Geothermal technologies
U.S. Department of Energy

DOE Selects Companies and Universities for EGS Projects

DOE has selected two geothermal operators to study the possible construction of new geothermal power plants in the western United States. DOE also has selected three university research proposals to enhance the department's geothermal R&D program. If successful, these projects will add 55 megawatts of electricity to the nation's power grid —enough to power 41,250 homes—and add next-generation geothermal exploration tools.

These actions support Energy Secretary Spencer Abraham's April 29, 2002 statement that developing and demonstrating enhanced geothermal technologies advance the president's National Energy Policy goals of deploying next-generation technology and increasing renewable energy production on federal lands.

The department will provide approximately $785,000 of fiscal year 2002 funds to the two commercial enhanced geothermal system (EGS) power plant projects that it selected from industry responses to a solicitation issued in March 2002 by DOE's Idaho Operations Office.

Calpine Siskiyou Geothermal Partners Ltd. will develop and demonstrate new EGS techniques at Glass Mountain in Siskiyou County, California. They will develop stimulation technology to extract energy from reduced permeability zones under the ground. If successful, the project could result in a geothermal power plant that produces 50 megawatts of electricity.

ORMAT Nevada, Inc., will develop and demonstrate EGS techniques at a prospective geothermal site east of the Desert Peak geothermal field in Churchill County, Nevada. They will fracture a low permeability zone under the ground to enable production of an estimated 2 megawatts to 5 megawatts of electricity. If successful, this project could have wide application to other geothermal sites in the Great Basin, because many sites in the west have similar subsurface characteristics.

The Glass Mountain and East Desert Peak Geothermal Plants will pay production royalties to the federal government.

The department also selected three universities' research proposals for enhancement of geothermal exploration tools. The department will provide approximately $600,000 of fiscal year 2002 funds. Resulting research by Southern Methodist University, University of Utah, and University of Wisconsin at Madison will support geoscience initiatives in EGS and geothermal exploration technology.

DOE made these selections from 21 research proposals submitted by universities in response to a solicitation issued by DOE's Idaho Operations Office. If additional funds become available, other university proposals may be selected for funding.

For more information, please contact Jay Nathwani, DOE Idaho Operations Office, nathwaj@inel.gov, 208.526.0239.

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OVERVIEW

The DOE-sponsored Geothermal Resource Exploration and Definition (GRED) program is a partnership with industry to identify new sources of geothermal power. Initial GRED activities began in August 2000 with the establishment of seven DOE cooperative agreements with various partners in four different states. A solicitation for a second round of GRED projects (GRED II) was released in April and awards for new projects will likely be made in August 2002. This ongoing collaboration between DOE and the U.S. geothermal industry has proven successful by promoting geophysical exploration, leading to the discovery and definition of new geothermal resources, thereby diversifying the geothermal electricity generation potential in the U.S.

GRED PROJECTS

GRED projects, which may include resources in currently non-producing states, resources from new locations in producing states, or even extensions of existing reservoirs into untapped regions, were selected for their potential to bring new geothermal electrical power on line. The locations of the seven projects are shown in the map in Figure 1. Projects are divided into three phases consisting of geophysical exploration (Phase I), drilling of a test well (Phase II), and evaluation of well performance (Phase III). However, some projects were sufficiently advanced that no additional exploration work was required; only an exploration report was needed to document site potential. A summary of each of the seven projects follows.

Figure 1. Map of current GRED project locations.

Rye Patch, NV (Presco Energy, LLC)

The Nevada Rye Patch project focuses on development of an abandoned high-temperature geothermal site with a nearly completed power plant. Since abandonment, new geophysical work has identified two target sites that could be sufficient to power the plant. This project funded the drilling and testing of a well to access one or more of the targets. The well was drilled by re-entering a pre-existing shallow well that had severe lost-circulation problems, using new foam technology to seal off the zone, and continued drilling to a target depth of 643 m, penetrating a limestone reservoir. Reservoir temperatures are around 150° C. An initial flow test produced excellent results and additional evaluation of the site is ongoing. Figure 2 shows a photograph of the well site during initial flow testing.

Figure 2. Rye Patch well during short flow test of the shallow limestone reservoir.

Blue Mountain, NV (Noramex Corp.)

The Nevada Blue Mountain project is a geothermal site identified during gold exploration. An approximately 650 m well was drilled to confirm the existence of a high-temperature geothermal reservoir associated with overlapping spontaneous potential, resistivity, and shallow temperature gradient anomalies, and to determine the reservoir's production characteristics. Figure 3 shows a photograph of the rig on site during drilling. Temperatures at depth are nearly 150° C and there is some evidence that the well may have intersected the target fault at intermediate depths. Evaluation of the site is continuing.

Figure 3. Drilling rig on site at Blue Mountain.

Cove Fort/Sulphurdale, UT (Utah Municipal Power Agency)

The Utah Cove Fort/Sulphurdale project entails locating and drilling a test well to explore the western extension of the Cove Fort/Sulphurdale geothermal area. Geophysical exploration consisted of resistivity, ground magnetic, and microgravity surveys that suggested the presence of fault structures and low resistivity zones, possibly indicating a major upflow zone for the geothermal system. A well was sited and drilled to a depth of 598 m, where temperatures reached about 157° C. The geologic structure observed during drilling is quite complicated and conditions are being evaluated.

Fourmile Hill, CA (Calpine Siskiyou Geothermal Partners, LP)

The California Fourmile Hill project near Glass Mountain is the focus of exploration work to characterize its resource. A Phase I temperature-gradient well was drilled to a total depth of 1346 m in order to aid in the assessment of the site. Several temperature logs were run and these indicated an equilibrium temperature exceeding 235° C. Phase II work will continue during the summer and fall of 2002. Figure 4 shows the final temperature log taken in this well. The temperature reversal is consistent with lateral outflow from a higher-temperature source.

Steamboat, NV (S B Geo, Inc.)

The Nevada Steamboat project investigates the existence of a shallow boiling reservoir in the northern Steamboat Hills and Steamboat Springs area. Two slim-hole wells were drilled, reaching total depths of 610 and 297 m. Several fracture zones were encountered with noticeably large fracture apertures observed in recovered core. Data from these two wells indicate a large thermal zone with temperatures comparable to nearby production wells. Testing of this reservoir is continuing, but preliminary data suggest that this area is very similar to productive intervals in the Steamboat Springs field to the north.

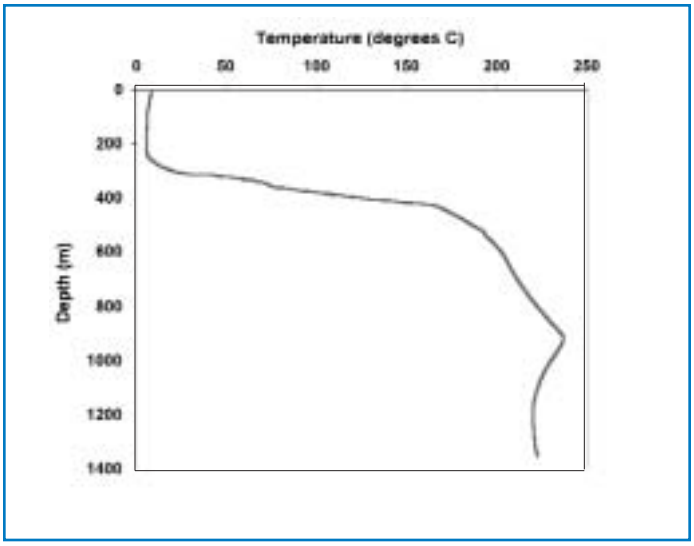

Figure 4. Temperature profile at Fourmile Hill temperature gradient well.

U-Boat, NV (Coso Operating Company, LLC)

The Nevada U-Boat project involves geophysical exploration of the deep geothermal resource beneath the Steamboat KGRA using seismic and gravity studies. The objective is to constrain the location of the deep fault system and productive zone at this site. Seismic data indicate that two major lineations of high velocity are running orthogonal to each other (presumably related to the fault system). Microseisms and gravity data appear to confirm the seismic structures. All of these results are being integrated into a final structural setting.

Lightning Dock, NM (Lightning Dock, Inc.)

The New Mexico Lightning Dock KGRA is currently used only for heating applications, but it is likely that higher-temperature waters are present in deeper fault systems. It is believed that major lineaments cross the geothermal region, providing pathways for movement of the hot water. Phase I exploration work included gravity, resistivity, and aeromagnetic surveys that have been assembled into a geologic interpretation which is now being used (along with other new geophysical information) to site a test well. Drilling of the well will take place this year.

CONCLUSIONS AND FUTURE WORK

The GRED projects are continuing into their third year of activity, with good progress in all of them. Future work includes completion of these seven projects and initiation of several new GRED II projects. The focus of GRED II is on previously undiscovered geothermal resources. Successful projects should be announced in August 2002.

For more information, please contact Norm Warpinski, NRWARPI@sandia.gov, 505.844.3640.

DOE will provide $12,608,524 to 47 states and three territories for 138 energy efficiency and renewable energy projects. The department is providing the funding through its State Energy Program Special Projects competitive grants.

Promoting Direct Use Development of Utah's Geothermal Resources

The goal of this project is to encourage further development of Utah's geothermal resources by providing readily available information and increasing the awareness of commercial opportunities. The three components of this project are: 1. Review and document the economics of selected, successful direct-use geothermal operations in Utah by determining critical project parameters and impediments to development. 2. Improve access to both geothermal resource information in Utah and development opportunities through an Internet site containing comprehensive information about geothermal resources, technologies, and economics of selected geothermal direct-use projects in Utah. 3. Improve knowledge and awareness of geothermal development opportunities in Utah by hosting a regional geothermal conference in Salt Lake City to highlight recent developments throughout the Great Basin and Intermountain regions. DOE Funding $87,812.

Idaho Geothermal Energy Development

Through this project, the Idaho Department of Water Resources will develop trade missions into Idaho communities that have greater geothermal water resources. Information will be developed to explain to these communities the geothermal potential and how to develop the resource. DOE Funding $100,000.

New Mexico Geothermal Clearinghouse

The objective of this project is to establish, manage, and publicize a Geothermal Information Clearinghouse for New Mexico. The purpose and goal of the clearinghouse is to provide a readily accessible source for a broad range of practical geothermal information that can be used by future developers as well as current geothermal businesses. The clearinghouse will include concise and specific information on New Mexico's geothermal resource base, low-temperature reservoir management for the direct-use operator, and the steps required to lease and permit various aspects of geothermal development. DOE Funding $50,000.

Alaska State Geothermal Energy Support

This project has the three following activities: (1) Resource assessment to update past work statewide with current opportunities. This activity will identify communities that are the most promising candidates for geothermal energy projects. (2) Site-specific feasibility investigations. (3) Program support. DOE Funding $75,000.

For more details on all of these projects, please contact Curtis Framel, DOE Seattle Regional Office, curtis.framel@ee.doe.gov, 206.553.7841.

New geothermal resource maps for Idaho and New Mexico have been completed by the Idaho National Engineering and Environmental Laboratory, with assistance from local experts. Maps for Utah, Washington, Oregon, and Nevada are nearing completion. Work has begun on a geothermal resource map for Alaska, and the Arizona map work will soon begin. A regional resource map for the western states also has been initiated, and maps for Hawaii, Montana, Wyoming, and Colorado will soon be underway to complete the region.

The Idaho and New Mexico maps are available for viewing on the INEEL geothermal website at geothermal.inel.gov/maps-software. For hard copies, please send requests to Pat Laney at ptl@inel.gov, 208.526.7468.

ully Silicon-On-Insulator ool Is Fielded

Aircraft engine Silicon-On-Insulator (SOI) technology advancements, commercialized by Honeywell, have pushed electronic temperature performance as high as 300° C. However, aircraft control electronics are missing two components necessary for high-temperature well logging: a digital circuit for storing large amounts of data, and high-temperature batteries. Sandia National Laboratories (Sandia) has developed a digital circuit suitable for logging named the HT83SNL00. A photo of the circuit is shown in Figure 1.

Figure 1. Photo of the HT83SNL00.

The HT83SNL00 can store up to 500 Kbytes of data. It also contains a built-in logging tool program, the capability to address 48 analog sensor readings, nine frequency counters, and the logic needed to monitor a spinner for a basic pressure/temperature/spinner tool. Using the HT83SNL00 circuit and other SOI devices, a simple pressure/temperature (PT) tool was built and tested.

A geothermal well log was completed in November 2001 (Figure 2). The well maximum temperature was 240°C and the tool was left in the well for approximately 40 hrs. Two other wells were also logged at 200°C and 210°C in predated testing. After the November logging, the tool was placed in an oven at 225°C for 1200 hours, then 250°C for an additional 500 hours.

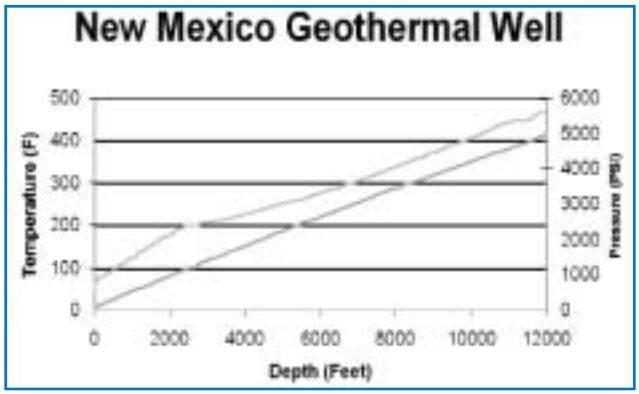

Figure 2. PT log data from SOI tool test.

The testing produced three important outcomes:

–SOI electronics are very capable of operating at these temperatures. Data from Honeywell suggests that the expected operating life is 2 years at 250°C.

–Capacitor design margins had to be increased. In future tools, 100-volt-rated capacitors will be used in place of 50-volt-rated capacitors, even when the operating voltage is only 10 volts.

–Measurement drift was seen. Later testing discovered that it was caused by thick-film resistors drift. Wire-wound resistors will replace thick metal film resistors in future tools. Initial laboratory testing has shown several orders of magnitude reduction in resistance drift using wire-wound resistor technology.

The initial well logs used a wire line. Using the full potential of this technology will require operating from a slick line, which will require high-temperature batteries. Prototype batteries are expected in 2003. The new battery will be a hybrid of two battery technologies, ceramic and thermal. Ceramic batteries have been demonstrated to provide small amounts of current (to keep memory alive, e.g., your PC clock battery) from room temperature to 500°C. Thermal batteries start working at temperatures above 150°C and continue to provide useable power up to 250°C in actual testing, but also should continue to work up to 300°C. Two commercial partners are involved in this project: General Atomics for ceramic batteries and Eagle-Picher Industries for thermal batteries.

Benefits of this technology include:

1. Reduced $$$ risk to operators. Tool loss due to heat damage inside the well will be eliminated or reduced, and there will be a higher likelihood of recovering lost tools.

2. Wells will not require cooling before logging. Most oil and gas tools require the well to be cooled before logging.

3. Increased time downhole. Casing inspection tools work best when they are run slowly. Continuous down-hole monitoring for production testing will be possible. New MWD tools will improve geothermal drilling.

4. Reduced tool diameters. The double walls of the heat shield housing can be eliminated.

5. Potential for 500°C—600°C well log. If high-temperature electronics are placed inside a heat shield (Dewar), then even higher temperatures can be realized.

6. New geothermal solutions yet to be realized.

To date, Sandia has given HT83SNL00 documentation to eight companies. It is our intention to help them build their first SOI tool and get over the initial R&D investment in SOI technology.

For more information, please contact Randy Normann, RANORMA@sandia.gov, 505.845.9675.

An R&D 100 Award was presented jointly to Brookhaven National Laboratory (Dr. Toshi Sugama), the National Renewable Energy Laboratory (Dr. Keith Gawlik), Ticona Corporation, and Bob Curran & Sons Corporation for the high-performance polyphenylenesulfide (PPS) coating system, now being marketed under the trade name CurraLon.

For more information, see the article in the December 2000 issue of Geothermal Technologies (http://www.eren.doe.gov/geothermal/geopressroom.html) or contact Keith Gawlik at keith_gawlik@nrel.gov, 303.384.7515.

Technical Exchange Group On Structural Performance of ell Cements

Long-term integrity of geothermal wells requires that cements maintain structural capacity. Design and selection of appropriate cements to meet this requirement need to be based on engineering analysis. Brookhaven National Laboratory (BNL) is currently conducting research in this area of geothermal cements for DOE. The objective of this research is to develop a comprehensive design and implementation approach for selection of cements through integrated experimental testing, modeling, and end-user input. The performance of geothermal cements is being investigated in terms of both materials and structural engineering. Conventional and advanced cement formulations are being studied. Numerical models are employed to evaluate the response to temperature and pressure loads.

BNL plans to form a Technical Exchange Group to deal with issues related to material behavior and structural response of high-temperature well cements, and to coordinate efforts between the geothermal and petroleum industries on this subject. The group will exchange information on such topics as design approaches and criteria, material property testing procedures, modelling of well cement response, cement property requirements, practical experience with cement failures and prevention, and other issues of common interest. The primary focus will be on mechanical and thermoelastic (rather than chemical) properties of hardened cements. Formation of this group represents an important opportunity for involvement of industry members in BNL's research so that existing and future needs can be addressed.

Any person or organization wishing to actively participate in this Technical Exchange Group should contact either Dr. Marita Berndt (631.344.3060, allan@bnl.gov) or Dr. Mike Philippacopoulos (631.344.6090, ajph@bnl.gov) for further information.

The first meeting of the National Geothermal Collaborative (NGC) was convened on July 17, 2002, in Denver, Colorado. Resolve, Inc., through a grant from the DOE Geothermal Technologies Program, leads the NGC effort.

The purpose of the NGC is to bring together stakeholders interested in geothermal energy development. The collaborative will work toward the responsible development of geothermal power and direct use in the U.S by identifying issues that impact the use of geothermal energy, and by establishing a dialogue among stakeholders to catalyze activities.

Some of the elements of the NGC vision are:

- a clear federal mandate for renewable energy
- 1000 megawatts of geothermal power in development by 2007
- a streamlined permitting process
- a production tax credit for geothermal energy
- greater resource exploration
- direct use doubled by 2012

With approximately 20 members, the NGC currently includes individuals who represent the geothermal industry, academia, public and investor-owned utilities, environment and energy-interest organizations, state legislative groups, tribes, the Council on Environmental Quality, the U.S. Departments of Interior and Energy, and others.

Resolve, Inc., is a non-profit organization specializing in environmental dispute resolution, mediation, consensus building, facilitation, conflict resolution, and policy dialogue. Resolve facilitates the successful collaborative for the wind energy community, the National Wind Coordinating Committee.

Any individual interested in supporting geothermal energy development in the U.S. is encouraged to become a member of the NGC. The first general meeting of the NGC, open to all geothermal stakeholders, is planned for Fall 2002. More information will be available in September on the GeoPowering the West website: www.eren.doe.gov/geothermal.

For further information on the NGC, please contact Susan Norwood, DOE Geothermal Technologies Program, 202.586.4779, susan.norwood@ee.doe.gov, or Mike Hughes, Resolve, Inc., 303.861.1500, mhughes@resolv.org.

orking Group

DOE, the Western Area Power Administration, Sandia National Laboratories, and other regional and national partners involved in GeoPowering the West will host a one-day organizational meeting on August 21, 2002, to explore the opportunities of using geothermal energy in Arizona.

Objectives are to:

– Understand the opportunities for and barriers to advancing geothermal power in Arizona, and

– Create a team of Arizona stakeholders that can address these issues and facilitate geothermal advancement by working in technology, finance, regulatory, policy, and other areas.

All are welcome to attend this no-charge meeting, to be held at the WAPA offices in Phoenix. To register, contact Roger Hill, GPW Technical Director, at rrhill@sandia.gov.

owering the West—
ashington Update

The kickoff meeting for activities in Oregon and Washington under the GeoPowering the West (GPW) initiative was held in Portland on June 20, 2002. The event featured a morning session of technical presentations followed by a stakeholder working session in the afternoon. Approximately 75 attendees representing private sector developers, system owners, government, and the public gathered to discuss opportunities and barriers to expanded geothermal development in the Northwest. Organization and coordination for the event was provided by Gordon Bloomquist of the Washington State University Energy Program, Kevin Rafferty of the Geo-Heat Center, Pacific Northwest GRC president Al Waibel of Columbia Geoscience, and Curtis Framel of the DOE Seattle Regional Office.

The morning session began with an update from national GPW coordinator Susan Norwood and DOE regional representative Curtis Framel. Also included were presentations on resources of the region (Joe LaFleur), geothermal power plants (Gordon Bloomquist), the power developer's perspective (Hiram Bingham), direct use (Kevin Rafferty), federal land issues (Paul Dunlevy), renewable portfolio standards (Jon Wellinghoff), Oregon's geothermal policy (Michael Grainey), and financing (Liz Battocletti).

The afternoon session was devoted to identifying key issues related to development of electric power projects in the Northwest. The primary issues identified by the group were: 1.) awareness/education (public, legislature, local benefits, etc); 2.) electricity marketing issues (costs, state RPS, long-term contracts); and 3.) national/federal issues (leasing, PTC, national renewable portfolio, etc).

A second working group meeting is planned for the near future to flesh out the strategic plan, develop tasks, and identify action items. Key regional geothermal representatives will be meeting at the Reno GRC meeting in September.

A draft of a regulatory guidebook has been written and is out for review to the state agencies. It includes a summary of the regulatory situation in Oregon relating to well drilling, construction, water rights, fluid disposal (surface and injection), and all necessary applications and forms. The document is intended to serve as a geothermal-specific guide for potential direct use developers. A proposal is also under development to the Oregon Energy Trust for funds to permit a geothermal presence at key energy events and public gatherings around the state. Geothermal energy, previously omitted from the Natural Resources section of the Oregon State web site has now been added with a link to the Geo-Heat Center's site.

Primary contacts for the working group are Gordon Bloomquist (bloomquistr@energy.wsu.edu) and Kevin Rafferty (raffertk@oit.edu).

orking Group

The Idaho Geothermal Energy Working Group has developed their Strategic Plan, which also includes initial action plans for each of the strategies. Subcommittees were set up for each of the strategies, and subcommittee chairs are now identifying and getting commitments from Idaho stakeholders to serve on the subcommittees. An IGEWG Steering Committee meeting is planned for September in Boise.

The group also developed a mission statement: "to continue Idaho leadership in innovative development and effective utilization of the state's geothermal heat resources for direct use, power generation, and cascading applications."

The committee developed the following draft objectives:

1. Educate the stakeholders and increase public awareness of Idaho's geothermal energy resources, rules, laws, benefits, and cost-effective applications.

2. Organize an Idaho Geothermal Energy Working Group and implement a strategic plan.

3. Promote water policies that encourage the use and development of geothermal energy.

4. Promote the establishment of laws, legislation, and policies that encourage the development of geothermal energy for direct use, power generation, and cascading applications.

The new six-story Ada County Courthouse and Administration Building in Boise, Idaho, is heated by geothermal water supplied by the City of Boise. Since the building came on line in October 2001, the system heats the building on moderately cold days. When temperature falls below 20 degrees, boilers assist the geothermal heating system. (Photo by Ken Neely, Idaho Department of Water Resources)

5. Increase technical knowledge and understanding of Idaho's geothermal resources and their uses.

6. Promote financial assistance for geothermal energy projects.

7. Promote innovative and broader use of geothermal energy.

8. Promote opportunities for geothermal electric power development.

A Group Structure and Operating Guide was also drafted. The guide explains how the group is structured, and how it is going to operate in order to implement the various action plans contained in the strategic plan.

For more information, please contact Bob Neilson, rmn@inel.gov, 208.526.8274.

On Wednesday, June 19 at the Solar 2002 Conference in Reno, Nevada, approximately 40-50 people attended a 1-1/2 hour Geothermal Technology Panel. Chaired by Dr. Chuck Kutscher of NREL, the session included 15-minute presentations by three Nevada geothermal experts, followed by a panel discussion. Jon Wellinghoff of Beckley Singleton presented an "Overview of Geothermal Technologies and Potential." Dan Schochet of ORMAT International, Inc., presented "Geothermal Electric Power Generation." He showed examples of many binary-cycle plants around the world and explained how the same power cycle technology can also work with solar energy heat input. Finally, Larry Green of Empire Energy LLC presented "Geothermal Industrial Direct Use and Geothermal Heat Pumps." He described the successful use of geothermal energy for onion and garlic dehydration in Empire, Nevada, and also explained the economics of geothermal heat pump systems. The panelists fielded many questions from the enthusiastic audience and continued an informal dialogue with audience members long after the session had ended.

For more information, please contact Chuck Kutscher, chuck_kutscher@nrel.gov, 303.384.7521.

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