MASTER

AN OVERVIEW OF THE MONO-LONG VALLEY KNOWN GEOTHERMAL RESOURCE AREA

NOISE EFFECTS

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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 (10). 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 Mono-Long Valley 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

It seems likely that noise emissions in the Mono-Long Valley KGRA will be of moderate intensity compared to those experienced during development and operation of the vapor-dominated geothermal field at The Geysers. Nevertheless, the existing quiet ambient conditions, the lack of other industrial noise sources, and the sensitivity of many visitors and residents to changes that might detract from the natural setting suggest that potential noise effects should receive serious consideration. 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 Mono-Long Valley 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, characterization of ambient 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 very little published noise information is available for geothermal industry operations in the Mono-Long Valley area, extensive studies of noise emissions have been carried out at The Geysers-Calistoga KGRA in northern California (1, 2, 3, 4, 5, 6, 13). Wells drilled into the vapor-dominated reservoir at The Geysers produce superheated steam at high pressure. The jet noise which results when there is large-scale venting to atmosphere has been the source of the majority of community complaints (9, 10). 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) (9, 14). 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 (10, 21).

Because the geothermal reservoirs at the Mono-Long Valley KGRA are most probably of the liquid-dominated type, no 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 Mono-Long Valley 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 the power plant 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) (18).
2. Well Drilling. -- Drilling operations begin with exploration and continue through the field development stage. Make-up wells must be drilled periodically during the production stage to replace the 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) (21). SPL of about 62 dB(A) was measured at 182.4 m (200 yd) from a large rotary drill rig in Long Valley (7).

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 (21). Since this procedure is not extensively used in liquid-dominated reservoirs, it should not be of concern in the Mono-Long Valley KGRA.

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 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 (18). Construction of facilities for direct heat applications should result in similar levels of noise emissions.
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, 11). 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). 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 (19).

Ambient Noise Environment

The Mono-Long Valley region is sparsely populated and much of the land is administered by public agencies such as the U.S. Forest Service, Bureau of Land Management, and Los Angeles Department of Water & Power. Major land uses are live-stock grazing, timber production, watershed, and outdoor recreation. The only community of any size within the KGRA is Mammoth Lakes Village, with a permanent population of about 3,000 that can rise to 20,000 or more during the ski season.

In general, the ambient noise environment appears to be quiet, typical of rural and open space areas. Natural noise sources include animals, wind, and occasional summer thunderstorms (22). The most significant man-made noise is associated with transportation corridors (15). U. S. Route 395, the main Reno-Los Angeles highway, traverses the Mono-Long Valley KGRA on a north-south alignment. It is heavily traveled during the winter sports season and in the summer as well. State Route 120 carries traffic to and from Yosemite National Park and central California in the summer. A major transcontinental airline route crosses the region, while Mammoth Airport is used by both general aviation and small commercial carriers operating turbo-prop and jet aircraft. Machinery used in logging, mining, and ranching operations is sometimes audible in various localities. Recreational activities are sometimes accompanied by vehicular noise sources such as motorcycles, snowmobiles, and motor-boats (15). No industrial noise sources of any significance currently exist in the region.

Quantitative data on ambient noise conditions are very limited. The U. S. Geological Survey Environmental Analysis for an exploratory geothermal drilling project stated that ambient SPL in the lease area (approximately 6.4 km or 4 mi. northeast of the Mammoth Airport) were well below 50 dB(A) in the absence of human activity (17). Measurements carried out at the same site just prior to the

drilling operation yielded SPL of approximately 30 dB(A) (7). Noise from aircraft approaching or leaving the Mammoth Airport was audible during the time that these measurements were taken. The highest instantaneous SPL recorded was 48 dB(A) when a jet aircraft was in the area.

The California Department of Transportation has measured highway noise at several points along U.S. Route 395: Mammoth Airport, June Lake Junction, and Crestview. Traffic noise at various distances from a roadway can also be estimated by a graphic method which relates the number of vehicles per hour past a given point, percent of trucks, and traffic speed.

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 which may be a significant source of noise. In the Mono-Long Valley KGRA such receptors are concentrated at Mammoth Lakes Village and Lee Vining. Some other residences are scattered along U.S. Route 395 and on short side roads. In addition, a few isolated ranch houses are located near the Owens River. Recreation sites such as camp grounds and ski areas may be considered sensitive to geothermal noise. Designated wilderness areas should also be protected from noise intrusion. Finally, certain kinds of wildlife habitat such as sage grouse strutting grounds, raptor nest, trees or cliffs, waterfowl breeding areas, and game migration routes may fall into the sensitive noise receptor category.

The locations of most receptor sites in the KGRA are well-known and could be readily plotted on a map for convenient reference. However, it is possible that not all of the sensitive wildlife areas have been discovered and accurately located. In any case, no maps of noise receptors are available for the region.

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 which are currently in use at The Geysers-Calistoga KGRA in northern California seem to give reasonable results and can be adapted for use in the Mono-Long Valley area (4, 11, 14). 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 would be attenuated to about 55 dB(A) at that distance.

However, winter meteorological conditions in the Mono-Long Valley KGRA may have to receive special consideration in the prediction of SPL at receptors. Shallow temperature inversions are common during clear cold weather and sound could propagate longer distances than expected by refraction from these inversion layers (12).

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 (20). 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

* 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.

criterion may not be adequate in the Mono-Long Valley area because of the low existing ambient noise levels. 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. Mono County has not yet adopted a General Plan Noise Element and 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 (16). 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.

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 (20).

RECOMMENDATIONS

In general, adequate information is available to assess the potential for environmental noise impacts from geothermal resource development in the Mono-Long Valley 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 (8). 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

* 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.

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. Hospitals
3. Schools
4. Recreation Sites
5. Wilderness Areas
6. 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 Mono-Long Valley KGRA. There should be little difficulty in meeting the standard of 65 dB(A) at 0.8 km (0.5 mi) from the source set by the U.S. Geological Survey (16). However, because of the low ambient noise levels and occasional winter temperature inversions, 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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