

# **AGENDA**

## **SEISMIC MONITORING ADVISORY COMMITTEE**

November 16, 2015 @ 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 May 11, 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, May 9, 2015
- XVI. Adjournment

# SEISMIC MONITORING ADVISORY COMMITTEE (SMAC)

Monday, May 11, 2015 9:30 a.m.  
Calpine Geothermal Visitors Center  
15500 Central Park Road  
Middletown, California

## **FINAL MINUTES**

Meeting called to order by Mark Dellinger, Committee Chairman (Lake County Special Districts) at 9:37 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), Linda Diehl-Darms (Middletown Rep. Advisory Committee Member) Lester Drake (Northern California Power Agency (NCPA), Ed Voge (NCPA), Craig Hartline (Calpine), Danielle Matthews Seperas (Calpine), Brian Harms (Bottle Rock Power), Jody Spooner (Calpine), Margaret Lewis (Calpine), Joe Austin (Department of Conservation, Division of Oil, Gas & Geothermal Resources - DOGGR), Ben Minks (DOGGR), Bob Young (NCPA), Meriel Medrano (Anderson Springs), Jeff Gospe (Anderson Springs), Kurt Seel (Calpine), Tim Conant (Calpine), Joan Clay (Anderson Springs) and Lind Gee (USGS Menlo Park) via telephone conference.

**I. November 17, 2014 Meeting Minutes for Approval: Mark Dellinger**

Mark Dellinger pointed out updates to the agenda as follows: Section VI, third paragraph, the fifth line. Mark thought it should read shear waves; and the following paragraph on the bottom line, should be injection lines.

Announcements: Margaret Lewis (Calpine) will be transcribing the minutes from this meeting forward.

**II. Cobb Area Public Report:** Mark Dellinger reported that there were no residents from Cobb present. Since it is difficult for Hamilton Hess to attend all meetings, an alternate community representative was discussed. Dellinger will follow up.

**III. General Public Input:** No comments from the general public.

**IV. Northern California Power Agency (NCPA) Report: Lester Drake**

Drake's presentation covered the operations in the South East Geysers pipeline, the effect of the drought and the operating seismic activity that has been observed for the past 6 months. The presentation covered three main areas: 1) Operations at The Geysers and the impact the drought has had; 2) Focus on the South East Geysers and the seismic activity observed, and 3) Segway into Craig's discussion on overall Geysers and the seismic activity observed.

**i. Pipeline Operations:**

- a. The Southeast Geysers Effluent Pipeline (SEGEF) has been in operation for over 18 years and has delivered approximately 48.8 billion gallons of water at an average rate of 5,276 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 October 1, 2014 – March 31, 2015, the SEGEF Pipeline has been in operation almost every day. The pipeline was shut down in January and part of February for pump station maintenance.
- c. May 1, 2015 the Clearlake Rumsey gauge was above 3.5 normal pipeline operations have resumed with an average flow rate of approximately 5.1 million gallons per day.

- ii. Observed Seismicity / South East Geysers
  - a. The USGS recorded a total of 54 seismic events of magnitude 1.5 and greater within the SE Geysers area from 10/01/15 – 03/31/15. Regarding seismic activity between magnitude 1.5 and 3.0, the Southeast Geysers averaged 9 events per month which is down from 13.2 per month for 4/1/14 – 9/30/14.
  - b. Steam production for the SE Geysers was 18.34 billion pounds for the past six months with is slightly down from the previous six month period where 19.78 billion pounds was produced.
- iii. Seismic Activity in the Geysers Known Geothermal Resource Area
  - a. There have been 345 events of magnitude of 1.5 and greater recorded by USGS for the past 6 months.
  - b. There were 3 earthquake events of magnitude 3.0 and greater. The largest event was a magnitude 3.59 occurring on January 12, 2014 in the central Geysers located about 3.9 miles from Anderson Springs.
  - c. For 2014, the cumulative total of seismic events greater than 1.5 was 1,029 which is down from 2013 of 1,344 events.

## V. **Calpine Corporation: Craig Hartline**

- i. Seismicity Hotline: The Community Hotline is checked, reviewed, transcribed daily. During this current period Calpine had 18 calls from October 1, 2014 to March 31, 2015 which is the same number of calls of the prior reporting period of April 1, 2014 to September 30, 2014.
- ii. Yearly Field-Wide Water Injection: Hartline reports steam production is down which relates to seismicity count.
  - a. Water injection vs. Magnitude 1.0 and greater is at 1642 events from 1080.
  - b. Magnitude 2.0 and greater are down to 101 events from 225 events during the past reporting period.
  - c. Magnitude 2.5 and greater showed only 23 events which is a very low number, declining since 1988.
  - d. Magnitude 3.0 and greater are on the decline field wide since about 1985.
- iii. Strong Motion Sensor Analysis: The strong motion instruments have been used to evaluate the ground acceleration during the past reporting period. During this period, there were a limited amount of events. Hartline provided information on estimated Cobb magnitude 2.68, of November 6, 2014 which had a maximum peak ground acceleration of about 3.68% of G. Anderson Springs magnitude 3.21 had a maximum peak ground acceleration of 5.25% of G and the magnitude 2.68 had a maximum peak ground acceleration of 4.69%.
- iv. 3D Visualization and 3D Structural Model Building: A three-dimensional geological/geophysical model is currently under development for The Geysers geothermal field.
  - a. Minor pressure variations that result from sub-surface fluid flow are indicated by the seismicity thus these fluid flow pathways and barriers are important constraints on development of the 3D structural model.

- b. Software advances for seismicity analysis, along with 3D modeling constraints from lithology logs, surface geology, temperature logs, pressure logs, tracer analysis, heat flow and reservoir history matching are improving Calpine's ability to develop a 3D Structural Model for The Geysers.
  - c. The developing 3D structural model (including existing fault zones and fractures) will assist in understanding and potentially mitigating induced seismicity at The Geysers. The goal is to better manage water injection flow rates with local steam reservoir conditions.
  - d. Hartline shared a 3D analysis of wells GGC4-STI and GGC5-OH which showed an unanticipated seismicity cluster development that was not an injection well and discovered the fluid is migrating down a conduit. Hartline also offered a 3D analysis of LF-9 which showed the lost circulation zone associated with the Top Serpentinite and Base Serpentinite.
- v. Borehole Fiber Optic Seismic Sensor Tests
  - a. The fiber is the sensor – no electronics below ground surface. Partially reflects light of a specific wavelength.
  - b. A test was completed 1/20/15 at well CA956A-2 by United States Seismic Systems, Calpine and Lawrence Berkeley National Laboratory (LBNL).
  - c. A proposal was submitted to the California Energy Commission and approved for \$900,000 in research funding for a two-well program: 1) Passive induced seismicity monitoring; 2) Active vertical seismic profile (VSP) imaging (with a "Vibroseis" energy source; 3) Target is summer of 2015.
  - d. This collaboration is being expanded beyond the recent Prati 9 injection well analysis and Calpine is providing data for additional NW Geysers wells.
- vi. Additional Seismic Monitoring and Research:
  - a) Seven Alta Rock Microseismic Array (MSA) Boreholes have been transferred to Calpine Corporation in collaboration with LBNL.
  - b) Research collaboration with Seismic Warning Systems for early detection for natural earthquakes.
    - Seismic Warning Systems: Primary Goal – 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. Geysers project goals are refinement of event detection software to: avoid false positives; and, distinguish between smaller seismic events and large seismic events (earthquakes) triggering automated warnings and shutdowns)

Follow Up Comment/Question:

On slide 30, a question was asked whether MSA-6 was in Anderson Springs. Hartine responded that it was north of the community.

**VI. Lawrence Berkeley National Laboratories Report: Craig Hartline for Ernie Majer**

- i. Mr. Hartline summarized that LBNL has 32 permanent 3-C stations at The Geysers as well as 5 temporary stations that are around EGS well, the enhanced geothermal system well at Prati 31, 32 and those are still in place that EGS project is still continuing.
- ii. Hartline discussed the funding available for seismic monitoring and there was no cost extension related to the funding that is estimated to extend to March, 2016. According to Ernie Majer the Department of Energy is likely to be the source of funding but they won't commit as their 2016 fiscal budget has not been completed. Hartline also discussed streamlining between LBNL and the USGS as some sites are redundant.
- iii. Ernie Majer will be retiring June 30, 2015. A replacement has not yet been named.

**VII. Seismic Data Report: Lind Gee**

- i. Lind Gee introduced herself as David Oppenheimer's replacement and discussed her involvement in seismicity.
  - Gee is currently overseeing the Northern California Seismic Network and National Strong Motion Program for four months now.
  - Prior, Gee was the scientist in charge of the USGS Albuquerque seismological lab in New Mexico where she oversaw the global seismic graphic network and the US National Seismic Network.
  - Gee also oversaw the earthquake monitoring program at the UC Berkeley Seismological Lab.
- ii. Ms. Gee stated that one of the efforts in her current position is doing some work on their earthquake catalogue with one effort to compute an additional adept parameter, in order to facilitate the inclusion of their catalogue in a national earthquake catalogue.

**Follow up Comment/Question:**

Ms. Gee was asked to send her contact email and phone number to the committee.

Mr. Gospe suggested having an outside agency help look into the strong ground motion besides Mr. Hartline, though he does a great job at analyzing and presenting the data. Gee replied stating she is still trying to discern what personnel resources she has. She did state that over the next few years, they anticipate upgrading portions of their network (Northern California) and hope to be in the position to upgrade their older analog instrumentation to sites that would include three component strong motion monitoring and one component of velocity.

**VIII. Anderson Springs Report: Jeff Gospe**

Jeff Gospe commented on the California drought and the decline of seismicity at all levels magnitude 3s and larger and magnitude 1s, 2s and larger.

Gospe stated he wanted to clarify the combination of Craig Hartline and Lind Gee related to the strong ground motion stations. Gospe wanted to know who was responsible for the machines as it wasn't clear who was paying for the station ADS-2 which is down by the recreation center and installed by Alta Rock. He stated the station at the end of Hot Springs Road was maintained by Calpine and Calpine was paying for the electricity for that machine.

Gee stated ADS-2 was one of their sites but would need to follow up to see who is paying for the communication.

Gospe stated that both stations are invaluable. Gospe thought the electricity was being paid for by the County as it is hooked into the air station (GAMP), but the phone line was thought to be paid for by Alta Rock who is no longer in the picture.

Gee stated the units are so low powered they are often installed in fire houses or other locations that power is provided by the host. Gee will check into the communications and will report back.

**IX. Report on Bottle Rock Power Company: Brian Harms**

The Bottle Rock plant has been shut down. There is one injection well that is maintained with minimal injection.

**VIII. Report on Coordination with Santa Rosa: Nothing to report.**

**Next meeting:** The next SMAC meeting will be **November 16, 2015** at the Calpine Geothermal Visitors Center. Meeting was adjourned by Chairman Dellinger at 10:50 a.m.

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