TRUE GEOTHERMAL ENERGY COMPANY
KMERZ WELL NO. KA2-1
GEOTHERMAL EXPLORATION WELL PROGRAM

The following well program is designed to drill and complete a nominal 10,000′ geothermal exploration well in the KMERZ. (See Figure 001) Based on the results of prior drilling, a large degree of flexibility is built into the program. It should be clear that being an exploration well, the casing setting depths and drilling procedures are subject to change at any time. DLNR will be notified and updated as drilling progresses on any changes.

1. Install 30" conductor pipe in 42" hole to 60′ to 100′ or as deep as possible below ground level prior to rotary rig moving onto location. Cement conductor from total depth back to surface with redi-mix cement. If a burial cave or lava tube is encountered when setting the conductor pipe, further investigation is required prior to proceeding. Notify DLNR and consult with archaeologist. If conditions warrant, conductor installation may also be performed with rotary rig.

2. Construct 10′ x 10′ x 9′ deep cellar around conductor pipe with a cemented bottom and stairway exit toward front of rig. See attached Figure 002.

3. Move in rotary drilling rig to drill well. Center rig over conductor pipe and rig up. Drill 42" hole with bucket bit and install 30" conductor, if not installed prior to moving in. Add 30" OD extension to conductor pipe to bring it up under rotary table. Install flow line on conductor pipe to return mud to pits.

4. Notify DLNR upon startup of drilling of a pilot hole. Pick up an 8-1/2" bit on a 26" hole opener or reamer and run into the bottom of the conductor pipe. Center punch 8-1/2" hole and drill 8-10′. Pull out of hole and remove 26" hole opener or reamer. Run 8-1/2" bit and drill to 100′+/-. During the drilling of this 8-1/2" pilot hole progress should be monitored constantly to determine if a lava tube which may contain archaeological artifacts might be encountered directly under the rig. If the bit drops free for more than eight (8) feet then drilling will stop. If this drop occurs the hole will be flushed with clear water and a light source with video camera lowered into the hole to investigate the possibility of any archaeological value. If archaeological value is determined then drilling will stop and the rig moved. If no archaeological value is determined then provisions would be made to continue drilling. Drilling supervisor shall be on drill rig floor throughout complete pilot hole drilling operations.

5. Open 8-1/2" hole to 26" with 26" bit and drill with mud to 800-1000′ depending on geology. Maintain hole as straight as

possible, take drift shots every 100'. Maximum rate of change 1 degree per 100'. Install mud loggers at surface to log entire well from 0' to total depth. Catch three clean and dry samples every 10'.

6. Rig up and run 20" casing to total depth as per attached 20" casing program with 20" stab-in float collar and float shoe on bottom.

7. Once 20" casing has been run to bottom, run in hole with stab-in tool on bottom of drill pipe and stab into float collar. Circulate hole clean with at least two full circulations.

8. Cement 20" casing through drill pipe as per attached program. Circulate cement back to surface between 20" and 30" casing. Observe cement level. If cement falls back in annulus, bring same back to surface with 1" pipe.

9. Wait on cement 8 hours.

10. Land 20" casing. Cut off and remove 30" conductor drilling nipple. Cut off 20" casing and weld on 20" S.O.W. x 21-1/4" 2000 psi wellhead. Install two 3" valves. Install 20" blow out preventer equipment as per attached Figure 003.

11. Test 20" casing and blow out preventer equipment to 1500 psi for 30 minutes.

12. Drill out cement and float collar and float shoe from 20" casing with 17-1/2" bit using mud. Drill 30' of formation and trip to pick up stabilization.

13. Continue to drill 17-1/2" hole as vertical as possible with mud to 3500'+/- as indicated by formation. Directionally survey well at least every 100'. If lost circulation presents severe problems, an aerated mud system may be utilized. Severe loss circulation zones should be cemented off prior to drilling ahead.

14. Once 17-1/2" hole has been completed to casing point, rig up and run logs if indicated by geologic staff.

15. Upon completion of logging program, run in hole with bit and circulate to condition hole for casing.

16. Rig up and run 13-3/8" casing as per attached 13-3/8" casing program and running procedure. If lost circulation presents severe problems during drilling it may be necessary to set 13-3/8" pipe as a liner then tie it back to the surface rather than a full string of casing. See running procedure for alternative options.

17. Cement 13-3/8" casing as per attached program. Circulate cement back to surface between 13-3/8" and 20" casings. Observe cement, if it falls back, bring level back to surface using 1" pipe.

18. Wait on cement 12 hours or until samples are set.

19. Land 13-3/8" casing. Remove 20" blow out preventer stack. Cut off 13-3/8" casing and install 12" x 21-1/4" 900 ANSI expansion spool wellhead with two 3" flanged outlets equipped with 3" 2000 psi wing valves. Install 12" 900 series blow out preventer stack with 12-1/4" bore as per attached Figure 004.

20. Test 13-3/8" blow out preventer stack to 1500 psi for 30 minutes.

21. Drill out all cement, float collar and shoe from the 13-3/8" casing with a 12-1/4" bit using mud. Drill 30' of formation and trip to pick up stabilization.

22. Drill 12-1/4" hole with mud or aerated mud as required by hole conditions to 6000-8000', the 9-5/8" casing point, as indicated by geologic staff. Lock up drilling assembly to maintain direction and angle as straight as possible to casing point.

23. Once 12-1/4" hole has been completed to casing point, rig up and run logs if indicated by geologic staff.

24. Upon completion of logging program, run in hole with bit and circulate to condition hole for casing.

25. Rig up and run 9-5/8" casing as a liner equipped as required with external casing packer located 200-300' from bottom. Hang same using a double slip liner hanger with tie-back sleeve. Run 9-5/8" liner from total depth to hanger located 200' up inside of 13-3/8" casing as per attached 9-5/8" liner program and running procedure.

26. Once liner is hung, circulate hole clean through drill pipe with at least two full circulations.

27. Cement 9-5/8" liner and external casing packer from total depth back up to top of liner lap as per attached cementing program.

28. Once cement is in place, disengage from liner hanger and pull up 60' and circulate out excess cement.

29. Pull out of hole with liner hanging tool and run in hole with 12-1/4" bit and drill out cement from 13-3/8" casing to top of 9-5/8" liner lap. Test lap to 1000 psi only after cement has been in place 12 hours. Squeeze lap area if necessary to

obtain a 1000 psi squeeze pressure.

30. Trip for 8-1/2" bit and drill out excess cement from 9-5/8" liner down to top of float collar. Pressure up and retest 13-3/8" casing, liner lap and 9-5/8" casing to 1000 psi.

31. Drill out cement, float collar and float shoe from 9-5/8" casing using 8-1/2" bit and mud. Drill 30' of formation and circulate to change out mud for water. Re-install rotating head on blow out preventer stack for air drilling if not already installed for the drilling of the 12-1/4" hole.

32. Trip to pick up 8-1/2" stabilization. Drill 8-1/2" hole through production zone to total depth of 9,000'-12,000' using air or aerated water as a drilling medium.

33. Pull out of hole with drill pipe and test well for short term with rig on location.

34. If results appear commercial, pull out of hole and release rig for long production test or proceed ahead with attached 9-5/8" tie-back procedure to complete well with 9-5/8" tie-back, if 13-3/8" casing shows damage or excessive wear. If well test results prove that the flow rate from the well is not commercial then either deepen or redrill to obtain production.

35. Evaluate well and complete with either open hole or 7" slotted liner.

SPECIAL CONSIDERATIONS
AUXILIARY EQUIPMENT THAT SHOULD BE MAINTAINED WITH THE RIG

1. Six pen drilling recorders on drill floor with: a) string weight; b) rpm; c) rotary torque; d) rate of penetration; e) pump pressure; f) exit pressure. Additional real time monitoring of drilling parameters to be considered upon consultation with DLNR Staff.

2. Special rotating head with rubbers, capable of stripping 17-1/2", 12-1/4" and 8-1/2" bottomhole assemblies. Complete with spare rotating head stripper drive bushing assembly. Rotating head should be installed on top of hydril or at least on location, available for installation if necessary. Run cold water continuously on head while producing geothermal fluids.

3. Use tong torque assembly with torque gauge for making up collars to API torque requirements.

4. Temperature should be taken with every directional survey by running a maximum recording thermometer in the survey instrument.

5. Catch drill cutting samples (3 sets) every 10', to be cleaned and sacked.

6. In and out temperatures, both of mud, air or aerated water, shall be recorded in the Tour Reports every 30'. All steam/water entries shall be recorded in the Tour Reports.

7. All lost circulation zones encountered shall be recorded in Tour Book recording both the depth at which the loss occurred, as well as the amount of fluid lost. All flows shall also be recorded giving depth and the amount of increase.

8. Periodic tests may be conducted to determine well potential. Drilling will be stopped and the hole evacuated to check for flow at lost circulation zones.

9. Upon completion, the well will be shut in by closing the lower master valve. The remainder of the blow out preventer equipment will then be removed.

10. Rotary table will be equipped with a torque gauge with visual display for driller.

HYDROGEN SULFIDE MONITORING AND ABATEMENT

Hydrogen sulfide monitoring should be maintained during the drilling of the well. Detectors should be placed on the rig floor, cellar area, and flowline region to detect and announce (with alarms and lights) the presence of hydrogen

sulfide. These monitors are typically provided by and maintained daily by the geothermal data loggers. Proper functioning of these monitors is essential in maintaining a safe working environment.

Hydrogen sulfide abatement equipment and materials, i.e. pumps and caustic soda, should be maintained on location when drilling with lighter than water drilling fluids, i.e. air or aerated mud systems.

Escape breathing equipment, as well as resuscitators shall be available on site with mud logging unit. Fans should also be available on the rig floor to clear H2S contaminated floor areas, making it safer to work.

PIPE AND BLOW OUT PREVENTER INSPECTION

The initial acceptance of drill pipe should be based on an IODC-API Class II specification inspection. All subsequent inspections should discard pipe with 30% wear or greater; i.e., use 30% where Class II states 20%.

The drill pipe should include:

1. Electromagnetic inspection of tubes (Sonoscope or Scanalog).

2. Wall thickness and cross sectional area (ultrasonic or gamma ray).

3. End area inspection (electronic or magnetic particle).

All drill collar end areas should be magnetic particle inspected every 14 days or every 9 days while drilling with production or drilling with air or aerated mud systems.

All BOPs should be inspected for wear by the manufacturer or an authorized agent prior to installation. All BOPs should be tested after installation prior to drilling out cement.

Remind service companies furnishing bottomhole assemblies that their equipment should be magna-fluxed prior to delivery.

AIR EQUIPMENT REQUIREMENTS

Minimum air and pressure requirements are 4500 SCFM at 1000 psig for rotary drilling 12-1/4" hole below 13-3/8" casing.

Minimum air and pressure requirements are 3000 SCFM at 1000 psig for rotary drilling below 9-5/8" casing.

Hook-up lines, air meter, and scrubber, misting pump with minimum capacity of 10 gpm, and operating personnel will be furnished by the air contractor. Use Union Oil's UniSteam corrosion inhibitor while drilling in steam, to be injected into the drill pipe. The mixture for UniSteam is as follows:

Steam lbs/hr	Injection
0-20,000	5 gal UniSteam-10/BBl water
20,000-40,000	10-15 gal UniSteam-10/BBl water
40,000-150,000	20-35 gal UniSteam-10/BBl water
150,000+	40 gal UniSteam-10/BBl water

PROCEDURE FOR RUNNING AND CEMENTING 13-3/8" CASING

1. Drill to casing depth.

2. Circulate for 2-3 hours, two complete circulations to clean hole of cuttings.

3. Pick up excess drill pipe needed to stab into float collar for cementing the 13-3/8" casing.

4. Make short trip and circulate for 1-2 hours.

5. Pull out of hole and rig up to run 13-3/8" casing. Run multi-shot survey while pulling out of hole if necessary. If loss circulation has not been a severe problem in drilling the 17-1/2" hole, then proceed ahead to step 8 and run 13-3/8" casing as a full string. If loss circulation has presented problems, then proceed to step 23 and run 13-3/8" as a liner with tie-back string.

6. Run 13-3/8" casing grades, weights and thread design as indicated on attached detailed sheet with stab-in collar 40' from float shoe on bottom with centralizers located one in middle of bottom two joints and then one every other collar upward omitting any from the top 200'.

7. Set casing in elevators on spider. Do not set casing slips. Drop centralizing ring of 13-3/8" casing inside 20" wellhead. Install return hoses from 20" wellhead to mud pits.

8. Rig up with landing plate on top of 13-3/8" casing. Run drill pipe into 13-3/8" with stab-in sub on bottom. Stab into collar and rig up to circulate. Tie down drill pipe.

9. Circulate for 3 hours, or at least two full circulations, to clean up and cool down hole.

10. Rig up to cement.

11. If loss circulation is a problem, pump 20 BBls CaCl2 water, 10 BBls fresh water, 20 BBls sodium silicate, followed by 20 BBls viscous Geo-Gel mud spacer.

12. Pump cement without any additional spacers. Pump stage 1 consisting of Class G perlite blended 1:1 with 40% silica flour, 3% gel and 0.5% CFR-2. Retard as needed. Pump this cement until you see returns of cement at the surface. If loss circulation has been a problem, the cement may have to be changed to a spherelite blended cement, see Note below.

13. Pump stage 2 cement: Class G cement with 40% silica flour, 3% gel and 0.5% CFR-2. Retard as needed. Pump 200 cu ft of this stage 2 cement. The last 100 cu ft should be staged in: Pump 35 cu ft and shut down for 5-10 minutes, then pump 35 cu

ft and shut down again for 5-10 minutes before pumping last 30 cu ft. Check for fall back in annulus each time. Pull out of stab-in shoe and clear drill pipe, dropping all excess cement from drill pipe on top of float collar.

14. Rig down circulating equipment and pull out of hole with drill pipe.

15. Hook up to 13-3/8" casing elevators and pick up slightly to remove spider, then center 13-3/8" casing in stack.

16. Drain blow out preventer equipment after 30 minutes from the time cement was in place.

17. Wait on cement 12 hours before landing casing. Check for cement fall back in annulus periodically. Bring cement back to surface using 1" pipe if necessary.

18. Cut off 13-3/8" casing. Remove 20" blow out preventer equipment. Install 21-1/4" x 12" 900 ANSI expansion spool, 12" master valve and nipple up blow out preventer equipment as in attached Figure 004.

19. Test blow out preventer equipment to 1000 psi.

20. Change out bottom hole drilling assembly for 12-1/4" tools and run in hole.

PROCEDURE FOR RUNNING & CEMENTING 13-3/8" AS A LINER AND TIE-BACK STRING

1. Follow steps 1-4 above.

2. Pick up 13-3/8" liner. If circulation was never achieved, then a stage collar should be installed at approximately 2000'. Install cement basket type centralizers in the middle of the bottom two joints and one just below stage collar. Install one cement basket type centralizer to be located 20' up inside 20" casing shoe.

3. Run liner in hole and hang same 100' up inside of 20" casing with shoe just off bottom.

4. Attempt to circulate with two times total volume of fresh water. If unsuccessful, then proceed with cement job.

5. Pump 20 BBls CaCl2 water and 10 BBls fresh water, followed by 20 BBls sodium silicate, 20 BBls Geo-Gel flush, then cement slurries for stage 1. Follow stage 1 cement with 200 cu ft of stage 2 cement.

6. Release plugs after stage 2 cement and open cementing ports if stage collar is run.

7. Circulate through stage collar. Repeat preflush prior to pumping cement. Pump stage 1 and stage 2 cement as in prior cement job on bottom section of 13-3/8" liner.

8. Release plugs and displace cement and plugs down hole to close stage collar.

9. Release hanger and pull out of hole with setting tool. Wait on cement for 6 hours.

10. Run in hole with 17-1/2" bit and clean out excess cement, if any, from the top of the 13-3/8" liner.

11. Test lap to 750 psi. If unable to get a test, trip to lay down bit, run in open ended. Squeeze lap with Class G cement blended with 40% silica flour and 0.5% CFR-2 using pipe rams.

12. Re-squeeze until a squeeze pressure is achieved. Fill hole with water.

13. Drill out excess cement with 17-1/2" bit and retest lap to 750 psi.

14. If successful in testing lap, run in hole with 12-1/4" bit and 13-3/8" casing scraper to clean out tie-back sleeve.

15. Pick up 13-3/8" tie-back with float collar located 40' above tie-back stinger on bottom.

16. Run tie-back string in hole and land same in sleeve at hanger.

17. Circulate around with fresh water, then run cement slurry. Use top plug only.

18. Wait on cement 6 hours. If after 6 hours cement is not to surface level in 13-3/8" x 20" annulus, insert 1" tubing and bring it back to surface with cement.

19. Cut off 13-3/8" casing. Remove 20" blow out preventer equipment. Install 21-1/4" x 12" 900 ANSI expansion spool, 12" master valve, and nipple up blow out preventer equipment as in attached Figure 004.

20. Test blow out preventer equipment to 1000 psi for 30 minutes.

21. Change out bottom hole drilling assembly for 12-1/4" tools and run in hole.

NOTE: Spherelite cement should be blended as follows:

Class G cement blended with 40% silica flour, 50 lbs per sack of cement of spherelite, 4% gel, 5% lime, 1.25% CFR-2, and 0.5% Halad-22A.

Cement should be mixed at 82.2#/cu ft (11 ppg). Slurry yield is 3.21 cu ft/sack.

Mixing water requirements are 1.50 cu ft/sack (11.22 gal/sack).

9-5/8" LINER RUNNING PROCEDURE

The drilling program for Well KA2-1 has been written in such a way as to handle all situations that occur during the drilling. Due to the remote location and shipping requirements we must consider all possible hole conditions. These conditions that should be anticipated are listed in order of increasing severity as follows:

1. The 12-1/4" hole is drilled with little or no loss circulation encountered. Due to lost circulation encountered in drilling it would be highly probable that loss of circulation may occur during the cementing of the 9-5/8" liner.
   In this situation where lost circulation has not presented a significant problem during drilling, I feel that a conventional method should be employed in the running and cementing procedure for the 9-5/8" liner. The attached program "PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER WITHOUT EXTERNAL CASING PACKER AND MULTI-STAGE CEMENTER" should be used.

2. The 12-1/4" hole is drilled with air, aerated water or mud, with moderate loss circulation, that is loss circulation encountered in several zones which could be sealed with cement or LCM, or partial loss circulation zones which may take fluid periodically during drilling operations. Probability of lost circulation during cementing is high and should be anticipated.
   In this situation a certain amount of caution should be used in running and cementing the 9-5/8" liner to insure a competent cement job. A 9-5/8" liner utilizing a multi-stage cement collar strategically located could assist in obtaining an adequate cement job. The attached program "PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER WITH MULTI-STAGE CEMENTER" should be used.

3. The 12-1/4" hole is drilled using air or aerated water because of complete loss of circulation during the drilling. Sealing of these loss circulation zones prove to be unsuccessful or extensive causing a great loss of time therefore air or aerated fluid is used to drill the well. Probability of loss circulation during the cement job is high, therefore extreme methods of cementing the liner should be used.
   In this situation where major problems exist in the well, extreme procedures and technologies should be employed to insure an adequate cement job. The attached program "PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER EQUIPPED WITH EXTERNAL CASING PACKER AND HYDRAULIC CEMENTER" should be used.

PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER
WITHOUT EXTERNAL CASING PACKER AND MULTI-STAGE CEMENTER

1. Drill to casing depth at approximately 6000-7000′ dependent on temperature and geology.

2. Circulate for 2-3 hours to clean and cool hole.

3. Pull out of hole.

4. Rig up and run logs as indicated by geologic staff. Wait on bottom with temperature log for 30 minutes before pulling out of hole.

5. Rig down loggers and run in hole with bit and monel to total depth.

6. Circulate for 2 hours and make short trip. Circulate for 1-2 hours after short trip.

7. Pull out of hole and rig up to run 9-5/8" liner. Run additional directional surveys while pulling out of hole if necessary.

8. Run 9-5/8" liner grades, weights and thread design as indicated in detail sheet with float shoe on bottom and float collar two joints up. Centralizers should be located one in the middle of the bottom two joints and then one every to every other collar upward to within 60′ of the hanger. Use T-Bar rigid centralizers totally in bottom portion of the string and then as required in the upper portion. Run casing adjusters at 600′, 1800′ and 3400′ above shoe joint if required.

9. Circulate two full circulations to clean up and cool down well prior to cementing.

   Note: If casing can still be moved after running to bottom then move casing throughout circulation and cementing job and hang after cement is in place. If casing will not move after running to bottom, then hang liner before circulating and cementing job.

10. If loss circulation is encountered, pump 20 BBls of CaCl2 water and 10 BBls of fresh water ahead of 20 BBls of sodium silicate.

11. Pump in 20 BBls of viscous Geo-Gel mud preflush.

12. Pump cement without any water spacers. Pump stage 1: Class G cement and perlite blended at a ratio of 1:1 with 40% silica flour, 3% gel and friction reducer. Retard to give 2-3 hours

pumping time at 350 degrees F. Use 100% excess. If lost circulation is a problem, cement may be required to be changed to a spherelite blend. See note at bottom of this procedure. Pump stage 1 as per precalculated volumes.

13. Pump stage 2: Class G cement blended with 40% silica flour, 3% gel and friction reducer. Retard to give 2-3 hours pumping time at 350 degrees F. Pump 200 cu ft of this stage 2 cement. The last 100 cu ft should be staged in: Pump 35 cu ft and shut down for 5-10 minutes, then pump 35 cu ft and shut down again for 5-10 minutes before pumping the last 30 cu ft.

14. Once all cement has been pumped then rig down circulating equipment, hang liner and pull out of liner hanger with drill pipe and pull up 90' and circulate out excess cement on top of liner top.

15. Wait on cement 12 hours. Run in hole with 12-1/4" bit to top of cement, drill out cement to liner top. Wait a full 24 hours from the time cement was in place or until samples have set before pressure testing lap to 1000 psi surface pressure. Squeeze lap if necessary to obtain a pressure test.

16. Trip to change bits to 8-1/2" and clean out cement from inside of the 9-5/8" liner top.

17. Retest liner lap to 1000 psi surface pressure. Squeeze if necessary to obtain a pressure test.

18. Drill out cement, float collar and float shoe with 8-1/2" bit. Drill 60' of formation with mud.

19. Circulate to clean hole and then displace mud in hole for water.

20. Trip out of hole to pick up stabilization.

21. Run back in hole and aerate water. Drill ahead with aerated water to commercial production or total depth.

NOTE: Spherelite cement should be blended as follows:

Class G cement blended with 40% silica flour, 50 lbs per sack of cement of spherelite, 4% gel, 1.25% friction reducer and fluid loss agent.

Cement should be mixed at 88.3 lbs per cu ft (11.8 ppg). Slurry yield is 3.16 cu ft per sack of cement.

Mixing water requirements are 1.5 cu ft per sack (11.22 gal/sack).

9-5/8" CASING PROPERTIES

L-80, 47 ppf, Buttress, Burst: 6870 psi, Collapse: 4760 psi,
Tension: 1,122,000 lbs.

L-80, 53.5 ppf, Buttress, Burst: 6330 psi, Collapse: 3810 psi
Tension: 1,038,000 lbs.

L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi,
Tension: 947,000 lbs.

PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER
WITH MULTI-STAGE CEMENTER

1. Drill to casing depth at approximately 6000 - 8000' dependent on temperature and geology.

2. Circulate for 2-3 hours to clean and cool hole.

3. Pull out of hole.

4. Rig up and run logs as indicated by geologic staff. Wait on bottom with temperature log for 30 minutes before pulling out of hole.

5. Rig down loggers and run in hole with bit and monel to total depth.

6. Circulate for 2 hours and make short trip. Circulate for 1-2 hours after short trip.

7. Pull out of hole and rig up to run 9-5/8" liner. Run additional directional surveys while pulling out of hole if necessary.

8. Run 9-5/8" liner grades, weights and thread design as indicated in detail sheet with float shoe on bottom and float collar two joints up. Centralizers should be located one in the middle of the bottom two joints and then one every to every other collar upward to within 60' of the hanger. Install multi-stage cementer in a strategic location in the liner string. The location of the multi-stage cementer should be such that the bottom portion can be cemented successfully without loss circulation. The upper portion can then be cemented after the bottom has had time to set without any loss circulation during cementing. A probable location is just above the loss circulation zones. If the hole was air drilled a good location would be approximately 1200' above the casing shoe. Use 12" T-bar rigid centralizers totally in the bottom portion of the string and then as required in the upper portion. Run casing adjusters at 600', 1800', and 3400' above shoe joint as required.

9. Circulate two full circulations to clean up and cool down well prior to cementing.

   Note: If casing can still be moved after running to bottom then move casing throughout circulation and cementing job and hang after stage 1 cement is in place. If casing will not move after running to bottom, then hang liner before circulating and cementing job.

10. If loss circulation is a problem then pump 20 BBls of CaCl2 water and 10 BBls of fresh water ahead of 20 BBls of sodium

silicate.

11. Pump in 20 BBls of viscous Geo-Gel mud preflush.

12. Pump cement without any water spacers. Pump stage 1: Class G cement and perlite blended at a ratio of 1:1 with 40% silica flour, 3% gel and friction reducer. Retard to give 4-5 hours pumping time at 350 degrees F. Pump in calculated volume to fill the annulus of the 12-1/4" hole x 9-5/8" liner from the liner shoe to the stage collar with 100% excess, with approximately 200 cu ft of tail cement consisting of Class G cement blended with 40% silica flour, 3% gel and friction reducer. If loss circulation is a problem, cement may be changed to a spherelite blend. See note at the bottom of this procedure.

13. Pump stage 1 cement and drop dart for wiper plug. Displace cement with water. Bump plug and open multi-stage cementer.

14. After the stage collar has been opened then circulate out excess cement. Circulate and cool hole for 2 hours prior to pumping stage 2 cement. Hang liner at this point.

15. Pump in 20 BBls of CaCl2 water and 10 BBls of fresh water ahead of 20 BBls of sodium silicate.

16. Pump in 220 BBls of viscous Geo-Gel mud preflush.

17. Pump in stage 2 cement without any water spacers. Pump Class G cement and perlite blended at a ratio of 1:1 with 40% silica flour, 3% gel and friction reducer. Retard to give 2-3 hours pumping time at 350 degress F. Pump in calculated volume of cement to fill 12-1/4" hole x 9-5/8" liner to lap area without excess. Calculated volume should include a 200 cu ft tail slurry of Class G cement blended with 40% silica flour, 3% gel and friction reducer. Retard to give 2-3 hours of pumping time at 350 degrees F. Displace cement with water.

18. Once all cement has been pumped then rig down circulating equipment and pull out of liner hanger with drill pipe and pull up 90' and circulate out excess cement on top of liner top.

19. Wait on cement 12 hours. Run in hole with 12-1/4" bit to top of cement, drill out cement to liner top. Wait a full 24 hours from the time cement was in place or until samples have set before pressure testing lap to 1000 psi surface pressure. Squeeze lap if necessary to obtain a pressure test.

20. Trip to change bits to 8-1/2" and clean out cement from inside of 9-5/8" liner top.

21. Retest liner lap to 1000 psi surface pressure. Squeeze if necessary to obtain a pressure test.

22. Drill out cement, float collar and float shoe with 8-1/2" bit. Drill 60' of formation with mud or water.

23. Circulate to clean hole and then displace mud in hole for water if necessary.

24. Trip out of hole to pick up stabilization.

25. Run back in hole and aerate water. Drill ahead with aerated water to commercial production or total depth.

NOTE: Spherelite cement should be blended as follows:

Class G cement blended with 40% silica flour, 50 lbs per sack of cement of spherelite, 4% gel, 1.25% friction reducer and fluid loss agent.

Cement should be mixed at 88.3 lbs per sack of cement. Slurry yield is 3.16 cu ft per sack of cement.

Mixing water requirements are 1.5 cu ft per sack (11.22 gal/sack).

9-5/8" CASING PROPERTIES

L-80, 47 ppf, Buttress, Burst: 6870 psi, Collapse: 4760 psi, Tension: 1,122,000 lbs.

L-80, 43.5 ppf, Buttress, Burst 6330 psi, Collapse: 3810 psi, Tension: 1,038,000 lbs.

L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi, Tension: 947,000 lbs.

PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER
EQUIPPED WITH EXTERNAL CASING PACKER AND HYDRAULIC CEMENTER

1. Drill to casing depth at approximately 6000 - 8000′ dependent on temperature and geology.

2. Circulate for 2-3 hours.

3. Pull out of hole.

4. Rig up and run logs as indicated by geologic staff. Wait on bottom with temperature log for 30 minutes before pulling out of hole.

5. Rig down loggers and run in hole with bit and monel to total depth.

6. Circulate for 2 hours and short trip. Circulate for 1-2 hours after short trip.

7. Pull out of hole and rig up to run 9-5/8" liner. Run additional directional surveys while pulling out of hole if necessary.

8. Run 9-5/8" liner grades, weights and thread design as indicated in attached detail sheet with float shoe on bottom and float collar two joints up. Centralizers should be located one in the middle of bottom two joints and then one every other collar upward to within 60′ of hanger. Use T-Bar rigid centralizers in the bottom portion of the string and then as required in the upper portion. If lost circulation is a problem or the hole has been drilled with air or aerated water then CTC external casing packer should be positioned in string 200-300′ from bottom with Halliburton hydraulic stage cementer located above packer. Run casing adjuster at 600′, 1800′, and 3400′ from shoe joint as required. A T-Bar centralizer should be located above and below packer.

9. Run liner equipment. See attached Pre-Job Recommendations.

   Check all equipment to be run on 9-5/8" liner.
   a. Use Instructions & Operations Sheet TE 7.00381. Measure all parts OD and ID.
   b. Check threads on all tools.
   c. Midway liner hanger running tool. Stinger must be reduced down to 3" OD 2.75 ID and run 10-12.5" below bottom of liner hanger as shown on print TE 7.00378. This is when the liner hanger string is at the bottom of its travel.
   d. Part numbers are given on print TE 7.00377 for tools. ID and OD for SR Plug set is given on print TE 7.00379 OD and OD for HOS Cementer are given on print TE 7.00380.

e. All parts and number should check with prints.
f. HOS Tool has four shear pins that will take 2880 psi over Hydrostatic pressure to open it, two other pins are with the tool. Each pin adds 712.5 psi pressure to shear. Open pressure may be adjusted as needed.

10. Installing equipment onto casing strings. See attached Recommendations During Job for further details.

a. Guide shoe.
b. Centralizers on two joints.
c. Float collar.
d. Centralizers as per program.
e. Casing.
f. CTC Packers 200' off bottom.
g. One joint with centralizer in middle.
h. HOS Cementer.
i. Centralizers as per program - run casing adjusters located 1500' and 3000' from shoe.
j. Casing to top of liner. Fill liner as going in hole.
k. Make up SR Baffle Collar on bottom of liner hanger.*
l. Take O-ring off SR plug set and put on SR Baffle Collar.
m. Make up SR plug set on Baffle Collar and tighten at plug set to Baffle Collar. Be sure all parts are tight.
n. Circulate the liner at 3-4 BPM. Stop and circulate 2-3 times while running in hole with liner assembly on drill pipe.

*Be sure there are no areas of drill pipe on liner hanger less than 2.75 ID.

11. Cement liner in three stages.

a. Calculate volume of cement for bottom stage. (200 ft of 12-1/4" hole and 9-5/8" annulus plus shoe joint volume and volume to inflate CTC Packer).
b. Mix cement for above.
c. Pump cement for 200' annulus and shoe joint. Release first stage dart 809.81266 and pump cement for inflated CTC. (Cement to inflate packer should be Class G with 40% silica flour and friction reducer, no perlite.)
d. Pump 10 BBls spacer then displace with mud at 3-4 BPM until 10 BBls before dart should land in SR lower plug - slow rate to 2 BPM. Pressure should go to 1800 psi and plug release.
e. Displace shut off plug at 5-6 BPM until 30 BBls before plug lands. Then pump at 1-2 BPM.

f. When shut off plug lands in shut off baffle, pressure up to 500 psi and shut down.

12. Inflate CTC Packer with cement. See attached Recommendations During Inflation Sequence for further details.

a. Check volume of displacement tank.
b. Increase pressure slowly to 700 psi and shut down.
c. Increase pressure slowly to 800 psi.
d. Increase pressure slowly to 900 psi or until tool opens.
e. Pump in 2-5 cu ft of cement per stage until CTC packer is inflated.
f. Increase pressure to 1000 psi to close CTC packer.
g. With pressure at 500 psi, check volume of cement needed to inflate tools.
h. Pressure up to 2800 psi and open HOS.
i. Circulate well as needed.
j. Cement liner as per program. Pump spacer. Pump cement.
k. Release dart for shut off plug. Pump at 4-5 BPM. Pump 10 BBls spacer - then mud.
l. Displace to within 10 BBls of plug, slow to 2 BPM.
m. Pressure to 1950-2000 psi to release plug.
n. Displace at 4-5 BPM.
o. When plug lands in HOS, pressure up to 3000 psi to close tool. You may have to go to 3500 psi. Hold pressure for 2 minutes.
p. Release pressure if holding; back off liner hanger tool.
q. Come out of hole with tools.
r. Wait 24 hrs and drill out.

13. Rig down circulating equipment, pull out of hanger with drill pipe and pull up 90' and circulate out excess cement leaving 90 linear ft of cement on top of liner top.

14. Wait on cement for 12 hrs. Run in hole with 12-1/4" bit to top of liner and circulate to clean out excess cement. Wait 24 hrs from the time cement was in place and pressure test lap to 1000 psi. Squeeze if necessary.

15. Trip to change bits to 8-1/2" and clean out cement from inside the 9-5/8" liner top.

16. Retest liner lap to 1000 psi surface pressure. Squeeze if necessary.

17. Drill out cement, float collar and float shoe with 8-1/2" bit. Drill 30' of formation.

18. Circulate and change out mud system for water.

19. Trip to pick up stabilization.

NOTE: Spherelite cement should be blended as follows:

Class G cement blended with 40% silica flour, 50 lbs per sack of cement of spherelite, 4% gel, 1.25% CFR-2, and 0.5% Halad-22A.

Cement should be mixed at 88.3lbs/cu ft (11.8 ppg). Slurry yield is 3.16 cu ft/sack.

Mixing water requirements are 1.50 cu ft/sack (11.22 gal/sack).

CASING PROPERTIES

L-80, 47ppf, Buttress, Burst: 6870 psi, Collapse: 4760 psi, Tension: 1,122,000 lbs.

L-80, 43.5ppf, Buttress, Burst: 7930 psi, Collapse: 6620 psi, Tension: 1,286,000 lbs.

L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi, Tension: 947,000 lbs.

PRE-JOB RECOMMENDATIONS

1. In close clearance (1/2"-1") installations:

    a. Run a casing scraper.
    b. Drill open hole section with a stabilized packed hole assembly if possible.

2. In liner installations, notify CTC of type of liner equipment before packers are shipped.

3. Insure that everyone involved understands the Payzone Packer system and specific duties they are to perform.

4. Obtain all pertinent well data, including:

    a. Minimum wellbore restriction (should be 1/2" greater than packer OD).
    b. If casing damage is suspected, run a microscopic caliper and/or casing scraper.
    c. Calipered hole size in zone of interest should not exceed maximum recommended hole size. Use "Hole Size vs. Recommended Inflation Pressure Chart" to set pressure control valve.
    d. If junk has been lost in hole it should be fished or driven to below Payzone setting depth.
    e. Clients maximum allowable surface pressure (burst strength of casing with a safety factor), should be obtained prior to setting shear pin.
    f. If hole size adjacent to end assemblies is more than 1" larger than packer OD run one centralizer above and below each packer.

5. Inspect auxiliary equipment.

    a. Float shoe.
    b. Float collar.
    c. Bottom cement wiper plug (proper size, rupture diaphragm).
    d. Two top cement wiper plugs (proper size, no rupture diaphragm).
    e. Pressure recorder (5000 psi scale if possible).
    f. Chicksan lines.
    g. Cementing head.
    h. Verify that adequate inflation cement is available.
    i. Obtain a dry sample of all cements used on the job.

6. Review primary cementing plans and calculate theoretical bottom hole pressure during cementing operations. If expected pressures approach fracture gradient, pressure anomalies are probable and bottom wiper plug should not be run so that knockoff rod protection stays intact.

7. Calculate displacement volumes. Know at what displacement the following events should take place:

    a. Bottom wiper passes packers (knockoff rods).
    b. Bottom wiper lands in float collar.
    c. First top wiper passes packer.
    d. First top wiper lands in float collar, and
    e. Top of inflation cement (second top wiper plug) relative to upper packer.

8. Total inflation pressure is critical to Payzone Packer performance. Before starting a job know and/or calculate: 1. hydrostatic pressure inside and outside the casing at packer setting depth, 2. pore pressure, 3. fracture pressure, 4. maximum recommended differential inflation pressure from hole size vs pressure chart, 5. resultant effective stress.

    a. Total inflation pressure equals:
        1. Hydrostatic pressure inside casing (packer depth) + Applied surface pressure

        OR

        2. Hydrostatic pressure outside casing (packer depth) + Differential inflation pressure

    b. Differential inflation pressure equals:
        1. Total inflation pressure minus Pressure outside casing (packer depth)

        OR

        2. Applied surface pressure minus Balance pressure

    c. Balance pressure equals:
        1. Surface pressure required to offset "U" tube pressure
        2. Approximated by surface pressure (pumping at 1/4-1/2 BBl/min) just prior to plug bump.

    d. Radial effective stress (Seal Load, Wellbore Support) equals:
    Total inflation pressure minus pore pressure.
    -In all cases the differential inflation pressure must be within the hole size vs differential pressure capabilities of the equipment.
    -For zone isolation the radial effective stress (seal load) should be at least 500 psi and total inflation pressure must be less than fracture pressure.

9. Review casing tally. Re-tally casing during run-in if necessary. This is critical if positioning log is not to be run.

10. Make up casing according to API specifications with proper torque and API pipe dope.

Note: It is extremely difficult to properly inflate packers with a casing leak.

11. Epoxy thread lock should be used on packer/casing connections, float collar, and float shoe.

12. A minimum number of only high quality (API approved) centralizers be run below packer(s). If pipe is to be reciprocated, and hole size adjacent to end assemblies does not exceed packer OD plus 2", spacing between packers and centralizers should be greater than reciprocation stroke. Do not place scratchers in this area.

13. If positioning is critical, packers should be logged into position.

14. Insure that cement has adequate pump time.

15. Inflation cement should have an API water loss of less than 150 cc. Inflation cement must not contain lost circulation material.

RECOMMENDATIONS DURING JOB

1. Verify that external cementing aids (centralizers, scratchers, etc.) are properly installed.

2. Run-in speed 1 ft/sec (may be prudently increased to 2 ft/sec per Steps 3 and 4 below).

3. Monitor returns, if more than 30' of casing is run before receiving full returns - SLOW DOWN.

4. Monitor weight indicator - excessive weight loss during run indicates that run-in speed may be too fast.

5. Pressure test lines before beginning cement job. Repair all leaks no matter how small.

6. Verify that wiper plugs are dropped at proper time in proper sequence.

7. Monitor returns during entire job.

8. Monitor mixing and pumping of inflation cement. Verify volume and weight of inflation cement. Batch mix if possible.

   Note: If inflation cement is not batch mixed, monitor BBl counter, but do not rely on its accuracy. Insist that mix water be accurately measured from tanks and that cement density remains constant and proper. (If cement is mixed at proper weight, mix water volume is an accurate indicator of cement volume.)

9. Insist that plug drop be verified via tattle-tale, flag or radioactive techniques.

10. Monitor displacement volume, pump rate and surface pressure during entire displacement process.

11. Determine balance pressure during last 5 BBl of displacement. (Slow displacement to 1/4-1/2 BBl/min and record pressure.)

12. Required displacement volume will normally exceed theoretical casing volume. If mud is used for displacement, expect up to 6%.

RECOMMENDATIONS DURING INFLATION SEQUENCE

1. When first plug lands in float collar:

2. Open shear valve in first or bottom packer by rapidly applying appropriate surface pressure, i.e. balance pressure plus pressure rating of shear valve. (Monitor volume displaced.) Stop pumps and monitor pressure decline, increase pressure by 200 psi or as needed to open valve. Record volume in displacement tanks.

   NOTES:

   a. Flow rate into Payzone packers is relatively slow (1/4 BBl/min). Therefore, it is generally impractical and not advisable to pump continuously during inflation. The preferred procedure is to rapidly increase surface pressure, stop pumping and monitor pressure decline. When the packer is full, the pressure decline will stop.

   b. The expected pressure response during inflation is a function of several variables. In general the following reduce the distinctiveness of the pressure response.
      1. Increased well depth.
      2. Compressability and volume of fluid within the casing string.
      3. Large diameter casing.
      4. Viscosity of inflation cement.
      5. Small inflation volume.

      For example, the pressure response during inflation of a 9-5/8" packer at 12,000' with 3/4 BBl of 16.4 lbs/gal cement may be non-distinct while inflation of a 5-1/2" packer with 1 BBl at 6000' would be very distinct.

3. When packer is completely inflated (surface pressure remains constant), apply final desired inflation pressure.

   a. Record volume pumped and hold pressure for 5-10 min.

   b. Bleed surface pressure slowly back to balance pressure (and/or point 1a above and record flowback volume.

   c. Release pressure slowly.

Note: In shallow (less than 7000') unconsolidated sands, the hole size often enlarges as the packer re-stresses the sand. In these installations, final inflation pressure should be adjusted or reduced in accordance with hole size.

This may be done by converting inflation volume to equivalent hole diameter and using "Hole Size vs Recommended Inflation Pressure Chart".

THINGS TO AVOID

1. Avoid using bottom wiper plugs whenever possible. This is critical if bottomhole pressures during the cement operation are likely to exceed frac pressure.

2. Avoid using spacer fluids below inflation cement because volumetric error and/or pressure anomalies may result in mud-filled packers.

   Note: The use of lightweight spacer fluids below the inflation cement imposes a hydrostatic differential pressure across the valve collar equal to [Weight of cement in annulus (lbs/gal) minus weight of spacer fluid below packer (lbs/gal)] multiplied by .052 times height of spacer fluid below packer.

3. Do not exceed fracture pressure in isolation installations.

4. If spacer fluids are used as substitues for wiper plugs above inflation cement, increase cement volume to compensate for contamination of the upper 100′ of inflation cement.

5. Do not use differential fill equipment because debris may enter casing. Some varieties of differential fill equipment must be opened via applied casing pressure prior to circulation. This is not compatible with our valve system.

6. Insist that liner hanger packoffs not be set prior to packer inflation.

7. Do not spud casing - circulate through bridges.

8. Do not use cement with more than 6% Plaster of Paris or Calseal cement.

9. Do not use loss circulation material in inflation cement.

PROCEDURE FOR RUNNING 9-5/8" TIE-BACK CASING
OPTIONAL

1. Kill well with cold water. Pick up Halliburton 9-5/8" EZSV cement retainer on drill pipe and run in hole to 300' below liner top. Set EZSV at this point.

2. Spot a 50 linear foot thick viscous gel pill on top of EZSV and 50 linear feet of cement on top of gel. Fill hole with water and circulate to cool and clean hole. Make appropriate changes to wellhead assembly.

3. Run 9-5/8" casing scraper to clean out liner tie-back sleeve.

4. Rig up and run 9-5/8" tie-back string to top of liner with float collar 40' (1 joint) above stab-in tool on bottom. Stab-in tool will be equipped with slip. Stab into liner, engage slips on the 13-3/8" and pull up on tie-back to 200,000 lbs to pretension tie-back.

5. Cement tie-back as per attached cementing program. Bring cement back to surface between 9-5/8" and 13-3/8" casing, setting centralizer in 13-3/8" casing head before cementing.

6. Wait on cement 12 hours, then release tension.

7. Land 9-5/8" casing. Pick up 12" blow out preventer stack and install expansion spool (12" 900 x 10" 900) equipped with two 3" flanged outlets with 3" 2000 psi wing valves. Install 10" 900 Master Valve and 10" 900 x 12" 1500 adaptor spool and reinstall blow out preventer stack.

8. Test blow out preventer stack, 10" master valve, expansion spool and 9-5/8" tie-back to 1500 psi.

9. Pick up 8-1/2" bit and drill out excess cement and float collar. Work bit through lap area and retest to 1000 psi. Squeeze if necessary.

10. Drill out cement and clean out gel to top of EZSV.

11. Trip for EZSV picking tool and remove EZSV.

12. Return well to production and retest if necessary, using air to induce well to flow.

13. Lay down drill pipe, remove blow out preventer equipment,and move rig off, releasing rig.

14. Prepare for long term test.

15. Test well.

9-5/8" CASING PROPERTIES

L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi, Tension: 947,000 lbs.

FIGURES

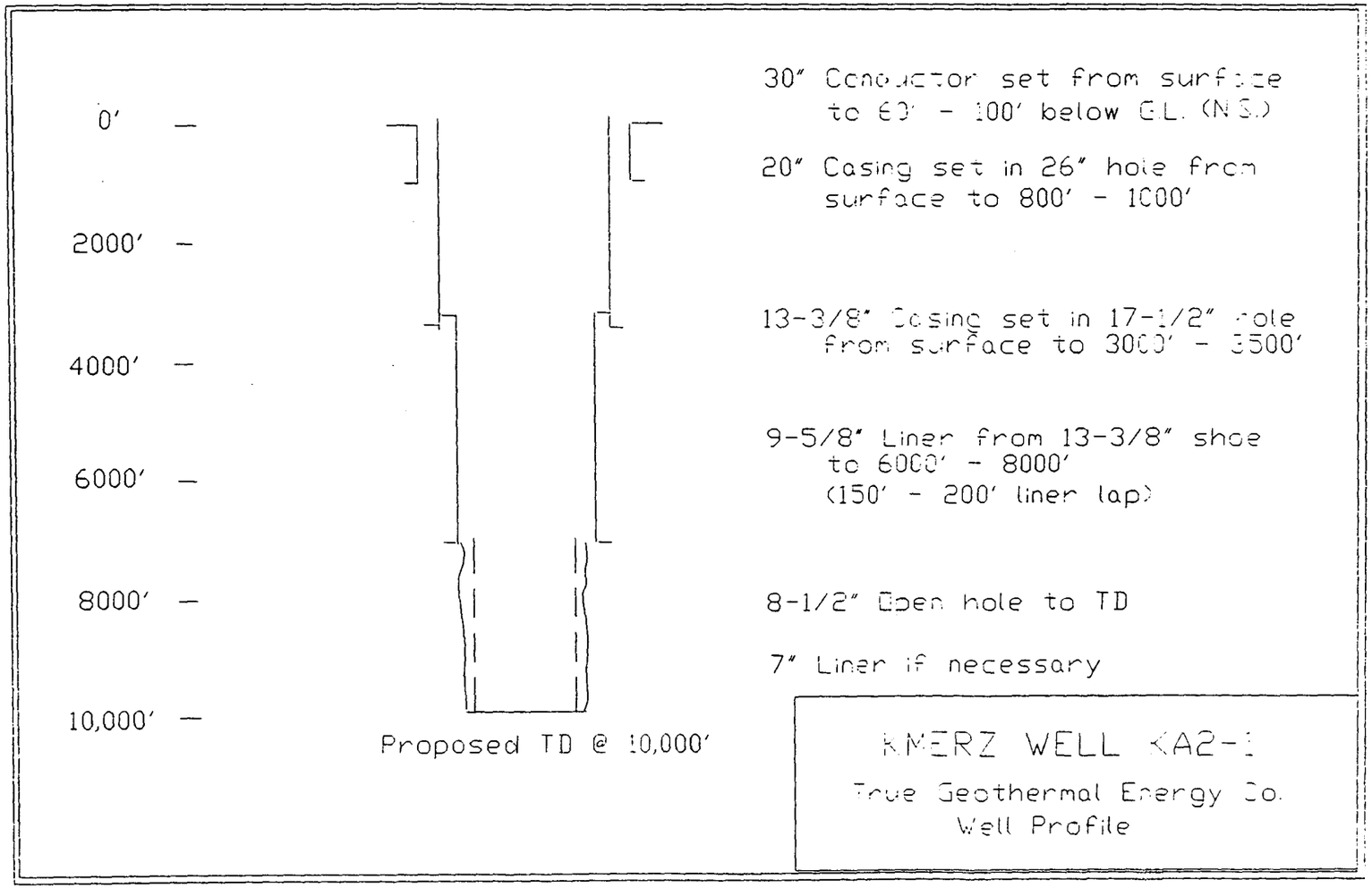
0'
2000'
4000'
6000'
8000'
10,000'
Proposed TD @ 10,000'
30" Conductor set from surface to 60' - 100' below G.L. (N.S.)
20" Casing set in 26" hole from surface to 800' - 1000'
13-3/8" Casing set in 17-1/2" hole from surface to 3000' - 3500'
9-5/8" Liner from 13-3/8" shoe to 6000' - 8000'
(150' - 200' liner lap)
8-1/2" Open hole to TD
7" Liner if necessary
KMERZ WELL KA2-1
True Geothermal Energy Co.
Well Profile

FIGURE 001

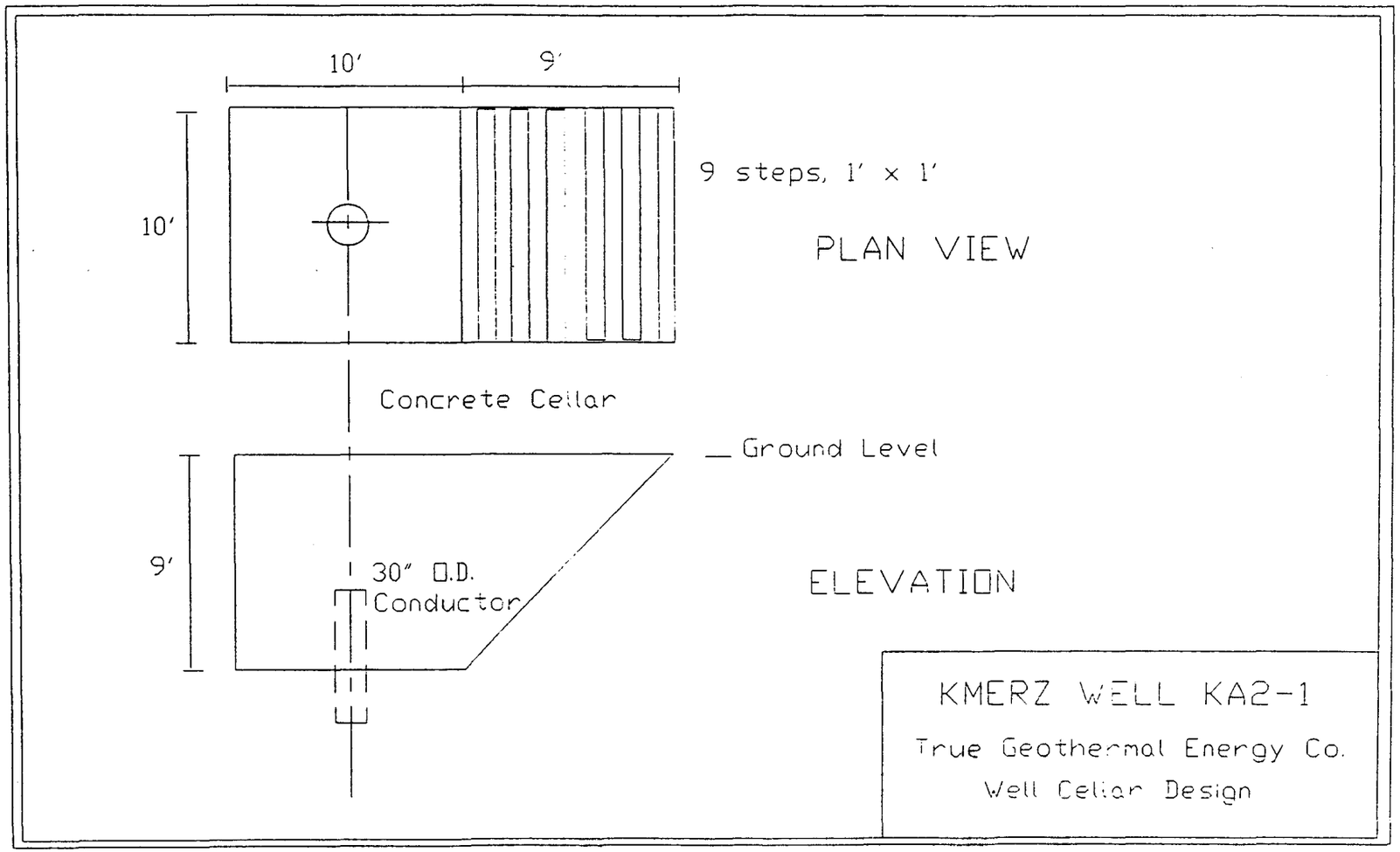
10'
9'
10'
9 steps, 1' x 1'
PLAN VIEW
Concrete Cellar
Ground Level
9'
30" O.D.
Conductor
ELEVATION
KMERZ WELL KA2-1
True Geothermal Energy Co.
Well Cellar Design

FIGURE 002

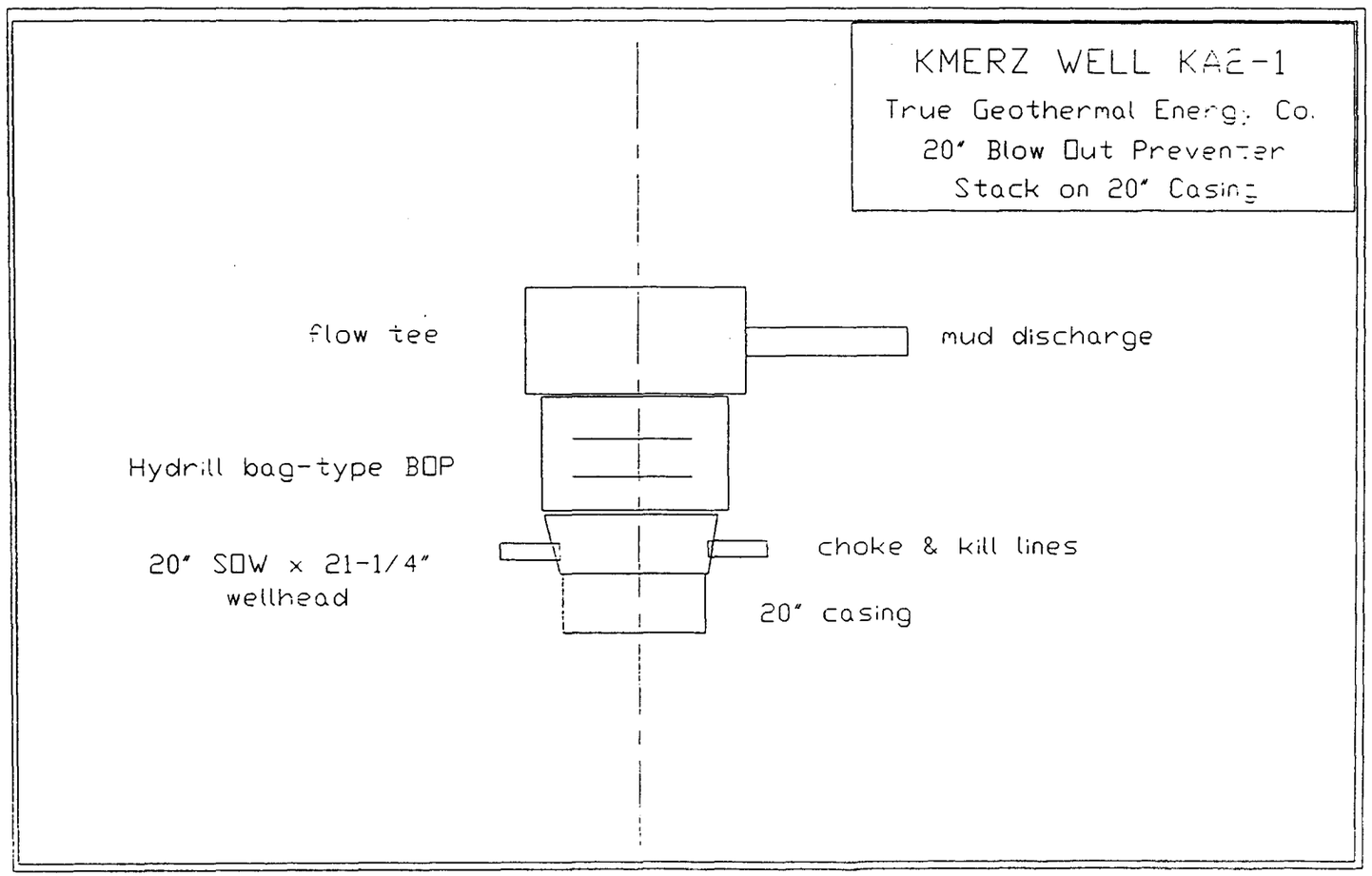
KMERZ WELL KAE-1
True Geothermal Energy Co.
20" Blow Out Preventer
Stack on 20" Casing
flow tee
mud discharge
Hydrill bag-type BOP
20" SOW x 21-1/4"
wellhead
choke & kill lines
20" casing

FIGURE 003

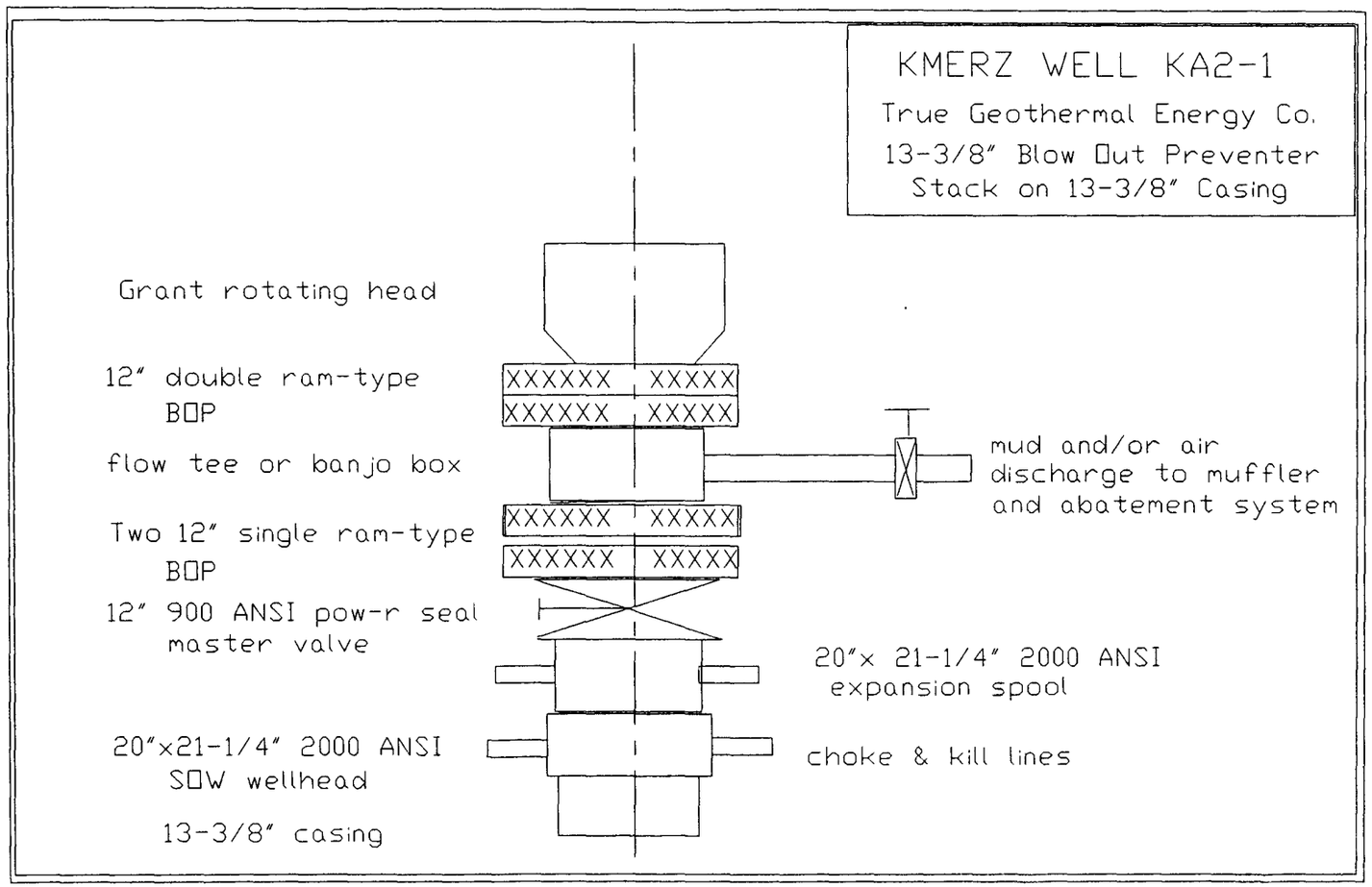
KMERZ WELL KA2-1
True Geothermal Energy Co.
13-3/8" Blow Out Preventer
Stack on 13-3/8" Casing
Grant rotating head
12" double ram-type
BOP
flow tee or banjo box
Two 12" single ram-type
BOP
12" 900 ANSI pow-r seal
master valve
20"x21-1/4" 2000 ANSI
SOW wellhead
13-3/8" casing
XXXXXX XXXXX
XXXXXX XXXXX
XXXXXX XXXXX
XXXXXX XXXXX
mud and/or air
discharge to muffler
and abatement system
20"x 21-1/4" 2000 ANSI
expansion spool
choke & kill lines

FIGURE 004

TABLES

ThermaSource Inc.
P.O. Box 1236 • Santa Rosa, CA 95402

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM

SIZE: 20" | DEPTH: 1000' | WELL: KA2-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
0-1000'	106.5	K-55	Buttress	3.31	9.21	1.64	9.99+
Casing Properties:							
Collapse-770 psi							
Burst-2320 psi							
Tension-1,683,000 lbs.							

DESIGN CONDITIONS

SURFACE BURST PRESSURE	- 2000 PSI	OUTSIDE MUD WT. (COLLAPSE)	- 9.95 PPG		
INSIDE MUD WEIGHT (BURST)	- 9.5 PPG	INSIDE MUD WT. (COLLAPSE)	- 0 PPG		
OUTSIDE MUD WEIGHT (BURST)	- 9.5 PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE)	- 9.5 PPG		
FRAC. GRAD. AT SHOE (BURST)	- 14.5 PPG	BIAXIAL LOAD: COLL. ☐ BURST ☐		BOUYANCY: YES ☐ NO ☒	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

2690 cu ft (838 sx) of Class G cement blended with 50 lbs of spherelite per sack of cement, 40% silica flour, 4% gel, 5% hydrated lime, 1.25% CFR-2 and 0.5% Halad-22A tailed with 400 cu ft (252 sx) of Class G cement blended with 40% silica flour and 3% CaCl2

DESIRED TOP: Surface | EXCESS: 100%

SLURRY VOL. - CU FT / (SLURRY NO.)	2690		400	
SLURRY YIELD - CUBIC FEET/SACK	3.21 cu ft/sx		1.59 cu ft/sx	
SLURRY DENSITY - PPG	82.2#/cu ft(11 ppg)		118#/cu ft(15.8 ppg)	
THICKENING TIME - DEPTH SCH/HRS, MIN.	2-3 hrs		2-3 hrs	
COMPRESSIVE STRENGTH - PSI/HOURS				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Stab in float collar located 40' (1 joint) above float shoe on bottom.
2. Weld bottom of collars on bottom 4 joints.
3. Clean and Baker loc threads on float collar and shoe as well as bottom 4 joints.
4. Tac weld top of collars on bottom 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Run rigid centralizer in middle of bottom 2 joints, then one every other tool joint to within 100' of surface.
2. Use centralizer cement baskets as required due to lost circulation.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Stab into float collar with drill pipe. Attempt to circulate with water.
2. Pump 200 cu ft CaCl2 water followed by 100 cu ft of fresh water, 200 cu ft Flo-chek, 200 cu ft Geo-gel, then cement slurries.

PRESSURE TESTING AND LANDING

1. Use 1" pipe in annulus of 20" AND 26" hole to bring cement back to surface if necessary.
2. Wait on cement 8 hours.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	2000	20"	See attached drawing	1500	1500	

ThermaSource Inc.
P.O. Box 1236 • Santa Rosa, CA 95402

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM

SIZE	DEPTH		WELL
13-3/8"	3500'	Full String	KA?-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
0-3000'*	68	L-80	Buttress	2.03	1.95	1.51	6.44
3000-3500'**	72	L-80	Buttress	2.08	2.05	1.55	45.83
Casing Properties:*			Casing Propertires:**				
Collapse-2260 psi			Collapse-2670 psi				
Burst-5020 psi			Burst-5380 psi				
Tension-1,545,000 lbs			Tension-1,650,000 lbs				

DESIGN CONDITIONS

SURFACE BURST PRESSURE	- 3000 PSI	OUTSIDE MUD WT. (COLLAPSE)	- 9.5 PPG		
INSIDE MUD WEIGHT (BURST)	- 9.5 PPG	INSIDE MUD WT. (COLLAPSE)	- 0 PPG		
OUTSIDE MUD WEIGHT (BURST)	- 9.5 PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE)	- 9.5 PPG		
FRAC. GRAD. AT SHOE (BURST)	- 14.5 PPG	BIAXIAL LOAD: COLL. [X]	BURST [X]	BOUYANCY: YES [ ]	NO [X]

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

4257 cu ft (1723 sx) Class G cemetn blended 1:1 with perlite and 40% silica flour, 4% gel and 0.65% CRF-2. Tailed with 300 cu ft (192 sx) of Class G cement blended with 40% silica flour and friction reducer. Both slurries to be blended with retardant to give 2-3 hours pumping time at reservoir temperature.

DESIRED TOP: Surface | EXCESS: 100%

SLURRY VOL. - CU FT / (SLURRY NO.)	4257		300	
SLURRY YIELD - CUBIC FEET/SACK	2.47		1.56	
SLURRY DENSITY - PPG	97.25#/cu ft(13.0 ppg)		118#/cu ft (15.8 ppg)	
THICKENING TIME - DEPTH SCH/HRS. MIN.	2-3 hrs		2-3 hrs	
COMPRESSIVE STRENGTH - PSI/HOURS				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run stab in float collar 40' (1 joint) above float shoe on bottom.
2. Weld bottom of collars on bottom 4 joints.
3. Clean and Baker loc threads on float collar and shoe as well as bottom 4 joints.
4. Tac-weld top of collars on bottom 2 joints.
5. Run 13-3/8" as full string or liner with tie-back as hole conditions dictate. See attached procedure.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Run rigid centralizer in middle of bottom 8 joints. Then turbo-type centralizer on every other collar from bottom to within 200' of surface.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. If lost circulation is a problem run casing as directed in attached procedure. Use sodium silicate preflush as directoed.
2. Cement through drill pipe.
3. Pump cement of Stage 1 until cement appears at surface, then pump stage 2 cement.

PRESSURE TESTING AND LANDING

1. Wait on cement 12 hrs or until samples have set.
2. Cut & remove 20" casing. Install 12" x 20" expansion spool and blow out preventer stack as in attached drawing.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	3000	12-3/8"	Rotating head & ram	1500	1500	1000

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM | SIZE 13-3/8" | DEPTH 3500'± | Liner | WELL KA2-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
900-3000'	68	L-80	Buttress	2.01	1.95	1.49	8.68
3000-3500'	72	L-80	Buttress	2.07	2.05	1.53	45.83

DESIGN CONDITIONS

SURFACE BURST PRESSURE	- 3000 PSI	OUTSIDE MUD WT. (COLLAPSE)	- 9.5 PPG		
INSIDE MUD WEIGHT (BURST)	- 9.5 PPG	INSIDE MUD WT. (COLLAPSE)	- 0 PPG		
OUTSIDE MUD WEIGHT (BURST)	- 9.5 PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE)	- 9.5 PPG		
FRAC. GRAD. AT SHOE (BURST)	- 14.5 PPG	BIAXIAL LOAD: COLL. [X] BURST [X]		BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

3340 cu ft (1041 sx) Class G cement blended with 50# per sack of cement of spherelite, 40% silica flour, 5% hydrated lime, 4% gel, 1.25% CFR-2, and 0.5% Halad-22A, tailed with 300 cu ft (189 sx) of Class G cement blended with 40% silica flour and friction reducer. Both slurries retarded to give 2-3 hrs pumping time at reservoir temperature.

DESIRED TOP 900'± | EXCESS 100%

SLURRY VOL. - CU FT / (SLURRY NO.)	3340	300		
SLURRY YIELD - CUBIC FEET/SACK	3.21	1.59		
SLURRY DENSITY - PPG	82.2	118		
THICKENING TIME - DEPTH SCH/HRS, MIN.	2-3 hrs	2-3 hrs		
COMPRESSIVE STRENGTH - PSI/HOURS				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run float collar 40' above float shoe.
2. Weld bottom of collars on bottom 4 joints.
3. Clean and Baker loc threads on bottom 4 joints.
4. Tac-weld top of collars on last 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Hang liner 100' up inside 20" casing on drill pipe.
2. Run rigid centralizer cement baskets in middle of bottom 2 joints and one 10' up inside 20" casing and one just below stage collar if a stage is indicated.
3. Run centralizers every other tool joint to bottome of 20" casing.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Attempt to circulate with water.
2. Pump 20 cu ft CaCl2 water and 100 cu ft water, followed by 200 cu ft Flo-Chek the 200 cu ft of Geo-gel, then cement slurries.
3. See attached program for more detail.

PRESSURE TESTING AND LANDING

1. Wait on cement 8 hrs. Clean out cement from top of 13-3/8" liner. Test lap to 1000 psi. Squeeze lap if necessary. Clean out and retest until a test is obtaned.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM

SIZE	DEPTH		WELL
13-3/8"	900'±	Tie-Back	KA2-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
0-900'	68	K-55	Buttress	1.76	1.67	5.04	25.25

DESIGN CONDITIONS

SURFACE BURST PRESSURE	-	3000 PSI	OUTSIDE MUD WT. (COLLAPSE) -	9.5	PPG
INSIDE MUD WEIGHT (BURST)	-	9.5 PPG	INSIDE MUD WT. (COLLAPSE) -	0	PPG
OUTSIDE MUD WEIGHT (BURST)	-	9.5 PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE) -	9.5	PPG
FRAC. GRAD. AT SHOE (BURST)	-	14.5 PPG	BIAXIAL LOAD: COLL. [X] BURST [X]	BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

1059.8 cu ft (666 sx) Class G cement blended with 40% silica flour and 0.5% CFR-2.

	DESIRED TOP	EXCESS
	Surface	30%

SLURRY VOL. - CU FT / (SLURRY NO.)	1059.8			
SLURRY YIELD - CUBIC FEET/SACK	1.59			
SLURRY DENSITY - PPG	118			
THICKENING TIME - DEPTH SCH/HRS, MIN.	2-3 hrs			
COMPRESSIVE STRENGTH - PSI/HOURS	±2323/8 hrs			

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run float collar 40' above tie-back sleeve on bottom.
2. Clean and Baker loc threads on bottom 4 joints.
3. Tac-weld top and bottom of collars on bottom 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Run rigid centralizer in middle of bottom joint and one every other tool joint to surface except for top 100'.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Circulate with fresh water.
2. Run top plug only.
3. See attached program for more detail.

PRESSURE TESTING AND LANDING

1. Wait on cement 6 hrs before landing and cutting off 13-3/8" for wellhead.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	3000	13-5/8"				

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM | SIZE 9-5/8" | DEPTH 7000' | Liner | WELL KA2-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
3300-5300'	40	L-80	Buttress	2.04	1.97	1.08	6.08
5300-6500'	43.5	L-80	Buttress	2.17	2.30	1.16	13.71
6500-7000'	47	L-80	Buttress	2.30	2.29	1.36	47.74

DESIGN CONDITIONS

SURFACE BURST PRESSURE	- 3000 PSI	OUTSIDE MUD WT. (COLLAPSE)	- 9.5 PPG		
INSIDE MUD WEIGHT (BURST)	- 9.5 PPG	INSIDE MUD WT. (COLLAPSE)	- 0 PPG		
OUTSIDE MUD WEIGHT (BURST)	- 9.5 PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE)	- 9.5 PPG		
FRAC. GRAD. AT SHOE (BURST)	- 14.5 PPG	BIAXIAL LOAD: COLL. [X] BURST [X]		BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

2000 cu ft (810 sx) of Class G cement blended 1:1 with perlite and 40% silica flour, 4% gel, and 0.65% friction reducer. Tailed with 300 cu ft (192 sx) of Class G cement blended with 40% silica flour and friction reducer. Both slurries to be blended with retardant to give 2-3 hrs pumping time at reservoir temperature. DESIRED TOP: To liner top | EXCESS: 100%

SLURRY VOL. - CU FT / (SLURRY NO.)	2000		300	
SLURRY YIELD - CUBIC FEET/SACK	2.47		1.56	
SLURRY DENSITY - PPG	97.25#/cu ft (13.0 ppg)		118#/cu ft (15.8 ppg)	
THICKENING TIME - DEPTH SCH/HRS. MIN.	2-3 hrs		2-3 hrs	
COMPRESSIVE STRENGTH - PSI/HOURS				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run float collar 80' (2 joints) above float shoe on bottom.
2. Weld bottom of collars on bottom 4 joints.
3. Clean and Baker loc threads on bottom 4 joints as well as threads on float collar and shoe.
4. Tac weld top of collars on bottom 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Hand liner 200' up inside 13-3/8" casing with drill pipe.
2. Run rigid centralizers in middle of bottom 4 jonts and then 1 turbo type centralizer every collar to within 200' of top.
3. Run stage collars and external casing packer as in attached procedures.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Attempt to circulate with water.
2. Pump cement and preflush as in attached procedures.

PRESSURE TESTING AND LANDING

1. Wait on cement 12 hrs. Clean out cement from top of 9-5/8" liner. Test lap to 1000 psi. Squeeze lap if necessary to obtain good pressure test.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM | SIZE 9-5/8" | DEPTH 3300'± | Tie-Back | WELL KA2-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
0-3300'	40	L-80	Buttress	2.10	1.92	2.34	7.17

DESIGN CONDITIONS

SURFACE BURST PRESSURE	- 3000	PSI	OUTSIDE MUD WT. (COLLAPSE) -	9.5	PPG
INSIDE MUD WEIGHT (BURST)	- 9.5	PPG	INSIDE MUD WT. (COLLAPSE) -	0	PPG
OUTSIDE MUD WEIGHT (BURST)	- 9.5	PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE) -	9.5	PPG
FRAC. GRAD. AT SHOE (BURST)	- 14.5	PPG	BIAXIAL LOAD: COLL. [X] BURST [X]	BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

1140 cu ft (704 sx) Class G cement blended with 40% silica flour and 0.5% CFR-2.

			DESIRED TOP	EXCESS
			Surface	30%
SLURRY VOL. - CU FT / (SLURRY NO.)	1140			
SLURRY YIELD - CUBIC FEET/SACK	1.62			
SLURRY DENSITY - PPG	116			
THICKENING TIME - DEPTH SCH/HRS. MIN.	2-3 hrs			
COMPRESSIVE STRENGTH - PSI/HOURS	±2323/8 hrs			

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run float collar 40' above tie-back sleeve on bottom.
2. Clean and Baker loc threads on bottom 4 joints.
3. Tac-weld top and bottom of collars on bottom 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Run centralizers in middle of bottom joint and one every other tool joint to surface except for top 100'.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Circulate with fresh water.
2. Run top plug only.
3. See attached program for more detail.

PRESSURE TESTING AND LANDING

1. Wait on cement 6 hrs before landing and cutting off 9-5/8" for expansion spool and blow out preventers.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	1500	9 1/2"				

ThermaSource Inc.
P.O. Box 1236 • Santa Rosa, CA 95402

MUD

MUD, LOGGING, WELLHEAD & DIRECTIONAL PROGRAMS

WELL: KA2-1

DEPTH INTERVAL	MUD TYPE	WEIGHT	API FLUID LOSS	YIELD POINT	PH	
0-100'	Gel and water	65#/ft³	---	15	9.0	
100-1000'	Gel and water or air*	70#/ft³	10cc	15	9.0	
1000-3500'	Gel and water or air*	70#/ft³	10cc	15	10.0	
3500-7000'±	Gel and water or air*	70#/ft³	3.2cc	15	10.0	
7000-T.D.	Water or air*	65#/ft³	or 3000 cfm			

REMARKS
*If unable to maintain circulation due to lost circulation, first attempt to aerate system, then attempt to drill with air with rotary bit or air hammer (see attached). If misting is required, it may be necessary to increase air volume 30%. Misting mix should be fresh water mixed with 2-6 gal/10BBls of Magcobar Foamer. Maintain a solution pH above 10.0 to inhibit corrosion. Use Unisteam as outlined in special considerations.

LOGGING

DEPTH INTERVAL	LOG TYPES	LOG SCALES
100-1000'*	Temperature log & logs as directed	1" and 5" = 100'
1000-3500'*	Temperature log & logs as directed	1" and 5" = 100'
3500--7000'	Temperature log & logs as directed	1" and 5" = 100'
7000-T.D.	Temperature log & logs as directed	1" and 5" = 100'
0-T.D.	Samples every 10'	

REMARKS
All logs to be determined by geologist.
*Apply for waiver requiring E-log on these sections of the well.

WELLHEAD

API NOMINAL SIZE	WORKING PRESSURE PSI	TYPE	MAKE
26"	100 psi		
20" S.O.W. x 21-1/4" 2000	2000 psi	*Weld on wellhead	WKM
21-1/4" 2000 x 12" 900	3000 psi	21-1/4" x 12" expansion spool with two 3" 2000 outlets	WKM
12" x 12"	3000 psi	12" 900 Ansi WKM Pow-R-Seal master valve	WKM

REMARKS

DIRECTIONAL OR STRAIGHT-HOLE

Drill hole as straight as possible, taking directional shots every 100'± from 0-7000' and on dull bits after 7000'. 0-3500' maximum deviation to be 5°, maximum rate of change to be 1½° per 100'. 3500-7000' maximum deviation to be 8°, maximum rate of change to be 1½° per 100'. 7000-T.D. monitor without control.

TRUE GEOTHERMAL ENERGY COMPANY
KMERZ WELL NO. KA3-1
GEOTHERMAL EXPLORATION WELL PROGRAM

The following well program is designed to drill and complete a nominal 10,000′ geothermal exploration well in the KMERZ. (See Figure 001) Based on the results of prior drilling, a large degree of flexibility is built into the program. It should be clear that being an exploration well, the casing setting depths and drilling procedures are subject to change at any time. DLNR will be notified and updated as drilling progresses on any changes.

1. Install 30" conductor pipe in 42" hole to 60′ to 100′ or as deep as possible below ground level prior to rotary rig moving onto location. Cement conductor from total depth back to surface with redi-mix cement. If a burial cave or lava tube is encountered when setting the conductor pipe, further investigation is required prior to proceeding. Notify DLNR and consult with archaeologist. If conditions warrant, conductor installation may also be performed with rotary rig.

2. Construct 10′ x 10′ x 9′ deep cellar around conductor pipe with a cemented bottom and stairway exit toward front of rig. See attached Figure 002.

3. Move in rotary drilling rig to drill well. Center rig over conductor pipe and rig up. Drill 42" hole with bucket bit and install 30" conductor, if not installed prior to moving in. Add 30" OD extension to conductor pipe to bring it up under rotary table. Install flow line on conductor pipe to return mud to pits.

4. Notify DLNR upon startup of drilling of a pilot hole. Pick up an 8-1/2" bit on a 26" hole opener or reamer and run into the bottom of the conductor pipe. Center punch 8-1/2" hole and drill 8-10′. Pull out of hole and remove 26" hole opener or reamer. Run 8-1/2" bit and drill to 100′+/-. During the drilling of this 8-1/2" pilot hole progress should be monitored constantly to determine if a lava tube which may contain archaeological artifacts might be encountered directly under the rig. If the bit drops free for more than eight (8) feet then drilling will stop. If this drop occurs the hole will be flushed with clear water and a light source with video camera lowered into the hole to investigate the possibility of any archaeological value. If archaeological value is determined then drilling will stop and the rig moved. If no archaeological value is determined then provisions would be made to continue drilling. Drilling supervisor shall be on drill rig floor throughout complete pilot hole drilling operations.

5. Open 8-1/2" hole to 26" with 26" bit and drill with mud to 800-1000′ depending on geology. Maintain hole as straight as

possible, take drift shots every 100'. Maximum rate of change 1 degree per 100'. Install mud loggers at surface to log entire well from 0' to total depth. Catch three clean and dry samples every 10'.

6. Rig up and run 20" casing to total depth as per attached 20" casing program with 20" stab-in float collar and float shoe on bottom.

7. Once 20" casing has been run to bottom, run in hole with stab-in tool on bottom of drill pipe and stab into float collar. Circulate hole clean with at least two full circulations.

8. Cement 20" casing through drill pipe as per attached program. Circulate cement back to surface between 20" and 30" casing. Observe cement level. If cement falls back in annulus, bring same back to surface with 1" pipe.

9. Wait on cement 8 hours.

10. Land 20" casing. Cut off and remove 30" conductor drilling nipple. Cut off 20" casing and weld on 20" S.O.W. x 21-1/4" 2000 psi wellhead. Install two 3" valves. Install 20" blow out preventer equipment as per attached Figure 003.

11. Test 20" casing and blow out preventer equipment to 1500 psi for 30 minutes.

12. Drill out cement and float collar and float shoe from 20" casing with 17-1/2" bit using mud. Drill 30' of formation and trip to pick up stabilization.

13. Continue to drill 17-1/2" hole as vertical as possible with mud to 3500'+/- as indicated by formation. Directionally survey well at least every 100'. If lost circulation presents severe problems, an aerated mud system may be utilized. Severe loss circulation zones should be cemented off prior to drilling ahead.

14. Once 17-1/2" hole has been completed to casing point, rig up and run logs if indicated by geologic staff.

15. Upon completion of logging program, run in hole with bit and circulate to condition hole for casing.

16. Rig up and run 13-3/8" casing as per attached 13-3/8" casing program and running procedure. If lost circulation presents severe problems during drilling it may be necessary to set 13-3/8" pipe as a liner then tie it back to the surface rather than a full string of casing. See running procedure for alternative options.

17. Cement 13-3/8" casing as per attached program. Circulate cement back to surface between 13-3/8" and 20" casings. Observe cement, if it falls back, bring level back to surface using 1" pipe.

18. Wait on cement 12 hours or until samples are set.

19. Land 13-3/8" casing. Remove 20" blow out preventer stack. Cut off 13-3/8" casing and install 12" x 21-1/4" 900 ANSI expansion spool wellhead with two 3" flanged outlets equipped with 3" 2000 psi wing valves. Install 12" 900 series blow out preventer stack with 12-1/4" bore as per attached Figure 004.

20. Test 13-3/8" blow out preventer stack to 1500 psi for 30 minutes.

21. Drill out all cement, float collar and shoe from the 13-3/8" casing with a 12-1/4" bit using mud. Drill 30′ of formation and trip to pick up stabilization.

22. Drill 12-1/4" hole with mud or aerated mud as required by hole conditions to 6000-8000′, the 9-5/8" casing point, as indicated by geologic staff. Lock up drilling assembly to maintain direction and angle as straight as possible to casing point.

23. Once 12-1/4" hole has been completed to casing point, rig up and run logs if indicated by geologic staff.

24. Upon completion of logging program, run in hole with bit and circulate to condition hole for casing.

25. Rig up and run 9-5/8" casing as a liner equipped as required with external casing packer located 200-300′ from bottom. Hang same using a double slip liner hanger with tie-back sleeve. Run 9-5/8" liner from total depth to hanger located 200′ up inside of 13-3/8" casing as per attached 9-5/8" liner program and running procedure.

26. Once liner is hung, circulate hole clean through drill pipe with at least two full circulations.

27. Cement 9-5/8" liner and external casing packer from total depth back up to top of liner lap as per attached cementing program.

28. Once cement is in place, disengage from liner hanger and pull up 60′ and circulate out excess cement.

29. Pull out of hole with liner hanging tool and run in hole with 12-1/4" bit and drill out cement from 13-3/8" casing to top of 9-5/8" liner lap. Test lap to 1000 psi only after cement has been in place 12 hours. Squeeze lap area if necessary to

obtain a 1000 psi squeeze pressure.

30. Trip for 8-1/2" bit and drill out excess cement from 9-5/8" liner down to top of float collar. Pressure up and retest 13-3/8" casing, liner lap and 9-5/8" casing to 1000 psi.

31. Drill out cement, float collar and float shoe from 9-5/8" casing using 8-1/2" bit and mud. Drill 30' of formation and circulate to change out mud for water. Re-install rotating head on blow out preventer stack for air drilling if not already installed for the drilling of the 12-1/4" hole.

32. Trip to pick up 8-1/2" stabilization. Drill 8-1/2" hole through production zone to total depth of 9,000'-12,000' using air or aerated water as a drilling medium.

33. Pull out of hole with drill pipe and test well for short term with rig on location.

34. If results appear commercial, pull out of hole and release rig for long production test or proceed ahead with attached 9-5/8" tie-back procedure to complete well with 9-5/8" tie-back, if 13-3/8" casing shows damage or excessive wear. If well test results prove that the flow rate from the well is not commercial then either deepen or redrill to obtain production.

35. Evaluate well and complete with either open hole or 7" slotted liner.

SPECIAL CONSIDERATIONS
AUXILIARY EQUIPMENT THAT SHOULD BE MAINTAINED WITH THE RIG

1. Six pen drilling recorders on drill floor with: a) string weight; b) rpm; c) rotary torque; d) rate of penetration; e) pump pressure; f) exit pressure. Additional real time monitoring of drilling parameters to be considered upon consultation with DLNR Staff.

2. Special rotating head with rubbers, capable of stripping 17-1/2", 12-1/4" and 8-1/2" bottomhole assemblies. Complete with spare rotating head stripper drive bushing assembly. Rotating head should be installed on top of hydril or at least on location, available for installation if necessary. Run cold water continuously on head while producing geothermal fluids.

3. Use tong torque assembly with torque gauge for making up collars to API torque requirements.

4. Temperature should be taken with every directional survey by running a maximum recording thermometer in the survey instrument.

5. Catch drill cutting samples (3 sets) every 10', to be cleaned and sacked.

6. In and out temperatures, both of mud, air or aerated water, shall be recorded in the Tour Reports every 30'. All steam/water entries shall be recorded in the Tour Reports.

7. All lost circulation zones encountered shall be recorded in Tour Book recording both the depth at which the loss occurred, as well as the amount of fluid lost. All flows shall also be recorded giving depth and the amount of increase.

8. Periodic tests may be conducted to determine well potential. Drilling will be stopped and the hole evacuated to check for flow at lost circulation zones.

9. Upon completion, the well will be shut in by closing the lower master valve. The remainder of the blow out preventer equipment will then be removed.

10. Rotary table will be equipped with a torque gauge with visual display for driller.

HYDROGEN SULFIDE MONITORING AND ABATEMENT

Hydrogen sulfide monitoring should be maintained during the drilling of the well. Detectors should be placed on the rig floor, cellar area, and flowline region to detect and announce (with alarms and lights) the presence of hydrogen

sulfide. These monitors are typically provided by and maintained daily by the geothermal data loggers. Proper functioning of these monitors is essential in maintaining a safe working environment.

Hydrogen sulfide abatement equipment and materials, i.e. pumps and caustic soda, should be maintained on location when drilling with lighter than water drilling fluids, i.e. air or aerated mud systems.

Escape breathing equipment, as well as resuscitators shall be available on site with mud logging unit. Fans should also be available on the rig floor to clear H2S contaminated floor areas, making it safer to work.

PIPE AND BLOW OUT PREVENTER INSPECTION

The initial acceptance of drill pipe should be based on an IODC-API Class II specification inspection. All subsequent inspections should discard pipe with 30% wear or greater; i.e., use 30% where Class II states 20%.

The drill pipe should include:

1. Electromagnetic inspection of tubes (Sonoscope or Scanalog).

2. Wall thickness and cross sectional area (ultrasonic or gamma ray).

3. End area inspection (electronic or magnetic particle).

All drill collar end areas should be magnetic particle inspected every 14 days or every 9 days while drilling with production or drilling with air or aerated mud systems.

All BOPs should be inspected for wear by the manufacturer or an authorized agent prior to installation. All BOPs should be tested after installation prior to drilling out cement.

Remind service companies furnishing bottomhole assemblies that their equipment should be magna-fluxed prior to delivery.

AIR EQUIPMENT REQUIREMENTS

Minimum air and pressure requirements are 4500 SCFM at 1000 psig for rotary drilling 12-1/4" hole below 13-3/8" casing.

Minimum air and pressure requirements are 3000 SCFM at 1000 psig for rotary drilling below 9-5/8" casing.

Hook-up lines, air meter, and scrubber, misting pump with minimum capacity of 10 gpm, and operating personnel will be furnished by the air contractor. Use Union Oil's UniSteam corrosion inhibitor while drilling in steam, to be injected into the drill pipe. The mixture for UniSteam is as follows:

Steam lbs/hr	Injection
0-20,000	5 gal UniSteam-10/BBl water
20,000-40,000	10-15 gal UniSteam-10/BBl water
40,000-150,000	20-35 gal UniSteam-10/BBl water
150,000+	40 gal UniSteam-10/BBl water

PROCEDURE FOR RUNNING AND CEMENTING 13-3/8" CASING

1. Drill to casing depth.

2. Circulate for 2-3 hours, two complete circulations to clean hole of cuttings.

3. Pick up excess drill pipe needed to stab into float collar for cementing the 13-3/8" casing.

4. Make short trip and circulate for 1-2 hours.

5. Pull out of hole and rig up to run 13-3/8" casing. Run multi-shot survey while pulling out of hole if necessary. If loss circulation has not been a severe problem in drilling the 17-1/2" hole, then proceed ahead to step 8 and run 13-3/8" casing as a full string. If loss circulation has presented problems, then proceed to step 23 and run 13-3/8" as a liner with tie-back string.

6. Run 13-3/8" casing grades, weights and thread design as indicated on attached detailed sheet with stab-in collar 40' from float shoe on bottom with centralizers located one in middle of bottom two joints and then one every other collar upward omitting any from the top 200'.

7. Set casing in elevators on spider. Do not set casing slips. Drop centralizing ring of 13-3/8" casing inside 20" wellhead. Install return hoses from 20" wellhead to mud pits.

8. Rig up with landing plate on top of 13-3/8" casing. Run drill pipe into 13-3/8" with stab-in sub on bottom. Stab into collar and rig up to circulate. Tie down drill pipe.

9. Circulate for 3 hours, or at least two full circulations, to clean up and cool down hole.

10. Rig up to cement.

11. If loss circulation is a problem, pump 20 BBls CaCl2 water, 10 BBls fresh water, 20 BBls sodium silicate, followed by 20 BBls viscous Geo-Gel mud spacer.

12. Pump cement without any additional spacers. Pump stage 1 consisting of Class G perlite blended 1:1 with 40% silica flour, 3% gel and 0.5% CFR-2. Retard as needed. Pump this cement until you see returns of cement at the surface. If loss circulation has been a problem, the cement may have to be changed to a spherelite blended cement, see Note below.

13. Pump stage 2 cement: Class G cement with 40% silica flour, 3% gel and 0.5% CFR-2. Retard as needed. Pump 200 cu ft of this stage 2 cement. The last 100 cu ft should be staged in: Pump 35 cu ft and shut down for 5-10 minutes, then pump 35 cu

ft and shut down again for 5-10 minutes before pumping last 30 cu ft. Check for fall back in annulus each time. Pull out of stab-in shoe and clear drill pipe, dropping all excess cement from drill pipe on top of float collar.

14. Rig down circulating equipment and pull out of hole with drill pipe.

15. Hook up to 13-3/8" casing elevators and pick up slightly to remove spider, then center 13-3/8" casing in stack.

16. Drain blow out preventer equipment after 30 minutes from the time cement was in place.

17. Wait on cement 12 hours before landing casing. Check for cement fall back in annulus periodically. Bring cement back to surface using 1" pipe if necessary.

18. Cut off 13-3/8" casing. Remove 20" blow out preventer equipment. Install 21-1/4" x 12" 900 ANSI expansion spool, 12" master valve and nipple up blow out preventer equipment as in attached Figure 004.

19. Test blow out preventer equipment to 1000 psi.

20. Change out bottom hole drilling assembly for 12-1/4" tools and run in hole.

PROCEDURE FOR RUNNING & CEMENTING 13-3/8" AS A LINER AND TIE-BACK STRING

1. Follow steps 1-4 above.

2. Pick up 13-3/8" liner. If circulation was never achieved, then a stage collar should be installed at approximately 2000'. Install cement basket type centralizers in the middle of the bottom two joints and one just below stage collar. Install one cement basket type centralizer to be located 20' up inside 20" casing shoe.

3. Run liner in hole and hang same 100' up inside of 20" casing with shoe just off bottom.

4. Attempt to circulate with two times total volume of fresh water. If unsuccessful, then proceed with cement job.

5. Pump 20 BBls CaCl2 water and 10 BBls fresh water, followed by 20 BBls sodium silicate, 20 BBls Geo-Gel flush, then cement slurries for stage 1. Follow stage 1 cement with 200 cu ft of stage 2 cement.

6. Release plugs after stage 2 cement and open cementing ports if stage collar is run.

7. Circulate through stage collar. Repeat preflush prior to pumping cement. Pump stage 1 and stage 2 cement as in prior cement job on bottom section of 13-3/8" liner.

8. Release plugs and displace cement and plugs down hole to close stage collar.

9. Release hanger and pull out of hole with setting tool. Wait on cement for 6 hours.

10. Run in hole with 17-1/2" bit and clean out excess cement, if any, from the top of the 13-3/8" liner.

11. Test lap to 750 psi. If unable to get a test, trip to lay down bit, run in open ended. Squeeze lap with Class G cement blended with 40% silica flour and 0.5% CFR-2 using pipe rams.

12. Re-squeeze until a squeeze pressure is achieved. Fill hole with water.

13. Drill out excess cement with 17-1/2" bit and retest lap to 750 psi.

14. If successful in testing lap, run in hole with 12-1/4" bit and 13-3/8" casing scraper to clean out tie-back sleeve.

15. Pick up 13-3/8" tie-back with float collar located 40' above tie-back stinger on bottom.

16. Run tie-back string in hole and land same in sleeve at hanger.

17. Circulate around with fresh water, then run cement slurry. Use top plug only.

18. Wait on cement 6 hours. If after 6 hours cement is not to surface level in 13-3/8" x 20" annulus, insert 1" tubing and bring it back to surface with cement.

19. Cut off 13-3/8" casing. Remove 20" blow out preventer equipment. Install 21-1/4" x 12" 900 ANSI expansion spool, 12" master valve, and nipple up blow out preventer equipment as in attached Figure 004.

20. Test blow out preventer equipment to 1000 psi for 30 minutes.

21. Change out bottom hole drilling assembly for 12-1/4" tools and run in hole.

NOTE: Spherelite cement should be blended as follows:

Class G cement blended with 40% silica flour, 50 lbs per sack of cement of spherelite, 4% gel, 5% lime, 1.25% CFR-2, and 0.5% Halad-22A.

Cement should be mixed at 82.2#/cu ft (11 ppg). Slurry yield is 3.21 cu ft/sack.

Mixing water requirements are 1.50 cu ft/sack (11.22 gal/sack).

9-5/8" LINER RUNNING PROCEDURE

The drilling program for Well KA3-1 has been written in such a way as to handle all situations that occur during the drilling. Due to the remote location and shipping requirements we must consider all possible hole conditions. These conditions that should be anticipated are listed in order of increasing severity as follows:

1. The 12-1/4" hole is drilled with little or no loss circulation encountered. Due to lost circulation encountered in drilling it would be highly probable that loss of circulation may occur during the cementing of the 9-5/8" liner.
   In this situation where lost circulation has not presented a significant problem during drilling, I feel that a conventional method should be employed in the running and cementing procedure for the 9-5/8" liner. The attached program "PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER WITHOUT EXTERNAL CASING PACKER AND MULTI-STAGE CEMENTER" should be used.

2. The 12-1/4" hole is drilled with air, aerated water or mud, with moderate loss circulation, that is loss circulation encountered in several zones which could be sealed with cement or LCM, or partial loss circulation zones which may take fluid periodically during drilling operations. Probability of lost circulation during cementing is high and should be anticipated.
   In this situation a certain amount of caution should be used in running and cementing the 9-5/8" liner to insure a competent cement job. A 9-5/8" liner utilizing a multi-stage cement collar strategically located could assist in obtaining an adequate cement job. The attached program "PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER WITH MULTI-STAGE CEMENTER" should be used.

3. The 12-1/4" hole is drilled using air or aerated water because of complete loss of circulation during the drilling. Sealing of these loss circulation zones prove to be unsuccessful or extensive causing a great loss of time therefore air or aerated fluid is used to drill the well. Probability of loss circulation during the cement job is high, therefore extreme methods of cementing the liner should be used.
   In this situation where major problems exist in the well, extreme procedures and technologies should be employed to insure an adequate cement job. The attached program "PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER EQUIPPED WITH EXTERNAL CASING PACKER AND HYDRAULIC CEMENTER" should be used.

PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER
WITHOUT EXTERNAL CASING PACKER AND MULTI-STAGE CEMENTER

1. Drill to casing depth at approximately 6000-7000′ dependent on temperature and geology.

2. Circulate for 2-3 hours to clean and cool hole.

3. Pull out of hole.

4. Rig up and run logs as indicated by geologic staff. Wait on bottom with temperature log for 30 minutes before pulling out of hole.

5. Rig down loggers and run in hole with bit and monel to total depth.

6. Circulate for 2 hours and make short trip. Circulate for 1-2 hours after short trip.

7. Pull out of hole and rig up to run 9-5/8" liner. Run additional directional surveys while pulling out of hole if necessary.

8. Run 9-5/8" liner grades, weights and thread design as indicated in detail sheet with float shoe on bottom and float collar two joints up. Centralizers should be located one in the middle of the bottom two joints and then one every to every other collar upward to within 60′ of the hanger. Use T-Bar rigid centralizers totally in bottom portion of the string and then as required in the upper portion. Run casing adjusters at 600′, 1800′ and 3400′ above shoe joint if required.

9. Circulate two full circulations to clean up and cool down well prior to cementing.

   Note: If casing can still be moved after running to bottom then move casing throughout circulation and cementing job and hang after cement is in place. If casing will not move after running to bottom, then hang liner before circulating and cementing job.

10. If loss circulation is encountered, pump 20 BBls of CaCl2 water and 10 BBls of fresh water ahead of 20 BBls of sodium silicate.

11. Pump in 20 BBls of viscous Geo-Gel mud preflush.

12. Pump cement without any water spacers. Pump stage 1: Class G cement and perlite blended at a ratio of 1:1 with 40% silica flour, 3% gel and friction reducer. Retard to give 2-3 hours

pumping time at 350 degrees F. Use 100% excess. If lost circulation is a problem, cement may be required to be changed to a spherelite blend. See note at bottom of this procedure. Pump stage 1 as per precalculated volumes.

13. Pump stage 2: Class G cement blended with 40% silica flour, 3% gel and friction reducer. Retard to give 2-3 hours pumping time at 350 degrees F. Pump 200 cu ft of this stage 2 cement. The last 100 cu ft should be staged in: Pump 35 cu ft and shut down for 5-10 minutes, then pump 35 cu ft and shut down again for 5-10 minutes before pumping the last 30 cu ft.

14. Once all cement has been pumped then rig down circulating equipment, hang liner and pull out of liner hanger with drill pipe and pull up 90' and circulate out excess cement on top of liner top.

15. Wait on cement 12 hours. Run in hole with 12-1/4" bit to top of cement, drill out cement to liner top. Wait a full 24 hours from the time cement was in place or until samples have set before pressure testing lap to 1000 psi surface pressure. Squeeze lap if necessary to obtain a pressure test.

16. Trip to change bits to 8-1/2" and clean out cement from inside of the 9-5/8" liner top.

17. Retest liner lap to 1000 psi surface pressure. Squeeze if necessary to obtain a pressure test.

18. Drill out cement, float collar and float shoe with 8-1/2" bit. Drill 60' of formation with mud.

19. Circulate to clean hole and then displace mud in hole for water.

20. Trip out of hole to pick up stabilization.

21. Run back in hole and aerate water. Drill ahead with aerated water to commercial production or total depth.

NOTE: Spherelite cement should be blended as follows:

Class G cement blended with 40% silica flour, 50 lbs per sack of cement of spherelite, 4% gel, 1.25% friction reducer and fluid loss agent.

Cement should be mixed at 88.3 lbs per cu ft (11.8 ppg). Slurry yield is 3.16 cu ft per sack of cement.

Mixing water requirements are 1.5 cu ft per sack (11.22 gal/sack).

9-5/8" CASING PROPERTIES

L-80, 47 ppf, Buttress, Burst: 6870 psi, Collapse: 4760 psi,
Tension: 1,122,000 lbs.

L-80, 53.5 ppf, Buttress, Burst: 6330 psi, Collapse: 3810 psi
Tension: 1,038,000 lbs.

L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi,
Tension: 947,000 lbs.

PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER
WITH MULTI-STAGE CEMENTER

1. Drill to casing depth at approximately 6000 - 8000′ dependent on temperature and geology.

2. Circulate for 2-3 hours to clean and cool hole.

3. Pull out of hole.

4. Rig up and run logs as indicated by geologic staff. Wait on bottom with temperature log for 30 minutes before pulling out of hole.

5. Rig down loggers and run in hole with bit and monel to total depth.

6. Circulate for 2 hours and make short trip. Circulate for 1-2 hours after short trip.

7. Pull out of hole and rig up to run 9-5/8" liner. Run additional directional surveys while pulling out of hole if necessary.

8. Run 9-5/8" liner grades, weights and thread design as indicated in detail sheet with float shoe on bottom and float collar two joints up. Centralizers should be located one in the middle of the bottom two joints and then one every to every other collar upward to within 60′ of the hanger. Install multi-stage cementer in a strategic location in the liner string. The location of the multi-stage cementer should be such that the bottom portion can be cemented successfully without loss circulation. The upper portion can then be cemented after the bottom has had time to set without any loss circulation during cementing. A probable location is just above the loss circulation zones. If the hole was air drilled a good location would be approximately 1200′ above the casing shoe. Use 12" T-bar rigid centralizers totally in the bottom portion of the string and then as required in the upper portion. Run casing adjusters at 600′, 1800′, and 3400′ above shoe joint as required.

9. Circulate two full circulations to clean up and cool down well prior to cementing.

   Note: If casing can still be moved after running to bottom then move casing throughout circulation and cementing job and hang after stage 1 cement is in place. If casing will not move after running to bottom, then hang liner before circulating and cementing job.

10. If loss circulation is a problem then pump 20 BBls of CaCl2 water and 10 BBls of fresh water ahead of 20 BBls of sodium

silicate.

11. Pump in 20 BBls of viscous Geo-Gel mud preflush.

12. Pump cement without any water spacers. Pump stage 1: Class G cement and perlite blended at a ratio of 1:1 with 40% silica flour, 3% gel and friction reducer. Retard to give 4-5 hours pumping time at 350 degrees F. Pump in calculated volume to fill the annulus of the 12-1/4" hole x 9-5/8" liner from the liner shoe to the stage collar with 100% excess, with approximately 200 cu ft of tail cement consisting of Class G cement blended with 40% silica flour, 3% gel and friction reducer. If loss circulation is a problem, cement may be changed to a spherelite blend. See note at the bottom of this procedure.

13. Pump stage 1 cement and drop dart for wiper plug. Displace cement with water. Bump plug and open multi-stage cementer.

14. After the stage collar has been opened then circulate out excess cement. Circulate and cool hole for 2 hours prior to pumping stage 2 cement. Hang liner at this point.

15. Pump in 20 BBls of CaCl2 water and 10 BBls of fresh water ahead of 20 BBls of sodium silicate.

16. Pump in 220 BBls of viscous Geo-Gel mud preflush.

17. Pump in stage 2 cement without any water spacers. Pump Class G cement and perlite blended at a ratio of 1:1 with 40% silica flour, 3% gel and friction reducer. Retard to give 2-3 hours pumping time at 350 degress F. Pump in calculated volume of cement to fill 12-1/4" hole x 9-5/8" liner to lap area without excess. Calculated volume should include a 200 cu ft tail slurry of Class G cement blended with 40% silica flour, 3% gel and friction reducer. Retard to give 2-3 hours of pumping time at 350 degrees F. Displace cement with water.

18. Once all cement has been pumped then rig down circulating equipment and pull out of liner hanger with drill pipe and pull up 90' and circulate out excess cement on top of liner top.

19. Wait on cement 12 hours. Run in hole with 12-1/4" bit to top of cement, drill out cement to liner top. Wait a full 24 hours from the time cement was in place or until samples have set before pressure testing lap to 1000 psi surface pressure. Squeeze lap if necessary to obtain a pressure test.

20. Trip to change bits to 8-1/2" and clean out cement from inside of 9-5/8" liner top.

21. Retest liner lap to 1000 psi surface pressure. Squeeze if necessary to obtain a pressure test.

22. Drill out cement, float collar and float shoe with 8-1/2" bit. Drill 60' of formation with mud or water.

23. Circulate to clean hole and then displace mud in hole for water if necessary.

24. Trip out of hole to pick up stabilization.

25. Run back in hole and aerate water. Drill ahead with aerated water to commercial production or total depth.

NOTE: Spherelite cement should be blended as follows:

Class G cement blended with 40% silica flour, 50 lbs per sack of cement of spherelite, 4% gel, 1.25% friction reducer and fluid loss agent.

Cement should be mixed at 88.3 lbs per sack of cement. Slurry yield is 3.16 cu ft per sack of cement.

Mixing water requirements are 1.5 cu ft per sack (11.22 gal/sack).

9-5/8" CASING PROPERTIES

L-80, 47 ppf, Buttress, Burst: 6870 psi, Collapse: 4760 psi, Tension: 1,122,000 lbs.

L-80, 43.5 ppf, Buttress, Burst 6330 psi, Collapse: 3810 psi, Tension: 1,038,000 lbs.

L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi, Tension: 947,000 lbs.

PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER
EQUIPPED WITH EXTERNAL CASING PACKER AND HYDRAULIC CEMENTER

1. Drill to casing depth at approximately 6000 - 8000′ dependent on temperature and geology.

2. Circulate for 2-3 hours.

3. Pull out of hole.

4. Rig up and run logs as indicated by geologic staff. Wait on bottom with temperature log for 30 minutes before pulling out of hole.

5. Rig down loggers and run in hole with bit and monel to total depth.

6. Circulate for 2 hours and short trip. Circulate for 1-2 hours after short trip.

7. Pull out of hole and rig up to run 9-5/8" liner. Run additional directional surveys while pulling out of hole if necessary.

8. Run 9-5/8" liner grades, weights and thread design as indicated in attached detail sheet with float shoe on bottom and float collar two joints up. Centralizers should be located one in the middle of bottom two joints and then one every other collar upward to within 60′ of hanger. Use T-Bar rigid centralizers in the bottom portion of the string and then as required in the upper portion. If lost circulation is a problem or the hole has been drilled with air or aerated water then CTC external casing packer should be positioned in string 200-300′ from bottom with Halliburton hydraulic stage cementer located above packer. Run casing adjuster at 600′, 1800′, and 3400′ from shoe joint as required. A T-Bar centralizer should be located above and below packer.

9. Run liner equipment. See attached Pre-Job Recommendations.

   Check all equipment to be run on 9-5/8" liner.
   a. Use Instructions & Operations Sheet TE 7.00381. Measure all parts OD and ID.
   b. Check threads on all tools.
   c. Midway liner hanger running tool. Stinger must be reduced down to 3" OD 2.75 ID and run 10-12.5" below bottom of liner hanger as shown on print TE 7.00378. This is when the liner hanger string is at the bottom of its travel.
   d. Part numbers are given on print TE 7.00377 for tools. ID and OD for SR Plug set is given on print TE 7.00379 OD and OD for HOS Cementer are given on print TE 7.00380.

e. All parts and number should check with prints.
f. HOS Tool has four shear pins that will take 2880 psi over Hydrostatic pressure to open it, two other pins are with the tool. Each pin adds 712.5 psi pressure to shear. Open pressure may be adjusted as needed.

10. Installing equipment onto casing strings. See attached Recommendations During Job for further details.

a. Guide shoe.
b. Centralizers on two joints.
c. Float collar.
d. Centralizers as per program.
e. Casing.
f. CTC Packers 200' off bottom.
g. One joint with centralizer in middle.
h. HOS Cementer.
i. Centralizers as per program - run casing adjusters located 1500' and 3000' from shoe.
j. Casing to top of liner. Fill liner as going in hole.
k. Make up SR Baffle Collar on bottom of liner hanger.*
l. Take O-ring off SR plug set and put on SR Baffle Collar.
m. Make up SR plug set on Baffle Collar and tighten at plug set to Baffle Collar. Be sure all parts are tight.
n. Circulate the liner at 3-4 BPM. Stop and circulate 2-3 times while running in hole with liner assembly on drill pipe.

*Be sure there are no areas of drill pipe on liner hanger less than 2.75 ID.

11. Cement liner in three stages.

a. Calculate volume of cement for bottom stage. (200 ft of 12-1/4" hole and 9-5/8" annulus plus shoe joint volume and volume to inflate CTC Packer).
b. Mix cement for above.
c. Pump cement for 200' annulus and shoe joint. Release first stage dart 809.81266 and pump cement for inflated CTC. (Cement to inflate packer should be Class G with 40% silica flour and friction reducer, no perlite.)
d. Pump 10 BBls spacer then displace with mud at 3-4 BPM until 10 BBls before dart should land in SR lower plug - slow rate to 2 BPM. Pressure should go to 1800 psi and plug release.
e. Displace shut off plug at 5-6 BPM until 30 BBls before plug lands. Then pump at 1-2 BPM.

f. When shut off plug lands in shut off baffle, pressure up to 500 psi and shut down.

12. Inflate CTC Packer with cement. See attached Recommendations During Inflation Sequence for further details.

    a. Check volume of displacement tank.
    b. Increase pressure slowly to 700 psi and shut down.
    c. Increase pressure slowly to 800 psi.
    d. Increase pressure slowly to 900 psi or until tool opens.
    e. Pump in 2-5 cu ft of cement per stage until CTC packer is inflated.
    f. Increase pressure to 1000 psi to close CTC packer.
    g. With pressure at 500 psi, check volume of cement needed to inflate tools.
    h. Pressure up to 2800 psi and open HOS.
    i. Circulate well as needed.
    j. Cement liner as per program. Pump spacer. Pump cement.
    k. Release dart for shut off plug. Pump at 4-5 BPM. Pump 10 BBls spacer - then mud.
    l. Displace to within 10 BBls of plug, slow to 2 BPM.
    m. Pressure to 1950-2000 psi to release plug.
    n. Displace at 4-5 BPM.
    o. When plug lands in HOS, pressure up to 3000 psi to close tool. You may have to go to 3500 psi. Hold pressure for 2 minutes.
    p. Release pressure if holding; back off liner hanger tool.
    q. Come out of hole with tools.
    r. Wait 24 hrs and drill out.

13. Rig down circulating equipment, pull out of hanger with drill pipe and pull up 90' and circulate out excess cement leaving 90 linear ft of cement on top of liner top.

14. Wait on cement for 12 hrs. Run in hole with 12-1/4" bit to top of liner and circulate to clean out excess cement. Wait 24 hrs from the time cement was in place and pressure test lap to 1000 psi. Squeeze if necessary.

15. Trip to change bits to 8-1/2" and clean out cement from inside the 9-5/8" liner top.

16. Retest liner lap to 1000 psi surface pressure. Squeeze if necessary.

17. Drill out cement, float collar and float shoe with 8-1/2" bit. Drill 30' of formation.

18. Circulate and change out mud system for water.

19. Trip to pick up stabilization.

NOTE: Spherelite cement should be blended as follows:

Class G cement blended with 40% silica flour, 50 lbs per sack of cement of spherelite, 4% gel, 1.25% CFR-2, and 0.5% Halad-22A.

Cement should be mixed at 88.3lbs/cu ft (11.8 ppg). Slurry yield is 3.16 cu ft/sack.

Mixing water requirements are 1.50 cu ft/sack (11.22 gal/sack).

CASING PROPERTIES

L-80, 47ppf, Buttress, Burst: 6870 psi, Collapse: 4760 psi, Tension: 1,122,000 lbs.

L-80, 43.5ppf, Buttress, Burst: 7930 psi, Collapse: 6620 psi, Tension: 1,286,000 lbs.

L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi, Tension: 947,000 lbs.

PRE-JOB RECOMMENDATIONS

1. In close clearance (1/2"-1") installations:

    a. Run a casing scraper.
    b. Drill open hole section with a stabilized packed hole assembly if possible.

2. In liner installations, notify CTC of type of liner equipment before packers are shipped.

3. Insure that everyone involved understands the Payzone Packer system and specific duties they are to perform.

4. Obtain all pertinent well data, including:

    a. Minimum wellbore restriction (should be 1/2" greater than packer OD).
    b. If casing damage is suspected, run a microscopic caliper and/or casing scraper.
    c. Calipered hole size in zone of interest should not exceed maximum recommended hole size. Use "Hole Size vs. Recommended Inflation Pressure Chart" to set pressure control valve.
    d. If junk has been lost in hole it should be fished or driven to below Payzone setting depth.
    e. Clients maximum allowable surface pressure (burst strength of casing with a safety factor), should be obtained prior to setting shear pin.
    f. If hole size adjacent to end assemblies is more than 1" larger than packer OD run one centralizer above and below each packer.

5. Inspect auxiliary equipment.

    a. Float shoe.
    b. Float collar.
    c. Bottom cement wiper plug (proper size, rupture diaphragm).
    d. Two top cement wiper plugs (proper size, no rupture diaphragm).
    e. Pressure recorder (5000 psi scale if possible).
    f. Chicksan lines.
    g. Cementing head.
    h. Verify that adequate inflation cement is available.
    i. Obtain a dry sample of all cements used on the job.

6. Review primary cementing plans and calculate theoretical bottom hole pressure during cementing operations. If expected pressures approach fracture gradient, pressure anomalies are probable and bottom wiper plug should not be run so that knockoff rod protection stays intact.

7. Calculate displacement volumes. Know at what displacement the following events should take place:

    a. Bottom wiper passes packers (knockoff rods).
    b. Bottom wiper lands in float collar.
    c. First top wiper passes packer.
    d. First top wiper lands in float collar, and
    e. Top of inflation cement (second top wiper plug) relative to upper packer.

8. Total inflation pressure is critical to Payzone Packer performance. Before starting a job know and/or calculate: 1. hydrostatic pressure inside and outside the casing at packer setting depth, 2. pore pressure, 3. fracture pressure, 4. maximum recommended differential inflation pressure from hole size vs pressure chart, 5. resultant effective stress.

    a. Total inflation pressure equals:
        1. Hydrostatic pressure inside casing (packer depth) + Applied surface pressure

        OR

        2. Hydrostatic pressure outside casing (packer depth) + Differential inflation pressure

    b. Differential inflation pressure equals:
        1. Total inflation pressure minus Pressure outside casing (packer depth)

        OR

        2. Applied surface pressure minus Balance pressure

    c. Balance pressure equals:
        1. Surface pressure required to offset "U" tube pressure
        2. Approximated by surface pressure (pumping at 1/4-1/2 BBl/min) just prior to plug bump.

    d. Radial effective stress (Seal Load, Wellbore Support) equals:
    Total inflation pressure minus pore pressure.
    -In all cases the differential inflation pressure must be within the hole size vs differential pressure capabilities of the equipment.
    -For zone isolation the radial effective stress (seal load) should be at least 500 psi and total inflation pressure must be less than fracture pressure.

9. Review casing tally. Re-tally casing during run-in if necessary. This is critical if positioning log is not to be run.

10. Make up casing according to API specifications with proper torque and API pipe dope.

Note: It is extremely difficult to properly inflate packers with a casing leak.

11. Epoxy thread lock should be used on packer/casing connections, float collar, and float shoe.

12. A minimum number of only high quality (API approved) centralizers be run below packer(s). If pipe is to be reciprocated, and hole size adjacent to end assemblies does not exceed packer OD plus 2", spacing between packers and centralizers should be greater than reciprocation stroke. Do not place scratchers in this area.

13. If positioning is critical, packers should be logged into position.

14. Insure that cement has adequate pump time.

15. Inflation cement should have an API water loss of less than 150 cc. Inflation cement must not contain lost circulation material.

RECOMMENDATIONS DURING JOB

1. Verify that external cementing aids (centralizers, scratchers, etc.) are properly installed.

2. Run-in speed 1 ft/sec (may be prudently increased to 2 ft/sec per Steps 3 and 4 below).

3. Monitor returns, if more than 30′ of casing is run before receiving full returns - SLOW DOWN.

4. Monitor weight indicator - excessive weight loss during run indicates that run-in speed may be too fast.

5. Pressure test lines before beginning cement job. Repair all leaks no matter how small.

6. Verify that wiper plugs are dropped at proper time in proper sequence.

7. Monitor returns during entire job.

8. Monitor mixing and pumping of inflation cement. Verify volume and weight of inflation cement. Batch mix if possible.

   Note: If inflation cement is not batch mixed, monitor BBl counter, but do not rely on its accuracy. Insist that mix water be accurately measured from tanks and that cement density remains constant and proper. (If cement is mixed at proper weight, mix water volume is an accurate indicator of cement volume.)

9. Insist that plug drop be verified via tattle-tale, flag or radioactive techniques.

10. Monitor displacement volume, pump rate and surface pressure during entire displacement process.

11. Determine balance pressure during last 5 BBl of displacement. (Slow displacement to 1/4-1/2 BBl/min and record pressure.)

12. Required displacement volume will normally exceed theoretical casing volume. If mud is used for displacement, expect up to 6%.

RECOMMENDATIONS DURING INFLATION SEQUENCE

1. When first plug lands in float collar:

2. Open shear valve in first or bottom packer by rapidly applying appropriate surface pressure, i.e. balance pressure plus pressure rating of shear valve. (Monitor volume displaced.) Stop pumps and monitor pressure decline, increase pressure by 200 psi or as needed to open valve. Record volume in displacement tanks.

   NOTES:

   a. Flow rate into Payzone packers is relatively slow (1/4 BBl/min). Therefore, it is generally impractical and not advisable to pump continuously during inflation. The preferred procedure is to rapidly increase surface pressure, stop pumping and monitor pressure decline. When the packer is full, the pressure decline will stop.

   b. The expected pressure response during inflation is a function of several variables. In general the following reduce the distinctiveness of the pressure response.
      1. Increased well depth.
      2. Compressability and volume of fluid within the casing string.
      3. Large diameter casing.
      4. Viscosity of inflation cement.
      5. Small inflation volume.

      For example, the pressure response during inflation of a 9-5/8" packer at 12,000' with 3/4 BBl of 16.4 lbs/gal cement may be non-distinct while inflation of a 5-1/2" packer with 1 BBl at 6000' would be very distinct.

3. When packer is completely inflated (surface pressure remains constant), apply final desired inflation pressure.

   a. Record volume pumped and hold pressure for 5-10 min.

   b. Bleed surface pressure slowly back to balance pressure (and/or point 1a above and record flowback volume.

   c. Release pressure slowly.

Note: In shallow (less than 7000') unconsolidated sands, the hole size often enlarges as the packer re-stresses the sand. In these installations, final inflation pressure should be adjusted or reduced in accordance with hole size.

This may be done by converting inflation volume to equivalent hole diameter and using "Hole Size vs Recommended Inflation Pressure Chart".

THINGS TO AVOID

1. Avoid using bottom wiper plugs whenever possible. This is critical if bottomhole pressures during the cement operation are likely to exceed frac pressure.

2. Avoid using spacer fluids below inflation cement because volumetric error and/or pressure anomalies may result in mud-filled packers.

   Note: The use of lightweight spacer fluids below the inflation cement imposes a hydrostatic differential pressure across the valve collar equal to [Weight of cement in annulus (lbs/gal) minus weight of spacer fluid below packer (lbs/gal)] multiplied by .052 times height of spacer fluid below packer.

3. Do not exceed fracture pressure in isolation installations.

4. If spacer fluids are used as substitues for wiper plugs above inflation cement, increase cement volume to compensate for contamination of the upper 100′ of inflation cement.

5. Do not use differential fill equipment because debris may enter casing. Some varieties of differential fill equipment must be opened via applied casing pressure prior to circulation. This is not compatible with our valve system.

6. Insist that liner hanger packoffs not be set prior to packer inflation.

7. Do not spud casing - circulate through bridges.

8. Do not use cement with more than 6% Plaster of Paris or Calseal cement.

9. Do not use loss circulation material in inflation cement.

PROCEDURE FOR RUNNING 9-5/8" TIE-BACK CASING
OPTIONAL

1. Kill well with cold water. Pick up Halliburton 9-5/8" EZSV cement retainer on drill pipe and run in hole to 300' below liner top. Set EZSV at this point.

2. Spot a 50 linear foot thick viscous gel pill on top of EZSV and 50 linear feet of cement on top of gel. Fill hole with water and circulate to cool and clean hole. Make appropriate changes to wellhead assembly.

3. Run 9-5/8" casing scraper to clean out liner tie-back sleeve.

4. Rig up and run 9-5/8" tie-back string to top of liner with float collar 40' (1 joint) above stab-in tool on bottom. Stab-in tool will be equipped with slip. Stab into liner, engage slips on the 13-3/8" and pull up on tie-back to 200,000 lbs to pretension tie-back.

5. Cement tie-back as per attached cementing program. Bring cement back to surface between 9-5/8" and 13-3/8" casing, setting centralizer in 13-3/8" casing head before cementing.

6. Wait on cement 12 hours, then release tension.

7. Land 9-5/8" casing. Pick up 12" blow out preventer stack and install expansion spool (12" 900 x 10" 900) equipped with two 3" flanged outlets with 3" 2000 psi wing valves. Install 10" 900 Master Valve and 10" 900 x 12" 1500 adaptor spool and reinstall blow out preventer stack.

8. Test blow out preventer stack, 10" master valve, expansion spool and 9-5/8" tie-back to 1500 psi.

9. Pick up 8-1/2" bit and drill out excess cement and float collar. Work bit through lap area and retest to 1000 psi. Squeeze if necessary.

10. Drill out cement and clean out gel to top of EZSV.

11. Trip for EZSV picking tool and remove EZSV.

12. Return well to production and retest if necessary, using air to induce well to flow.

13. Lay down drill pipe, remove blow out preventer equipment,and move rig off, releasing rig.

14. Prepare for long term test.

15. Test well.

9-5/8" CASING PROPERTIES

L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi, Tension: 947,000 lbs.

FIGURES

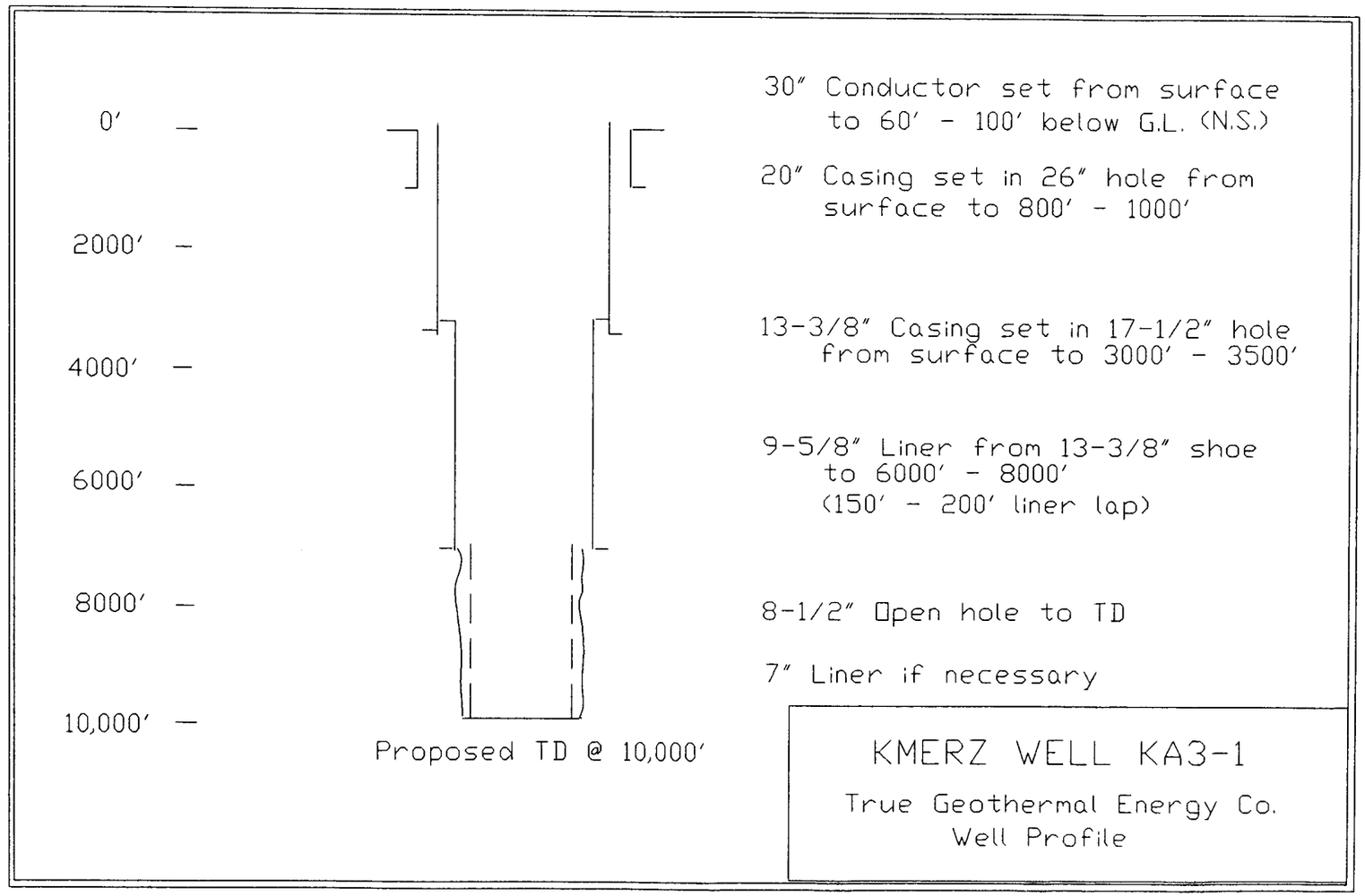
0'
2000'
4000'
6000'
8000'
10,000'
Proposed TD @ 10,000'
30" Conductor set from surface to 60' - 100' below G.L. (N.S.)
20" Casing set in 26" hole from surface to 800' - 1000'
13-3/8" Casing set in 17-1/2" hole from surface to 3000' - 3500'
9-5/8" Liner from 13-3/8" shoe to 6000' - 8000' (150' - 200' liner lap)
8-1/2" Open hole to TD
7" Liner if necessary
KMERZ WELL KA3-1
True Geothermal Energy Co.
Well Profile

FIGURE 001

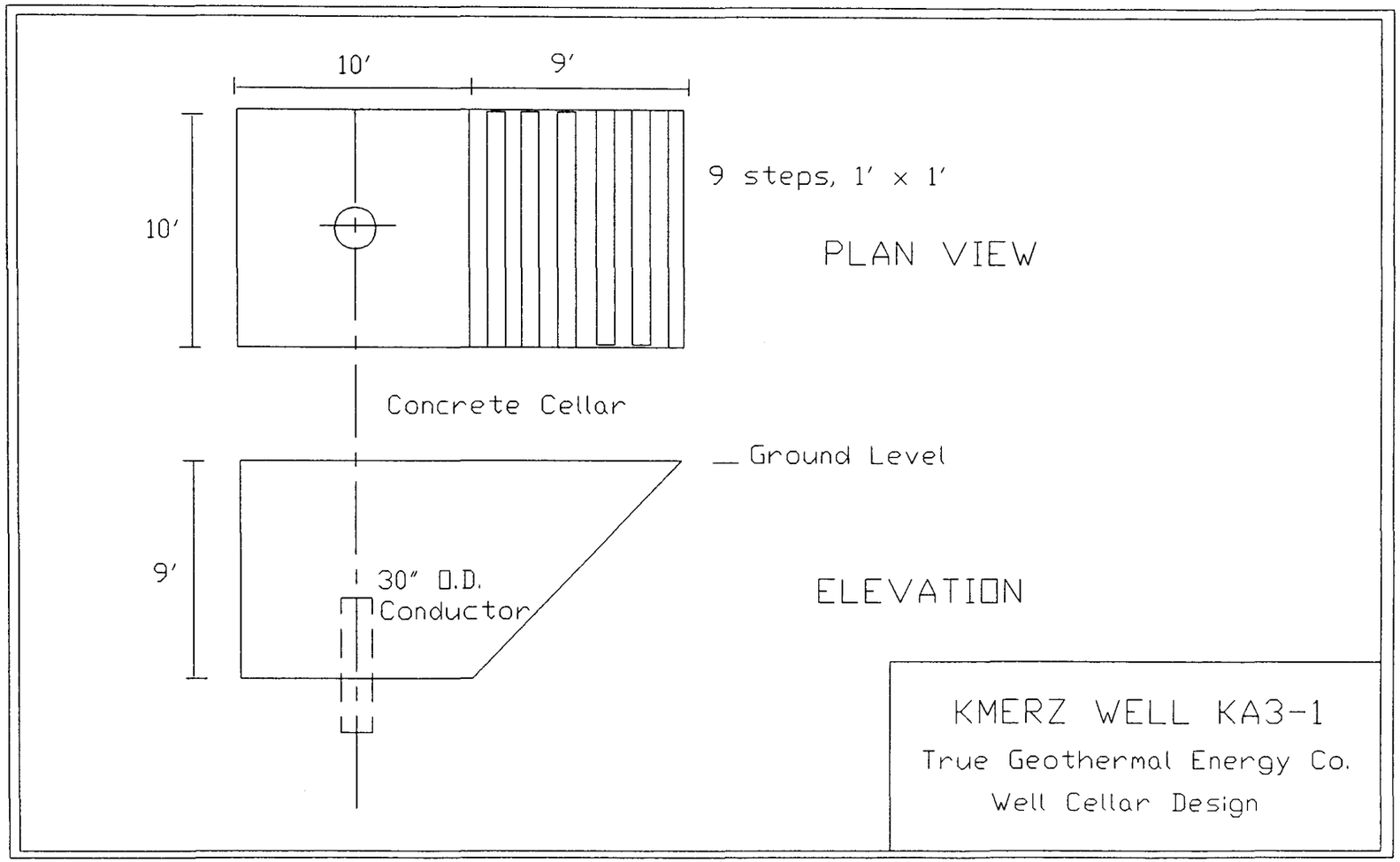
10'
9'
10'
9 steps, 1' x 1'
PLAN VIEW
Concrete Cellar
Ground Level
9'
30" O.D.
Conductor
ELEVATION
KMERZ WELL KA3-1
True Geothermal Energy Co.
Well Cellar Design

FIGURE 002

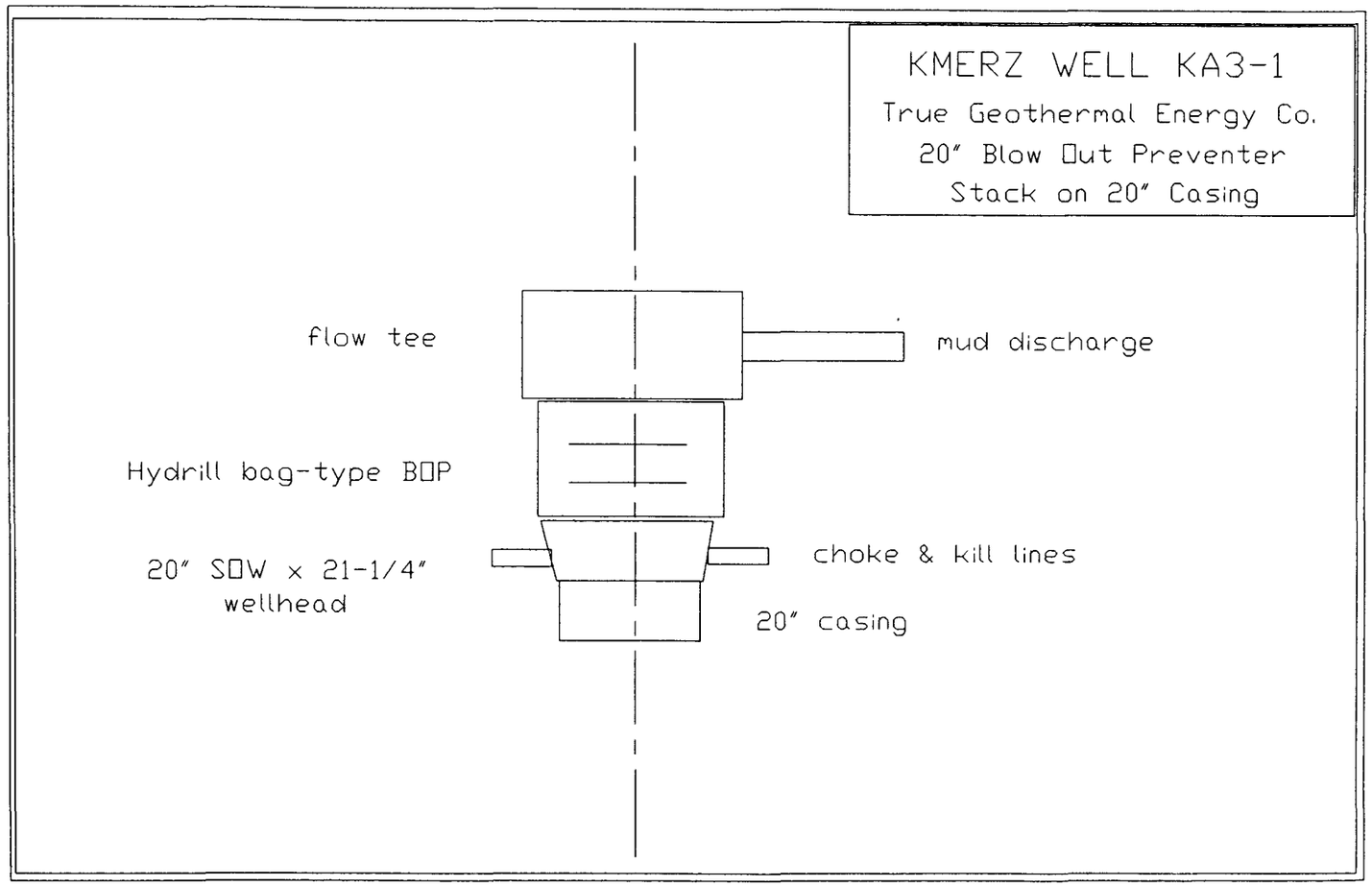
KMERZ WELL KA3-1
True Geothermal Energy Co.
20" Blow Out Preventer
Stack on 20" Casing
flow tee
mud discharge
Hydrill bag-type BOP
20" SOW x 21-1/4"
wellhead
choke & kill lines
20" casing

FIGURE 003

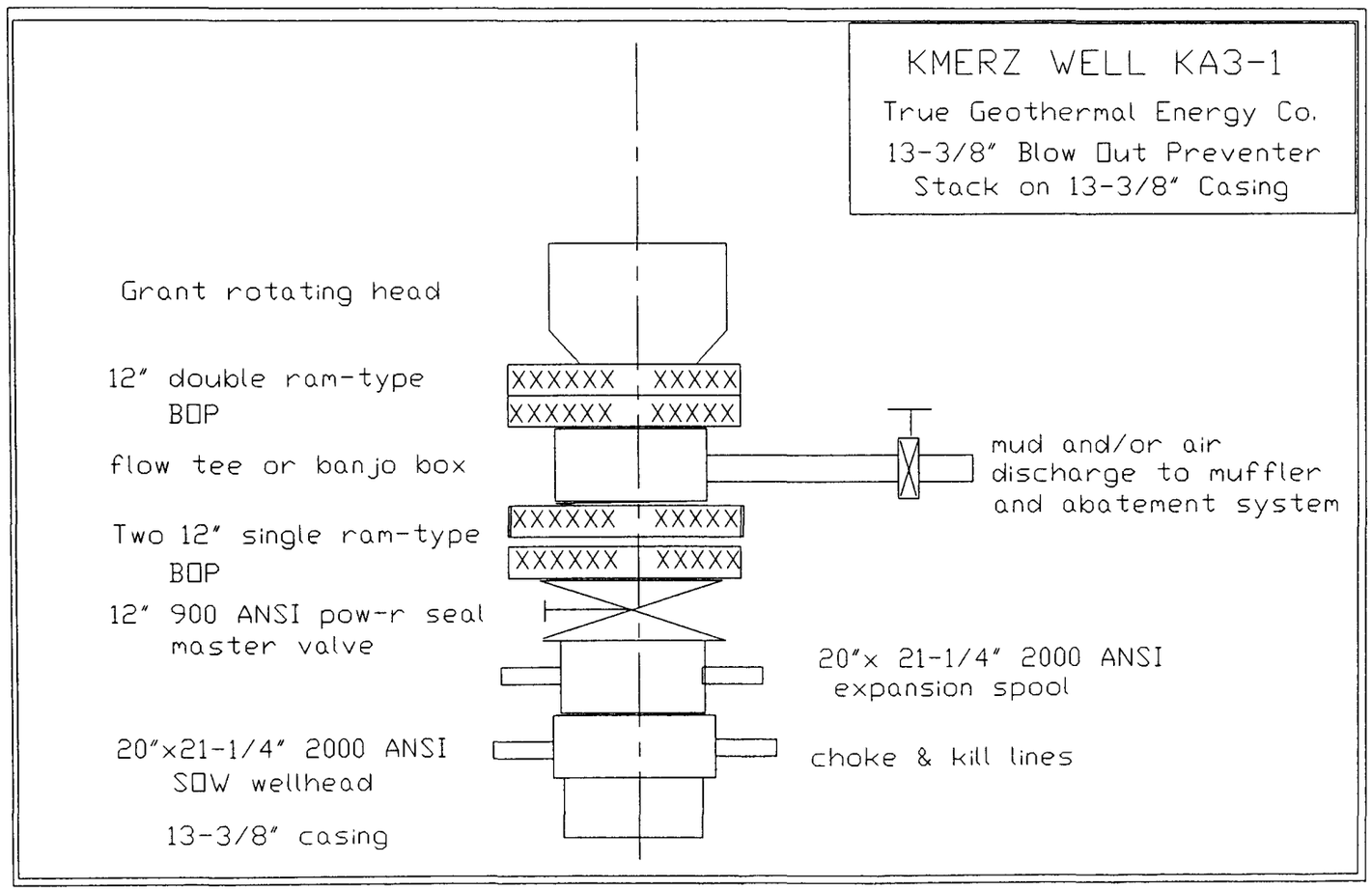
KMERZ WELL KA3-1
True Geothermal Energy Co.
13-3/8" Blow Out Preventer
Stack on 13-3/8" Casing
Grant rotating head
12" double ram-type
BOP
flow tee or banjo box
Two 12" single ram-type
BOP
12" 900 ANSI pow-r seal
master valve
20"x21-1/4" 2000 ANSI
SOW wellhead
13-3/8" casing
XXXXXX XXXXX
XXXXXX XXXXX
XXXXXX XXXXX
XXXXXX XXXXX
mud and/or air
discharge to muffler
and abatement system
20"x 21-1/4" 2000 ANSI
expansion spool
choke & kill lines

FIGURE 004

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CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM

SIZE: 20" | DEPTH: 1000' | WELL: KA3-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
0-1000'	106.5	K-55	Buttress	3.31	9.21	1.64	9.99+
Casing Properties:							
Collapse-770 psi							
Burst-2320 psi							
Tension-1,683,000 lbs.							

DESIGN CONDITIONS

SURFACE BURST PRESSURE	- 2000 PSI	OUTSIDE MUD WT. (COLLAPSE)	- 9.95 PPG		
INSIDE MUD WEIGHT (BURST)	- 9.5 PPG	INSIDE MUD WT. (COLLAPSE)	- 0 PPG		
OUTSIDE MUD WEIGHT (BURST)	- 9.5 PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE)	- 9.5 PPG		
FRAC. GRAD. AT SHOE (BURST)	- 14.5 PPG	BIAXIAL LOAD: COLL. ☐ BURST ☐		BOUYANCY: YES ☐ NO ☒	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

2690 cu ft (838 sx) of Class G cement blended with 50 lbs of spherelite per sack of cement, 40% silica flour, 4% gel, 5% hydrated lime, 1.25% CFR-2 and 0.5% Halad-22A tailed with 400 cu ft (252 sx) of Class G cement blended with 40% silica flour and 3% CaCl2

DESIRED TOP: Surface | EXCESS: 100%

SLURRY VOL. - CU FT / (SLURRY NO.)	2690		400	
SLURRY YIELD - CUBIC FEET/SACK	3.21 cu ft/sx		1.59 cu ft/sx	
SLURRY DENSITY - PPG	82.2#/cu ft(11 ppg)		118#/cu ft(15.8 ppg)	
THICKENING TIME - DEPTH SCH/HRS. MIN.	2-3 hrs		2-3 hrs	
COMPRESSIVE STRENGTH - PSI/HOURS				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Stab in float collar located 40' (1 joint) above float shoe on bottom.
2. Weld bottom of collars on bottom 4 joints.
3. Clean and Baker loc threads on float collar and shoe as well as bottom 4 joints.
4. Tac weld top of collars on bottom 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Run rigid centralizer in middle of bottom 2 joints, then one every other tool joint to within 100' of surface.
2. Use centralizer cement baskets as required due to lost circulation.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Stab into float collar with drill pipe. Attempt to circulate with water.
2. Pump 200 cu ft CaCl2 water followed by 100 cu ft of fresh water, 200 cu ft Flo-chek, 200 cu ft Geo-gel, then cement slurries.

PRESSURE TESTING AND LANDING

1. Use 1" pipe in annulus of 20" AND 26" hole to bring cement back to surface if necessary.
2. Wait on cement 8 hours.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	2000	20"	See attached drawing	1500	1500	

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CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM

SIZE: 13-3/8" | DEPTH: 3500' | Full String | WELL: KA3-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS: TOP BURST	BOT. BURST	COLL.	TENSION
0-3000'*	68	L-80	Buttress	2.03	1.95	1.51	6.44
3000-3500'**	72	L-80	Buttress	2.08	2.05	1.55	45.83
Casing Properties:*				Casing Propertires:**			
Collapse-2260 psi				Collapse-2670 psi			
Burst-5020 psi				Burst-5380 psi			
Tension-1,545,000 lbs				Tension-1,650,000 lbs			

DESIGN CONDITIONS

SURFACE BURST PRESSURE	-	3000 PSI	OUTSIDE MUD WT. (COLLAPSE)	-	9.5 PPG
INSIDE MUD WEIGHT (BURST)	-	9.5 PPG	INSIDE MUD WT. (COLLAPSE)	-	0 PPG
OUTSIDE MUD WEIGHT (BURST)	-	9.5 PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE)	-	9.5 PPG
FRAC. GRAD. AT SHOE (BURST)	-	14.5 PPG	BIAXIAL LOAD: COLL. [X] BURST [X]		BOUYANCY: YES [ ] NO [X]

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

4257 cu ft (1723 sx) Class G cemetn blended 1:1 with perlite and 40% silica flour, 4% gel and 0.65% CRF-2. Tailed with 300 cu ft (192 sx) of Class G cement blended with 40% silica flour and friction reducer. Both slurries to be blended with retardant to give 2-3 hours pumping time at reservoir temperature.

DESIRED TOP: Surface | EXCESS: 100%

SLURRY VOL. - CU FT / (SLURRY NO.)	4257		300	
SLURRY YIELD - CUBIC FEET/SACK	2.47		1.56	
SLURRY DENSITY - PPG	97.25#/cu ft(13.0 ppg)		118#/cu ft (15.8 ppg)	
THICKENING TIME - DEPTH SCH/HRS. MIN.	2-3 hrs		2-3 hrs	
COMPRESSIVE STRENGTH - PSI/HOURS				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run stab in float collar 40' (1 joint) above float shoe on bottom.
2. Weld bottom of collars on bottom 4 joints.
3. Clean and Baker loc threads on float collar and shoe as well as bottom 4 joints.
4. Tac-weld top of collars on bottom 2 joints.
5. Run 13-3/8" as full string or liner with tie-back as hole conditions dictate. See attached procedure.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Run rigid centralizer in middle of bottom 8 joints. Then turbo-type centralizer on every other collar from bottom to within 200' of surface.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. If lost circulation is a problem run casing as directed in attached procedure. Use sodium silicate preflush as directoed.
2. Cement through drill pipe.
3. Pump cement of Stage 1 until cement appears at surface, then pump stage 2 cement.

PRESSURE TESTING AND LANDING

1. Wait on cement 12 hrs or until samples have set.
2. Cut & remove 20" casing. Install 12" x 20" expansion spool and blow out preventer stack as in attached drawing.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI: RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	3000	12-3/8"	Rotating head & ram	1500	1500	1000

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM

SIZE	DEPTH		WELL
13-3/8"	3500'±	Liner	KA3-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
900--3000'	68	L-80	Buttress	2.01	1.95	1.49	8.68
3000--3500'	72	L-80	Buttress	2.07	2.05	1.53	45.83

DESIGN CONDITIONS

SURFACE BURST PRESSURE	-	3000 PSI	OUTSIDE MUD WT. (COLLAPSE) -	9.5	PPG
INSIDE MUD WEIGHT (BURST)	-	9.5 PPG	INSIDE MUD WT. (COLLAPSE) -	0	PPG
OUTSIDE MUD WEIGHT (BURST)	-	9.5 PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE) -	9.5	PPG
FRAC. GRAD. AT SHOE (BURST)	-	14.5 PPG	BIAXIAL LOAD: COLL. [X] BURST [X]	BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

3340 cu ft (1041 sx) Class G cement blended with 50# per sack of cement of spherelite, 40% silica flour, 5% hydrated lime, 4% gel, 1.25% CFR-2, and 0.5% Halad-22A, tailed with 300 cu ft (189 sx) of Class G cement blended with 40% silica flour and friction reducer. Both slurries retarded to give 2--3 hrs pumping time at reservoir temperature.

DESIRED TOP: 900'± EXCESS: 100%

SLURRY VOL. - CU FT / (SLURRY NO.)	3340	300		
SLURRY YIELD - CUBIC FEET/SACK	3.21	1.59		
SLURRY DENSITY - PPG	82.2	118		
THICKENING TIME - DEPTH SCH/HRS, MIN.	2-3 hrs	2-3 hrs		
COMPRESSIVE STRENGTH - PSI/HOURS				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run float collar 40' above float shoe.
2. Weld bottom of collars on bottom 4 joints.
3. Clean and Baker loc threads on bottom 4 joints.
4. Tac-weld top of collars on last 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Hang liner 100' up inside 20" casing on drill pipe.
2. Run rigid centralizer cement baskets in middle of bottom 2 joints and one 10' up inside 20" casing and one just below stage collar if a stage is indicated.
3. Run centralizers every other tool joint to bottome of 20" casing.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Attempt to circulate with water.
2. Pump 20 cu ft CaCl2 water and 100 cu ft water, followed by 200 cu ft Flo-Chek the 200 cu ft of Geo-gel, then cement slurries.
3. See attached program for more detail.

PRESSURE TESTING AND LANDING

1. Wait on cement 8 hrs. Clean out cement from top of 13-3/8" liner. Test lap to 1000 psi. Squeeze lap if necessary. Clean out and retest until a test is obtaned.

BOP PROGRAM

API STACK. ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
		No change until tie-back run				

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM

SIZE	DEPTH		WELL
13-3/8"	900'±	Tie-Back	KA3-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
0-900'	68	K-55	Buttress	1.76	1.67	5.04	25.25

DESIGN CONDITIONS

SURFACE BURST PRESSURE	-	3000 PSI	OUTSIDE MUD WT. (COLLAPSE) -	9.5	PPG
INSIDE MUD WEIGHT (BURST)	-	9.5 PPG	INSIDE MUD WT. (COLLAPSE) -	0	PPG
OUTSIDE MUD WEIGHT (BURST)	-	9.5 PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE) -	9.5	PPG
FRAC. GRAD. AT SHOE (BURST)	-	14.5 PPG	BIAXIAL LOAD: COLL. [X] BURST [X]	BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

1059.8 cu ft (666 sx) Class G cement blended with 40% silica flour and 0.5% CFR-2.

	DESIRED TOP	EXCESS
	Surface	30%

SLURRY VOL. - CU FT / (SLURRY NO.)	1059.8			
SLURRY YIELD - CUBIC FEET/SACK	1.59			
SLURRY DENSITY - PPG	118			
THICKENING TIME - DEPTH SCH/HRS, MIN.	2-3 hrs			
COMPRESSIVE STRENGTH - PSI/HOURS	±2323/8 hrs			

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run float collar 40' above tie-back sleeve on bottom.
2. Clean and Baker loc threads on bottom 4 joints.
3. Tac-weld top and bottom of collars on bottom 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Run rigid centralizer in middle of bottom joint and one every other tool joint to surface except for top 100'.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Circulate with fresh water.
2. Run top plug only.
3. See attached program for more detail.

PRESSURE TESTING AND LANDING

1. Wait on cement 6 hrs before landing and cutting off 13-3/8" for wellhead.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	3000	12-3/8"	See attached drawing	1500	1500	

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM

SIZE: 9-5/8" | DEPTH: 7000' | Liner | WELL: KA3-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
3300--5300'	40	L--80	Buttress	2.04	1.97	1.08	6.08
5300--6500'	43.5	L--80	Buttress	2.17	2.30	1.16	13.71
6500--7000'	47	L--80	Buttress	2.30	2.29	1.36	47.74

DESIGN CONDITIONS

SURFACE BURST PRESSURE	-	3000 PSI	OUTSIDE MUD WT. (COLLAPSE) -	9.5	PPG
INSIDE MUD WEIGHT (BURST)	-	9.5 PPG	INSIDE MUD WT. (COLLAPSE) -	0	PPG
OUTSIDE MUD WEIGHT (BURST)	-	9.5 PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE) -	9.5	PPG
FRAC. GRAD. AT SHOE (BURST)	-	14.5 PPG	BIAXIAL LOAD: COLL. [X] BURST [X]	BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

2000 cu ft (810 sx) of Class G cement blended 1:1 with perlite and 40% silica flour. 4% gel and 0.65% friction reducer. Tailed with 300 cu ft (192 sx) of Class G cement blended with 40% silica flour and friction reducer. Both slurries to be blended with retardant to give 2-3 hrs pumping time at reservoir temperature.

DESIRED TOP: To liner top | EXCESS: 100%

SLURRY VOL. - CU FT / (SLURRY NO.)	2000		300	
SLURRY YIELD - CUBIC FEET/SACK	2.47		1.56	
SLURRY DENSITY - PPG	97.25#/cu ft (13.0 ppg)		118#/cu ft (15.8 ppg)	
THICKENING TIME - DEPTH SCH/HRS. MIN.	2-3 hrs		2-3 hrs	
COMPRESSIVE STRENGTH - PSI/HOURS				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run float collar 80' (2 joints) above float shoe on bottom.
2. Weld bottom of collars on bottom 4 joints.
3. Clean and Baker loc threads on bottom 4 joints as well as threads on float collar and shoe.
4. Tac weld top of collars on bottom 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Hand liner 200' up inside 13-3/8" casing with drill pipe.
2. Run rigid centralizers in middle of bottom 4 jonts and then 1 turbo type centralizer every collar to within 200' of top.
3. Run stage collars and external casing packer as in attached procedures.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Attempt to circulate with water.
2. Pump cement and preflush as in attached procedures.

PRESSURE TESTING AND LANDING

1. Wait on cement 12 hrs. Clean out cement from top of 9-5/8" liner. Test lap to 1000 psi. Squeeze lap if necessary to obtain good pressure test.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
		No change until tie-back run				

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM

SIZE	DEPTH		WELL
9-5/8"	3300'±	Tie-Back	KA3-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
0-3300'	40	L-80	Buttress	2.10	1.92	2.34	7.17

DESIGN CONDITIONS

SURFACE BURST PRESSURE	- 3000	PSI	OUTSIDE MUD WT. (COLLAPSE)	- 9.5	PPG
INSIDE MUD WEIGHT (BURST)	- 9.5	PPG	INSIDE MUD WT. (COLLAPSE)	- 0	PPG
OUTSIDE MUD WEIGHT (BURST)	- 9.5	PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE)	- 9.5	PPG
FRAC. GRAD. AT SHOE (BURST)	- 14.5	PPG	BIAXIAL LOAD: COLL. [X] BURST [X]	BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

1140 cu ft (704 sx) Class G cement blended with 40% silica flour and 0.5% CFR-2.

	DESIRED TOP	EXCESS
	Surface	30%

SLURRY VOL. - CU FT / (SLURRY NO.)	1140			
SLURRY YIELD - CUBIC FEET/SACK	1.62			
SLURRY DENSITY - PPG	116			
THICKENING TIME - DEPTH SCH/HRS, MIN.	2-3 hrs			
COMPRESSIVE STRENGTH - PSI/HOURS	±2323/8 hrs			

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run float collar 40' above tie-back sleeve on bottom.
2. Clean and Baker loc threads on bottom 4 joints.
3. Tac-weld top and bottom of collars on bottom 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Run centralizers in middle of bottom joint and one every other tool joint to surface except for top 100'.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Circulate with fresh water.
2. Run top plug only.
3. See attached program for more detail.

PRESSURE TESTING AND LANDING

1. Wait on cement 6 hrs before landing and cutting off 9-5/8" for expansion spool and blow out preventers.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	1500	8-1/2"	See attached drawing	1500	1500	1000

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MUD

MUD, LOGGING, WELLHEAD & DIRECTIONAL PROGRAMS

WELL: KA3-1

DEPTH INTERVAL	MUD TYPE	WEIGHT	API FLUID LOSS	YIELD POINT	PH	
0-100'	Gel and water	65#/ft³	---	15	9.0	
100-1000'	Gel and water or air*	70#/ft³	10cc	15	9.0	
1000-3500'	Gel and water or air*	70#/ft³	10cc	15	10.0	
3500-7000'±	Gel and water or air*	70#/ft³	3.2cc	15	10.0	
7000-T.D.	Water or air*	65#/ft³	or 3000 cfm			

REMARKS
*If unable to maintain circulation due to lost circulation, first attempt to aerate system, then attempt to drill with air with rotary bit or air hammer (see attached). If misting is required, it may be necessary to increase air volume 30%. Misting mix should be fresh water mixed with 2-6 gal/10BBls of Magcobar Foamer. Maintain a solution pH above 10.0 to inhibit corrosion. Use Unisteam as outlined in special considerations.

LOGGING

DEPTH INTERVAL	LOG TYPES	LOG SCALES
100-1000'*	Temperature log & logs as directed	1" and 5" = 100'
1000-3500'*	Temperature log & logs as directed	1" and 5" = 100'
3500-7000'	Temperature log & logs as directed	1" and 5" = 100'
7000-T.D.	Temperature log & logs as directed	1" and 5" = 100'
0-T.D.	Samples every 10'	

REMARKS
All logs to be determined by geologist.
*Apply for waiver requiring E-log on these sections of the well.

WELLHEAD

API NOMINAL SIZE	WORKING PRESSURE PSI	TYPE	MAKE
26"	100 psi		
20" S.O.W. x 21-1/4" 2000	2000 psi	*Weld on wellhead	WKM
21-1/4" 2000 x 12" 900	3000 psi	21-1/4" x 12" expansion spool with two 3" 2000 outlets	WKM
12" x 12"	3000 psi	12" 900 Ansi WKM Pow-R-Seal master valve	WKM

REMARKS

DIRECTIONAL OR STRAIGHT-HOLE

Drill hole as straight as possible, taking directional shots every 100'± from 0-7000' and on dull bits after 7000'. 0-3500' maximum deviation to be 5°, maximum rate of change to be $1\frac{1}{2}$° per 100'. 3500-7000' maximum deviation to be 8°, maximum rate of change to be $1\frac{1}{2}$° per 100'. 7000-T.D. monitor without control.

TRUE GEOTHERMAL ENERGY COMPANY
KMERZ WELL NO. KA2-1
GEOTHERMAL EXPLORATION WELL PROGRAM

The following well program is designed to drill and complete a nominal 10,000′ geothermal exploration well in the KMERZ. (See Figure 001) Based on the results of prior drilling, a large degree of flexibility is built into the program. It should be clear that being an exploration well, the casing setting depths and drilling procedures are subject to change at any time. DLNR will be notified and updated as drilling progresses on any changes.

1. Install 30" conductor pipe in 42" hole to 60′ to 100′ or as deep as possible below ground level prior to rotary rig moving onto location. Cement conductor from total depth back to surface with redi-mix cement. If a burial cave or lava tube is encountered when setting the conductor pipe, further investigation is required prior to proceeding. Notify DLNR and consult with archaeologist. If conditions warrant, conductor installation may also be performed with rotary rig.

2. Construct 10′ x 10′ x 9′ deep cellar around conductor pipe with a cemented bottom and stairway exit toward front of rig. See attached Figure 002.

3. Move in rotary drilling rig to drill well. Center rig over conductor pipe and rig up. Drill 42" hole with bucket bit and install 30" conductor, if not installed prior to moving in. Add 30" OD extension to conductor pipe to bring it up under rotary table. Install flow line on conductor pipe to return mud to pits.

4. Notify DLNR upon startup of drilling of a pilot hole. Pick up an 8-1/2" bit on a 26" hole opener or reamer and run into the bottom of the conductor pipe. Center punch 8-1/2" hole and drill 8-10′. Pull out of hole and remove 26" hole opener or reamer. Run 8-1/2" bit and drill to 100′+/-. During the drilling of this 8-1/2" pilot hole progress should be monitored constantly to determine if a lava tube which may contain archaeological artifacts might be encountered directly under the rig. If the bit drops free for more than eight (8) feet then drilling will stop. If this drop occurs the hole will be flushed with clear water and a light source with video camera lowered into the hole to investigate the possibility of any archaeological value. If archaeological value is determined then drilling will stop and the rig moved. If no archaeological value is determined then provisions would be made to continue drilling. Drilling supervisor shall be on drill rig floor throughout complete pilot hole drilling operations.

5. Open 8-1/2" hole to 26" with 26" bit and drill with mud to 800-1000′ depending on geology. Maintain hole as straight as

possible, take drift shots every 100'. Maximum rate of change 1 degree per 100'. Install mud loggers at surface to log entire well from 0' to total depth. Catch three clean and dry samples every 10'.

6. Rig up and run 20" casing to total depth as per attached 20" casing program with 20" stab-in float collar and float shoe on bottom.

7. Once 20" casing has been run to bottom, run in hole with stab-in tool on bottom of drill pipe and stab into float collar. Circulate hole clean with at least two full circulations.

8. Cement 20" casing through drill pipe as per attached program. Circulate cement back to surface between 20" and 30" casing. Observe cement level. If cement falls back in annulus, bring same back to surface with 1" pipe.

9. Wait on cement 8 hours.

10. Land 20" casing. Cut off and remove 30" conductor drilling nipple. Cut off 20" casing and weld on 20" S.O.W. x 21-1/4" 2000 psi wellhead. Install two 3" valves. Install 20" blow out preventer equipment as per attached Figure 003.

11. Test 20" casing and blow out preventer equipment to 1500 psi for 30 minutes.

12. Drill out cement and float collar and float shoe from 20" casing with 17-1/2" bit using mud. Drill 30' of formation and trip to pick up stabilization.

13. Continue to drill 17-1/2" hole as vertical as possible with mud to 3500'+/- as indicated by formation. Directionally survey well at least every 100'. If lost circulation presents severe problems, an aerated mud system may be utilized. Severe loss circulation zones should be cemented off prior to drilling ahead.

14. Once 17-1/2" hole has been completed to casing point, rig up and run logs if indicated by geologic staff.

15. Upon completion of logging program, run in hole with bit and circulate to condition hole for casing.

16. Rig up and run 13-3/8" casing as per attached 13-3/8" casing program and running procedure. If lost circulation presents severe problems during drilling it may be necessary to set 13-3/8" pipe as a liner then tie it back to the surface rather than a full string of casing. See running procedure for alternative options.

17. Cement 13-3/8" casing as per attached program. Circulate cement back to surface between 13-3/8" and 20" casings. Observe cement, if it falls back, bring level back to surface using 1" pipe.

18. Wait on cement 12 hours or until samples are set.

19. Land 13-3/8" casing. Remove 20" blow out preventer stack. Cut off 13-3/8" casing and install 12" x 21-1/4" 900 ANSI expansion spool wellhead with two 3" flanged outlets equipped with 3" 2000 psi wing valves. Install 12" 900 series blow out preventer stack with 12-1/4" bore as per attached Figure 004.

20. Test 13-3/8" blow out preventer stack to 1500 psi for 30 minutes.

21. Drill out all cement, float collar and shoe from the 13-3/8" casing with a 12-1/4" bit using mud. Drill 30' of formation and trip to pick up stabilization.

22. Drill 12-1/4" hole with mud or aerated mud as required by hole conditions to 6000-8000', the 9-5/8" casing point, as indicated by geologic staff. Lock up drilling assembly to maintain direction and angle as straight as possible to casing point.

23. Once 12-1/4" hole has been completed to casing point, rig up and run logs if indicated by geologic staff.

24. Upon completion of logging program, run in hole with bit and circulate to condition hole for casing.

25. Rig up and run 9-5/8" casing as a liner equipped as required with external casing packer located 200-300' from bottom. Hang same using a double slip liner hanger with tie-back sleeve. Run 9-5/8" liner from total depth to hanger located 200' up inside of 13-3/8" casing as per attached 9-5/8" liner program and running procedure.

26. Once liner is hung, circulate hole clean through drill pipe with at least two full circulations.

27. Cement 9-5/8" liner and external casing packer from total depth back up to top of liner lap as per attached cementing program.

28. Once cement is in place, disengage from liner hanger and pull up 60' and circulate out excess cement.

29. Pull out of hole with liner hanging tool and run in hole with 12-1/4" bit and drill out cement from 13-3/8" casing to top of 9-5/8" liner lap. Test lap to 1000 psi only after cement has been in place 12 hours. Squeeze lap area if necessary to

obtain a 1000 psi squeeze pressure.

30. Trip for 8-1/2" bit and drill out excess cement from 9-5/8" liner down to top of float collar. Pressure up and retest 13-3/8" casing, liner lap and 9-5/8" casing to 1000 psi.

31. Drill out cement, float collar and float shoe from 9-5/8" casing using 8-1/2" bit and mud. Drill 30' of formation and circulate to change out mud for water. Re-install rotating head on blow out preventer stack for air drilling if not already installed for the drilling of the 12-1/4" hole.

32. Trip to pick up 8-1/2" stabilization. Drill 8-1/2" hole through production zone to total depth of 9,000'-12,000' using air or aerated water as a drilling medium.

33. Pull out of hole with drill pipe and test well for short term with rig on location.

34. If results appear commercial, pull out of hole and release rig for long production test or proceed ahead with attached 9-5/8" tie-back procedure to complete well with 9-5/8" tie-back, if 13-3/8" casing shows damage or excessive wear. If well test results prove that the flow rate from the well is not commercial then either deepen or redrill to obtain production.

35. Evaluate well and complete with either open hole or 7" slotted liner.

SPECIAL CONSIDERATIONS
AUXILIARY EQUIPMENT THAT SHOULD BE MAINTAINED WITH THE RIG

1. Six pen drilling recorders on drill floor with: a) string weight; b) rpm; c) rotary torque; d) rate of penetration; e) pump pressure; f) exit pressure. Additional real time monitoring of drilling parameters to be considered upon consultation with DLNR Staff.

2. Special rotating head with rubbers, capable of stripping 17-1/2", 12-1/4" and 8-1/2" bottomhole assemblies. Complete with spare rotating head stripper drive bushing assembly. Rotating head should be installed on top of hydril or at least on location, available for installation if necessary. Run cold water continuously on head while producing geothermal fluids.

3. Use tong torque assembly with torque gauge for making up collars to API torque requirements.

4. Temperature should be taken with every directional survey by running a maximum recording thermometer in the survey instrument.

5. Catch drill cutting samples (3 sets) every 10', to be cleaned and sacked.

6. In and out temperatures, both of mud, air or aerated water, shall be recorded in the Tour Reports every 30'. All steam/water entries shall be recorded in the Tour Reports.

7. All lost circulation zones encountered shall be recorded in Tour Book recording both the depth at which the loss occurred, as well as the amount of fluid lost. All flows shall also be recorded giving depth and the amount of increase.

8. Periodic tests may be conducted to determine well potential. Drilling will be stopped and the hole evacuated to check for flow at lost circulation zones.

9. Upon completion, the well will be shut in by closing the lower master valve. The remainder of the blow out preventer equipment will then be removed.

10. Rotary table will be equipped with a torque gauge with visual display for driller.

HYDROGEN SULFIDE MONITORING AND ABATEMENT

Hydrogen sulfide monitoring should be maintained during the drilling of the well. Detectors should be placed on the rig floor, cellar area, and flowline region to detect and announce (with alarms and lights) the presence of hydrogen

sulfide. These monitors are typically provided by and maintained daily by the geothermal data loggers. Proper functioning of these monitors is essential in maintaining a safe working environment.

Hydrogen sulfide abatement equipment and materials, i.e. pumps and caustic soda, should be maintained on location when drilling with lighter than water drilling fluids, i.e. air or aerated mud systems.

Escape breathing equipment, as well as resuscitators shall be available on site with mud logging unit. Fans should also be available on the rig floor to clear H2S contaminated floor areas, making it safer to work.

PIPE AND BLOW OUT PREVENTER INSPECTION

The initial acceptance of drill pipe should be based on an IODC-API Class II specification inspection. All subsequent inspections should discard pipe with 30% wear or greater; i.e., use 30% where Class II states 20%.

The drill pipe should include:

1. Electromagnetic inspection of tubes (Sonoscope or Scanalog).

2. Wall thickness and cross sectional area (ultrasonic or gamma ray).

3. End area inspection (electronic or magnetic particle).

All drill collar end areas should be magnetic particle inspected every 14 days or every 9 days while drilling with production or drilling with air or aerated mud systems.

All BOPs should be inspected for wear by the manufacturer or an authorized agent prior to installation. All BOPs should be tested after installation prior to drilling out cement.

Remind service companies furnishing bottomhole assemblies that their equipment should be magna-fluxed prior to delivery.

AIR EQUIPMENT REQUIREMENTS

Minimum air and pressure requirements are 4500 SCFM at 1000 psig for rotary drilling 12-1/4" hole below 13-3/8" casing.

Minimum air and pressure requirements are 3000 SCFM at 1000 psig for rotary drilling below 9-5/8" casing.

Hook-up lines, air meter, and scrubber, misting pump with minimum capacity of 10 gpm, and operating personnel will be furnished by the air contractor. Use Union Oil's UniSteam corrosion inhibitor while drilling in steam, to be injected into the drill pipe. The mixture for UniSteam is as follows:

Steam lbs/hr	Injection
0-20,000	5 gal UniSteam-10/BBl water
20,000-40,000	10-15 gal UniSteam-10/BBl water
40,000-150,000	20-35 gal UniSteam-10/BBl water
150,000+	40 gal UniSteam-10/BBl water

PROCEDURE FOR RUNNING AND CEMENTING 13-3/8" CASING

1. Drill to casing depth.

2. Circulate for 2-3 hours, two complete circulations to clean hole of cuttings.

3. Pick up excess drill pipe needed to stab into float collar for cementing the 13-3/8" casing.

4. Make short trip and circulate for 1-2 hours.

5. Pull out of hole and rig up to run 13-3/8" casing. Run multi-shot survey while pulling out of hole if necessary. If loss circulation has not been a severe problem in drilling the 17-1/2" hole, then proceed ahead to step 8 and run 13-3/8" casing as a full string. If loss circulation has presented problems, then proceed to step 23 and run 13-3/8" as a liner with tie-back string.

6. Run 13-3/8" casing grades, weights and thread design as indicated on attached detailed sheet with stab-in collar 40' from float shoe on bottom with centralizers located one in middle of bottom two joints and then one every other collar upward omitting any from the top 200'.

7. Set casing in elevators on spider. Do not set casing slips. Drop centralizing ring of 13-3/8" casing inside 20" wellhead. Install return hoses from 20" wellhead to mud pits.

8. Rig up with landing plate on top of 13-3/8" casing. Run drill pipe into 13-3/8" with stab-in sub on bottom. Stab into collar and rig up to circulate. Tie down drill pipe.

9. Circulate for 3 hours, or at least two full circulations, to clean up and cool down hole.

10. Rig up to cement.

11. If loss circulation is a problem, pump 20 BBls CaCl2 water, 10 BBls fresh water, 20 BBls sodium silicate, followed by 20 BBls viscous Geo-Gel mud spacer.

12. Pump cement without any additional spacers. Pump stage 1 consisting of Class G perlite blended 1:1 with 40% silica flour, 3% gel and 0.5% CFR-2. Retard as needed. Pump this cement until you see returns of cement at the surface. If loss circulation has been a problem, the cement may have to be changed to a spherelite blended cement, see Note below.

13. Pump stage 2 cement: Class G cement with 40% silica flour, 3% gel and 0.5% CFR-2. Retard as needed. Pump 200 cu ft of this stage 2 cement. The last 100 cu ft should be staged in: Pump 35 cu ft and shut down for 5-10 minutes, then pump 35 cu

ft and shut down again for 5-10 minutes before pumping last 30 cu ft. Check for fall back in annulus each time. Pull out of stab-in shoe and clear drill pipe, dropping all excess cement from drill pipe on top of float collar.

14. Rig down circulating equipment and pull out of hole with drill pipe.

15. Hook up to 13-3/8" casing elevators and pick up slightly to remove spider, then center 13-3/8" casing in stack.

16. Drain blow out preventer equipment after 30 minutes from the time cement was in place.

17. Wait on cement 12 hours before landing casing. Check for cement fall back in annulus periodically. Bring cement back to surface using 1" pipe if necessary.

18. Cut off 13-3/8" casing. Remove 20" blow out preventer equipment. Install 21-1/4" x 12" 900 ANSI expansion spool, 12" master valve and nipple up blow out preventer equipment as in attached Figure 004.

19. Test blow out preventer equipment to 1000 psi.

20. Change out bottom hole drilling assembly for 12-1/4" tools and run in hole.

PROCEDURE FOR RUNNING & CEMENTING 13-3/8" AS A LINER AND TIE-BACK STRING

1. Follow steps 1-4 above.

2. Pick up 13-3/8" liner. If circulation was never achieved, then a stage collar should be installed at approximately 2000'. Install cement basket type centralizers in the middle of the bottom two joints and one just below stage collar. Install one cement basket type centralizer to be located 20' up inside 20" casing shoe.

3. Run liner in hole and hang same 100' up inside of 20" casing with shoe just off bottom.

4. Attempt to circulate with two times total volume of fresh water. If unsuccessful, then proceed with cement job.

5. Pump 20 BBls CaCl2 water and 10 BBls fresh water, followed by 20 BBls sodium silicate, 20 BBls Geo-Gel flush, then cement slurries for stage 1. Follow stage 1 cement with 200 cu ft of stage 2 cement.

6. Release plugs after stage 2 cement and open cementing ports if stage collar is run.

7. Circulate through stage collar. Repeat preflush prior to pumping cement. Pump stage 1 and stage 2 cement as in prior cement job on bottom section of 13-3/8" liner.

8. Release plugs and displace cement and plugs down hole to close stage collar.

9. Release hanger and pull out of hole with setting tool. Wait on cement for 6 hours.

10. Run in hole with 17-1/2" bit and clean out excess cement, if any, from the top of the 13-3/8" liner.

11. Test lap to 750 psi. If unable to get a test, trip to lay down bit, run in open ended. Squeeze lap with Class G cement blended with 40% silica flour and 0.5% CFR-2 using pipe rams.

12. Re-squeeze until a squeeze pressure is achieved. Fill hole with water.

13. Drill out excess cement with 17-1/2" bit and retest lap to 750 psi.

14. If successful in testing lap, run in hole with 12-1/4" bit and 13-3/8" casing scraper to clean out tie-back sleeve.

15. Pick up 13-3/8" tie-back with float collar located 40' above tie-back stinger on bottom.

16. Run tie-back string in hole and land same in sleeve at hanger.

17. Circulate around with fresh water, then run cement slurry. Use top plug only.

18. Wait on cement 6 hours. If after 6 hours cement is not to surface level in 13-3/8" x 20" annulus, insert 1" tubing and bring it back to surface with cement.

19. Cut off 13-3/8" casing. Remove 20" blow out preventer equipment. Install 21-1/4" x 12" 900 ANSI expansion spool, 12" master valve, and nipple up blow out preventer equipment as in attached Figure 004.

20. Test blow out preventer equipment to 1000 psi for 30 minutes.

21. Change out bottom hole drilling assembly for 12-1/4" tools and run in hole.

NOTE: Spherelite cement should be blended as follows:

Class G cement blended with 40% silica flour, 50 lbs per sack of cement of spherelite, 4% gel, 5% lime, 1.25% CFR-2, and 0.5% Halad-22A.

Cement should be mixed at 82.2#/cu ft (11 ppg). Slurry yield is 3.21 cu ft/sack.

Mixing water requirements are 1.50 cu ft/sack (11.22 gal/sack).

9-5/8" LINER RUNNING PROCEDURE

The drilling program for Well KA2-1 has been written in such a way as to handle all situations that occur during the drilling. Due to the remote location and shipping requirements we must consider all possible hole conditions. These conditions that should be anticipated are listed in order of increasing severity as follows:

1. The 12-1/4" hole is drilled with little or no loss circulation encountered. Due to lost circulation encountered in drilling it would be highly probable that loss of circulation may occur during the cementing of the 9-5/8" liner.
   In this situation where lost circulation has not presented a significant problem during drilling, I feel that a conventional method should be employed in the running and cementing procedure for the 9-5/8" liner. The attached program "PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER WITHOUT EXTERNAL CASING PACKER AND MULTI-STAGE CEMENTER" should be used.

2. The 12-1/4" hole is drilled with air, aerated water or mud, with moderate loss circulation, that is loss circulation encountered in several zones which could be sealed with cement or LCM, or partial loss circulation zones which may take fluid periodically during drilling operations. Probability of lost circulation during cementing is high and should be anticipated.
   In this situation a certain amount of caution should be used in running and cementing the 9-5/8" liner to insure a competent cement job. A 9-5/8" liner utilizing a multi-stage cement collar strategically located could assist in obtaining an adequate cement job. The attached program "PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER WITH MULTI-STAGE CEMENTER" should be used.

3. The 12-1/4" hole is drilled using air or aerated water because of complete loss of circulation during the drilling. Sealing of these loss circulation zones prove to be unsuccessful or extensive causing a great loss of time therefore air or aerated fluid is used to drill the well. Probability of loss circulation during the cement job is high, therefore extreme methods of cementing the liner should be used.
   In this situation where major problems exist in the well, extreme procedures and technologies should be employed to insure an adequate cement job. The attached program "PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER EQUIPPED WITH EXTERNAL CASING PACKER AND HYDRAULIC CEMENTER" should be used.

PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER
WITHOUT EXTERNAL CASING PACKER AND MULTI-STAGE CEMENTER

1. Drill to casing depth at approximately 6000-7000′ dependent on temperature and geology.

2. Circulate for 2-3 hours to clean and cool hole.

3. Pull out of hole.

4. Rig up and run logs as indicated by geologic staff. Wait on bottom with temperature log for 30 minutes before pulling out of hole.

5. Rig down loggers and run in hole with bit and monel to total depth.

6. Circulate for 2 hours and make short trip. Circulate for 1-2 hours after short trip.

7. Pull out of hole and rig up to run 9-5/8" liner. Run additional directional surveys while pulling out of hole if necessary.

8. Run 9-5/8" liner grades, weights and thread design as indicated in detail sheet with float shoe on bottom and float collar two joints up. Centralizers should be located one in the middle of the bottom two joints and then one every to every other collar upward to within 60′ of the hanger. Use T-Bar rigid centralizers totally in bottom portion of the string and then as required in the upper portion. Run casing adjusters at 600′, 1800′ and 3400′ above shoe joint if required.

9. Circulate two full circulations to clean up and cool down well prior to cementing.

   Note: If casing can still be moved after running to bottom then move casing throughout circulation and cementing job and hang after cement is in place. If casing will not move after running to bottom, then hang liner before circulating and cementing job.

10. If loss circulation is encountered, pump 20 BBls of CaCl2 water and 10 BBls of fresh water ahead of 20 BBls of sodium silicate.

11. Pump in 20 BBls of viscous Geo-Gel mud preflush.

12. Pump cement without any water spacers. Pump stage 1: Class G cement and perlite blended at a ratio of 1:1 with 40% silica flour, 3% gel and friction reducer. Retard to give 2-3 hours

pumping time at 350 degrees F. Use 100% excess. If lost circulation is a problem, cement may be required to be changed to a spherelite blend. See note at bottom of this procedure. Pump stage 1 as per precalculated volumes.

13. Pump stage 2: Class G cement blended with 40% silica flour, 3% gel and friction reducer. Retard to give 2-3 hours pumping time at 350 degrees F. Pump 200 cu ft of this stage 2 cement. The last 100 cu ft should be staged in: Pump 35 cu ft and shut down for 5-10 minutes, then pump 35 cu ft and shut down again for 5-10 minutes before pumping the last 30 cu ft.

14. Once all cement has been pumped then rig down circulating equipment, hang liner and pull out of liner hanger with drill pipe and pull up 90' and circulate out excess cement on top of liner top.

15. Wait on cement 12 hours. Run in hole with 12-1/4" bit to top of cement, drill out cement to liner top. Wait a full 24 hours from the time cement was in place or until samples have set before pressure testing lap to 1000 psi surface pressure. Squeeze lap if necessary to obtain a pressure test.

16. Trip to change bits to 8-1/2" and clean out cement from inside of the 9-5/8" liner top.

17. Retest liner lap to 1000 psi surface pressure. Squeeze if necessary to obtain a pressure test.

18. Drill out cement, float collar and float shoe with 8-1/2" bit. Drill 60' of formation with mud.

19. Circulate to clean hole and then displace mud in hole for water.

20. Trip out of hole to pick up stabilization.

21. Run back in hole and aerate water. Drill ahead with aerated water to commercial production or total depth.

NOTE: Spherelite cement should be blended as follows:

Class G cement blended with 40% silica flour, 50 lbs per sack of cement of spherelite, 4% gel, 1.25% friction reducer and fluid loss agent.

Cement should be mixed at 88.3 lbs per cu ft (11.8 ppg). Slurry yield is 3.16 cu ft per sack of cement.

Mixing water requirements are 1.5 cu ft per sack (11.22 gal/sack).

9-5/8" CASING PROPERTIES

L-80, 47 ppf, Buttress, Burst: 6870 psi, Collapse: 4760 psi,
Tension: 1,122,000 lbs.

L-80, 53.5 ppf, Buttress, Burst: 6330 psi, Collapse: 3810 psi
Tension: 1,038,000 lbs.

L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi,
Tension: 947,000 lbs.

PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER
WITH MULTI-STAGE CEMENTER

1. Drill to casing depth at approximately 6000 - 8000′ dependent on temperature and geology.

2. Circulate for 2-3 hours to clean and cool hole.

3. Pull out of hole.

4. Rig up and run logs as indicated by geologic staff. Wait on bottom with temperature log for 30 minutes before pulling out of hole.

5. Rig down loggers and run in hole with bit and monel to total depth.

6. Circulate for 2 hours and make short trip. Circulate for 1-2 hours after short trip.

7. Pull out of hole and rig up to run 9-5/8" liner. Run additional directional surveys while pulling out of hole if necessary.

8. Run 9-5/8" liner grades, weights and thread design as indicated in detail sheet with float shoe on bottom and float collar two joints up. Centralizers should be located one in the middle of the bottom two joints and then one every to every other collar upward to within 60′ of the hanger. Install multi-stage cementer in a strategic location in the liner string. The location of the multi-stage cementer should be such that the bottom portion can be cemented successfully without loss circulation. The upper portion can then be cemented after the bottom has had time to set without any loss circulation during cementing. A probable location is just above the loss circulation zones. If the hole was air drilled a good location would be approximately 1200′ above the casing shoe. Use 12" T-bar rigid centralizers totally in the bottom portion of the string and then as required in the upper portion. Run casing adjusters at 600′, 1800′, and 3400′ above shoe joint as required.

9. Circulate two full circulations to clean up and cool down well prior to cementing.

   Note: If casing can still be moved after running to bottom then move casing throughout circulation and cementing job and hang after stage 1 cement is in place. If casing will not move after running to bottom, then hang liner before circulating and cementing job.

10. If loss circulation is a problem then pump 20 BBls of CaCl2 water and 10 BBls of fresh water ahead of 20 BBls of sodium

silicate.

11. Pump in 20 BBls of viscous Geo-Gel mud preflush.

12. Pump cement without any water spacers. Pump stage 1: Class G cement and perlite blended at a ratio of 1:1 with 40% silica flour, 3% gel and friction reducer. Retard to give 4-5 hours pumping time at 350 degrees F. Pump in calculated volume to fill the annulus of the 12-1/4" hole x 9-5/8" liner from the liner shoe to the stage collar with 100% excess, with approximately 200 cu ft of tail cement consisting of Class G cement blended with 40% silica flour, 3% gel and friction reducer. If loss circulation is a problem, cement may be changed to a spherelite blend. See note at the bottom of this procedure.

13. Pump stage 1 cement and drop dart for wiper plug. Displace cement with water. Bump plug and open multi-stage cementer.

14. After the stage collar has been opened then circulate out excess cement. Circulate and cool hole for 2 hours prior to pumping stage 2 cement. Hang liner at this point.

15. Pump in 20 BBls of CaCl2 water and 10 BBls of fresh water ahead of 20 BBls of sodium silicate.

16. Pump in 220 BBls of viscous Geo-Gel mud preflush.

17. Pump in stage 2 cement without any water spacers. Pump Class G cement and perlite blended at a ratio of 1:1 with 40% silica flour, 3% gel and friction reducer. Retard to give 2-3 hours pumping time at 350 degress F. Pump in calculated volume of cement to fill 12-1/4" hole x 9-5/8" liner to lap area without excess. Calculated volume should include a 200 cu ft tail slurry of Class G cement blended with 40% silica flour, 3% gel and friction reducer. Retard to give 2-3 hours of pumping time at 350 degrees F. Displace cement with water.

18. Once all cement has been pumped then rig down circulating equipment and pull out of liner hanger with drill pipe and pull up 90' and circulate out excess cement on top of liner top.

19. Wait on cement 12 hours. Run in hole with 12-1/4" bit to top of cement, drill out cement to liner top. Wait a full 24 hours from the time cement was in place or until samples have set before pressure testing lap to 1000 psi surface pressure. Squeeze lap if necessary to obtain a pressure test.

20. Trip to change bits to 8-1/2" and clean out cement from inside of 9-5/8" liner top.

21. Retest liner lap to 1000 psi surface pressure. Squeeze if necessary to obtain a pressure test.

22. Drill out cement, float collar and float shoe with 8-1/2" bit. Drill 60' of formation with mud or water.

23. Circulate to clean hole and then displace mud in hole for water if necessary.

24. Trip out of hole to pick up stabilization.

25. Run back in hole and aerate water. Drill ahead with aerated water to commercial production or total depth.

NOTE: Spherelite cement should be blended as follows:

Class G cement blended with 40% silica flour, 50 lbs per sack of cement of spherelite, 4% gel, 1.25% friction reducer and fluid loss agent.

Cement should be mixed at 88.3 lbs per sack of cement. Slurry yield is 3.16 cu ft per sack of cement.

Mixing water requirements are 1.5 cu ft per sack (11.22 gal/sack).

9-5/8" CASING PROPERTIES

L-80, 47 ppf, Buttress, Burst: 6870 psi, Collapse: 4760 psi, Tension: 1,122,000 lbs.

L-80, 43.5 ppf, Buttress, Burst 6330 psi, Collapse: 3810 psi, Tension: 1,038,000 lbs.

L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi, Tension: 947,000 lbs.

PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER
EQUIPPED WITH EXTERNAL CASING PACKER AND HYDRAULIC CEMENTER

1. Drill to casing depth at approximately 6000 - 8000′ dependent on temperature and geology.

2. Circulate for 2-3 hours.

3. Pull out of hole.

4. Rig up and run logs as indicated by geologic staff. Wait on bottom with temperature log for 30 minutes before pulling out of hole.

5. Rig down loggers and run in hole with bit and monel to total depth.

6. Circulate for 2 hours and short trip. Circulate for 1-2 hours after short trip.

7. Pull out of hole and rig up to run 9-5/8" liner. Run additional directional surveys while pulling out of hole if necessary.

8. Run 9-5/8" liner grades, weights and thread design as indicated in attached detail sheet with float shoe on bottom and float collar two joints up. Centralizers should be located one in the middle of bottom two joints and then one every other collar upward to within 60′ of hanger. Use T-Bar rigid centralizers in the bottom portion of the string and then as required in the upper portion. If lost circulation is a problem or the hole has been drilled with air or aerated water then CTC external casing packer should be positioned in string 200-300′ from bottom with Halliburton hydraulic stage cementer located above packer. Run casing adjuster at 600′, 1800′, and 3400′ from shoe joint as required. A T-Bar centralizer should be located above and below packer.

9. Run liner equipment. See attached Pre-Job Recommendations.

   Check all equipment to be run on 9-5/8" liner.
   a. Use Instructions & Operations Sheet TE 7.00381. Measure all parts OD and ID.
   b. Check threads on all tools.
   c. Midway liner hanger running tool. Stinger must be reduced down to 3" OD 2.75 ID and run 10-12.5" below bottom of liner hanger as shown on print TE 7.00378. This is when the liner hanger string is at the bottom of its travel.
   d. Part numbers are given on print TE 7.00377 for tools. ID and OD for SR Plug set is given on print TE 7.00379 OD and OD for HOS Cementer are given on print TE 7.00380.

e. All parts and number should check with prints.
f. HOS Tool has four shear pins that will take 2880 psi over Hydrostatic pressure to open it, two other pins are with the tool. Each pin adds 712.5 psi pressure to shear. Open pressure may be adjusted as needed.

10. Installing equipment onto casing strings. See attached Recommendations During Job for further details.

a. Guide shoe.
b. Centralizers on two joints.
c. Float collar.
d. Centralizers as per program.
e. Casing.
f. CTC Packers 200' off bottom.
g. One joint with centralizer in middle.
h. HOS Cementer.
i. Centralizers as per program - run casing adjusters located 1500' and 3000' from shoe.
j. Casing to top of liner. Fill liner as going in hole.
k. Make up SR Baffle Collar on bottom of liner hanger.*
l. Take O-ring off SR plug set and put on SR Baffle Collar.
m. Make up SR plug set on Baffle Collar and tighten at plug set to Baffle Collar. Be sure all parts are tight.
n. Circulate the liner at 3-4 BPM. Stop and circulate 2-3 times while running in hole with liner assembly on drill pipe.

*Be sure there are no areas of drill pipe on liner hanger less than 2.75 ID.

11. Cement liner in three stages.

a. Calculate volume of cement for bottom stage. (200 ft of 12-1/4" hole and 9-5/8" annulus plus shoe joint volume and volume to inflate CTC Packer).
b. Mix cement for above.
c. Pump cement for 200' annulus and shoe joint. Release first stage dart 809.81266 and pump cement for inflated CTC. (Cement to inflate packer should be Class G with 40% silica flour and friction reducer, no perlite.)
d. Pump 10 BBls spacer then displace with mud at 3-4 BPM until 10 BBls before dart should land in SR lower plug - slow rate to 2 BPM. Pressure should go to 1800 psi and plug release.
e. Displace shut off plug at 5-6 BPM until 30 BBls before plug lands. Then pump at 1-2 BPM.

f. When shut off plug lands in shut off baffle, pressure up to 500 psi and shut down.

12. Inflate CTC Packer with cement. See attached Recommendations During Inflation Sequence for further details.

    a. Check volume of displacement tank.
    b. Increase pressure slowly to 700 psi and shut down.
    c. Increase pressure slowly to 800 psi.
    d. Increase pressure slowly to 900 psi or until tool opens.
    e. Pump in 2-5 cu ft of cement per stage until CTC packer is inflated.
    f. Increase pressure to 1000 psi to close CTC packer.
    g. With pressure at 500 psi, check volume of cement needed to inflate tools.
    h. Pressure up to 2800 psi and open HOS.
    i. Circulate well as needed.
    j. Cement liner as per program. Pump spacer. Pump cement.
    k. Release dart for shut off plug. Pump at 4-5 BPM. Pump 10 BBls spacer - then mud.
    l. Displace to within 10 BBls of plug, slow to 2 BPM.
    m. Pressure to 1950-2000 psi to release plug.
    n. Displace at 4-5 BPM.
    o. When plug lands in HOS, pressure up to 3000 psi to close tool. You may have to go to 3500 psi. Hold pressure for 2 minutes.
    p. Release pressure if holding; back off liner hanger tool.
    q. Come out of hole with tools.
    r. Wait 24 hrs and drill out.

13. Rig down circulating equipment, pull out of hanger with drill pipe and pull up 90' and circulate out excess cement leaving 90 linear ft of cement on top of liner top.

14. Wait on cement for 12 hrs. Run in hole with 12-1/4" bit to top of liner and circulate to clean out excess cement. Wait 24 hrs from the time cement was in place and pressure test lap to 1000 psi. Squeeze if necessary.

15. Trip to change bits to 8-1/2" and clean out cement from inside the 9-5/8" liner top.

16. Retest liner lap to 1000 psi surface pressure. Squeeze if necessary.

17. Drill out cement, float collar and float shoe with 8-1/2" bit. Drill 30' of formation.

18. Circulate and change out mud system for water.

19. Trip to pick up stabilization.

NOTE: Spherelite cement should be blended as follows:

Class G cement blended with 40% silica flour, 50 lbs per sack of cement of spherelite, 4% gel, 1.25% CFR-2, and 0.5% Halad-22A.

Cement should be mixed at 88.3lbs/cu ft (11.8 ppg). Slurry yield is 3.16 cu ft/sack.

Mixing water requirements are 1.50 cu ft/sack (11.22 gal/sack).

CASING PROPERTIES

L-80, 47ppf, Buttress, Burst: 6870 psi, Collapse: 4760 psi, Tension: 1,122,000 lbs.

L-80, 43.5ppf, Buttress, Burst: 7930 psi, Collapse: 6620 psi, Tension: 1,286,000 lbs.

L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi, Tension: 947,000 lbs.

PRE-JOB RECOMMENDATIONS

1. In close clearance (1/2"-1") installations:

    a. Run a casing scraper.
    b. Drill open hole section with a stabilized packed hole assembly if possible.

2. In liner installations, notify CTC of type of liner equipment before packers are shipped.

3. Insure that everyone involved understands the Payzone Packer system and specific duties they are to perform.

4. Obtain all pertinent well data, including:

    a. Minimum wellbore restriction (should be 1/2" greater than packer OD).
    b. If casing damage is suspected, run a microscopic caliper and/or casing scraper.
    c. Calipered hole size in zone of interest should not exceed maximum recommended hole size. Use "Hole Size vs. Recommended Inflation Pressure Chart" to set pressure control valve.
    d. If junk has been lost in hole it should be fished or driven to below Payzone setting depth.
    e. Clients maximum allowable surface pressure (burst strength of casing with a safety factor), should be obtained prior to setting shear pin.
    f. If hole size adjacent to end assemblies is more than 1" larger than packer OD run one centralizer above and below each packer.

5. Inspect auxiliary equipment.

    a. Float shoe.
    b. Float collar.
    c. Bottom cement wiper plug (proper size, rupture diaphragm).
    d. Two top cement wiper plugs (proper size, no rupture diaphragm).
    e. Pressure recorder (5000 psi scale if possible).
    f. Chicksan lines.
    g. Cementing head.
    h. Verify that adequate inflation cement is available.
    i. Obtain a dry sample of all cements used on the job.

6. Review primary cementing plans and calculate theoretical bottom hole pressure during cementing operations. If expected pressures approach fracture gradient, pressure anomalies are probable and bottom wiper plug should not be run so that knockoff rod protection stays intact.

7. Calculate displacement volumes. Know at what displacement the following events should take place:

    a. Bottom wiper passes packers (knockoff rods).
    b. Bottom wiper lands in float collar.
    c. First top wiper passes packer.
    d. First top wiper lands in float collar, and
    e. Top of inflation cement (second top wiper plug) relative to upper packer.

8. Total inflation pressure is critical to Payzone Packer performance. Before starting a job know and/or calculate: 1. hydrostatic pressure inside and outside the casing at packer setting depth, 2. pore pressure, 3. fracture pressure, 4. maximum recommended differential inflation pressure from hole size vs pressure chart, 5. resultant effective stress.

    a. Total inflation pressure equals:
        1. Hydrostatic pressure inside casing (packer depth) + Applied surface pressure

        OR

        2. Hydrostatic pressure outside casing (packer depth) + Differential inflation pressure

    b. Differential inflation pressure equals:
        1. Total inflation pressure minus Pressure outside casing (packer depth)

        OR

        2. Applied surface pressure minus Balance pressure

    c. Balance pressure equals:
        1. Surface pressure required to offset "U" tube pressure
        2. Approximated by surface pressure (pumping at 1/4-1/2 BBl/min) just prior to plug bump.

    d. Radial effective stress (Seal Load, Wellbore Support) equals:
    Total inflation pressure minus pore pressure.
    -In all cases the differential inflation pressure must be within the hole size vs differential pressure capabilities of the equipment.
    -For zone isolation the radial effective stress (seal load) should be at least 500 psi and total inflation pressure must be less than fracture pressure.

9. Review casing tally. Re-tally casing during run-in if necessary. This is critical if positioning log is not to be run.

10. Make up casing according to API specifications with proper torque and API pipe dope.

Note: It is extremely difficult to properly inflate packers with a casing leak.

11. Epoxy thread lock should be used on packer/casing connections, float collar, and float shoe.

12. A minimum number of only high quality (API approved) centralizers be run below packer(s). If pipe is to be reciprocated, and hole size adjacent to end assemblies does not exceed packer OD plus 2", spacing between packers and centralizers should be greater than reciprocation stroke. Do not place scratchers in this area.

13. If positioning is critical, packers should be logged into position.

14. Insure that cement has adequate pump time.

15. Inflation cement should have an API water loss of less than 150 cc. Inflation cement must not contain lost circulation material.

RECOMMENDATIONS DURING JOB

1. Verify that external cementing aids (centralizers, scratchers, etc.) are properly installed.

2. Run-in speed 1 ft/sec (may be prudently increased to 2 ft/sec per Steps 3 and 4 below).

3. Monitor returns, if more than 30' of casing is run before receiving full returns - SLOW DOWN.

4. Monitor weight indicator - excessive weight loss during run indicates that run-in speed may be too fast.

5. Pressure test lines before beginning cement job. Repair all leaks no matter how small.

6. Verify that wiper plugs are dropped at proper time in proper sequence.

7. Monitor returns during entire job.

8. Monitor mixing and pumping of inflation cement. Verify volume and weight of inflation cement. Batch mix if possible.

   Note: If inflation cement is not batch mixed, monitor BBl counter, but do not rely on its accuracy. Insist that mix water be accurately measured from tanks and that cement density remains constant and proper. (If cement is mixed at proper weight, mix water volume is an accurate indicator of cement volume.)

9. Insist that plug drop be verified via tattle-tale, flag or radioactive techniques.

10. Monitor displacement volume, pump rate and surface pressure during entire displacement process.

11. Determine balance pressure during last 5 BBl of displacement. (Slow displacement to 1/4-1/2 BBl/min and record pressure.)

12. Required displacement volume will normally exceed theoretical casing volume. If mud is used for displacement, expect up to 6%.

RECOMMENDATIONS DURING INFLATION SEQUENCE

1. When first plug lands in float collar:

2. Open shear valve in first or bottom packer by rapidly applying appropriate surface pressure, i.e. balance pressure plus pressure rating of shear valve. (Monitor volume displaced.) Stop pumps and monitor pressure decline, increase pressure by 200 psi or as needed to open valve. Record volume in displacement tanks.

   NOTES:

   a. Flow rate into Payzone packers is relatively slow (1/4 BBl/min). Therefore, it is generally impractical and not advisable to pump continuously during inflation. The preferred procedure is to rapidly increase surface pressure, stop pumping and monitor pressure decline. When the packer is full, the pressure decline will stop.

   b. The expected pressure response during inflation is a function of several variables. In general the following reduce the distinctiveness of the pressure response.
      1. Increased well depth.
      2. Compressability and volume of fluid within the casing string.
      3. Large diameter casing.
      4. Viscosity of inflation cement.
      5. Small inflation volume.

      For example, the pressure response during inflation of a 9-5/8" packer at 12,000' with 3/4 BBl of 16.4 lbs/gal cement may be non-distinct while inflation of a 5-1/2" packer with 1 BBl at 6000' would be very distinct.

3. When packer is completely inflated (surface pressure remains constant), apply final desired inflation pressure.

   a. Record volume pumped and hold pressure for 5-10 min.

   b. Bleed surface pressure slowly back to balance pressure (and/or point 1a above and record flowback volume.

   c. Release pressure slowly.

   Note: In shallow (less than 7000') unconsolidated sands, the hole size often enlarges as the packer re-stresses the sand. In these installations, final inflation pressure should be adjusted or reduced in accordance with hole size.

This may be done by converting inflation volume to equivalent hole diameter and using "Hole Size vs Recommended Inflation Pressure Chart".

THINGS TO AVOID

1. Avoid using bottom wiper plugs whenever possible. This is critical if bottomhole pressures during the cement operation are likely to exceed frac pressure.

2. Avoid using spacer fluids below inflation cement because volumetric error and/or pressure anomalies may result in mud-filled packers.

   Note: The use of lightweight spacer fluids below the inflation cement imposes a hydrostatic differential pressure across the valve collar equal to [Weight of cement in annulus (lbs/gal) minus weight of spacer fluid below packer (lbs/gal)] multiplied by .052 times height of spacer fluid below packer.

3. Do not exceed fracture pressure in isolation installations.

4. If spacer fluids are used as substitues for wiper plugs above inflation cement, increase cement volume to compensate for contamination of the upper 100′ of inflation cement.

5. Do not use differential fill equipment because debris may enter casing. Some varieties of differential fill equipment must be opened via applied casing pressure prior to circulation. This is not compatible with our valve system.

6. Insist that liner hanger packoffs not be set prior to packer inflation.

7. Do not spud casing - circulate through bridges.

8. Do not use cement with more than 6% Plaster of Paris or Calseal cement.

9. Do not use loss circulation material in inflation cement.

PROCEDURE FOR RUNNING 9-5/8" TIE-BACK CASING
OPTIONAL

1. Kill well with cold water. Pick up Halliburton 9-5/8" EZSV cement retainer on drill pipe and run in hole to 300' below liner top. Set EZSV at this point.

2. Spot a 50 linear foot thick viscous gel pill on top of EZSV and 50 linear feet of cement on top of gel. Fill hole with water and circulate to cool and clean hole. Make appropriate changes to wellhead assembly.

3. Run 9-5/8" casing scraper to clean out liner tie-back sleeve.

4. Rig up and run 9-5/8" tie-back string to top of liner with float collar 40' (1 joint) above stab-in tool on bottom. Stab-in tool will be equipped with slip. Stab into liner, engage slips on the 13-3/8" and pull up on tie-back to 200,000 lbs to pretension tie-back.

5. Cement tie-back as per attached cementing program. Bring cement back to surface between 9-5/8" and 13-3/8" casing, setting centralizer in 13-3/8" casing head before cementing.

6. Wait on cement 12 hours, then release tension.

7. Land 9-5/8" casing. Pick up 12" blow out preventer stack and install expansion spool (12" 900 x 10" 900) equipped with two 3" flanged outlets with 3" 2000 psi wing valves. Install 10" 900 Master Valve and 10" 900 x 12" 1500 adaptor spool and reinstall blow out preventer stack.

8. Test blow out preventer stack, 10" master valve, expansion spool and 9-5/8" tie-back to 1500 psi.

9. Pick up 8-1/2" bit and drill out excess cement and float collar. Work bit through lap area and retest to 1000 psi. Squeeze if necessary.

10. Drill out cement and clean out gel to top of EZSV.

11. Trip for EZSV picking tool and remove EZSV.

12. Return well to production and retest if necessary, using air to induce well to flow.

13. Lay down drill pipe, remove blow out preventer equipment,and move rig off, releasing rig.

14. Prepare for long term test.

15. Test well.

9-5/8" CASING PROPERTIES

L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi, Tension: 947,000 lbs.

FIGURES

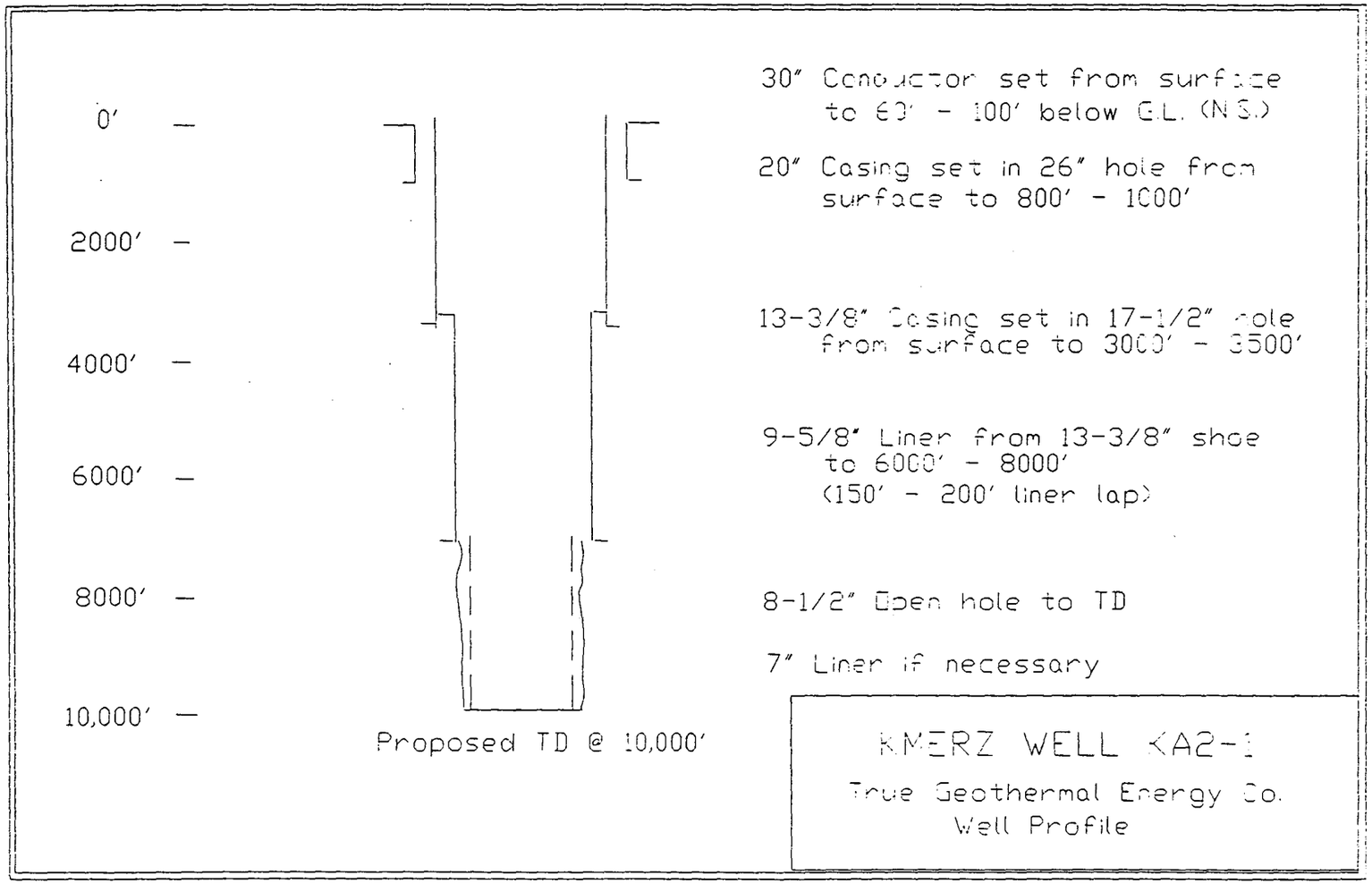
0'
2000'
4000'
6000'
8000'
10,000'
Proposed TD @ 10,000'
30" Conductor set from surface to 60' - 100' below G.L. (N.S.)
20" Casing set in 26" hole from surface to 800' - 1000'
13-3/8" Casing set in 17-1/2" hole from surface to 3000' - 3500'
9-5/8" Liner from 13-3/8" shoe to 6000' - 8000'
(150' - 200' liner lap)
8-1/2" Open hole to TD
7" Liner if necessary
KMERZ WELL KA2-1
True Geothermal Energy Co.
Well Profile

FIGURE 001

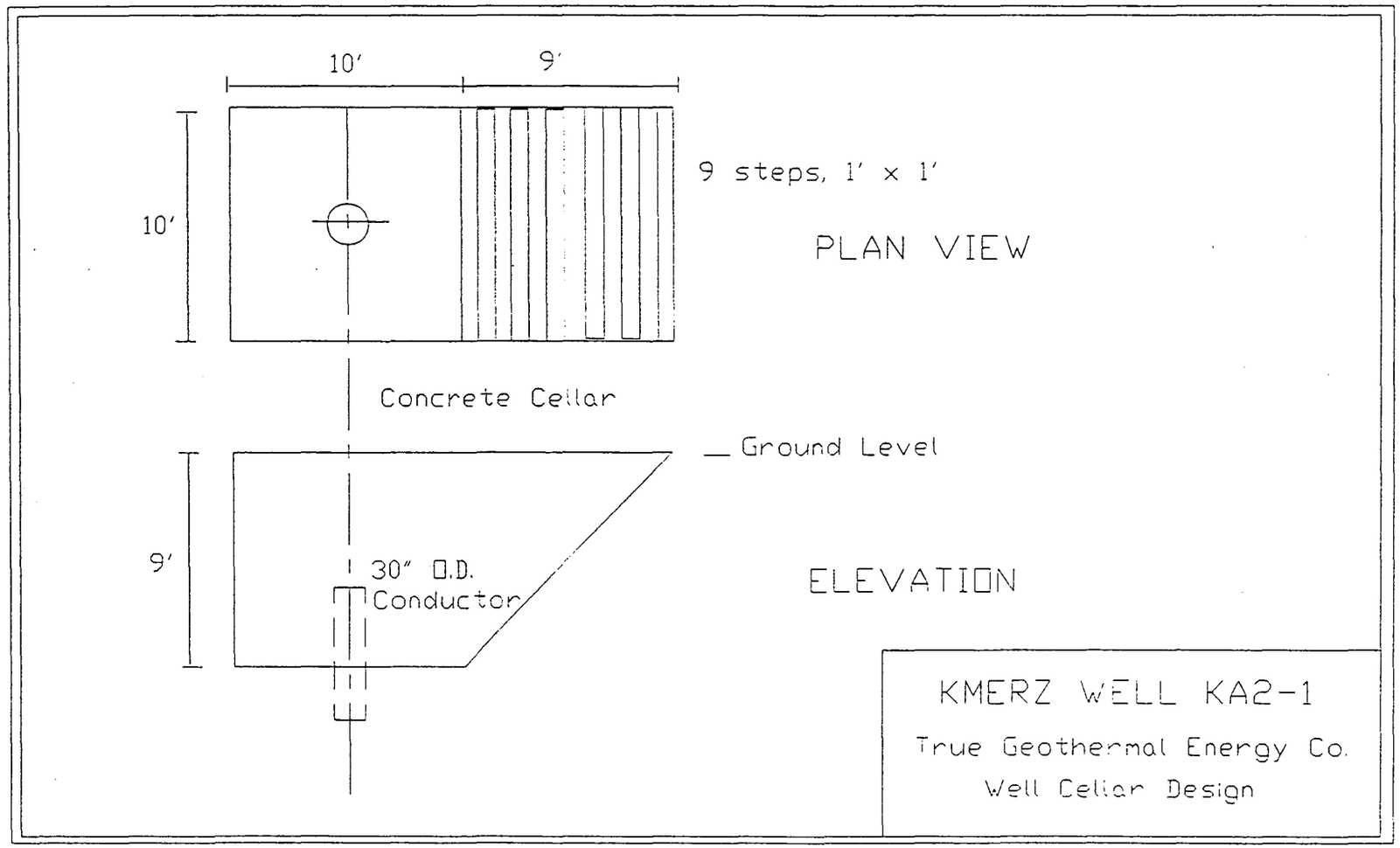
10'
9'
10'
9 steps, 1' x 1'
PLAN VIEW
Concrete Cellar
Ground Level
9'
30" O.D.
Conductor
ELEVATION
KMERZ WELL KA2-1
True Geothermal Energy Co.
Well Cellar Design

FIGURE 002

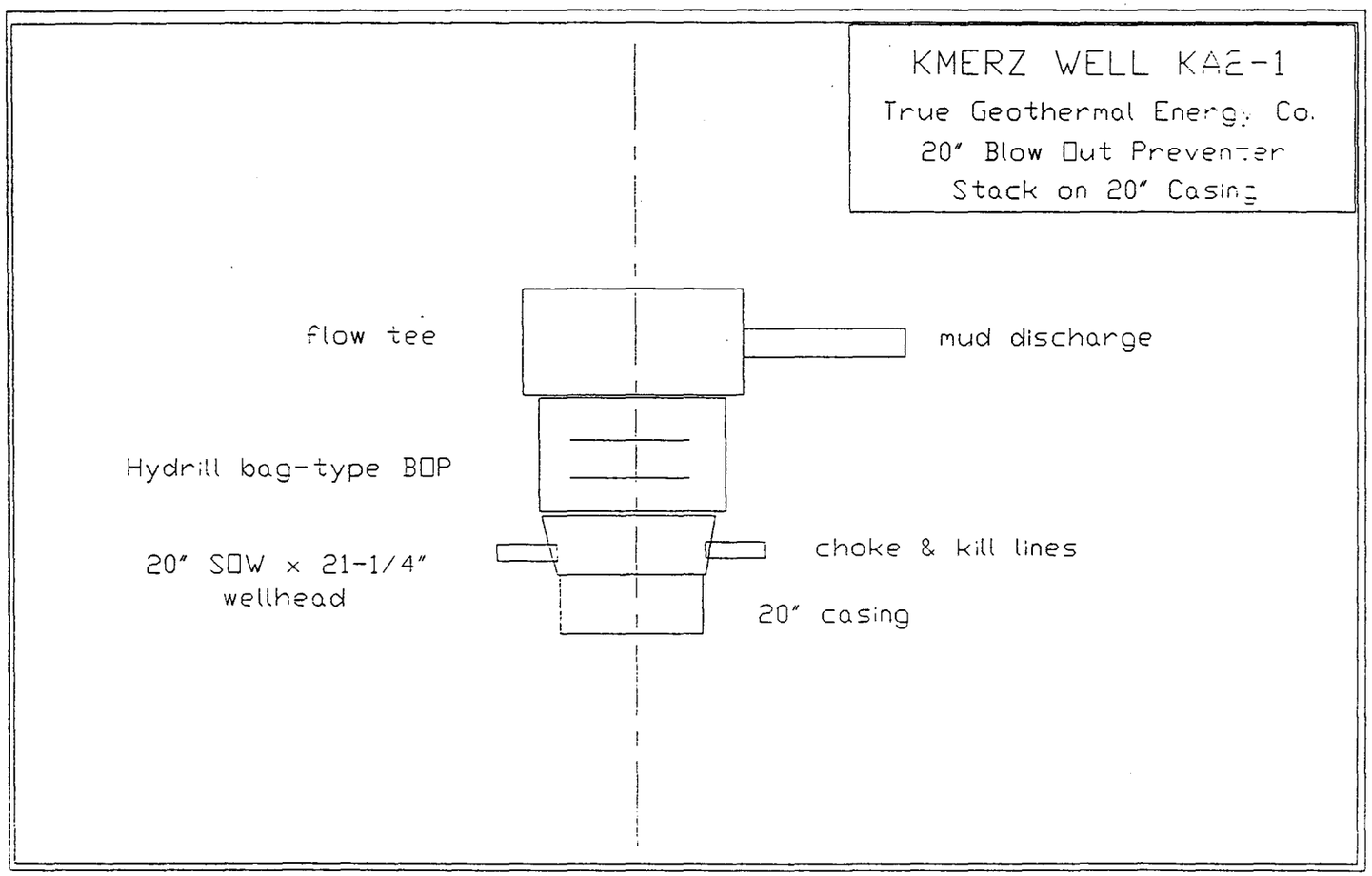
KMERZ WELL KAZ-1
True Geothermal Energy Co.
20" Blow Out Preventer
Stack on 20" Casing
flow tee
mud discharge
Hydrill bag-type BOP
20" SOW x 21-1/4"
wellhead
choke & kill lines
20" casing

FIGURE 003

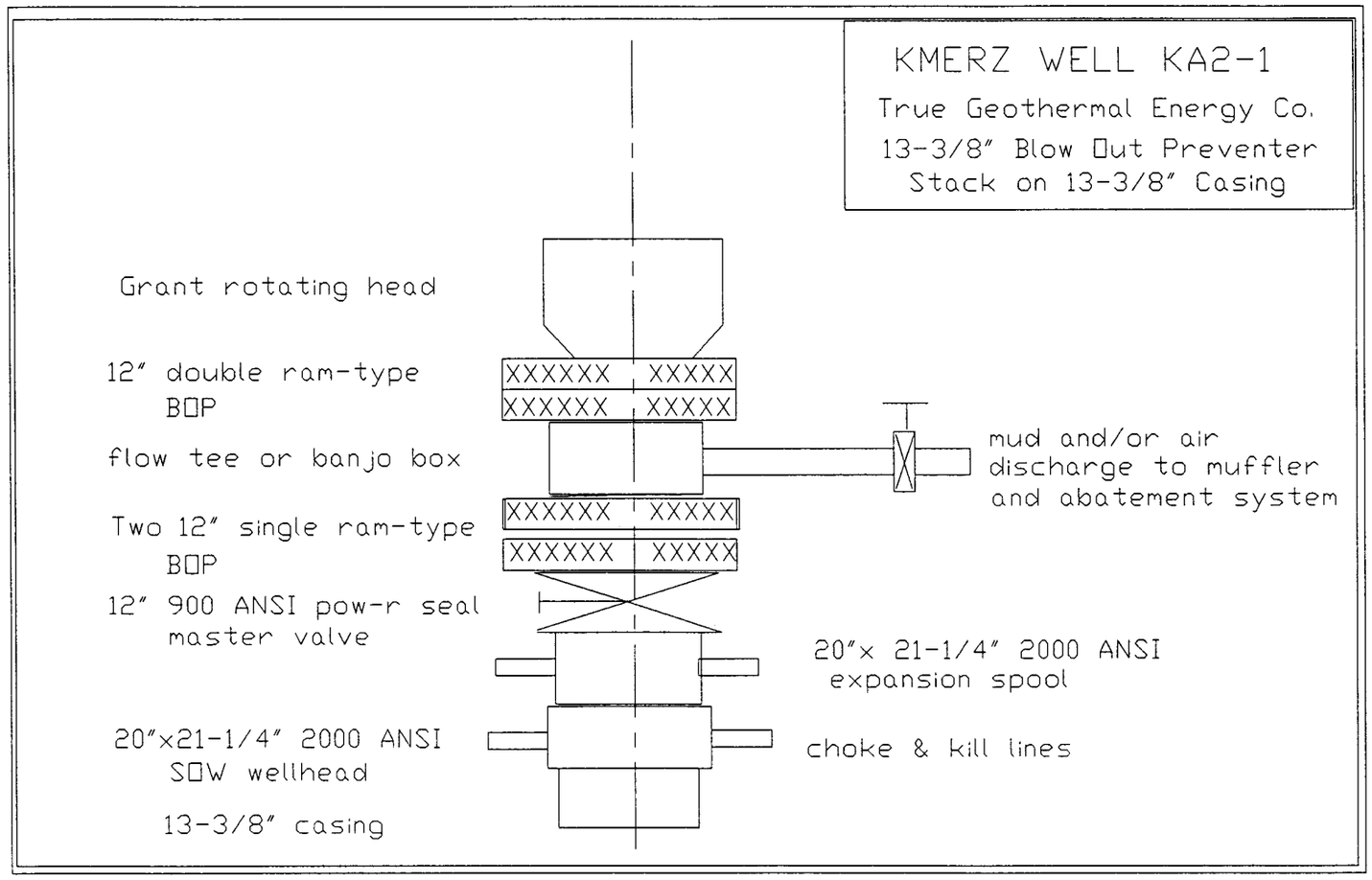
KMERZ WELL KA2-1
True Geothermal Energy Co.
13-3/8" Blow Out Preventer
Stack on 13-3/8" Casing
Grant rotating head
12" double ram-type
BOP
flow tee or banjo box
Two 12" single ram-type
BOP
12" 900 ANSI pow-r seal
master valve
20"x21-1/4" 2000 ANSI
SOW wellhead
13-3/8" casing
XXXXXX XXXXX
XXXXXX XXXXX
XXXXXX XXXXX
XXXXXX XXXXX
mud and/or air
discharge to muffler
and abatement system
20"x 21-1/4" 2000 ANSI
expansion spool
choke & kill lines

FIGURE 004

TABLES

ThermaSource Inc.
P.O. Box 1236 • Santa Rosa, CA 95402

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM

SIZE	DEPTH	WELL
20"	1000'	KA2-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
0-1000'	106.5	K-55	Buttress	3.31	9.21	1.64	9.99+
Casing Properties:							
Collapse-770 psi							
Burst-2320 psi							
Tension-1,683,000 lbs.							

DESIGN CONDITIONS

SURFACE BURST PRESSURE	- 2000	PSI	OUTSIDE MUD WT. (COLLAPSE) -	9.95	PPG
INSIDE MUD WEIGHT (BURST)	- 9.5	PPG	INSIDE MUD WT. (COLLAPSE) -	0	PPG
OUTSIDE MUD WEIGHT (BURST)	- 9.5	PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE) -	9.5	PPG
FRAC. GRAD. AT SHOE (BURST)	- 14.5	PPG	BIAXIAL LOAD: COLL. ☐ BURST ☐	BOUYANCY: YES ☐ NO ☒	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

2690 cu ft (838 sx) of Class G cement blended with 50 lbs of spherelite per sack of cement, 40% silica flour, 4% gel, 5% hydrated lime, 1.25% CFR-2 and 0.5% Halad-22A tailed with 400 cu ft (252 sx) of Class G cement blended with 40% silica flour and 3% CaCl2

DESIRED TOP	EXCESS
Surface	100%

SLURRY VOL. - CU FT / (SLURRY NO.)	2690		400	
SLURRY YIELD - CUBIC FEET/SACK	3.21 cu ft/sx		1.59 cu ft/sx	
SLURRY DENSITY - PPG	82.2#/cu ft(11 ppg)		118#/cu ft(15.8 ppg)	
THICKENING TIME - DEPTH SCH/HRS, MIN.	2-3 hrs		2-3 hrs	
COMPRESSIVE STRENGTH - PSI/HOURS				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Stab in float collar located 40' (1 joint) above float shoe on bottom.
2. Weld bottom of collars on bottom 4 joints.
3. Clean and Baker loc threads on float collar and shoe as well as bottom 4 joints.
4. Tac weld top of collars on bottom 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Run rigid centralizer in middle of bottom 2 joints, then one every other tool joint to within 100' of surface.
2. Use centralizer cement baskets as required due to lost circulation.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Stab into float collar with drill pipe. Attempt to circulate with water.
2. Pump 200 cu ft CaCl2 water followed by 100 cu ft of fresh water, 200 cu ft Flo-chek, 200 cu ft Geo-gel, then cement slurries.

PRESSURE TESTING AND LANDING

1. Use 1" pipe in annulus of 20" AND 26" hole to bring cement back to surface if necessary.
2. Wait on cement 8 hours.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	2000	20"	See attached drawing	1500	1500	

ThermaSource Inc.
P.O. Box 1236 • Santa Rosa, CA 95402

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM

SIZE: 13-3/8" | DEPTH: 3500' | Full String | WELL: KA?-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS: TOP BURST	BOT. BURST	COLL.	TENSION
0-3000'*	68	L-80	Buttress	2.03	1.95	1.51	6.44
3000-3500'**	72	L-80	Buttress	2.08	2.05	1.55	45.83
Casing Properties:*				Casing Properties:**			
Collapse-2260 psi				Collapse-2670 psi			
Burst-5020 psi				Burst-5380 psi			
Tension-1,545,000 lbs				Tension-1,650,000 lbs			

DESIGN CONDITIONS

SURFACE BURST PRESSURE	- 3000 PSI	OUTSIDE MUD WT. (COLLAPSE)	- 9.5 PPG		
INSIDE MUD WEIGHT (BURST)	- 9.5 PPG	INSIDE MUD WT. (COLLAPSE)	- 0 PPG		
OUTSIDE MUD WEIGHT (BURST)	- 9.5 PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE)	- 9.5 PPG		
FRAC. GRAD. AT SHOE (BURST)	- 14.5 PPG	BIAXIAL LOAD: COLL. [X] BURST [X]		BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

4257 cu ft (1723 sx) Class G cemetn blended 1:1 with perlite and 40% silica flour, 4% gel and 0.65% CRF-2. Tailed with 300 cu ft (192 sx) of Class G cement blended with 40% silica flour and friction reducer. Both slurries to be blended with retardant to give 2-3 hours pumping time at reservoir temperature.

DESIRED TOP: Surface | EXCESS: 100%

SLURRY VOL. - CU FT / (SLURRY NO.)	4257		300	
SLURRY YIELD - CUBIC FEET/SACK	2.47		1.56	
SLURRY DENSITY - PPG	97.25#/cu ft(13.0 ppg)		118#/cu ft (15.8 ppg)	
THICKENING TIME - DEPTH SCH/HRS. MIN.	2-3 hrs		2-3 hrs	
COMPRESSIVE STRENGTH - PSI/HOURS				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run stab in float collar 40' (1 joint) above float shoe on bottom.
2. Weld bottom of collars on bottom 4 joints.
3. Clean and Baker loc threads on float collar and shoe as well as bottom 4 joints.
4. Tac-weld top of collars on bottom 2 joints.
5. Run 13-3/8" as full string or liner with tie-back as hole conditions dictate. See attached procedure.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Run rigid centralizer in middle of bottom 8 joints. Then turbo-type centralizer on every other collar from bottom to within 200' of surface.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. If lost circulation is a problem run casing as directed in attached procedure. Use sodium silicate preflush as directoed.
2. Cement through drill pipe.
3. Pump cement of Stage 1 until cement appears at surface, then pump stage 2 cement.

PRESSURE TESTING AND LANDING

1. Wait on cement 12 hrs or until samples have set.
2. Cut & remove 20" casing. Install 12" x 20" expansion spool and blow out preventer stack as in attached drawing.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI: RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	3000	12-3/8"	Rotating head & ram	1500	1500	1000

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM | SIZE 13-3/8" | DEPTH 3500'± | Liner | WELL KA2-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
900-3000'	68	L-80	Buttress	2.01	1.95	1.49	8.68
3000-3500'	72	L-80	Buttress	2.07	2.05	1.53	45.83

DESIGN CONDITIONS

SURFACE BURST PRESSURE	- 3000 PSI	OUTSIDE MUD WT. (COLLAPSE)	- 9.5 PPG		
INSIDE MUD WEIGHT (BURST)	- 9.5 PPG	INSIDE MUD WT. (COLLAPSE)	- 0 PPG		
OUTSIDE MUD WEIGHT (BURST)	- 9.5 PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE)	- 9.5 PPG		
FRAC. GRAD. AT SHOE (BURST)	- 14.5 PPG	BIAXIAL LOAD: COLL. [X] BURST [X]		BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

3340 cu ft (1041 sx) Class G cement blended with 50# per sack of cement of spherelite, 40% silica flour, 5% hydrated lime, 4% gel, 1.25% CFR-2, and 0.5% Halad-22A, tailed with 300 cu ft (189 sx) of Class G cement blended with 40% silica flour and friction reducer. Both slurries retarded to give 2-3 hrs pumping time at reservoir temperature. DESIRED TOP 900'± EXCESS 100%

SLURRY VOL. - CU FT / (SLURRY NO.)	3340	300		
SLURRY YIELD - CUBIC FEET/SACK	3.21	1.59		
SLURRY DENSITY - PPG	82.2	118		
THICKENING TIME - DEPTH SCH/HRS, MIN.	2-3 hrs	2-3 hrs		
COMPRESSIVE STRENGTH - PSI/HOURS				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run float collar 40' above float shoe.
2. Weld bottom of collars on bottom 4 joints.
3. Clean and Baker loc threads on bottom 4 joints.
4. Tac-weld top of collars on last 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Hang liner 100' up inside 20" casing on drill pipe.
2. Run rigid centralizer cement baskets in middle of bottom 2 joints and one 10' up inside 20" casing and one just below stage collar if a stage is indicated.
3. Run centralizers every other tool joint to bottome of 20" casing.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Attempt to circulate with water.
2. Pump 20 cu ft CaCl2 water and 100 cu ft water, followed by 200 cu ft Flo-Chek the 200 cu ft of Geo-gel, then cement slurries.
3. See attached program for more detail.

PRESSURE TESTING AND LANDING

1. Wait on cement 8 hrs. Clean out cement from top of 13-3/8" liner. Test lap to 1000 psi. Squeeze lap if necessary. Clean out and retest until a test is obtaned.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCH	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM — SIZE: 13-3/8" | DEPTH: 900'± | Tie-Back | WELL: KA2-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
0-900'	68	K-55	Buttress	1.76	1.67	5.04	25.25

DESIGN CONDITIONS

SURFACE BURST PRESSURE	-	3000 PSI	OUTSIDE MUD WT. (COLLAPSE) -	9.5	PPG
INSIDE MUD WEIGHT (BURST)	-	9.5 PPG	INSIDE MUD WT. (COLLAPSE) -	0	PPG
OUTSIDE MUD WEIGHT (BURST)	-	9.5 PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE) -	9.5	PPG
FRAC. GRAD. AT SHOE (BURST)	-	14.5 PPG	BIAXIAL LOAD: COLL. [X] BURST [X]	BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

1059.8 cu ft (666 sx) Class G cement blended with 40% silica flour and 0.5% CFR-2.

			DESIRED TOP	EXCESS
			Surface	30%
SLURRY VOL. - CU FT / (SLURRY NO.)	1059.8			
SLURRY YIELD - CUBIC FEET/SACK	1.59			
SLURRY DENSITY - PPG	118			
THICKENING TIME - DEPTH SCH/HRS, MIN.	2-3 hrs			
COMPRESSIVE STRENGTH - PSI/HOURS	±2323/8 hrs			

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run float collar 40' above tie-back sleeve on bottom.
2. Clean and Baker loc threads on bottom 4 joints.
3. Tac-weld top and bottom of collars on bottom 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Run rigid centralizer in middle of bottom joint and one every other tool joint to surface except for top 100'.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Circulate with fresh water.
2. Run top plug only.
3. See attached program for more detail.

PRESSURE TESTING AND LANDING

1. Wait on cement 6 hrs before landing and cutting off 13-3/8" for wellhead.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	3000	13-5/8"				

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM — SIZE: 9-5/8" | DEPTH: 7000' | Liner | WELL: KA2-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
3300-5300'	40	L-80	Buttress	2.04	1.97	1.08	6.08
5300-6500'	43.5	L-80	Buttress	2.17	2.30	1.16	13.71
6500-7000'	47	L-80	Buttress	2.30	2.29	1.36	47.74

DESIGN CONDITIONS

SURFACE BURST PRESSURE	- 3000 PSI	OUTSIDE MUD WT. (COLLAPSE)	- 9.5 PPG		
INSIDE MUD WEIGHT (BURST)	- 9.5 PPG	INSIDE MUD WT. (COLLAPSE)	- 0 PPG		
OUTSIDE MUD WEIGHT (BURST)	- 9.5 PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE)	- 9.5 PPG		
FRAC. GRAD. AT SHOE (BURST)	- 14.5 PPG	BIAXIAL LOAD: COLL. [X] BURST [X]	BOUYANCY: YES [ ] NO [X]		

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

2000 cu ft (810 sx) of Class G cement blended 1:1 with perlite and 40% silica flour, 4% gel, and 0.65% friction reducer. Tailed with 300 cu ft (192 sx) of Class G cement blended with 40% silica flour and friction reducer. Both slurries to be blended with retardant to give 2-3 hrs pumping time at reservoir temperature.

			DESIRED TOP	EXCESS
			To liner top	100%
SLURRY VOL. - CU FT / (SLURRY NO.)	2000		300	
SLURRY YIELD - CUBIC FEET/SACK	2.47		1.56	
SLURRY DENSITY - PPG	97.25#/cu ft (13.0 ppg)		118#/cu ft (15.8 ppg)	
THICKENING TIME - DEPTH SCH/HRS. MIN.	2-3 hrs		2-3 hrs	
COMPRESSIVE STRENGTH - PSI/HOURS				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run float collar 80' (2 joints) above float shoe on bottom.
2. Weld bottom of collars on bottom 4 joints.
3. Clean and Baker loc threads on bottom 4 joints as well as threads on float collar and shoe.
4. Tac weld top of collars on bottom 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Hand liner 200' up inside 13-3/8" casing with drill pipe.
2. Run rigid centralizers in middle of bottom 4 jonts and then 1 turbo type centralizer every collar to within 200' of top.
3. Run stage collars and external casing packer as in attached procedures.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Attempt to circulate with water.
2. Pump cement and preflush as in attached procedures.

PRESSURE TESTING AND LANDING

1. Wait on cement 12 hrs. Clean out cement from top of 9-5/8" liner. Test lap to 1000 psi. Squeeze lap if necessary to obtain good pressure test.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM | SIZE: 9-5/8" | DEPTH: 3300'± | Tie-Back | WELL: KA2-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
0-3300'	40	L-80	Buttress	2.10	1.92	2.34	7.17

DESIGN CONDITIONS

SURFACE BURST PRESSURE	- 3000	PSI	OUTSIDE MUD WT. (COLLAPSE) -	9.5	PPG
INSIDE MUD WEIGHT (BURST)	- 9.5	PPG	INSIDE MUD WT. (COLLAPSE) -	0	PPG
OUTSIDE MUD WEIGHT (BURST)	- 9.5	PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE) -	9.5	PPG
FRAC. GRAD. AT SHOE (BURST)	- 14.5	PPG	BIAXIAL LOAD: COLL. [X] BURST [X]	BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

1140 cu ft (704 sx) Class G cement blended with 40% silica flour and 0.5% CFR-2.

			DESIRED TOP	EXCESS
			Surface	30%
SLURRY VOL. - CU FT / (SLURRY NO.)	1140			
SLURRY YIELD - CUBIC FEET/SACK	1.62			
SLURRY DENSITY - PPG	116			
THICKENING TIME - DEPTH SCH/HRS, MIN.	2-3 hrs			
COMPRESSIVE STRENGTH - PSI/HOURS	±2323/8 hrs			

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run float collar 40' above tie-back sleeve on bottom.
2. Clean and Baker loc threads on bottom 4 joints.
3. Tac-weld top and bottom of collars on bottom 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Run centralizers in middle of bottom joint and one every other tool joint to surface except for top 100'.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Circulate with fresh water.
2. Run top plug only.
3. See attached program for more detail.

PRESSURE TESTING AND LANDING

1. Wait on cement 6 hrs before landing and cutting off 9-5/8" for expansion spool and blow out preventers.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	1500	8 1/2"				

ThermaSource Inc.
P.O. Box 1236 • Santa Rosa, CA 95402

MUD

MUD, LOGGING, WELLHEAD & DIRECTIONAL PROGRAMS

WELL KA2-1

DEPTH INTERVAL	MUD TYPE	WEIGHT	API FLUID LOSS	YIELD POINT	PH	
0-100'	Gel and water	65#/ft³	---	15	9.0	
100-1000'	Gel and water or air*	70#/ft³	10cc	15	9.0	
1000-3500'	Gel and water or air*	70#/ft³	10cc	15	10.0	
3500-7000'±	Gel and water or air*	70#/ft³	3.2cc	15	10.0	
7000-T.D.	Water or air*	65#/ft³	or 3000 cfm			

REMARKS
*If unable to maintain circulation due to lost circulation, first attempt to aerate system, then attempt to drill with air with rotary bit or air hammer (see attached). If misting is required, it may be necessary to increase air volume 30%. Misting mix should be fresh water mixed with 2-6 gal/10BBls of Magcobar Foamer. Maintain a solution pH above 10.0 to inhibit corrosion. Use Unisteam as outlined in special considerations.

LOGGING

DEPTH INTERVAL	LOG TYPES	LOG SCALES
100-1000'*	Temperature log & logs as directed	1" and 5" = 100'
1000-3500'*	Temperature log & logs as directed	1" and 5" = 100'
3500-7000'	Temperature log & logs as directed	1" and 5" = 100'
7000-T.D.	Temperature log & logs as directed	1" and 5" = 100'
0-T.D.	Samples every 10'	

REMARKS
All logs to be determined by geologist.
*Apply for waiver requiring E-log on these sections of the well.

WELLHEAD

API NOMINAL SIZE	WORKING PRESSURE PSI	TYPE	MAKE
26"	100 psi		
20" S.O.W. x 21-1/4" 2000	2000 psi	*Weld on wellhead	WKM
21-1/4" 2000 x 12" 900	3000 psi	21-1/4" x 12" expansion spool with two 3" 2000 outlets	WKM
12" x 12"	3000 psi	12" 900 Ansi WKM Pow-R-Seal master valve	WKM

REMARKS

DIRECTIONAL OR STRAIGHT-HOLE

Drill hole as straight as possible, taking directional shots every 100'± from 0-7000' and on dull bits after 7000'. 0-3500' maximum deviation to be 5°, maximum rate of change to be 1½° per 100'. 3500-7000' maximum deviation to be 8°, maximum rate of change to be 1½° per 100'. 7000-T.D. monitor without control.

TRUE GEOTHERMAL ENERGY COMPANY
KMERZ WELL NO. KA3-1
GEOTHERMAL EXPLORATION WELL PROGRAM

The following well program is designed to drill and complete a nominal 10,000′ geothermal exploration well in the KMERZ. (See Figure 001) Based on the results of prior drilling, a large degree of flexibility is built into the program. It should be clear that being an exploration well, the casing setting depths and drilling procedures are subject to change at any time. DLNR will be notified and updated as drilling progresses on any changes.

1. Install 30" conductor pipe in 42" hole to 60′ to 100′ or as deep as possible below ground level prior to rotary rig moving onto location. Cement conductor from total depth back to surface with redi-mix cement. If a burial cave or lava tube is encountered when setting the conductor pipe, further investigation is required prior to proceeding. Notify DLNR and consult with archaeologist. If conditions warrant, conductor installation may also be performed with rotary rig.

2. Construct 10′ x 10′ x 9′ deep cellar around conductor pipe with a cemented bottom and stairway exit toward front of rig. See attached Figure 002.

3. Move in rotary drilling rig to drill well. Center rig over conductor pipe and rig up. Drill 42" hole with bucket bit and install 30" conductor, if not installed prior to moving in. Add 30" OD extension to conductor pipe to bring it up under rotary table. Install flow line on conductor pipe to return mud to pits.

4. Notify DLNR upon startup of drilling of a pilot hole. Pick up an 8-1/2" bit on a 26" hole opener or reamer and run into the bottom of the conductor pipe. Center punch 8-1/2" hole and drill 8-10′. Pull out of hole and remove 26" hole opener or reamer. Run 8-1/2" bit and drill to 100′+/-. During the drilling of this 8-1/2" pilot hole progress should be monitored constantly to determine if a lava tube which may contain archaeological artifacts might be encountered directly under the rig. If the bit drops free for more than eight (8) feet then drilling will stop. If this drop occurs the hole will be flushed with clear water and a light source with video camera lowered into the hole to investigate the possibility of any archaeological value. If archaeological value is determined then drilling will stop and the rig moved. If no archaeological value is determined then provisions would be made to continue drilling. Drilling supervisor shall be on drill rig floor throughout complete pilot hole drilling operations.

5. Open 8-1/2" hole to 26" with 26" bit and drill with mud to 800-1000′ depending on geology. Maintain hole as straight as

possible, take drift shots every 100'. Maximum rate of change 1 degree per 100'. Install mud loggers at surface to log entire well from 0' to total depth. Catch three clean and dry samples every 10'.

6. Rig up and run 20" casing to total depth as per attached 20" casing program with 20" stab-in float collar and float shoe on bottom.

7. Once 20" casing has been run to bottom, run in hole with stab-in tool on bottom of drill pipe and stab into float collar. Circulate hole clean with at least two full circulations.

8. Cement 20" casing through drill pipe as per attached program. Circulate cement back to surface between 20" and 30" casing. Observe cement level. If cement falls back in annulus, bring same back to surface with 1" pipe.

9. Wait on cement 8 hours.

10. Land 20" casing. Cut off and remove 30" conductor drilling nipple. Cut off 20" casing and weld on 20" S.O.W. x 21-1/4" 2000 psi wellhead. Install two 3" valves. Install 20" blow out preventer equipment as per attached Figure 003.

11. Test 20" casing and blow out preventer equipment to 1500 psi for 30 minutes.

12. Drill out cement and float collar and float shoe from 20" casing with 17-1/2" bit using mud. Drill 30' of formation and trip to pick up stabilization.

13. Continue to drill 17-1/2" hole as vertical as possible with mud to 3500'+/- as indicated by formation. Directionally survey well at least every 100'. If lost circulation presents severe problems, an aerated mud system may be utilized. Severe loss circulation zones should be cemented off prior to drilling ahead.

14. Once 17-1/2" hole has been completed to casing point, rig up and run logs if indicated by geologic staff.

15. Upon completion of logging program, run in hole with bit and circulate to condition hole for casing.

16. Rig up and run 13-3/8" casing as per attached 13-3/8" casing program and running procedure. If lost circulation presents severe problems during drilling it may be necessary to set 13-3/8" pipe as a liner then tie it back to the surface rather than a full string of casing. See running procedure for alternative options.

17. Cement 13-3/8" casing as per attached program. Circulate cement back to surface between 13-3/8" and 20" casings. Observe cement, if it falls back, bring level back to surface using 1" pipe.

18. Wait on cement 12 hours or until samples are set.

19. Land 13-3/8" casing. Remove 20" blow out preventer stack. Cut off 13-3/8" casing and install 12" x 21-1/4" 900 ANSI expansion spool wellhead with two 3" flanged outlets equipped with 3" 2000 psi wing valves. Install 12" 900 series blow out preventer stack with 12-1/4" bore as per attached Figure 004.

20. Test 13-3/8" blow out preventer stack to 1500 psi for 30 minutes.

21. Drill out all cement, float collar and shoe from the 13-3/8" casing with a 12-1/4" bit using mud. Drill 30' of formation and trip to pick up stabilization.

22. Drill 12-1/4" hole with mud or aerated mud as required by hole conditions to 6000-8000', the 9-5/8" casing point, as indicated by geologic staff. Lock up drilling assembly to maintain direction and angle as straight as possible to casing point.

23. Once 12-1/4" hole has been completed to casing point, rig up and run logs if indicated by geologic staff.

24. Upon completion of logging program, run in hole with bit and circulate to condition hole for casing.

25. Rig up and run 9-5/8" casing as a liner equipped as required with external casing packer located 200-300' from bottom. Hang same using a double slip liner hanger with tie-back sleeve. Run 9-5/8" liner from total depth to hanger located 200' up inside of 13-3/8" casing as per attached 9-5/8" liner program and running procedure.

26. Once liner is hung, circulate hole clean through drill pipe with at least two full circulations.

27. Cement 9-5/8" liner and external casing packer from total depth back up to top of liner lap as per attached cementing program.

28. Once cement is in place, disengage from liner hanger and pull up 60' and circulate out excess cement.

29. Pull out of hole with liner hanging tool and run in hole with 12-1/4" bit and drill out cement from 13-3/8" casing to top of 9-5/8" liner lap. Test lap to 1000 psi only after cement has been in place 12 hours. Squeeze lap area if necessary to

obtain a 1000 psi squeeze pressure.

30. Trip for 8-1/2" bit and drill out excess cement from 9-5/8" liner down to top of float collar. Pressure up and retest 13-3/8" casing, liner lap and 9-5/8" casing to 1000 psi.

31. Drill out cement, float collar and float shoe from 9-5/8" casing using 8-1/2" bit and mud. Drill 30' of formation and circulate to change out mud for water. Re-install rotating head on blow out preventer stack for air drilling if not already installed for the drilling of the 12-1/4" hole.

32. Trip to pick up 8-1/2" stabilization. Drill 8-1/2" hole through production zone to total depth of 9,000'-12,000' using air or aerated water as a drilling medium.

33. Pull out of hole with drill pipe and test well for short term with rig on location.

34. If results appear commercial, pull out of hole and release rig for long production test or proceed ahead with attached 9-5/8" tie-back procedure to complete well with 9-5/8" tie-back, if 13-3/8" casing shows damage or excessive wear. If well test results prove that the flow rate from the well is not commercial then either deepen or redrill to obtain production.

35. Evaluate well and complete with either open hole or 7" slotted liner.

SPECIAL CONSIDERATIONS
AUXILIARY EQUIPMENT THAT SHOULD BE MAINTAINED WITH THE RIG

1. Six pen drilling recorders on drill floor with: a) string weight; b) rpm; c) rotary torque; d) rate of penetration; e) pump pressure; f) exit pressure. Additional real time monitoring of drilling parameters to be considered upon consultation with DLNR Staff.

2. Special rotating head with rubbers, capable of stripping 17-1/2", 12-1/4" and 8-1/2" bottomhole assemblies. Complete with spare rotating head stripper drive bushing assembly. Rotating head should be installed on top of hydril or at least on location, available for installation if necessary. Run cold water continuously on head while producing geothermal fluids.

3. Use tong torque assembly with torque gauge for making up collars to API torque requirements.

4. Temperature should be taken with every directional survey by running a maximum recording thermometer in the survey instrument.

5. Catch drill cutting samples (3 sets) every 10', to be cleaned and sacked.

6. In and out temperatures, both of mud, air or aerated water, shall be recorded in the Tour Reports every 30'. All steam/water entries shall be recorded in the Tour Reports.

7. All lost circulation zones encountered shall be recorded in Tour Book recording both the depth at which the loss occurred, as well as the amount of fluid lost. All flows shall also be recorded giving depth and the amount of increase.

8. Periodic tests may be conducted to determine well potential. Drilling will be stopped and the hole evacuated to check for flow at lost circulation zones.

9. Upon completion, the well will be shut in by closing the lower master valve. The remainder of the blow out preventer equipment will then be removed.

10. Rotary table will be equipped with a torque gauge with visual display for driller.

HYDROGEN SULFIDE MONITORING AND ABATEMENT

Hydrogen sulfide monitoring should be maintained during the drilling of the well. Detectors should be placed on the rig floor, cellar area, and flowline region to detect and announce (with alarms and lights) the presence of hydrogen

sulfide. These monitors are typically provided by and maintained daily by the geothermal data loggers. Proper functioning of these monitors is essential in maintaining a safe working environment.

Hydrogen sulfide abatement equipment and materials, i.e. pumps and caustic soda, should be maintained on location when drilling with lighter than water drilling fluids, i.e. air or aerated mud systems.

Escape breathing equipment, as well as resuscitators shall be available on site with mud logging unit. Fans should also be available on the rig floor to clear H2S contaminated floor areas, making it safer to work.

PIPE AND BLOW OUT PREVENTER INSPECTION

The initial acceptance of drill pipe should be based on an IODC-API Class II specification inspection. All subsequent inspections should discard pipe with 30% wear or greater; i.e., use 30% where Class II states 20%.

The drill pipe should include:

1. Electromagnetic inspection of tubes (Sonoscope or Scanalog).

2. Wall thickness and cross sectional area (ultrasonic or gamma ray).

3. End area inspection (electronic or magnetic particle).

All drill collar end areas should be magnetic particle inspected every 14 days or every 9 days while drilling with production or drilling with air or aerated mud systems.

All BOPs should be inspected for wear by the manufacturer or an authorized agent prior to installation. All BOPs should be tested after installation prior to drilling out cement.

Remind service companies furnishing bottomhole assemblies that their equipment should be magna-fluxed prior to delivery.

AIR EQUIPMENT REQUIREMENTS

Minimum air and pressure requirements are 4500 SCFM at 1000 psig for rotary drilling 12-1/4" hole below 13-3/8" casing.

Minimum air and pressure requirements are 3000 SCFM at 1000 psig for rotary drilling below 9-5/8" casing.

Hook-up lines, air meter, and scrubber, misting pump with minimum capacity of 10 gpm, and operating personnel will be furnished by the air contractor. Use Union Oil's UniSteam corrosion inhibitor while drilling in steam, to be injected into the drill pipe. The mixture for UniSteam is as follows:

Steam lbs/hr	Injection
0-20,000	5 gal UniSteam-10/BBl water
20,000-40,000	10-15 gal UniSteam-10/BBl water
40,000-150,000	20-35 gal UniSteam-10/BBl water
150,000+	40 gal UniSteam-10/BBl water

PROCEDURE FOR RUNNING AND CEMENTING 13-3/8" CASING

1. Drill to casing depth.

2. Circulate for 2-3 hours, two complete circulations to clean hole of cuttings.

3. Pick up excess drill pipe needed to stab into float collar for cementing the 13-3/8" casing.

4. Make short trip and circulate for 1-2 hours.

5. Pull out of hole and rig up to run 13-3/8" casing. Run multi-shot survey while pulling out of hole if necessary. If loss circulation has not been a severe problem in drilling the 17-1/2" hole, then proceed ahead to step 8 and run 13-3/8" casing as a full string. If loss circulation has presented problems, then proceed to step 23 and run 13-3/8" as a liner with tie-back string.

6. Run 13-3/8" casing grades, weights and thread design as indicated on attached detailed sheet with stab-in collar 40' from float shoe on bottom with centralizers located one in middle of bottom two joints and then one every other collar upward omitting any from the top 200'.

7. Set casing in elevators on spider. Do not set casing slips. Drop centralizing ring of 13-3/8" casing inside 20" wellhead. Install return hoses from 20" wellhead to mud pits.

8. Rig up with landing plate on top of 13-3/8" casing. Run drill pipe into 13-3/8" with stab-in sub on bottom. Stab into collar and rig up to circulate. Tie down drill pipe.

9. Circulate for 3 hours, or at least two full circulations, to clean up and cool down hole.

10. Rig up to cement.

11. If loss circulation is a problem, pump 20 BBls CaCl2 water, 10 BBls fresh water, 20 BBls sodium silicate, followed by 20 BBls viscous Geo-Gel mud spacer.

12. Pump cement without any additional spacers. Pump stage 1 consisting of Class G perlite blended 1:1 with 40% silica flour, 3% gel and 0.5% CFR-2. Retard as needed. Pump this cement until you see returns of cement at the surface. If loss circulation has been a problem, the cement may have to be changed to a spherelite blended cement, see Note below.

13. Pump stage 2 cement: Class G cement with 40% silica flour, 3% gel and 0.5% CFR-2. Retard as needed. Pump 200 cu ft of this stage 2 cement. The last 100 cu ft should be staged in: Pump 35 cu ft and shut down for 5-10 minutes, then pump 35 cu

ft and shut down again for 5-10 minutes before pumping last 30 cu ft. Check for fall back in annulus each time. Pull out of stab-in shoe and clear drill pipe, dropping all excess cement from drill pipe on top of float collar.

14. Rig down circulating equipment and pull out of hole with drill pipe.

15. Hook up to 13-3/8" casing elevators and pick up slightly to remove spider, then center 13-3/8" casing in stack.

16. Drain blow out preventer equipment after 30 minutes from the time cement was in place.

17. Wait on cement 12 hours before landing casing. Check for cement fall back in annulus periodically. Bring cement back to surface using 1" pipe if necessary.

18. Cut off 13-3/8" casing. Remove 20" blow out preventer equipment. Install 21-1/4" x 12" 900 ANSI expansion spool, 12" master valve and nipple up blow out preventer equipment as in attached Figure 004.

19. Test blow out preventer equipment to 1000 psi.

20. Change out bottom hole drilling assembly for 12-1/4" tools and run in hole.

PROCEDURE FOR RUNNING & CEMENTING 13-3/8" AS A LINER AND TIE-BACK STRING

1. Follow steps 1-4 above.

2. Pick up 13-3/8" liner. If circulation was never achieved, then a stage collar should be installed at approximately 2000'. Install cement basket type centralizers in the middle of the bottom two joints and one just below stage collar. Install one cement basket type centralizer to be located 20' up inside 20" casing shoe.

3. Run liner in hole and hang same 100' up inside of 20" casing with shoe just off bottom.

4. Attempt to circulate with two times total volume of fresh water. If unsuccessful, then proceed with cement job.

5. Pump 20 BBls CaCl2 water and 10 BBls fresh water, followed by 20 BBls sodium silicate, 20 BBls Geo-Gel flush, then cement slurries for stage 1. Follow stage 1 cement with 200 cu ft of stage 2 cement.

6. Release plugs after stage 2 cement and open cementing ports if stage collar is run.

7. Circulate through stage collar. Repeat preflush prior to pumping cement. Pump stage 1 and stage 2 cement as in prior cement job on bottom section of 13-3/8" liner.

8. Release plugs and displace cement and plugs down hole to close stage collar.

9. Release hanger and pull out of hole with setting tool. Wait on cement for 6 hours.

10. Run in hole with 17-1/2" bit and clean out excess cement, if any, from the top of the 13-3/8" liner.

11. Test lap to 750 psi. If unable to get a test, trip to lay down bit, run in open ended. Squeeze lap with Class G cement blended with 40% silica flour and 0.5% CFR-2 using pipe rams.

12. Re-squeeze until a squeeze pressure is achieved. Fill hole with water.

13. Drill out excess cement with 17-1/2" bit and retest lap to 750 psi.

14. If successful in testing lap, run in hole with 12-1/4" bit and 13-3/8" casing scraper to clean out tie-back sleeve.

15. Pick up 13-3/8" tie-back with float collar located 40' above tie-back stinger on bottom.

16. Run tie-back string in hole and land same in sleeve at hanger.

17. Circulate around with fresh water, then run cement slurry. Use top plug only.

18. Wait on cement 6 hours. If after 6 hours cement is not to surface level in 13-3/8" x 20" annulus, insert 1" tubing and bring it back to surface with cement.

19. Cut off 13-3/8" casing. Remove 20" blow out preventer equipment. Install 21-1/4" x 12" 900 ANSI expansion spool, 12" master valve, and nipple up blow out preventer equipment as in attached Figure 004.

20. Test blow out preventer equipment to 1000 psi for 30 minutes.

21. Change out bottom hole drilling assembly for 12-1/4" tools and run in hole.

NOTE: Spherelite cement should be blended as follows:

Class G cement blended with 40% silica flour, 50 lbs per sack of cement of spherelite, 4% gel, 5% lime, 1.25% CFR-2, and 0.5% Halad-22A.

Cement should be mixed at 82.2#/cu ft (11 ppg). Slurry yield is 3.21 cu ft/sack.

Mixing water requirements are 1.50 cu ft/sack (11.22 gal/sack).

9-5/8" LINER RUNNING PROCEDURE

The drilling program for Well KA3-1 has been written in such a way as to handle all situations that occur during the drilling. Due to the remote location and shipping requirements we must consider all possible hole conditions. These conditions that should be anticipated are listed in order of increasing severity as follows:

1. The 12-1/4" hole is drilled with little or no loss circulation encountered. Due to lost circulation encountered in drilling it would be highly probable that loss of circulation may occur during the cementing of the 9-5/8" liner.
   In this situation where lost circulation has not presented a significant problem during drilling, I feel that a conventional method should be employed in the running and cementing procedure for the 9-5/8" liner. The attached program "PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER WITHOUT EXTERNAL CASING PACKER AND MULTI-STAGE CEMENTER" should be used.

2. The 12-1/4" hole is drilled with air, aerated water or mud, with moderate loss circulation, that is loss circulation encountered in several zones which could be sealed with cement or LCM, or partial loss circulation zones which may take fluid periodically during drilling operations. Probability of lost circulation during cementing is high and should be anticipated.
   In this situation a certain amount of caution should be used in running and cementing the 9-5/8" liner to insure a competent cement job. A 9-5/8" liner utilizing a multi-stage cement collar strategically located could assist in obtaining an adequate cement job. The attached program "PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER WITH MULTI-STAGE CEMENTER" should be used.

3. The 12-1/4" hole is drilled using air or aerated water because of complete loss of circulation during the drilling. Sealing of these loss circulation zones prove to be unsuccessful or extensive causing a great loss of time therefore air or aerated fluid is used to drill the well. Probability of loss circulation during the cement job is high, therefore extreme methods of cementing the liner should be used.
   In this situation where major problems exist in the well, extreme procedures and technologies should be employed to insure an adequate cement job. The attached program "PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER EQUIPPED WITH EXTERNAL CASING PACKER AND HYDRAULIC CEMENTER" should be used.

PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER
WITHOUT EXTERNAL CASING PACKER AND MULTI-STAGE CEMENTER

1. Drill to casing depth at approximately 6000-7000′ dependent on temperature and geology.

2. Circulate for 2-3 hours to clean and cool hole.

3. Pull out of hole.

4. Rig up and run logs as indicated by geologic staff. Wait on bottom with temperature log for 30 minutes before pulling out of hole.

5. Rig down loggers and run in hole with bit and monel to total depth.

6. Circulate for 2 hours and make short trip. Circulate for 1-2 hours after short trip.

7. Pull out of hole and rig up to run 9-5/8" liner. Run additional directional surveys while pulling out of hole if necessary.

8. Run 9-5/8" liner grades, weights and thread design as indicated in detail sheet with float shoe on bottom and float collar two joints up. Centralizers should be located one in the middle of the bottom two joints and then one every to every other collar upward to within 60′ of the hanger. Use T-Bar rigid centralizers totally in bottom portion of the string and then as required in the upper portion. Run casing adjusters at 600′, 1800′ and 3400′ above shoe joint if required.

9. Circulate two full circulations to clean up and cool down well prior to cementing.

   Note: If casing can still be moved after running to bottom then move casing throughout circulation and cementing job and hang after cement is in place. If casing will not move after running to bottom, then hang liner before circulating and cementing job.

10. If loss circulation is encountered, pump 20 BBls of CaCl2 water and 10 BBls of fresh water ahead of 20 BBls of sodium silicate.

11. Pump in 20 BBls of viscous Geo-Gel mud preflush.

12. Pump cement without any water spacers. Pump stage 1: Class G cement and perlite blended at a ratio of 1:1 with 40% silica flour, 3% gel and friction reducer. Retard to give 2-3 hours

pumping time at 350 degrees F. Use 100% excess. If lost circulation is a problem, cement may be required to be changed to a spherelite blend. See note at bottom of this procedure. Pump stage 1 as per precalculated volumes.

13. Pump stage 2: Class G cement blended with 40% silica flour, 3% gel and friction reducer. Retard to give 2-3 hours pumping time at 350 degrees F. Pump 200 cu ft of this stage 2 cement. The last 100 cu ft should be staged in: Pump 35 cu ft and shut down for 5-10 minutes, then pump 35 cu ft and shut down again for 5-10 minutes before pumping the last 30 cu ft.

14. Once all cement has been pumped then rig down circulating equipment, hang liner and pull out of liner hanger with drill pipe and pull up 90' and circulate out excess cement on top of liner top.

15. Wait on cement 12 hours. Run in hole with 12-1/4" bit to top of cement, drill out cement to liner top. Wait a full 24 hours from the time cement was in place or until samples have set before pressure testing lap to 1000 psi surface pressure. Squeeze lap if necessary to obtain a pressure test.

16. Trip to change bits to 8-1/2" and clean out cement from inside of the 9-5/8" liner top.

17. Retest liner lap to 1000 psi surface pressure. Squeeze if necessary to obtain a pressure test.

18. Drill out cement, float collar and float shoe with 8-1/2" bit. Drill 60' of formation with mud.

19. Circulate to clean hole and then displace mud in hole for water.

20. Trip out of hole to pick up stabilization.

21. Run back in hole and aerate water. Drill ahead with aerated water to commercial production or total depth.

NOTE: Spherelite cement should be blended as follows:

Class G cement blended with 40% silica flour, 50 lbs per sack of cement of spherelite, 4% gel, 1.25% friction reducer and fluid loss agent.

Cement should be mixed at 88.3 lbs per cu ft (11.8 ppg). Slurry yield is 3.16 cu ft per sack of cement.

Mixing water requirements are 1.5 cu ft per sack (11.22 gal/sack).

9-5/8" CASING PROPERTIES

L-80, 47 ppf, Buttress, Burst: 6870 psi, Collapse: 4760 psi,
Tension: 1,122,000 lbs.

L-80, 53.5 ppf, Buttress, Burst: 6330 psi, Collapse: 3810 psi
Tension: 1,038,000 lbs.

L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi,
Tension: 947,000 lbs.

PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER
WITH MULTI-STAGE CEMENTER

1. Drill to casing depth at approximately 6000 - 8000′ dependent on temperature and geology.

2. Circulate for 2-3 hours to clean and cool hole.

3. Pull out of hole.

4. Rig up and run logs as indicated by geologic staff. Wait on bottom with temperature log for 30 minutes before pulling out of hole.

5. Rig down loggers and run in hole with bit and monel to total depth.

6. Circulate for 2 hours and make short trip. Circulate for 1-2 hours after short trip.

7. Pull out of hole and rig up to run 9-5/8" liner. Run additional directional surveys while pulling out of hole if necessary.

8. Run 9-5/8" liner grades, weights and thread design as indicated in detail sheet with float shoe on bottom and float collar two joints up. Centralizers should be located one in the middle of the bottom two joints and then one every to every other collar upward to within 60′ of the hanger. Install multi-stage cementer in a strategic location in the liner string. The location of the multi-stage cementer should be such that the bottom portion can be cemented successfully without loss circulation. The upper portion can then be cemented after the bottom has had time to set without any loss circulation during cementing. A probable location is just above the loss circulation zones. If the hole was air drilled a good location would be approximately 1200′ above the casing shoe. Use 12" T-bar rigid centralizers totally in the bottom portion of the string and then as required in the upper portion. Run casing adjusters at 600′, 1800′, and 3400′ above shoe joint as required.

9. Circulate two full circulations to clean up and cool down well prior to cementing.

   Note: If casing can still be moved after running to bottom then move casing throughout circulation and cementing job and hang after stage 1 cement is in place. If casing will not move after running to bottom, then hang liner before circulating and cementing job.

10. If loss circulation is a problem then pump 20 BBls of CaCl2 water and 10 BBls of fresh water ahead of 20 BBls of sodium

silicate.

11. Pump in 20 BBls of viscous Geo-Gel mud preflush.

12. Pump cement without any water spacers. Pump stage 1: Class G cement and perlite blended at a ratio of 1:1 with 40% silica flour, 3% gel and friction reducer. Retard to give 4-5 hours pumping time at 350 degrees F. Pump in calculated volume to fill the annulus of the 12-1/4" hole x 9-5/8" liner from the liner shoe to the stage collar with 100% excess, with approximately 200 cu ft of tail cement consisting of Class G cement blended with 40% silica flour, 3% gel and friction reducer. If loss circulation is a problem, cement may be changed to a spherelite blend. See note at the bottom of this procedure.

13. Pump stage 1 cement and drop dart for wiper plug. Displace cement with water. Bump plug and open multi-stage cementer.

14. After the stage collar has been opened then circulate out excess cement. Circulate and cool hole for 2 hours prior to pumping stage 2 cement. Hang liner at this point.

15. Pump in 20 BBls of CaCl2 water and 10 BBls of fresh water ahead of 20 BBls of sodium silicate.

16. Pump in 220 BBls of viscous Geo-Gel mud preflush.

17. Pump in stage 2 cement without any water spacers. Pump Class G cement and perlite blended at a ratio of 1:1 with 40% silica flour, 3% gel and friction reducer. Retard to give 2-3 hours pumping time at 350 degress F. Pump in calculated volume of cement to fill 12-1/4" hole x 9-5/8" liner to lap area without excess. Calculated volume should include a 200 cu ft tail slurry of Class G cement blended with 40% silica flour, 3% gel and friction reducer. Retard to give 2-3 hours of pumping time at 350 degrees F. Displace cement with water.

18. Once all cement has been pumped then rig down circulating equipment and pull out of liner hanger with drill pipe and pull up 90' and circulate out excess cement on top of liner top.

19. Wait on cement 12 hours. Run in hole with 12-1/4" bit to top of cement, drill out cement to liner top. Wait a full 24 hours from the time cement was in place or until samples have set before pressure testing lap to 1000 psi surface pressure. Squeeze lap if necessary to obtain a pressure test.

20. Trip to change bits to 8-1/2" and clean out cement from inside of 9-5/8" liner top.

21. Retest liner lap to 1000 psi surface pressure. Squeeze if necessary to obtain a pressure test.

22. Drill out cement, float collar and float shoe with 8-1/2" bit. Drill 60' of formation with mud or water.

23. Circulate to clean hole and then displace mud in hole for water if necessary.

24. Trip out of hole to pick up stabilization.

25. Run back in hole and aerate water. Drill ahead with aerated water to commercial production or total depth.

NOTE: Spherelite cement should be blended as follows:

Class G cement blended with 40% silica flour, 50 lbs per sack of cement of spherelite, 4% gel, 1.25% friction reducer and fluid loss agent.

Cement should be mixed at 88.3 lbs per sack of cement. Slurry yield is 3.16 cu ft per sack of cement.

Mixing water requirements are 1.5 cu ft per sack (11.22 gal/sack).

9-5/8" CASING PROPERTIES

L-80, 47 ppf, Buttress, Burst: 6870 psi, Collapse: 4760 psi, Tension: 1,122,000 lbs.

L-80, 43.5 ppf, Buttress, Burst 6330 psi, Collapse: 3810 psi, Tension: 1,038,000 lbs.

L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi, Tension: 947,000 lbs.

PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER
EQUIPPED WITH EXTERNAL CASING PACKER AND HYDRAULIC CEMENTER

1. Drill to casing depth at approximately 6000 - 8000′ dependent on temperature and geology.

2. Circulate for 2-3 hours.

3. Pull out of hole.

4. Rig up and run logs as indicated by geologic staff. Wait on bottom with temperature log for 30 minutes before pulling out of hole.

5. Rig down loggers and run in hole with bit and monel to total depth.

6. Circulate for 2 hours and short trip. Circulate for 1-2 hours after short trip.

7. Pull out of hole and rig up to run 9-5/8" liner. Run additional directional surveys while pulling out of hole if necessary.

8. Run 9-5/8" liner grades, weights and thread design as indicated in attached detail sheet with float shoe on bottom and float collar two joints up. Centralizers should be located one in the middle of bottom two joints and then one every other collar upward to within 60′ of hanger. Use T-Bar rigid centralizers in the bottom portion of the string and then as required in the upper portion. If lost circulation is a problem or the hole has been drilled with air or aerated water then CTC external casing packer should be positioned in string 200-300′ from bottom with Halliburton hydraulic stage cementer located above packer. Run casing adjuster at 600′, 1800′, and 3400′ from shoe joint as required. A T-Bar centralizer should be located above and below packer.

9. Run liner equipment. See attached Pre-Job Recommendations.

   Check all equipment to be run on 9-5/8" liner.
   a. Use Instructions & Operations Sheet TE 7.00381. Measure all parts OD and ID.
   b. Check threads on all tools.
   c. Midway liner hanger running tool. Stinger must be reduced down to 3" OD 2.75 ID and run 10-12.5" below bottom of liner hanger as shown on print TE 7.00378. This is when the liner hanger string is at the bottom of its travel.
   d. Part numbers are given on print TE 7.00377 for tools. ID and OD for SR Plug set is given on print TE 7.00379 OD and OD for HOS Cementer are given on print TE 7.00380.

e. All parts and number should check with prints.
f. HOS Tool has four shear pins that will take 2880 psi over Hydrostatic pressure to open it, two other pins are with the tool. Each pin adds 712.5 psi pressure to shear. Open pressure may be adjusted as needed.

10. Installing equipment onto casing strings. See attached Recommendations During Job for further details.

a. Guide shoe.
b. Centralizers on two joints.
c. Float collar.
d. Centralizers as per program.
e. Casing.
f. CTC Packers 200′ off bottom.
g. One joint with centralizer in middle.
h. HOS Cementer.
i. Centralizers as per program - run casing adjusters located 1500′ and 3000′ from shoe.
j. Casing to top of liner. Fill liner as going in hole.
k. Make up SR Baffle Collar on bottom of liner hanger.*
l. Take O-ring off SR plug set and put on SR Baffle Collar.
m. Make up SR plug set on Baffle Collar and tighten at plug set to Baffle Collar. Be sure all parts are tight.
n. Circulate the liner at 3-4 BPM. Stop and circulate 2-3 times while running in hole with liner assembly on drill pipe.

*Be sure there are no areas of drill pipe on liner hanger less than 2.75 ID.

11. Cement liner in three stages.

a. Calculate volume of cement for bottom stage. (200 ft of 12-1/4" hole and 9-5/8" annulus plus shoe joint volume and volume to inflate CTC Packer).
b. Mix cement for above.
c. Pump cement for 200′ annulus and shoe joint. Release first stage dart 809.81266 and pump cement for inflated CTC. (Cement to inflate packer should be Class G with 40% silica flour and friction reducer, no perlite.)
d. Pump 10 BBls spacer then displace with mud at 3-4 BPM until 10 BBls before dart should land in SR lower plug - slow rate to 2 BPM. Pressure should go to 1800 psi and plug release.
e. Displace shut off plug at 5-6 BPM until 30 BBls before plug lands. Then pump at 1-2 BPM.

f. When shut off plug lands in shut off baffle, pressure up to 500 psi and shut down.

12. Inflate CTC Packer with cement. See attached Recommendations During Inflation Sequence for further details.

    a. Check volume of displacement tank.
    b. Increase pressure slowly to 700 psi and shut down.
    c. Increase pressure slowly to 800 psi.
    d. Increase pressure slowly to 900 psi or until tool opens.
    e. Pump in 2-5 cu ft of cement per stage until CTC packer is inflated.
    f. Increase pressure to 1000 psi to close CTC packer.
    g. With pressure at 500 psi, check volume of cement needed to inflate tools.
    h. Pressure up to 2800 psi and open HOS.
    i. Circulate well as needed.
    j. Cement liner as per program. Pump spacer. Pump cement.
    k. Release dart for shut off plug. Pump at 4-5 BPM. Pump 10 BBls spacer - then mud.
    l. Displace to within 10 BBls of plug, slow to 2 BPM.
    m. Pressure to 1950-2000 psi to release plug.
    n. Displace at 4-5 BPM.
    o. When plug lands in HOS, pressure up to 3000 psi to close tool. You may have to go to 3500 psi. Hold pressure for 2 minutes.
    p. Release pressure if holding; back off liner hanger tool.
    q. Come out of hole with tools.
    r. Wait 24 hrs and drill out.

13. Rig down circulating equipment, pull out of hanger with drill pipe and pull up 90′ and circulate out excess cement leaving 90 linear ft of cement on top of liner top.

14. Wait on cement for 12 hrs. Run in hole with 12-1/4" bit to top of liner and circulate to clean out excess cement. Wait 24 hrs from the time cement was in place and pressure test lap to 1000 psi. Squeeze if necessary.

15. Trip to change bits to 8-1/2" and clean out cement from inside the 9-5/8" liner top.

16. Retest liner lap to 1000 psi surface pressure. Squeeze if necessary.

17. Drill out cement, float collar and float shoe with 8-1/2" bit. Drill 30′ of formation.

18. Circulate and change out mud system for water.

19. Trip to pick up stabilization.

NOTE: Spherelite cement should be blended as follows:

Class G cement blended with 40% silica flour, 50 lbs per sack of cement of spherelite, 4% gel, 1.25% CFR-2, and 0.5% Halad-22A.

Cement should be mixed at 88.3lbs/cu ft (11.8 ppg). Slurry yield is 3.16 cu ft/sack.

Mixing water requirements are 1.50 cu ft/sack (11.22 gal/sack).

CASING PROPERTIES

L-80, 47ppf, Buttress, Burst: 6870 psi, Collapse: 4760 psi, Tension: 1,122,000 lbs.

L-80, 43.5ppf, Buttress, Burst: 7930 psi, Collapse: 6620 psi, Tension: 1,286,000 lbs.

L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi, Tension: 947,000 lbs.

PRE-JOB RECOMMENDATIONS

1. In close clearance (1/2"-1") installations:

    a. Run a casing scraper.
    b. Drill open hole section with a stabilized packed hole assembly if possible.

2. In liner installations, notify CTC of type of liner equipment before packers are shipped.

3. Insure that everyone involved understands the Payzone Packer system and specific duties they are to perform.

4. Obtain all pertinent well data, including:

    a. Minimum wellbore restriction (should be 1/2" greater than packer OD).
    b. If casing damage is suspected, run a microscopic caliper and/or casing scraper.
    c. Calipered hole size in zone of interest should not exceed maximum recommended hole size. Use "Hole Size vs. Recommended Inflation Pressure Chart" to set pressure control valve.
    d. If junk has been lost in hole it should be fished or driven to below Payzone setting depth.
    e. Clients maximum allowable surface pressure (burst strength of casing with a safety factor), should be obtained prior to setting shear pin.
    f. If hole size adjacent to end assemblies is more than 1" larger than packer OD run one centralizer above and below each packer.

5. Inspect auxiliary equipment.

    a. Float shoe.
    b. Float collar.
    c. Bottom cement wiper plug (proper size, rupture diaphragm).
    d. Two top cement wiper plugs (proper size, no rupture diaphragm).
    e. Pressure recorder (5000 psi scale if possible).
    f. Chicksan lines.
    g. Cementing head.
    h. Verify that adequate inflation cement is available.
    i. Obtain a dry sample of all cements used on the job.

6. Review primary cementing plans and calculate theoretical bottom hole pressure during cementing operations. If expected pressures approach fracture gradient, pressure anomalies are probable and bottom wiper plug should not be run so that knockoff rod protection stays intact.

7. Calculate displacement volumes. Know at what displacement the following events should take place:

    a. Bottom wiper passes packers (knockoff rods).
    b. Bottom wiper lands in float collar.
    c. First top wiper passes packer.
    d. First top wiper lands in float collar, and
    e. Top of inflation cement (second top wiper plug) relative to upper packer.

8. Total inflation pressure is critical to Payzone Packer performance. Before starting a job know and/or calculate: 1. hydrostatic pressure inside and outside the casing at packer setting depth, 2. pore pressure, 3. fracture pressure, 4. maximum recommended differential inflation pressure from hole size vs pressure chart, 5. resultant effective stress.

    a. Total inflation pressure equals:
        1. Hydrostatic pressure inside casing (packer depth) + Applied surface pressure

        OR

        2. Hydrostatic pressure outside casing (packer depth) + Differential inflation pressure

    b. Differential inflation pressure equals:
        1. Total inflation pressure minus Pressure outside casing (packer depth)

        OR

        2. Applied surface pressure minus Balance pressure

    c. Balance pressure equals:
        1. Surface pressure required to offset "U" tube pressure
        2. Approximated by surface pressure (pumping at 1/4-1/2 BBl/min) just prior to plug bump.

    d. Radial effective stress (Seal Load, Wellbore Support) equals:
    Total inflation pressure minus pore pressure.
    -In all cases the differential inflation pressure must be within the hole size vs differential pressure capabilities of the equipment.
    -For zone isolation the radial effective stress (seal load) should be at least 500 psi and total inflation pressure must be less than fracture pressure.

9. Review casing tally. Re-tally casing during run-in if necessary. This is critical if positioning log is not to be run.

10. Make up casing according to API specifications with proper torque and API pipe dope.

Note: It is extremely difficult to properly inflate packers with a casing leak.

11. Epoxy thread lock should be used on packer/casing connections, float collar, and float shoe.

12. A minimum number of only high quality (API approved) centralizers be run below packer(s). If pipe is to be reciprocated, and hole size adjacent to end assemblies does not exceed packer OD plus 2", spacing between packers and centralizers should be greater than reciprocation stroke. Do not place scratchers in this area.

13. If positioning is critical, packers should be logged into position.

14. Insure that cement has adequate pump time.

15. Inflation cement should have an API water loss of less than 150 cc. Inflation cement must not contain lost circulation material.

RECOMMENDATIONS DURING JOB

1. Verify that external cementing aids (centralizers, scratchers, etc.) are properly installed.

2. Run-in speed 1 ft/sec (may be prudently increased to 2 ft/sec per Steps 3 and 4 below).

3. Monitor returns, if more than 30′ of casing is run before receiving full returns - SLOW DOWN.

4. Monitor weight indicator - excessive weight loss during run indicates that run-in speed may be too fast.

5. Pressure test lines before beginning cement job. Repair all leaks no matter how small.

6. Verify that wiper plugs are dropped at proper time in proper sequence.

7. Monitor returns during entire job.

8. Monitor mixing and pumping of inflation cement. Verify volume and weight of inflation cement. Batch mix if possible.

   Note: If inflation cement is not batch mixed, monitor BBl counter, but do not rely on its accuracy. Insist that mix water be accurately measured from tanks and that cement density remains constant and proper. (If cement is mixed at proper weight, mix water volume is an accurate indicator of cement volume.)

9. Insist that plug drop be verified via tattle-tale, flag or radioactive techniques.

10. Monitor displacement volume, pump rate and surface pressure during entire displacement process.

11. Determine balance pressure during last 5 BBl of displacement. (Slow displacement to 1/4-1/2 BBl/min and record pressure.)

12. Required displacement volume will normally exceed theoretical casing volume. If mud is used for displacement, expect up to 6%.

RECOMMENDATIONS DURING INFLATION SEQUENCE

1. When first plug lands in float collar:

2. Open shear valve in first or bottom packer by rapidly applying appropriate surface pressure, i.e. balance pressure plus pressure rating of shear valve. (Monitor volume displaced.) Stop pumps and monitor pressure decline, increase pressure by 200 psi or as needed to open valve. Record volume in displacement tanks.

   NOTES:

   a. Flow rate into Payzone packers is relatively slow (1/4 BBl/min). Therefore, it is generally impractical and not advisable to pump continuously during inflation. The preferred procedure is to rapidly increase surface pressure, stop pumping and monitor pressure decline. When the packer is full, the pressure decline will stop.

   b. The expected pressure response during inflation is a function of several variables. In general the following reduce the distinctiveness of the pressure response.
      1. Increased well depth.
      2. Compressability and volume of fluid within the casing string.
      3. Large diameter casing.
      4. Viscosity of inflation cement.
      5. Small inflation volume.

      For example, the pressure response during inflation of a 9-5/8" packer at 12,000' with 3/4 BBl of 16.4 lbs/gal cement may be non-distinct while inflation of a 5-1/2" packer with 1 BBl at 6000' would be very distinct.

3. When packer is completely inflated (surface pressure remains constant), apply final desired inflation pressure.

   a. Record volume pumped and hold pressure for 5-10 min.

   b. Bleed surface pressure slowly back to balance pressure (and/or point 1a above and record flowback volume.

   c. Release pressure slowly.

Note: In shallow (less than 7000') unconsolidated sands, the hole size often enlarges as the packer re-stresses the sand. In these installations, final inflation pressure should be adjusted or reduced in accordance with hole size.

This may be done by converting inflation volume to equivalent hole diameter and using "Hole Size vs Recommended Inflation Pressure Chart".

THINGS TO AVOID

1. Avoid using bottom wiper plugs whenever possible. This is critical if bottomhole pressures during the cement operation are likely to exceed frac pressure.

2. Avoid using spacer fluids below inflation cement because volumetric error and/or pressure anomalies may result in mud-filled packers.

   Note: The use of lightweight spacer fluids below the inflation cement imposes a hydrostatic differential pressure across the valve collar equal to [Weight of cement in annulus (lbs/gal) minus weight of spacer fluid below packer (lbs/gal)] multiplied by .052 times height of spacer fluid below packer.

3. Do not exceed fracture pressure in isolation installations.

4. If spacer fluids are used as substitues for wiper plugs above inflation cement, increase cement volume to compensate for contamination of the upper 100′ of inflation cement.

5. Do not use differential fill equipment because debris may enter casing. Some varieties of differential fill equipment must be opened via applied casing pressure prior to circulation. This is not compatible with our valve system.

6. Insist that liner hanger packoffs not be set prior to packer inflation.

7. Do not spud casing - circulate through bridges.

8. Do not use cement with more than 6% Plaster of Paris or Calseal cement.

9. Do not use loss circulation material in inflation cement.

PROCEDURE FOR RUNNING 9-5/8" TIE-BACK CASING
OPTIONAL

1. Kill well with cold water. Pick up Halliburton 9-5/8" EZSV cement retainer on drill pipe and run in hole to 300' below liner top. Set EZSV at this point.

2. Spot a 50 linear foot thick viscous gel pill on top of EZSV and 50 linear feet of cement on top of gel. Fill hole with water and circulate to cool and clean hole. Make appropriate changes to wellhead assembly.

3. Run 9-5/8" casing scraper to clean out liner tie-back sleeve.

4. Rig up and run 9-5/8" tie-back string to top of liner with float collar 40' (1 joint) above stab-in tool on bottom. Stab-in tool will be equipped with slip. Stab into liner, engage slips on the 13-3/8" and pull up on tie-back to 200,000 lbs to pretension tie-back.

5. Cement tie-back as per attached cementing program. Bring cement back to surface between 9-5/8" and 13-3/8" casing, setting centralizer in 13-3/8" casing head before cementing.

6. Wait on cement 12 hours, then release tension.

7. Land 9-5/8" casing. Pick up 12" blow out preventer stack and install expansion spool (12" 900 x 10" 900) equipped with two 3" flanged outlets with 3" 2000 psi wing valves. Install 10" 900 Master Valve and 10" 900 x 12" 1500 adaptor spool and reinstall blow out preventer stack.

8. Test blow out preventer stack, 10" master valve, expansion spool and 9-5/8" tie-back to 1500 psi.

9. Pick up 8-1/2" bit and drill out excess cement and float collar. Work bit through lap area and retest to 1000 psi. Squeeze if necessary.

10. Drill out cement and clean out gel to top of EZSV.

11. Trip for EZSV picking tool and remove EZSV.

12. Return well to production and retest if necessary, using air to induce well to flow.

13. Lay down drill pipe, remove blow out preventer equipment,and move rig off, releasing rig.

14. Prepare for long term test.

15. Test well.

9-5/8" CASING PROPERTIES

L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi, Tension: 947,000 lbs.

FIGURES

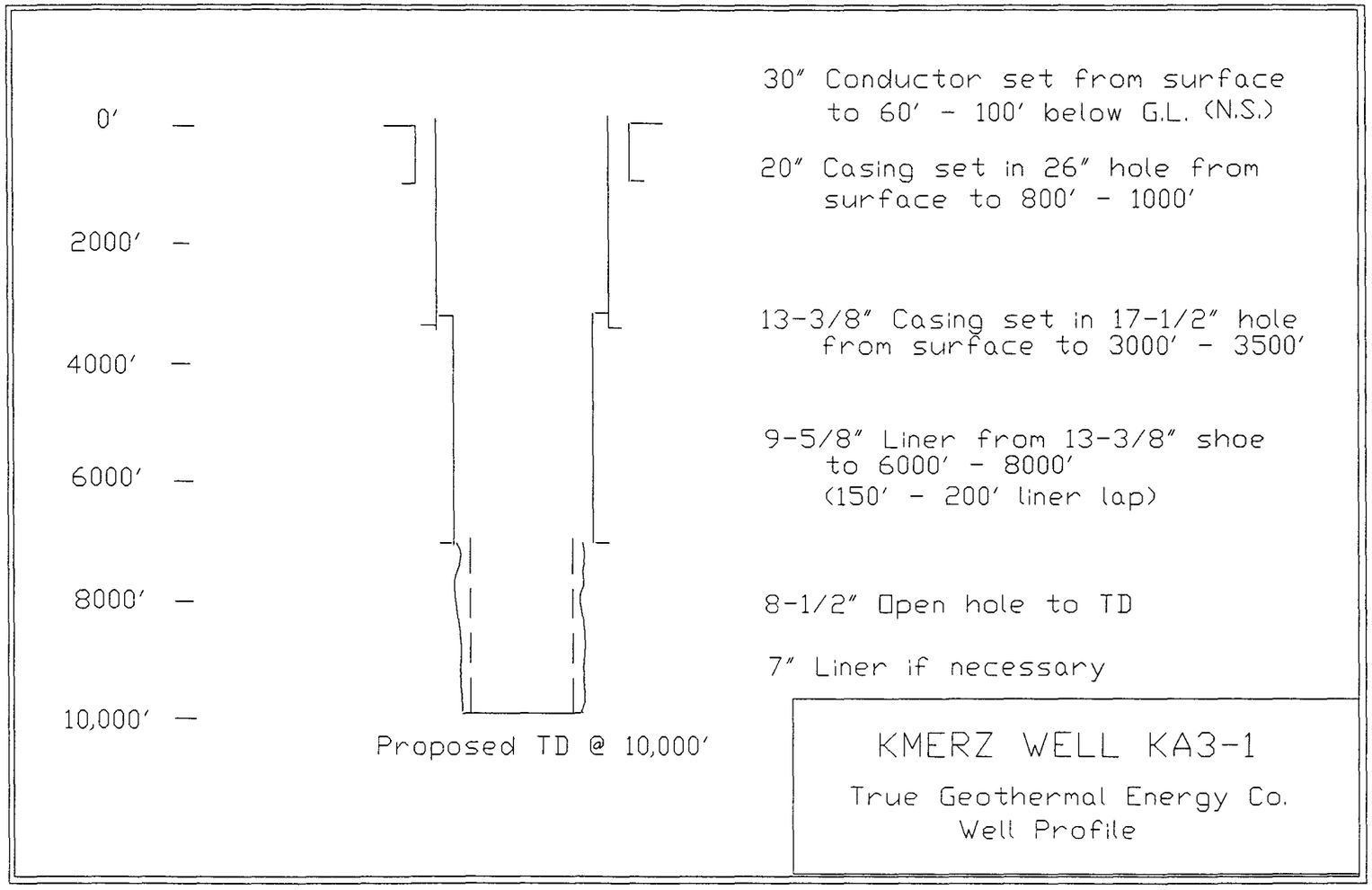
0'
2000'
4000'
6000'
8000'
10,000'
Proposed TD @ 10,000'
30" Conductor set from surface to 60' - 100' below G.L. (N.S.)
20" Casing set in 26" hole from surface to 800' - 1000'
13-3/8" Casing set in 17-1/2" hole from surface to 3000' - 3500'
9-5/8" Liner from 13-3/8" shoe to 6000' - 8000' (150' - 200' liner lap)
8-1/2" Open hole to TD
7" Liner if necessary
KMERZ WELL KA3-1
True Geothermal Energy Co.
Well Profile

FIGURE 001

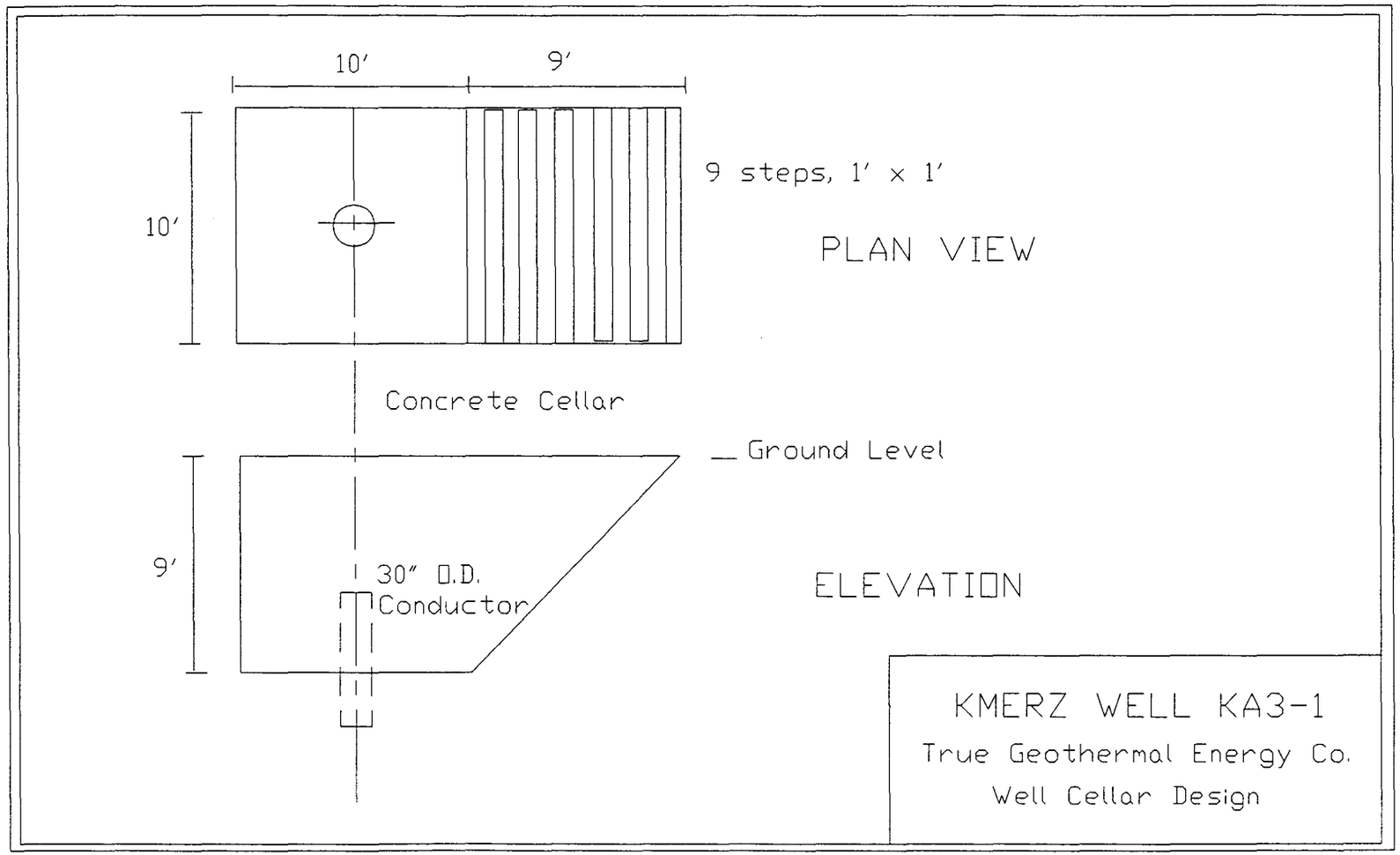
10′
9′
10′
9 steps, 1′ x 1′
PLAN VIEW
Concrete Cellar
Ground Level
9′
30″ O.D.
Conductor
ELEVATION
KMERZ WELL KA3-1
True Geothermal Energy Co.
Well Cellar Design

FIGURE 002

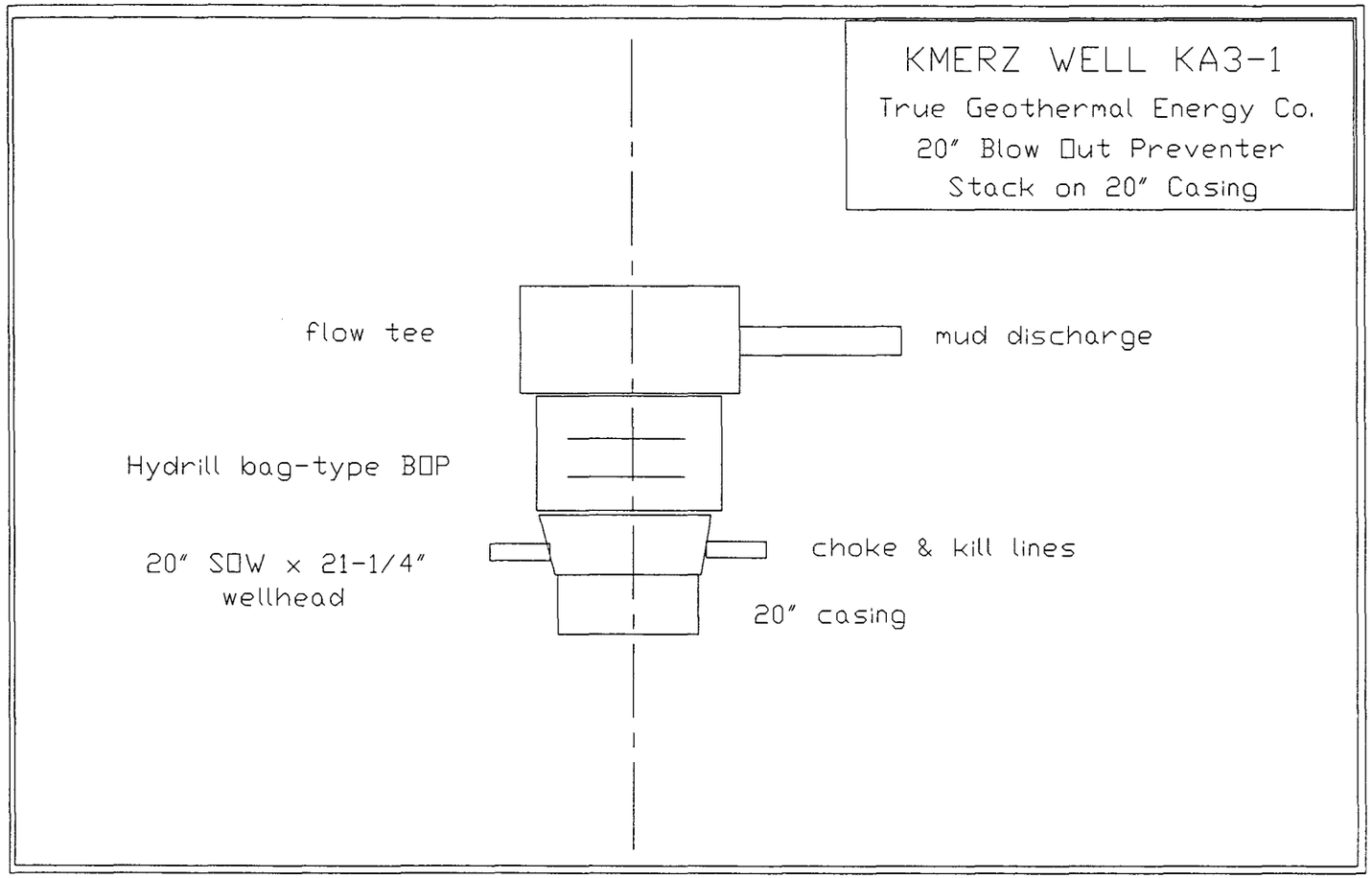
KMERZ WELL KA3-1
True Geothermal Energy Co.
20" Blow Out Preventer
Stack on 20" Casing
flow tee
mud discharge
Hydrill bag-type BOP
20" SOW x 21-1/4"
wellhead
choke & kill lines
20" casing

FIGURE 003

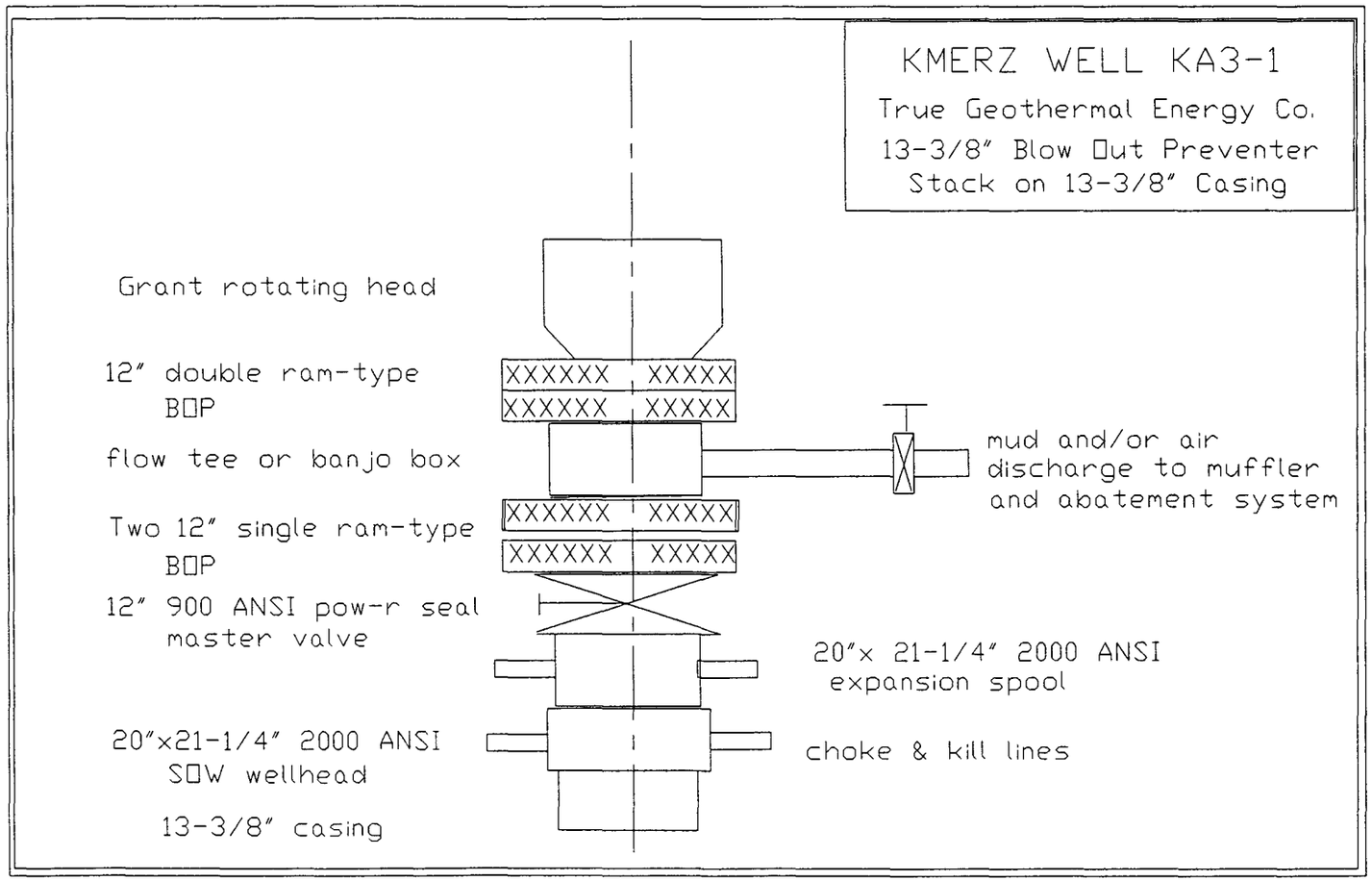
KMERZ WELL KA3-1
True Geothermal Energy Co.
13-3/8" Blow Out Preventer
Stack on 13-3/8" Casing
Grant rotating head
12" double ram-type
BOP
flow tee or banjo box
Two 12" single ram-type
BOP
12" 900 ANSI pow-r seal
master valve
20"x21-1/4" 2000 ANSI
SOW wellhead
13-3/8" casing
XXXXXX XXXXX
XXXXXX XXXXX
XXXXXX XXXXX
XXXXXX XXXXX
mud and/or air
discharge to muffler
and abatement system
20"x 21-1/4" 2000 ANSI
expansion spool
choke & kill lines

FIGURE 004

TABLES

ThermaSource Inc.
P.O. Box 1236 • Santa Rosa, CA 95402

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM

SIZE	DEPTH	WELL
20"	1000'	KA3-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
0-1000'	106.5	K-55	Buttress	3.31	9.21	1.64	9.99+
Casing Properties:							
Collapse-770 psi							
Burst-2320 psi							
Tension-1,683,000 lbs.							

DESIGN CONDITIONS

SURFACE BURST PRESSURE	- 2000	PSI	OUTSIDE MUD WT. (COLLAPSE) -	9.95	PPG
INSIDE MUD WEIGHT (BURST)	- 9.5	PPG	INSIDE MUD WT. (COLLAPSE) -	0	PPG
OUTSIDE MUD WEIGHT (BURST)	- 9.5	PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE) -	9.5	PPG
FRAC. GRAD. AT SHOE (BURST)	- 14.5	PPG	BIAXIAL LOAD: COLL. ☐ BURST ☐	BOUYANCY: YES ☐ NO ☒	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

2690 cu ft (838 sx) of Class G cement blended with 50 lbs of spherelite per sack of cement, 40% silica flour, 4% gel, 5% hydrated lime, 1.25% CFR-2 and 0.5% Halad-22A tailed with 400 cu ft (252 sx) of Class G cement blended with 40% silica flour and 3% CaCl2

	DESIRED TOP	EXCESS
	Surface	100%

SLURRY VOL. - CU FT / (SLURRY NO.)	2690		400	
SLURRY YIELD - CUBIC FEET/SACK	3.21 cu ft/sx		1.59 cu ft/sx	
SLURRY DENSITY - PPG	82.2#/cu ft(11 ppg)		118#/cu ft(15.8 ppg)	
THICKENING TIME - DEPTH SCH/HRS. MIN.	2-3 hrs		2-3 hrs	
COMPRESSIVE STRENGTH - PSI/HOURS				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Stab in float collar located 40' (1 joint) above float shoe on bottom.
2. Weld bottom of collars on bottom 4 joints.
3. Clean and Baker loc threads on float collar and shoe as well as bottom 4 joints.
4. Tac weld top of collars on bottom 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Run rigid centralizer in middle of bottom 2 joints, then one every other tool joint to within 100' of surface.
2. Use centralizer cement baskets as required due to lost circulation.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Stab into float collar with drill pipe. Attempt to circulate with water.
2. Pump 200 cu ft CaCl2 water followed by 100 cu ft of fresh water, 200 cu ft Flo-chek, 200 cu ft Geo-gel, then cement slurries.

PRESSURE TESTING AND LANDING

1. Use 1" pipe in annulus of 20" AND 26" hole to bring cement back to surface if necessary.
2. Wait on cement 8 hours.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	2000	20"	See attached drawing	1500	1500	

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CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM

SIZE	DEPTH		WELL
13-3/8"	3500'	Full String	KA3-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
0-3000'*	68	L-80	Buttress	2.03	1.95	1.51	6.44
3000-3500'**	72	L-80	Buttress	2.08	2.05	1.55	45.83
Casing Properties:*				Casing Propertires:**			
Collapse-2260 psi				Collapse-2670 psi			
Burst-5020 psi				Burst-5380 psi			
Tension-1,545,000 lbs				Tension-1,650,000 lbs			

DESIGN CONDITIONS

SURFACE BURST PRESSURE	- 3000	PSI	OUTSIDE MUD WT. (COLLAPSE) -	9.5	PPG
INSIDE MUD WEIGHT (BURST)	- 9.5	PPG	INSIDE MUD WT. (COLLAPSE) -	0	PPG
OUTSIDE MUD WEIGHT (BURST)	- 9.5	PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE) -	9.5	PPG
FRAC. GRAD. AT SHOE (BURST)	- 14.5	PPG	BIAXIAL LOAD: COLL. [X] BURST [X]	BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

4257 cu ft (1723 sx) Class G cemetn blended 1:1 with perlite and 40% silica flour, 4% gel and 0.65% CRF-2. Tailed with 300 cu ft (192 sx) of Class G cement blended with 40% silica flour and friction reducer. Both slurries to be blended with retardant to give 2-3 hours pumping time at reservoir temperature.

DESIRED TOP	EXCESS
Surface	100%

SLURRY VOL. - CU FT / (SLURRY NO.)	4257		300	
SLURRY YIELD - CUBIC FEET/SACK	2.47		1.56	
SLURRY DENSITY - PPG	97.25#/cu ft(13.0 ppg)		118#/cu ft (15.8 ppg)	
THICKENING TIME - DEPTH SCH/HRS. MIN.	2-3 hrs		2-3 hrs	
COMPRESSIVE STRENGTH - PSI/HOURS				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run stab in float collar 40' (1 joint) above float shoe on bottom.
2. Weld bottom of collars on bottom 4 joints.
3. Clean and Baker loc threads on float collar and shoe as well as bottom 4 joints.
4. Tac-weld top of collars on bottom 2 joints.
5. Run 13-3/8" as full string or liner with tie-back as hole conditions dictate. See attached procedure.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Run rigid centralizer in middle of bottom 8 joints. Then turbo-type centralizer on every other collar from bottom to within 200' of surface.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. If lost circulation is a problem run casing as directed in attached procedure. Use sodium silicate preflush as directoed.
2. Cement through drill pipe.
3. Pump cement of Stage 1 until cement appears at surface, then pump stage 2 cement.

PRESSURE TESTING AND LANDING

1. Wait on cement 12 hrs or until samples have set.
2. Cut & remove 20" casing. Install 12" x 20" expansion spool and blow out preventer stack as in attached drawing.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	3000	12-3/8"	Rotating head & ram	1500	1500	1000

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM

SIZE	DEPTH		WELL
13-3/8"	3500'±	Liner	KA3-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
900--3000'	68	L-80	Buttress	2.01	1.95	1.49	8.68
3000--3500'	72	L-80	Buttress	2.07	2.05	1.53	45.83

DESIGN CONDITIONS

SURFACE BURST PRESSURE	-	3000 PSI	OUTSIDE MUD WT. (COLLAPSE) -	9.5	PPG
INSIDE MUD WEIGHT (BURST)	-	9.5 PPG	INSIDE MUD WT. (COLLAPSE) -	0	PPG
OUTSIDE MUD WEIGHT (BURST)	-	9.5 PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE) -	9.5	PPG
FRAC. GRAD. AT SHOE (BURST)	-	14.5 PPG	BIAXIAL LOAD: COLL. [X] BURST [X]	BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

3340 cu ft (1041 sx) Class G cement blended with 50# per sack of cement of spherelite, 40% silica flour, 5% hydrated lime, 4% gel, 1.25% CFR-2, and 0.5% Halad-22A, tailed with 300 cu ft (189 sx) of Class G cement blended with 40% silica flour and friction reducer. Both slurries retarded to give 2--3 hrs pumping time at reservoir temperature.

DESIRED TOP: 900'± EXCESS: 100%

SLURRY VOL. - CU FT / (SLURRY NO.)	3340	300		
SLURRY YIELD - CUBIC FEET/SACK	3.21	1.59		
SLURRY DENSITY - PPG	82.2	118		
THICKENING TIME - DEPTH SCH/HRS, MIN.	2-3 hrs	2-3 hrs		
COMPRESSIVE STRENGTH - PSI/HOURS				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run float collar 40' above float shoe.
2. Weld bottom of collars on bottom 4 joints.
3. Clean and Baker loc threads on bottom 4 joints.
4. Tac-weld top of collars on last 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Hang liner 100' up inside 20" casing on drill pipe.
2. Run rigid centralizer cement baskets in middle of bottom 2 joints and one 10' up inside 20" casing and one just below stage collar if a stage is indicated.
3. Run centralizers every other tool joint to bottome of 20" casing.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Attempt to circulate with water.
2. Pump 20 cu ft CaCl2 water and 100 cu ft water, followed by 200 cu ft Flo-Chek the 200 cu ft of Geo-gel, then cement slurries.
3. See attached program for more detail.

PRESSURE TESTING AND LANDING

1. Wait on cement 8 hrs. Clean out cement from top of 13-3/8" liner. Test lap to 1000 psi. Squeeze lap if necessary. Clean out and retest until a test is obtaned.

BOP PROGRAM

API STACK. ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
		No change until tie-back run				

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM

SIZE	DEPTH		WELL
13-3/8"	900'±	Tie-Back	KA3-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
0-900'	68	K-55	Buttress	1.76	1.67	5.04	25.25

DESIGN CONDITIONS

SURFACE BURST PRESSURE	-	3000 PSI	OUTSIDE MUD WT. (COLLAPSE) -	9.5	PPG
INSIDE MUD WEIGHT (BURST)	-	9.5 PPG	INSIDE MUD WT. (COLLAPSE) -	0	PPG
OUTSIDE MUD WEIGHT (BURST)	-	9.5 PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE) -	9.5	PPG
FRAC. GRAD. AT SHOE (BURST)	-	14.5 PPG	BIAXIAL LOAD: COLL. [X] BURST [X]	BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

1059.8 cu ft (666 sx) Class G cement blended with 40% silica flour and 0.5% CFR-2.

			DESIRED TOP	EXCESS
			Surface	30%
SLURRY VOL. - CU FT / (SLURRY NO.)	1059.8			
SLURRY YIELD - CUBIC FEET/SACK	1.59			
SLURRY DENSITY - PPG	118			
THICKENING TIME - DEPTH SCH/HRS, MIN.	2-3 hrs			
COMPRESSIVE STRENGTH - PSI/HOURS	±2323/8 hrs			

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run float collar 40' above tie-back sleeve on bottom.
2. Clean and Baker loc threads on bottom 4 joints.
3. Tac-weld top and bottom of collars on bottom 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Run rigid centralizer in middle of bottom joint and one every other tool joint to surface except for top 100'.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Circulate with fresh water.
2. Run top plug only.
3. See attached program for more detail.

PRESSURE TESTING AND LANDING

1. Wait on cement 6 hrs before landing and cutting off 13-3/8" for wellhead.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	3000	12-3/8"	See attached drawing	1500	1500	

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM — SIZE: 9-5/8" | DEPTH: 7000' | Liner | WELL: KA3-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
3300--5300'	40	L--80	Buttress	2.04	1.97	1.08	6.08
5300--6500'	43.5	L--80	Buttress	2.17	2.30	1.16	13.71
6500--7000'	47	L--80	Buttress	2.30	2.29	1.36	47.74

DESIGN CONDITIONS

SURFACE BURST PRESSURE	-	3000 PSI	OUTSIDE MUD WT. (COLLAPSE) -	9.5	PPG
INSIDE MUD WEIGHT (BURST)	-	9.5 PPG	INSIDE MUD WT. (COLLAPSE) -	0	PPG
OUTSIDE MUD WEIGHT (BURST)	-	9.5 PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE) -	9.5	PPG
FRAC. GRAD. AT SHOE (BURST)	-	14.5 PPG	BIAXIAL LOAD: COLL. [X] BURST [X]	BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

2000 cu ft (810 sx) of Class G cement blended 1:1 with perlite and 40% silica flour. 4% gel and 0.65% friction reducer. Tailed with 300 cu ft (192 sx) of Class G cement blended with 40% silica flour and friction reducer. Both slurries to be blended with retardant to give 2-3 hrs pumping time at reservoir temperature. DESIRED TOP: To liner top | EXCESS: 100%

SLURRY VOL. - CU FT / (SLURRY NO.)	2000		300	
SLURRY YIELD - CUBIC FEET/SACK	2.47		1.56	
SLURRY DENSITY - PPG	97.25#/cu ft (13.0 ppg)		118#/cu ft (15.8 ppg)	
THICKENING TIME - DEPTH SCH/HRS. MIN.	2-3 hrs		2-3 hrs	
COMPRESSIVE STRENGTH - PSI/HOURS				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run float collar 80' (2 joints) above float shoe on bottom.
2. Weld bottom of collars on bottom 4 joints.
3. Clean and Baker loc threads on bottom 4 joints as well as threads on float collar and shoe.
4. Tac weld top of collars on bottom 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Hand liner 200' up inside 13-3/8" casing with drill pipe.
2. Run rigid centralizers in middle of bottom 4 jonts and then 1 turbo type centralizer every collar to within 200' of top.
3. Run stage collars and external casing packer as in attached procedures.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Attempt to circulate with water.
2. Pump cement and preflush as in attached procedures.

PRESSURE TESTING AND LANDING

1. Wait on cement 12 hrs. Clean out cement from top of 9-5/8" liner. Test lap to 1000 psi. Squeeze lap if necessary to obtain good pressure test.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
		No change until tie-- back run				

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM

SIZE	DEPTH		WELL
9-5/8"	3300'±	Tie-Back	KA3-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
0-3300'	40	L-80	Buttress	2.10	1.92	2.34	7.17

DESIGN CONDITIONS

SURFACE BURST PRESSURE	- 3000	PSI	OUTSIDE MUD WT. (COLLAPSE) -	9.5	PPG
INSIDE MUD WEIGHT (BURST)	- 9.5	PPG	INSIDE MUD WT. (COLLAPSE) -	0	PPG
OUTSIDE MUD WEIGHT (BURST)	- 9.5	PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE) -	9.5	PPG
FRAC. GRAD. AT SHOE (BURST)	- 14.5	PPG	BIAXIAL LOAD: COLL. [X] BURST [X]	BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

1140 cu ft (704 sx) Class G cement blended with 40% silica flour and 0.5% CFR-2.

	DESIRED TOP	EXCESS
	Surface	30%

SLURRY VOL. - CU FT / (SLURRY NO.)	1140			
SLURRY YIELD - CUBIC FEET/SACK	1.62			
SLURRY DENSITY - PPG	116			
THICKENING TIME - DEPTH SCH/HRS, MIN.	2-3 hrs			
COMPRESSIVE STRENGTH - PSI/HOURS	±2323/8 hrs			

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run float collar 40' above tie-back sleeve on bottom.
2. Clean and Baker loc threads on bottom 4 joints.
3. Tac-weld top and bottom of collars on bottom 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Run centralizers in middle of botton joint and one every other tool joint to surface except for top 100'.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Circulate with fresh water.
2. Run top plug only.
3. See attached program for more detail.

PRESSURE TESTING AND LANDING

1. Wait on cement 6 hrs before landing and cutting off 9-5/8" for expansion spool and blow out preventers.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	1500	8-1/2"	See attached drawing	1500	1500	1000

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MUD

MUD, LOGGING, WELLHEAD & DIRECTIONAL PROGRAMS

WELL KA3-1

DEPTH INTERVAL	MUD TYPE	WEIGHT	API FLUID LOSS	YIELD POINT	PH	
0-100'	Gel and water	65#/ft³	---	15	9.0	
100-1000'	Gel and water or air*	70#/ft³	10cc	15	9.0	
1000-3500'	Gel and water or air*	70#/ft³	10cc	15	10.0	
3500-7000'±	Gel and water or air*	70#/ft³	3.2cc	15	10.0	
7000-T.D.	Water or air*	65#/ft³	or 3000 cfm			

REMARKS
*If unable to maintain circulation due to lost circulation, first attempt to aerate system, then attempt to drill with air with rotary bit or air hammer (see attached). If misting is required, it may be necessary to increase air volume 30%. Misting mix should be fresh water mixed with 2-6 gal/10BBls of Magcobar Foamer. Maintain a solution pH above 10.0 to inhibit corrosion. Use Unisteam as outlined in special considerations.

LOGGING

DEPTH INTERVAL	LOG TYPES	LOG SCALES
100-1000'*	Temperature log & logs as directed	1" and 5" = 100'
1000-3500'*	Temperature log & logs as directed	1" and 5" = 100'
3500-7000'	Temperature log & logs as directed	1" and 5" = 100'
7000-T.D.	Temperature log & logs as directed	1" and 5" = 100'
0-T.D.	Samples every 10'	

REMARKS
All logs to be determined by geologist.
*Apply for waiver requiring E-log on these sections of the well.

WELLHEAD

API NOMINAL SIZE	WORKING PRESSURE PSI	TYPE	MAKE
26"	100 psi		
20" S.O.W. x 21-1/4" 2000	2000 psi	*Weld on wellhead	WKM
21-1/4" 2000 x 12" 900	3000 psi	21-1/4" x 12" expansion spool with two 3" 2000 outlets	WKM
12" x 12"	3000 psi	12" 900 Ansi WKM Pow-R-Seal master valve	WKM

REMARKS

DIRECTIONAL OR STRAIGHT-HOLE

Drill hole as straight as possible, taking directional shots every 100'± from 0-7000' and on dull bits after 7000'. 0-3500' maximum deviation to be 5°, maximum rate of change to be 1½° per 100'. 3500-7000' maximum deviation to be 8°, maximum rate of change to be 1½° per 100'. 7000-T.D. monitor without control.