APPENDIX C

Cost Effectiveness Analysis
For Proposed Amendments to Rule 4311

November 25, 2020

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COST EFFECTIVENESS ANALYSIS FOR REVISED PROPOSED RULE 4311

I. SUMMARY

The California Health and Safety Code (CH&SC) Section 40920.6(a) requires the District to conduct both an absolute cost effectiveness analysis and an incremental cost effectiveness analysis of available emission control options before adopting each Best Available Retrofit Control Technology (BARCT) rule. The purpose of conducting a cost effectiveness analysis is to evaluate the economic reasonableness of the pollution control measure or rule. The analysis also serves as a guideline in developing the control requirements of a rule.

Absolute cost effectiveness of a control option is the added annual compliance cost to meet the proposed rule's requirements, in dollars per year, divided by the emission reduction achieved in tons of pollutant reduced per year.

Table 1 shows the costs and the results of the cost effectiveness analysis for flares expected to be replaced as a result of the proposed Rule 4311. District staff estimates that operators will need to replace or modify a total of 31 flares at an annualized cost of approximately $7.4 million. For flares at oil and gas facilities, the estimated cost effectiveness is $157,120 per ton NOx removed. For flares at landfill facilities, the absolute cost effectiveness for this rule project is approximately $56,578 per ton NOx removed. For flares at wastewater treatment facilities, the absolute cost effectiveness for this rule project is approximately $52,492 per ton NOx removed. Taking the rule amendments as a whole, the cost effectiveness is approximately $100,581 per ton NOx removed.

Table 1 *– Absolute Cost-effectiveness of Flare Replacements*

Facility Category	Total Permitted Flares	Number Replacing Flares	Estimated NOx Reductions (tpy)	Estimated Annualized Cost ($/yr)	Cost-Effectiveness ($/ton)
Oil and Gas Facilities	161	19	32.5	$5,106,410	$157,120
Landfill Facilities	28	10	34.8	$1,968,911	$56,578
Wastewater Treatment	22	2	6.43	$337,523	$52,492
Other Facilities	55	0	0	0	—
Totals	266	31	73.7	$7,412,844	$100,581

II. BACKGROUND

Based on the comprehensive technology assessment that District staff have conducted for this source category, as well as a thorough review of state, federal, and other air district regulations, District staff are proposing several modifications to Rule 4311. District staff are proposing to remove the non-major source exemption, remove landfill exemption, add performance standards to require ultra-low NOx technology for new and existing flares to the current flare rule in order to reduce flare emissions in the District.

The proposed amendments to Rule 4311 are designed to encourage flare operators to find beneficial alternative uses of gas combusted or deploy the cleanest flaring technologies to achieve additional NOx emission reductions from this sector. Specific limits are proposed depending on the applicability of the ultra-low NOx technology to different flaring processes with industry specific considerations. The installation of ULN flare technology would be required for flares that combust the majority of gas in the Valley. This would require installation of ULN flares associated with 65% of total gas flared from all categories. The new ULN requirements would be in addition to current requirements, including flare minimization plans.

The emissions reduction analysis in Appendix B to this staff report identified flares that have had an average throughput over the years 2017, 2018, and 2019 exceeding the thresholds as proposed, and are likely to be affected by the more stringent emissions limits.

This analysis identifies 31 of 266 flares likely to be affected by the more stringent limits, located at 26 facilities, representing 63% of the total flared gas. Of the 26 facilities, 14 are oil and gas production, 10 are landfills, and two are wastewater treatment plants. This cost-effectiveness analysis focuses primarily on these three facility types, as the locations of affected flares.

III. ESTIMATED COMPLIANCE COSTS

District staff used cost information provided by control equipment manufacturers and vendors, and from stakeholders to conduct a cost effectiveness analysis of the proposed NOx limits in Draft Rule 4311. Specifically the data used in the analysis came from the following sources:

1. Aereon
2. California Resources Corporation
3. A large oil producer in the Valley
4. SCAQMD Rule 1118.1 Staff Report
5. Foothill landfill (San Joaquin County)
6. Badlands landfill (Riverside County)
7. Monterey Peninsula landfill (Monterey county)
8. Fresno/Clovis wastewater treatment plant

9. Bakersfield City wastewater treatment plant
10. Visalia wastewater treatment plant

In some cases, OAQPS methodologies were used to estimate annual operation and maintenance costs. Cost information submitted to the District is summarized in Table 2.

Table 2 – Flare Costs Analyzed

Category	Capacity (MMbtu/hr)	Installed Cost	Annual Operations & Maintenance Cost
Landfill	60.7	$1,935,000	Not provided
Landfill	54.6	$754,000	$59,275
Landfill	167	$1,386,400	$219,850
Oil and Gas	36	$2,200,000	$40,000
Oil and Gas	27	$3,020,000	Not provided
Oil and Gas	75.7	$492,820	Not provided
Oil and Gas	3.4	$800,000	Not provided
Oil and Gas	25	$950,000	Not provided
Wastewater Treatment	16.5	$361,858	$79,195
Wastewater Treatment	53.2	$2,518,000	$30,000

A. Cost Scaling to Flare Capacity

Cost information was obtained for a certain capacity of flare at certain operation types. In order to determine costs for flares with capacity different from the base cost, District staff used the following equation:

$$Cost_{Flare} = Cost_{Basis} \times \left[\frac{Capacity_{Flare}}{Capacity_{Basis}}\right]^{6/10}$$

Where

$Cost_{Flare}$ = Estimated cost of replacement flare; and
$Cost_{Basis}$ = Cost of flare used as basis of calculation; and
$Capacity_{Flare}$ = Rated capacity of replacement flare; and
$Capacity_{Basis}$ = Rated capacity of flare used as basis of calculation.

B. Baseline Flares for Analysis

Of the various flare estimates and cost data collected in Table 2, the following analysis is based on two costs from actual installations. One provided by Riverside County for a flare installed at the Badlands Landfill, the other was a flare from a large oil and gas producer in Kern County. As actual installed costs, with annual operation and maintenance data to support it, these two flares were deemed the most suitable for scaling. The landfill flare costs was used as the baseline for both wastewater treatment as well as landfill facilities, and the oil and gas flare was used for oil and gas operations.

Table 3 – Baseline Flare Costs

Category	Capacity (MMbtu/hr)	Installed Cost	Annual Operations & Maintenance Cost
Landfill and Wastewater	54.6	$754,000	$59,275
Oil and Gas	36	$2,200,000	$40,000

C. Replacement Flare Size

The District found that some of the back-up/emergency flares were sized beyond the levels where an ULN replacement flare would be feasible. For the cost analysis, it is assumed that these large flares would likely have to be kept for their role as emergency use flares to prevent significant catastrophes and loss of life. In those cases, this analysis assumes that a smaller ULN flare would have to be installed to manage the more routine gas.

For cost scaling purposes, District staff assumed a flare size for replacements smaller than the flare to be replaced. Table 4 includes a column labeled ULN capacity with the size of flare assumed for this purpose. Where that column is empty, the size of the original flare was used. These capacities, coupled with the baseline flare costs, and the scaling process detailed above were used to estimate the range of costs located in Table 4.

IV. ABSOLUTE AND INCREMENTAL COST EFFECTIVENESS ANALYSIS

Absolute cost effectiveness of a control option is the added annual cost, in dollars per year, of a control technology or technique divided by the emission reductions achieved, in tons reduced per year. The costs can include, but are not limited to, capital equipment costs, engineering design costs, and additional labor or fuel costs. The costs also can include any monetary savings realized by implementation of the pollution controls.

Incremental cost effectiveness is intended to measure the change in costs and the potential additional emission reductions between progressively more effective control options or technologies. Incremental cost effectiveness does not reveal the emission reduction potential of the control options, but merely indicates the additional cost of adding the next most effective control to a given control measure. Although absolute cost effectiveness and incremental cost effectiveness are in the same units, the relative values produced in the incremental cost effectiveness analysis and the absolute cost effectiveness values are not comparable and cannot be evaluated using similar standards.

A. Absolute Cost Effectiveness Analysis

The absolute cost effectiveness is the cost in dollars per year of the expected control technology divided by the estimated annual emission reductions achieved in tons of pollutant reduced per year. Details of the expected emission reductions are in Appendix B of this staff report.

1. Oil and Gas Facilities

Using the costs calculated above and the estimated emission reductions from Appendix B, the cost effectiveness for flares at oil and gas facilities due to the change in NOx limit is $157,120 per ton NOx removed. The cost effectiveness is shown in Table 4.

2. Landfill Facilities

Using the costs calculated above and the estimated emission reductions from Appendix B, the cost effectiveness for flares at landfill facilities due to the change in NOx limit is $56,578 per ton NOx removed. The cost effectiveness is shown in Table 4.

3. Wastewater Treatment Facilities

Using the costs calculated above and the estimated emission reductions from Appendix B, the cost effectiveness for flares at wastewater treatment facilities due to the change in NOx limit is $52,738 per ton NOx removed. The cost effectiveness is shown in Table 4.

B. Incremental Cost Effectiveness Analysis

The incremental cost effectiveness is the difference in cost between successively more effective controls divided by the additional emission reductions achieved. Proposed Rule 4311 requires flares used at an annual throughput exceeding thresholds to meet more stringent emissions limits. The progressively more stringent control option is to require all flares emitting higher than these limits to be replaced if they do not meet any of the proposed exemptions.

The proposed control option would impact 31 flares, cost a total of $10,026,733 per year, and achieve 73.7 tons per year of NOx emissions reductions. The progressively more stringent control option would impact approximately 93 flares, would cost a total of $18,626,556 per year, and achieve 95.6 tons per year of NOx emissions reductions. The incremental cost-effectiveness for replacing all higher emitting flares is $392,686 per ton of NOx reduced as calculated below.

$$Incremental\ Cost\ Effectiveness = \frac{\$18{,}626{,}556 - \$10{,}026{,}733}{95.6 - 73.7} = \$392{,}686/ton$$

Thus, the progressively more stringent control option was not chosen.

ATTACHMENT A – DETAIL TABLE

Table 4 – Cost-Effectiveness Calculation Detail Table

SIC	Flare Capacity (MMBtu/hr)	ULN Capacity (MMBtu/hr)[1]	Annualized Replacement Cost	NOx Reduction (tpy)	Cost-Effectiveness ($/ton)
1311	14.5		$230,657	4.40	$52,386
1311	535.5	40	$424,015	4.30	$98,526
1311	20		$279,745	4.05	$69,127
1311	41.2		$431,602	2.79	$154,622
1311	5		$121,766	2.16	$56,330
1311	15.1		$236,337	2.13	$110,869
1311	21		$288,056	1.60	$179,885
1311	41	12	$205,899	1.32	$156,270
1311	208.3	40	$424,015	1.31	$322,970
1311	58.3	27	$334,937	1.08	$310,127
1311	7.3		$152,805	0.94	$162,862
1311	10.4		$188,958	0.94	$201,482
1311	140	40	$424,015	0.93	$455,811
1311	20		$279,745	0.92	$305,616
1311	41.7	27	$334,937	0.87	$384,974
1311	21.6	12	$205,899	0.74	$278,272
1311	16.38	12	$205,899	0.69	$297,933
1311	6.6		$143,837	0.66	$217,523
1311	10.8		$193,286	0.66	$294,717
4953	162		$349,485	7.72	$45,249
4953	150		$333,714	7.31	$45,656
4953	60		$192,580	3.51	$54,934
4953	78.33		$225,984	3.63	$62,171
4953	63		$198,301	3.22	$61,661
4953	24.4		$112,242	2.99	$37,581
4953	45.5		$163,127	1.78	$91,764
4953	35		$139,367	1.78	$78,434
4953	30		$127,055	1.25	$101,490
4953	30		$127,055	1.63	$77,858
4952	36.3		$142,451	3.66	$38,876
4952	61.3		$195,073	2.77	$70,511

[1]See Replacement Flare Size (Page 6)