DRILLING PLAN
RAFT RIVER GEOTHERMAL
EXPLORATORY HOLE NO. 3

FEBRUARY 1976

GEO-HEAT CENTER

U. S. ENERGY RESEARCH
AND
DEVELOPMENT ADMINISTRATION
IDAHO OPERATIONS OFFICE
NEVADA OPERATIONS OFFICE
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I. INTRODUCTION

A. Background

The Raft River valley of south-central Idaho lies within a region identified as a Known Geothermal Resource Area (KGRA) which has in the past and may yet be undergoing severe tectonic stresses. The past stresses have resulted in a complex fault system which provides for the circulation of water to very deep hot rock.

The existence of a geothermal reservoir of significant size has been determined by the preliminary testing and evaluation of the two previously drilled exploratory holes; RRGE-1 and RRGE-2, drilled to the respective depths of 4,987 feet ground level (G.L.), and 5,906 feet G.L. Additional drilling planned for the RRGE-2 hole will bring its total depth to approximately 6,500 feet. The two exploratory holes are each under artesian pressure controlled by the vast groundwater system of the area, with bottom-hole temperatures of approximately 300°F.

A third exploratory hole will be drilled to provide data to further investigate and evaluate the geothermal reservoir, as well as to optimize the location of possible future resource and/or injection wells and to develop methods to reduce the cost of geothermal wells.

This document describes programs, plans, and procedures to be used in drilling and completion of the Raft River Geothermal Exploratory Hole No. 3 (RRGE-3).

B. Program Description

The third deep exploratory hole will be located in the Raft River valley of south-central Idaho, southeast of Burley, and approximately 16 miles south of Malta, Idaho. (See Figures I-1, I-2 and I-3.)
Figure I-1 Idaho Geothermal R&D Project Site Location
Figure I-2 Raft River Valley with Drill Site Locations
SECTION 25

T-15-S  R-26-E

23 24 24 19
26 25 25 30
26 25 25 30
35 36 36 31

SCALE: 1" = 1000'

FIGURE 1-3
LOCATION SURVEY
Program direction and management of the Idaho Geothermal R&D Project is provided by the Aerojet Nuclear Company (ANC), a prime contractor to the Energy Research and Development Administration's Idaho National Engineering Laboratory (INEL). The drilling of RRGE-3, at the request of ERDA-ID/ANC, will be performed by the Reynolds Electrical & Engineering Co., Inc. (REECo), a prime contractor to the U. S. Energy Research and Development Administration's Nevada Operations Office (NV).

The drilling of RRGE-3 will require the relocation of the ERDA drill rig from the RRGE-2 to the RRGE-3 site approximately 1-1/2 miles southeast where REECo personnel will drill the third exploratory hole. The schedule of major activities is shown in Appendix A.

ANC will subcontract for the drilling, running and cementing of the 20-inch conductor pipe to 120 feet.

The REECo drilling operation will consist of: (1) drilling a 17 1/2-inch hole with mud to approximately 1,400 feet and running and cementing 13 3/8-inch casing to the surface; (2) drilling a 12 1/4-inch hole with water to approximately 3,500 feet or to the depth determined by ANC to be above the geothermal resource zone, check the hole for geothermal resource, then circulate hole with mud, run 9 5/8-inch casing to approximately 3,500 feet with casing hanger about 200 feet above the bottom of the 13 3/8-inch casing, and cement from the 9 5/8-inch casing shoe to the casing hanger; (3) drill with water an 8 3/4-inch hole from the 9 5/8-inch casing shoe, alternately coring and conducting drill stem tests (DST's), as directed by ANC, to a total depth (T.D.) of approximately 6,000 feet, or to the depth at which it is either indicated from temperature and test flow data and from logs that an acceptable hot water resource is available or that the hole is accepted as a possible reinjection well; (4) if directed by ANC, sidetrack and directionally drill with water an additional 8 3/4-inch hole from near the
9 5/8-inch casing shoe so as to achieve a total horizontal displacement of at least 400 feet between the two holes at T.D.; and (5) if directed by AMC, sidetrack and drill one or two additional 8 3/4-inch holes to similar depths and horizontal displacement. Neither coring nor DST's will be conducted in the sidetrack holes, however, logging will be performed, if practicable, as described in Section IV.M.
II. GENERALIZED SITE ACTIVITIES

A. Site Preparation and Maintenance

The drilling will take place on a 300 foot by 400 foot drill pad (see Figure II-1): ANC will subcontract and provide necessary site preparation as follows:

1. Prepare a drill pad (approximately 300 feet X 400 feet) by leveling, compacting, and surfacing with run-of-bank gravel.

2. Excavate mud reserve pit and stabilize slope adjacent to mud pits. Excavate mud storage pit (24 feet X 36 feet X 8 feet deep) and line with plastic.

3. Construct a concrete-lined cellar (8 feet X 10 feet X 8 feet deep).

4. Drill, run and cement a 20-inch conductor pipe to 120 feet.

5. Drill "rat" and "mouse" holes.

6. Provide an access road.

7. Provide for site and access road maintenance, as required.

8. Provide all fencing as required.

B. Trailer

ANC will provide one combination living and office trailer (60 feet long, 12 feet wide). This trailer will contain cooking facilities, bunks, office furnishings, and sanitary facilities and will accommodate REECo drilling, supervisory, and service personnel. A second, smaller trailer will be supplied by ANC to accommodate NV, ID, and ANC personnel.

C. Drilling Water

ANC will provide pipeline to pump water from the Raft River or a nearby well to the location. REECo will lay and maintain the pipeline system, and furnish and operate the surface pump, if required.
RESERVE WASTE PIT
Depth of pit ~ 12' from ground level.

Mud storage pit (plastic lined)
Mud house

K-700 Mud pumps
Generator

500 Bbl. Water tank

ERDA Drill rig
Doghouse

Figure II-1 Typical Site Layout
D. Potable Water
ANC will provide potable water for drinking.

E. Communications
ANC will provide three telephone lines to the site. The telephones will be located in both the 60 foot and the smaller trailers. The telephones can be dialed into the leased line at the INEL where access to the FTS is available at all hours.

An intercom will be installed between the trailers, and the "doghouse."

F. Power
ANC will negotiate with the Raft River Rural Electric Cooperative for the extension of power from nearby lines to the drill site. The power requirements are 75 kva at 60 Hertz and 120/240 volts, three phase. Further on-site distribution of power to trailers, pumps, and other facilities, as required, will be provided by ANC, as well as three daylight sensitive flood lamps.

G. Fuel, Lubricants and Miscellaneous
ANC will provide the fuel to operate the drill rig and the trailers as required. ANC will supply oil, grease, antifreeze, etc., from INEL warehouse stock. Any lubricating materials not available from INEL will be purchased by ANC locally, as needed, if not obtainable through their warehouse.

H. Vehicles
ANC will provide five vehicles. Spare tires will be supplied by ANC and kept at a local service station. Fuel and maintenance will also be provided by ANC. These vehicles will be apportioned in the following manner:

3 vehicles for REECo.
1 vehicle for NV.
1 vehicle located at the drill site for emergency use.
I. Trailer Maintenance
Janitorial and repair services will be provided by ANC. This will include necessary repair and maintenance of living and office quarters, including sanitary facilities.

J. General Operational and Logistics Support
ANC will provide the following general logistical support:

1. Crafts (except drilling and associated work).
2. Clerical.
3. Office supplies.

K. Site Cleanup and Restoration
Upon completion of drilling, REECo will remove the drill rig and all rig-associated equipment. ANC will dispose of drilling fluids and backfill the mud reserve pits; dress and restore the pad.

L. Reproduction Machine
ANC will furnish a reproduction machine.
III. OCCUPATIONAL HEALTH AND SAFETY

A. General

All drilling operations and other site activities will be conducted in accordance
with ERDA standards, and in accordance with other rules and regulations, as
applicable, inclusive of record keeping and reporting responsibilities.

All participating organizations are responsible for the health and safety of
their own personnel and for conducting all activities in accordance with
procedures that assure:

1. A safe and healthful environment for the employees.

2. Control and minimization of hazards to the public and to personnel of other
   participants.

3. Minimization of the accidental damage or loss of equipment, materials, and
   property.

B. First-Aid

ANC will determine the location of local medical facilities and physicians in
the area for use in the event of accident or illness. An emergency vehicle will
be provided by ANC for injured persons of all participating organizations.

ANC will provide first-aid supplies as approved by the Director of the ID Medical
Division. REEGCo will have personnel with first-aid training available at the
site at all times. First-aid services will be available to all project
participants at the site.
C. Fire Protection

Hand-operated fire extinguishers for the drill rig and associated equipment will be provided by REECo. ANC will provide extinguishers at points convenient to each significant structure or piece of equipment. Extinguisher types will be varied for control of Class A, B, or C fires, as appropriate.

D. Sanitation

Chemical or standard toilets will be provided and services, as required, by ANC. Solid wastes will be disposed of by ANC in accordance with ERDA regulations. Potable water will be provided for drinking and cooking.

The trailer at the well location may be connected to a nonpotable water source and sewage system involving a septic tank or provided with other sanitary facilities in accordance with ERDA health regulations.
IV. DRILLING OPERATIONS

A. General
The site will be prepared by ANC prior to moving the rig on, which will include construction of the concrete cellar, setting and cementing the 20-inch conductor pipe to approximately 120 feet, and excavating mud reserve waste pit and mud storage pit.

Vertical Hole (120 Feet to 3,500 Feet)
A 17 1/2-inch hole will be drilled with mud through the alluvium and into the Salt Lake formation to a total depth of approximately 1,400 feet (see Figure IV-1). As practicable, fluid losses will be treated during drilling as they occur, but, if necessary, prior to running casing, the mud weight will be increased to simulate the cementing program hydrostatic pressures while simultaneously curing the remaining hole fluid loss problems. If the mud weight is increased, it will be reduced prior to cementing to maximize the differential density of the mud and cement slurry prior to cementing. A 13 3/8-inch intermediate casing will be set at approximately 1,400 feet and cemented to the surface. The optional installation and utilization of a differential valve (DV) tool will be based upon an evaluation of hole conditions prior to running casing and during cementing operations.

After the 13 3/8-inch casing has been set, drilling will be resumed with 12 1/4-inch bits using water as drilling fluid to a depth of approximately 3,500 feet or to a depth determined by ANC from DST's, fluid tests, and logs. Should the tests and data reveal that an acceptable resource zone has been bypassed in the drilled interval, an additional depth of hole will be plugged back with sand and sealed with a barite and cement plug or by a single cement plug to the established casing setting depth.
FIGURE IV-1
RAFT RIVER GEOTHERMAL EXPLORATORY HOLE NO. 3
After establishing the production casing setting depth, the hole will be mudded up and circulated to build an acceptable "filter cake" to control fluid losses, and, if necessary, the mud weight will be increased to simulate the cementing program hydrostatic pressures. Prior to cementing, the mud weight will be reduced to maximize the differential density of the mud and cement slurry.

The 9 5/8-inch primary casing will then be run to T.D., hung in the 13 3/8-inch casing on the casing liner hanger with 200 feet of casing overlap, and cemented through the shoe back into the 13 3/8-inch casing hanger. If cement fails to cover the casing overlap, circulating ports in the casing hanger will permit remedial cementing from the top of the hanger down.

The 17 1/2-inch and 12 1/4-inch holes will be drilled using a centralized and stabilized assembly.

**Vertical Hole/3,500 Feet to 6,000 Feet**
An 8 3/4-inch hole will be drilled from the 9 5/8-inch casing shoe to a total depth of approximately 6,000 feet with water as a circulating fluid. DST's and core drilling will be conducted at the intervals directed by ANC.

**Sidetrack Hole(s)**
If directed by ANC after an ANC evaluation of the reservoir resource data from the vertically drilled hole, a sidetrack hole will be directionally drilled commencing near the top of the vertical 8 3/4-inch hole utilizing a turbodrill with water as a circulating fluid, the turbodrill will be used until sufficient angle is built to resume drilling with a centralized and stabilized assembly. The direction of the first sidetrack hole will be opposite the deviation encountered in the original hole.
Sufficient angle will be built with the turbodrill in the sidetrack hole to achieve a total horizontal displacement of not less than 400 feet between the holes at their T.D.'s. If directed by AHIC, up to three directionally drilled sidetrack holes may be drilled.

B. Drilling Fluid Solids Removal
Minimum annular drilling fluid velocities for the 17 1/2-inch and 12 1/4-inch holes using 6 5/8-inch drill pipe will be such that it will carry out the formation cutting particle sizes. The drilling fluid program should try to obtain optimum hydraulics and/or impact at the bit, utilizing a large enough flow rate to clean the hole without causing excessive hole erosion.

C. Estimated Formation Tops
All drilling, casing, and any other depth measurements will be referenced to the Kelly bushing (KB). Logging and formation tops will be referenced to the top of the cellar wall as ground level (G.L.).

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<th>Sea Level (ft.)</th>
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<tr>
<td>1. Alluvium of loose, coarse, and cemented gravel with silty clay and sand (from 15 to 40 feet is loose sand and gravel).</td>
<td>Surface</td>
<td>+4,860</td>
</tr>
<tr>
<td>2. Raft River formation of gray sandstone and conglomerate with beds of siltstone.</td>
<td>300</td>
<td>+4560</td>
</tr>
<tr>
<td>3. Salt Lake formation of sand, silt, and clay interbedded with siltstone and sandstone.</td>
<td>1,200</td>
<td>+3,660</td>
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</table>
Formation tops below surface are approximated from the RRGE-1 and RRGE-2 holes.

D. Drilling Materials Equipment & Services

1. ANC will be responsible for providing at the drill site the following drilling materials, equipment and services:

a. Casing, Casing Head & Liner Hanger
   (1) 120 feet of 20-inch, 94 lb./ft., H-40, Short T&C casing.
   (2) 1 20-inch casing head, weld-on type with two 3-inch flanged outlets.
   (3) 1400 + feet of 13 3/8-inch, 54.5 lb./ft., K-55, Short T&C casing.
   (4) 2300 feet of 9 5/8-inch, 36 lb./ft., K-55, buttress T&C casing.
   (5) 1 each 9 5/8-inch x 13 3/8-inch Baash-Ross Plain type casing liner hanger; with a fluted cone and ports, and including pump-down plug and liner wiper plug (see C(1) below for services and equipment).
   (6) Baker"KB"drillable production packer.

b. Wellhead Assembly
   (1) 1 each 20-inch x 12-inch double flanged Brewster expansion spool (API) with 13 3/8-inch casing guide bushing.
   (2) 1 each 12-inch x 12-inch double flanged Brewster gate valve (API).
   (3) 1 each 12-inch x 12-inch double-flanged flow spool (API) with one 8-inch flanged outlet.
   (4) All studs, bolts, nuts and API ring gaskets for the above, as required.

b. Services and Equipment
   (1) Regular action setting tool and cementing manifold for casing liner hanger and Baash-Ross Engineer Services.
   (2) Welding services.
   (3) Logging services.
   (4) Mud logging services.
(5) Drilling mud materials and mud engineer.
(6) Drill bits (except diamond core bit).
(7) Crane, 80-ton with operator for location-to-location move, and
demob, as required.

2. REECo will be responsible for providing the following materials, equipment,
and services:
   a. Casing cementing equipment and hardware:
      Centralizers, float shoes, float collars, cement baskets, stage cementing
      (DV) collars, 13 3/8-inch casing plugs and bomb, as required.

   b. Turbodrill, tools and operator.

   c. Cementing services and materials.

   d. Coring equipment and operator.

   e. DST equipment and services.

   f. BOP, tools, and equipment rentals. Expendable materials purchases, and
      miscellaneous services, including transportation and rig truck support.

   g. Casing crew.

E. Drilling Procedure

1. Use rotary drill and drill 26-inch hole for 20-inch conductor pipe to 120 +
   feet. Cement conductor pipe from 120 feet to surface (by ANC).

2. Construct a concrete-lined cellar, approximately 8 feet wide, 10 feet long,
   and 8 feet deep, cut off 20-inch casing and install 20-inch casing head (by ANC).

3. Move in drilling rig and rig up.

5. Drill 17 1/2-inch hole to approximately 1,400 feet with mud. Run single-shot directional survey every bit trip, or as required. Treat fluid loss zones as they occur with mud additives, and, if necessary, with cement plugs. Condition hole to log and run casing. If deemed necessary, test hold for fluid loss integrity by raising mud weight to simulate hydrostatic pressure conditions during cementing while further curing fluid losses.

6. Run integrated 4-arm caliper log and induction electric or borehole compensated sonic log 1,400 feet to 120 feet.

7. Run temperature log (ANC) from 1,400 feet to 120 feet.

8. Condition hole and run 1,400 feet of 13 3/8-inch, 54.5 lb./ft. casing. Run guide shoe, float collar, centralizers and stage cementing (DV) collar, if required. (The optional running and subsequent use of the DV collar will be based upon an evaluation of drilling data, open-hole logs, and the cementing operation experience.) If mud weight was increased to test hole integrity, circulate to reduce mud weight prior to cementing.

**Cementing without DV collar:***

Circulate and condition hole and cement through shoe to the surface, using water to displace cement. If cement was not displaced to the surface, determine the top of cement, perform work under Item 9 below, then perform remedial cementing through the 20-inch casing head down the annulus. WOC 12 hours and proceed to Item 10.

**Cementing with DV collar:***

Circulate and condition hole and cement first stage, open DV collar and circulate out excess cement above DV collar. WOC 12 hours while circulating hole, then cement second stage to the surface, using water to displace cement.
If remedial cementing is required because the first stage cement did not circulate to the surface, WOC 12 hours while circulating, close DV collar, perform work under Item 9 below then cement through the 20-inch casing head down the annulus. WOC 12 hours and proceed to Item 10.

If remedial cementing is required because the second stage cement was not displaced to the surface, determine the top of cement, perform the work under Item 9, then cement through the 20-inch casing head down the annulus. WOC 12 hours and proceed to Item 10.

Mud and cement "returns" will be monitored during cementing operations. Retain displaced drilling mud in mud storage pit for conditioning 12 1/4-inch hole before casing.

9. While WOC 24 hours cut off 13 3/8-inch casing 10-inches above 20-inch casing head and install 20-inch x 20-inch Brewster expansion spool and slips, 12-inch x 12-inch Brewster gate valve, 12-inch x 12-inch flow spool, 12-inch single gate Shaffer BOP, 12-inch Hydril BOP with kill line and choke line, Grant rotating head, and nipple-up flow lines. Use dual controls on BOP's. Pressure test BOP's and casing with 300 psig surface pressure. (Appropriate notifications of scheduled BOP pressure tests will be made by ANC.)

10. After displacing mud with water, tag top of cement and drill out to above casing shoe. If a DV collar was used, pressure test the collar to 300 psig surface pressure. Run logs as specified in Section IV-M, and evaluate logs and cementing operation to determine if additional remedial cementing is required.
11. Drill out shoe and drill formation with 12 1/4-inch bit using water. Use mud logging service below 1,400 feet. Use a centralized and stabilized assembly for drilling the 12 1/4-inch hole. Run single-shot magnetic survey every trip, or as required. Drill to approximately 3,500 feet and run tests as directed by ANC to determine the 9 5/8-inch casing setting depth. If a resource zone has been bypassed, plug back with sand, barite, and/or cement plug to the appropriate casing setting depth as determined by ANC.

12. Mud up and condition hole for logging and running casing with mud retained from the 17 1/2-inch hole. Treat hole for fluid losses and if deemed necessary, increase the mud weight to simulate cementing program hydrostatic pressures while treating for loss of fluids. Mud weight will be reduced before cementing.

13. Condition hole for logs. Run open-hole logs as specified in Section IV-M.

14. Condition hole and run 9 5/8-inch, 36 lb./ft., buttress thread casing and set in 13 3/8-inch casing with casing liner hanger, with approximately 200 feet of casing overlap. Run a differential-fill-up shoe and collar, centralizers, and cement baskets, as required.

Reduce mud weight, if required, and cement 9 5/8-inch casing through drill pipe latched into casing liner hanger. Displace cement with water. Monitor returns during cementing operations. In the event cement is not circulated to the surface, locate top of cement and perform remedial cementing by squeezing down through the liner hanger ports.
15. WOC 48 hours while nippling up, and run logs as necessary to determine if remedial cementing is required (see Section IV-M). Pressure test BOP, casing and wellhead to 300 psi.

16. Drill out of shoe with 8 3/4-inch bit with water as the drilling fluid. Alternately drill and core (approximately four) and conduct DST's (approximately three) at the intervals as determined by ANC, to a total depth of approximately 6,000 feet or as determined by ANC. Run single-shot magnetic surveys every 90 feet between 3,500 feet and 4,000 feet, and every 180 feet from 4,000 feet to T.D.

17. Run logs as specified in Section IV-M. Run flow and/or reinjection tests as determined by ANC.

18. If directed by ANC as a result of its evaluation of the geothermal resource potential, sidetrack an 8 3/4-inch hole from below the 9 5/8-inch casing shoe KOP, using a turbodrill with water as a drilling fluid. ANC will establish the bearing of the sidetrack hole from true north. Hole deviation will be maintained so as to reach a total horizontal displacement of at least 400 feet between the two holes at T.D. Magnetic single-shot surveys will be taken approximately every 30 feet while drilling with the turbodrill, or as directed by the directional driller, and every 60 feet until the required 400 foot hole displacement has been achieved, and thereafter every 180 feet to T.D.

19. Run logs as specified in Section IV-M. Run flow and/or injection tests.

20. If directed by ANC, sidetrack one or two additional 8 3/4-inch holes as in Item 18 above.
21. Run logs, if practicable, as specified in Section IV-M. Run flow and/or injection tests as directed by ANC.

22. Run and set Baker "KB" packer at approximately 1000 feet and release rig.

F. Surface Equipment and Services

1. Wellhead
   A 2,000# casing head will be used on the 20-inch casing with two 3-inch flanged outlets. After the 13 3/8-inch casing is set and cemented from 1,400 feet to the surface, a 20-inch by 12-inch Brewster expansion spool with 13 3/8-inch casing slips will be installed on the 20-inch casing head, 12-inch 300# Brewster valve will be installed on the expansion spool, and 12-inch double flanged flow spool with an 8-inch flanged outlet will be installed on the Brewster valve.

2. Blowout Preventor (BOP) Equipment
   A 20-inch single gate valve will be used while drilling the 17 1/2-inch hole to 1,400 feet.

   A 12-inch single gate Shaffer BOP, a 12-inch Hydril BOP and a 12-inch Grant rotating head will be installed on the 12-inch flow spool for drilling the 12 1/4-inch and 8 3/4-inch holes. All this equipment shall have a minimum working pressure of 1,000 psi.

3. Pit Level Recorder
   Mud pit fluid levels (gains and losses) will be recorded by a pit level recorder from 120 foot depth to approximately 3,500 feet, and if directed by ANC continued to T.D.
4. **Drilling Recorder**
   A three-pen recorder to record penetration rate, weight, and pump pressure will be used.

5. **Mud Logging**
   A mud logging unit will be used to record the following information below 1,400 feet (i.e. 13 3/8-inch casing setting depth):
   
   a. "In" and "out" mud temperatures (instrumentation provided by ANC).
   
   b. Drilling rates and lithologic characteristics.
   
   c. Hydrogen sulfide and hydrocarbon gas volume with alarms.

6. **Downhole Equipment and Services**
   
   1. **20-Inch Casing**
      20-inch, 94 lb./ft., H-40 grade, ST&C casing will be set at 120 feet.

   2. **13 3/8-Inch Casing**
      Run 13 3/8-inch, 54.5 lb./ft., K-55, ST&C casing to approximately 1,400 feet.
      Run stage collar (if required), differential-fill-up shoe, float collar and cement baskets (if required). If run, the stage collar depth will be determined by evaluation of drilling and logging data.

   3. **9 5/8-Inch Casing**
      Run 9 5/8-inch, 36 lb./ft., K-55, buttress thread casing from 1,200 feet to 3,500 feet or to depth determined by ANC. Run a guide shoe, differential fill float collar and centralizers with 200 feet of overlap inside the 13 3/8-inch casing.
4. 9 5/8-Inch By 13 3/8-Inch Liner Hanger

Baash-Ross plain type with fluted cone, circulating ports, and buttress thread pin.

5. Centralizers

Centralizers will be located 15 feet above shoe and on every third collar to the surface, or as determined.

H. Cement Systems

1. Conductor Pipe

Use excess cement retained from RRGE-2.

2. 13 3/8-Inch and 9 5/8-Inch Casing Slurry

Cement slurries will be designed for geothermal applications by the cementing services subcontractor, approved by ANC as meeting its technical criteria, and by REECo as operable systems.

Cement slurry volume requirements will be based upon caliper logs and the percentage of slurry excess will be established by an evaluation of hole conditions, logs and other data at the conclusion of drilling the casing intervals.

I. Drilling Fluid

The 17 1/2-inch hole above the potential resource is planned to be drilled using a gel-mud system with mud weight between 8.8 and 9.5 ppg. Viscosity will be held high enough to clean the hole. Water loss should be held to between 8 ml and 14 ml API or less. Lost circulation material will be added to cure fluid losses as they occur during the drilling operation, and, if required, cement plugs will
also be used. If deemed necessary, the mud weight may be increased to simulate the cementing program hydrostatic pressures prior to running the casing to establish the formation competency while further curing fluid losses. Mud weight will be reduced prior to cementing to maximize mud and slurry weight differential. Drilling below the 13 3/8-inch casing will be by the use of 12 1/4-inch bits with water until the 9 5/8-inch casing depth has been established. The hole will be mudded up utilizing the reconditioned mud retained from the 17 1/2-inch hole and fluid loss zones will be similarly cured before running casing. Again, if necessary, the mud weight may also be increased to test the hole integrity prior to running casing and reduced prior to cementing the 9 5/8-inch casing. Drilling below the 9 5/8-inch casing will be with water.

J. Drill Cuttings

Four sets of sample cuttings will be obtained every 30 feet or as otherwise requested by ANC. The samples will be washed and placed in legibly labeled sample bags and shipped by ANC to pre-indicated points.

K. Coring

A maximum of four 30 foot cores will be taken with method and depths to be determined by ANC.

L. Drill Stem Tests

Approximately three DST's are planned at depths to be determined by ANC. Obtain water samples for chemical analysis.

M. Logging

1. 17 1/2-Inch Open-Hole Logs (by ANC tools, as available)

   Four-Arm Caliper Survey--1,400 feet to 120 feet.
   Electric or Borehole Compensated Sonic--1,400 feet to 120 feet.
   Temperature Log--1,400 feet to 120 feet.
2. **13 3/8-Inch Cased-Holed Logs**
   
   Temperature Logs—Determine casing cement tops (by ANC).
   
   Cement Bond or Nuclear Cement Log—1,400 feet to surface, if required.

3. **12 1/4-Inch Open-Hole Logs**
   
   The following logs will be taken all or in part as determined by ANC in order to deduce the formation water content and temperature and geological and hydrological data prior to installing casing.
   
   a. Integrated Four-Arm Caliper Survey—T.D. to 1,400 feet.
   
   b. Dual Induction Laterolog—T.D. to 1,400 feet.
   
   c. Simultaneous Compensated Neutron-Formation Density—T.D. to 1,400 feet.
   
   d. Temperature—T.D. to 1,400 feet.
   
   e. Borehole Compensated Sonic—T.D. to 1,400 feet.
   
   f. Flowmeter Tests—T.D. to 1,400 feet (by ANC).

4. **9 5/8-Inch Cased-Hole Logs**
   
   Temperature Log—Determination of cement tops (by ANC).
   
   Cement Bond or Nuclear Cement Log—T.D. to 1,400 feet, if required.

5. **8 3/4-Inch Original Drilled Open-Hole Logs, and Sidetrack Holes, as Practicable**
   
   a. Simultaneous Caliper Survey—T.D. to 3,500 feet.
   
   b. Dual Induction Laterolog—T.D. to 3,500 feet.
   
   c. Simultaneous Compensated Neutron-Formation Density—T.D. to 3,500 feet.
   
   d. Temperature—T.D. to 3,500 feet (by ANC).
e. Borehole Compensated Sonic--T.D. to 3,500 feet.

f. Flowmeter Tests--T.D. to 3,500 feet (by ANC).

N. Directional Survey

Run magnetic single-shot surveys as specified in Section IV.E, Drilling Procedure. Direction driller services will be required for the directional drilled portions of the sidetrack hole(s).

O. Completion

The completion procedures include flow tests and/or reinjection tests, DST's, etc., as determined by ANC.

P. Abandonment

If ID directs the abandonment of the project because of the inability to locate sufficient geothermal resource, or for any other reasons, development of abandonment procedures will be the joint responsibility of NV, ID, REECo and ANC. NV/REECo will perform abandonment work required at the drilling site and ID will be responsible for providing funding and coordinating the procedure with the appropriate organizations.

Abandonment procedures will be based upon the following criteria: (1) prevent contamination of freshwaters or other natural resources; (2) prevent damage to geothermal reservoirs; (3) prevent loss of reservoir energy; and (4) protect life, health, environment, and property.

The following are general requirements which will be met:

1. A notice to abandon any geothermal resource wells will be filed with the Idaho Department of Water Resources (Department) five days prior to beginning abandonment procedures.
2. A history of geothermal resource wells (well completion report) shall be filed with the Department within 60 days after completion of abandonment procedures.

3. All wells abandoned shall be monumented and the description of the monument shall be included in the history of well report. Such monument shall consist of a four-inch diameter pipe ten feet in length, of which four feet shall be above ground. The remainder shall be imbedded in concrete. The name, number, and location of the well shall be shown on the monument.

4. Good quality heavy drilling fluid shall be used to replace any water in the hole and to fill all portions of the hole not plugged with cement.

5. All cement plugs, with a possible exception of the surface plug, shall be pumped into the hole through drill pipe or tubing.

6. The annuli shall be cemented to straddle the interface or transition zones at the base of the groundwater aquifers.

7. A minimum of 100 feet of cement shall be emplaced straddling the interface or transition zone at the base of groundwater aquifers.

8. One hundred feet of cement shall straddle the placement of the shoe plug on all casings including conductor pipe.

9. A surface plug of either neat cement or concrete mix shall be in place from the top of the casing to at least 50 feet below the top of the casing.

10. All casing shall be cut off at least five feet below land surface.

11. Cement plugs shall extend at least 50 feet over the top of any liner installed in the well.
12. Abandonment of injection wells will be conducted in the same manner as other wells.
V. PERMITS

The location of this hole is on public land managed by the Bureau of Land Management. ID will provide REECo (through NV) information so they can obtain any necessary geothermal and/or drilling permits or will advise NV that none are required of REECo. REECo will have the responsibility to do whatever is required under Idaho law to enable it as a foreign (out-of-state) corporation to do business in Idaho.

ANC will advise ERDA/ID in a timely manner of any special permits which will be required.
VI. ENVIRONMENTAL ASSESSMENT

ANC is responsible for preparing an environmental assessment for the project which covers all drilling and testing work covered by this plan.
VII. INDUSTRIAL RELATIONS

ID will be responsible for the determination as to whether the Davis-Bacon Act applies to this project. ID will also be responsible for the industrial relations activities of ID contractors.

NV will be responsible for industrial relations activities related to NV contractors.
VIII. PUBLIC INFORMATION

All site visits and inquiries will be coordinated through the ID Public Information Officer. All formal press releases made periodically during the program (e.g. start of drilling and termination of drilling) will be cleared through the ID office for public information.
IX. PROGRAM MANAGEMENT

A. General

This section describes the basic authorities and responsibilities of the principal participants in the drilling operations. The principal participants include the following:

1. ERDA-Idaho Operations Office
2. ERDA-Nevada Operations Office
3. Aerojet Nuclear Company
4. Reynolds Electrical & Engineering Co., Inc.

Figure IX-1 indicates the interrelationship between the project participants and the channels of funding and communications.

B. U. S. Energy Research and Development Administration--Idaho Operations Office

The Manager, ID, shall be responsible for all project-related activities assigned to the government by Contract AT(10-1)-1375 between ID and ANC and by this document. The Manager, ID, shall also be responsible for funding the drilling operations in accordance with the procedures outlined in Section X of this drilling plan. In addition, the Manager, ID, shall appoint an ID Project Manager who will be the interface responsible for coordinating activities between ANC and NV/REECo. The ID Manager will request the U. S. Geological Survey to perform any activities required of the USGS in the accomplishment of program objectives.

C. U. S. Energy Research and Development Administration--Nevada Operations Office

The Manager, NV, shall be responsible for all project-related activities assigned to the government by Contract AT(26-1)-410 with REECo and this document. The Manager, NV, shall also provide an NV Project Manager responsible for all field
FIG. IX-1 PROJECT ORGANIZATION - DRILLING OPERATIONS
IDAHO GEOTHERMAL R&D PROJECT
activities described in this drilling plan which are assigned to NV.

The areas of authority and responsibility of the NV Project Manager are as follows:

1. Provide one or more contractors to conduct the drilling and completion operations as specified in Section IV.

2. Provide an NV site representative to direct all NV and NV-contractor activities.

3. Assure that the provisions for occupational health and safety are met in accordance with Section III of this report, for NV and REECo employees.

4. Prepare cost reports and technical documentation to the ID as described in Sections X and XI of this report.

D. Aerojet Nuclear Company

ANC will appoint a Project Manager. The ANC Project Manager will be responsible to the General Manager of ANC and the General Manager of ANC will be responsible to the Manager of ID for all project-related functions being accomplished in an effective and timely manner. The ANC Project Manager will continuously monitor the activities of all the program participants as to assure that all the participants are accomplishing all of the activities required by this drilling plan. The ANC Project Manager will also assure that the appropriate technical expertise is available to allow the technical program tasks, as defined in this drilling plan and as stated in the Idaho Geothermal R&D Project, to be accomplished. The ANC Project Manager is further charged with the primary responsibility of accomplishing the goals of the Idaho Geothermal R&D Project.

The ANC Project Manager will appoint an ANC Field Operations Manager who will be responsible to the ANC Project Manager. The ANC Field Operations Manager responsibilities will include the following:
1. Provide technical criteria for the development of the drilling plan including identifying the requirements for technical data to be obtained during the drilling operation.

2. Provide technical program direction to the NV site representative and technical program support to REECo to assure that the objectives of the project are accomplished.

3. Provide on-site logistical support activities as specified in Section II.

4. Management of ANC activities on site.

5. Be continually aware of all drilling site-related activities and assure that the project participants are cognizant of any development which may impair the drilling program or the objectives of the Idaho Geothermal R&D Project.

6. Provide drilling materials, equipment and services as specified in Section IV.

7. Assure that all provisions for occupational health and safety are met in accordance with Section III for ANC and other site support work other than NV and REECo personnel.

E. Reynolds Electrical & Engineering Co., Inc.

REECo, under direction of NV, will provide the necessary equipment, material and personnel with authority and responsibility to conduct the drilling operations as described in this plan and as may be modified by technical criteria furnished by ANC.

REECo will also be responsible for any additional procurement of materials and services directly related to drilling operations that are not assigned to ANC or REECo in Sections II and IV of this plan.
X. FUNDING AND COST REPORTING

Costs incurred by REECo will be reported to ID on a weekly basis by NV at the REECo work order level (see Figure X-1). It is recognized and agreed to by the parties that such costs are unofficial and subject to change when official monthly costs are reported.

A comprehensive cost report will be prepared by NV for ID at the conclusion of the drilling.

The official costs incurred will be transferred monthly to ID via non-reconciling transfer from NV.
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<th>Work Order</th>
<th>Description</th>
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<th>Costs This Week To Date</th>
<th>Cost Outstanding Commitments</th>
<th>Subtotal Costs and Commitments</th>
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<td>LOCATION TO LOCATION MOVE &amp; RIG UP</td>
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<tr>
<td>TOTAL</td>
<td></td>
<td></td>
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**NOTE**

**FIGURE X-1—REECO COST REPORT**
XI. TECHNICAL DOCUMENTATION AND REPORTING

A. General
The documentation and reporting requirements during the drilling of RRGE-3 will be limited to those necessary for the participants to maintain a thorough working knowledge of day-to-day operations and the final well configuration.

B. Reports
The required reports for RRGE-3 include:
1. A daily drilling report similar to that shown in Figure XI-1.
2. A well completion report estimated to be issued within 120 days of completion of the hole. This report will document the drilling and completion procedure, and will be prepared by NV and REECo and 175 copies submitted to ID/ANC.
**DATE**

**LOCATION**

**PRESENT OPERATION**

**FORMATION**

**HOLE SIZE**

**PRESENT T.D.**

**DRILLED FROM**

**FEET TO**

**FEET:**

**MADE**

**FEET OF HOLE**

**IN**

**HOURS:**

**TRIPS**

**HOURS:**

**SERVICE RIG**

**HOURS:**

**D.S.T.**

**HOLE SURVEY**

**HOURS:**

**OTHER DOWNTIME:**

**HOURS**

**MUD LOG TEMPERATURES:**

**MUD IN--HIGH**

**°C @**

**FEET T.D., LOW**

**°C @**

**FEET T.D.**

**MUD OUT--HIGH**

**°C @**

**FEET T.D., LOW**

**°C @**

**FEET T.D.**

**REMARKS:**

**DRILLING INFO:**

**ROTARY RPM**

**WEIGHT ON BIT**

**PUMP PRESSURE**

**PUMP ON HOLE**

**PUMP LINER SIZE**

**PUMP STROKES**

**CIRCULATION RATE (GPM)**

**MUD INFO:**

**WT.**

**VISCOITY**

**PLASTIC VISCOSITY**

**WATER LOSS**

**FILTER CAKE**

**PH**

**SAND CONTENT**

**BIT INFO:**

**PRESENT BIT #**

**DEPTH IN**

**MAKE**

**TYPE**

**JET NOZZLES**

**LAST BIT RUN #**

**MAKE**

**TYPE**

**JET NOZZLES**

**DEPTH IN**

**DEPTH OUT**

**FOOTAGE**

**HOURS RUN**

**CONDITION OF BIT**

**DRILL COLLAR INFORMATION:**

**NO. OF COLLARS IN USE**

**O.D.**

**I.D.**

**PLACEMENT OF STABILIZERS**

**FUEL CONSUMPTION:**

**BUTANE**

**GAL.**

**DIESEL**

**GAL.**

**FIGURE XI-1--DAILY DRILLING REPORT**

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IDAHOGEO TermAL R&D PROJECT
DAILY DRILLING REPORT

DATE: __________________________ LOCATION: __________________________

PRESENT OPERATION: __________________ FORMATION: __________________ HOLE SIZE: __________________


HOLE SURVEY: _______ HOURS: OTHER DOWNTIME: _______ HOURS

MUD LOG TEMPERATURES: MUD IN: -- HIGH °C @ _______ FEET T.D., LOW °C @ _______ FEET T.D.
MUD OUT: -- HIGH °C @ _______ FEET T.D., LOW °C @ _______ FEET T.D.

REMARKS: ____________________________________________

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

DRILLING INFO: ROTARY RPM: _______ WEIGHT ON BIT: _______ PUMP PRESSURE: _______

PUMP ON HOLE: _______ 2 PUMP LINER SIZE: _______ 2

PUMP STROKES: _______ CIRCULATION RATE (GPM): _______

MUD INFO: WT.: _______ VISCOSITY: _______ PLASTIC VISCOSITY: _______ WATER LOSS: _______

FILTER CAKE: PH: _______ SAND CONTENT: _______

BIT INFO: PRESENT BIT#: _______ DEPTH IN: _______ MAKE: _______ TYPE: _______

JET NOZZLES: _______

LAST BIT RUN #: _______ MAKE: _______ TYPE: _______ JET NOZZLES: _______

DEPTH IN: _______ DEPTH OUT: _______ FOOTAGE: _______ HOURS RUN: _______

CONDITION OF BIT: __________________________

DRILL COLLAR INFORMATION: NO. OF COLLARS IN USE: _______ O.D.: _______ I.D.: _______

PLACEMENT OF STABILIZERS: __________________________

FUEL CONSUMPTION: BUTANE: _______ GAL. DIESEL: _______ GAL.

FIGURE XI-1--DAILY DRILLING REPORT
APPENDIX A

SCHEDULE OF MAJOR ACTIVITIES
RRGE-3

DAYS DURATION

0  7  14  21  28  35  42  49  56  63  70  77

- MOVE FROM RRGE-2
- RIG-UP/DRILL 17-1/2" HOLE TO 1400'
- RUN/CEMENT 13-3/8" CASING
- DRILL 12-1/4" HOLE TO 3500'
- RUN/CEMENT 9-5/8" CASING
- DRILL 8-3/4" HOLE TO 6000'
- CORING OPERATION
- PERFORM DSTs
- FLOW TEST/LOGGING
- DRILL SIDE TRACK HOLE TO 6000'
- COMPLETION
- RELEASE RIG
- RIG DOWN
- TRANSPORT - NTS
Distribution:

R. L. Hirsch, Actg. AA/SG&AES, HQ
E. H. Willis, Dir., DGE, HQ
L. B. Werner, DGE, HQ
R. S. H. Toms, DGE, HQ
L. J. P. Muffler, USGS, Menlo Park, CA
F. W. Stead, USGS, Denver, CO
B. A. Boudeau, USGS, Menlo Park, CA
P. L. Russell, USBM, Denver, CO
W. E. Ogle, Consultant, Anchorage, AK
P. A. Witherspoon, LBL, Berkeley, CA
A. L. Austin, LLL, Livermore, CA
H. C. Gleason, LLL, Mercury, NV
J. C. Rowley, LASL, Los Alamos, NM
G. E. Brandvold, SL, Albuq., NM
R. W. Kiehn, REECo, Las Vegas, NV (3)
J. D. Auten, REECo, Mercury, NV (3)
F. R. Huckabee, REECo, Raft River Site, ID (5)
R. S. Bostian, REECo, Las Vegas, NV (3)
J. F. Kunze, ANC, Idaho Falls, ID (25)
R. G. Bradley, Manager, ID
J. X. Combo, Chief Counsel, ID
C. W. Bills, Dir., PM&WMID, ID
J. L. Griffith, PM&WMID, ID (25)
R. A. DuVal, PMSEP, SAN
D. K. Nowlin, SPD, AL
R. R. Loux, OPA, NV (2)
B. G. DiBona, Dir., IAD, NV (10)
TIC, Oak Ridge, TN (2)
NV Technical Library (5)
NV Principal Staff