

AGENDA

SEISMIC MONITORING ADVISORY COMMITTEE

May 9, 2016 @ 9:30 a.m. Calpine Geothermal
Visitors Center
15500 Central Park Road, Middletown

Call In: 1-888-449-6492; Participant Passcode: 226083

- I. Introductions
- II. Approval of SMAC report to the Board of Supervisors of November 16, 2015 meeting.
- III. Anderson Springs Report, (Jeff Gospe) and Input
- IV. Cobb Area Public Input
- V. General Public Input
- VI. Update of SE Geysers pipeline operations (Voge, Drake)
- VII. Summary of Seismic Data from USGS Network (Voge, Drake) VIII Report by Calpine on Strong Motion Seismic Sensors (Hartline) IX. Report by Calpine on Santa Rosa Pipeline Operations (Hartline) X. Calpine EGS (Hartline)
- XI. Report on LBNL Seismic Array (Majer) and Induced Seismicity Update
- XII. Report by Lind Gee Seismic Data
- XIII. Report on Bottle Rock Power Co. Operations
- XIV. Coordination with Santa Rosa
- XV. Schedule Next Meeting for Monday, November 14, 2016
- XVI. Adjournment

SEISMIC MONITORING ADVISORY COMMITTEE (SMAC)

Monday, November 16, 2015 9:30 a.m.

Calpine Geothermal Visitors Center

15500 Central Park Road

Middletown, California

FINAL MINUTES (as approved 05/09/2016)

Meeting called to order by Mark Dellinger, Committee Chairman (Lake County Special Districts) at 9:46 a.m. Minutes were recorded by tape recorder and transcribed to Draft Minutes. Dellinger initiated introductions.

Present: Mark Dellinger, Committee Chairman (Lake County Special Districts), Hamilton Hess (Friends of Cobb Mountain), Craig Hartline (Calpine), Lester Drake (NCPA), Ed Voge (NCPA), Ernie Majer (LBNL), Lund Gee (USGS), Joe Austin (DOGGR), Jan Coppinger (Lake County Special Districts), Paul Marshall (CEC), Christopher Dennis (CEC), Danielle Matthews (Calpine), Tim Conant (Calpine), Joan Clay (Anderson Springs), Meriel Medrano (Anderson Springs), Jody Spooner (Calpine), Margaret Lewis (Calpine), Linda Diehl-Darms (Middletown Rep. Advisory Committee Member), Jeff Gospe (Anderson Springs).

- I. **May 11, 2015 Meeting Minutes for Approval: Mark Dellinger**
Mr. Mark Dellinger presented the Draft Minutes for approval and they were approved by consensus.
- II. **Anderson Springs Report:** Mr. Jeff Gospe summarized that seismicity is down due to there being less water. The strong ground motion stations survived the Valley Fire, though 91% of the homes in Anderson Springs were destroyed. Items of concern are greater creek flow; erosion control; sewer system. Ms. Meriel Medrano reported the water plant survived. Divers were hired to inspect the tanks and they are good. A big issue is there are very few customers. The yearly budget is \$75K per year and reserves are \$238K but the debt of the project is \$258K. Medrano stated the plant could run no more than 3 years at this rate.
- III. **Cobb Area Public Report:** Mr. Hamilton Hess stated a desire to have a public report of some sort showing what is being done to minimize the incidents of earthquakes.
- IV. **General Public Input:** No comments from the general public.
- V. **Northern California Power Agency (NCPA) Report: Lester Drake**
Drake's presentation covered the operations in the South East Geysers pipeline for the period of April 1, 2015 through September 31, 2015. The presentation covered two main areas: 1) Pipeline Operations; 2) Observed Seismicity.
 - i. Pipeline Operations:
 - a. The Southeast Geysers Effluent Pipeline (SEGEP) has been in operation for over 18 years and has delivered approximately 49.8 billion gallons of water at an average rate of 5,260 gpm to The Geysers steam fields for injection. That averages about 2.95 million gallons per day.
 - b. During the more recent 6 month period from April 1, 2015 – September 31, 2015, the SEGEP Pipeline has been in operation 91% of the time. The pipeline was shut down September 12, 2015, due to damaged power and communication lines by the Valley Fire. There was minimal damage to the pump stations and operations were restored September 30, 2015. Average delivery rate is 6.51 mgd or 4,523 gpm.
 - c. Drought flow conditions were lifted May 1, 2015.
 - ii. Observed Seismicity / South East Geysers

- a. The USGS recorded a total of 66 seismic events of magnitude 1.5 and greater within the SE Geysers area from 04/01/15 – 09/31/15. Regarding seismic activity between magnitude 1.5 and 3.0, the Southeast Geysers averaged 10.7 events per month which is slightly up from 9 per month for 10/1/14 – 3/31/15.
- b. Steam production for the SE Geysers was 17.95 billion pounds for the past six months with is slightly down from the previous six month period where 18.34 billion pounds was produced.
- iii. Seismic Activity in the Geysers Known Geothermal Resource Area
 - a. There have been 346 events of magnitude of 1.5 and greater recorded by USGS for the past 6 months.
 - b. There were 5 earthquake events of magnitude 3.0 and greater. The largest events were two magnitude 3.83 occurring on July 10th, August 23rd, 2015. The July event was located in the Central Geysers 5.2 miles NE from the Anderson Springs instrument. The August even was located I the SE Geysers area approximately 2.2 miles NE from the Anderson Springs instrument.
 - c. 712 seismic events greater than magnitude 1.5 are projected for 2015. This is down from 932 events recorded in 2014.

VI. Calpine Corporation: Craig Hartline

- i. Valley Fire Damage and Current Status of Seismic Monitoring Networks
 - a. LBNL Seismic Monitoring Network – One LBNL station (DES) was destroyed by the Valley Fire and several other LBNL stations sustained varying degrees of damage (MNS, ACR, DEB, ACR, FNF...) and were quickly repaired by Ramsey Haught. Preliminary costs for replacement is in the range of \$10K to \$12K. LBNL seismic data is sent by radio telemetry to the North Geysers Radio Repeater and the Socrates Container. The 28 stations received at the NG Radio Repeater are now sent via the internet to meq.lbl.gov by the normal file transfer programs. The 8 stations received at the Socrates Container will be manually downloaded until restoration of the Calpine fiber loop communications to the Geysers Administration Center.
 - b. USGS/Northern California Seismic Network – Two USGS monitoring stations were destroyed by the Valley Fire and quickly repaired.
 - c. Strong Motion Stations – COB destroyed; ADSP housing fire damaged, no power or communication; ADS2 is locked within the snack bar at community center and may have survived, no power or communication.
Note: Further discussion regarding phone line responsibility. Alta Rock no longer wants to pay but is still paying. USGS contract employee to assess. Also discussed replacement options and costs and a possible third unit of the Strong Motion Stations.
- ii. Seismicity Hotline
 - a. The Community Hotline continues to be check, reviewed and transcribed daily. During the reporting period April 1, 2015 to September 30, 2015 there were 38 calls.
- iii. Field-Wide Seismicity Analysis
 - a. April 1, 2015 to September 30, 2015 - $\geq 2.0-101$; $\geq 2.5-38$; $\geq 3.0-5$; $\geq 3.5-2$.
- iv. Yearly Field-wide Water Injection and Seismicity. Hartline stated the yearly numbers are lower. Some events weren't captured due to the destruction of monitors from the Valley Fire.
 - a. Water injection vs. Magnitude 1.5 is lower at 736 events from 1080.
 - b. Magnitude 2.0 and greater are down to 193 events from 225 events during the past reporting period.
 - c. Magnitude 2.5 and greater showed 65 events up from 48 events.
 - d. Magnitude 3.0 and greater are 7 events, the same as last year's events of 7.
- v. Monthly Field-wide Water Injection and Seismicity – Hartline explained the events of ≥ 4.0 have decreased to about one event per year from January 1, 2000.
- vi. Daily SRGRP Water Supply – Hartline shared a slide, mainly for reference, of the SRGRP water supply to Calpine from April 1, 2015 to September 30, 2015.

- vii. Strong Motion Sensor Station Analysis - The strong motion instruments have been used to evaluate the ground acceleration during the past reporting period. Cobb Strong Motion: magnitude 2.72, of June 12, 2015 which had a maximum peak ground acceleration of about 4.1% of g; magnitude 3.83, of July 10, 2015 which had a maximum peak ground acceleration of about 4.7% of g; magnitude 3.05, of July 22, 2015 which had a maximum peak ground acceleration of about 4.3% of g. Anderson Springs Strong Motion: magnitude 3.28, of April 25, 2015, had a maximum peak ground acceleration of 17.8% of g; magnitude 2.92, of July 5, 2015, had a maximum peak ground acceleration of 4.4% of g; magnitude 3.83, of July 10, 2015, had a maximum peak ground acceleration of 9.0% of g; magnitude 2.99, of July 17, 2015, had a maximum peak ground acceleration of 4.1% of g; magnitude 3.83, of August 23, 2015, had a maximum peak ground acceleration of 12.1% of g; magnitude 2.36, of September 7, 2015, had a maximum peak ground acceleration of 6.7% of g;
- viii. Seismicity, Fracture Zones and Reservoir Compartmentalization – Hartline presented information on Cobb and Anderson Springs peak ground acceleration.
- ix. 3D Visualization and Structural Model Building
 - a. Seismic event magnitude is dependent on fault area, average slip and rock rigidity. The earth's crust is crossed by a network of pre-existing faults and fractures of various sizes.
 - b. Within The Geysers, CGS/USGS mapped faults are inactive and restricted in area. This fact, along with highly-fractured steam reservoir provides confidence that there is not sufficient fault area to support a large earthquake (Majer et al, 2007).
 - c. A 3D structural model is currently under development for The Geysers geothermal field which will assist in understanding induced seismicity at The Geysers.
- x. Additional Seismic Monitoring and Research
 - a. Borehole Fiber Optic Seismic Sensor Program. The fiber is a sensor, no electronics below ground surface. Partially reflects light of a specific wavelength. #1) a test was completed 1/20/15 at well CA956A-2 by United States Seismic Systems, Calpine and Lawrence Berkeley National Laboratory (LBNL). #2) A test was completed 9/12/15 at well Prati State 29 by Paulsson Incorporated, Calpine and Lawrence Berkeley National Laboratory (LBNL), funding provided by CEC. Seismic data analysis is in progress.
 - b. Research collaboration with Seismic Warning Systems for early detection for natural earthquakes. Automated Control (and shutdown) of natural gas, electricity and water supply for refineries, chemical plants, public schools, medical facilities. Two test sensors installed at The Geysers Prati 32 Well Pad and tied into Calpine Power and communications. Project update 11/5/15 shows excellent data allowing refinement of seismic event detection and hypocenter determination algorithms. Seismic Warning Systems wishes to install a second site to the southeast of the existing station.
 - c. No EGS update.

Follow up Comment/Question:

Mr. Gospe questioned the impact the Valley Fire had on other facilities at Calpine. Tim Conant, Director of Engineering, responded that the pipeline of Bear Canyon is now moving the steam to Unit 16. Bear Canyon is currently not operating. Unit 16 cooling tower was damaged and permits are being requested to rebuild Unit 16 cooling tower February, 2016. Unit 13 is running. West Ford Flat (WFF) was damaged and will not be rebuilt and the tower will be removed. The steam is being rerouted to Calistoga Power Plant. Unit 18 and Unit 20 cooling towers were destroyed as well and will be rebuilt. Half of Sonoma Power Plant's cooling tower was destroyed and the plant is still operational but not at full capability. The pipeline insulations were damaged but the pipeline is intact and insulation is being repaired. A comment was made thanking Lake County for being so tremendously helpful in keeping the WFF projects going which assists in the moving stranded steam. A community briefing will be taking place shortly.

There was a question regarding drilling program similar to Geysers Gun Club (deepening the wells GGC4 and GGC5). Hartline couldn't comment other than there was some degree of enhance permeability there. Joe Austin (DOGGR) stated Calpine has been reacting to seismicity over the years and the 3D models are working. These are encouraging signs.

Anderson Springs representatives, Jeff Gospe and Joan Clay, complimented the interaction and communication they have with Calpine. There was mention of the lack of representation from Cobb. Danielle Seperas stated she will be meeting with the Cobb Community Committee soon and will bring this up.

VII. Lawrence Berkeley National Laboratories Report: Ernie Majer

- i. Valley Fire Impact on Operations – Didn't lose too much but did lose sensitivity in the array.
 - a. As of 11/15/15, all sites (except strong motion sites in Anderson Springs and Cobb) are now recording data. Two separate arrays; Normal operations will depend on resumption of power and communication lines.
 - b. LBNS is working with Calpine and the USGS to resume strong motion data collection.
- ii. Induced Seismicity Summary
 - a. An increase Eqs in the mid content from oil and gas operations has prompted an effort to create a "best practices" for oil and gas operators to follow (suggested).
 - b. Follows a similar logic as geothermal best practices.
 - c. This came out in September, 2015.
 - d. The document was produced by a private company "States First" and can be googled: Potential Injection Induced Seismicity Associated with Oil & Gas Development. Majer offered to send it to anyone who wanted a copy.

VIII. Seismic Data Report: Lind Gee

- i. Valley Fire Update – This was a very challenging wildfire season for the USGS in general. Two USGS' regional network stations were destroyed during the Valley Fire and restored in late September, 2015. Western Sierra fire destroyed a microwave tower which took our 24 stations that were communicating through it. This recently was restored. Gee stated her appreciation regarding the assistance from Ramsey and Calpine.

Follow up Comment/Question:

Ms. Medrano requested Anderson Springs be put back on USGS mapping. Gee stated she will look into it.

IX. Report on Bottle Rock Power Company: No update

VIII. Report on Coordination with Santa Rosa: No update

Note: Mr. Mark Dellinger will be retiring April 29, 2016, and may be volunteering to some degree.

Next meeting: The next SMAC meeting will be **May 9, 2016**, at the Calpine Geothermal Visitors Center. Meeting was adjourned by Chairman Dellinger at 11:39 a.m.

Meeting Agenda and Full Presentations are available online at:
<http://www.geysers.com/smac.aspx>