



# Geothermal Testing Facilities in an Oil Field

Lyle A. Johnson, RMOTC



# Project Overview



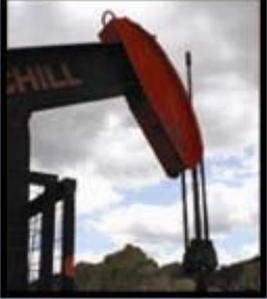
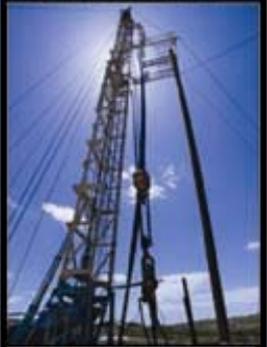
The proposed project is to develop a long term testing facility and test geothermal power units for the evaluation of electrical power generation from low-temperature and co-produced fluids. The facility will provide the ability to conduct both long and short term testing of different power generation configurations to determine reliability, efficiency and to provide economic evaluation data.

- Project started September 2009 for a 3 year period
- Infrastructure advances 40% complete, overall project 10%.
- Budget: EERE (GTP) \$775,000 to \$1,135,00  
FE (RMOTC) \$400,000 to \$900,000
- Present Barrier : Decision on second unit for long term testing
- Collaborative agreement between GTP and RMOTC

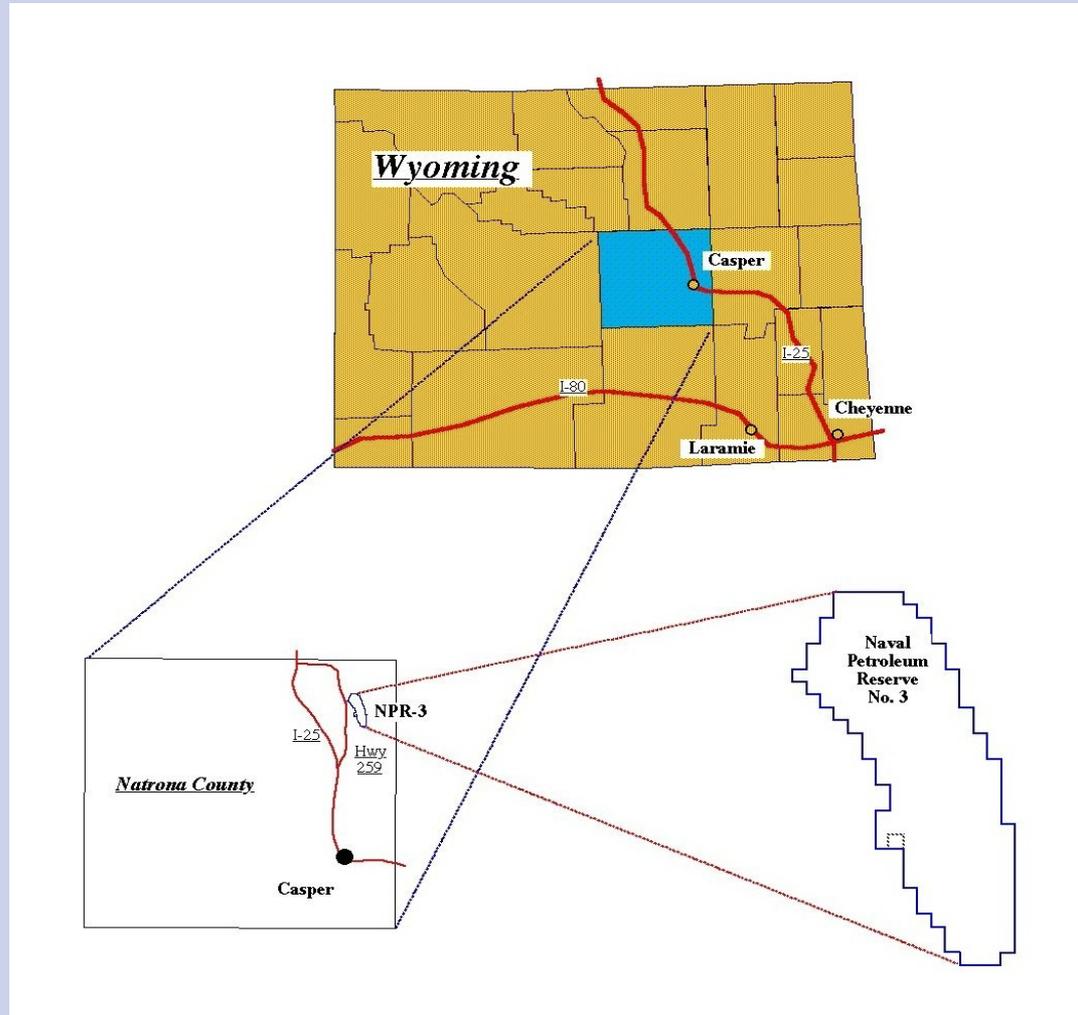


**RMOTC**

# Location of RMOTC

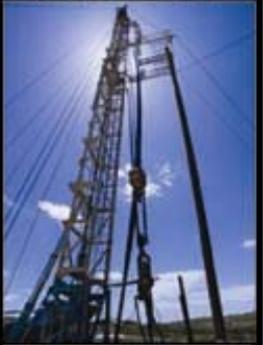


**RMOTC**



Geothermal Technologies Program 2010 Peer Review  
Arlington, VA, May 19, 2010

# Water Treatment Pond

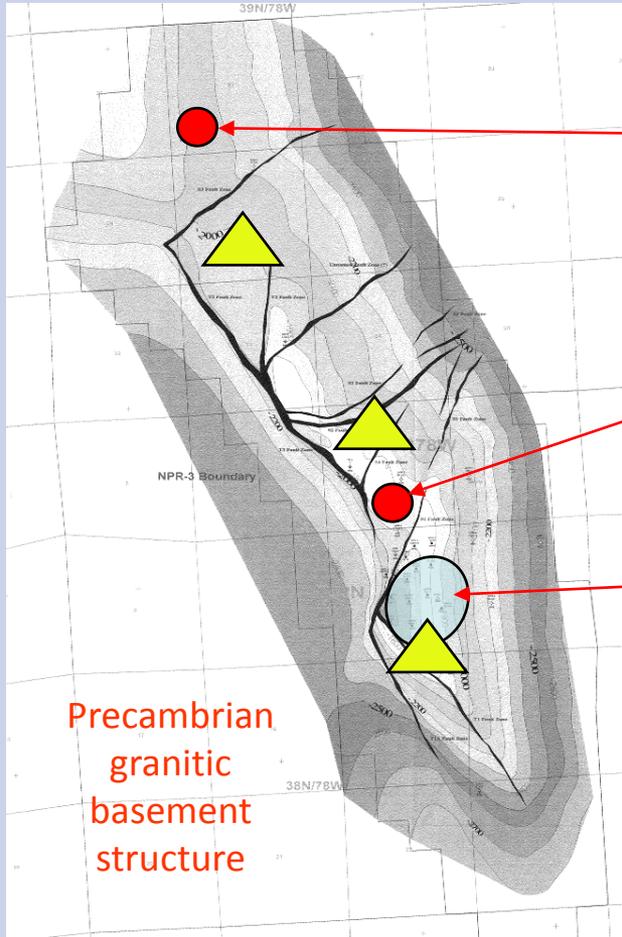


Geothermal Technologies Program 2010 Peer Review  
Arlington, VA, May 19, 2010

# Potential Geothermal Supply Wells



**RMOTC**



Precambrian  
granitic  
basement  
structure

**17-WX-21**  
Madison and Tensleep  
Possibly 35 MBWPD flowing

**57-WX-3**  
Madison and Tensleep  
Possibly 10 MBWPD flowing

TENSLEEP PRODUCING AREA

OTHER POSSIBLE TENSLEEP SOURCE  
WELLS AND DEEPENING CANDIDATES



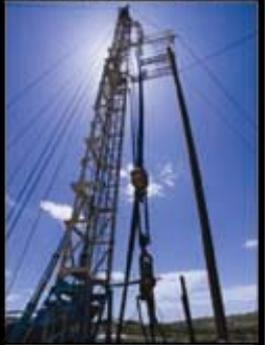
Well	Zone	Rate, MBWPD		Comments
		Low	High	
Projected				
17-WX-21	Madison	20	25	Flowing
17-WX-21	Tensleep	4	10	Needs perforating
41-2-X-3	Tensleep	1	3	Flowing
41-2-X-3	Madison	6	12	Needs deeping
48-X-28	Tensleep	2	6	Flowing
61-2-X-15	Tensleep	2	6	Flowing
61-2-X-15	Madison	6	12	Needs deeping
57-WX-3	Madison	2	6	Flowing
Projected Flowing Production		43	80	Projected flowing
Projected Pumping Production		86	160	Twice flowing rate
Total Present Tensleep Production		40	50	Pumping
All Potential Production		126	210	All on pump



# Project Goals



- Validate the use of a binary geothermal power generation system that uses hot produced oil field water to produce electricity.
  - Testing partners
- Initial Partner: ORMAT Nevada, Inc.
- Collaborating Partner: Geothermal Technologies Program, U.S.DOE



RMOTC

# Projected Generator Performance

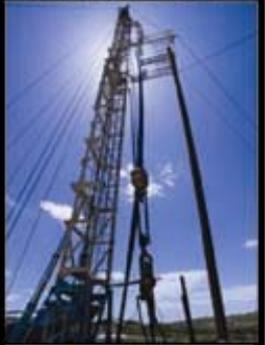


Flow Rate:	40,000 bpd (6,358 m <sup>3</sup> /d)
Inlet Temperature:	170°F (77°C)
Outlet Temperature:	152°F (67°C)
Ambient Temperature:	50°F (10°C)
Generator Gross Power:	180 kW
Net Power Output:	132 kW

Unit designed and built by Ormat Systems Ltd, Yavne, Israel.



# Test Unit



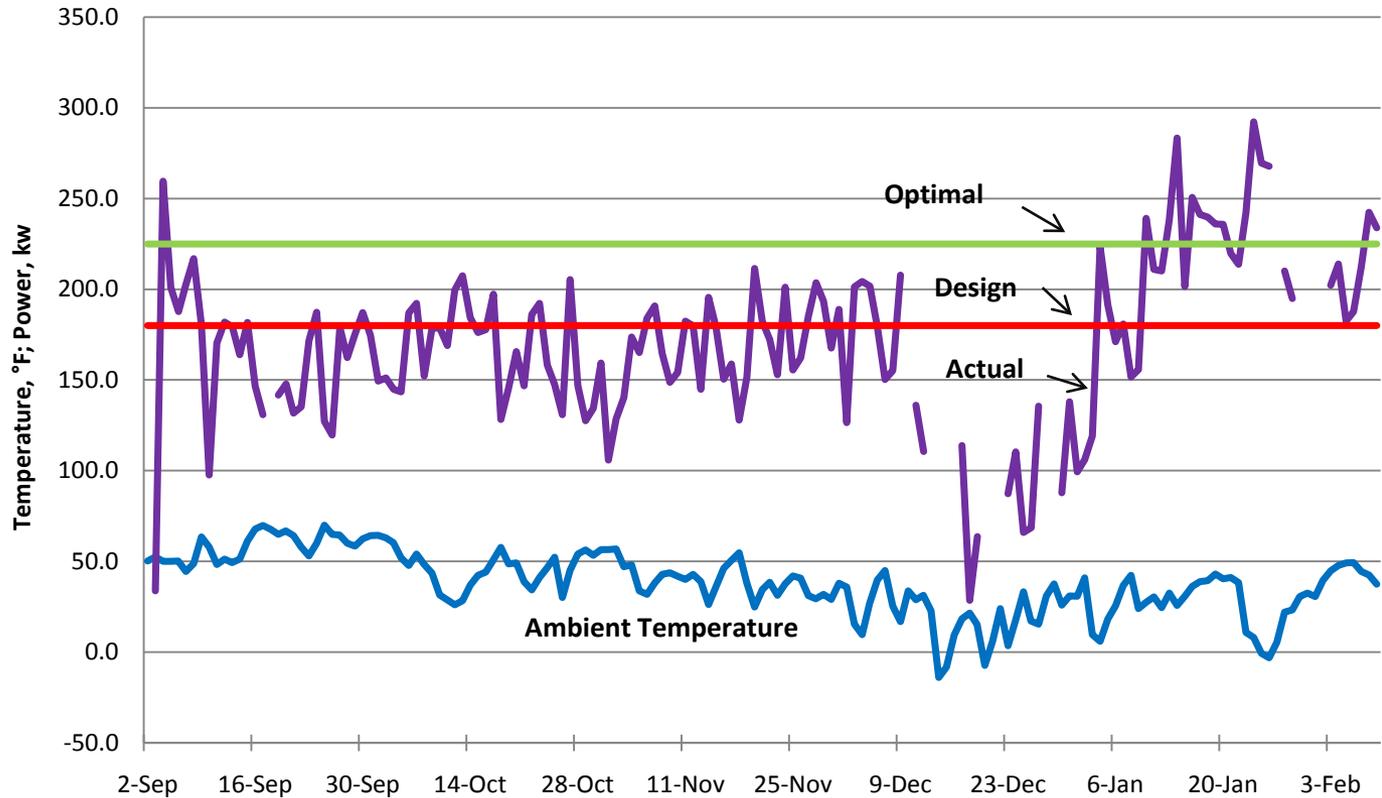
**RMOTC**

Geothermal Technologies Program 2010 Peer Review  
Arlington, VA, May 19, 2010

# Phase 1 Operational Trends



RMOTC

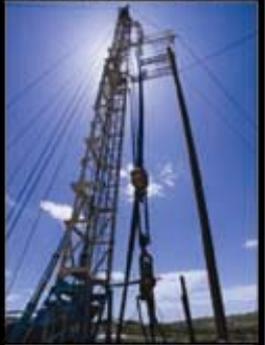


Geothermal Technologies Program 2010 Peer Review  
Arlington, VA, May 19, 2010

# System Modifications



- Changed system control to a source control loop with an additional control valve
- Installed vapor bypass line around turbine to ease unit starting when hot
- Installed thermocouples on generator bearings
- Heat traced air lines and all oil lines to prevent line plugging and oil thickening,
- Upgraded electrical supply and the ESPs in the production wells.
- To Be Done: Reduce air cooling capacity in winter

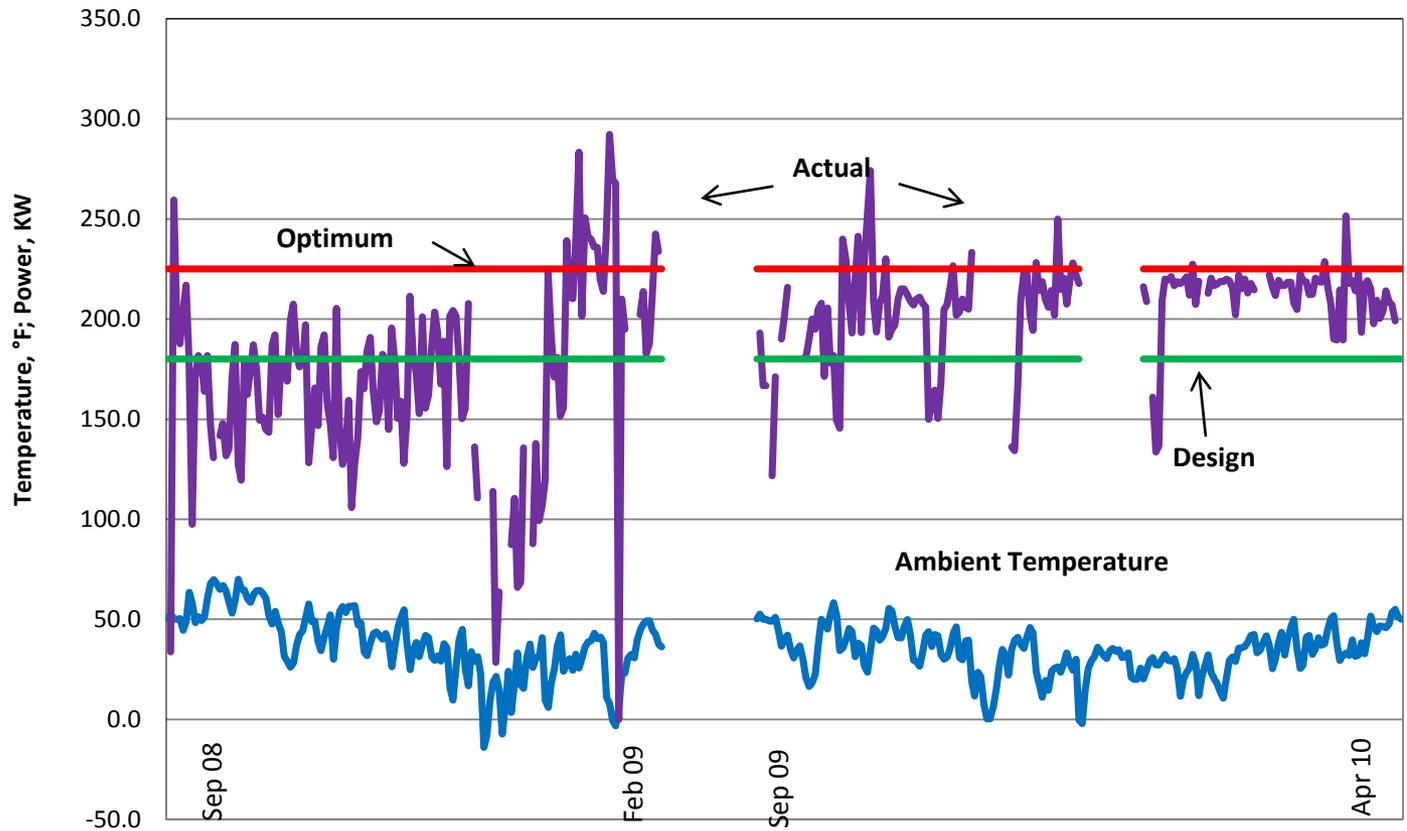


**RMOTC**

# Operational Trends

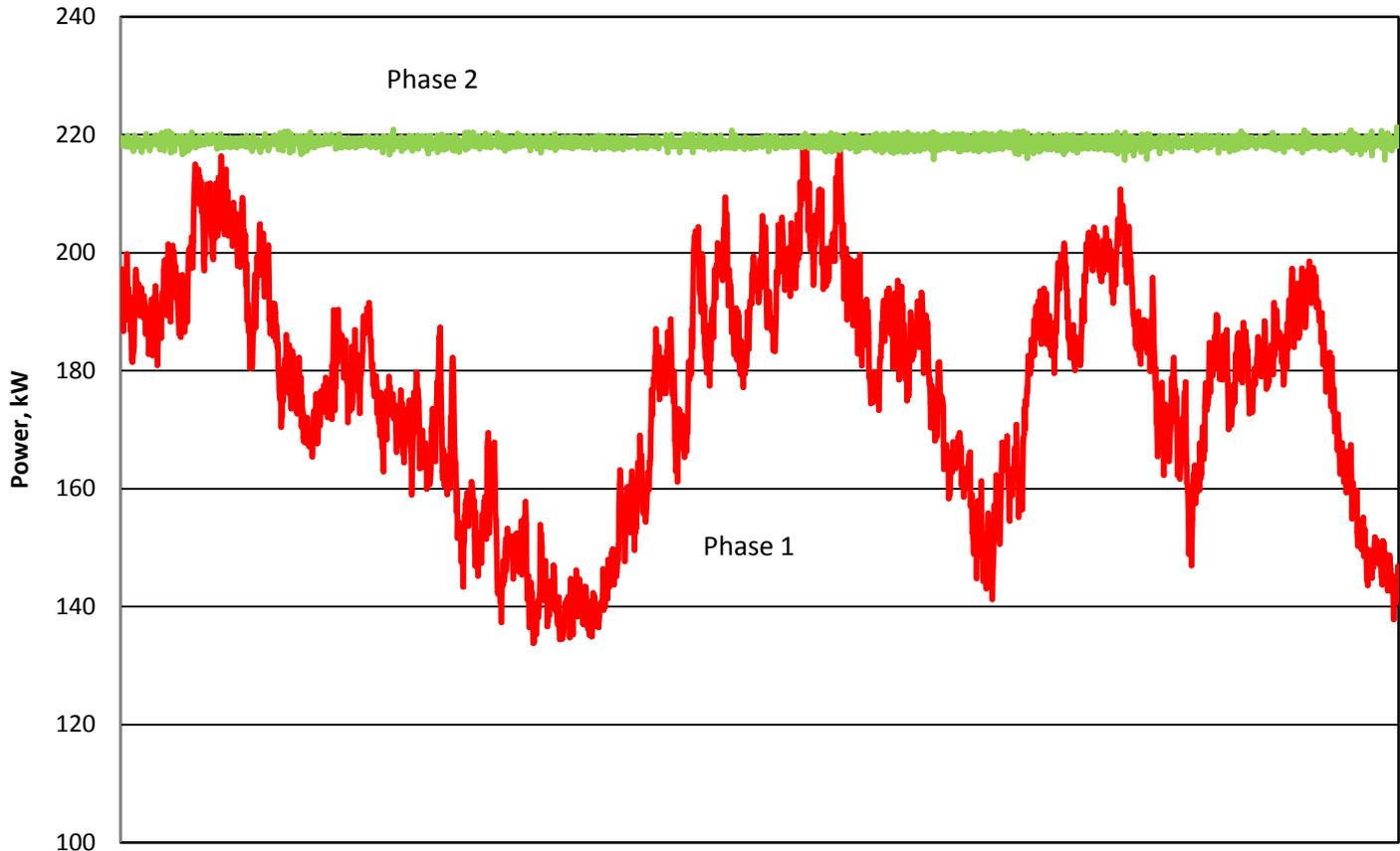


**RMOTC**



Geothermal Technologies Program 2010 Peer Review  
Arlington, VA, May 19, 2010

# Daily Power Fluctuation



**RMOTC**

Geothermal Technologies Program 2010 Peer Review  
Arlington, VA, May 19, 2010



# Project Management and Coordination



The project is in the 9<sup>th</sup> month of a 3 year collaborative agreement.

Half of the scheduled two large geothermal units scheduled for testing is operating. The decision on the second unit is pending resolution of issues on another GTP project.

Funding is at the planned level except for the second unit installation and testing.

The site is open to visitation by interested parties and has been visited by academia, industry and governmental parties.

3 presentations have been made and 3 are scheduled at geothermal, professional society and renewable meetings in FY10.

Data from testing has been provided to GTP and NREL personnel for evaluation and is available to the National Geothermal Data System.



**RMOTC**

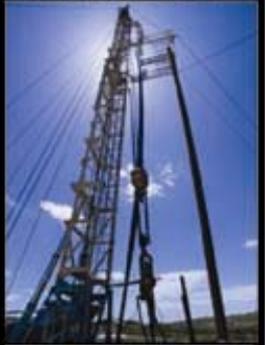
# Future Direction



Through a collaborative program with the U.S. DOE's Geothermal Technologies Program, RMOTC's infrastructure is being increased to permit:

- Continued operation of the existing 250kW unit (ORMAT) for a total of 3 years to look at long term operability issues
- Install a water cooled unit with associated cooling tower and operate for 3 years to look at long term operability issues
- Provide a testing facility for smaller scale prototype power production systems requiring either air or water cooling

Also analyzing infrastructure needs to provide an EGS testing facilities

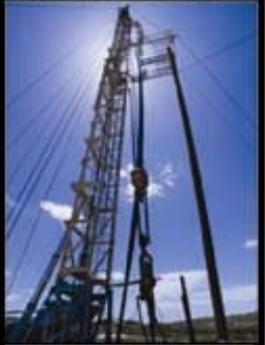


**RMOTC**

# Summary



- A geothermal power unit has been operating at RMOTC since September 2008 using co-produced fluid.
- Data has been provided to both GTP and NREL personnel for evaluation of the air-cooled system.
- The facility provides a cost-effective and third party development and demonstration facility.
- The project demonstrates to the Oil and Gas industry that geothermal units can be integrated into fields and operated by oil field personnel.
- This a collaborative effort by GTP (EERE) and RMOTC (FE) to assist in the development and deployment of a renewable technology.



**RMOTC**