Noise Methodology Technical Memorandum

Date: April 29, 2024

Project Name: Former Manufactured Gas Plant, Bakersfield, California

Project No: D31111HG

Attention: Ken Simas, Senior Consulting Project Manager, Pacific Gas and Electric Company (PG&E) Environmental Remediation

Prepared by: Mark Bastasch, Senior Noise Specialist, Jacobs

Document No: 240419090114_37252105

Copies to: Ben Dykstra, Project Manager, Jacobs
Betsi Phoebus, CEQA Lead, Jacobs

2201 Broadway Street
Suite 03-W101
Oakland, CA 94612
United States
T +1.510.251.2426
www.jacobs.com

Introduction

This Noise Methodology Technical Memorandum summarizes the methods used to support the noise analysis documented in Section 3.13, Noise, of the Initial Study for the PG&E Former Manufactured Gas Plant remediation project in Bakersfield, Kern County, California

Methodology

Construction Noise

Typical noise levels generated by the construction equipment listed in Appendix B, Table B-1, have been calculated previously and published in various reference documents. The expected equipment noise levels listed in the Federal Highway Administration (FHWA) *Roadway Construction Noise Model User Guide* (User Guide) (FHWA 2006) were used for this evaluation. The User Guide provides the most recent comprehensive assessment of noise levels from construction equipment. Table 1 provides typical noise levels and usage factors for general construction equipment and activities consistent with the FHWA Roadway Construction Noise Model. The acoustical usage factor does not equate to the percentage of time the equipment is in use, but rather the percentage of time the equipment is operated at its maximum sound emission level.

Table 1. Typical Construction Equipment Noise Levels

Equipment	Acoustical usage factor (%)	Specified L_{max} at 50 feet (dBA)	Calculated L_{eq} at specified distance (dba)			
			100 feet	200 feet	500 feet	1,000 feet
Auger drill rig	20	85	72	66	58	52
Backhoe	40	80	70	64	56	50
Bar bender	20	80	67	61	53	47
Boring jack power unit	50	80	71	65	57	51
Chain saw	20	85	72	66	58	52

Equipment	Acoustical usage facto (%)	Specified L_{max} at 50 feet (dBA)	Calculated L_{eq} at specified distance (dba			
			100 feet	200 feet	500 feet	1,000 feet
Clamshovel (dropping)	20	93	80	74	66	60
Compactor (ground)	20	80	67	61	53	47
Compressor (air)	40	80	70	64	56	50
Concrete batch plant	15	83	69	63	55	49
Concrete mixer truck	40	85	75	69	61	55
Concrete pump truck	20	82	69	63	55	49
Concrete saw	20	90	77	71	63	57
Crane	16	85	71	65	57	51
Dozer	40	85	75	69	61	55
Drill rig truck	20	84	71	65	57	51
Drum mixer	50	80	71	65	57	51
Dump truck	40	84	74	68	60	54
Excavator	40	85	75	69	61	55
Flat-bed truck	40	84	74	68	60	54
Front-end loader	40	80	70	64	56	50
Generator	50	82	73	67	59	53
Generator (< 25 kVa)	50	70	61	55	47	41
Gradall	40	85	75	69	61	55
Grader	40	85	75	69	61	55
Grapple (on backhoe)	40	85	75	69	61	55
Horizontal boring hydrau jack	25	80	68	62	54	48
Hydra break ram	10	90	74	68	60	54
Impact pile driver	20	95	82	76	68	62
Jackhammer	20	85	72	66	58	52
Man lift	20	85	72	66	58	52
Mounted impact hamme (hoe-ram)	20	90	77	71	63	57
Pavement scarifier	20	85	72	66	58	52
Paver	50	85	76	70	62	56
Pickup truck	40	55	45	39	31	25
Pneumatic tools	50	85	76	70	62	56

Equipment	Acoustical usage facto (%)	Specified L_{max} at 50 feet (dBA)	Calculated L_{eq} at specified distance (dba			
			100 feet	200 feet	500 feet	1,000 feet
Pumps	50	77	68	62	54	48
Refrigerator unit	100	82	76	70	62	56
Rivet buster/chipping gu	20	85	72	66	58	52
Rock drill	20	85	72	66	58	52
Roller	20	85	72	66	58	52
Sand blasting (single nozzle)	20	85	72	66	58	52
Scraper	40	85	75	69	61	55
Shears (on backhoe)	40	85	75	69	61	55
Slurry plant	100	78	72	66	58	52
Slurry trenching machine	50	82	73	67	59	53
Soil mix drill rig	50	80	71	65	57	51
Tractor	40	84	74	68	60	54
Vacuum excavator (vac-truck)	40	85	75	69	61	55
Vacuum street sweeper	10	80	64	58	50	44
Ventilation fan	100	85	79	73	65	59
Vibrating hopper	50	85	76	70	62	56
Vibratory concrete mixer	20	80	67	61	53	47
Vibratory pile driver	20	95	82	76	68	62
Warning horn	5	85	66	60	52	46
Welder/torch	40	73	63	57	49	43
All other equipment > 5 horsepower	50	85	76	70	62	56

Notes:
> = greater than
< = less than
dBa = decibel(s)
kVa = kilovolt-ampere(s)
L_{eq} = time-averaged sound level
L_{max} = highest sound level measured during a single noise event

As shown in Table 1, the loudest typical construction equipment generally emits noise in the range of 80 to 90 dBA at 50 feet, with usage factors of 40 percent to 50 percent. Noise at any specific receptor is dominated by the closest and loudest equipment. The types and numbers of construction equipment near any specific receptor location will vary over time. As described by the Federal Transit Administration (FTA) (2018), the average noise level from each piece of equipment is determined by the following formula for geometric spreading:

$$\text{Typical Noise Level at 50 feet} + 10 * \log(Adj_{usage}) - 20 * \log(\text{distance to receptor}/50) - 10 * G * \log(\text{distance to receptor}/50)$$

Where:

- Usage factor (Adj_{usage}) = 1 (equipment is operating continuously)
- Ground effect factor (G) = 0, representing hard ground (such as a ground condition that does not result in additional attenuation)

The following assumptions were used for modeling construction noise:

- One piece of equipment generating a reference noise level of 85 dBA (at 50 feet distance with a 40 percent usage factor) located on the transmission line route
- Two pieces of equipment generating reference noise levels of 85 dBA located 50 feet farther away on the transmission line route (100 feet distance with a 40 percent usage factor)
- Two additional pieces of equipment generating reference noise levels of 85 dBA located 100 feet farther away on the transmission line route (200 feet distance with a 40 percent usage factor)

Table 2 presents construction equipment noise levels at various distances based on these assumptions.

Table 2. Construction Equipment Noise Levels versus Distance

Distance from constructio activity (feet)	L_{eq} noise level (dBA)
50	83
100	79
200	74
400	69
800	63
1,600	58
3,200	52
6,400	46

Note:
Refer to text preceding this table for the assumptions of this noise modeling scenario

Pile Driving Noise

Pile driving may be used to install temporary excavation shoring walls during vault installation activities for the underground portion of the rebuilt power line. Driven piles may result in noise levels higher than specified in Table 1. In this pile driving noise analysis, a noise level of 101 dBA at 50 feet from the equipment and a usage factor of 20 percent are assumed. As shown in Table 3, incorporating the 20 percent usage factor yields an average noise level of 94 dBA at 50 feet. Pile driving noise levels would be expected to decrease at a rate of 6 dBA per doubling of distance. Pile driving is typically a limited-duration activity during construction and would be scheduled to occur during daytime hours. Table 3 presents the predicted noise level from impact pile driving at various distances.

Table 2. Average Predicted Pile Driving Noise Levels

Distance from pile driver (feet)	Noise level (dBA)
50	94
100	88
200	82
400	76
800	70

Vibration

Generally speaking, vibration is energy transmitted in waves through the ground. Because energy is lost during the transfer of energy from one particle to another, vibratory energy is reduced with increasing distance from the source. Human perception of vibration varies with the individual and is a function of physical setting and the type of vibration. Those exposed to elevated ambient vibration levels, such as people in an urban environment, may tolerate a higher vibration level.

The California Department of Transportation (Caltrans) has developed guidance on addressing vibration issues associated with construction, operation, and maintenance of transportation projects (Caltrans 2020). Table 4 outlines typical human response to short-term (transient) sources of vibration.

Table 4. Human Response to Transient Vibration

Human response	Peak particle velocity (inches/second)
Severe	2.000
Strongly perceptible	0.900
Distinctly perceptible	0.240
Barely perceptible	0.035

Source: Caltrans 2020

The Caltrans *Transportation and Construction Vibration Guidance Manual* (2020) notes, "[t]here are no Caltrans or FHWA standards for vibration and it is not the purpose of this manual to set standards." Rather, agencies such as Caltrans provide "a synthesis of these criteria that can be used to evaluate the potential for damage and annoyance from vibration-generating activities." In addition, Caltrans (2020) also notes that, "in most cases, vibration induced by typical construction equipment does not result in adverse effects on people or structures. Noise from the equipment typically overshadows any meaningful ground vibration effects on people."

For most projects, the highest levels of vibration occur during construction, and assessment is conducted to evaluate the potential damage to nearby buildings. The FTA manual establishes construction damage criteria in terms of peak particle velocity (PPV). These criteria are presented in Table 5 and range from a threshold of 0.12 inch per second for "buildings extremely susceptible to vibration damage" to 0.5 inch per second for "reinforced concrete, steel, or timber (no plaster)" (FTA 2018).

Table 5. Construction Vibration Damage Criteria

Building category	PPV (inches/second)	Single event PP (inches/second)
1. Reinforced concrete, steel, or timber (no plaster) (buildings in steel or reinforced concrete, such as fact retaining walls, bridges, steel towers, open channels, underground chambers, and tunnels with and without alignment)	0.50	1.2
2. Engineered concrete and masonry (no plaster) (buildings with foundation walls and floors in concrete concrete or masonry, stone masonry retaining walls, underground chambers and tunnels with masonry alig and conduits in loose material)	0.30	0.7
3. Nonengineered timber and masonry buildings (buildings as mentioned previously but with wooden c and walls in masonry)	0.20	0.5
4. Buildings extremely susceptible to vibration damage (construction very sensitive to vibration; objects of his interest)	0.12	0.3

Sources: Table 5-7, FTA 2018; Caltrans 2020

Note:

These limits and building categories align with the Caltrans (2020) summary of the Swiss Association's Standard vibration damage criteria for continuous sources. The Swiss criteria provide additional details regarding the building category and a single event limit.

Although the guidance is not enforceable, it provides a basis for evaluating potential vibration from the proposed project because the construction equipment and activities associated with transportation projects are similar to those used to construct electrical transmission projects.

Construction activities have the potential to result in varying degrees of temporary ground-borne vibration, depending on the specific equipment used and operations involved. Vibration generated by construction equipment spreads through the ground and diminishes in magnitude as distance increases. Table 6 displays vibration levels for typical construction equipment.

Table 3. Typical Construction Equipment Vibration Levels

Equipment	PPV at 25 feet (inches/second)
Pile driver (impact – upper range)	1.518
Pile driver (impact – typical)	0.644
Pile driver (sonic – upper range)	0.734
Pile driver (sonic – typical)	0.170
Large bulldozer	0.089
Caisson drilling	0.089
Trucks	0.076
Jackhammer	0.035
Small bulldozer	0.003

Source: FTA 2018

Bulldozers and other construction equipment would be used regularly in project construction. In addition, heavy trucks would be used to deliver and remove material to and from the site.

The risk of construction vibration damage from each piece of equipment can be assessed by adjusting the PPV from the reference PPV at 25 feet to the actual distance from the equipment to the receiver by applying the following equation:

$$PPV_{equip} = PPV_{ref} \times \left(\frac{25}{D}\right)^{1.5}$$

Where:

- PPV_{equip} = the peak particle velocity of the equipment adjusted for distance, inches per second (in/sec)
- PPV_{ref} = the source reference vibration level at 25 feet, in/sec
- D = distance from the equipment to the receiver, feet

To determine how close each type of building category (Table 5) can be to each type of equipment before sustaining damage, the equation was solved to find the distance at which the construction vibration damage criteria were met for each building category (Table 7).

Table 4. Distance to Construction Vibration Damage by Building Category

Equipment	PPV at 25feet (in/sec)	Building category (Construction vibration damage criteria; distance in			
		1 (0.5 in/sec)	2 (0.3 in/sec)	3 (0.2 in/sec)	4 (0.12 in/sec)
Pile driver (impact – upper range)	1.518	50	75	100	135
Pile driver (impact – typical)	0.644	30	40	55	75
Pile driver (sonic – upper range)	0.734	30	45	60	85

Equipment	PPV at 25 feet (in/sec)	Building category (Construction vibration damage criteria; distance i			
		1 (0.5 in/sec)	2 (0.3 in/sec)	3 (0.2 in/sec)	4 (0.12 in/sec
Pile driver (sonic-typical)	0.170	< 25	< 25	< 25	30
Large bulldozer	0.089	< 25	< 25	< 25	< 25
Caisson drilling	0.089	< 25	< 25	< 25	< 25
Trucks	0.076	< 25	< 25	< 25	< 25
Jackhammer	0.035	< 25	< 25	< 25	< 25
Small bulldozer	0.003	< 25	< 25	< 25	< 25

The distances determined indicate that for all building categories, general construction equipment must be less than 25 feet from the building to cause damage. Impact pile driving in the upper range has the greatest potential to cause damage to buildings; 135 feet is the closest that pile driving can occur to a Category 4 building. Category 4 buildings are “extremely susceptible to vibration damage” (FTA 2018); construction is very sensitive to vibration and may be objects or buildings of historic interest.

References

California Department of Transportation (Caltrans). 2020. *Transportation and Construction Vibration Guidance Manual*. April. https://dot.ca.gov/-/media/dot-media/programs/environmental-analysis/documents/env/tcvgm-apr2020-a11y.pdf.

Federal Highway Administration (FHWA) 2017. *Roadway Construction Noise Model User Guide*. June 28. https://www.fhwa.dot.gov/Environment/noise/construction_noise/rcnm/rcnm00.cfm.

Federal Transit Administration (FTA). 2018. *Transit Noise and Vibration Impact Assessment Manual.* September. FTA Report No. 0123. https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/research-innovation/118131/transit-noise-and-vibration-impact-assessment-manual-fta-report-no-0123_0.pdf.