DRAFT ENGINEERING EVALUATION
Roy Cloud Elementary School
Plant No. 24986
Application No. 31163
3790 Red Oak Way, Redwood City, CA 94061

BACKGROUND

Bayside Equipment Company is applying on behalf of Redwood City School District for an Authority to Construct and Permit to Operate an Emergency Standby Generator Set fueled by Natural Gas (NG).

S-1 Emergency Standby NG Engine Generator Set: NG Engine, Make Kohler, Model KG2204T, Model Year: 2021; EPA Family MKHXB2.237DT, Rated 63.9 HP Abated by:

A-1: 3-Way Catalytic Converter (Non-Selective Catalytic Reduction), Make: Nett Technologies Inc., Model: TG-Series Catalytic Converter.

S-1 will be located at Roy Cloud Elementary School, 3790 Red Oak Way, Redwood City, CA. The primary pollutants from NG engines are the products of combustion, including nitrogen oxides (NO_x), carbon monoxide (CO), hydrocarbon and other organic compounds (precursor organic compounds, POCs), sulfur dioxide (SO_2), and particulate matter (PM_{10} and $PM_{2.5}$). Various toxic air contaminants (TACs) are also emitted during the combustion of NG. S-1 will be abated by A-1 (3-way catalyst) which reduces NO_x, CO, and POC emissions through nonselective catalytic reduction.

EMISSION CALCULATIONS

Basis:

- Maximum output rating of 63.9 HP or 47.6 kW, per engine specs sheet.
- Maximum operational duration: 50 hours per year for non-emergency purposes, up to 24 hours per day
- Maximum fuel usage rate of 492 cubic feet per hour
  (Equivalent to 0.51168 MMBtu/hr, assuming NG heat content = 1,040 Btu/SCF)
- The manufacturer states the abatement efficiency for the catalytic convertor is ≤98% for NOx, ≤97% for NMHC+NOx, and ≤94% for CO. To be conservative, abatement efficiencies of 85% for NO_x, 40% for POC, and 91% for CO were applied to the emission factors.

Annual Emissions and Daily Maximum Emissions

The EPA Certification Emission Rates for NO_x, CO, and POC emissions from the engine were used for the emission calculations. Vendor also provided the same emission factors.

EPA Certification Emission Rates (unabated)

NO_x = 4.7 g/kW-hr (3.5 g/bhp-hr)
CO = 42.8 g/kW-hr (31.92 g/bhp-hr)
POC = 0.09 g/kW-hr (0.07 g/bhp-hr)

The particulate matter (PM) and SO_2 emissions were calculated using emission factors from AP-42 Chapter 3.2 Natural Gas-fired Reciprocating Engines, Table 3.2-3 (Uncontrolled Emission Factors For 4-Stroke Rich-Burn Engines). The total PM emission factor consists of the sum of filterable plus condensable emission factors in AP-42. The SO_2 emission factor in AP-42 was multiplied by a factor of by 5 since the sulfur content of the natural gas used to develop the AP-42 factor is based on 2000 grains/MMSCF (vs. sulfur content in PUC quality natural gas of 1 grain/100 SCF).

The daily maximum emissions were calculated assuming 24-hr/day of operation.

The annual and daily maximum emissions from S-1 are summarized below in Table 1.

Table 1 - Annual and Daily Maximum Emissions for S-1

Pollutant	Abated E.F.	E.F. Unit	Abatement Efficiency (%)	Abated Daily Emissions (lbs/day)	Abated Annual Emissions (lbs/yr)	Abated Annual Emissions (TPY)
NO_x	5.26E-01 [a, b]	g/bhp-hr	85	1.777	3.703	0.002
CO	2.87E+00 [a, b]	g/bhp-hr	91	9.712	20.233	0.010
POC	1.01E-02 [a, b]	g/bhp-hr	40	0.136	0.284	0.000
PM_{10}	1.94E-02 [c]	lb/MMBtu	0	0.238	0.497	0.000
$PM_{2.5}$	1.94E-02 [c]	lb/MMBtu	0	0.238	0.497	0.000
SO_2	2.94E-03 [c]	lb/MMBtu	0	0.036	0.075	0.000

[a] The emission factors for NO_x, CO, and POC per EPA certification, after inclusion of the 3-way catalyst abatement effects.
[b] The manufacturer provided emission factors which were the same as those from the EPA Engine Certification.
[c] The emission factors for PM_{10} and SO_2 were retrieved from AP-42 Chapter 3.2 Natural Gas-fired Reciprocating Engines, Table 3.2-3. PM emission factors consist of filterable plus condensable fractions. The sulfur emission factor is multiplied by a factor of 5 to account for PUC quality natural gas content of 1 grain/100 SCF. These numbers are uncontrolled (unabated) emissions.

Plant Cumulative Increase

Table 2 summarizes the cumulative increase in criteria pollutant emissions resulting from the operation of S-1.

Table 2 - Plant Cumulative Emissions

Pollutant	Existing Emissions (TPY)	New Emissions (TPY)	Total Emissions (TPY)
NOx	0.000	0.002	0.002
CO	0.000	0.010	0.010
POC	0.000	0.000	0.000
PM_{10}	0.000	0.000	0.000
$PM_{2.5}$	0.000	0.000	0.000
SO_2	0.000	0.000	0.000

TOXIC HEALTH RISK ASSESSMENT

Per BAAQMD Engineering Division Permit Handbook, Chapter 2.3.2 Stationary Natural Gas Engines, toxic emission factors from California Air Toxics Emission Factors (CATEF) are generally preferred over those found in AP-42. TAC emission factors were therefore retrieved from CATEF for Natural Gas-fired Rich Burn Engines rated < 650 hp. The TAC emission estimates are based on uncontrolled emission factors for natural gas engines. **S-1 will be equipped with a NSCR 3-way catalyst (A-1); an abatement effiency of 50% was conservatively assumed for all TACs except benzene and formaldehyde. CATEF provided post-abatement emission factors for benzene and formaldehyde. Thus, no additional abatement credit was given for benzene and formaldehyde.**

Based on the calculations in Table 3 below, no TACs exceed the District's Risk Screening trigger levels set forth in Table 1 of Reg. 2-5 (New Source Review for Toxic Air Contaminants). Therefore, a Health Risk Assessment (HRA) is not required.

Table 3 - TAC Emission Estimates for TACs based on CATEF Emission Factors for Rich-burn, 4 Stroke, Natural Gas Engines < 650 HP

Compound	PEF for PAHs[1]	E.F.[2] [lb/MMcf]	Hourly Abated Emissions[3] [lb/hr]	Acute Trigger Level [lb/hr]	HRA Triggered? (Acute)	Annual Abated Emissions [lb/yr]	Chronic Trigger Level [lb/yr]	HRA Triggered? (Chronic)
1,3-Butadiene		1.04E-01	2.56E-05	1.50E+00	No	1.28E-03	4.8E-01	No
Acetaldehyde		8.83E-01	2.17E-04	1.00E+00	No	1.09E-02	2.9E+01	No
Acrolein		5.47E-01	1.35E-04	5.50E-03	No	6.73E-03	1.4E+01	No
Benzene		7.39E-02	3.64E-05	6.00E-02	No	1.82E-03	2.9E+00	No
Ethyl benzene		1.16E-02	2.85E-06	None	No	1.43E-04	3.3E+01	No
Formaldehyde		4.99E-02	2.45E-05	1.20E-01	No	1.23E-03	1.4E+01	No
Naphthalene		7.65E-02	1.88E-05	None	No	9.41E-04	2.4E+00	No
Benzo(a)anthracene	0.1	2.94E-04	7.23E-08	None	No	3.62E-06	None	No
Benzo(a)pyrene	1.0	1.15E-04	2.83E-08	None	No	1.41E-06	None	No
Benzo(b)fluoranthene	0.1	2.37E-04	5.83E-08	None	No	2.92E-06	None	No
Benzo(k)fluoranthene	0.1	1.03E-04	2.53E-08	None	No	1.27E-06	None	No
Chrysene	0.01	3.10E-04	7.63E-08	None	No	3.81E-06	None	No
Dibenz(a,h)anthracene	1.05	1.25E-05	3.08E-09	None	No	1.54E-07	None	No
Indeno(1,2,3-cd)pyrene	0.1	1.69E-04	4.16E-08	None	No	2.08E-06	None	No
PAH or derivative TOTAL		2.12E-04	5.20E-08	None	No	2.60E-06	3.3E-03	No
Propylene		1.60E+01	3.94E-03	None	No	1.97E-01	1.2E+05	No
Toluene		1.07E+00	2.63E-04	8.20E+01	No	1.32E-02	1.2E+04	No
Xylene		6.02E-02	1.48E-05	4.90E+01	No	7.40E-04	2.7E+04	No

[1] These substances are PAH-derivatives that have OEHHA-developed Potency Equivalency Factors (PEFs). PAHs should be evaluated as benzo(a)pyrene-equivalents. This evaluation process consists of multiplying individual PAH-specific emission levels with their corresponding PEFs listed below. The sum of these products is the benzo(a)pyrene-equivalent level and should be compared to the benzo(a)pyrene equivalent trigger level. (Source 2-5, Table 2-5-1, Footnote #8). Note: CATEF Emission Factors for Rich Burn, 4 Stroke, Natural Gas Engines, < 650 HP also lists anthracene, acenaphthylene, acenaphthylene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene and pyrene. However, Reg 2-5-1 does not list any PAH derivative PEFs listed. Therefore, these are not included in calculating the PAH E.F (see E.F. calculation backup, table below):

Table 3A – PAH E.F. Derivation			
Compound	**PEF for PAHs**	**E.F. [lb/MMcf]**	**E.F. × PEF**
Benzo(a)anthracene	0.1	2.94E-04	2.94E-05
Benzo(a)pyrene	1.0	1.15E-04	1.15E-04
Benzo(b)fluoranthene	0.1	2.37E-04	2.37E-05
Benzo(k)fluoranthene	0.1	1.03E-04	1.03E-05
Chrysene	0.01	3.10E-04	3.10E-06
Dibenz(a,h)anthracene	1.05	1.25E-05	1.69E-05
Indeno(1,2,3-cd)pyrene	0.1	1.69E-04	1.69E-05
		PAH E.F.	2.12E-04

[2] CATEFs are used when AP-42 EFs are less conservative than CATEFs. Reported mean emission factor values are used in accordance with District procedures.

[3] As a conservative estimate for organic air toxic compounds it assumed that the Catalytic Converter will have a 50% reduction in Air Toxic Organic Emissions except for benzene and formaldehyde; CATEF provided post-abatement emission factors for benzene and formaldehyde.

GRAIN LOADING RATE

The grain loading rate calculation is required for determining the compliance of this application with BAAQMD Regulation 6, Rule 1 (refer to "Statement of Compliance" section, below).

[9.93E-03 lb PM_{10}/hr * 7000 grain/lb] / [60 min/hr * 123.0 DSCFM] = 9.41E-03 grain/dscf

Assumptions:

- 1.94E-02 lb PM_{10}/MMBtu * 0.51168 MMBtu/hr = 9.93E-03 lb PM_{10}/hr
- 7000 grain/lb standard conversion factor (AP-42 Appendix A, Page A-19)
- Using the following equation, DSCFM is calculated to be equal to: 123.0

$$DSCFM = ACFM \times [(460°R + 70°F)/(460°R + temp)] \times (Actual\ P/14.7\ psi) \times (1-B_{wo})$$

Where: ACFM[1] = 379 cfm, temp = 1171°F, Actual P = 14.7 psi, B_w = 0 (fraction of water vapor)

[1]**Note:** Exhaust flow (ACFM) was not given in the engine specs sheet. Exhaust flow for another Kohler engine (97.9 bhp) was scaled down to 63.9 bhp of this engine and used, which is accurate enough, for this calculation.

STATEMENT OF COMPLIANCE

The owner/operator of S-1 shall comply with Reg. 6-1 (Particulate Matter and Visible Emissions Standards), Reg. 9-1-301 (Inorganic Gaseous Pollutants: Sulfur Dioxide for Limitations on Ground Level Concentrations), and Reg. 9-8 (Nitrogen Oxides and Carbon Monoxide from Stationary ICE).

The owner/operator is expected to comply with Reg. 6-1 since the unit is fueled with NG. Because the S-1 engine has displacement of 2.2L (134.25 cubic inch), the Ringelmann No. 2 Limitation applies per Section 6-1-303 (ICE engine of less than 25 L or 1500 cubic inch displacement). Thus, for any period aggregating more than three minutes in any hour, there should be no visible emission as dark or darker than No. 2 on the Ringelmann Chart or be equal to or greater than 40% opacity. S-1 is expected to comply with this requirement, as well as the visible particles requirement of Section 6-1-305. The emission rate from S-1 results in an outlet grain loading of 9.59E-03 grains/dscf, which is less than the limit 0.15 grains/dscf and therefore complies with Regulation 6-1-310.1. The TSP limits in 6-1-310.2 (effective as of July 1, 2020) will not apply because the potential to emit TSP is below 1,000 kg per year.

The owner/operator is expected to comply with Regulation 9-1 by restricting fuel to NG only. Combustion of NG is expected to produce a SO_2 concentration of no more than 1 ppmv. Therefore, the source is expected to comply with Section 9-1-301 (Limitations on Ground Level Concentrations) and 9-1-304 (Fuel Burning).

Based on Reg. 9-8-110.5 (Exemptions for Emergency Standby Engines), S-1 is exempt from the requirements of Reg. 9-8-301 (Emission Limits on Fossil Derived Fuel Gas), 9-8-302 (Emission Limits on Waste Derived Fuel Gas), 9-8-303 (Emissions Limits – Delayed Compliance, Existing Spark-Ignited Engines, 51 to 250 bhp or Model Year 1996 or Later), 9-8-304 (Emission Limits – Compression-Ignited Engines), 9-8-305 (Emission Limits – Delayed Compliance, Existing Compression-Ignited Engines, Model Year 1996 or Later), 9-8-501 (Initial Demonstration of Compliance) and 9-8-503 (Quarterly Demonstration of Compliance). However, S-1 is subject to the monitoring and record keeping procedures described in Reg. 9-8-530 (Emergency Standby Engines, Monitoring and Recordkeeping). The requirements of this Regulation are included in the permit conditions below.

S-1 is also subject to and expected to comply with Regulation 9-8-330 (Emergency Standby Engines, Hours of Operation) since non-emergency hours of operation will be limited in the permit conditions to 50 hours per year.

California Environmental Quality Act (CEQA)

The project is ministerial under the District's CEQA Reg. 2-1-311 and therefore is not subject to CEQA review. The engineering review for this project requires only the application of standard permit conditions and standard emissions factors as specified in District permit handbook chapter 2.3.2 (Stationary Natural Gas Engines) and therefore is not discretionary as defined by CEQA.

School Notification (Regulation 2-1-412)

The proposed engine will be located at Roy Cloud Elementary School and therefore is subject to the public notification requirements of Reg. 2-1-412.

Best Available Control Technology (BACT)

In accordance with Reg. 2-2-301 (Best Available Control Technology Requirement), BACT is triggered for any new or modified source with the potential to emit 10 pounds or more per highest day of POC, NPOC, NOx, CO,

SO_2, PM_{10}, or $PM_{2.5}$. Based on the emission calculations in Table 1, BACT is not triggered since the maximum daily emission for all the criteria pollutants are less than 10 pounds per day.

Offsets
Offsets must be provided for any new or modified source at a facility that emits more than 10 tons per year of POC or NO_x. Based on the emission calculations in Table 1, offsets are not required for this application per Reg 2-2-302 (Offset Requirements, Precursor Organic Compounds and Nitrogen Oxides).

New Source Performance Standards (NSPS)
S-1 is subject to 40 CFR 60, Subpart JJJJ, Standards of Performance for Stationary Spark Ignition (SI) Internal Combustion Engines (ICEs), per Section §60.4230(a)(4)(iv) because the owner/operator will commence construction after June 12, 2006 and the source is an emergency engine which was manufactured after January 1, 2009 and has a maximum power greater than 25 hp.

The engine will comply with the limits in (40 CFR 60 Subpart JJJJ) Table 1 for emergency spark-ignited engines greater than 25 and less than 130 hp.

Table 4. NSPS Emission Standards vs. S-1 Engine Family Emission Rates (Unabated)

Pollutant	NSPS Emission Standard*	S-1 Emission Rate
NOx	10.0 g/bhp-hr	3.50 g/bhp-hr
CO	387.0 g/bhp-hr	31.92 g/bhp-hr

*https://www.law.cornell.edu/cfr/text/40/appendix-Table_1_to_subpart_JJJJ_of_part_60

Based on the EPA Annual Emission Certification Data, S-1 complies with NSPS requirements.

National Emission Standards for Hazardous Air Pollutants (NESHAP)
S-1 is subject to 40 CFR 63, Subpart ZZZZ, National Emission Standards for Hazardous Air Pollutants for Reciprocating Internal Combustion Engines (RICE). Per 40 CFR 63.6590(c)(1), a new or reconstructed stationary RICE located at an area source must meet the requirements of NSPS (40 CFR 60, Subpart JJJJ) for spark ignition engines. As stated above in the NSPS section, S-1 meets the emissions requirements of NSPS.

Prevention of Significant Deterioration (PSD)
Regulation 2-2-224 defines a PSD project as one at a facility that has the potential to emit 100 tons or more per year of any PSD pollutant. This facility will not have the potential to emit 100 tons or more of any PSD pollutant therefore, this project is not a PSD project.

PERMIT CONDITIONS

Permit Condition # 23107 (applicable to S-1)

1. The owner or operator shall operate the stationary emergency standby engine, only to mitigate emergency conditions or for reliability-related activities (maintenance and testing). Operating while mitigating emergency conditions and while emission testing to show compliance with this part is unlimited. Operating for reliability-related activities are limited to 50 hours per year.
(Basis: Emergency Standby Engines, Hours of Operation Regulation 9-8-330)

2. The Owner/Operator shall equip the emergency standby engine(s) with: a non-resettable totalizing meter that measures hours of operation or fuel usage.
(Basis: Emergency Standby Engines, Monitoring and Recordkeeping 9-8-530)

3. The Owner/Operator shall not operate unless the natural gas fired engine is abated with a Catalytic Converter/Silencer Unit.

4. Records: The Owner/Operator shall maintain the following monthly records in a District- approved log for at least 24 months from the date of entry. Log entries shall be retained on-site, either at a

central location or at the engine's location, and made immediately available to the District staff upon request.

a. Hours of operation (maintenance and testing).
b. Hours of operation for emission testing.
c. Hours of operation (emergency).
d. For each emergency, the nature of the emergency condition.
e. Fuel usage for engine.

(Basis: Emergency Standby Engines, Monitoring and Recordkeeping 9-8-530)

RECOMMENDATION

Issue an Authority to Construct and Permit to Operate for the following source:

S-1 Emergency Standby NG Engine Generator Set: NG Engine, Make Kohler, Model KG2204T, Model Year: 2021; EPA Family MKHXB2.237DT, Rated 63.9 HP Abated by:

A-1: 3-Way Catalytic Converter (Non-Selective Catalytic Reduction), Make: Nett Technologies Inc., Model: TG-Series Catalytic Converter.

Prepared by: _____ **Date:** _____

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Air Quality Engineer