U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION REPORT 77-121-490
PACIFIC GAS AND ELECTRIC COMPANY GEYSERS POWER PLANT
HEALDSBURG, CALIFORNIA

MAY 1978

I. TOXICITY DETERMINATION

It has been determined at the Pacific Gas and Electric Company Geysers Power Plant, Healdsburg, California, that:

1) Employees working in and around Unit #11 where the hydrogen sulfide (H_2S) abatement system is in operation, can develop dermatitis and/or pharyngitis unless proper work practices are followed.

2) The toxic agent(s) which are responsible for the dermatitis and upper respiratory problems are probably contained in the H_2S abatement system sludge, but the specific substance(s) has not been identified.

3) The H_2S gas exposure at the Geysers does not seem to present an occupational health problem to the workers.

The above determinations and conclusions were made concerning the incidences of occupational illnesses at the Geysers Power Plant. More detailed information is contained in the body of the report. Recommendations are included in Section V of this report.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available upon request from the National Institute for Occupational Safety and Health (NIOSH), Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from the NIOSH Publications Office at the Cincinnati address.

Copies of this report have been sent to:

(a) Pacific Gas and Electric Company, San Francisco, California

(b) U.S. Department of Labor, Region IX

(c) CAL/OSHA

(d) NIOSH, Region IX

(e) Authorized Representative of Employees - International Brotherhood of Electrical Workers

For the purpose of informing the approximate 30 affected employees, the employer will post the report in a prominent place(s) accessible to the employees for a period of 30 calendar days.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health (NIOSH) received such a request from Local #1245 of the International Brotherhood of Electrical Workers, Walnut Creek, California, to determine the causes of dermatitis and upper respiratory problems at the Pacific Gas and Electric (PG&E) Geysers facility near Healdsburg, California, and whether the alleged illnesses were related to hydrogen sulfide gas exposure.

IV. HEALTH HAZARD EVALUATION

A. Description of Plant Process

On November 2, 1977, an initial visit to the PG&E Company's geothermal power plant was made by NIOSH representative Melvin T. Okawa. The Geysers Power Plant is a unique process where geothermal energy is converted to electrical power. It is currently the only geothermal plant in the United States and is the largest in the world. Expansion is continuing at the Geysers, and the current capacity of 500 megawatts is enough power to provide service for a city of one-half million people. In a geothermal field, natural gases and water vapor evolving from the cooling of the earth's core heat the near surface water which produces steam. The steam escapes into the atmosphere via hot springs or fumaroles. By sinking wells and capturing this steam, the Union Oil Corporation is able to produce a commodity which can be used by PG&E. Thus, PG&E only purchases the steam for its power plants and does not conduct any drilling operations.

The steam is piped into one of the power plants (units) where it is used to turn the blades of a turbine. After the steam passes through the turbine, it flows to a condenser which converts it to hot water. The hot

water is piped to a cooling tower where the surplus cool water is returned to the Union Oil Corporation where it is reinjected into the steam-producing reservoir. Non-condensable gases are carried along with the hot water into the cooling tower. These gases include hydrogen sulfide (H_2S), carbon dioxide, and ammonia. From an occupational health standpoint, only the H_2S seems to present a potential air contaminant problem in this system because of its relatively high concentration. Extremely low levels of carbon dioxide and ammonia have been measured by PG&E's environmental group, and these substances do not appear to be a problem.

As part of the H_2S air pollution abatement program, a process designed to remove H_2S from air vented to the environment from the cooling towers was built and tested at Unit #11. The process used an iron catalyst to oxidize H_2S to elemental sulfur and water. The sulfur is part of the precipitated sludge which also contains other substances. The sludge is approximately 63% elemental sulfur, 19% iron, and 17% oxygen and hydrogen. The remaining one percent of the sludge contains over 20 minerals and metals in trace quantities. Some of these trace elements have been known to cause dermatitis under the right exposure conditions. Although it has not been quantified, some sulfuric acid is apparently present in the sludge at Unit #11. During 1976, the sludge was removed by hand from sludge pots, and workers were experiencing dermatitis and upper respiratory tract problems. However, because of these episodes, the sludge disposal was modified into a more automated process. Outside contractors now pump the sludge out by mechanical means and there is very little direct contact by PG&E employees with the sludge. The sludge sand filter banks are now backwashed, and the sand no longer has to be changed. Additionally, stricter protective measures became mandatory whenever sludge is handled or when workers enter the ferric sulfate room at Unit #11. Full raingear, goggles, and respirators became mandatory. Barrier creams were utilized and a shower was constructed in the area. Because of these changes, the number of cases of dermatitis and upper respiratory problems dropped dramtically.

B. Evaluation Methods

1. Environmental

The environmental evaluation was limited to surveying the work practices of employees, reviewing the data from numerous PG&E studies at the Geysers, and evaluating the hydrogen sulfide monitoring program. Direct reading instruments were used to measure H_2S levels around the cooling towers.

2. Medical

The medical evaluation consisted of a team of NIOSH physicians reviewing company medical records of affected employees and interviewing some of the workers at the Geysers. Also, all toxicological work completed by PG&E on substances found at the Geysers was reviewed by the physicians.

C. Evaluation Criteria (Environmental)

The only evaluation criteria used for the purposes of this investigation were the NIOSH recommended ceiling limit of 15 milligrams of hydrogen sulfide per cubic meter of air (approximately 10 parts per million)[1] and the CAL/OSHA standard for H_2S. The latter standard limits exposure to H_2S at 10 ppm based on a time-weighted average over a work shift. The CAL/OSHA standard also allows a 10-minute (per any eight-hour exposure) excursion between 20-50 ppm, with no exposure to exceed 50 ppm.

D. Evaluation Results and Discussion

1. Hydrogen Sulfide

The H_2S control program was surveyed on November 2, 1977, at Units #5 and #6. In general, the program is adequate to protect workers from H_2S exposures at the CAL/OSHA standard. Certain power plant areas may have H_2S concentrations at or above the CAL/OSHA standard since levels will fluctuate, and entry permits are required. These areas are the cooling tower decks, cooling tower cells, near barometric condensers, and on top of some of the power plant roofs. Prior to entering one of these areas, an employee must test a Bacharach personnel H_2S monitor with a cylinder of H_2S test gas, obtain the permit, and wear the monitor. The monitors have been set to sound an alarm at 10 ppm of H_2S. If the alarm sounds, the employee must evacuate the area immediately. Also, spot readings are taken with direct reading instruments.

In 1976, a concerted effort was made by the PG&E industrial hygiene group to document H_2S levels in the above areas. The vast majority of H_2S readings were below 10 ppm. The highest levels found were between 15-20 ppm. Several readings were taken by NIOSH on November 2, 1977, in various spots on the cooling tower deck of Units #5 and #6 using Draeger length-of-stain indicator tubes and an Ecolyzer Model 2000 H_2S direct reading instrument. The H_2S concentration ranged between 0-4 ppm using the Ecolyzer, but the Draeger tubes did not register (minimum detection level is less than 5.0 ppm). Thus, the H_2S levels were well below 10 ppm although concentrations can fluctuate rapidly. The NIOSH recommended limit calls for a 10 ppm ceiling concentration, and the procedures used at the Geysers seemed to afford workers the necessary protection. The only question

that arose was whether the Bacharach monitors would continue to send an alarm at 10 ppm. The H_2S test gas is rated at 25 ppm, and the alarm will sound at H_2S concentrations somewhere between 10 and 25 ppm using the standard test procedure employed at the Geysers. It was recommended in November by NIOSH that a periodic check and servicing program for the monitors by PG&E was desirable to insure that the alarms would sound at 10 ppm. Since that time, the test gas has been reduced to 15 ppm which would more accurately test the 10 ppm alarm.

2. Sludge

As noted previously, the make-up of the sludge was analyzed by Battelle Pacific Northwest Laboratories and by PG&E's engineering research group. The major components of the sludge were elemental sulfur, iron, and oxygen and hydrogen in the form of ferric hydroxide. There were also trace amounts of over 20 other substances including chromium, copper, nickel, arsenic, and sulfuric acid. Some of these substances in the right amounts, combinations, or conditions may result in dermatitis. Samples of the sludge were also sent to a private toxicology laboratory in San Francisco by PG&E where the researchers concluded that the sludge was minimally irritating to the skin and did not produce sensitization. Because of the numbers of substances present in trace quantities, it is difficult to pinpoint one or more compound as being the cause of the skin rashes among the employees.

3. Medical Evaluation

In 1976, as stated previously, employees belonging to a division of PG&E known as "General Construction" began to complain of skin rashes and sore throats while working on Geysers Unit #11. Most of the cases appeared to be related to work requiring the hand-cleaning of the sand filtration system that was part of the H_2S air pollution abatement process. Since the initial episode, the process has been automated, and no longer requires direct worker contact with the filtration system. In 1977, there was only one case of dermatitis reported and several cases of pharyngitis. In 1978, there have been two problems of dermatitis and/or pharyngitis.

On February 22, 1978, Drs. Thomas H. Milby and Donald Whorton, physicians under contract to NIOSH, and Mr. Melvin Okawa met with PG&E representatives to continue NIOSH's evaluation of the Geysers request. The NIOSH representatives were informed that PG&E has no medical department but utilizes physicians in various communities for evaluation of medical problems. PG&E also utilizes the services of an internist in San Francisco for specific medical problems, and a consultant for occupational medical and toxicological problems. At the February meeting, the investigators were provided medical records for 10 of the 18 individuals whose records

were requested under subpoena by NIOSH. There were no records for eight of the employees who allegedly contracted dermatitis while assigned to the Geysers Power Plant.

All of the individuals who had problems were assigned to General Construction; none were plant operators or research and development personnel. During the February meeting PG&E stated that approximately 44 individuals had reported problems with either dermatitis and/or pharyngitis since 1976. Most of the cases occurred in late 1976 and early 1977. The information was retrievable by PG&E from its "pink slip" system for reporting occupational injuries or illnesses that occur on the job. These slips are taken to a foreman and a decision is made whether the individual needs to see a physician. Frequently the illnesses or injuries are minor and a decision is made that no physician visit is required. During the initial visit by NIOSH in November of 1977, it was expressed by the union that workers were hesitant to turn in pink slips.

The records provided by PG&E were reviewed. All 10 individuals had been examined by a general practice physician located in Healdsburg, California. One of these persons was also examined by PG&E consulting physicians. Additionally, the records of another affected individual were previously studied by Drs. Milby and Whorton. The recorded medical problems were as follows: seven had dermatitis only; one had dermatitis and and pharyngitis; one had pharyngitis, conjunctivitis, and sinusitis; and two had sinusitis, pharyngitis, and bronchitis.

On March 22, 1978, Drs. Milby and Whorton toured the Geysers facility and interviewed five employees concerning alleged problems of dermatitis and pharyngitis. One of these employees was the supervisor of the entire Geysers site. It was learned that the two employees affected in February of 1978 were working in the ferric sulfate room without adequate protective clothing. He developed a rash on his face that he described as welt-like but "larger than poison oak." The rash appeared two to three days after exposure to the sludge material. The rash lasted four to five days and appeared to be spontaneously regressing when examined by Drs. Milby and Whorton on March 22, 1978.

E. Conclusions

From the available information, the following conclusions are made:

1. It appears that one or more chemical compound(s) is present in the sludge which is an irritant to the skin and/or the respiratory tract (especially the upper respiratory tract). The irritant does become airborne under certain conditions.

2. Apparently, the alteration of work practices and the automation of the sand filtration cleaning process has greatly reduced the irritant problem.

3. However, even with the procedural changes, there appears to be a potential for exposure to the irritant as evidenced by the individual who recently developed the rash after coming in contact with sludge.

4. It is likely that the observed medical problems - principally skin irritation - are associated with exposure to the sludge.

5. The precise causal agent has yet to be identified.

V. RECOMMENDATIONS

On the basis of NIOSH's investigation of the Geysers Power Plant, the following recommendations are made:

1. The occupational health surveillance should be continued by PG&E and employees should be encouraged to make use of the "pink slips" so that this surveillance is up-to-date.

2. Provision of a more convenient change-house facility with additional showers so that employees coming off shift may have the opportunity to bathe in an expeditious manner and change into non-work clothes.

3. Provision of washing machines so that employees whose work clothes have become soiled may have the opportunity to wash them in order to remove potentially irritating materials.

4. A more concerted effort should be made by PG&E to train and educate its employees on proper work practices near where protective gear is required. The three cases of occupational illness occurring in 1978 seemed to result from working without adequate personal protection.

VI. REFERENCES

1. NIOSH; "Criteria for a Recommended Standard...Occupational Exposure to Hydrogen Sulfide," Department of Health, Education, and Welfare Publication No. (NIOSH) 77-158, 1977.

VII. AUTHORSHIP AND ACKNOWLEDGEMENTS

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