities of hydrogen fuel fed to the blending apparatus and combusted.

3. SDG&E shall use a default SO_2 emission rate of 0 lb/mmBtu in equation D-5 in section 3.3.2 of appendix D to part 75 to determine reported hourly SO_2 mass emission rate from combustion of hydrogen fuel.

4. For each quarterly report submitted after the date of this letter, SDG&E shall use a default GCV of 31,890 Btu/100 scf in equation D-6 in section 3.4.1 of appendix D to part 75 to calculate reported hourly heat input rate from combustion of hydrogen fuel. In the event that SDG&E has already submitted quarterly reports using the requested GCV of 31,870 Btu/100 scf, SDG&E

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[4] EPA computed the approved default value for GCV for hydrogen gas as the negative of the heat of formation of liquid water at conditions of 20°C, which in turn was determined according to the following formula: $\Delta_f H°$ (H_2O liquid, 20°C) = $\Delta_f H°$ (H_2O liquid, 25°C) + [H° (H_2 gas, 25°C) - H° (H_2 gas, 20°C)] + 0.5 * [H° (O_2 gas, 25°C) - H° (O_2 gas, 20°C)] – [H° (H_2O liquid, 25°C) - H° (H_2O liquid, 20°C)]. Using input values in kJ/mol from the National Institute of Science and Technology (NIST) Chemistry WebBook at webbook.nist.gov, this formula yields a heat of formation for liquid water at 20°C of -285.989 kJ/mol (-285.830 + (7.9260 - 7.7819) + 0.5 * (8.6720 - 8.5249) - (1.8902 - 1.5134) = -285.989 kJ/mol). EPA then converted the negative of this result to Btu/lb as follows, using conversion factors obtained from NIST publications: 285.989 kJ/mol * (1 Btu / 1.0550559 kJ) * (1 mol H_2 / 2.01588 g) * (453.59237 g / 1 lb) = 60,992 Btu/lb. Finally, EPA converted the GCV per unit of mass to the GCV per unit of volume as follows, using the NIST Webbook value for the density of hydrogen gas at 20°C and 1 atm: 60,992 Btu/lb * (0.0052285 lb H_2 / 1 scf H_2) = 318.9 Btu/scf = 31,890 Btu/100 scf.

[5] EPA computed the approved default value for F-factor for hydrogen gas by applying equation F-7a in section 3.3.6 of appendix F to a fuel consisting of 100% hydrogen with a GCV of 60,992 Btu/lb and rounding to the nearest multiple of 10 (like the values for the F-factors for the fuels listed in Table 1 of section 3.3.5 of appendix F).

[6] Given the small magnitudes of the differences between the approved values and SDG&E's requested values, EPA does not consider it necessary to investigate the possible causes of the differences for purposes of this petition response. The NIST Webbook does not directly provide the GCV of hydrogen gas at EPA's required conditions of 20°C and 1 atm, and EPA is aware that different procedures for calculating this value from the available NIST data, including rounding procedures, may produce slightly different results.

may, but is not required to, resubmit the quarterly reports recalculated with the approved default GCV value.

5. SDG&E shall use equation F-5 in section 3.1 of appendix F to part 75 to calculate reported hourly NO_X emission rate from combustion of PNG-hydrogen fuel blends, using prorated F-factors determined according to equation F-8 in section 3.3.6.4 of appendix F to part 75. For each quarterly report submitted after the date of this letter, SDG&E shall use a default F-factor of 5,970 dscf/mmBtu for the hydrogen fuel in equation F-8 when calculating the prorated F-factors. In the event that SDG&E has already submitted quarterly reports using the requested F-factor of 5,966 dscf/mmBtu for hydrogen fuel, SDG&E may, but is not required to, resubmit the quarterly reports recalculated with the approved default F-factor value.

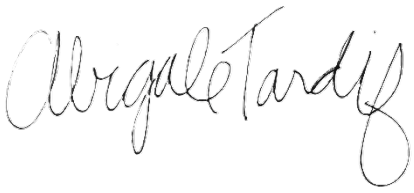
6. SDG&E shall use a default F_c-factor of 0 scf CO_2/mmBtu in equation G-4 in section 2.3 of appendix G to part 75 to determine reported hourly CO_2 mass emission rate from combustion of hydrogen fuel.

7. SDG&E shall update the monitoring plan(s) for PEC as needed to reflect the approved procedures.

8. In the event that EPA revises part 75 to include provisions on monitoring, reporting, and recordkeeping related to hydrogen fuel combustion that differ in any substantive way from the provisions of this letter, such revisions shall supersede the provisions of this letter with respect to all quarterly reports due on or after the effective date of the revisions.

EPA's determination is conditioned and relies on the accuracy and completeness of SDG&E's June 4, 2024, petition, and is appealable under 40 CFR part 78. If you have any questions regarding this determination, please contact Charles Frushour at (202) 343-9847 or by email at frushour.charles@epa.gov.

Sincerely,



Abigale Tardif
Principal Deputy Assistant Administrator
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cc: Gerardo Rios, EPA Region 9
Nathan Gutzwiller, San Diego County APCD