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GOVERNOR OF HAWAII

FILE COPY

CHIYOME L. FUKINO, M.D.
DIRECTOR OF HEALTH

Initials JY 12/21/09

Mailed Out DEC 21 2009

In reply, please refer to:
File:

STATE OF HAWAII
DEPARTMENT OF HEALTH
P.O. Box 3378
HONOLULU, HAWAII 96801-3378

December 21, 2009

09-1091E CAB
File No. 0008-02

Mr. Mike L. Kaleikini
Plant Manager
Puna Geothermal Venture
P. O. Box 30
Pahoa, Hawaii 96778

Dear Mr. Kaleikini:

**Subject: Drilling, Flow Testing, and Abated Well Cleanout of Production Well KS-14**
**Noncovered Source Permit No. 0008-02-N**
**Attachment IIB, Special Condition Nos. B.9, D.1, E.3 and E.4**

The Department of Health acknowledges receipt of the following plans for production well KS-14:

1. Drilling Plan dated December 8, 2009;
2. Chemical Treatment Plan dated December 8, 2009; and
3. Analytical Test Plan and Procedures dated December 8, 2009.

The Department has reviewed your plans and procedures and has no objections. The plans are hereby approved. Please note that Puna Geothermal Venture is still required to comply with all conditions of Noncovered Source Permit No. 0008-02-N during the drilling, flow testing, and abated well cleanout operations of production well KS-14.

If you have any questions, please call Mr. Darin Lum of my staff at (808) 586-4200.

Sincerely,

Wilfred K. Nagamine

WILFRED K. NAGAMINE
Manager, Clean Air Branch

DL:smk

c: Ed Yamamoto, EHS - Hilo
CAB Monitoring Section

PUNA GEOTHERMAL VENTURE

HAWAI'I

DEC 14 2009

POSTMARKED DEC 10 2009 DATE

December 8, 2009

Mr. Wilfred Nagamine, Chief
Clean Air Branch
Environmental Management Division
Hawaii Department of Health
P.O. Box 3378
Honolulu, HI 96801

**SUBJECT: NOTIFICATION OF COMMENCEMENT TO DRILL KAPOHO STATE 14 (KS-14)**

Dear Mr. Nagamine:

In accordance with the Noncovered Source Permit (NSP) No. 0008-02-N, Attachment IIB, Section D.1, Puna Geothermal Venture (PGV) hereby submits its written plan in accordance with said provision. Due to reduced capacity of the plant, PGV intends to drill production well KS-14 January 15, 2010 or shortly thereafter.

This correspondence is a notice of PGV's intention to perform work on KS-14 and as such, provides updated and/or additional information in accordance with IIB.D.1.

The plan is comprised of the following items, which are included as enclosures:

1. A drawing identifying all of PGV's geothermal well locations, the property boundary, access roads approaching and traversing the property, the locations of the nearest residences and the locations of the ambient air monitoring stations.

2. Hydrogen sulfide abatement procedures.

3. Status of all previously constructed wells.

PGV requests approval from the Hawaii Department of Health (HDOH) for the plan outlined above.

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We certify that this document and all attachments are true, accurate, and complete, pursuant to HAR 11-60.1-4.

Post Office Box 30 • 14-3860 Kapoho-Pāhoa Road
Pāhoa, Hawai'i 96778
Tel (808) 965-6233 • Fax (808) 965-7254
PunaGeothermalVenture.com

an ORMAT company

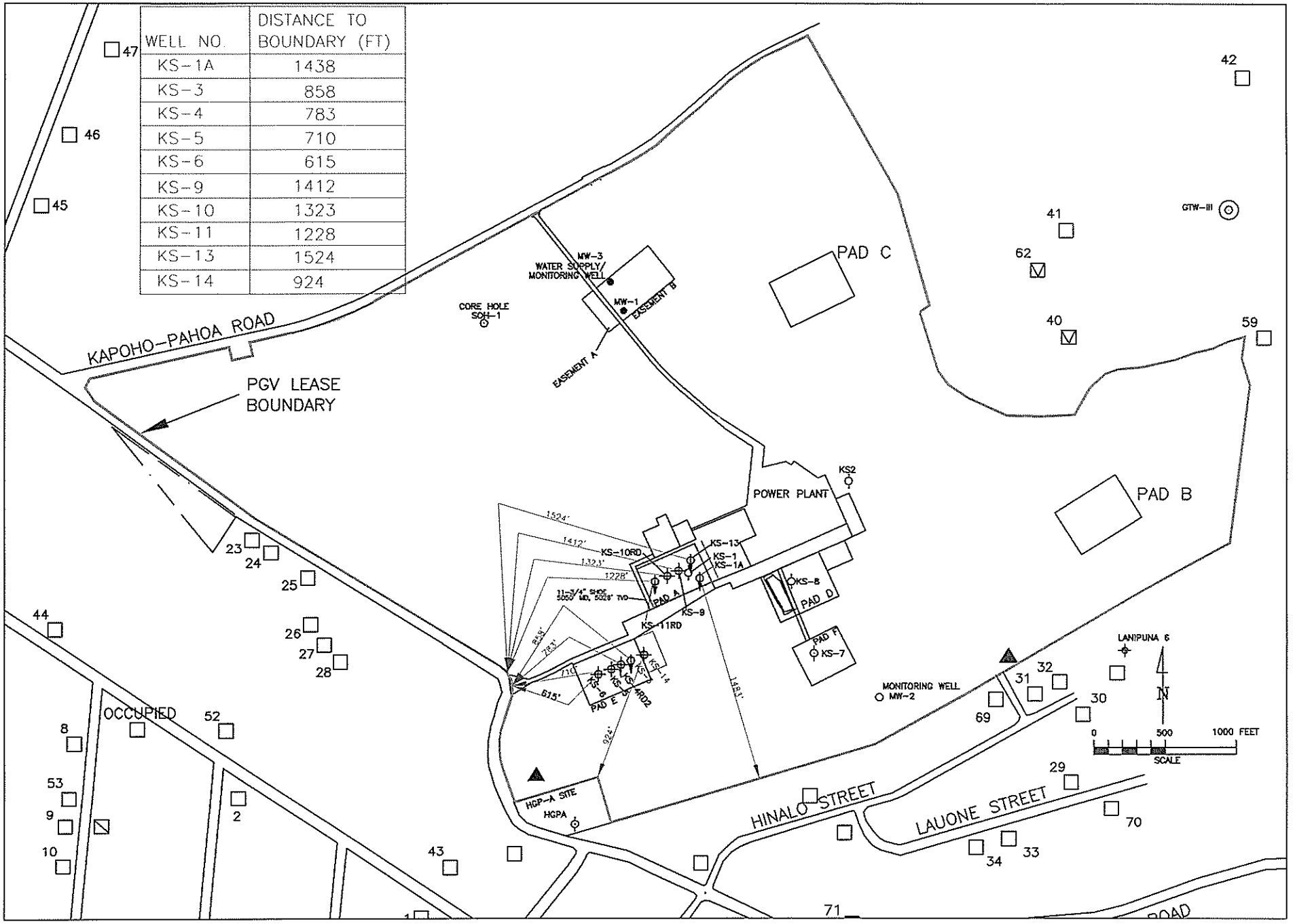
Should you have any questions or need additional information, please do not hesitate to contact me at (808) 965-2838.

Sincerely,

Michael L. Kaleikini
Plant Manager

Enclosures: Site Plan
Hydrogen Sulfide Abatement Procedures
Well Status Report

cc: Ron Quesada, PGV




EXPLANATION

710' DISTANCE (FT) FROM WELLHEAD TO NEAREST PGV LEASE BOUNDARY

GEOTHERMAL WELL, PLUGGED AND ABANDONED

GEOTHERMAL INJECTION WELL

GEOTHERMAL PRODUCTION WELL

PUNA GEOTHERMAL VENTURE

DISTANCE FROM WELLHEADS TO NEAREST PGV LEASE BOUNDARY

DATE: 12/7/2009

BY: WM. TEPLOW

FIGURE 1

# $H_2S$ ABATEMENT PROCEDURE

## KS-14 OPERATIONS

## I. INTRODUCTION

The purpose of this procedure is to outline the process of abating geothermal fluids which might contain hydrogen sulfide. This procedure is designed to address abatement during those times when unplanned geothermal fluids might enter the atmosphere while performing work on production well (KS-14).

In general, if an upset or near upset condition occurs during the work, the wellhead configuration will have two (2) lines which can be used to direct geothermal fluids to the abatement system. One (1) line is called a choke line and is routed to a "mud pit" tank/container, which is open to the atmosphere. The other line is called a blooie line and is routed to an atmospheric separator (see figure 1). These lines will be used to avoid the release of unabated geothermal fluid to the atmosphere.

For most upset conditions, the blooie line will be used. When an upset condition occurs, wherein pressure builds to a sufficient amount to break the "rupture disk", geothermal fluid passes through the blooie line and into the atmospheric separator. This path allows appropriate relief of the geothermal fluid and permits abatement of such fluid.

For near-upset and some upset conditions, the choke line can be used to prevent the use of the atmospheric separator. When near-upset and sometimes upset conditions exist, geothermal fluid can be regulated, via valving, etc., so as to relieve the pressure and, thus, reduce the potential for use of the atmospheric separator. The geothermal fluid is mixed, after abatement, with the "mud" in the mud pit.

## II. STEAM SAMPLING

In order to determine the concentration of $H_2S$ contained within the geothermal fluid, discrete samples of steam will be withdrawn from whichever of the two aforementioned lines is being used.

For the atmospheric separator, sampling ports are provided both upstream and downstream of the caustic injection point. Samples are taken at both locations and analyzed by chemical test. Steam is withdrawn by a vacuum pump, condensed, and collected in an impinger. The sample is analyzed for $H_2S$ according to the method described in Section III.

For the choke line, a sampling port is only provided upstream of the caustic injection point. A sample is taken and analyzed by chemical test, in a fashion similar to that which is mentioned above.

## III. $H_2S$ TESTING

Discrete samples of steam are withdrawn at appropriate times. The samples are then immediately analyzed for $H_2S$ concentration using a proven analytical method. The test method employed is the Silver Nitrate Potentiometric Determination.

Basically, to determine $H_2S$ concentration, the steam sample is condensed and flowed through a solution of sodium hydroxide. The $H_2S$ is chemically trapped in the sodium hydroxide solution. The sample bottle is weighed before and after the sampling procedure, allowing the precise weight of condensed steam to be determined. The weight of $H_2S$ in the sample is determined by a chemical titration. Silver nitrate of a known concentration is slowly added to the sample. The silver nitrate removes $H_2S$ from the solution by reacting with it to form an insoluble salt. An electrode placed in the solution alerts the technician when excess silver ions are present, thus, indicating that all of the $H_2S$ has been removed. Since the reaction between silver ions and $H_2S$ is well understood, the amount of silver nitrate used during the titration can be related to the amount of $H_2S$ removed. The ratio of $H_2S$ to the total sample is equal to the concentration of $H_2S$ in the steam.

## IV. ABATEMENT PROCESS

1. Abatement Method

   $H_2S$ is removed from the steam by adding an aqueous solution of sodium hydroxide. The reaction is as follows:

$$H_2S + NaOH \Leftrightarrow NaHS + H_2O$$
$$H_2S + NaOH \Leftrightarrow Na_2S + 2H_2O$$

   Caustic (sodium hydroxide) is injected into the choke line or blooie line using metered high pressure pump(s). If additional water is needed, then up to 350 gallons of water per minute can be injected into the blooie line using auxiliary and/or rig pumps.

2. Description of Equipment

Two, metered, high pressure pumps are mounted on a skid. The pumps can be used singly or in combination to pump caustic for $H_2S$ abatement. Each pump has a capacity of 600 gallons per hour at a discharge pressure of 60 psi. A caustic storage tank will be on location and plumbed into the abatement skid while drilling is in progress.

## V. ABATEMENT PROCEDURE

1. If geothermal fluid begins to flow through the choke line or the blooie line, then immediately begin injecting caustic. Also, begin injecting water using the auxiliary or rig pumps, if the geothermal fluid flow is dry or nearly so.

2. Withdraw steam sample(s) from sample point(s) and analyze sample(s) immediately for $H_2S$ concentration. Sample(s) include both unabated and abated, as appropriate.

3. Record results, including date, time, $H_2S$ concentration upstream and downstream of chemical injection, and caustic usage.

## STATUS OF PREVIOUSLY CONSTRUCTED WELLS

The following is a summary of the status of all previously constructed wells at the Puna Geothermal Venture (PGV) project:

**KS-1** Well KS-1 has been plugged and abandoned. The program was approved by the DLNR.

**KS-2** Well KS-2 has been plugged and abandoned. The program was approved by the DLNR.

**KS-1A** Injection well KS-1A is completed to a depth of 6,505 feet. This well is currently one of four injection wells in operation at the project.

**KS-3** Injection well KS-3 is completed to a depth of 7,406 feet. This well is currently one of four injection wells at the project.

**KS-4** Production well KS-4 is completed to a depth of 6,796 feet. This well is currently being used to supply geothermal steam to the power plant.

**KS-5** Production well KS-5 is completed to a depth of 6,418 feet. This well is currently being used to supply geothermal steam to the power plant.

**KS-6** Production well KS-6 is completed to a depth of 6,584 feet. This well is currently out of service and requires a workover.

**KS-7** Well KS-7 has been plugged and abandoned. The program was approved by the DLNR.

**KS-8** Well KS-8 has been plugged and abandoned. The program was approved by the DLNR.

**KS-9** Production well KS-9 is completed to a depth of 4,564 feet. This well is currently being used to supply geothermal steam to the power plant.

**KS-10** Production well KS-10 is completed to a depth of 5,083 feet. This well is currently being used to supply geothermal steam to the power plant

**KS-11** Injection well KS-11 is completed to a depth of 7,950 feet. This well is currently one of four injection wells at the project.

**KS-13** Injection well KS-13 is completed to a depth of 6,970 feet. This well is currently one of four injection wells at the project.

**MW-1** Monitoring/water supply well MW-1 is completed to a depth of 731 feet. This well supplies water for the power plant operations. MW-1 is sampled in accordance with the Hydrologic Monitoring Program.

**MW-2** Monitoring/water supply well MW-2 is completed to a depth of 646 feet. MW-2 is sampled in accordance with the Hydrologic Monitoring Program.

**MW-3** Monitoring/water supply well MW-3 is completed to a depth of 720 feet. This well supplies water for the power plant and drilling operations. MW-3 is sampled in accordance with the Hydrologic Monitoring Program.