State Of California

The Resources Agency of California

Memorandum

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To : Che McFarlin

File: Starwood Power Project (06-AFC-10)

From : California Energy Commission - Shahab Khoshmashrab
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Subject : **Comments from the Prehearing Conference on 10-30-2007 – Noise and Vibration**

Condition of Certification **NOISE-5** in staff's **Noise and Vibration** testimony requires a noise survey if the residents at the multi-plex, near monitoring location ML1, are relocated to a location within one mile of the project site. At the prehearing conference, staff agreed to change this distance to 1,320 feet. However, at that time, staff was under the impression that this change was related to the other affected residential receptors, ML2 and ML3.

After further examination, staff concludes that in order for the project to meet the local noise LORS at the new location, this distance should not be less than 3,000 feet. The reasons are as follows:

- Using strictly mathematical calculations, which in the absence of noise modeling, is the only way staff can calculate the impact, the new location must be at least ½-mile, or 2,640 feet, from the project site in order for the project to comply with the LORS.

- The resulting noise level will depend on the ambient noise level at the new location. Staff believes that the ambient noise levels within the project area are only slightly different than the noise level at ML1. If the ambient noise level at the new location is slightly higher than at ML1, a slightly longer distance than 2,640 feet would be required to achieve the LORS limit. Thus, staff concludes a 3000-foot radius would be a reasonable threshold and beyond that distance the project will likely be inaudible.

Staff recommends that the distance of one mile in Condition of Certification **NOISE-5** be revised to 3,000 feet. Staff has revised its testimony accordingly (please see the staff's supplemental testimony).

Staff has also revised the testimony to reflect the hearing officer's comment that the Energy Commission will not force the relocation and that the relocation will occur as the result of implementing the signed agreement between the applicant and the landowner of the multi-plex (please see Condition of Certification **NOISE-5** in the supplemental testimony).

cc: Jared Babula
Garret Shean

NOISE AND VIBRATION

Testimony of Shahab Khoshmashrab and Steve Baker

SUMMARY OF CONCLUSIONS

The Starwood Power Project, if built and operated in conformance with the proposed conditions of certification below, would comply with all applicable noise and vibration laws, ordinances, regulations, and standards, and would produce no significant adverse noise impacts on people within the affected area including the minority population, either direct or cumulative.

INTRODUCTION

The construction and operation of any power plant creates noise, or unwanted sound. The character and loudness of this noise, the times of day or night that 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, vibration may be produced as a result of power plant construction practices, such as blasting or pile driving. The ground-borne energy of vibration has the potential to cause structural damage and annoyance.

The purpose of this analysis of the proposed Starwood Power Project (SPP) is to identify and examine the likely noise and vibration impacts from the construction and operation of the SPP, and to recommend procedures to ensure that the resulting noise and vibration impacts would be adequately mitigated to comply with applicable laws, ordinances, regulations, and standards (LORS). For an explanation of technical terms and concepts discussed in this section please refer to **Noise Appendix A** immediately following.

LAWS, ORDINANCES, REGULATIONS, AND STANDARDS

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

Applicable Law	Description
Federal	
Occupational Safety & Health Act (OSHA): 29 USC § 651 et seq	Protects workers from the effects of occupational noise exposure.
U.S. Environmental Protection Agency Guidelines	Assists state and local government entities in development of state and local LORS for noise.
State	
California Occupational Safety and Health Act (Cal-OSHA): 29 USC § 651 et seq, Cal Code Regs, Title 8, §§ 5095-5099	Protects workers from the effects of occupational noise exposure.
Local	
Fresno County General Plan, Noise Element	Refers to the County of Fresno ordinance code for noise limits.
Fresno County Ordinance Code, Noise Control, section 8.40.040	Sets sound level limits at residences and outdoor activity areas.
Fresno County Ordinance Code, Noise Control, section 8.40.060	Restricts the hours of construction activities.

FEDERAL

Under the Occupational Safety and Health Act of 1970 (29 USC § 651 et seq.), the US Department of Labor, Occupational Safety and Health Administration (OSHA) has adopted regulations (29 CFR § 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 (see **Noise Appendix A, Noise Table A4** immediately following this section). The regulations further specify a hearing conservation program that involves monitoring the noise to which workers are exposed, assuring that workers are made aware of overexposure to noise, and periodically testing the workers' hearing to detect any degradation.

Guidelines are available from the US Environmental Protection Agency to assist state and local government entities in development of state and local LORS for noise. Because there are existing local LORS that apply to this project, the US Environmental Protection Agency guidelines are not applicable.

There are no federal laws governing offsite (community) noise.

The Federal Transit Administration (FTA) published guidelines for assessing the impacts of ground-borne vibration associated with construction of rail projects. These guidelines have since been applied by other jurisdictions to 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, 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 State of California, Office of Noise Control, prepared a Model Community Noise Control Ordinance, which provides guidance for acceptable noise levels in the absence of local noise standards. The model defines a simple tone, or "pure tone," in terms of one-third octave band sound pressure levels that can be used to determine whether a noise source contains annoying tonal components. The Model Community Noise Control Ordinance recommends that when a pure tone is present, the applicable noise standard should be lowered (made more stringent) by five dBA.

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

LOCAL

Noise Element of the Fresno County General Plan

The SPP is located in an unincorporated area of western Fresno County. The noise element of the Fresno County General Plan (County 2006a) applies to the project. Policy HS-G.4 of this element requires an acoustical analysis where a proposed project is likely to produce noise levels in excess of the County's Ordinance Code at noise-sensitive locations (URS 2006a, section 5.12.2.3.1, Table 5.12-4). Policy HS-G.6 of this element states that the county shall regulate construction-related noise to reduce impacts on adjacent communities in accordance with the County's Ordinance Code.

According to this element, an exterior noise level of up to 60 dBA CNEL is compatible with residential land uses. (CNEL is 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.) Because of the weighting and averaging nature of the CNEL, a constant noise source such as a power plant produces a CNEL approximately 7 dBA higher than its L_{eq}. Therefore, exterior noise levels produced by the SPP to levels up to 53 dBA L_{eq}

are compatible with residential land uses in the project area. This analysis requires the project to meet the more stringent requirement of the applicable local noise LORS, the County's Ordinance Code, as shown below.

Fresno County Ordinance Code

Chapter 8.40, Noise Ordinance, of the Fresno County Code (County 2006b) also applies to the SPP. Section 8.40.040 of this ordinance limits exterior noise levels from any stationary on-site or non-transportation noise source at any affected single- or multiple-family residence, school, hospital, church, or public library. These limits are summarized in **Noise Table 2** below.

NOISE Table 2
Exterior Noise Standards

Category	Cumulative Number of Minutes in any One-hour Time Period	Maximum Allowable Noise Level in dBA Daytime (7 a.m. to 10 p.m.)	Maximum Allowable Noise Level in dBA Nighttime (10 p.m. to 7 a.m.)
1	30	50	45
2	15	55	50
3	5	60	55
4	1	65	60
5	0	70	65

As seen above, this ordinance prohibits a project from producing a nighttime exterior sound level at any residence in excess of 45 dBA for more than 30 minutes in any one-hour period, or 45 dBA L_{50}. This is the lowest level, and thus, the most stringent requirement in the above table. The SPP operational noise levels shall meet this requirement at the most noise-sensitive residential receptors in the project vicinity (see below for the locations of these receptors).

Section 8.40.060 of this ordinance restricts construction activities to the hours between 6:00 a.m. and 9:00 p.m. on any day except Saturdays and Sundays, and between 7:00 a.m. and 5:00 p.m. on Saturdays and Sundays.

Staff uses these standards to evaluate the project noise impact from the operation and construction of the SPP.

SETTING

The proposed power plant will be built on a 5.6-acre parcel, located in an unincorporated area of western Fresno County, approximately 15 miles southwest of the city of Mendota. This site is zoned AE-20, Exclusive Agriculture District (see **Noise Figure 1**). Surrounding land uses are generally agricultural, with some residential use. The predominant noise sources in the area include vehicular noise from automobiles and agricultural equipment and industrial noise from mechanical equipment and

processes at the existing CalPeak Power Project, Wellhead Peaker Plant and Pacific Gas & Electric (PG&E) substation (URS 2006a, section 5.12.1.2).

Sensitive residential properties in the vicinity of the project include structures located north, northeast, and west of the site. The residential building north of the site is a multiplex with five units. This building (near ambient noise monitoring location ML1) is located approximately 460 feet from the center of the SPP. There are three single-family residential structures to the west of the site, in a row from east to west. The center building is inhabited; the other two appear to be uninhabitable. These buildings are near ambient noise monitoring location ML2 and are approximately 1,600 feet from the center of the SPP. There is a single-family residential structure to the northeast (near ambient noise monitoring location ML3), located approximately 1,300 feet from the center of the site.

For purposes of evaluating impacts on residential uses, the project noise is compared to the measured nighttime ambient noise levels, when residents are trying to sleep.

ASSESSMENT OF IMPACTS AND DISCUSSION OF MITIGATION

METHOD AND THRESHOLD FOR DETERMINING SIGNIFICANCE

California Environmental Quality Act

The California Environmental Quality Act requires that significant environmental impacts be identified and that such impacts be eliminated or mitigated 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:

- 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;
- exposure of persons to or generation of excessive ground-borne vibration or ground-borne noise levels;
- substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project; or
- 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 bullet 3 above to the analysis of this and other projects, has concluded that a potential for a significant noise impact exists where the noise of the project plus the background exceeds the background at the nearest sensitive receptor by 5 dBA or more, including those receptors that are considered minority population (as identified in **Socioeconomics Figure 1**).

Staff considers it reasonable to assume that an increase in background noise levels up to 5 dBA in a residential setting is insignificant; an increase of more than 10 dBA is

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 noise level[1];
- 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.

Ambient Noise Monitoring

To establish a baseline for comparison of predicted project noise to existing ambient noise, the applicant has presented the results of an ambient noise survey (URS 2006a, section 5.12.1.2, Tables 5.12-2, 5.12-3, Figure 5.12-1). This survey was performed on Monday, June 19, through Tuesday, June 20, 2006, using acceptable equipment and techniques. The noise survey monitored existing noise levels at the following three locations, shown on **Noise Figure 2**:

- Location ML1: This location is approximately 460 feet from the project site and represents the five-unit multiplex north of the site. It was monitored continuously from 1:00 p.m. on June 19 through 2:00 p.m. on June 20.
- Location ML2: This location is approximately 1,600 feet from the project site and represents the three single-family residential structures west of the site. It was monitored on June 19 from 2:00 p.m. to 3:00 p.m. and from 9:05 p.m. to 10:00 p.m., and on June 20 from 12:35 a.m. to 1:35 a.m.
- Location ML3: This location is approximately 1,300 feet from the project site and represents the single-family residential structure northeast of the site. This location

[1] For example, a noise level of 40 dBA would be considered quiet in many locations. A noise limit of 40 dBA would be consistent with the recommendations of the California Model Community Noise Control Ordinance for rural environments, and with industrial noise regulations adopted by European jurisdictions. If the project would create an increase in ambient noise no greater than 10 dBA at nearby sensitive receptors, and the resulting noise level would be 40 dBA or less, the project noise level would likely be insignificant.

was monitored on June 19 from 3:30 p.m. to 4:30 p.m. and from 7:00 p.m. to 8:00 p.m., and on June 20 from 1:40 a.m. to 2:40 a.m.

As described above, the noise environment in the vicinity of the project site is dominated by vehicular traffic and industrial noise sources.

Noise Table 3 summarizes the ambient noise measurements (URS 2006a, section 5.12.1.2, Tables 5.12-2, 5.12-3).

NOISE Table 3
Summary of Measured Noise Levels

Measurement Sites	Measured Noise Levels, dBA		
	Average During Nighttime Hours		
	L_{eq}	L_{50}	L_{90}
ML1, five-unit multiplex to the north of the project site	50[1]	44[1]	42[1]
ML2, three single-family residential structures to the west of the project site	41[2]	41[2]	39[2]
ML3, single-family residential structure to the northeast of the project site	47[2]	41[2]	41[2]

Source: URS 2006a, sec 5.12.1.2, Tables 5.12-2, 5.12-3
[1] Staff's calculations of average of four quietest consecutive hours of the nighttime
[2] Results of the hourly measurements between midnight and 2:40 a.m.

DIRECT IMPACTS AND MITIGATION

Noise impacts associated with the project can be created by short-term construction activities, and by normal long-term operation of the power plant.

Construction Impacts and Mitigation

Construction noise is usually considered a temporary phenomenon. Construction of the SPP is expected to be typical of other power plants in terms of schedule, equipment used, and other types of activities.

Compliance with Laws, Ordinances, Regulations, and Standards

Construction of an industrial facility such as a power plant is typically noisier than permissible under usual noise ordinances. To allow the construction of new facilities, construction noise during certain hours of the day is commonly exempt from enforcement by local ordinances.

Sound levels of typical construction equipment range from approximately 65 dBA to 95 dBA at 50 feet from the source, with an average of 89 dBA at 50 feet during the noisiest activities. Based on this reference noise level for the noisiest activities, the applicant has predicted construction noise levels at the three noise monitoring locations. They are summarized here in **Noise Table 4**.

NOISE Table 4
Predicted Construction Noise Levels

Receptor/Distance	Highest Estimated Construction Noise Level (dBA)[1]	Measured Existing Ambient, Average Daytime L_{eq} (dBA)[2]	Cumulative (Combined)	Change
ML1/460 feet	70	63	71	+8
ML2/1,600 feet	58	46	58	+12
ML3/1,300 feet	60	55	61	+6

Sources: [1] URS 2006a, Table 5.12-6
[2] URS 2006a, Tables 5.12-2, 5.12-3; and staff's calculations

The applicable local noise LORS do not limit the loudness of construction noise, but staff compares the projected noise levels to ambient noise levels. 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 Table 4** above, construction noise at the residential units near monitoring location ML1 may reach 70 dBA. The ambient daytime L_{eq} level at this location, as seen in **Noise Table 4**, is 63 dBA. The addition of the highest construction noise to the ambient would result in 71 dBA, an increase of 8 dBA over the ambient level. As described above (in **Method and Threshold for Determining Significance**), staff regards an increase of up to 5 dBA as a less than significant impact. 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, such as the duration and frequency of the noise, the resulting noise level, and land use designation of the affected receptor. The applicant and the landowner of the five-unit multiplex have signed an agreement to relocate the current occupants to a more distant location prior to start of noisy construction activities (URS 2006a, sections 5.9.3, 5.12.5.1). To ensure that the relocation of these residents will occur, staff proposes Condition of Certification **NOISE-5**. Also, as required by proposed Condition of Certification **NOISE-7**, construction activities will be limited to daytime hours. 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 noise complaint process that requires the applicant to resolve any problems caused by construction noise.

As seen in **Noise Table 4**, the ambient daytime L_{eq} noise level at ML2, or 46 dBA, when added to the highest construction noise at this location, or 58 dBA, results in 58 dBA L_{eq}, an increase of 12 dBA over the existing ambient level. As described above (in **Method and Threshold for Determining Significance**), staff considers an increase of more than 10 dBA to be significant. Panoche Energy Center, LLC recently filed an application for certification with the California Energy Commission to construct and operate the Panoche Energy Center (PEC). The center of the PEC site would be approximately 800 feet from ML2. The PEC applicant has signed an agreement with the

landowner of the residence at ML2 to relocate the residents to a location that is approximately 4,000 feet north of the PEC site prior to start of the PEC's construction activities (PEC 2007d, data responses 69 and 70). Construction of the PEC is scheduled to begin ahead of the SPP's construction. So, at the time construction of SPP begins, ML2 will likely be unoccupied. At the new location, the above projected construction noise level would be substantially lower, about 50 dBA. This level would not likely create annoyance. However, because relocating the residents at ML2 would be done by the PEC applicant and because the following conditions of certification apply only to the SPP project, this analysis cannot require the relocation. It can, however, require that the applicant ensure the project's construction noise levels create less than significant impacts at the noise-sensitive receptors. Thus, staff proposes Conditions of Certification **NOISE-1** and **NOISE-2**, which would establish a noise complaint process to resolve any complaints regarding construction noise. Also, the construction activities will be temporary and use of heavy equipment and noisy activities will be limited to daytime hours. Therefore, this impact will likely create less annoyance than expected.

As seen in **Noise Table 4**, the ambient daytime L_{eq} level at ML3, or 55 dBA, when added to the highest construction noise at this location, or 60 dBA, results in 61 dBA L_{eq}, an increase of 6 dBA over the existing ambient level. This increase is noticeable and can potentially cause annoyance. Staff's proposed Conditions of Certification **NOISE-1**, **NOISE-2**, and **NOISE-7** ensure that the construction noise would not cause annoyance at ML3.

The applicant commits to performing noisy construction work during the daytime hours between 6:00 a.m. and 9:00 p.m. on any day except Saturdays and Sundays, and between 7:00 a.m. and 5:00 p.m. on Saturdays and Sundays (URS 2006a, section 5.12.5.1). This would be in compliance with the noise ordinance of the Fresno County Code (see Condition of Certification **NOISE-7**).

If the applicant complies with the conditions of certification below, the noise impacts of SPP construction activities will comply with the noise LORS and no further construction mitigation measures are necessary. For the evaluation of the impacts from pile driving activities, see below.

California Environmental Quality Act Impacts

As explained above, increases in the ambient noise levels resulting from construction activities would be mitigated to acceptable levels, construction noise is temporary in nature, and construction activities will occur during daytime hours. Staff thus concludes that project construction will create less than significant adverse impacts at these receptors. To ensure this, staff proposes Conditions of Certification NOISE-1 and NOISE-2, which would establish a noise complaint process to resolve any complaints regarding construction noise, and Condition of Certification **NOISE-7**, which would limit construction activities to daytime hours.

Linear Facilities

New offsite linear facilities associated with SPP construction would include approximately 200 feet of gas pipeline and a gas metering set, which will tap into the PG&E gas line, a 300-foot electric transmission line to tie into the PG&E Substation,

and a 1,200-foot underground water pipeline connecting the project to the existing CalPeak plant well (URS 2006a, sections 1.2.3, 1.2.5, 3.4.1, 3.4.4).

Construction of linear facilities typically moves along at a rapid pace, thus not subjecting any one receptor to noise impacts for more than two or three days. Further, the noise ordinance of the Fresno County Code limits the hours of construction to daytime hours. The applicant has committed to complying with this requirement (URS 2006a, section 5.12.5.1). To ensure compliance with these limitations and the remaining applicable restrictions, staff proposes Condition of Certification **NOISE-7**.

Pile Driving

It is anticipated that pile driving will be required for construction of the SPP. The applicant has predicted noise levels from pile driving at the three noise monitoring locations. They are summarized here in **Noise Table 5**.

NOISE Table 5
Predicted Pile Driving Noise Levels

Receptor/Distance	Measured Existing Ambient, Average Daytime L_{eq} (dBA) [1]	Estimated Pile Driving Noise Level (dBA L_{eq}) [2]
ML1/460 feet	63	81
ML2/1,600 feet	46	69
ML3/1,300 feet	55	71

Sources: [1] URS 2006a, Tables 5.12-2, 5.12-3; and staff's calculations
[2] URS 2006a, Table 5.12-6

As seen in this table, the predicted noise level from pile driving could reach 81 dBA L_{eq} at ML1. However, as described above, residents will be moved and no further mitigation will be necessary. To ensure the relocation, staff proposes Condition of Certification **NOISE-5**.

The above **Noise Table 5** shows the estimated pile driving noise levels of 69 dBA L_{eq} and 71 dBA L_{eq} at ML2 and ML3, respectively. These levels are high and can cause annoyance at the above receptors. Therefore, staff recommends that pile driving be performed using a quieter process. Staff has identified several commercially available technologies that reduce pile driving noise by 20 to 40 dBA compared to traditional pile driving techniques. These include padded hammers, "Hush" noise-attenuating enclosures, vibratory drivers, and hydraulic techniques that press the piles into the ground instead of hammering them (Eaton 2000, Gill 1983, Ken-Jet, Kessler & Schomer 1980, NCT, WOMA 1999, Yap 1987). To ensure that pile driving noise will not cause annoyance, staff proposes Conditions of Certification **NOISE-7** and **NOISE-8**.

Vibration

The only construction operation likely to produce vibration that could be perceived off site would be pile driving. ML1 is relatively close to the project site (460 feet) but not close enough to be significantly impacted by vibration. In addition, residents at this location will be moved prior to start of construction. At the distances of 1,600 feet at ML2 and 1,300 feet at ML3, pile driving vibration will be insignificant.

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 (URS 2006a, Table 5.12-4, sections 5.12.2.2, 5.12.2.2.2). 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 SPP during operational activities include the gas turbine generators, gas turbine air inlets, exhaust stacks, air compressors, electrical transformers, selective catalytic reduction duct walls, and various pumps and fans. Staff compares the projected SPP noise with applicable LORS, in this case, the noise ordinance of the Fresno County Code (County 2006b). In addition, staff evaluates any increase in noise levels at sensitive receptors due to the project to identify any significant adverse impacts.

Proposed noise mitigation measures include the following (URS 2006a, section 5.12.5.2; URS 2007b, data response 50):

- noise barriers;
- acoustical enclosures;
- upgraded exhaust stack or air inlet silencers;
- building sound insulation treatments (in conjunction with other methods); and
- power plant operational controls.

In addition, the creation of annoying tonal (pure-tone) noises will be avoided by balancing the noise emissions of various power plant features during plant design.

Compliance with Laws, Ordinances, Regulations, and Standards

The applicant performed noise modeling to determine the project's operational noise impacts on sensitive receptors (URS 2006a, section 5.12.3.4, Table 5.12-8). Project operating noise is predicted to be 55 dBA at monitoring location ML1 (the multiplex north of the project site), 42 dBA at monitoring location ML2 (the residential receptor west of the project site), and 44 dBA at monitoring location ML3 (the single-family residential receptor northeast of the project site).

For residential receptors staff compares nighttime levels, when people are sleeping and more likely to be bothered by excessive noise. As explained above, the noise ordinance of the Fresno County Code (County 2006b) establishes the noise limits shown in **Noise**

Table 2 above. Staff uses the lowest of these limits, or 45 dBA L_{50}, to evaluate the project's noise impact at the above receptors.

The predicted project noise level at ML1, or 55 dBA, when combined with the average ambient noise level of the four quietest consecutive hours of the nighttime at this location, or 44 dBA L_{50} (see **Noise Table 3**), would result in 55 dBA L_{50}. This is 10 dBA above the LORS limit of 45 dBA L_{50} and thus violates county code. As explained above, the applicant has signed an agreement to relocate the current residents to a more distant location (URS 2006a, sections 5.9.3, 5.12.5.1). To ensure that the relocation of these residents will occur and the project noise level at this new location will comply with the LORS, staff proposes Condition of Certification **NOISE-5**. If the applicant relocates the residents to a location within 3,000 feet of the SPP project site, the SPP shall perform a noise monitoring survey during its operation at the new location. Staff chooses the 3,000-foot zone because beyond that distance the power plant would likely be inaudible. If the survey indicates noncompliance with the noise LORS or significant impact at the new location, the SPP shall implement additional mitigation measures in order to bring the noise level into compliance (see Condition of Certification **NOISE-5** below).

The applicant has stated that after the construction and commissioning of the project, the project owner may wish to reevaluate the operational noise impact at ML1 and convert the five-unit multiplex back to a residential use if the project owner can demonstrate compliance with the LORS (URS 2007b, data response 50). To ensure the applicant will comply with the above noise LORS, Condition of Certification **NOISE-5** requires the project owner to conduct a community noise survey at ML1 after the start of operations if it wishes to convert the multiplex back to a residential use. The condition further requires implementing any additional mitigation measures necessary to reduce the noise in order to comply with the LORS and CEQA requirements at ML1.

The predicted project noise level at ML2, or 42 dBA, when combined with the nighttime ambient level of 41 dBA L_{50} (see **Noise Table 3** above), would result in 45 dBA L_{50}, which is in compliance with the LORS limit of 45 dBA L_{50}. The predicted project noise level at ML3, or 44 dBA, when combined with the nighttime ambient level of 41 dBA L_{50} at this location (see **Noise Table 3** above), would result in 46 dBA L_{50}. This is 1 dBA above the LORS limit. A 1 dBA increase is not audible and thus, staff considers the project's operational noise at ML3 to be in compliance with the LORS requirement. To ensure the applicant will comply with the above noise LORS, staff proposes Condition of Certification **NOISE-4**.

Staff concludes that the project operational noise levels at the most sensitive residential receptors will be in compliance with the noise ordinance of the Fresno County Code. To ensure compliance, staff also proposes Conditions of Certification **NOISE-1** and **NOISE-2**.

California Environmental Quality Act Impacts

Power plant noise is unique. A power plant operates essentially as 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 typically 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 remove the impact.

In most cases, a power plant will be intended to operate around the clock for much of the year. Nighttime operation of a peaking power plant such as the SPP, though rare, could occasionally occur, which could annoy nearby residents. For residential receptors, staff evaluates project noise emissions by comparing them to the nighttime ambient background level; this assumes that 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 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 residential receptors (ML1, ML2, and ML3).

Combining the ambient noise level of 42 dBA L_{90} (**Noise Table 3** above) with the project noise level of 55 dBA at ML1 will result in 55 dBA L_{90}, 13 dBA above ambient. As described above (in **Method and Threshold for Determining Significance**), staff considers an increase of more than 10 dBA to be significant. As explained above, the applicant has signed an agreement to relocate the residents at this location. As such, this location will no longer be considered a sensitive receptor. Therefore, staff considers the project operational noise impact at ML1 to be less than significant. To ensure the relocation will occur and the project will not create significant adverse noise impact at the new location, staff proposes Condition of Certification **NOISE-5**.

Combining the ambient noise level of 39 dBA L_{90} (**Noise Table 3** above) with the project noise level of 42 dBA at ML2 will result in 44 dBA L_{90}, 5 dBA above the ambient. Staff typically considers the impact of 5 dBA increase in the ambient noise level to be less than significant.

Combining the ambient noise level of 41 dBA L_{90} (**Noise Table 3** above) with the project noise level of 44 dBA at ML3 will result in 46 dBA L_{90}, 5 dBA above the ambient. This increase is considered less than significant.

Staff thus concludes that project operation will create less than significant adverse impacts at the most noise-sensitive receptors. Staff has considered the minority population (as identified in **Socioeconomics Figure 1**) in its impact analysis and concludes that with the following proposed mitigation measures there are no potential significant adverse impacts, and therefore, there are no environmental justice issues.

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. 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 (URS 2006a, section 5.12.3.3.). To ensure that tonal noises do not cause annoyance, staff proposes Conditions of Certification **NOISE-4** and **NOISE-5**.

Linear Facilities

All water and gas piping will lie underground, and will 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 will thus be inaudible to any receptors (see **Transmission Line Safety And Nuisance** for further discussion).

Vibration

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

The operating components of a simple cycle power plant consist of high-speed gas turbines, compressors, and various pumps. All of these pieces of equipment must be carefully balanced in order to operate; permanent vibration sensors are attached to the turbines and generators. Gas turbine generator facilities using the FT8 machine have not resulted in ground-borne or airborne vibration impacts. Staff believes that the noise-sensitive receptors are not close enough to the project site to be affected by ground-borne vibration from the project equipment.

Airborne vibration (low-frequency noise) can rattle windows and objects on shelves, and can rattle the walls of lightweight structures. The SPP's chief source of airborne vibration would be the gas turbines' exhaust. In a power plant such as the SPP, however, the exhaust must pass through the selective catalytic reduction modules and the stack silencers before it reaches the atmosphere. The SCRs act as efficient mufflers; the combination of SCR units and stack silencers makes it highly unlikely that the SPP 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 (URS 2006a, Table 5.12-4, sections 5.12.2.2, 5.12.2.2.2). 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 hearing protection would be required. To ensure that plant operation and maintenance workers are, in fact, adequately protected, Energy Commission staff has proposed Condition of Certification **NOISE-6**.

CUMULATIVE IMPACTS AND MITIGATION

Section 15130 of the CEQA Guidelines (Cal Code Regs, Title 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.

As described above, the proposed 400 MW PEC would be located west/southwest of the SPP. It would be approximately 1,900 feet from ML1, about 800 feet from ML2, and approximately 3,300 feet from ML3 (PEC 2006a, section 5.12.1.2, Table 5.12-5). The SPP, in combination with the PEC project, will result in increases in the project area ambient noise. **Noise Table 6** below shows estimated noise levels from the individual operations of the two projects and their cumulative noise impacts at these monitoring locations during the nighttime hours.

NOISE Table 6
Cumulative Noise Impact (SPP plus PEC)

Receptor	Measured Ambient During Nighttime Hours, dBA L_{90}	SPP Generated Noise Level, dBA	PEC Generated Noise Level, dBA	Cumulative, dBA L_{90}	Change
ML1	42[1]	55	51	56	+14
ML2	39[2]	42	58	58	+19
ML3	41[2]	44	40	46	+5

Sources: URS 2006a, section 5.12.3.4, Table 5.12-8; PEC 2006a, section 5.12.1.2, Tables 5.12-2, 5.12-3
[1] Staff's calculations of average of four quietest consecutive hours of the nighttime
[2] Results of the hourly measurements between midnight and 2:40 a.m.

As shown in the above table, the cumulative noise would result in a 14 dBA increase in the ambient noise level at ML1. However, as explained above, the current residents at ML1 would be relocated to a new location not near the project site and any necessary noise mitigation measures would be implemented to comply with the above-identified noise LORS. Also, the above cumulative result is based on the assumption that both projects would be operating simultaneously during late night and early morning hours when L_{90} levels are lowest. Both of these are peaker projects and would likely operate mostly during day time. Therefore, it is anticipated that both of the projects would rarely operate simultaneously for long periods of time during nighttime hours. Thus, the above cumulative impact would likely cause less annoyance than expected. To ensure the relocation and compliance with the LORS, staff proposes Condition of Certification **NOISE-5** below.

As shown above, the cumulative noise would result in a 19 dBA increase in the ambient noise level at ML2. However, as explained above, the residents at ML2 would be relocated to approximately 4,000 feet away from the PEC site. At this distance, the cumulative noise level from these two projects would be substantially lower, approximately 45 dBA L_{50} or less (see **Compliance with Laws, Ordinances, Regulations, and Standards** under **Operation Impacts and Mitigation** above). This level of noise is considered tolerable and would not likely create significant impact. Alternatively, if the relocation does not occur, additional mitigation measures would need to be implemented to mitigate the impact to an acceptable level. To ensure compliance, staff proposes Condition of Certification **NOISE-4** below. At ML3, an

increase of 5 dBA would result due to the cumulative impact. This increase is noticeable but it is not likely to create annoyance.

Other projects within the vicinity of the SPP include the CalPeak Power Plant and the Wellhead Peaker Project. These are, however, existing projects and their noise impacts have been measured as part of the above existing ambient noise measurements and therefore included in the above cumulative analysis. Staff is not aware of any other projects that, when combined with the SPP, would create significant direct cumulative noise impacts in the project area.

In light of the above proposed mitigation measures and the following proposed conditions of certification, staff believes that it is unlikely that the SPP, combined with other new noise-producing developments, would produce significant cumulative noise impacts. Staff has considered the minority population in its cumulative impact analysis and concludes that with the following proposed mitigation measures there are no potential significant adverse impacts, and therefore, there are no environmental justice issues.

FACILITY CLOSURE

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

RESPONSE TO AGENCY AND PUBLIC COMMENTS

The County of Fresno submitted the following comment regarding the project noise. "Section 5.12 of the AFC concludes that no impacts from operational noise were identified at locations ML2 and ML3 utilizing CNEL and L_{eq} measurements. However, these do not directly correlate with the exterior noise standards outlined in the Fresno County Ordinance Code 8.40.040 (County 2006c)."

Staff's response:

Staff, in this analysis, compares the project noise at all three monitoring locations to the most stringent noise limit of 45 dBA L_{50}, as outlined in the County Ordinance Code 8.40.040 (see the above analysis). Staff concludes that, in light of the mitigation measures proposed above and the following conditions of certification, the SPP would comply with this noise standard.

CONCLUSIONS

The SPP, if built and operated in conformance with the proposed conditions of certification below, would comply with all applicable noise and vibration laws, ordinances, regulations, and standards, and would produce no significant adverse noise impacts on people within the affected area, either direct or cumulative. Staff has considered the minority population (as identified in **Socioeconomics Figure 1**) in its impact analysis and concludes that with the following proposed mitigation measures there are no potential significant adverse impacts, and therefore, there are no environmental justice issues. The applicant has proposed appropriate mitigation, in the form of good design practice and inclusion of necessary project equipment that would avoid any significant adverse impacts.

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 one mile of the site and one-half mile of the linear facilities, 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. 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 SPP, 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 local jurisdiction and the CPM, documenting the resolution of the complaint. If mitigation is required to resolve a complaint, and the complaint is not resolved within a three-day period, the project owner shall submit an updated noise complaint resolution form when the mitigation is implemented. The owner may present proof of compliance with established and agreed upon noise limits in lieu of implementing additional noise mitigation elements, when appropriate as determined by the CPM.

NOISE-3 The project owner shall submit to the CPM for review and approval a noise control program. 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. 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 plant operation plus ambient, during the four quietest consecutive hours of the nighttime, to exceed an average of 45 dBA L_{50} as measured near monitoring locations ML2 (approximately 1,600 feet west of the center of the project site) should the residents at ML2 not be relocated, and ML3 (43405 West Panoche Road).

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.

- When the project first achieves a sustained output of 90 percent or greater of rated capacity, the project owner shall conduct a short-term nighttime noise survey during every hour of the nighttime hours, from 10 p.m. to 7 a.m. at monitoring location ML3 (or at monitoring location ML2 if the residents at ML2 have not been relocated) or at a closer location acceptable to the CPM. This survey during full load power plant operation shall also include measurement of one-third octave band sound pressure levels to ensure that no new pure-tone noise components have been caused by the project.

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 receptor locations to determine the presence of pure tones or other dominant sources of plant noise.

- If the results from the above noise survey indicate that the power plant noise level plus ambient (L_{50}) at the affected receptor site(s) exceeds the above value during the above specified time periods, mitigation measures shall be implemented to reduce noise to a level of compliance with this limit.

- 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 90 percent 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 this new noise survey, performed as described above and showing compliance with this condition.

NOISE-5 Prior to ground disturbance, in order to implement the agreement between the project owner and the landowner of the property at ML1, dated November 6, 2006, the project owner shall relocate the residents on this property to a location not near the project site. 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 plant operation plus ambient, during the four quietest consecutive hours of the nighttime, to exceed an average of 45 dBA L_{50} as measured near this new location.

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.

- If the new location is within 3,000 feet of the project site, when the project first achieves a sustained output of 90 percent or greater of rated capacity, the project owner shall conduct a short-term survey of noise at this new location or at a closer location acceptable to the CPM. The short-term noise measurements shall be conducted during every hour of the nighttime hours, from 10 p.m. to 7 a.m., during the period of the survey.

- If during the operating life of the project, the project owner plans to convert the five-unit multiplex at ML1 back to a residential use, the project owner shall repeat this survey at ML1 or at a closer location acceptable to the CPM, prior to any resident(s) occupying the multiplex.
- 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 receptor locations to determine the presence of pure tones or other dominant sources of plant noise.
- If the results from any of the above noise surveys indicate that the power plant noise level plus ambient (L_{50}) at the affected receptor sites exceeds the above value during the above specified time period, mitigation measures shall be implemented to reduce noise to a level of compliance with this limit. ML1 shall not be reoccupied (as explained above), unless the SPP can demonstrate compliance with this requirement at this location.
- If the results from the noise surveys indicate that pure tones are present, mitigation measures shall be implemented to eliminate the pure tones.

Verification: Prior to ground disturbance, the project owner shall transmit to the CPM a statement, signed by the project owner's project manager, stating that the residents in the property at ML1 have been relocated, and describing the new location and its distance to the project site.

The first noise survey shall take place within 30 days of the project first achieving a sustained output of 90 percent or greater of rated capacity. If the second survey is needed (as described above) it shall take place prior to the property at ML1 being reoccupied. Within 15 days after completing each of the surveys, 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 (conducted after implementation of the above mitigation measures), the project owner shall submit to the CPM a summary report of this new noise survey, performed as described above and showing compliance with this condition.

NOISE-6 Following the project first achieving a sustained output of 90 percent 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

(Article 105) 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-7 Heavy equipment operation and noisy construction work relating to any project features (including pile driving work) shall be restricted to the times delineated below, unless a special permit has been issued by the County of Fresno:

Any day except Saturdays and Sundays	6 a.m. to 9 p.m.
Saturdays and Sundays	7 a.m. to 5 p.m.

Haul trucks and other engine-powered equipment shall be equipped with adequate mufflers. 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.

PILE DRIVING MANAGEMENT

NOISE-8 The project owner shall perform pile driving using a quieter process than the traditional pile driving techniques to ensure that noise from these operations does not cause annoyance at monitoring locations ML2 (if the residents at ML2 have not been relocated) and ML3.

Verification: At least 30 days prior to first pile driving, the project owner shall submit to the CPM a description of the pile driving technique to be employed, including calculations showing its projected noise impacts at monitoring locations ML2 (if the residents at ML2 have not been relocated) and ML3.

EXHIBIT 1 - NOISE COMPLAINT RESOLUTION FORM

Starwood Power Project (06-AFC-10)

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

County 2006a. Fresno County, California. Noise Element of the Fresno County General Plan.

County 2006b. Fresno County, California. Noise Ordinance of the Fresno County Code, Chapter 8.40.

County 2006c. Fresno County, California (tn 38769). Starwood Midway-Power AFC Comments. 12/14/2006 Rec'd 12/22/2006.

Eaton, Stuart, 2000. Construction Noise. Engineering Section Report, Worker's Compensation Board of BC, Vancouver, BC, Canada. p 8.

Gill, Harjodh S. 1983. Control of Impact Pile Driving Noise and Study of Alternative Techniques. Noise Control Engineering Journal pp. 76-83.

Ken-Jet. Still Worker, Mississauga, Ont., Canada; www.ken-jet.com

Kessler, FM and PD Schomer. 1980. Pile Driver Noise Control. Inter-Noise 80 Proceedings, Volume I, pp. 321-324. Miami, FL, pp. 8-10.

NCT (Noise Control Technologies). Pile Shields for Pile Drivers & Vibratory Hammers. Miami, FL. www.noisecontroltechnologies.com

PEC 2006a – Application for Certification for Panoche Energy Center Project. Submitted to the California Energy Commission on August 2, 2006.

PEC 2007d – Data Responses Round 2 for Panoche Energy Center Project. Submitted to the California Energy Commission on March 1, 2007.

URS 2006a. URS Corporation/ R. Watkins (tn 38405). Application for Certification with Cover Letter for Starwood Power-Midway, LLC Peaking Project. 11/17/2006 Rec'd 11/17/2006.

URS 2007b. URS Corporation/ A. Leiba (tn 39567). Starwood responses to data requests (#1-67). 03/09/2007 Rec'd 03/12/2007.

WOMA News. 1999. Waterjet Assisted Pile Driving. WOMA Apparatebau GmbH. www.woma.de

Yap, KT. 1987. Control of Pile Driving Noise. Inter-Noise 87 Proceedings, Volume I, pp. 167-170. Beijing, China, September 15-17.

NOISE APPENDIX A
FUNDAMENTAL CONCEPTS OF COMMUNITY NOISE

To describe noise environments and to assess impacts on noise sensitive areas, 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 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} (day-night) 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 metropolitan 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, these noise levels 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 that 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. At 70 dBA, sleep interference becomes considerable (US Environmental Protection Agency, 1971, Effects of Noise on People).

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

Noise 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 document 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 (often used for an existing or pre-project noise condition for comparison study).
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 an individual sound that stands out in sound quality. It 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 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 Table A2
Typical Environmental and Industry Sound Levels

Noise Source (at distance)	A-Weighted Sound Level in Decibels (dBA)	Noise Environment Producing Similar Level	Subjective Impression
Civil Defense Siren (at 100')	140-130		Pain threshold
Jet take-off (at 200')	120		Very loud
Very loud music	110	Rock music concert	
Pile driver (at 50')	100		
Ambulance siren (at 100')	90	Boiler room	
Train (at 50')	85		
Pneumatic drill (at 50')	80	Printing press Kitchen with garbage disposal running	Loud
Freeway traffic (at 100')	70		Moderately loud
Vacuum cleaner (at 100')	60	Data-processing center Department store Office	
Light traffic (at 100')	50	Private business office	
Large transformer (at 200')	40		Quiet
Soft whisper (at 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 that one has become accustomed with the level of the new noise. In general, the more the level or 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.

- Except under special conditions, a change in sound level of one dB cannot be perceived.
- Outside of the laboratory, a three dB change is considered a barely noticeable difference.
- A change in level of at least five dB is required before any noticeable change in community response would be expected.
- A 10 dB change is subjectively heard as an approximate doubling in loudness and almost always causes an adverse community response. (Kryter, Karl D., 1970, The Effects of Noise on Man)

Combination of Sound Levels

People perceive both the level and frequency of sound in a nonlinear 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 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. These levels are listed in the table below.

Noise 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 CFR § 1910.

[Insert NOISE Figure 1] Use AFC, Figure 5.9-2

[Insert NOISE Figure 2] Use AFC, Figure 5.12-1