

Exhibit A Work Statement

TECHNICAL TASK LIST

Task #	CPR	Task Name
1	N/A	Administration
2		Design and Fabrication of the Bottom Hole Assembly
3		Specification and Assembly of Complete Drill Rig
4	X	Field Site Preparation
5		Field Trials
6		Research on Advanced Heating Technologies

KEY NAME LIST

Task #	Key Personnel	Key Subcontractor(s)	Key Partner(s)
1	Jared Potter – Potter Drilling Inc. Don Dreesen – Potter Drilling Inc. Jason Unzelman-Langsdorf – Potter Drilling Inc. Olivier Brzozowski – Potter Drilling Inc.	N/A	N/A
2	Jared Potter – Potter Drilling Inc. Thomas Wideman – Potter Drilling Inc. Don Dreesen – Potter Drilling Inc. Robert Potter – Potter Drilling Inc. Jim Basler – Potter Drilling Inc. Bill Bauer – Potter Drilling Inc. Nick Sazdanoff – Potter Drilling Inc. Jason Unzelman-Langsdorf – Potter Drilling Inc. Eugene Sevillo – Potter Drilling Inc. Conrad Pasion – Potter Drilling Inc. Olivier Brzozowski – Potter Drilling Inc.	N/A	N/A
3	Jared Potter – Potter Drilling Inc. Thomas Wideman – Potter Drilling Inc. Don Dreesen – Potter Drilling Inc. Jim Basler – Potter Drilling Inc. Bill Bauer – Potter Drilling Inc. Jason Unzelman-Langsdorf – Potter Drilling Inc. Eugene Sevillo – Potter Drilling Inc. Olivier Brzozowski – Potter Drilling Inc.	N/A	AmKin Technologies, LLC
4	Jared Potter – Potter Drilling Inc. Thomas Wideman – Potter Drilling Inc. Don Dreesen – Potter Drilling Inc.	N/A	Wellco Drilling, Inc.

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	Jason Unzelman-Langsdorf – Potter Drilling Inc Eugene Sevillo – Potter Drilling Inc Olivier Brzozowski – Potter Drilling Inc.		
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6		N/A	Cornell University

GLOSSARY

Specific terms and acronyms used throughout this scope of work are defined as follows:

Term/ Acronym	Definition
BHA	Bottom Hole Assembly
CPR	Critical Project Review
CTU	Coiled Tubing Unit
DIC	Downhole Instrumentation and Controls
DOC	Depth of Cut
DOD	Department of Defense
DOE	Department of Energy
EGS	Enhanced Geothermal Systems
Energy Commission	California Energy Commission
GPM	Gallons Per Minute
OD	Outer Diameter
PIER	Public Interest Energy Research
PSI	Pounds per Square Inch
RD&D	Research, Development and Demonstration
ROP	Rate of Penetration
RPM	Revolutions Per Minute (rotary speed)
SGA	Steam Generation Assembly

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Problem Statement:

The cost of drilling wells with conventional technologies is a major barrier to the economic viability of Enhanced Geothermal Systems (EGS). Using conventional rotary bit technologies, drilling costs increase exponentially with depth. Broad-based deployment of EGS technology requires boreholes drilled to a depth of 10 km (roughly 30,000 ft) or more, at which point the cost of conventional drilling can constitute more than 60% of total capital expenditure. Recent analyses of EGS well construction have shown that the largest cost drivers include rate of penetration (ROP), tripping time for bit replacement, bottom hole assembly handling time, and casing and completion. Reducing these cost drivers in hard rock environments is necessary to make EGS competitive with other forms of base load energy.

In addition, exploratory drilling expenses for both EGS and conventional geothermal energy are excessive. The cost of a 6,000 ft exploratory wellbore with a 4-inch bottom hole diameter may be as much as one third of the cost of a full production wellbore. These high exploration costs amplify the risks of developing unproven geothermal resources, thereby making geothermal energy difficult to finance within the private sector.

Potter Drilling's Hydrothermal Spallation technology is a revolutionary solution to reduce the current high cost of drilling for Enhanced Geothermal Systems (EGS) and geothermal exploration.

Hydrothermal Spallation technology utilizes a jet of superheated fluid to bore through rock, achieving substantial increases ROP with virtually no mechanical wear on the drilling assembly compared to conventional rotary drilling technology. Increasing ROP through deep hard rock by an order of magnitude, while also eliminating the contact and wear that necessitates drill string tripping, will push EGS deployment across a major economic threshold – one that may be unreachable through incremental advances in conventional rotary drilling.

Potter Drilling is currently the only company in the world to have successfully developed Hydrothermal Spallation drilling, including successfully demonstrating a laboratory prototype drill capable of producing 4-inch boreholes in solid granite. Other laboratory experiments have shown the effectiveness of the technology in a variety of rock types and under pressures ranging from ambient atmospheric pressure to 3500 Pressure per Square Inch (PSI) (simulating a borehole depth of 7500 ft).

Scientific and technological barriers:

Conventional rotary drilling technology, even with the benefit of incremental advances, is unlikely to achieve the performance needed to enable widespread use of geothermal energy at acceptable and predictable costs. Rotary drilling uses a rotating drill string to turn bits which crush, scour, or shear the exposed surface. The rate of penetration of traditional drilling techniques in hard rocks is the product of the depth-of-cut (DOC) and the rate per minute (rotary speed) (RPM) of the bit. In deep hard rock, such as granites,

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metamorphic rocks, or dense sandstones, which are the target formations for geothermal reservoirs, both DOC and RPM are limited, and the ROP is typically less than 10 ft/hr. In addition, bit and drilling assembly wear, drill string fatigue, and parted tool joints in these hard rocks are frequent, often requiring bit replacement and drill assembly maintenance after only a few hundred feet of penetration. To replace the bit, hundreds of sections of steel drill string must be pulled out and reinserted (tripping), resulting in huge increases in drilling time and cost, especially at depth. For ultra-deep wells (>20,000 ft in depth), more time may be spent tripping than actually drilling rock. Furthermore, the ROP for rotary drilling systems typically reduces with depth, as vibration and friction of the drill string against the wellbore reduce the capacity to control the weight-on-bit and rotary speed needed to maintain optimal drilling penetration and preclude damage to the bit. In addition to low ROP, rotary drilling is beset with unpredictable and very costly “trouble time” in deep, high temperature hard rock drilling.

An alternative to more conventional rotary and slide drilling is the use of air and mud powered downhole hammers and percussion drill bits. These methods have promised the highest penetration rates in hard rock of any mechanical drilling process. Unfortunately, the high performance observed in laboratory scale demonstrations and shallow drilling has not been consistently duplicated in the field using any of the downhole mud hammers presently available.

Of all the non-conventional drilling technologies being developed, thermal spallation drilling has demonstrated the greatest success in the field. As previously described, the Department of Defense (DOD) funded air spallation field trials conducted by Bob Potter and Browning Engineering in the 1980's, produced 8- to 12-inch boreholes to a depth of 1000 ft at rates in excess of 50 ft/hr in solid granite. At some points, ROP exceeded 100 ft/hr.

By increasing ROP significantly and eliminating contact stress on the drill bit, Potter Drilling's Hydrothermal Spallation technology addresses the two primary barriers that impede the use of conventional drilling for EGS applications. Past experience with flame-jet technology in air-filled boreholes has shown that thermal spallation can achieve ROP of 50 ft/hr, possibly *increasing* with depth. At 30 ft/hr, Potter Drilling's current target ROP for a 1000 ft. borehole is many times faster than the expected ROP for conventional rotary drilling technology under similar conditions. Furthermore, the Potter Drilling system improves on previous spallation techniques by operating a steam catalyst in a fluid-filled borehole. The air-filled borehole produced by flame-jet spallation diminishes borehole stability and greatly complicates the extraction of solid cuttings. *Hydrothermal Spallation*, an approach unique to Potter Drilling, addresses both of these challenges by maintaining constant circulation of fluid through the borehole.

Market barriers:

The technology currently employed by geothermal drillers is not ideal because it was designed for use in shallow, low temperature, sedimentary environments typical of oil

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and gas drilling applications. The market size for geothermal drilling technology, estimated at \$500M,¹ is miniscule in comparison to the \$70B² world oilfield equipment market. Because of the disparity in market size, incumbent drilling technology developers have little incentive to spend the capital required to adapt their technology to the deep, high temperature, hard rock environments encountered in geothermal drilling applications.

Lowering the cost of geothermal exploration and EGS development will significantly contribute to meeting the goals of SB 1078 passed in 2002 and creating employment in California. This project is expected to overcome the identified technical and market barriers in order to lower geothermal drilling costs and to help achieve these important policy goals and public benefits.

Goals of the Agreement:

The primary goal of this Agreement is to develop a fully-operational, field-ready prototype Hydrothermal Spallation drilling unit that can be used immediately for slim-hole hard rock drilling. This goal will be reached by applying Potter Drilling's technology to a coiled tube drilling unit and testing it in the field. The secondary goal of this Agreement is to research downhole chemical heating processes and fast mineral dissolution/re-precipitation kinetics that will lay the foundation for future commercial-scale operations of Hydrothermal Spallation technology drilling units. This goal will be reached through research conducted by Prof. Jefferson's Tester Group at Cornell University.

Objectives of the Agreement:

The objective of this Agreement is to drill three 4-inch boreholes to 1000 ft in the field using the Hydrothermal Spallation system. Another objective is to determine if the system is suitable for moving to a full-scale, commercialization-ready design and demonstration. Specifically, successful Hydrothermal Spallation drilling system verification will be based on meeting the following performance criteria:

- Demonstrated means to achieve ROP of 30 ft/hr.
- Bottom hole tool hardware survivability in excess of 120 hours of drilling time.
- Predicted cost and completion time that provides an advantage over conventional slim-hole drilling technologies.
- Determination of the drill's performance specifications under real-world conditions to allow scaling to typical production borehole diameters.

The last objective of this Agreement is to advance concepts for next-generation chemical heating processes and downhole mineral kinetics needed to optimize the performance of next-generation, full-scale Hydrothermal Spallation systems. Specifically, the success of this research will be based on meeting the following criteria:

¹ Estimated using a production drilling cost of \$1000/kW and 500 MW of geothermal capacity brought online per year.

² World Oilfield Equipment market research report # FG2046966. Freedonia Group Inc., Nov 1 2008.

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- Experimental measurements of catalyzed hydrothermal combustion reactions, including reaction enthalpies, combustion products and reaction by-products.
- Experimental determination of catalyst lifetimes, cause of catalyst deactivation, and evaluation of downhole regeneration procedures.
- Experimental measurements of the ultra-fast kinetics of dissolution and precipitation/recrystallization of minerals and basement rocks in conditions representative of downhole heat exchangers.
- Development of a computation model to predict the mineral dissolution and precipitation processes more accurately.

Product Guidelines:

For complete product guidelines, refer to Section 5 in the Terms and Conditions.

TASK 1 ADMINISTRATION

Task 1.1 Attend Kick-off Meeting

The goal of this task is to establish the lines of communication and procedures for implementing this Agreement.

The Recipient shall:

- Attend a “Kick-Off” meeting with the Commission Project Manager, the Grants Officer, and a representative of the Accounting Office. The Recipient shall bring its Project Manager, Agreement Administrator, Accounting Officer, and others designated by the Commission Project Manager to this meeting. The administrative and technical aspects of this Agreement will be discussed at the meeting. Prior to the kick-off meeting, the Commission Project Manager will provide an agenda to all potential meeting participants.

The administrative portion of the meeting shall include, but not be limited to, the following:

- Discussion of the terms and conditions of the Agreement
- Discussion of Critical Project Review (Task 1.2)
- Match fund documentation (Task 1.6)
- Permit documentation (Task 1.7)

The technical portion of the meeting shall include, but not be limited to, the following:

- The Commission Project Manager’s expectations for accomplishing tasks described in the Scope of Work
- An updated Schedule of Products
- Discussion of Progress Reports (Task 1.4)

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- Discussion of Technical Products (Product Guidelines located in Section 5 of the Terms and Conditions)
- Discussion of the Final Report (Task 1.5)

The Commission Project Manager shall designate the date and location of this meeting.

Recipient Products:

- Updated Schedule of Products (no draft)
- Updated List of Match Funds (no draft)
- Updated List of Permits (no draft)

Commission Project Manager Product:

- Kick-Off Meeting Agenda

Task 1.2 Critical Project Review (CPR) Meeting

The goal of this task is to determine if the project should continue to receive Energy Commission funding to complete this Agreement and to identify any needed modifications to the tasks, products, schedule or budget.

CPRs provide the opportunity for frank discussions between the Energy Commission and the Recipient. CPRs generally take place at key, predetermined points in the Agreement, as determined by the Commission Project Manager and as shown in the Technical Task List above. However, the Commission Project Manager may schedule additional CPRs as necessary, and any additional costs will be borne by the Recipient.

Participants include the Commission Project Manager and the Recipient and may include the Commission Grants Officer, the Public Interest Energy Research (PIER) Program Team Lead, other Energy Commission staff and Management as well as other individuals selected by the Commission Project Manager to provide support to the Energy Commission.

If the Department of Energy (DOE) is conducting a similar meeting, the Recipient shall notify and invite the Commission Project Manager to participate, either by teleconference or by actual meeting attendance. The DOE required meeting (Go/No-GO) can be used in place of the Commission's CPR meeting, at the discretion of the Commission project manager.

The Commission Project Manager shall:

- Determine the location, date, and time of each CPR meeting with the Recipient. These meetings generally take place at the Energy Commission, but they may take place at another location.
- Send the Recipient the agenda and a list of expected participants in advance of each CPR. If applicable, the agenda shall include a discussion on both match funding and permits.

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- Conduct and make a record of each CPR meeting. One of the outcomes of this meeting will be a schedule for providing the written determination described below.
- Determine whether to continue the project, and if continuing, whether or not modifications are needed to the tasks, schedule, products, and/or budget for the remainder of the Agreement. Modifications to the Agreement may require a formal amendment (please see the Terms and Conditions). If the Commission Project Manager concludes that satisfactory progress is not being made, this conclusion will be referred to the Energy Commission's Research, Development and Demonstration (RD&D) Policy Committee for its concurrence.
- Provide the Recipient with a written determination in accordance with the schedule. The written response may include a requirement for the Recipient to revise one or more product(s) that were included in the CPR.

The Recipient shall:

- Prepare a CPR Report for each CPR that discusses the progress of the Agreement toward achieving its goals and objectives. This report shall include recommendations and conclusions regarding continued work of the projects. This report shall be submitted along with any other products identified in this scope of work. The Recipient shall submit these documents to the Commission Project Manager and any other designated reviewers at least 15 working days in advance of each CPR meeting.
- Present the required information at each CPR meeting and participate in a discussion about the Agreement.
- Recipient will provide copies of any DOE correspondence (emails, reports, letters, etc.) that relate to the project status. This includes copies of project performance reviews on Recipient work and summaries and results of project review meetings with DOE.

Commission Project Manager Products:

- Agenda and a list of expected participants
- Schedule for written determination
- Written determination

Recipient Product:

- CPR Report(s) (no draft)
- DOE correspondence and reporting

Task 1.3 Final Meeting

The goal of this task is to closeout this Agreement. If DOE is conducting a similar final meeting, the Recipient shall notify and invite the Commission project manager to participate, either by teleconference or by actual meeting attendance. The DOE required meeting can be used in place of the Commission's final meeting, at the

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discretion of the Commission Project Manager. However, all items listed in this task will need to be covered in the meeting.

The Recipient shall:

- Meet with Energy Commission staff to present the findings, conclusions, and recommendations. The final meeting must be completed during the closeout of this Agreement.

This meeting will be attended by, at a minimum, the Recipient, the Commission Grants Office Officer, and the Commission Project Manager. The technical and administrative aspects of Agreement closeout will be discussed at the meeting, which may be two separate meetings at the discretion of the Commission Project Manager.

The technical portion of the meeting shall present an assessment of the degree to which project and task goals and objectives were achieved, findings, conclusions, recommended next steps (if any) for the Agreement, and recommendations for improvements. The Commission Project Manager will determine the appropriate meeting participants.

The administrative portion of the meeting shall be a discussion with the Commission Project Manager and the Grants Officer about the following Agreement closeout items:

- What to do with any equipment purchased with Energy Commission funds (Options)
- Energy Commission's request for specific "generated" data (not already provided in Agreement products)
- Need to document Recipient's disclosure of "subject inventions" developed under the Agreement
- "Surviving" Agreement provisions, such as repayment provisions and confidential Products
- Final invoicing and release of retention
- Prepare a schedule for completing the closeout activities for this Agreement.
- Copies of all correspondence and reports discussing DOE's findings on the project, and future disposition of the project, if applicable. Recipient will provide copies of any DOE correspondence (emails, reports, letters, etc.) that relate to project performance.

Products:

- Written documentation of meeting agreements (no draft)
- Schedule for completing closeout activities (no draft)
- DOE correspondence on project findings and results

Task 1.4 Quarterly Progress Reports

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The goal of this task is to periodically verify that satisfactory and continued progress is made towards achieving the research objectives of this Agreement on time and within budget.

The objectives of this task are to summarize activities performed during the reporting period, to identify activities planned for the next reporting period, to identify issues that may affect performance and expenditures, and to form the basis for determining whether invoices are consistent with work performed.

If Recipient is submitting a Progress Report to DOE, this Progress Report can fulfill the Energy Commission's required report, if it contains the information listed in Attachment 1 of the Terms and Conditions.

The Recipient shall:

- Prepare Quarterly Progress Reports which summarize all Agreement activities conducted by the Recipient for the reporting period, including an assessment of the ability to complete the Agreement within the current budget and any anticipated cost overruns. Each progress report is due to the Commission Project Manager within 10 days of the end of the reporting period. The recommended specifications for each progress report are contained in the terms and conditions of this Agreement.
- Unless otherwise directed by the Commission Project Manager, each Progress Report must contain any reports made to DOE, including summaries of meetings with DOE, as it relates to the project outcome and performance. Include names and contacts of DOE representatives.

Product:

- Quarterly Progress Reports (no draft)
- Copies of DOE reporting and meeting summaries

Task 1.5 Final Report

The goal of the Final Report is to assess the project's success in achieving its goals and objectives, advancing science and technology, and providing energy-related and other benefits to California.

The final report shall describe the following at a minimum: a) original purpose, approach, activities performed, results and conclusions of the work done under this Agreement; b) how the project advanced science and technology to the benefit of California's ratepayers and the barriers overcome; c) assessment of the success of the project as measured by the degree to which goals and objectives were achieved; d) how the project supported California's economic recovery in the near term and number of jobs created or sustained; e) how the project results will be used by California industry, markets and others; f) projected cost reduction impact and other benefits resulting from the project; g) discuss the project budget, including the total project cost and all the funding partners and their

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cost share; h) discuss how the Energy Commission funding was spent on the project, including any unique products and benefits; i) observations, conclusions and recommendations for further RD&D projects and improvements to the PIER project management process.

The final report shall include a cost-effectiveness analysis and a description of the steps in commercializing the technology.

If a final report is required by DOE, the Recipient will include a copy of it along with the Energy Commission's final report requirements. In addition, the Recipient shall submit the draft final DOE report to the Energy Commission for review at the same time it submits it to DOE.

The Final Report shall be a public document. If the Recipient has obtained confidential status from the Energy Commission and will be preparing a confidential version of the Final Report as well, the Recipient shall perform the following activities for both the public and confidential versions of the Final Report.

The Recipient shall:

- Provide a draft copy of the Final Report including a copy of the draft submitted to the U.S. DOE in response to the American Recovery and Reinvestment Act Funding Opportunity Notice for which an award was received. The Final Report must be completed on or before the end of the Agreement Term.
- Submit written correspondence from DOE regarding acceptance of the final report.

Products:

- Draft Final Report, including a copy of the draft report submitted to DOE
- Final Report, including a copy of the final report submitted to DOE
- Written correspondence from DOE regarding acceptance of final report

Task 1.6 Identify and Obtain Matching Funds

The goal of this task is to ensure that the match funds planned for this Agreement are obtained for and applied to this Agreement during the term of this Agreement.

The costs to obtain and document match fund commitments are not reimbursable through this Agreement. Although the PIER budget for this task will be zero dollars, the Recipient may utilize match funds for this task. Match funds shall be spent concurrently or in advance of PIER funds for each task during the term of this Agreement. Match funds must be identified in writing and the associated commitments obtained before the Recipient can incur any costs for which the Recipient will request reimbursement.

The Recipient shall:

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- Prepare a letter documenting the match funding committed to this Agreement and submit it to the Commission Project Manager at least 2 working days prior to the kick-off meeting. If no match funds were part of the proposal that led to the Energy Commission awarding this Agreement and none have been identified at the time this Agreement starts, then as state such in the letter. If match funds were a part of the proposal that led to the Energy Commission awarding this Agreement, then provide in the letter a list of the match funds that identifies the:
 - Amount of each cash match fund, its source, including a contact name, address and telephone number and the task(s) to which the match funds will be applied.
 - Amount of each in-kind contribution, a description, documented market or book value, and its source, including a contact name, address and telephone number and the task(s) to which the match funds will be applied. If the in-kind contribution is equipment or other tangible or real property, the Recipient shall identify its owner and provide a contact name, address and telephone number, and the address where the property is located.
- Provide a copy of the letter of commitment from an authorized representative of each source of cash match funding or in-kind contributions that these funds or contributions have been secured.
- Discuss match funds and the implications to the Agreement if they are reduced or not obtained as committed, at the kick-off meeting. If applicable, match funds will be included as a line item in the progress reports and will be a topic at CPR meetings.
- Provide the appropriate information to the Commission Project Manager if during the course of the Agreement additional match funds are received.
- Notify the Commission Project Manager within 10 days if during the course of the Agreement existing match funds are reduced. Reduction in match funds must be approved through a formal amendment to the Agreement and may trigger an additional CPR.

Products:

- A letter regarding match funds or stating that no match funds are provided
- Copy(ies) of each match fund commitment letter(s) (if applicable)
- Letter(s) for new match funds (if applicable)
- Letter that match funds were reduced (if applicable)

Task 1.7 Identify and Obtain Required Permits

The goal of this task is to obtain all permits required for work completed under this Agreement in advance of the date they are needed to keep the Agreement schedule on track.

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Permit costs and the expenses associated with obtaining permits are not reimbursable under this Agreement. Although the PIER budget for this task will be zero dollars, the Recipient shall budget match funds for any expected expenditures associated with obtaining permits. Permits must be identified in writing and obtained before the Recipient can make any expenditures for which a permit is required.

The Recipient shall:

- Prepare a letter documenting the permits required to conduct this Agreement and submit it to the Commission Project Manager at least 2 working days prior to the kick-off meeting. If there are no permits required at the start of this Agreement, then state such in the letter. If it is known at the beginning of the Agreement that permits will be required during the course of the Agreement, provide in the letter:
 - A list of the permits that identifies the:
 - Type of permit
 - Name, address and telephone number of the permitting jurisdictions or lead agencies
 - The schedule the Recipient will follow in applying for and obtaining these permits.
- Discuss the list of permits and the schedule for obtaining them at the kick-off meeting and develop a timetable for submitting the updated list, schedule and the copies of the permits. The implications to the Agreement if the permits are not obtained in a timely fashion or are denied will also be discussed. If applicable, permits will be included as a line item in the Progress Reports and will be a topic at CPR meetings.
- If during the course of the Agreement additional permits become necessary, provide the appropriate information on each permit and an updated schedule to the Commission Project Manager.
- As permits are obtained, send a copy of each approved permit to the Commission Project Manager.
- If during the course of the Agreement permits are not obtained on time or are denied, notify the Commission Project Manager within 5 working days. Either of these events may trigger an additional CPR.

Products:

- Letter documenting the permits or stating that no permits are required
- A copy of each approved permit (if applicable)
- Updated list of permits as they change during the term of the Agreement (if applicable)
- Updated schedule for acquiring permits as changes occur during the term of the Agreement (if applicable)

Task 1.8 Technical Project Management and Reporting

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The goal of this task is to prepare reports which summarize and thoroughly document all the Design Reviews, Tests, Milestones and Go/No-Go decisions described above.

The Recipient shall:

- Write reports within 30 days of the Tests, Design Reviews, Milestones and Go/No-Go decisions.
- Deliver all technical reports including the following:
 - BHA Wet Test Report (no draft)
 - BHA Design Review Report (no draft)
 - Drill Rig and Coiled Tubing Test Report (no draft)
 - Operational Procedures Report (no draft)
 - Drill Rig and Coiled Tubing Design Review Report (no draft)
 - Starter Wells Test Report (no draft)
 - Starter Wells Design Review Report (no draft)
 - Test Plan (no draft)
 - Drilling Program (no draft)
 - Operational, Maintenance and Safety Procedures (no draft)
 - Field Trials Reports (no draft)
 - Field Trial Design Review Reports (no draft)
 - Advanced heating Technologies Report (no draft)
 - Downhole Mineral Kinetics Report (no draft)
 - DOE Go/No Go Milestone Reports (no draft)
 - Quarterly Progress Reports (no draft)
 - CPR Report(s) (no draft)
 - Updated Schedule of Products (no draft)
 - Updated List of Match Funds (no draft)
 - Updated List of Permits (no draft)
 - Written documentation of meeting agreements (no draft)
 - Schedule for completing closeout activities (no draft)
 - Final Report (Draft, Final)

TECHNICAL TASKS

Task 2.0 DESIGN AND FABRICATION OF THE BOTTOM HOLE ASSEMBLY

The goal of this task is to design, fabricate and test the Bottom Hole Assembly (BHA) system which will include a 3-inch Outer Diameter (OD) drill head housing the Steam Generation Assembly and Downhole Instrumentation and Controls. The BHA will also include a series of sub-assemblies to connect the system to the 2-inch Coiled Tubing.

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The Recipient shall:

- Define the Bottom Hole Assembly Requirements Specification. After requirements are specified and approved through a design review, the recipient will design and fabricate the Steam Generation Assembly, the Dynamic Seal Assembly, and other sub assemblies including Downhole Instrumentation and Controls.

Products:

- Copies of reports provided to DOE, including:
 - BHA modules Wet Test Report (no draft)
 - BHA Design Review Report (no draft)

Task 3.0 SPECIFICATION AND ASSEMBLY OF COMPLETE DRILL RIG

The goal of this task is to modify a newly built AmKin 800V track mounted Coiled Tubing Unit and adapt it for novel drilling operations.

The Recipient shall:

- Specify and implement the modifications to the AmKin Coiled Tubing Unit (CTU) and coiled tubing. The Recipient will also design, fabricate and integrate the Surface Equipment and perform an equipment shake-down in their facilities.

Products:

- Copies of reports provided to DOE, including:
 - Drill Rig and Coiled Tubing Test Report (no draft)
 - Operational Procedures Report (no draft)
 - Drill Rig and Coiled Tubing Design Review Report (no draft)

Task 4.0 FIELD SITE PREPARATION

The goal of this task is to prepare the pre-selected test site in Raymond, CA, and construct the Starter Wells that the Recipient will use.

The Recipient shall:

- Define the site requirements and construct starter wells.
- Participate in CPR meeting as per task 1.2.

Products:

- Copies of reports provided to DOE, including:
 - Starter Wells Test Report (no draft)
 - Starter Wells Design Review Report (no draft)

Task 5.0 FIELD TRIALS

The goal of this task is to extend three Starter Wells from depths of 300 ft to 1000 ft with a 4-inch diameter in a series of three iterative field experiments using the Hydrothermal Spallation drilling system. Iterative design modifications will be conducted after each

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trial. This task is critical in developing a fully-operational drilling unit that can be used immediately for slim hole hard rock drilling.

The Recipient shall:

- Define the Test Plan, Drilling Program and Operational and Safety Procedures.
- Perform Field Trials and Demonstration.
 - Mobilize the equipment to the site, rig up the CTU and wellhead equipment, and assemble Surface Equipment.
 - Perform operational equipment checks, required calibrations, testing of remote controls, and completion of check lists.
 - Conduct Hydrothermal Spallation drilling trials and analyze wellbore, data and results.
- Following each trial, conduct a Design Review and prepare work plans for the modifications to the Bottom Hole Assembly, CTU, Surface Equipment or drilling procedures and complete iterative design cycles.

Products:

- Test Plan (no draft)
- Drilling Program (no draft)
- Operational, Maintenance and Safety Procedures (no draft)
- Field Trial Test Reports (no draft)
 - The Test Report will evaluate the completion of three 1000-ft boreholes to assess ROP, reliability and durability of downhole equipment, and expected cost of completion at commercial scale. This will serve to evaluate the prototype drilling system and facilitate the design of drilling systems for production-scale boreholes. The target objectives of the evaluation will be:
 - Demonstrated means to achieve ROP of 30 ft/hr.
 - Bottom hole tool hardware survivability in excess of 120 hours of drilling time.
 - Predicted cost and completion time that provides an advantage over conventional slim-hole drilling technologies.
 - Determination of performance specifications of the drill under real-world conditions to allow scaling to typical production borehole diameters.
- Field Trial Design Review Reports (no draft)
 - Following each trial, a Design Review will be undertaken to identify areas of the Bottom Hole Assembly, Coiled Tubing Unit, Surface Equipment or drilling procedures that need to be modified to meet the performance criteria listed above. The report will also identify changes necessary to operate the equipment safely and efficiently in the field.

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Task 6.0 RESEARCH ON ADVANCED HEATING TECHNOLOGIES

The goal of this task is to conduct research aimed at advancing the understanding of chemical heating systems for deep, large diameter drilling systems and mineral kinetics in high gradient, downhole heat exchanger systems. This research program will be executed in collaboration with an academic energy group approved by the Commission's PM. It is important to perform these research and development projects and the initial field trials concurrently, so that next-generation technologies are available for the development and incorporation into the full-scale drilling system.

The Recipient shall:

- Provide guidance and design assistance to the academic group to research chemical heating systems for deep, large diameter drilling systems.
 - The academic group will evaluate various chemical heating systems and will focus on understanding the kinetics of the proprietary hydrothermal combustion systems currently used by the Grant Recipient.
 - The academic group will research and develop novel chemical heating systems with greater performance and/or lower costs in deep, large diameter drilling systems.

Products:

- Copies of reports provided to DOE, including:
 - Advanced Heating Technologies (no draft), and
 - Downhole Mineral Kinetics (no draft)