THE COSO GEOTHERMAL ENVIRONMENTAL OVERVIEW STUDY

NOISE EFFECTS

MASTER

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INTRODUCTION

The development and utilization of geothermal energy resources, like many other industrial operations, can be a source of unwanted sound. Geothermal industry noise emissions have become a significant environmental issue at The Geysers-Calistoga Known Geothermal Resource Area in northern California (9). In this KGRA, major geothermal development projects have been constructed or proposed in proximity to a number of small residential communities. Some local residents who have chosen The Geysers area for its recreational and retirement values object to increased noise levels resulting from the truck traffic, the drilling of geothermal wells, and the venting of large quantities of superheated steam.

Therefore, it is important to evaluate the potential for environmental noise problems prior to large-scale geothermal development at the Coso KGRA. This chapter will identify key issues relating to noise effects. It will describe existing data that may be useful in resolving these issues: ambient noise conditions within the region, geothermal noise sources to be expected, types of sensitive noise receptors, and any applicable regulations or standards. Finally, it will outline the additional information needed to help ensure that geothermal development can proceed without creating unacceptable noise impacts.

KEY ISSUES

The development and utilization of vapor-dominated geothermal resource areas such as The Geysers field is likely to be accompanied by high noise levels from steam releases (19). Noise emissions are expected to be of

only moderate intensity in liquid-dominated fields because of the absence of unmuffled steam venting (11). Since the nature of the geothermal resource at the Coso KGRA has not yet been defined, the types of noise sources and the levels of noise emissions cannot be accurately predicted. Nevertheless, noise should not be a serious problem because very few people would be affected and the most promising areas for exploration are remote from most noise-sensitive receptor sites. The following issues have been identified:

1. What noise levels are likely to be associated with the various stages of the geothermal development process in the Coso KGRA?
2. What will be the effects on local communities and sensitive land-uses?
3. What will be the effects on wildlife and domestic animals?
4. Are new noise regulations or special noise control technologies required?

EXISTING DATA BASE

The information needed in order to adequately address these issues includes quantitative data on geothermal noise sources and baseline noise conditions, the locations of proposed facilities and existing receptors, and noise propagation models appropriate to the terrain and meteorological properties of the area. With these data, it is possible to predict the impacts that geothermal projects will have on the noise environment at particular receptor sites and to make recommendations for such noise control measures and other mitigations as may be required.

Geothermal Noise Sources

Although no published noise information is available for geothermal industry operations in the Coso area, extensive studies of noise emissions have been carried out at The Geysers-Calistoga KGRA in northern California (1, 2, 3, 4, 5, 6, 12). Wells drilled into the vapor-dominated reservoir at The Geysers produce superheated steam at high pressure. The jet noise that results when there is large-scale venting to atmosphere has been the source of the majority of community complaints (8, 9). Sound pressure levels (SPL) over 120 dB(A) have been recorded at 15.2 m (50 ft) from well-venting operations and the noise can be heard at distances of 3.2 - 4.8 km (2-3 mi) (8, 13). Noise abatement measures have been successful in reducing the frequency of venting episodes and in effectively silencing certain venting procedures, but additional work is needed to bring all sources under acceptable control (9, 19).

If the geothermal reservoirs at the Coso KGRA are of the liquid-dominated type, no unmuffled venting of superheated steam should occur. Wells could be completely shut-in when not producing, eliminating the need to release geothermal fluid. Furthermore, no venting should be necessary when wells are put back into production. Liquid-dominated geothermal fields can therefore be developed and operated without the problem of very high noise emissions. Major noise sources should not exceed 95 dB(A) at 15.2 m (50 ft) and standard noise control measures are available for these sources if required.

A summary of noise sources expected to accompany geothermal resource development in the Coso area is given below, along with typical SPL ranges.

1. Road and Site Preparation. -- Especially during the exploration and field development stages, heavy earth-moving equipment is used to prepare roads, drill pads, sumps, and sites for power plants and other facilities. Data from the EPA document PB 206 717 suggest a SPL range of 70-95 dB(A) at 15.2 m (50 ft) (15).
2. Well Drilling. -- Drilling operations begin with exploration and continue through the field development stage. In addition, make-up wells must be drilled periodically during the production stage to replace original wells whose yield has declined. The dominant noise sources associated with drilling are the large diesel engines which power the rotary rig and mud pumps. Typical SPL during drilling when mud is used as the circulating medium ranges from 75 to 85 dB(A) at 15.2 m (50 ft) (19).

Compressed air is routinely used as a circulation medium in the final phase of drilling at The Geysers; the large compressors and the release of the air to atmosphere can be troublesome noise sources with SPL up to 5 dB(A) above that recorded for mud drilling (19). Unless a vapor-dominated reservoir is discovered in the Coso KGRA, compressed air drilling will probably not be used.

3. Production Testing. -- The process of flowing geothermal wells to test production capability begins in the exploration stage and will occur periodically for the life of the field as new make-up wells are drilled. Data from Imperial Valley in California suggest that in liquid-dominated fields SPL during this operation should be below 90 dB(A) at 15.2 m (50 ft) (P. Leitner, unpubl. data).
4. Facilities Construction. -- Construction of a power plant, pipelines, and transmission lines involves the use of many standard pieces of heavy motorized equipment. The resulting SPL can be estimated at 70-95 dB(A) at 15.2 m (50 ft) by reference to the EPA document PB 206 717 (15).
5. Operation of Geothermal Field and Power Plant. -- The noise emission characteristics of geothermal power plants, including turbine building, cooling tower, and steam jet ejector system, are well-documented and adequate data are readily available. SPL of 75-85 dB(A) are typical at 15.2 m (50 ft) from the cooling tower, the dominant noise source (4, 10). Other potential noise sources are the flash units in which a portion of the geothermal fluid is allowed to flash to steam. These units may be located at the wellheads or near the turbine building, although the exact design will depend on the electric generation

technology used. SPL at 15.2 m (50 ft) from a flash unit undergoing testing in Imperial Valley was measured at 85 dB(A) (P. Leitner, unpubl. data). Any downhole pumps required to produce the geothermal fluid and reinjection pumps used to dispose of residual liquids should be powered by electric motors; these motors are not expected to be significant noise sources.

6. Vehicular Traffic. -- Auto and truck traffic is an important source of noise throughout the life of any geothermal project, with maximum SPL ranging from 70-95 dB(A) at 15.2 m (50 ft) depending on the type of vehicle (16).

Existing Noise Environment

The Coso KGRA is very sparsely populated and most of the land is administered by public agencies. The entire eastern portion of the KGRA lies within the China Lake Naval Weapons Center, much of it on public lands withdrawn since 1947 for military weapons testing. No permanent human habitations exist in this region. The western portion of the KGRA includes public lands administered by the Bureau of Land Management, as well as property owned by the Los Angeles Department of Water and Power. No towns exist within the KGRA, although a few scattered ranches are located in the Rose Valley area. The major land uses are livestock grazing and military operations, with some irrigated farming in Rose Valley.

The ambient noise environment of the Coso KGRA is generally quiet, typical of rural and open space areas. Existing background SPL has been estimated at 35 to 45 dB(A) or lower over most of the area (18). Natural noise sources include animals, wind, and occasional summer thunderstorms. Low-level flights by high-performance military jet aircraft may occur several times a day over any part of the KGRA. Sound pressure levels associated with these operations can range from 90 to 105 dB(A), depending on the type

of aircraft and the power setting (18). Military helicopters, as well as commercial and private aircraft, also overfly the KGRA from time to time. U.S. Route 395, the main Reno-Los Angeles highway, crosses the western portion of the KGRA on a north-south alignment. It is heavily travelled during most of the year, but especially on weekends in the winter sports season and during the summer vacation period. There is occasional activity on the Southern Pacific Railroad which parallels U.S. Route 395 through Rose Valley. Mining operations, including cinder extraction at Red Hill and pumice mines in the mountains northeast of Coso Junction, are another source of environmental noise. Farm machinery is used from time to time in the northern part of Rose Valley.

Quantitative data on existing noise conditions are very limited. The California Department of Transportation has measured highway noise at Dunsmuir Hill on U.S. Route 395. Traffic noise at various distances from a roadway can also be estimated by a graphic method that relates the number of vehicles past a given point, percent of trucks, and traffic speed. Ambient noise monitoring has been carried out recently for a two week period at the Rose Valley Ranch and in the valley east of Coso Hot Springs. Sound pressure levels in dB(A) were recorded continuously and the data will be presented as hourly averages in the Environmental Statement on geothermal leasing now being prepared for the Bureau of Land Management by Rockwell International (Patricia Casey, personal communication).

Noise Receptor Sites

Residences, schools, and health care facilities are particularly sensitive to noise intrusion and require special consideration in the planning of any industrial project that may be a significant source of noise. There are no schools or hospitals in or near the Coso KGRA and only a few scattered

ranch houses in Rose Valley near U. S. Route 395. The Owens Valley Band of Paiute-Shoshone Indians have indicated that noise intrusion would be inappropriate at the Coso Hot Springs and the nearby Prayer Site when these places are being used in traditional religious ceremonies (18). The only other sensitive noise receptor sites in the KGRA might be certain wildlife habitat features such as raptor nesting cliffs, waterfowl concentration areas, and water sources.

Noise Propagation Models

Once noise sources have been identified and characterized and the location of sensitive receptors has been determined, an adequate noise propagation model will allow accurate prediction of SPL and frequency spectra at the receptor. Methods that are currently in use at The Geysers-Calistoga KGRA in northern California seem to give reasonable results and can probably be adapted for use in the Coso KGRA (4, 10, 13). These field-tested noise propagation models indicate that an attenuation of at least 40 dB can be expected over a distance of 0.8 km (0.5 mi). This suggests that the loudest geothermal noise sources expected with the development of a liquid-dominated reservoir would be attenuated to about 55 dB(A) at that distance.

Noise Criteria and Standards

Community Noise

The so-called "Levels Document" published by the EPA identifies environmental noise levels which, according to the best available scientific studies, appear to protect against community annoyance and activity interference (17). The criterion proposed in this document for residential areas, schools, and hospitals is an outdoor day-night equivalent sound level

(L_{dn})^{*} of 55 dB. This level provides useful guidance in judging the acceptability of noise intrusion, but in no way represents a Federal standard. The document does not consider the economic or technological feasibility of attaining such a level, nor does it consider local needs and attitudes. For example, this criterion may not be adequate in some rural areas because of low existing ambient noise levels. Under these conditions, geothermal industry operations may be audible at considerable distances and could lead to annoyance even at noise levels well below an L_{dn} of 55 dB.

Regulatory authority over community noise levels is delegated to local government jurisdictions by the State of California. A Noise Element must be included in the General Plan for each county. This document provides the basis for local programs to control environmental noise. It does not set standards, but rather describes existing noise conditions, develops criteria for noise-compatible land-use planning, and outlines techniques for achieving an acceptable noise environment. A General Plan Noise Element for Inyo County is currently being prepared, but there is no county noise ordinance.

The only published environmental noise criterion which would specifically apply to geothermal industry operations is that contained in the U.S.G.S. Geothermal Resources Operational Order No. 4 (14). This document states that geothermal-related activities on Federal leases shall not exceed a noise level of 65 dB(A) at the lease boundary or at 0.8 km (0.5 mi) from the source, whichever is greatest. No such criteria exist for geothermal operations on land leased from the State or from private owners.

^{*} L_{dn} , day-night equivalent sound level, is the 24-hour A-weighted sound level that contains the same total acoustic energy as the actual time-varying sound, with a 10 dB penalty applied to the levels from 10:00 p.m. to 7:00 a.m.

Domestic Livestock and Wildlife

There are no generally accepted criteria which would apply to the prevention of adverse noise effects on animals. It must be assumed, in the absence of definitive studies, that application of the criteria suggested for humans in the EPA "Levels Document" will serve to protect animals against behavioral disruption and physiological damage from noise (17).

RECOMMENDATIONS

In general, adequate information is available to assess the potential for environmental noise impacts from geothermal resource development in the Coso KGRA. Although it does not appear that noise will be a significant problem, additional data of certain kinds would be very useful in future impact analyses.

Source Term Measurements

Sound pressure levels and frequency spectra are not available for some geothermal operations that may be important noise sources. These activities include (1) test flowing of full-scale fluid production from individual wells and (2) the operation of flash units at the wellhead or near the power plant to separate steam from residual hot water. Noise emissions data for these processes will probably become available in the near future as a result of field measurements at geothermal facilities in the Imperial Valley and at Roosevelt Hot Springs in Utah.

Ambient Noise Measurements

Existing environmental noise conditions should be documented prior to development at all sites where commercial use of geothermal resources is

proposed. Measurements should be made in general conformance with the guidelines of the Geothermal Environmental Advisory Panel (7). Sampling would normally be carried out at key locations within the geothermal leasehold unit, at its boundaries, and at nearby receptor sites; a map of these monitoring locations would be prepared. It is desirable to measure both A-weighted and C-weighted SPL. The results should be expressed as equivalent SPL (L_{eq})*, as day/night equivalent SPL (L_{dn}), and as the statistical descriptors L_{10} , L_{50} , and L_{90} ** . In addition, a description of existing noise sources at each monitoring location should be provided.

Noise Receptor Sites

A map should be prepared that shows the location of sensitive noise receptors in the vicinity of a proposed geothermal development area. These receptor sites should include:

1. Residences
2. Native American Cultural Areas
3. Sensitive Wildlife Areas

The mapping effort should be extended up to two miles beyond the sites of proposed geothermal development activities.

Noise Criteria and Standards

Noise emissions are expected to be of moderate intensity during the development and operation of geothermal facilities in the Coso KGRA. There should be little difficulty in meeting the standard of 65 dB(A) at 0.8 km

* L_{eq} , equivalent sound level, is the constant A-weighted sound level that, for a given period, contains the same total acoustic energy as the actual time-varying sound.

** L_{10} , L_{50} , L_{90} are the A-weighted sound levels that are equaled or exceeded 10, 50, and 90 percent of the time, respectively.

(0.5 mi) from the source set by the U.S. Geological Survey (14). However, because of the low ambient noise levels, geothermal noise might sometimes be audible at distances of 3.2 - 4.8 km (2-3 mi). If sensitive receptors or land-uses exist within 3.2 - 4.8 km of a project site, it would be well to consider the need for a noise standard lower than 65 dB(A) or even below an L_{dn} of 55 to avoid annoyance and activity interference. In most cases, a careful analysis of the expected source levels and available noise control strategies should indicate economically feasible ways of avoiding significant impacts.

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