PMC-EF2a
(2.04.02)

U.S. DEPARTMENT OF ENERGY
EERE PROJECT MANAGEMENT CENTER
NEPA DETERMINATION

RECIPIENT: Impact Technologies **STATE:** OK

PROJECT TITLE: Microhole Arrays Drilled With Advanced Abrasive Slurry Jet Technology To Efficiently Exploit Enhanced Geothermal Systems

Funding Opportunity Announcement Number	Procurement Instrument Number	NEPA Control Number	CID Number
DE-FOA-EE0000075	DE-EE0002783	GFO-10-156	GO2783

Based on my review of the information concerning the proposed action, as NEPA Compliance Officer (authorized under DOE Order 451.1A), I have made the following determination:

CX, EA, EIS APPENDIX AND NUMBER:
Description:

B3.1 Onsite and offsite site characterization and environmental monitoring, including siting, construction (or modification), operation, and dismantlement or closing (abandonment) of characterization and monitoring devices and siting, construction, and associated operation of a small-scale laboratory building or renovation of a room in an existing building for sample analysis. Activities covered include, but are not limited to, site characterization and environmental monitoring under CERCLA and RCRA. Specific activities include, but are not limited to:

B3.6 Siting, construction (or modification), operation, and decommissioning of facilities for indoor bench-scale research projects and conventional laboratory operations (for example, preparation of chemical standards and sample analysis); small-scale research and development projects; and small-scale pilot projects (generally less than two years) conducted to verify a concept before demonstration actions. Construction (or modification) will be within or contiguous to an already developed area (where active utilities and currently used roads are readily accessible).

A9 Information gathering (including, but not limited to, literature surveys, inventories, audits), data analysis (including computer modeling), document preparation (such as conceptual design or feasibility studies, analytical energy supply and demand studies), and dissemination (including, but not limited to, document mailings, publication, and distribution; and classroom training and informational programs), but not including site characterization or environmental monitoring.

Rational for determination:

Impact Technologies LLC (Impact) would (1) evaluate and optimize patent pending FLASH ASJTM drilling system in 572˚F (300˚C) deep geothermal reservoir rocks; (2) optimize the completion method (hole sizing, length and placement) of multiple microhole arrays for effective Enhanced Geothermal Systems (EGS) reservoir stimulation and heat recovery; (3) evaluate and identify required directional (kickoff, measurement, steering) capabilities for Abrasive Slurry Jet (ASJ) microhole drilling in EGS conditions; and (4) demonstrate the potential for effective and efficient exploitation of EGS using microhole arrays. Laboratory work would take place at Impact Technologies LLC, 8042 South Regency Drive, Tulsa, Oklahoma 84606; Missouri University of Science and Technology's Explosives and Water Jet Laboratory in Rolla, Missouri. Drilling would take place at the University of Science and Technology's rock quarry outside Rolla, Missouri located near the intersection of Highway 64 and Interstate 44 in Section 9.
The project is divided into four phases with multiple tasks.
PHASE 1: TECHNOLOGY AND SYSTEM FEASIBILITY STUDY
Task 1: Evaluation of Microhole ASJ Technology for EGS
Subtask 1.1: Evaluate and Identify FLASH Fluids for EGS Conditions
Determine the choice FLASH drilling fluids for EGS conditions.
Subtask 1.2: Evaluate and Identify Pipe Sizing & Configuration
Identify tubing sizes and pipe configurations for FLASH ASJTM drilling in EGS conditions. The availability of different steel alloys, composites, nano-particle tubing and CT would be set against the working depths and temperatures.

Subtask 1.3: Evaluate Heat Transfer & Hydraulics
Model drill pipe and annulus temperature and operating conditions to create a pressure profile used in evaluating the fluid selections. Data from an array of model runs for selected pipe configurations and fluids would identify those that decrease the required flow rate to maintain the minimum pressure throughout the pipe configuration.

Task 2: Demonstration of Increased Performance Using Microholes
Subtask 2.1: Define Drilling and Production Scenarios
Develop potential preliminary microhole array configurations as well as injection and production scenarios. Also, a first estimation of the drill string temperature and pressure profiles at various flow rates would be made.

Subtask 2.2: Develop Geothermal Reservoir Models
Develop basic numerical reservoir models for the scenarios identified in Subtask 2.1.

Subtask 2.3: Compare Fluid Flow and Heat Transfer Scenarios
Utilize the developed basic model to assess the potential of the proposed drilling technology to significantly improve stimulation and heat removal from a large volume of hot rock. Compare the various scenarios for expected drilling costs and thermal output.

PHASE 2: MICROHOLE TECHNOLOGY DEVELOPMENT FOR EGS

Task 1: Development of Microhole Drilling Technology for EGS
Subtask 1.1: Research and Testing of the Pipe
Obtain sample specimens of each pipe that met the Phase 1 requirements and test their strengths at EGS conditions. The expected outcome would be a plot of stress versus strain for various temperatures for each potential pipe.

Subtask 1.2: Research and Testing of the FLASH Fluids
Test the specific selected FLASH fluids and select possible additives from Phase I at the expected temperatures and (mostly) pressures.

Subtask 1.3: Research the FLASH ASJ Characteristics of 300°C Rocks
Determine and test the erosive nature of 572˚F (300˚C) rocks under the drilling processes.

Subtask 1.4: Expand the Directional Capabilities of Microholes
Test Impact's patent pending directional control technology and other technologies with this drilling system at the Missouri State limestone quarry.

Subtask 1.5: Safety and Control Issues
Identify all key concerns about EGS temperature, pressure, H2S and energized fluids and their control. The approach would be to look at available Blowout Preventer (BOP) equipment, adjustable chokes, instruments and other control devices at EGS conditions on the surface.

Task 2: Development of Simulation Capabilities for Microhole Technology
Subtask 2.1: Development of a Non-Isothermal Wellbore Simulator
Develop a numerical wellbore simulator capable of handling pressure, temperature, and thermodynamic properties of fluids used for the FLASH ASJTM drilling process.

Subtask 2.2: Coupling of Wellbore Simulator to Reservoir Simulator
Couple the wellbore simulator to the reservoir simulator to accurately simulate downhole and wellhead conditions, which affect drilling design and the optimization of operational parameters.

PHASE 3: DESIGN & OPTIMIZE MICROHOLE ARRAY DEPLOYMENT FOR EGS

Task 1: Operational Plan for Drilling and Completion of EGS Microhole Arrays
Subtask 1.1: Microhole ASJ Drilling Operational Plan for EGS
Prepare a drilling plan that includes an envelope for FLASH ASJ drilling for inserting microholes in EGS reservoirs.

Subtask 1.2: Microhole ASJ Directional Drilling Operational Plan for EGS
Make an operational plan to directionally install microholes from a central large bore. The completion equipment (control, monitors, sensors, packers, seals...) would be determined from the flow direction that is determined optimum.

Subtask 1.3: Safety and Environmental Assessment and Mitigation Plan
Make a plan for the protection of people and the environment during the proposed drilling, completion and operation.

Task 2: Optimized EGS Performance Using Microhole Technology
Subtask 2.1: Evaluate Intersection Probability of Microholes with Fracture Network
Develop a statistical framework that allows estimation of intersection probabilities of a microhole with natural or induced fractures.

Subtask 2.2: Develop Integrated EGS Approach Using Microhole Technology
Optimize the injection/production configurations of the EGS microhole array completion, and to integrate microhole drilling technology with reservoir simulation and resource management.

PHASE 4: FINAL REPORTING AND TECHNOLOGY TRANSFER

Task 1: Project Management and Reporting
Reports and other deliverables would be provided in accordance with the Federal Assistance Reporting Checklist, including the Final Report and Technology Transfer.

Impact and Missouri University (MU) claims there would be small generation of air emissions from engines driving pumps or generators; a drilling permit from the local water resources boards or other local or state commissions is needed for the drilling in the quarry. Vented gas cabinets and fumehoods are used with scrubbers to prevent release of air pollutants in the laboratories. Both parties, claim the liquid effluent, hazardous, and toxic waste would be disposed of according to local, university, state, and federals regulations accordingly. According to the Impact and MU, safety protocols are in place for instruments, chemicals and waste monitored by a Health and Safety officer.

At this time, the location of drilling the EGS well(s) has not been identified, and therefore cannot be analyzed. Therefore, EGS drilling would not be authorized. EGS drilling would be analyzed once the location of the EGS well(s) is identified and submitted to the DOE.
Condition of Approval: Prohibited: Drilling outside of the Missouri University quarry located near the intersection of Highway 64 and Interstate 44 in Missouri. This project comprises bench-scale research, conventional laboratory operations, and onsite and offsite characterization; therefore the DOE has categorized this proposal into Categorical Exclusions A9, B3.1 and B3.6.

NEPA PROVISION

DOE has made a conditional NEPA determination for this award, and funding for certain tasks under this award is contingent upon the final NEPA determination.

Insert the following language in the award:

You are restricted from taking any action using federal funds, which would have an adverse affect on the environment or limit the choice of reasonable alternatives prior to DOE/NNSA providing either a NEPA clearance or a final NEPA decision regarding the project.

Prohibited actions include:
Prohibited: Drilling outside of the Missouri University quarry located near the intersection of Highway 64 and Interstate 44 in Missouri
This restriction does not preclude you from:
Allowable: Drilling within the Missouri University quarry located near the intersection of Highway 64 and Interstate 44 in Missouri
If you move forward with activities that are not authorized for federal funding by the DOE Contracting Officer in advance of the final NEPA decision, you are doing so at risk of not receiving federal funding and such costs may not be recognized as allowable cost share.

Note to Specialist :

None Given.

SIGNATURE OF THIS MEMORANDUM CONSTITUTES A RECORD OF THIS DECISION.

NEPA Compliance Officer Signature: _____ Date: 2/9/2010
NEPA Compliance Officer

FIELD OFFICE MANAGER DETERMINATION

☐ Field Office Manager review required

NCO REQUESTS THE FIELD OFFICE MANAGER REVIEW FOR THE FOLLOWING REASON:

☐ Proposed action fits within a categorical exclusion but involves a high profile or controversial issue that warrants Field Office Manager's attention.
☐ Proposed action falls within an EA or EIS category and therefore requires Field Office Manager's review and determination.

BASED ON MY REVIEW I CONCUR WITH THE DETERMINATION OF THE NCO :

Field Office Manager's Signature: _____ Date: _____
Field Office Manager