NOISE AND VIBRATION

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SUMMARY OF CONCLUSIONS

California Energy Commission (Energy Commission) staff concludes that the Humboldt Bay Repowering Project (HBRP) can be built and operated in compliance with all applicable noise and vibration laws, ordinances, regulations, and standards (LORS) and in a manner that will cause no significant adverse noise impacts on sensitive receptors. With the adoption of the conditions of certification proposed below, noise from construction and operation of the project would be limited to levels that would produce no significant adverse noise impacts directly, indirectly, or cumulatively.

INTRODUCTION

The construction and operation of any power plant creates noise, or unwanted sound. The character and volume of this noise, the times of day or night when it is produced, and the proximity of the facility to sensitive receptors combine to determine whether the facility would meet applicable noise control laws and ordinances and whether it would cause significant adverse environmental impacts. In some cases, power plant construction practices, such as blasting or pile driving, may produce vibration, as may plant operation. The ground-borne energy of vibration has the potential to cause structural damage and annoyance.

The purpose of this analysis is threefold:

1. to identify and examine the likely noise and vibration impacts from the construction and operation of the HBRP;

2. to recommend procedures to ensure the resulting noise and vibration impacts would be adequately mitigated to comply with applicable LORS; and

3. to avoid creation of significant adverse noise or vibration impacts.

For an explanation of technical terms and acronyms employed in this section **(Noise and Vibration, Table A1)**.

LAWS, ORDINANCES, REGULATIONS, AND STANDARDS

NOISE AND VIBRATION Table 1
Laws, Ordinances, Regulations, and Standards (LORS)

Applicable Law	Description
Federal **(OSHA): 29 U.S.C. §651 et seq.**	Protects workers from the effects of occupational noise exposure.
State **(Cal-OSHA): Cal. Code Regs., tit. 8, §§5095–5099**	Protects workers from the effects of occupational noise exposure.
Local Humboldt County General Plan, §3240 - Noise: Land Use/Noise Compatibility Standards	Establishes L_{dn} values for exterior exposure of single-family residential and mobile homes. Levels up to 60 dBA are considered clearly acceptable; up to 65 dBA normally acceptable.
Humboldt County Zoning Regulations, Industrial Performance Standards, §313-103.1.3	Requires all noise generating operations be mitigated to not exceed exterior ambient noise level in residential zones by more than 5 dBA (§313-103.1.3.1). Prohibits perceptible vibrations off the site (§313-103.1.3.4).
Humboldt County Zoning Regulations, Industrial Performance Standards, §313-103.1.4	Requires all noise generating operations be mitigated so noise in nonresidential zones does not exceed 70 dBA off the site (§ 103.1.4.1). Requires that vibrations not be permitted to interfere with adjacent non-residential land uses (§103.1.4.4)

FEDERAL

Under the Occupational Safety and Health Act of 1970 (29 United States Code (U.S.C.) §651 et seq.), the Department of Labor, Occupational Safety. and Health Administration (OSHA) has adopted regulations (29 C.F.R. §1910.95) designed to protect workers against the effects of occupational noise exposure. These regulations list permissible noise exposure levels as a function of the amount of time during which the worker is exposed **(Noise and Vibration Appendix A, Table A4)**. The regulations further specify a hearing conservation program that involves monitoring the noise workers are exposed, assuring workers are made aware of overexposure to noise, and periodically testing the workers' hearing to detect any degradation.

No federal laws govern off-site (community) noise.

The only guidance available for evaluation of power plant vibration are guidelines published by the Federal Transit Administration (FTA) for assessing the impacts of ground-borne vibration associated with construction of rail projects. Other jurisdictions have applied these guidelines to assess ground-borne vibration of other types of projects. The FTA-recommended vibration standards are expressed in terms of the

"vibration level," which is calculated from the peak particle velocity measured from ground-borne vibration. The FTA measure of the threshold of perception is 65 VdB,[1] which correlates to a peak particle velocity of about 0.002 inches per second (in/sec). The FTA measure of the threshold of architectural damage for conventional sensitive structures is 100 VdB, which correlates to a peak particle velocity of about 0.2 in/sec.

STATE

California Government Code section 65302(f) encourages each local governmental entity to perform noise studies and implement a noise element as part of its General Plan. In addition, the California Office of Planning and Research has published guidelines for preparing noise elements, which include recommendations for evaluating the compatibility of various land uses as a function of community noise exposure.

The California Occupational Safety and Health Administration (Cal-OSHA) has promulgated Occupational Noise Exposure Regulations (Cal. Code Regs., tit. 8, §§5095–5099) establishing employee noise exposure limits. These standards are equivalent to the federal OSHA standards **(Worker Safety and Fire Protection** and **Noise and Vibration Appendix A, Table A4)**.

LOCAL

Humboldt County General Plan Noise Element

Section 3240 ("Noise") in Chapter 3 ("Hazards and Resources") of the Humboldt County General Plan (Humboldt 1984) requires the use of Figure 3-2, a noise compatibility matrix entitled "Land Use/Noise Compatibility Standards," in establishing requirements for new projects. This matrix regards noise impacts at single-family residential and mobile home uses as Clearly Acceptable up to 60 dBA L_{dn} and Normally Acceptable up to 65 dBA L_{dn}.

Humboldt County Zoning Regulations

The Humboldt County Zoning Regulations (Humboldt 2000) establishes performance standards for industrial development. For development that impacts residential zones, noise emissions must be limited, so they do not exceed the exterior ambient noise level by more than 5 dBA (§103.1.3.1), and vibration must be limited so that no vibrations are perceptible off the site (§103.1.3.4). For development impacting non-residential zones, noise emissions must be limited to 70 dBA anywhere off the site (§103.1.4.1), and vibration must be limited, as to not interfere with adjacent land uses (§103.1.4.4).

ASSESSMENT OF IMPACTS AND DISCUSSION OF MITIGATION

METHOD AND THRESHOLD FOR DETERMINING SIGNIFICANCE

California Environmental Quality Act

The California Environmental Quality Act (CEQA) requiring significant environmental impacts be identified and such impacts be reduced to less than significant or mitigated

[1] VdB is the common measure of vibration energy.

to the extent feasible. Section XI of Appendix G of CEQA Guidelines (Cal. Code Regs., tit. 14, App. G) sets forth some characteristics that may signify a potentially significant impact. Specifically, a significant effect from noise may exist if a project would result in **(Noise and Vibration Figure 1)**:

1. exposure of persons to, or generation of, noise levels in excess of standards established in the local General Plan or noise ordinance, or applicable standards of other agencies;

2. exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels;

3. substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project; or

4. substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.

The Energy Commission staff, in applying item 3 above to the analysis of this and other projects, has concluded a potential for a significant noise impact exists where the noise of the project plus the background exceeds the background by 5 dBA or more at the nearest sensitive receptor, including those receptors that are considered minority population.

Staff considers it reasonable to assume an increase in background noise levels up to 5 dBA in a residential setting is insignificant; an increase of more than 10 dBA is considered significant. An increase between 5 and 10 dBA should be considered adverse, but may be either significant or insignificant, depending on the particular circumstances of a case.

Factors to be considered in determining the significance of an adverse impact as defined above include:

- the resulting combined noise level;
- the duration and frequency of the noise;
- the number of people affected;
- the land use designation of the affected receptor sites; and
- public concern or controversy as demonstrated at workshops or hearings, or by correspondence.

Noise due to construction activities is usually considered to be insignificant in terms of CEQA compliance if:

- the construction activity is temporary;
- use of heavy equipment and noisy activities is limited to daytime hours; and
- all industry-standard noise abatement measures are implemented for noise-producing equipment.

Staff uses the above method and threshold to protect the most sensitive populations, including the minority population.

SETTING

The HBRP would be located on 5.4 acres of the 143-acre Humboldt Bay Power Plant (HBPP) site on the southern shoreline of Humboldt Bay and would replace the HBPP. Surrounding land uses include rural residential, port-related industrial, agricultural and recreational uses. The land use designation of the project site is Industrial and Industrial-Resource Dependent, and the land is zoned MC (Industrial/Coastal Dependent). The project site lies in unincorporated Humboldt County, bounded on the north by Humboldt Bay, on the west by the unincorporated residential community of King Salmon, on the east by the Northwestern Pacific Railroad tracks, and on the south by King Salmon Avenue. East of the railroad tracks lie Highway 101, rural parcels, and some commercial development (Pacific Gas and Electric Company [PG&E] 2006a, Application for Certification [AFC] §§1.1, 2.0, 2.3, 8.7.2.1).

The existing HBPP consists of Units 1 and 2, a pair of 1950s-era steam boiler units producing 52 and 53 megawatts (MW) each, respectively, and two 15-MW trailer-mounted gas turbine Mobile Emergency Power Plants (MEPPs). Unit 3, a 63-MW nuclear power plant that went into operation in 1963 and was shut down in 1976, was decommissioned in 1984; its spent nuclear fuel is still stored in the unit. This spent fuel will be placed in long-term storage in an Independent Spent Fuel Storage Installation (ISFSI) to be constructed adjacent to Unit 3.

Nearby sensitive noise receptors include the community of King Salmon, 1,500 feet to the west; the Humboldt Hill neighborhood and the South Bay Union School, 2,000 feet to the east; and the Sea View Mobile Estates neighborhood,2,500 feet to the south **(Noise And Vibration Figure 1)** (PG&E 2006a, AFC §§2.3, 8.7.2.1; CH2MHILL 2007a, Data Response 33).

Ambient Noise Monitoring

In order to establish a baseline for comparison of predicted project noise to existing ambient noise, the applicant has presented the results of two ambient noise surveys (PG&E 2006a, AFC §8.7.2.2 Tables 8.7-3, 8.7.4, 8.7-5 and Figure 8.7-1). The initial survey was performed from Monday, June 12 through Tuesday, June 13, 2006. The second survey was performed from Thursday, September 7 through Saturday, September 9, 2006, using acceptable equipment and techniques. The noise surveys monitored existing noise levels at the following locations:

1. Monitoring Location M1: A small dock at the eastern edge of the community of King Salmon, approximately 1,500 feet from the HBRP site, chosen to represent the nearest residential noise receptors. Continuous monitoring was performed June 12 through June 13, 2006, and September 7 through September 9, 2006.

2. Monitoring Location M2: A spot on the HBPP site, approximately 1,500 feet from the HBRP site and just west of a small hill that may shield some of the residences in King Salmon from power plant noise. Continuous monitoring was performed June 12 through June 13, 2006, and September 8 through September 9, 2006.

3. Monitoring Location M3: On a chain link fence, approximately 2,000 feet south of the HBRP site, separating the South Bay Union School parking lot from the Humboldt Hill residential neighborhood. Continuous monitoring was performed June 12 through June 13, 2006, and September 8 through September 9, 2006.

4. Monitoring Location M4: On Sunshine Way in the Sea View Mobile Estates mobile home park, approximately 2,500 feet southeast of the HBRP site. Continuous monitoring was performed June 12 through June 14, 2006, and September 8 through September 9, 2006.

5. Monitoring Location M5: On Loma Avenue, in a commercial neighborhood adjacent to the east side of Highway 101, approximately 3,000 feet southwest of the HBRP site. A 20-minute sample was taken just after 1:00 a.m. on June 13, 2006.

The applicant's first noise monitoring survey was taken in June, when HBPP power output, and thus noise, was fairly low. The second survey was taken in September, when power output and noise levels were slightly greater (see PG&E 2006a, AFC Tables 8.7-3 and 8.7-4). Staff has elected to use data from Table 8.7-4 (September monitoring survey) as more representative of the existing noise regime. Since the power plant's neighbors are accustomed to this noise regime, this represents a reasonable basis of comparison for noise impacts from the proposed HBRP.

In general, the noise environment in the vicinity of the project site and in King Salmon is dominated by the HBPP and by traffic on Highway 101. The noise environment at the sensitive receptors across Highway 101 is dominated in the daytime by highway traffic, and in the nighttime by the HBPP.

Noise and Vibration Table 2 summarizes the ambient noise measurements.

NOISE AND VIBRATION Table 2
Summary of Measured Ambient Noise Levels

Measurement Sites	Measured Noise Levels, dBA			
	Average During Nighttime Hours[1]		Average During Daytime[2]	L_{dn}
	L_{eq}	L_{90}	L_{eq}	
M1 – Dock representing nearest King Salmon residences	48	45	53	56
M2 – Power plant property west of hill	47	44	49	54
M3 – Humboldt Hill residential neighborhood	45	40	54	55
M4 – Sea View Mobile Estates	39	34	49	50
M5 – Loma Avenue commercial district	52[3]	35[3]	—	N/A[4]

Source: PG&E 2006a, AFC Tables 8.7-4, 8.7-5
1. Staff calculations of average of four quietest consecutive hours of the nighttime.
2. Staff calculations of average of all daytime hours for which data is available.
3. Results of 20-minute sample at 1:12 a.m. (from Table 8.7-5).
4. L_{dn} not available because monitoring did not encompass a 24-hour period.

DIRECT IMPACTS AND MITIGATION

Short-term construction activities, as well as normal long-term operation of the power plant, can create noise impacts associated with the project.

Construction Impacts and Mitigation

Construction noise is usually considered a temporary phenomenon. Construction of the HBRP is expected to last 18 months, typical of other power plants in terms of schedule, equipment used, and other types of activities (PG&E 2006a, AFC §1.7.2).

Compliance with LORS

Construction of an industrial facility such as a power plant is typically noisier than permissible under usual noise ordinances. In order to allow the construction of new facilities, construction noise during certain hours of the day is commonly exempt from enforcement by local ordinances. In Humboldt County, no such ordinance exists. Nevertheless, the applicant has committed to limit noisy construction to the hours between 7:00 a.m. and 8:00 p.m., seven days a week, to minimize noise impacts on sensitive receptors (PG&E 2006a, AFC § 8.7.5.3). In the absence of any applicable LORS limiting the hours of noisy construction work, and in light of the minor impacts of construction noise (see below), staff agrees with this proposal. In order to ensure compliance with this restriction, staff proposes Condition of Certification **NOISE-6**, which would limit noisy construction to these hours.

CEQA Impacts

The applicant has predicted construction noise levels, which are summarized here in **Noise and Vibration Table 3**:

NOISE AND VIBRATION Table 3
Predicted Construction Noise Levels

Receptor	Highest Construction Noise Level[1] (dBA L_{eq})	Measured Daytime Ambient[2] (dBA L_{eq})	Cumulative (dBA L_{eq})	Change (dBA)
M1 – Dock near King Salmon	**59**	**53**	**60**	+7
M2 – Power plant property west of hill	**59**	**49**	**59**	+10
M3 – Humboldt Hill residential neighborhood	**57**	**54**	**59**	+5
M4 – Sea View Mobile Estates	**55**	**49**	**56**	+7
M5 – Loma Avenue commercial district	53	N/A[3]	—	—

1. Source: PG&E 2006a, AFC Table 8.7-7 and staff calculations.
2. Source: PG&E 2006a, AFC Table 8.7-4: average of daytime hours for which data is available.
3. Not available since only one 20-minute nighttime sample was taken.

To evaluate construction noise impacts, staff compares the projected noise levels to the ambient. Since construction noise typically varies continually with time, it is most appropriately measured by, and compared to, the L_{eq} (energy average) metric. As seen in **Noise and Vibration Table 3** above, construction noise at the nearest sensitive receptors, the residences in King Salmon (M1), may reach 59 dBA. The ambient daytime L_{eq} level at this location, as seen in **Noise and Vibration Table 3** above, averages 53 dBA. The addition of construction noise to the ambient would result in 60 dBA, an increase of 7 dBA over the ambient level. As noted by the applicant (PG&E 2006a, AFC §8.7.3.2.1), the source figures used to produce the above construction noise estimates are from studies conducted 21 to 26 years ago. Construction equipment has grown noticeably quieter in the intervening years. Staff thus believes that the actual increase in the ambient noise level at this location would be considerably less than 7 dBA, or barely noticeable at these residences. Also, as explained above, noise due to construction activities is usually considered to be insignificant in terms of CEQA compliance if the construction activity is temporary and use of heavy equipment and noisy activities is limited to daytime hours. Because the HBRP construction noise is temporary in nature and noisy construction activities would occur during daytime hours, the noise effect of plant construction on these nearest sensitive receptors is considered to be less than significant.

As seen in **Noise and Vibration Table 3**, the ambient noise level of 54 dBA at monitoring location M3 (Humboldt Hill residences), when combined with the predicted

HBRP construction noise level of 57 dBA L_{eq} at this location, would result in 59 dBA L_{eq}. This is 5 dBA above the ambient level. (As explained above, the actual increase would likely be less due to the quieter nature of modern construction equipment and shielding effects from intervening structures.) As described above (under Method and Threshold for Determining Significance), staff regards an increase of up to 5 dBA as a less than significant impact. Likewise, the ambient noise level of 49 dBA at monitoring location M4 (Sea View Mobile Estates), when combined with the predicted HBRP construction noise level of 55 dBA at this location, would result in 56 dBA, an increase of 7 dBA above the ambient. As at M1, staff regards such an increase as an insignificant impact.

As discussed above, the applicant has volunteered to limit noisy construction to the hours between 7:00 a.m. and 8:00 p.m., seven days a week, and to employ properly equipped and muffled construction equipment, to minimize noise impacts on sensitive receptors (PG&E 2006a, AFC §8.7.5.3). Staff agrees that this should prove to be adequate mitigation of construction noise. To ensure adherence to these conditions, staff proposes Condition of Certification **NOISE-6**.

In the event that actual construction noise should annoy nearby workers or residents, staff proposes Conditions of Certification **NOISE-1** and **NOISE-2**, which would establish a Notification Requirement and a Noise Complaint Process that requires the applicant to resolve any problems caused by construction noise.

Linear Facilities

No new offsite linear facilities will be constructed to serve the HBRP (PG&E 2006a, AFC §§1.1, 2.4, 2.5.6, 2.5.7.2, 2.7.3.1, 6.2, 7.1, 9.8.1, 9.8.2, 9.8.3). Electrical interconnection, natural gas supply, water supply, and wastewater disposal will all connect on site to existing facilities that currently serve the HBPP. All construction noise related to linear facilities will occur on site and has been accounted for in the applicant's estimates of construction noise (see above).

Pile Driving

Pile driving would be necessary for construction of the HBRP (PG&E 2006a, AFC §8.7.3.2.2). Since the application did not quantify likely pile driving noise impacts at sensitive receptors, staff issued a data request (CEC 2006b, Data Request 33). The applicant's response displayed projected pile driving noise impacts at nearby sensitive receptors (CH2MHILL 2007a, Data Response 33, Table DR33-1); see **NOISE Table 4.**

NOISE AND VIBRATION Table 4
Projected Pile Driving Noise Impacts

Receptor	Pile Driving Noise Level (L_{eq})	Measured Daytime Ambient (dBA L_{eq})[1]	Cumulative (dBA L_{eq})	Change (dBA L_{eq})	Pile Driving Noise Level (L_{max})
M1 – Dock near King Salmon	**65**	**53**	**65**	**+12**	72
M2 – Power plant property west of hill	**65**	**49**	**65**	**+16**	72
M3 – Humboldt Hill residential neighborhood	**62**	**54**	**63**	**+9**	69
M4 – Sea View Mobile Estates	**60**	**49**	**60**	**+11**	67
M5 – Loma Avenue commercial district	59	—	—	—	66

Source: CH2MHILL 2007a, Table DR33-1
1. Source: PG&E 2006a, AFC Table 8.7-4: average of daytime hours for which data is available.

Pile driving noise is projected to reach average levels of 65 dBA L_{eq} at the nearest residential receptors in King Salmon (M1) and peak levels up to 72 dBA. This represents an increase of 12 dBA over the daytime ambient noise level at that location, with momentary peaks up to 19 dBA above ambient levels. Pile driving noise would likewise reach levels of 62 dBA at the residences on Humboldt Hill (M3) and 60 dBA at the Sea View Mobile Estates (M4), increases over ambient of 9 and 11 dBA respectively. While this would produce a noticeable impact, staff believes its temporary nature and its limitation to daytime hours would result in impacts that are tolerable to residents.

Vibration

The only construction operation likely to produce vibration that could be perceived off site would be pile driving. Vibration attenuates rapidly; it is likely that no vibration would be perceptible at any appreciable distance from the project site. Staff therefore believes there would be no significant impacts from construction vibration.

Worker Effects

The applicant has acknowledged the need to protect construction workers from noise hazards and has recognized those applicable LORS that would protect construction workers (PG&E 2006a, AFC § 8.7.3.2.3). To ensure that construction workers are, in fact, adequately protected, staff has proposed Condition of Certification **NOISE-3**.

Operation Impacts and Mitigation

The primary noise sources of the HBRP include the engine generators and their exhaust stacks, combustion air inlets, cooling radiator fans, electrical transformers, and various pumps and fans. Staff compares the predicted project noise with applicable LORS. In addition, staff evaluates any increase in noise levels at sensitive receptors due to the project in order to identify any significant adverse impacts.

Potential noise mitigation measures, if needed, could include the following equipment:

- engine hall ventilation treatment;
- increased combustion air inlet silencing;
- increased exhaust stack silencing;
- low noise radiator fans; and
- additional noise barriers.

Compliance with LORS

The applicant performed noise modeling to predict the project's noise impacts on sensitive receptors (PG&E 2006a, AFC § 8.7.3.3.3; Tables 8.7-10, 8.7-11, 8.7-12). Project noise levels at the nearest sensitive receptor, M1 (the dock near King Salmon), with the plant generating at maximum output, could reach 52 dBA L_{eq} (PG&E 2006a, AFC § 8.7.3.3.3).

As summarized above, applicable LORS include the Humboldt County General Plan and the Humboldt County Zoning Regulations.

The Humboldt County General Plan, § 3240, Land Use/Noise Compatibility Standards, allows exterior noise levels at residences up to 65 dBA L_{dn}. The predicted project noise level at M1 of 52 dBA L_{eq}, for a steady noise source such as a power plant (see below), would equate to 58 dBA L_{dn}. This exhibits compliance with the General Plan.

The Humboldt County Zoning Regulations, § 313-103.1.3.1, requires all noise generating operations to be mitigated to not exceed the exterior ambient noise level in residential zones by more than 5 dBA. Comparing the predicted maximum project noise level at M1 of 52 dBA L_{eq} to the ambient 24-hour average L_{eq} at M1 of 51 dBA (PG&E 2006a, § 8.7.3.3.3; Table 8.7-4) shows that the power plant noise is only one dB greater than the ambient level. Further, section 313-103.1.3.4 of the Regulations prohibits perceptible vibrations off the power plant site. Such will be the case; see "Vibration," below. This indicates compliance with this regulation.

The Humboldt County Zoning Regulations, § 313-103.1.4.1, requires all noise generating operations to be mitigated so noise in residential zones does not exceed 70 dBA off the site. As discussed above, the predicted project noise level of 52 dBA at M1 clearly meets this limit. Section 313-103.1.4.4 of this regulation further requires that vibration not be permitted to interfere with adjacent non-residential land uses. Such will be the case; see "Vibration," below. This indicates compliance with this regulation.

CEQA Impacts

Power plant noise is unique. A power plant operates as, essentially, a steady, continuous, broadband noise source, unlike the intermittent sounds that comprise the majority of the noise environment. As such, power plant noise contributes to, and becomes part of, the background noise level, or the sound heard when most intermittent noises cease. Where power plant noise is audible, it will tend to define the background noise level. For this reason, staff compares the projected power plant noise to the existing ambient background (L_{90}) noise levels at the affected sensitive receptors. If this comparison identifies a significant adverse impact, then feasible mitigation must be incorporated in the project to reduce or eliminate the impact.

In most cases, a power plant will be intended to operate around the clock for much of the year. Staff evaluates project noise emissions by comparing them to the nighttime ambient background level; this assumes the potential for annoyance due to power plant noise is greatest at night when residents are trying to sleep. Nighttime ambient noise levels are typically lower than the daytime levels; differences in background noise levels of 5 to 10 dBA are common. Staff believes it is prudent to average the lowest nighttime hourly background noise level values to arrive at a reasonable baseline for comparison with the project's predicted noise level.

Adverse impacts, as defined in CEQA, can be detected by comparing predicted power plant noise levels to the ambient nighttime background noise levels at the nearest sensitive receptors as shown above.

Noise emissions from the HBRP will differ from the existing HBPP, and from most other large power plants, in that noise levels from the plant will tend to drop steadily along with the electrical load on the plant. Power plant noise diminishes chiefly when a unit or units are shut down. When the load on a single unit is reduced, noise from the unit does not drop appreciably. Noise reductions from the HBPP, for example, occur only when each of the 15 MW gas turbine units is shut down, or when 52 MW Unit 1 or 53 MW Unit 2 is shut down, as load diminishes. Noise from the HBRP, however, would decrease at each 10 MW reduction in load.

The HBRP would consist of ten discrete 16.3 MW generating units operating in load following mode (PG&E 2006a, AFC §§ 1.4, 2.5.2, 2.5.16, 2.7.1, 9.3, 10.2.2). Further, the engine cooling radiators are to be equipped with variable speed fans. When the weather is cooler, as at night or during the winter, these fans runs more slowly, thus producing less noise. The applicant has modeled plant noise emissions on a warm day, and at night or on a cool winter day, at full load and at various levels of reduced electrical load (PG&E 2006a, AFC § 8.7.3.3.3; Tables 8.7-11, 8.7-12). The modeled noise levels at the nearest sensitive receptor, M1, are summarized in **Noise and Vibration Table 5**:

NOISE AND VIBRATION Table 5
Predicted Power Plant Noise Levels at M1

Plant Electrical Load	Power Plant Noise at M1 (dBA L_{eq})	
	Daytime	Nighttime/Winter Day
100% (145-163 MW)	52.0	49.0
90% (129-144 MW)	51.5	48.5
80% (113-128 MW)	51.0	48.0
70% (97-112 MW)	50.5	47.5
60% (81-96 MW)	49.8	46.8
50% (65-80 MW)	49.0	46.0
40% (49-64 MW)	48.0	45.0
30% (33-48 MW)	46.8	43.8
20% 17-32 MW)	45.0	42.0
10% (8-16 MW)	42.0	39.0

Source: PG&E 2006a, AFC Table 8.7-11

Using these predictions, power plant noise impacts at night under full load at the various sensitive receptors can be projected; see **Noise and Vibration Table 6**:

NOISE AND VIBRATION Table 6
Nighttime Power Plant Noise Impacts at Sensitive Receptors – Full Load

Receptor	**Measured Nighttime Ambient Level (dBA L_{90})[1]**	**Power Plant Noise Level (dBA L_{eq})[2]**	**Cumulative (dBA L_{eq})**	Change (dBA)
M1 – Dock near King Salmon	**45**	**49**	**50**	+5
M3 – Humboldt Hill residential neighborhood	**40**	**47**	**48**	+8
M4 – Sea View Mobile Estates	34	44	44	+10

Source: PG&E 2006a, AFC § 8.7.3.3.3; Tables 8.7-4, 8.7-11, 8.7-12; and staff calculations
1. Staff calculations of average of four quietest consecutive hours of the nighttime
2. Nighttime estimates from PG&E 2006a, AFC Table 8.7-11 and staff calculations

As seen in **Noise and Vibration Table 6**, power plant noise causes impacts at receptors M3 and M4 that could be considered significant, raising the nighttime ambient noise levels by eight to ten dBA. The applicant points out, however, how rare it is for the power plant to run at full load at night. A survey of historical operating data from the existing HBPP for the years 2003 through 2005 shows that plant load exceeded 49 MW (equivalent to four of the HBRP gensets running) only 10% of nighttime hours, and 79 MW (equivalent to five HBRP gensets running) only 0.7% of nighttime hours (PG&E 2006a, AFC § 8.7.3.3.3). The HBPP exceeded 80 MW only 1% of the nighttime hours during the survey. **Noise and Vibration Table 7** shows what power plant noise levels could actually be expected at the sensitive receptors:

NOISE AND VIBRATION Table 7
Power Plant Noise Impacts at Sensitive Receptors – Likely Nighttime Load

Receptor	Plant Load	Measured Nighttime Ambient Level (dBA L_{90})[1]	Power Plant Noise Level (dBA L_{eq})[2]	Cumulative (dBA L_{eq})	Change (dBA)
M1	**49 MW**	**45**	**45**	**48**	+3
	79 MW		**46**	**49**	+4
M3	**49 MW**	**40**	**43**	**45**	+5
	79 MW		**44**	**45**	+5
M4	**49 MW**	**34**	**40**	**41**	+7
	79 MW		41	42	+8

Source: PG&E 2006a, AFC § 8.7.3.3.3; Tables 8.7-4, 8.7-11, 8.7-12; and staff calculations
1. Staff calculations of average of four quietest consecutive hours of the nighttime
2. Nighttime estimates from PG&E 2006a, AFC Tables 8.7-11, 8.7-12; and staff calculations

Likely power plant noise impacts on the nearest receptors, residences in King Salmon, are only three to four dBA; and on homes in the Humboldt Hill neighborhood, only five dBA. Such increases are just noticeable, and generally unlikely to prompt complaints. Staff typically considers such increases as insignificant impacts. Noise impacts at the Sea View Mobile Estates may reach seven to eight dBA; such increases could be considered significant in some circumstances. The survey of historical operating data showed that the instances of relatively high output (79 MW) occurred during the months of November and December. It is highly likely that people in the affected residences are sleeping with their windows closed at these times of the year, thus reducing noise impacts even further (PG&E 2006a, AFC § 8.7.3.3.3). For this reason, staff believes that noise from operation of the HBRP would constitute an insignificant impact on all affected residential receptors.

Two further noise receptors are the South Bay Union School, located at M3, and the Loma Avenue commercial district, at M5. Neither of these receptors is expected to be sensitive to nighttime noise levels; school classes and work occur during the daytime. To evaluate impacts on these receptors, staff typically compares power plant noise to daytime ambient L_{eq} levels. **Noise and Vibration Table 8** shows likely daytime impacts at M3 and M5:

NOISE AND VIBRATION Table 8
Power Plant Noise Impacts at Daytime Receptors – Full Load

Receptor	Measured Daytime Ambient (dBA L_{eq})[1]	Power Plant Noise Level (dBA L_{eq})[2]	Cumulative (dBA L_{eq})	Change (dBA)
M3 – South Bay Union School	**54**	**47**	**55**	+1
M5 – Loma Avenue commercial district	N/A	44	—	—

1. Source: PG&E 2006a, AFC Table 8.7-4; average of daytime hours for which data is available
2. Source: PG&E 2006a, AFC Table 8.7-12 and staff calculations

Power plant noise at M3, the school, will raise daytime noise levels only one dBA, an imperceptible amount. The power plant can thus be expected to be nearly inaudible at the school. While daytime ambient noise levels are not available at M5, the Loma Street commercial neighborhood, staff believes they are likely as high as at M3, and perhaps higher due to proximity to Highway 101. Power plant noise impacts at M5 are thus likely to be even less than at the school; the plant should be inaudible at M5.

To ensure that noise from the HBRP does not, in fact, exceed these projected levels, staff proposes Condition of Certification **NOISE-4**.

Tonal Noises

One possible source of annoyance would be strong tonal noises. Tonal noises are individual sounds (such as pure tones) that, while not louder than permissible levels, stand out in sound quality. It is possible that some noise sources within the plant could produce tonal noises. The applicant plans to address overall noise in design, and to take appropriate measures, as necessary, to eliminate tonal noises as possible sources of annoyance (PG&E 2006a, AFC § 8.7.3.3.4). To ensure that tonal noises do not cause annoyance, staff proposes Condition of Certification **NOISE-4**.

Linear Facilities

All water and gas piping would lie underground, and would be silent during operation. Noise effects from the electrical interconnection line typically do not extend beyond the right-of-way easement of the line, and would thus be inaudible to any sensitive receptors.

Vibration

Vibration from an operating power plant could be transmitted by two chief means; through the ground (groundborne vibration), and through the air (airborne vibration).

The operating components of the HBRP would consist of low-speed reciprocating engine generator sets and various fans and pumps. All of these pieces of equipment must be carefully balanced in order to operate. The applicant explains that the Wärtsilä engines to be employed in the HBRP are mounted to their foundations with spring packs to isolate engine vibration. The resulting vibration is typically less than 0.02 inches/second (PG&E 2006a, AFC § 8.7.3.3.5). As explained above, a peak particle velocity of approximately 0.002 inches/second typically represents the threshold of perceptible vibration, while a peak particle velocity of 0.2 inches/second represents the threshold of architectural damage for conventional sensitive structures. The applicant maintains that groundborne vibration from the HBRP would attenuate rapidly enough that it would be imperceptible at the site boundaries. Energy Commission staff agrees with this conclusion, and agrees with the applicant that groundborne vibration from the HBRP would be undetectable by any likely receptor.

Airborne vibration (low frequency noise) can rattle windows and objects on shelves, and can rattle the walls of lightweight structures. The HBRP's chief source of airborne vibration would be the engines' exhaust. In a power plant such as the HBRP, however, the exhaust must pass through the selective catalytic reduction (SCR) units, the carbon monoxide (CO) catalysts and the stack silencers before it reaches the atmosphere.

These devices act as efficient mufflers; the combination of SCR units, CO catalysts and stack silencers makes it highly unlikely that the HBRP would cause perceptible airborne vibration effects.

Worker Effects

The applicant has acknowledged the need to protect plant operating and maintenance workers from noise hazards, and has committed to comply with applicable LORS (PG&E 2006a, AFC § 8.7.3.3.1). Signs would be posted in areas of the plant with noise levels exceeding 85 dBA (the level that OSHA recognizes as a threat to workers' hearing), and a hearing conservation program would be implemented. To ensure that plant operation and maintenance workers are, in fact, adequately protected, Energy Commission staff has proposed Condition of Certification **NOISE-5**.

CUMULATIVE IMPACTS AND MITIGATION

Section 15130 of the CEQA Guidelines (Cal. Code Regs., tit. 14) requires a discussion of cumulative environmental impacts. Cumulative impacts are two or more individual impacts that, when considered together, are considerable or that compound or increase other environmental impacts. The CEQA Guidelines require that the discussion reflect the severity of the impacts and the likelihood of their occurrence, but need not provide as much detail as the discussion of the impacts attributable to the project alone.

Nearby projects that could contribute to cumulative noise impacts include:

- decommissioning and removal of the existing HBPP Units 1 and 2 and the two MEPPs;
- construction of the ISFSI; and
- completion of decommissioning of the existing HBPP Unit 3.

Decommissioning and Removal of Units 1 and 2 and the MEPPs

This would consist of essentially construction work. Noise emissions would be similar to those during construction of the HBRP, with the exception that no exceptionally noisy work such as pile driving would be necessary. Like construction work, decommissioning and removal would be expected to take place during the daytime, thus not creating impacts at night, when nearby residents are sleeping. Note that, during this phase, while the HBRP would be operating, Units 1 and 2 and the MEPPs would not be operating; their noise would have ceased. Therefore, noise of removal of Units 1 and 2 and the MEPPs plus HBRP operational noise would be similar to, but not likely greater than, the noise of HBRP construction while Units 1 and 2 and the MEPPs operated. These noise impacts have been evaluated (see above) and found not significant.

Construction of the ISFSI

This work is scheduled to begin in Spring 2007 (PG&E 2006a, AFC § 2.2.1); it should be essentially complete before construction of the HBRP begins. There would thus be no cumulative noise impacts. Should the construction work of these projects overlap, it is highly unlikely that noise impacts would aggregate to significant levels. Construction noise varies constantly, thus is less likely to aggregate to annoying levels. Further, since this noise occurs during the daytime, nearby residents are unlikely to be annoyed.

Therefore, staff believes there is no likelihood that construction of the ISFSI would create significant noise impacts.

Decommissioning of Unit 3

Like decommissioning of Units 1 and 2 and the MEPPs, decommissioning of the nuclear unit would take place during the daytime, and would be unlikely to create significant noise impacts.

The existing Units 1 and 2 and the MEPPs will continue to operate during construction and commissioning of the HBRP. Noise emissions from the existing power plant units have been considered in this analysis as part of the ambient noise regime; they need not be regarded separately as cumulative impacts.

FACILITY CLOSURE

In the future, upon closure of the HBRP, all operational noise from the project would cease, and no further adverse noise impacts from operation of the HBRP would be possible. The remaining potential temporary noise source is the dismantling of the structures and equipment, and any site restoration work that may be performed. Since this noise would be similar to that caused by the original construction, it can be treated similarly. That is, noisy work could be performed during daytime hours, with machinery and equipment properly equipped with mufflers. Any noise LORS that were in existence at that time would apply. Applicable conditions of certification included in the Energy Commission decision would also apply unless modified.

CONCLUSIONS AND RECOMMENDATIONS

Staff concludes that the HBRP can be built and operated in compliance with all applicable noise and vibration LORS, and in a manner that will cause no significant adverse noise impacts on sensitive receptors. With the adoption of the conditions of certification proposed below, noise from construction and operation of the project would be limited to levels that would produce no significant adverse noise impacts, directly, indirectly or cumulatively.

PROPOSED CONDITIONS OF CERTIFICATION

NOISE-1 At least 15 days prior to the start of ground disturbance, the project owner shall notify all residents within three-quarter mile of the site, by mail or other effective means, of the commencement of project construction. At the same time, the project owner shall establish a telephone number for use by the public to report any undesirable noise conditions associated with the construction and operation of the project, and include that telephone number in the above notice. If the telephone is not staffed 24 hours per day, the project owner shall include an automatic answering feature, with date and time stamp recording, to answer calls when the phone is unattended. This telephone number shall be posted at the project site during construction in a

manner visible to passersby. This telephone number shall be maintained until the project has been operational for at least one year.

Verification: Prior to ground disturbance, the project owner shall transmit to the Compliance Project Manager (CPM) a statement, signed by the project owner's project manager, stating that the above notification has been performed, and describing the method of that notification, verifying that the telephone number has been established and posted at the site, and giving that telephone number.

NOISE COMPLAINT PROCESS

NOISE-2 Throughout the construction and operation of the HBRP, the project owner shall document, investigate, evaluate, and attempt to resolve all project-related noise complaints. The project owner or authorized agent shall:

- Use the Noise Complaint Resolution Form (below), or a functionally equivalent procedure acceptable to the CPM, to document and respond to each noise complaint;
- Attempt to contact the person(s) making the noise complaint within 24 hours;
- Conduct an investigation to determine the source of noise related to the complaint;
- If the noise is project related, take all feasible measures to reduce the noise at its source; and
- Submit a report documenting the complaint and the actions taken. The report shall include: a complaint summary, including final results of noise reduction efforts; and if obtainable, a signed statement by the complainant, stating that the noise problem is resolved to the complainant's satisfaction.

Verification: Within five days of receiving a noise complaint, the project owner shall file a copy of the Noise Complaint Resolution Form with the CPM, documenting the resolution of the complaint. If mitigation is required to resolve a complaint, and the complaint is not resolved within a 3-day period, the project owner shall submit an updated Noise Complaint Resolution Form when the mitigation is implemented.

NOISE-3 The project owner shall submit to the CPM for review and approval a noise control program, and a statement, signed by the project owner's project manager, verifying that the noise control program will be implemented throughout construction of the project. The noise control program shall be used to reduce employee exposure to high noise levels during construction and also to comply with applicable OSHA and Cal-OSHA standards.

Verification: At least 30 days prior to the start of ground disturbance, the project owner shall submit to the CPM the noise control program and the project owner's project manager's signed statement. The project owner shall make the program available to Cal-OSHA upon request.

NOISE RESTRICTIONS

NOISE-4 The project design and implementation shall include appropriate noise mitigation measures adequate to ensure that operation of the project will not cause noise levels due to full load plant operation to exceed an average of 49 dBA L_{eq} measured at monitoring location M1 in the community of King Salmon, an average of 47 dBA L_{eq} measured at monitoring location M3 on Humboldt Hill, or an average of 44 dBA L_{eq} at monitoring location M4 at the Sea View Mobile Estates. No new pure-tone components may be caused by the project. No single piece of equipment shall be allowed to stand out as a source of noise that draws legitimate complaints.

The measurement of power plant noise for the purposes of demonstrating compliance with this condition of certification may alternatively be made at a location, acceptable to the CPM, closer to the plant (e.g., 400 feet from the plant boundary) and this measured level then mathematically extrapolated to determine the plant noise contribution at the affected residence. The character of the plant noise shall be evaluated at the affected residential locations to determine the presence of pure tones or other dominant sources of plant noise.

A. When the project first achieves a sustained output of 95% or greater of rated capacity, the project owner shall conduct a community noise survey at monitoring locations M1, M3 and M4, or at closer locations acceptable to the CPM. This survey shall be performed during power plant full load operation and shall also include measurement of one-third octave band sound pressure levels to determine whether new pure-tone noise components have been caused by the project.

B. If the results from the noise survey indicate that the power plant average noise level (L_{eq}) at any affected receptor site exceeds the above value, mitigation measures shall be implemented to reduce noise to a level of compliance with this limit.

C. If the results from the noise survey indicate that pure tones are present, mitigation measures shall be implemented to eliminate the pure tones.

Verification: The survey shall take place within 30 days of the project first achieving a sustained output of 95% or greater of rated capacity. Within 15 days after completing the survey, the project owner shall submit a summary report of the survey to the CPM. Included in the survey report shall be a description of any additional mitigation measures necessary to achieve compliance with the above listed noise limit, and a schedule, subject to CPM approval, for implementing these measures. When these measures are in place, the project owner shall repeat the noise survey.

Within 15 days of completion of the new survey, the project owner shall submit to the CPM a summary report of the new noise survey, performed as described above and showing compliance with this condition.

NOISE-5 Following the project first achieving a sustained output of 95% or greater of rated capacity, the project owner shall conduct an occupational noise survey to identify the noise hazardous areas in the facility.

The survey shall be conducted by a qualified person in accordance with the provisions of Title 8, California Code of Regulations, sections 5095-5099 and Title 29, Code of Federal Regulations, section 1910.95. The survey results shall be used to determine the magnitude of employee noise exposure.

The project owner shall prepare a report of the survey results and, if necessary, identify proposed mitigation measures that will be employed to comply with the applicable California and federal regulations.

Verification: Within 30 days after completing the survey, the project owner shall submit the noise survey report to the CPM. The project owner shall make the report available to OSHA and Cal-OSHA upon request.

CONSTRUCTION TIME RESTRICTIONS

NOISE-6 Heavy equipment operation and noisy construction work relating to any project features shall be restricted to the times of day delineated below:

Any day	7 a.m. to 8 p.m.

Haul trucks and other engine-powered equipment shall be equipped with mufflers that meet all applicable regulations. Haul trucks shall be operated in accordance with posted speed limits. Truck engine exhaust brake use shall be limited to emergencies.

Verification: Prior to ground disturbance, the project owner shall transmit to the CPM a statement acknowledging that the above restrictions will be observed throughout the construction of the project.

EXHIBIT 1 - NOISE COMPLAINT RESOLUTION FORM

Humboldt Bay Repowering Project
(06-AFC-7)

NOISE COMPLAINT LOG NUMBER _____

Complainant's name and address:

Phone number: _____

Date complaint received: _____
Time complaint received: _____

Nature of noise complaint:

Definition of problem after investigation by plant personnel:

Date complainant first contacted: _____

Initial noise levels at 3 feet from noise source _____ dBA Date: _____

Initial noise levels at complainant's property: _____ dBA Date: _____

Final noise levels at 3 feet from noise source: _____ dBA Date: _____

Final noise levels at complainant's property: _____ dBA Date: _____

Description of corrective measures taken:

Complainant's signature: _____ Date: _____

Approximate installed cost of corrective measures: $ _____
Date installation completed: _____
Date first letter sent to complainant: _____ (copy attached)
Date final letter sent to complainant: _____ (copy attached)

This information is certified to be correct:

Plant Manager's Signature: _____

(Attach additional pages and supporting documentation, as required).

REFERENCES

CEC 2006b — California Energy Commission/J. Kessler (tn: 38581). Staff's Data Requests 1-57 dated 12/8/2007.

CH2MHILL 2007a — CH2MHill/D. Davy (tn: 38912). Applicant's Responses to CEC Staff's Data Requests 1-57. 1/12/2007.

Humboldt (Humboldt County) 1984 — Humboldt County General Plan. Adopted December 10, 1984.

Humboldt (Humboldt County) 2000 — Humboldt County Zoning Regulation. Adopted June 6, 2000.

PG&E (Pacific Gas and Electric Company) 2006a — PG&E/R. Kuga (tn: 38050). Humboldt Bay Repowering Project AFC Vol. 1 & 2. 9/29/2006.

NOISE AND VIBRATION APPENDIX A
FUNDAMENTAL CONCEPTS OF COMMUNITY NOISE

To describe noise environments and to assess impacts on noise sensitive area, a frequency weighting measure, which simulates human perception, is customarily used. It has been found that A-weighting of sound intensities best reflects the human ear's reduced sensitivity to low frequencies and correlates well with human perceptions of the annoying aspects of noise. The A-weighted decibel scale (dBA) is cited in most noise criteria. Decibels are logarithmic units that conveniently compare the wide range of sound intensities to which the human ear is sensitive. **Noise and Vibration Table A1** provides a description of technical terms related to noise.

Noise environments and consequences of human activities are usually well represented by an equivalent A-weighted sound level over a given time period (L_{eq}), or by average day and night A-weighted sound levels with a nighttime weighting of 10 dBA (L_{dn}). Noise levels are generally considered low when ambient levels are below 45 dBA, moderate in the 45 to 60 dBA range, and high above 60 dBA. Outdoor day-night sound levels vary over 50 dBA depending on the specific type of land use. Typical L_{dn} values might be 35 dBA for a wilderness area, 50 dBA for a small town or wooded residential area, 65 to 75 dBA for a major metropolis downtown (e.g., San Francisco), and 80 to 85 dBA near a freeway or airport. Although people often accept the higher levels associated with very noisy urban residential and residential-commercial zones, they nevertheless are considered to be levels of noise adverse to public health.

Various environments can be characterized by noise levels that are generally considered acceptable or unacceptable. Lower levels are expected in rural or suburban areas than what would be expected for commercial or industrial zones. Nighttime ambient levels in urban environments are about seven decibels lower than the corresponding average daytime levels. The day-to-night difference in rural areas away from roads and other human activity can be considerably less. Areas with full-time human occupation that are subject to nighttime noise, which does not decrease relative to daytime levels, are often considered objectionable. Noise levels above 45 dBA at night can result in the onset of sleep interference effects. At 70 dBA, sleep interference effects become considerable (Effects of Noise on People, U.S. Environmental Protection Agency, December 31, 1971).

In order to help the reader understand the concept of noise in decibels (dBA), **Noise and Vibration Table A2** has been provided to illustrate common noises and their associated sound levels, in dBA.

Noise and Vibration Table A1 Definition of Some Technical Terms Related to Noise	
Terms	**Definitions**
Decibel, dB	A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micropascals (20 micronewtons per square meter).
Frequency, Hz	The number of complete pressure fluctuations per second above and below atmospheric pressure.
A-Weighted Sound Level, dBA	The sound pressure level in decibels as measured on a Sound Level Meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise. All sound levels in this testimony are A-weighted.
L_{10}, L_{50}, & L_{90}	The A-weighted noise levels that are exceeded 10%, 50%, and 90% of the time, respectively, during the measurement period. L_{90} is generally taken as the background noise level.
Equivalent Noise Level, L_{eq}	The energy average A-weighted noise level during the Noise Level measurement period.
Community Noise Equivalent Level, CNEL	The average A-weighted noise level during a 24-hour day, obtained after addition of 4.8 decibels to levels in the evening from 7 p.m. to 10 p.m., and after addition of 10 decibels to sound levels in the night between 10 p.m. and 7 a.m.
Day-Night Level, L_{dn} or DNL	The Average A-weighted noise level during a 24-hour day, obtained after addition of 10 decibels to levels measured in the night between 10 p.m. and 7 a.m.
Ambient Noise Level	The composite of noise from all sources, near and far. The normal or existing level of environmental noise at a given location.
Intrusive Noise	That noise that intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence and tonal or informational content as well as the prevailing ambient noise level.
Pure Tone	A pure tone is defined by the Model Community Noise Control Ordinance as existing if the one-third octave band sound pressure level in the band with the tone exceeds the arithmetic average of the two contiguous bands by 5 decibels (dB) for center frequencies of 500 Hz and above, or by 8 dB for center frequencies between 160 Hz and 400 Hz, or by 15 dB for center frequencies less than or equal to 125 Hz.

Source: Guidelines for the Preparation and Content of Noise Elements of the General Plan, Model Community Noise Control Ordinance, California Department of Health Services 1976, 1977.

Noise and Vibration Table A2 Typical Environmental and Industry Sound Levels			
Noise Source (at distance)	A-Weighted Sound Level in Decibels (dBA)	Noise Environment	Subjective Impression
Civil Defense Siren (100')	140-130		Pain Threshold
Jet Takeoff (200')	120		Very Loud
Very Loud Music	110	Rock Music Concert	
Pile Driver (50')	100		
Ambulance Siren (100')	90	Boiler Room	
Freight Cars (50')	85		
Pneumatic Drill (50')	80	Printing Press Kitchen with Garbage Disposal Running	Loud
Freeway (100')	70		Moderately Loud
Vacuum Cleaner (100')	60	Data Processing Center Department Store/Office	
Light Traffic (100')	50	Private Business Office	
Large Transformer (200')	40		Quiet
Soft Whisper (5')	30	Quiet Bedroom	
	20	Recording Studio	
	10		Threshold of Hearing

Source: Handbook of Noise Measurement, Arnold P.G. Peterson, 1980

Subjective Response to Noise

The adverse effects of noise on people can be classified into three general categories:

- Subjective effects of annoyance, nuisance, dissatisfaction.
- Interference with activities such as speech, sleep, and learning.
- Physiological effects such as anxiety or hearing loss.

The sound levels associated with environmental noise, in almost every case, produce effects only in the first two categories. Workers in industrial plants can experience noise effects in the last category. There is no completely satisfactory way to measure the subjective effects of noise, or of the corresponding reactions of annoyance and dissatisfaction, primarily because of the wide variation in individual tolerance of noise.

One way to determine a person's subjective reaction to a new noise is to compare the level of the existing (background) noise, to which one has become accustomed, with the level of the new noise. In general, the more the level or the tonal variations of a new noise exceed the previously existing ambient noise level or tonal quality, the less acceptable the new noise will be, as judged by the exposed individual.

With regard to increases in A-weighted noise levels, knowledge of the following relationships can be helpful in understanding the significance of human exposure to noise.

1. Except under special conditions, a change in sound level of one dB cannot be perceived.

2. Outside of the laboratory, a three dB change is considered a barely noticeable difference.

3. A change in level of at least five dB is required before any noticeable change in community response would be expected.

4. A ten dB change is subjectively heard as an approximate doubling in loudness and almost always causes an adverse community response. (Kryter, Karl D., The Effects of Noise on Man, 1970)

Combination of Sound Levels

People perceive both the level and frequency of sound in a non-linear way. A doubling of sound energy (for instance, from two identical automobiles passing simultaneously) creates a three dB increase (i.e., the resultant sound level is the sound level from a single passing automobile plus three dB). The rules for decibel addition used in community noise prediction are:

Noise and Vibration Table A3
Addition of Decibel Values

When two decibel values differ by:	Add the following amount to the larger value
0 to 1 dB	3 dB
2 to 3 dB	2 dB
4 to 9 dB	1 dB
10 dB or more	0
Figures in this table are accurate to ± 1 dB.	

Source: Architectural Acoustics, M. David Egan, 1988

Sound and Distance

Doubling the distance from a noise source reduces the sound pressure level by six dB.

Increasing the distance from a noise source 10 times reduces the sound pressure level by 20 dB.

Worker Protection

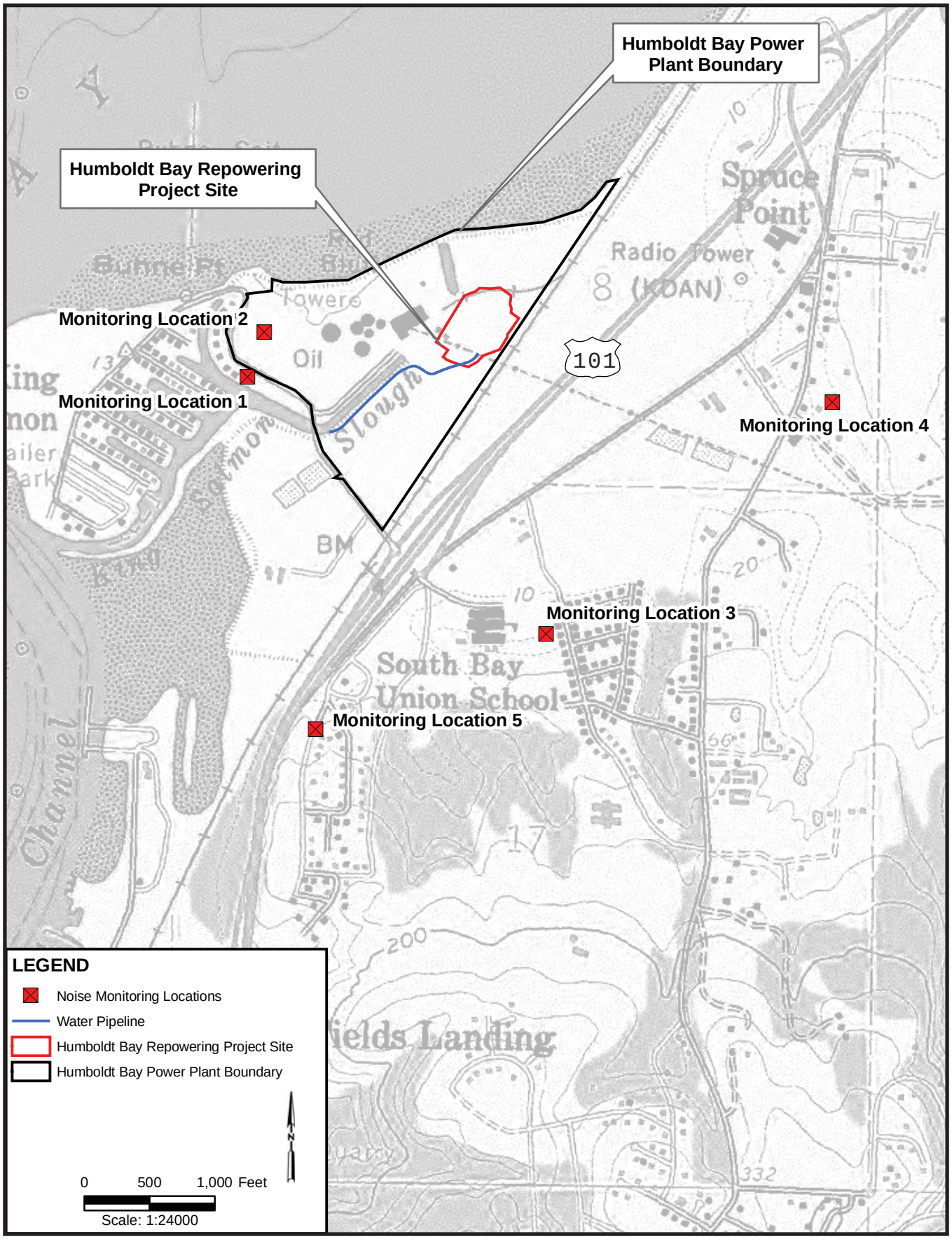
OSHA noise regulations are designed to protect workers against the effects of noise exposure, and list permissible noise level exposure as a function of the amount of time to which the worker is exposed:

Noise and Vibration Table A4
OSHA Worker Noise Exposure Standards

Duration of Noise (Hrs/day)	A-Weighted Noise Level (dBA)
8.0	90
6.0	92
4.0	95
3.0	97
2.0	100
1.5	102
1.0	105
0.5	110
0.25	115

Source: 29 C.F.R. § 1910.95

NOISE AND VIBRATION - FIGURE 1
Humboldt Bay Repowering Project - Noise Monitoring Locations



CALIFORNIA ENERGY COMMISSION - ENERGY FACILITY SITING DIVISION, NOVEMBER 2007
SOURCE: 06 - AFC - 7 - Figure 8.7-1