### 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.

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- 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

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AUXILIARY EQUIPMENT THAT SHOULD BE MAINTAINED WITH THE RIG

- 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 20,000-40,000 40,000-150,000 150,000+ 5 gal UniSteam-10/BBl water 10-15 gal UniSteam-10/BBl water 20-35 gal UniSteam-10/BBl water 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).

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. 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.

- Use Instructions & Operations Sheet TE 7.00381. a. Measure all parts OD and ID. Check threads on all tools.
- b.
- Midway liner hanger running tool. Stinger must be с. 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.
- Part numbers are given on print TE 7.00377 for d. 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.

- All parts and number should check with prints. e.
- 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.
  - Guide shoe. a.
  - b. Centralizers on two joints.
  - Float collar. c.
  - d. Centralizers as per program.
  - e. Casing.
  - f. CTC Packers 200' off bottom.
  - q. One joint with centralizer in middle.
  - h. HOS Cementer.
  - i. Centralizers as per program - run casing adjusters located 1500' and 3000' from shoe. Casing to top of liner. Fill liner as going in
  - j. hole.
  - k. Make up SR Baffle Collar on bottom of liner hanger.\*
  - 1. Take O-ring off SR plug set and put on SR Baffle Collar.
  - Make up SR plug set on Baffle Collar and tighten at m. plug set to Baffle Collar. Be sure all parts are tight.
  - Circulate the liner at 3-4 BPM. Stop and circulate 2-3 times while running in hole with liner assembly n. 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.
  - Calculate volume of cement for bottom stage. a. (200 ft of 12-1/4" hole and 9-5/8" annulus plus shoe joint volume and volume to inflate CTC Packer).
  - Mix cement for above. b.
  - Pump cement for 200' annulus and shoe joint. Release first stage dart 809.81266 and pump cement c. for inflated CTC. (Cement to inflate packer should be Class G with 40% silica flour and friction reducer, no perlite.)
  - Pump 10 BBls spacer then displace with mud at 3-4 d. 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.
  - Displace shut off plug at 5-6 BPM until 30 BB1s  $\,\cdot\,$ e. before plug lands. Then pump at 1-2 BPM.

- When shut off plug lands in shut off baffle, f. pressure up to 500 psi and shut down.
- 12. Inflate CTC Packer with cement. See attached Recommendations During Inflation Sequence for further details.
  - Check volume of displacement tank. а.
  - Increase pressure slowly to 700 psi and shut down. b.
  - Increase pressure slowly to 800 psi. c.
  - d. Increase pressure slowly to 900 psi or until tool opens.
  - Pump in 2-5 cu ft of cement per stage until CTC е. packer is inflated.
  - Increase pressure to 1000 psi to close CTC packer. With pressure at 500 psi, check volume of cement f.
  - g. needed to inflate tools.
  - h. Pressure up to 2800 psi and open HOS.
  - i. Circulate well as needed.
  - Cement liner as per program. Pump spacer. Pump j. cement.
  - k. Release dart for shut off plug. Pump at 4-5 BPM. Pump 10 BBls spacer - then mud.
  - Displace to within 10 BBls of plug, slow to 2 BPM. 1. Pressure to 1950-2000 psi to release plug. Displace at 4-5 BPM. m.
  - n.
  - When plug lands in HOS, pressure up to 3000 psi to ο. close tool. You may have to go to 3500 psi. Hold pressure for 2 minutes.
  - Release pressure if holding; back off liner hanger p. tool.
  - Come out of hole with tools. q.
  - Wait 24 hrs and drill out. r.
- 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.
- to change bits to 8-1/2" and clean out cement from 15. Trip 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:

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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).
  - Bottom wiper lands in float collar. b.
  - c.
  - First top wiper passes packer. First top wiper lands in float collar, and d.
  - Top of inflation cement (second top wiper plug) e. relative to upper packer.
- 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 8. Total 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:
    - Hydrostatic pressure inside casing (packer 1. depth) + Applied surface pressure
    - OR
    - 2. Hydrostatic pressure outside casing (packer depth) + Differential inflation pressure
  - b. Differential inflation pressure equals: Total inflation pressure minus Pressure 1.
    - outside casing (packer depth)
    - OR

d.

- 2. Applied surface pressure minus Balance pressure
- c. Balance pressure equals:
  - Surface pressure required to offset "U" tube 1. pressure
  - 2. Approximated by surface pressure (pumping at 1/4-1/2 BB1/min) just prior to plug bump.
  - 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.
- Re-tally casing during run-in 9. Review casing tally. 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.

- 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 BB1/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".

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#### 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.

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## 9-5/8" CASING PROPERTIES

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

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FIGURES

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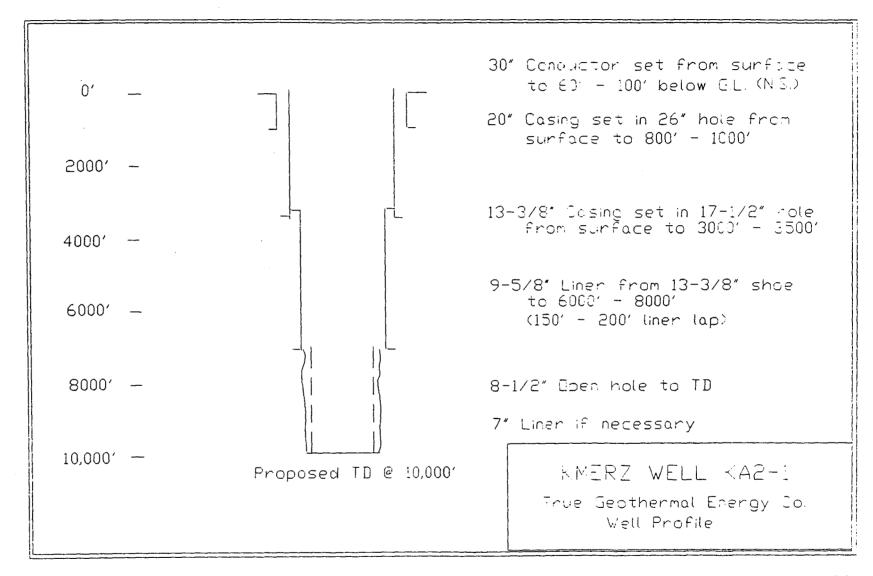
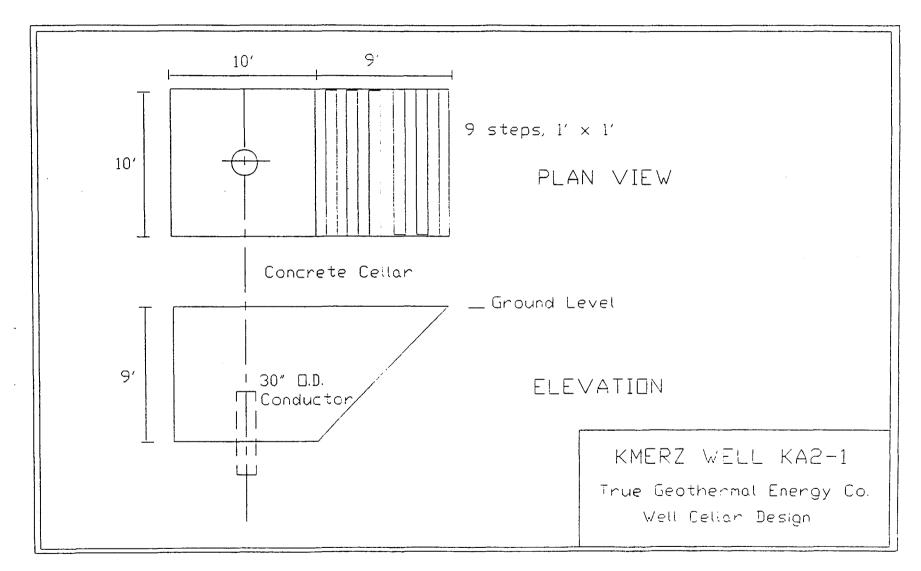
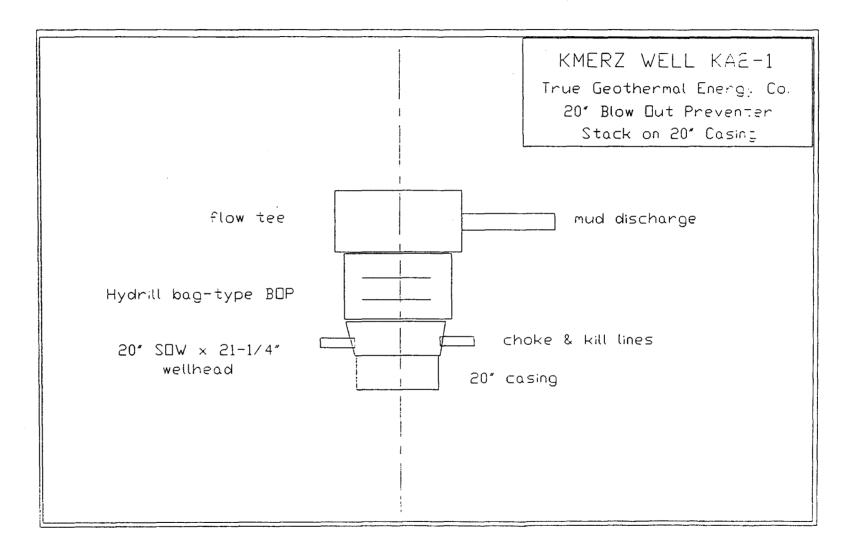


FIGURE 001





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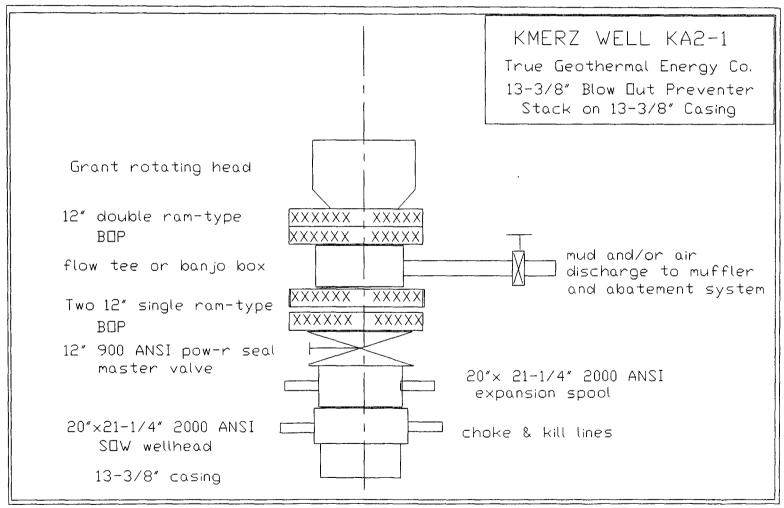


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FIGURE 003



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FIGURE 004

TABLES

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CASING PROGRAM	51	2e 20''	DEPTH 1000'		WEL	C A2-1	
INTERVAL	WEIGHT	GRADE	JOINT TYPE	CALCU TOP BURST	LATED SAFET		
0-1000'	106.5	K-55	Buttress	3.31	9.21	1.64	TENSIO
Casing Properties:						<u> </u>	
Collapse-770 psi							
Burst-2320 psi							<u>۰</u> .
Tension-1,683,000 lbs.							
		DESIGN C	CONDITIONS		I	L	4 <u></u>
SURFACE BUPST PRESSURE -	2000	PSI	OUTSIDE MUD WT. (CO	DLLAPSE) -	9.95	)	8 P
INSIDE MUD WEIGHT (BURST) -	9.5	PPG	INSIDE MUD WT. (COL	LAPSE) -	0		PP
OUTSIDE MUD WEIGHT (BURST) -	9.5	PPG	FORM, PRESS. GRAD.	AT SHOE (COL	LAPSE) -	9.5	. PP
FRAC. GRAD. AT SHOE (BURST) -	14.5	PPG	BIAXIAL LOAD: COLL.	BURST	BOUYANCY:	YES	ΝΟ 👔
CEMENTING PROGRAM	•						
	SLUP	RRY DESCRIPT	ION AND PROPERTIE	s			
SCUARY DESCRIPTION (AND NUMBER)	0					6	
2690 cu ft (838 sx) of Class							enc,
40% silica flour, 4% gel, 5%						WILI	<u> </u>
400 cu ft (252 sx) of Class (	cement	c blended w	1th 40% silica		GUAULZ	EXCESS	
				<u> </u>	Surface	100	)%
SLURRY VOL CU FT / (SLURRY NO.)	2	2690		400	)		
SLURRY YIELD - CUBIC FEET/SACK	3.2	21 cu ft/sx		1.59 cu	ft/sx		
SLURRY DENSITY - PPG	82.2	#/cu ft(11 ppg	3)	118#/cu ft(	15.8 ppg)	<u>.                                    </u>	
THICKENING TIME - DEPTH SCH/HRS, MIN	1. 2-	-3 hrs		23 hrs			
COMPRESSIVE STRENGTH - PSI/HOURS							
			NTING INSTRUCTION	IS			
<ol> <li>Stab in float collar located 40</li> <li>Weld bottom of collars on bottom</li> <li>Clean and Baker loc threads on f</li> <li>Tac weld top of collars on bottom</li> </ol>	1 4 joint: 10at coli	s. lar and shoe a		joints.			
<ul> <li>CENTRALIZERS AND SCRATCHERS. NUMBER.</li> <li>1. Run rigid centralizer in middle</li> <li>2. Use centralizer cement baskets a</li> </ul>	of botto	om 2 joints, ed due to los	then one every other t circulation.	r tool joint to	o within 100	)' of su	rface.
<ol> <li>PREFLUSH, DISPLACEMENT RATE, PLUGS, A</li> <li>Stab into float collar with dril</li> <li>Pump 200 cu ft CaCl2 water follo</li> </ol>	l pipe.	Attempt to c			00 cu ft Geo	⊢gel, t	hen

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

BOP PROGRAM

APISTACK	WORKING PRESSURE	MINIMUM		т	EST PRESSURES - PSI
ARRANGEMENT CODE	PRESSURE	INCHES	TYPE	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		13-3/8"	3'500'	Fı	ull Strin	O	ΚΛ2 -1		
INTERVAL	WEIGH		JOINT TYPE		CALCULATED SAFETY FACTORS				
	L8/F				TOP BURST	807. 8U. 14,7	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:*			·	Cas	ing Prope	rtires:**			
Collapse-2260 psi				Co1	Lapse-267	) psi			
Burst-5020 psi				Bure	st-5380 p	5i		L	
Tension-1.545.000 1bs		DESIG	N CONDITIONS	Tens	sion-1.65	0.000 lbs			
SURFACE BURST PRESSURE	- 30	<u>00 PSI</u>	OUTSIDE MUD WT. (	COLL	APSE) -	9	.5	PPG	
INSIDE MUD WEIGHT (BURST)	- 9	.5 PPC	INSIDE MUD WT. (CO	OLLAP	PSE) -	0		PPG	
OUTSIDE MUD WEIGHT (BURST)	- 9	.5 PPC	G FORM. PRESS. GRA	D. AT	SHOE (COLL	APSE) - 9	.5	PPG	
FRAC. GRAD. AT SHOE (BURST)	- 14	.5 PPC	BIAXIAL LOAD: COLL	L. 🚺	BURST X	BOUYANCY:	YES	№ 👔	
CEMENTING PROGRAM									

#### SLURRY DESCRIPTION AND PROPERTIES

SLUARY 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 blende	d with 40% s	ilica flour
and friction reducer. Both slurries to be blended with retardant to	give 2-3 hou	rs pumping
	DESIRED TOP	EXCESS
time at reservoir temperature.	Surface	100%

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

### RUNNING AND CEMENTING INSTRUCTIONS

Run stab in float collar 40' (1 joint) above float shoe on bottom.
 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.

# 1. If lost circulation is a problem run casing as directed in attached procedure. Use sodium silicate preflush as directoed.

Cement through drill pipe.
 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	MINIMUM BORE	TYPE	ŤI	EST PRESSURES .	P \$1
ANNANGEMENT CODE	PSI	INCHES		RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	3000	12-3/8"	Rotating head & ram	1500	1500	1000

<b>v</b> ,			IG AND BOP PROGRAMS				
CASING PROGRAM	SI	ze 133/8''	3500'±	Liner	WEL	 KA21	
INTERVAL	WEIGHT	GRADE	JOINT TYPE		LATED SAFET	Y FACTO	·····
	LB/FT	T 00		TOP BURST			TENSION
900-3000'	68	<u>L-80</u>	Buttress	2.01	1.95		8.68
3000-3500'	72	<u>L80</u>	Buttress	2.07	2.05	1.53	45.83
1		·					
					l		
URFACE BURST PRESSURE -			CONDITIONS	LAPSE) -			PPG
INSIDE MUD WEIGHT (BURST) -			INSIDE MUD WT. (COLL			9_5 0	PPG
)UTSIDE MUD WEIGHT (BURST) -			FORM. PRESS. GRAD.			v	PPG
FRAC. GRAD. AT SHOE (BURST) -			BIAXIAL LOAD: COLL.		r		NO [Y]
EMENTING PROGRAM	<u>_</u>						
· · · · · · · · · · · · · · · · · · ·	\$1.116		TION AND PROPERTIES		<u></u>		
SLURRY DESCRIPTION (AND NUMBER)		·····					<u></u>
3340 cu ft (1041 sx) Class (							
silica flour, 5% hydrated 1						<u>th 300</u>	cu ft
(189 sx) of Class G cement	plended v	vith 40% s	ilica flour and f			th slu	rries
retarded to give 23 hrs pur	nping tir	ne at rese	rvoir temperature		900'±	excess 100	%
LURRY VOL CU FT / (SLURRY NO.)		3340	300				
SLURRY YIELD - CUBIC FEET/SACK		3.21	1.59				
LURRY DENSITY - PPG		82.2	118				
HICKENING TIME - DEPTH SCH/HRS, M	IN.	2-3 hrs	2-3 hrs				
COMPRESSIVE STRENGTH - PSI/HOURS							
	RUNN	ING AND CEM	ENTING INSTRUCTIONS				
1. Run float collar 40' above floa 2. Weld bottom of collars on bottom	at shoe.						
<ol> <li>Weld bottom of collars on botto</li> <li>Clean and Baker loc threads on</li> </ol>							
4. Tac-weld top of collars on last		<i>,</i>					
ENTRALIZERS AND SCRATCHERS - NUMBER	•			· · · · · · · · · · · · · · · · · · ·			
<ol> <li>Hang liner 100' up inside 20" of 2. Run rigid centralizer cement be</li> </ol>			tom 2 joints and our	101 um impida	2011		<b>.</b>
<ol> <li>Run rigid centralizer cement be below stage collar if a stage t</li> </ol>	is indicate	ed.	LOM 2 JOINTS and one	10° up inside	20° casing	and one	just
3. Run centralizers every other to	xol joint (	to bottame of	20" casing.				
<ol> <li>Attempt to circulate with water</li> <li>Attemp 20 cu ft CaCl2 water and 1 slurries.</li> </ol>	<b>.</b>		ed by 200 cu ft Flo-C	hek the 200 c	u ft of Geo-	gel, th	en cement
3. See attached program for more of	letail.						
RESSURE TESTING AND LANDING			2 2/01 liner Test 1		. <u> </u>		

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

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## JOP PROGRAM

API STACK WORKING MINIMUM				TEST PRESSURES - PSI					
ARRANGEMENT CODE	PRESSURE PSI	BORE INC	TYPE	RAM TYPE	ANNULAR TYPE ROTATING HE				
		1	·····						

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CASING, CEMENTING AND BOP PROGRAMS

A		SIZE		DEPTH			WE	L L	
CASING PROGRAM		13:	3/8"	900'±	Ti	e-Back		KA21	
INTERVAL	WEIGH		ADE	JOINT TYPE		the second secon	LATED SAFE	TY FACTO	ORS
	LB/F	r				TOP BURST	BOT. BURST	COLL.	TENSION
0900'	68	K	55	Buttress		1.76	1.67	5.04	25.25
								1	
		D	ESIGN	CONDITIONS			4		· · · · · · · · · · · · · · · · · · ·
SURFACE BURST PRESSURE	-	3000	PSI	OUTSIDE MUD WT.	ICOLL	APSE) -		9.5	PPG
INSIDE MUD WEIGHT (BURST)	-	9.5	PPG	INSIDE MUD WT. (C	OLLA	PSE) -		0	PPG
OUTSIDE MUD WEIGHT (BURST)	-	9.5	PPG	FORM. PRESS. GRA	D. AT	SHOE (COLI	APSEI -	9.5	PPG
FRAC. GRAD. AT SHOE (BURST)		14.5	PPG	BIAXIAL LOAD: COLI	L. [X]	BURST [X]	BOUYANCY:	YES	мο [Ϋ]
CEMENTING PROGRAM									

SLURRY DESCRIPTION IAND NUMBERI

#### SLURRY DESCRIPTION AND PROPERTIES

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

			DESIRED TOP	EXCESS
			Surface	30%
LURRY VOL CU FT / (SLURRY NO.)	1059.8			
SLURRY YIELD - CUBIC FEET/SACK	1.59			·····
LURRY DENSITY - PPG	118			
THICKENING TIME - DEPTH SCH/HRS, MIN.	2-3 hrs			
COMPRESSIVE STRENGTH - PSI/HOURS	±2323/8 hrs			
	RUNNING AND CEMENTING	INSTRUCTIONS		

1. Run float collar 40' above tie-back sleeve on bottom.

2. 3.

Clean and Baker loc threads on bottom 4 joints. 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.

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

RESSURE TESTING AND LANDING

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

## JOP PROGRAM

API STACK .	WORKING	MINIMUM		Т	EST PRESSURES . PSI
ARRANGEMENT CODE	PS1	INCHES	TYPE	RAM TYPE	ANNULAR TYPE ROTATING HEAD

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in a constant			IG AND BOP PROGRA	MS		-		
CASING PROGRAM	SI	2E 95/8"	7000'	L	iner	1,	₩ELL KA21	
INTERVAL	WEIGHT	GRADE	JOINT TYPE	Ţ		Y ***	FETY FACTO	1
	LB/FT	L DO			TOP BURST			TENSION
3300-5300'	40	L80	Buttress		2.04	1.97		6.08
53006500'		L80	Buttress		2.17	2.30		13.71
6500-7000'	47	L80	Buttress		2.30	2.29	1.36	47.74
		DESIGN	CONDITIONS					
SURFACE BURST PRESSURE -	3000		OUTSIDE MUD WT. 1	COLL	APSE) -	·	9.5	DAd
INSIDE MUD WEIGHT (BURST) -	9.5		INSIDE MUD WT. (CC		PSE) -			PPG
OUTSIDE MUD WEIGHT (BURST) -	9.5		FORM. PRESS. GRAD	D. AT	SHOE (COLL	APSE) -		PPG
FRAC. GRAD. AT SHOE (BURST) -	14.5		BIAXIAL LOAD: COLL					NO ( <u>х</u>
EMENTING PROGRAM						·		
***************************************	SLUR	RY DESCRIPT	ION AND PROPERTI	ES				
SLURRY DESCRIPTION (AND NUMBER)								
2000 cu ft (810 sx) of Class	<u>G</u> cemer	<u>it blended</u>	1:1 with perli	te ai	nd 40% si	lica fl	our, 4%	gel
and 0.65% friction reducer.	Tailed w	ith 300 ci	u ft (192 sx) of	f_C1a	ass <u>G</u> cem	ent ble	nded with	h 40%
silica flour and friction re	ducer.	Both slur	ries to be blend	ded	<u>with reta</u>	<u>rdant t</u>	o give 2	<u>-3 hr.s</u>
<u>pumping time at reservoir te</u>						liner t		
SLURRY VOL CU FT / (SLURRY NO.)		2000			10			<u></u>
SLURRY YIELD - CUBIC FEET/SACK		2.47			<u></u>			
LURRY DENSITY - PPG	97.25	/cu ft (13.0	(2011 (		118#/cu ft (		)	
THICKENING TIME - DEPTH SCH/HRS. MI		-3 hrs			2-3 hr		<u> </u>	
COMPRESSIVE STRENGTH - PSI/HOURS								
	RUNN	ING AND CEM	ENTING INSTRUCTIC	 DNS				
<ol> <li>Run float collar 80' (2 joints)</li> <li>Run float collar 80' (2 joints)</li> <li>Weld bottom of collars on bottom</li> <li>Clean and Baker loc threads on</li> <li>Tac weld top of collars on bottom</li> </ol>	above flo m 4 joints bottom 4	s. joints as wel		oat co	ollar and s	hoe.		· · · · · · · · · · · · · · · · · · ·
<ol> <li>Hand liner 200' up inside 13-3/</li> <li>Run rigid centralizers in middl of top.</li> <li>Run stage collars and external</li> </ol>				e cent	tralizer ev	ery colla	<b>ir</b> to withi	n 200'
Attempt to circulate with water 2. Pump cement and preflush as in								
RESSURE TESTING AND LANDING 1. Wait on cement 12 hrs. Clean o sary to obtain good pressure te		from top of	9-5/8" liner. Test	t lap	to 1000 ps	i. Squee	eze lap if	neces

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DP PROGRAM					
API STACK	WORKING	พบพุเพษ		т	EST PRESSURES + PSI
RRANGEMENT CODE	PRESSURE PSI	BORE	TYPE	RAM TYPE	ANNULAR TYPE ROTATING

» · ·		ZE	NG AND BOP PROGRA	ma	WEI		
CASING PROGRAM		95/8"	3300'±	Tie-Back		KA2-1	
INTERVAL	WEIGHT	GRADE	JOINT TYPE	CALC TOP BURS	ULATED SAFE	1	TENSIO
03300'	40	L80	Buttress	2.10	1.92	2.34	7.17
		DESIGN	CONDITIONS				
URFACE BURST PRESSURE -	3000	PSI	OUTSIDE MUD WT. 10	COLLAPSE) -		9.5	990
INSIDE MUD WEIGHT (BURST) -	9.5	PPG	INSIDE MUD WT. (CO	LLAPSE) -		)	PPC
DUTSIDE MUD WEIGHT (BURST) -	9.5	PPG	FORM. PRESS. GRAD	AT SHOE (CO	LAPSEI - (	).5	PP(
FRAC. GRAD. AT SHOE (BURST) -	14.5	PPG	BIAXIAL LOAD: COLL.	[χ] BURST [χ]	BOUYANCY:	YES	ΝΟ [χ]
EMENTING PROGRAM							
SLURAY DESCRIPTION (AND NUMBER)	SLUR	RY DESCRIP	TION AND PROPERTI	ES			
1140 cu ft (704 sx) Class G (	ement b	lended wit	th 40% silica fl	our and 0.5	CFR-2.		
						, <b>*</b>	
					. <u></u>		
				0	Surface	EXCESS	0%
			<u> </u>	<u>I</u> _	Surface	<u>_</u>	J/6
LURRY VOL CU FT / (SLURRY NO.)		1140					
SLURRY YIELD . CUBIC FEET/SACK		1.62					
LURRY DENSITY - PPG		116					
THICKENING TIME - DEPTH SCH/HRS, MI		3 hrs					
COMPRESSIVE STRENGTH - PSI/HOURS		<u>3/8 hrs</u>					
SHOE, COLLARIS) AND JOINT STRENGTHENIN	G		ENTING INSTRUCTIO	NS			
<ol> <li>Run float collar 40' above tie-4</li> <li>Clean and Baker loc threads on 1</li> </ol>	ack sleev						
3. Tac-weld top and bottom of cold			S.				
				·····			
1. Run centralizers in middle of b			very other tool join	t to surface e	xcept for top	o 100'.	
	5		, j				
PREFLUSH, DISPLACEMENT RATE, PLUGS, R	ECIPROCAT	ION, ETC.			= · _ p		
<ol> <li>Circulate with fresh water.</li> <li>Run top plug only.</li> </ol>							
3. See attached program for more de	etail.						
			·				
1. Wait on cement 6 hrs before land							

⊳ОР	PROGR	AM
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API STACK	WORKING	MINIMUM		TEST PRESSURES - PSI
ARRANGEMENT CODE	P\$I	INCHES	TYPE	RAM TYPE ANNULAR TYPE ROTATING HEAD
1	1500	Q 1/21	C · · · · · ·	

ThermaSource Inc.

UD	MUD, LOGGING, WELLHE		KA2-1			
DEPTH INTERVAL	MUD TYPE	WEIGHT	API FLUID LOSS	YIELD POINT	РН	
0-100'	Gel and water	65#/ft <sup>3</sup>		15	9.0	
100-1000'	Gel and water or air*	70#/ft <sup>3</sup>	10cc	15	9.0	
1000-3500'	Gel and water or air*	70#/ft'	10cc	15	10.0	
3500-7000'±	Gel and water or air*		3.2cc	15	10.0	
7000-T.D.	Water or air*	65#/ft'	or_3000_cfm			

\*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/10BB1s of Magcobar Foamer. Maintain a solution pH above 10.0 to inhibit corrosion. Use Unisteam as outlined in special considerations.

#### LOGGING

LOG TYPES	LOG SCALES		
Temperature log & logs as directed	1" and 5" = 100'		
Temperature log & logs as directed	1" and 5" = 100'		
Temperature log & logs as directed	<u>1" and 5" = 100'</u>		
Temperature log & logs as directed	1" and 5" = 100'		
Samples every 10'			
-	Temperature log & logs as directed Temperature log & logs as directed Temperature log & logs as directed Temperature log & logs as directed		

er requiring E-log on these sections of the well. uppa y

## WELLHEAD

API NOMINAL SIZE	WORKING PRESSURE PSI	TYPE	MAKE
26''	<u>100 psi</u>		······································
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'. O-3500' maximum deviation to be 5°, maximum rate of change to be  $l\frac{1}{2}^{\circ}$  per 100'. 3500-7000' maximum deviation to be 8°, maximum rate of change to be  $l\frac{1}{2}^{\circ}$  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.

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- 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.

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- 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

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- 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.

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#### 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:

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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 20,000-40,000 40,000-150,000 150,000+

2

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5 gal UniSteam-10/BBl water 10-15 gal UniSteam-10/BBl water 20-35 gal UniSteam-10/BBl water 40 gal UniSteam-10/BBl water PROCEDURE FOR RUNNING AND CEMENTING 13-3/8" CASING

a construction of the second second

1. Drill to casing depth.

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a programme a construction

- 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.

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- 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.

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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.

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- 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.

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- 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

"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.

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- 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

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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.

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- 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

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- 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.

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- 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.\*
- 1. 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.
  - 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.
  - Check volume of displacement tank. a.
  - Increase pressure slowly to 700 psi and shut down. Increase pressure slowly to 800 psi. Increase pressure slowly to 900 psi or until tool b.
  - c.
  - d. opens.
  - Pump in 2-5 cu ft of cement per stage until CTC e. 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.
  - Circulate well as needed. i.
  - 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.
  - Displace to within 10 BBls of plug, slow to 2 BPM. 1.
  - Pressure to 1950-2000 psi to release plug. m.
  - Displace at 4-5 BPM. n.
  - When plug lands in HOS, pressure up to 3000 psi to ο. close tool. You may have to go to 3500 psi. Hold pressure for 2 minutes.
  - Release pressure if holding; back off liner hanger p. tool.
  - Come out of hole with tools. α.
  - Wait 24 hrs and drill out. r.
- 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.
- cement for 12 hrs. Run in hole with 12-1/4" bit to 14. Wait on 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:

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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 88.31bs/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:
  - Bottom wiper passes packers (knockoff rods). a.
  - Bottom wiper lands in float collar. b.
  - c.
  - First top wiper passes packer. First top wiper lands in float collar, and d.
  - Top of inflation cement (second top wiper plug) e. relative to upper packer.
- 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 8. Total setting depth, 2. pore pressure, 3. fracture pressure, 4. maximum recommended differential inflation pressure from hole size vs pressure chart, 5. resultant effective stress.
  - Total inflation pressure equals: a.
    - Hydrostatic pressure inside casing (packer 1. depth) + Applied surface pressure
    - OR
    - Hydrostatic pressure outside casing (packer 2. depth) + Differential inflation pressure
  - b. Differential inflation pressure equals:
    - Total inflation pressure minus Pressure 1. outside casing (packer depth) OR
    - Applied surface pressure minus Balance 2. pressure
  - Balance pressure equals: c.
    - Surface pressure required to offset "U" tube 1. pressure
    - Approximated by surface pressure (pumping at 2. 1/4-1/2 BB1/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.)
- 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 BB1/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.
  - 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".

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## THINGS TO AVOID

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- 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.

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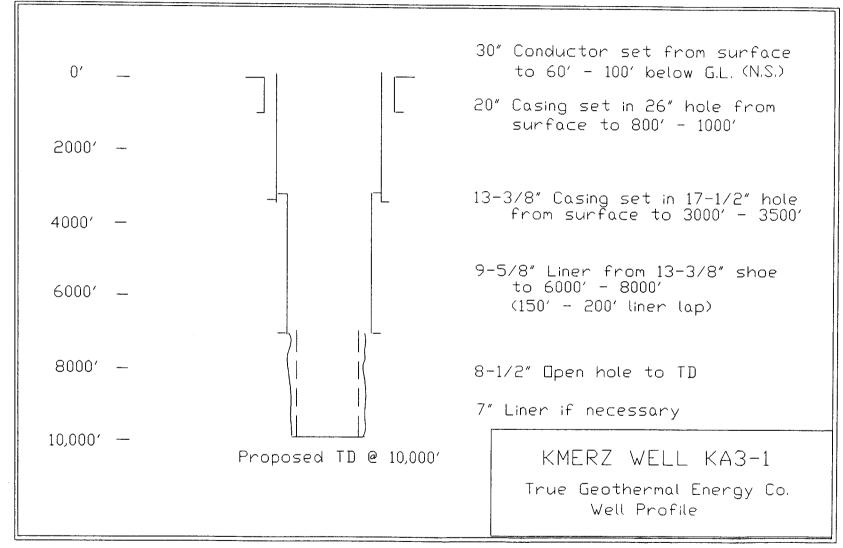
# 9-5/8" CASING PROPERTIES

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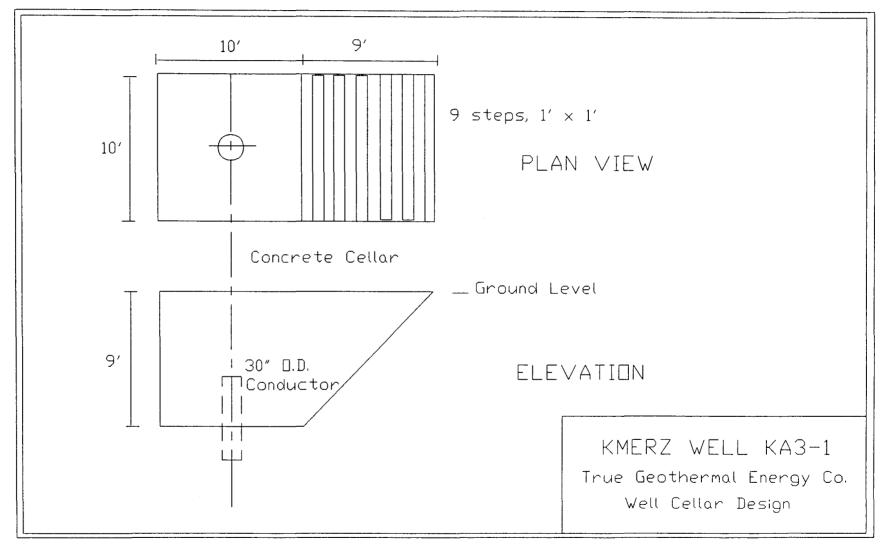
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L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi, Tension: 947,000 lbs. FIGURES



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FIGURE 001

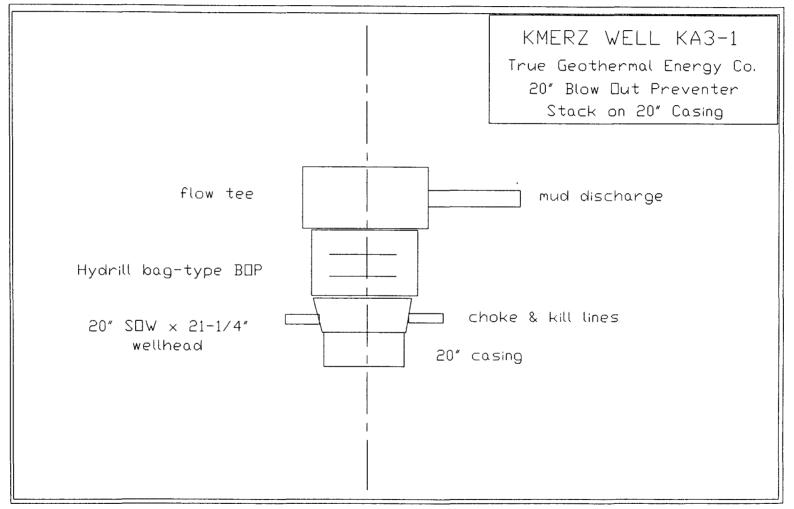


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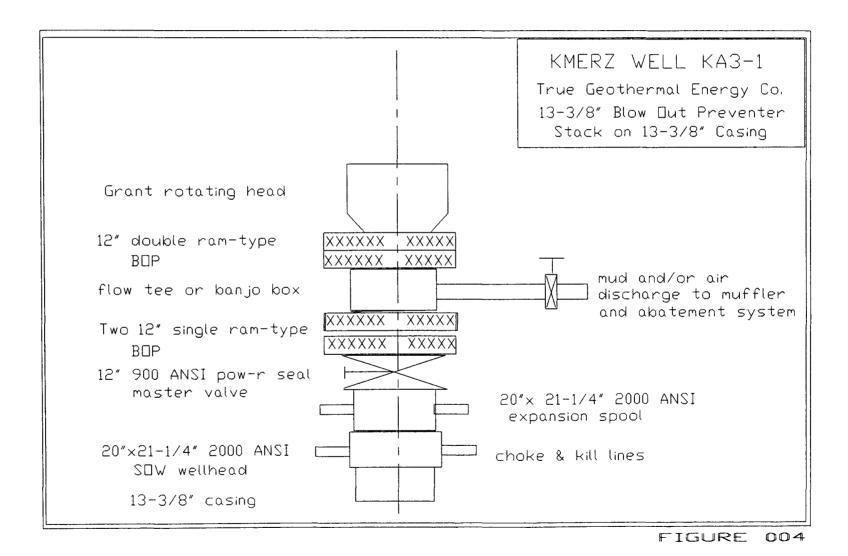
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# FIGURE 002



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FIGURE 003



	51	2 E	DEPTH		WE	LL				
CASING PROGRAM		20"	1000'		the second s	KA3-1				
INTERVAL	WEIGHT	GRADE	JOINT TYPE	TOP BURST	BOT. BURS		TENSIO			
0-1000'	106.5	K-55	Buttress	3.31	9.21	1.64	9.99-			
Casing Properties:		<u> </u>								
Collapse-770 psi						1	<u> </u>			
Burst-2320 psi										
Tension-1,683,000 lbs.										
		DESIGN C	ONDITIONS							
SURFACE BURST PRESSURE -	2000	PSI	OUTSIDE MUD WT. (COLLAPSE) - 9.95 PPG							
INSIDE MUD WEIGHT (BURST) -	9.5	PPG	INSIDE MUD WT. (COLI	LAPSE) -	C	)	PP			
OUTSIDE MUD WEIGHT (BURST) ~	9.5	PPG	FORM. PRESS. GRAD.	AT SHOE (COL	LAPSE) -	9.5				
FRAC. GRAD. AT SHOE (BURST) -	14.5	PPG	BIAXIAL LOAD: COLL.	BURST	BOUYANCY:	YES	NO (X			
CEMENTING PROGRAM										
	SLUR	RY DESCRIPT	ION AND PROPERTIES	5						
2600 an ft (222 and a f (1a)		t blandad	with 50 lbs of a	-hovelite		of 00-				
<u>2690 cu ft (838 sx) of Clas</u>							:11,			
40% silica flour, 4% gel,						WILN_				
400 cu ft (252 sx) of Clas	s <u>G</u> cement	Diended w	uth 40% silica f	Lour and 3	SIRED TOP	EXCESS				
·					Surface	100	0%			
SLURRY VOL CU FT / ISLURRY NO.	) 2	2690		40	0					
SLURRY YIELD - CUBIC FEET/SACK	3.2	21 cu ft/sx		1.59 cu	ft/sx					
SLURRY DENSITY - PPG	82.2	/cu ft(11 pp	3)	118#/cu ft	(15.8 ppg)					
THICKENING TIME - DEPTH SCH/HRS.	MIN. 2-	-3 hrs		23 hrs						
COMPRESSIVE STRENGTH - PSI/HOUR										
	RUNN	ING AND CEM	ENTING INSTRUCTION	5						
<ol> <li>Stab in float collar located</li> <li>Weld bottom of collars on bot</li> <li>Clean and Baker loc threads of</li> <li>Tac weld top of collars on bot</li> </ol>	tom 4 joints on float coli	s. lar and shoe :		joints.						
1. Run rigid centralizer in mic 2. Use centralizer cement basket				tool joint t	o within 10	00' of su	rface.			
<ol> <li>Stab into float collar with c</li> <li>Pump 200 cu ft CaCl2 water fo</li> <li>cement slurries.</li> </ol>	rill pipe.	Attempt to c			00 cu ft G	eo-gel, t	hen			

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

BOP PROGRAM

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	WORKING	MINIMUM		TEST PRESSURES . PSI					
RRANGEMENT CODE PRESSURE PSI	INCHES	TYPE	RAM TYPE	ANNULAR TYPE	ROTATING HEAD				
	2000	20''	See attached drawing	1500	1500	•			

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ThermaSource Inc.		
20. Box 1236 • Santa Rosa, CA 95402		

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# CASING. CEMENTING AND BOP PROGRAMS

90. Box 1236 • Santa Rosa, CA 95402			G AND BOP PROGR	AMS		_					
CASING PROGRAM	51	13-3/8" 3300'			ull Strin		WELL				
· · · ·	WEIGHT	1	+	F		×	KA3-1	RS			
INTERVAL	LB/FT	GRADE	JOINT TYPE		TOP BURST			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:*				Cas	ing Prope	rtires:	**	]			
Collapse-2260 psi				Co1	lapse-267	) psi		·			
Burst-5020 psi			l	Bur	st-5380 p	51		<u> </u>			
Tension-1,545,000 lbs DESIGN CONDITIONS Tension-1,650,000 lbs											
SURFACE BURST PRESSURE -	3000	PSI	OUTSIDE MUD WT.	COLL	APSE) -		9.5	8P(			
INSIDE MUD WEIGHT (BURST) -	9.5	PPG	INSIDE MUD WT. (C	OLLA	PSE) -		0	PPC			
OUTSIDE MUD WEIGHT (BURST) -	9.5	PPG	FORM, PRESS. GRA	D. AT	SHOE (COLI	APSE) -	9.5	PP(			
FRAC. GRAD. AT SHOE (BURST) -	14.5	PPG	BIAXIAL LOAD: COL	L. 🛛	BURST X	BOUYANC	Y: YES	NO X			
CEMENTING PROGRAM											
	SLUR	RY DESCRIP	TION AND PROPERT	IES							
SLUAAY DESCRIPTION LAND NUMBER	-							_			
4257 cu ft (1723 sx) Class	s G cemetn	blended	l:1 with perlit	e an	d 40% sil	ica flo	our, 4% g	el and			
0.65% CRF-2. Tailed with	300 cu ft	(192 sx)	of Class G cem	ent	blended w	ith 40%	& silica	flour			
and friction reducer. Bot	<u>ch slurrie</u>	s to be b	lended with ret	arda	nt to giv	e 2-3 h	nours pum	ping			
time at reservoir temperat						urface	100				
SLURRY VOL CU FT / (SLURRY NO.	) 4	257			300						
SLURRY YIELD - CUBIC FEET/SACK		. 47			1.56			· · · ·			
SLURRY DENSITY - PPG		#/cu_ft(13.C			118#/cu ft (15.8 ppg)						
THICKENING TIME - DEPTH SCH/HRS.		-3 hrs			2-3 h						
COMPRESSIVE STRENGTH - PSI/HOUR											
	RUNN	ING AND CEN	AENTING INSTRUCTI	IONS	<u> </u>						
<ol> <li>Run stab in float collar 40'</li> <li>Weld bottom of collars on bo</li> <li>Clean and Baker loc threads</li> <li>Tac-weld top of collars on b</li> <li>Run 13-3/8'' as full string of</li> <li>Run rigid centralizer in mid hottom to within 200' of sur</li> </ol>	(1 joint) a ottom 4 joint on float col ottom 2 joint or liner with the of botto	above float s. Llar and sho nts. n tie-back a	shoe on bottom. e as well as botto s hole conditions	m 4 jo dicta	te. See att	cached pr very othe	rocedure. er collar f	rom			
1. If lost circulation is a pro directoed.	blemrun casi	ing as direc	ted in attached pr	ocedu	re. Use soo	lium sili	cate prefl	ush as			

directoed.
 Cement through drill pipe.
 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.

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

		NG, CEMENTIN	G AND BOP PROGRAM	S			<u> </u>			
CASING PROGRAM	13	133/8"	3500'±	Liner	1					
INTERVAL	WEIGHT	GRADE	JOINT TYPE		BOT. BUR	FETY FACTO	T			
900-3000'	68	L-80	Buttroog				TENSION			
30003500'	72	L-80	Buttress	2.01	1.95	1.49	[			
	12	L0U	Buttress	2.07	2.05	3	45.83			
					·					
			· · · · · · · · · · · · · · · · · · ·							
	l			<u> </u>	1		]			
			CONDITIONS							
SURFACE BURST PRESSURE -	30		OUTSIDE MUD WT. (COLLAPSE) - 9.5 PPG							
INSIDE MUD WEIGHT (BURST)			INSIDE MUD WT. (COL			0	PPG			
OUTSIDE MUD WEIGHT (BURST)			FORM. PRESS. GRAD.		· · · · · · · · · · · · · · · · · · ·	9.5	PPO			
FRAC. GRAD. AT SHOE (BURST) -	14	.5 PPG	BIAXIAL LOAD: COLL.	χ BURST   χ	BOUYANCI	Y: YES   )	NO   X			
CEMENTING PROGRAM				·····						
SLURRY DESCRIPTION (AND NUMBER)	SLUR	RY DESCRIPT	ION AND PROPERTIE	<u>S</u>						
3340 cu ft (1041 sx) Class	G cement	blended wi	ith 50# per sack	of cement of	of spher	elite. 4	0%			
silica flour, 5% hydrated ]										
(189 sx) of Class G cement										
				DE	SIRED TOP	EXCESS				
retarded to give 23 hrs pu	mping tir	ne at reser	rvoir temperature	<u>e.</u>	900'±	100	%			
SLURRY VOL CU FT / (SLURRY NO.)		3340					. <u></u> ,			
LURRY YIELD - CUBIC FEET/SACK		3.21	1.59							
LURRY DENSITY - PPG		82.2	118							
THICKENING TIME - DEPTH SCH/HRS, M	11N.	2-3 hrs	2-3 hrs							
COMPRESSIVE STRENGTH - PSI/HOURS										
· · · · · · · · · · · · · · · · · · ·			ENTING INSTRUCTION	S						
1. Run float collar 40' above flo 2. Weld bottom of collars on bott 3. Clean and Baker loc threads on 4. Tac-weld top of collars on las	i bottom 4	joints.								
<ol> <li>Hang liner 100' up inside 20"</li> <li>Run rigid centralizer cement to below stage collar if a stage</li> <li>Run centralizers every other to BEFLUSH. DISPLACEMENT RATE, PLUGS,</li> </ol>	casing on o askets in s is indicate col joint s	drill pipe. middle of bot ed. to bottome of		e 10' up inside	e 20'' casii	ng and one	jusť			
<ol> <li>Attempt to circulate with wate</li> <li>Pump 20 cu ft CaCl2 water and slurries.</li> </ol>	er. 100 cu ft v		ed by 200 cu ft Flo-	Chek the 200 c	cuft of G	co-gel, th	en ceme			
3. See attached program for more	cetaii.									

# JOP PROGRAM

API STACK.	WORKING	MINIMUM		TEST PRESSURES - PSI					
ARRANGEMENT CODE PRESSURE		INCHES	TYPE	RAM TYPE	ANNULAR TYPE ROT	ATING HEAD			
L		No chang	e until tie-back run						

• <del>*</del> •	CASIN	IG, CEMENTIN	IG AND BOP PROGR	AMS					
CASING PROGRAM	51	133/8"	900'±	Ti	e-Back	WE	WELL		
INTERVAL	WEIGHT	GRADE	JOINT TYPE	110		LATED SAFE	KA3-1	RS	
	L8/FT				TOP BURST	BOT. BURST	COLL.	TENSION	
0900'	68	K-55	Buttress		1.76	1.67	5.04	25.25	
							ļ	ļ	
					· · · · · · · · · · · · · · · · · · ·				
		DESIGN	CONDITIONS			<u> =</u>		······	
SURFACE BURST PRESSURE -		3000 <b>ps</b> i	OUTSIDE MUD WT.	COLL	APSE) -		9.5	544	
INSIDE MUD WEIGHT (BURST) -	(	9.5 PPG	INSIDE MUD WT. (CO	OLLA	PSE) -		0	PPG	
DUTSIDE MUD WEIGHT (BURST) -	ç	9.5 PPG	FORM. PRESS. GRA	D. AT	SHOE (COL	LAPSE) -	9.5	PPG	
FRAC. GRAD. AT SHOE (BURST) _	14	4.5 PPG	BIAXIAL LOAD: COLL	- (X)	BURST [X]	BOUYANCY:	YES	ио 🚺	
EMENTING PROGRAM			<u> </u>			* <u></u>			
	SLUR	RY DESCRIP	TION AND PROPERT	IES					
SLURRY DESCRIPTION (AND NUMBER)			44 <b>77</b>						
1059.8 cu ft (666 sx) Class	G cement	t blended	with 40% silica	<u>a flo</u>	our and O.	<u>.5% CFR-2.</u>	·		
								· · · · ·	
						Surface	excess 30		
LURRY VOL CU FT / (SLURRY NO.)		1050 0		T	l		1		
		1059.8					<del></del>		
SLURRY YIELD - CUBIC FEET/SACK		1.59							
LURRY DENSITY - PPG		118							
THICKENING TIME - DEPTH SCH/HRS, M		<u>-3 hrs</u>							
COMPRESSIVE STRENGTH - PSI/HOURS		3/8 hrs						<u> </u>	
SHOE, COLLARIS) AND JOINT STRENGTHENI		ING AND CEM	ENTING INSTRUCTION	ONS					
1. Run float collar 40' above tie	-back slee								
<ol> <li>Clean and Baker loc threads or</li> <li>Tac-weld top and bottom of col</li> </ol>	lars on bo	joints. ttom 2 joint	s.						
ENTRALIZERS AND SCRATCHERS - NUMBER				. 1 •	·		·	<u></u>	
1. Run rigid centralizer in middl	e or botto	n joint and	one every other to	or jo:	INT TO SULLA	ace except i	or top I	ω.	
PREFLUSH, DISPLACEMENT RATE, PLUGS,	RECIRROCAT		·						
1. Circulate with fresh water.									
<ol> <li>Run top plug only.</li> <li>See attached program for more</li> </ol>	detail.								
1 0									
RESSURE TESTING AND LANDING		·				<u></u>			
1. Wait on cement 6 hrs before la	nding and o	cutting off	13-3/8" for wellhe	ad.					

J	0	Ρ	Ρ	R	0	G	R	A	M	
_	-	-	-	-		_	-	-	_	_

API STACK -	WORKING	MINIMUM		TEST PRESSURES + PSI					
ARRANGEMENT CODE	EMENT CODE PSI INCHES		TYPE	RAM TYPE	ANNULAR TYPE ROTATING HEAD				
·	3000	123/8"	See attached drawing	1500	1500				

CASING, CEMENTING AND BOP PROGRAMS												
CASING PROGRAM	ST	95/8"	7000'	I.	iner		WELL					
INTERVAL	WEIGHT	GRADE	JOINT TYPE			LATED S		<u>KA3-1</u>	RS			
	L8/FT				TOP BURST	BOT. BU	RST	COLL.	TENSION			
33005300'	40	L80	Buttress		2.04	1.97		_1.08	6.08			
53006500'	43.5	L <u>80</u>	Buttress		2.17	2.30		1.16	13.71			
65007000'	47	L80	Buttress		2.30	2.29		1.36	47.74			
	DESIGN CONDITIONS											
URFACE BURST PRESSURE -	3000		OUTSIDE MUD WT. (	COLL	APSE) -		0	. 5	PPG			
INSIDE MUD WEIGHT (BURST) -	9.5		INSIDE MUD WT. (CO	DLLA	PSE) -		<u>_</u>	··	PPG			
DUTSIDE 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												
EMENTING PROGRAM			· · · · · · · · · · · · · · · · · · ·			<u> </u>			<u> </u>			
	SLUR	RY DESCRIPT	ION AND PROPERTI	IES								
SLUARY DESCRIPTION IAND NUMBERI	2						_					
2000 cu ft (810 sx) of Class												
and 0.65% friction reducer.												
silica flour and friction re	educer.	Both slur	ries to be blen	ded	with reta	rdant IRED TOP	to g	ive 2- Excess	-3 hrs			
pumping time at reservoir to	emperatur	e			То	liner	top	100	0%			
LURRY VOL CU FT / (SLURRY NO.)		2000			30	0	ļ					
SLURRY YIELD - CUBIC FEET/SACK		2.47			1.5	6						
LURRY DENSITY - PPG	. 97.25#	/cu ft (13.0	) ppg)		118#/cu ft (15.8 ppg)							
HICKENING TIME - DEPTH SCH/HRS. M	in. 2-	3 hrs			2-3 hrs							
COMPRESSIVE STRENGTH - PSI/HOURS												
		NG AND CEM	ENTING INSTRUCTIO	ONS								
1. Run float collar 80' (2 joints 2. Weld bottom of collars on bott 3. Clean and Baker loc threads on 4. Tac weld top of collars on bot	) above flo om 4 joints bottom 4 j	joints as wel		loat c	ollar and s	hoe.						
<ol> <li>ENTRALIZERS AND SCRATCHERS - NUMBER</li> <li>Hand liner 200' up inside 13-3</li> <li>Run rigid centralizers in midd of top.</li> <li>Run stage collars and external</li> </ol>	/8" casing le of botto	with drill p m 4 jonts ar			tralizer ev	ery coll	lar to	o within	n 200'			
PREFLUSH, DISPLACEMENT RATE, PLUGS, 1. Attempt to circulate with wate 2. Pump cement and preflush as in	r.		- <u> </u>									
RESSURE TESTING AND LANDING		<u> </u>										
<ol> <li>Wait on cement 12 hrs. Clean sary to obtain good pressure t</li> </ol>		from top of	9-5/8 <sup>°</sup> liner. Tes	st lap	) to 1000 ps	ti. Squ€	æze í	lap if	neces			

JOP PROGRAM

API STACK -	WORKING PRESSURE			т	EST PRESSURES -	P\$1
ARRANGEMENT CODE	PRESSORE	INCHES	TYPE	RAM TYPE	ANNULAR TYPE	ROTATING HEAD
		No char	ge until tie back run			

CASING PROGRAM	13	ZE					
	ļ	95/8"	3300'±	Tie-Bac	1	KA3-1	
INTERVAL	WEIGHT	GRADE	JOINT TYPE	c,	LCULATED SA		DRS
	L8/FT			TOP BU		AST COLL.	TENSION
03300'	40	L80	Buttress	2.10	) 1.92	2.34	7.17
·			ļ				<u></u>
L							
		DESIGN	CONDITIONS				<u></u>
SURFACE BURST PRESSURE -	3000	PSI	OUTSIDE MUD WT.	COLLAPSE)	_	9.5	PPG
INSIDE MUD WEIGHT (BURST) -	9.5		INSIDE MUD WT. (CO	OLLAPSE) -		0	PPG
OUTSIDE MUD WEIGHT (BURST) ~	9.5		FORM. PRESS. GRA	D. AT SHOE (	COLLAPSE) -		PPG
FRAC. GRAD. AT SHOE (BURST) -							ио [Х]
CEMENTING PROGRAM	14.5				<u>* 1000 mile</u>		
			······			·····	
SLURRY DESCRIPTION IAND NUMBERI	SLUF	RY DESCRIP	TION AND PROPERT				
1140 cu ft (704 sx) Class G	cement b	lended wit	h 40% silica fi	Lour and O	.5% CFR-2.		
	· , , ==						
			· · · · · · · · · · · · · · · · · · ·			<u> </u>	·····
· · ·			· · · · · · · · · · · · · · · · · · ·		DESIRED TOP	EXCESS	
					Surface		)%
SLURRY VOL CU FT / (SLURRY NO.)		1140					
SLURRY YIELD - CUBIC FEET/SACK		1.62					
SLURRY DENSITY - PPG		116					
THICKENING TIME - DEPTH SCH/HRS, M	IIN. 2-	3 hrs					
COMPRESSIVE STRENGTH - PSI/HOURS		3/8 hrs				<u> </u>	
		<u> </u>	ENTING INSTRUCTION		A	<u></u>	
SHOE, COLLARIS) AND JOINT STRENGTHEN	NG				<u></u>		
<ol> <li>Run float collar 40' above tie</li> <li>Clean and Baker loc threads on</li> </ol>							
3. Tac-weld top and bottom of co			s.				
CENTRALIZERS AND SCRATCHERS . NUMBE			or other tool ici	at to surface	avcout for	top $1(Y)!$	
1. Run centralizers in middle of	DOLLON JOIN	ic and one ev	ery outer toor jon		except for	top 100 .	
PREFLUSH, DISPLACEMENT RATE, PLUGS, 1. Circulate with fresh water.	RECIPROCA	TION, ETC.					
2. Run top plug only.							
3. See attached program for more	detail.						
			and the second				•
1. Wait on cement 6 hrs before las	nding and c	utting off 9	-5/8" for expansion	n spool and t	olow out prev	enters.	

BOP PROGRAM

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

# ThermaSource Inc.

ar	MUD, LOGGING, WELLHE		KA3-1			
DEPTH INTERVAL	MUD TYPE	WEIGHT	API FLUID LOSS	YIELD POINT	РН	
0-100'	Gel and water	65#/ft <sup>3</sup>		15	9.0	
100-1000'	Gel and water or air*	70#/ft'	10cc	15	9.0	
1000-3500'	Gel and water or air*	70#/ft	10cc	15	10.0	
3500-7000'±	Gel and water or air*	70#/ft'	3.2cc	15	10.0	
7000-T.D.	Water or air*	65#/ft <sup>3</sup>	or 3000 cfm	L		

\*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'
35007000'	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'	

\*Apply for waiver requiring E-log on these sections of the well.

#### WELLHEAD

API NOMINAL SIZE	WORKING PRESSURE PSI	TÝPE	MAKE
26''	100 psi		
20'' S.O.W. x 211/4'' 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  $100'\pm$  from 0-7000' and on dull bits after 7000'. 0-3500' maximum deviation to be 5°, maximum rate of change to be  $1\frac{1}{2}^{\circ}$  per 100'. 3500-7000' maximum deviation to be 8°, maximum rate of change to be  $1\frac{1}{2}^{\circ}$  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.

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- 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 20,000-40,000 40,000-150,000 150,000+ 5 gal UniSteam-10/BBl water 10-15 gal UniSteam-10/BBl water 20-35 gal UniSteam-10/BBl water 40 gal UniSteam-10/BBl water PROCEDURE FOR RUNNING AND CEMENTING 13-3/8" CASING

1. Drill to casing depth.

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- 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.

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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.

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- 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).

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.

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- 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

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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. 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.

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- 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.

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- 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

- casing depth at approximately 1. Drill to 6000 - 8000' dependent on temperature and geology.
- 2. Circulate for 2-3 hours.
- 3. Pull out of hole.

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- 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.
- Run 9-5/8" liner grades, weights and thread design as indicated in attached detail sheet with float shoe on bottom 8. Run float collar two joints up. Centralizers should be and 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.

Use Instructions & Operations Sheet TE 7.00381. a. Measure all parts OD and ID. Check threads on all tools.

- b.
- Midway liner hanger running tool. Stinger must be c. reduced down to 3" OD 2.75 ID and run 10-12.5"below bottom of liner hanger as shown on print TE This is when the liner hanger string is 7.00378. at the bottom of its travel.
- Part numbers are given on print TE 7.00377 for d. ID and OD for SR Plug set is given on print tools. TE 7.00379 OD and OD for HOS Cementer are given on print TE 7.00380.

- All parts and number should check with prints. e. 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.
- equipment onto casing strings. 10. Installing See attached Recommendations During Job for further details.
  - Guide shoe. a.
  - b. Centralizers on two joints.
  - Float collar. c.
  - d. Centralizers as per program.
  - Casing. e.
  - CTC Packers 200' off bottom. f.
  - g. One joint with centralizer in middle.
  - HOS Cementer. h.
  - Centralizers as per program run casing adjusters located 1500' and 3000' from shoe. Casing to top of liner. Fill liner as going in i.
  - j. hole.
  - k. Make up SR Baffle Collar on bottom of liner hanger.\*
  - Take O-ring off SR plug set and put on SR Baffle 1. Collar.
  - Make up SR plug set on Baffle Collar and tighten at m. plug set to Baffle Collar. Be sure all parts are tight.
  - Circulate the liner at 3-4 BPM. Stop and circulate n. 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.
  - Calculate volume of cement for bottom stage. (200 a. ft of 12-1/4" hole and 9-5/8" annulus plus shoe joint volume and volume to inflate CTC Packer).
  - Mix cement for above. b.
  - Pump cement for 200' annulus and shoe joint. c. 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.)
  - Pump 10 BBls spacer then displace with mud at 3-4 d. 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.
  - Displace shut off plug at 5-6 BPM until 30 BBls before plug lands. Then pump at 1-2 BPM. e.

- 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.
  - Release dart for shut off plug. Pump at 4-5 BPM.
     Pump 10 BBls spacer then mud.
  - 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:
  - Bottom wiper passes packers (knockoff rods). Bottom wiper lands in float collar. a.
  - b.
  - c.
  - First top wiper passes packer. First top wiper lands in float collar, and d.
  - Top of inflation cement (second top wiper plug) e. 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.
  - Total inflation pressure equals: a.
    - Hydrostatic pressure inside casing (packer 1. depth) + Applied surface pressure
    - OR
    - Hydrostatic pressure outside casing (packer depth) + Differential inflation pressure 2.
  - b. Differential inflation pressure equals:
    - Total inflation pressure minus Pressure 1. outside casing (packer depth)
    - OR
    - 2. Applied surface pressure minus Balance pressure
  - c. Balance pressure equals:
    - Surface pressure required to offset "U" tube 1. pressure
    - 2. Approximated by surface pressure (pumping at 1/4-1/2 BB1/min) just prior to plug bump.
  - Radial effective stress (Seal Load, Wellbore d. 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:

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- a. Flow rate into Payzone packers is relatively slow (1/4 BB1/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".

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#### 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

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

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# FIGURES

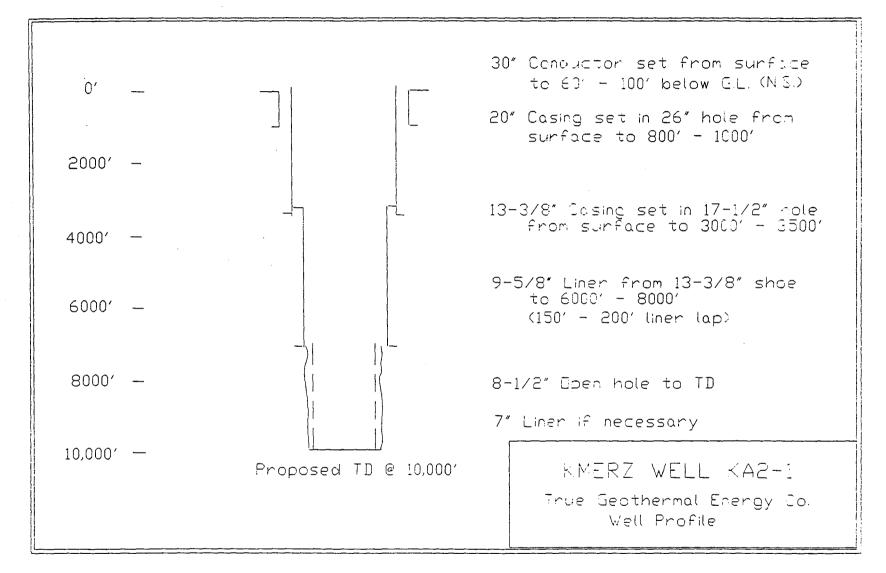
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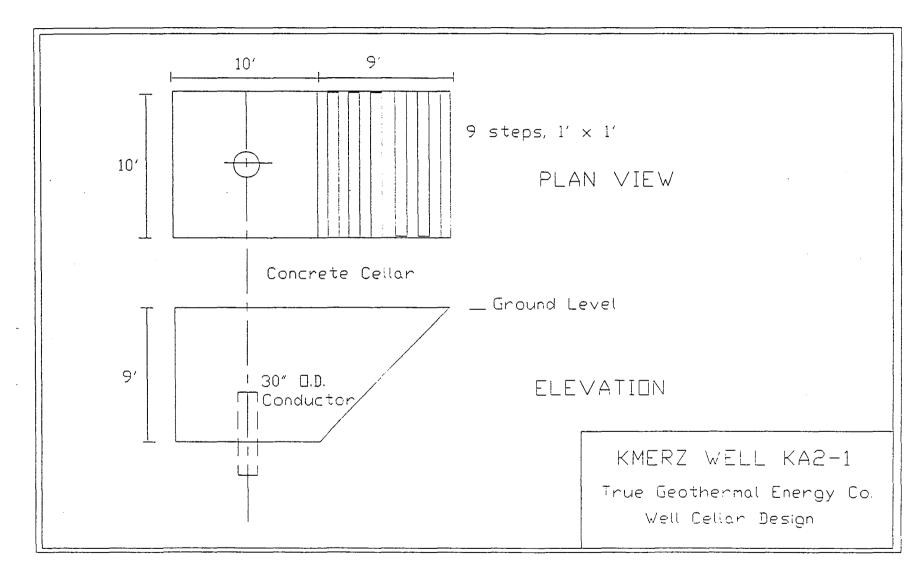
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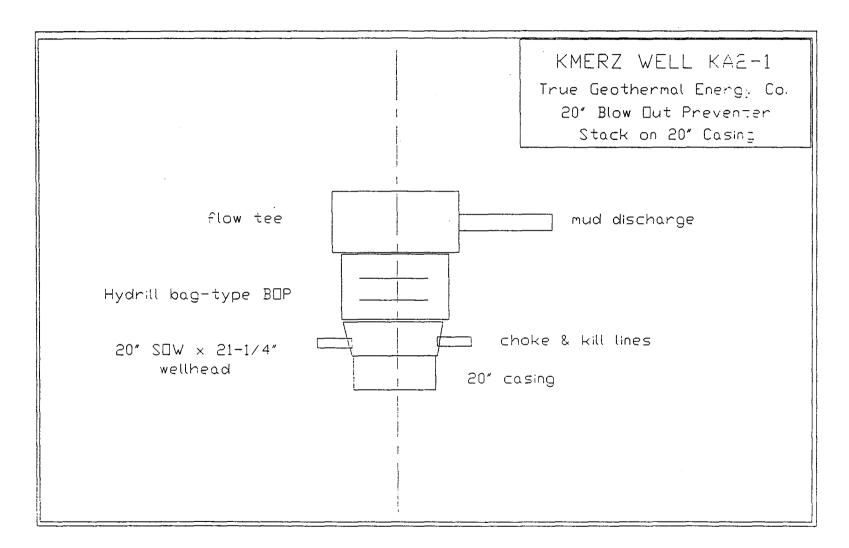




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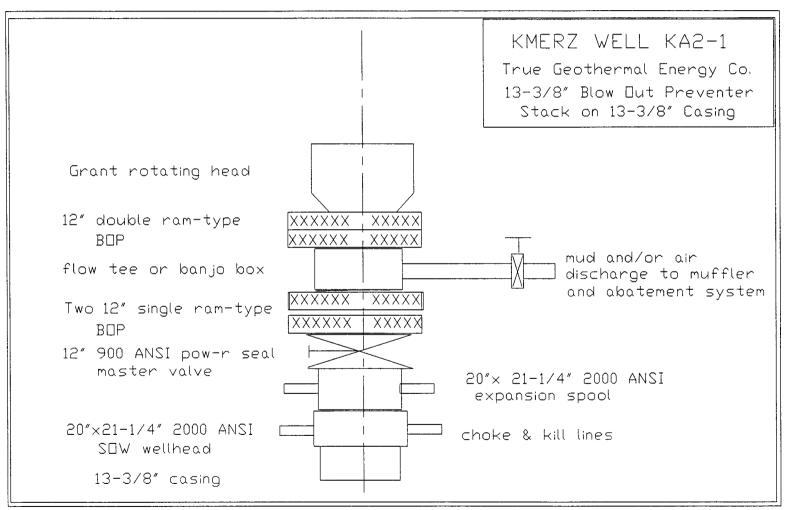
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TABLES

INTERAL       Lajor       Data for the start for th									
INTERVAL	WEIGHT	1			CALCULATED SAFETY FACTORS				
0-1000'		K-55	Buttress			-	7 ENSION		
	100.5	<u></u>	Duccicos		<u> </u>		2.2.2.2.		
			<u> </u>			-	· · .		
		DESIGN	CONDITIONS	K	1		1,		
SURFACE BURST PRESSURE -	2000	PSI	OUTSIDE MUD WT. (CO	OLLAPSE) -	9.9	5	PP(		
INSIDE MUD WEIGHT (BURST) -	·····	PPG	INSIDE MUD WT. (COL	LAPSE) -	0		PPC		
OUTSIDE MUD WEIGHT (BURST) -	9.5	PPG	FORM. PRESS. GRAD.	AT SHOE (COL	LAPSE) -	9.5	. PPC		
FRAC. GRAD. AT SHOE (BURST) -	14.5	PPG	BIAXIAL LOAD: COLL.	BURST	BOUYANCY:	YES	NO X		
CEMENTING PROGRAM	• · ·								
	SLUR	RY DESCRIPT	ION AND PROPERTIE	S					
							ent,		
						with			
400 cu ft (252 sx) of Class	<u>G</u> cement	blended v	ith 40% silica	flour and 3%	CaC12	EXCESS	<u> </u>		
			······		Surface	100	)%		
SLURRY VOL CU FT / (SLURRY NO.)	2	690		400	)		·		
SLURRY YIELD - CUBIC FEET/SACK	3.2	<u>l cu ft/s</u>	:	<u>1.59 cu</u>	ft/sx				
SLURRY DENSITY - PPG	82.2#	/cu ft(11 pp	g)	118#/cu ft(	15.8 ppg)				
THICKENING TIME - DEPTH SCH/HRS, M	IN. 2-	3 hrs		2-3 hrs					
COMPRESSIVE STRENGTH - PSI/HOURS									
				5					
<ol> <li>Weld bottom of collars on bottom</li> <li>Clean and Baker loc threads on</li> <li>Tac weld top of collars on bottom</li> </ol>	om 4 joints float coll tom 2 joint	ar and shoe s.	as well as bottom 4	-					
1. Run rigid centralizer in midd 2. Use centralizer cement baskets	le of botto as require	m 2 joints, d due to los	then one every other t circulation.	tool joint to	within 10	0' of sur	face.		
<ol> <li>Stab into float collar with dr.</li> <li>Pump 200 cu ft CaCl2 water fold</li> </ol>	ill pipe.	Attempt to c			10 cu ft Geo	o-gel, tł	nen		
<ol> <li>PRESSURE TESTING AND LANDING</li> <li>1. Use 1" pipe in annulus of 20" A</li> <li>2. Wait on cement 8 hours.</li> </ol>	ND 26" hol	e to bring c	ement back to surfac	e if necessary	•		v		
BOP PROGRAM				*****					

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# BOP PROGRAM

		· · · · · · · · · · · · · · · · · · ·			
WORKING			Т	EST PRESSURES -	PSt
PSI	INCHES	TYPE	RAM TYPE	ANNULAR TYPE	ROTATING HEAD
2000	20''	See attached drawing	1500	1500	
-	PRESSURE PSI	PRESSURE BORE PSI INCHES	PRESSURE BORE TYPE	PRESSURE BORE TYPE RAM TYPE RAM TYPE	PRESSURE BORE TYPE RAM TYPE ANNULAR TYPE

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

## CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM		51	13-3/8"	3500'	F	ull Strin	1	κλώ-1	
INTERVAL		GHT	GRADE	JOINT TYPE			LATED SAF		T
	LB	<u>/FT</u>				TOP BURST	BOT. BU.	T COLL.	TENSION
0-3000'*	6	8	L-80	Buttress		2.03	1.95	1.51	6.44
3000-3500'**	7	2	L-80	Buttress		2.08	2.05	1.55	45.83
Casing Properties:*				•	Cas	ing Prope	rtires:*	*	
Collapse-2260 psi					Col	lapse-267	) psi		
Burst-5020 psi					Bur	st-5380 p	5i		]
Tension-1.545.000 1bs			DESIGN	CONDITIONS	Ten	sion-1.65	0.000 11	S	
SURFACE BURST PRESSURE	-	3000	PSI	OUTSIDE MUD WT.	COLI	APSE) -		9.5	PPG
INSIDE MUD WEIGHT (BURST)	-	9.5	PPG	INSIDE MUD WT. IC	OLLA	PSE) -		0	PPG
OUTSIDE MUD WEIGHT (BURST)		9.5	PPG	FORM, PRESS. GRA	D. AT	SHOE (COLL	APSE) -	9.5	PPG
FRAC. GRAD. AT SHOE (BURST)	-	14.5	PPG	BIAXIAL LOAD: COL	L. (X)	BURST X	BOUYANCY	: YES 🛄	NΟ [Υ]
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. 100% Surface SLURRY VOL. - CU FT / (SLURRY NO.) 300

4257 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

- Run stab in float collar 40' (1 joint) above float shoe on bottom.
   Weld bottom of collars on bottom 4 joints.
   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.

If lost circulation is a problem run casing as directed in attached procedure. Use sodium silicate preflush as directoed.

Cement through drill pipe.
 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	MINIMUM BORE	BORE TYPE		TEST PRESSURES - PSI				
	P 51	INCHES		RAM TYPE	ANNULAR TYPE	ROTATING HEAD			
	3000	12-3/8''	Rotating head & ram	1500	1500	1000			

			IG, CEMENTIN	IG AND BOP PROGRA	MS			
CASING PROGRAM			133/8"	3500'±	Liner		KA21	
INTERVAL		EIGHT	GRADE	JOINT TYPE	TOP BUR	CULATED SAFE		TENSIO
9003000'		68.	L-80	Buttress	2.01	1,95		8.68
30003500'		72	L80	Buttress	2.07	2.05	1	45.83
				Ductiess				42.02
							+	
······								
· · · · · · · · · · · · · · · · · · ·			DESIGN	CONDITIONS	J		4	l
URFACE BURST PRESSU	RE -	300	····	OUTSIDE MUD WT. (	COLLAPSE) -		95	PP(
NSIDE MUD WEIGHT (BUR	ST) –	<u> </u>		INSIDE MUD WT. (CC	LLAPSE) -		0	PPC
UTSIDE MUD WEIGHT (BL	JRST) -	9.		FORM. PRESS. GRAD	D. AT SHOE (CO	LLAPSE) -	9.5	PPC
FRAC. GRAD. AT SHOE (B		14.		BIAXIAL LOAD: COLL	. X BURST X	BOUYANCY:		NO X
EMENTING PROGRAM			· · · · · · · · · · · · · · · · · · ·	L				
		SLUR	RY DESCRIP	TION AND PROPERTI	F S			
LURRY DESCRIPTION (AND								
3340 cu ft (1041								
silica flour, 5%								
(189 sx) of Class	G cement blo	ended w	/ith 40% s	ilica flour and	friction re	educer, Be	th slui	rries
retarded to give	23 hrs pump:	ing tim	ne at rese	rvoir temperatu		900'±	100%	7
LURRY VOL CU FT / 1	SLURRY NO.)	T	3340	300			-les	
LURRY YIELD - CUBIC FI			3.21	1.59				
LURRY DENSITY - PPG	······		82.2	118				
HICKENING TIME - DEPT	H SCH/HRS, MIN.		2-3 hrs	2-3 hrs			•	
COMPRESSIVE STRENGTH	- PSI/HOURS		<u> </u>	2 5 m 5				
	<u> </u>	RUNNI	NG AND CEM	ENTING INSTRUCTIO	INS			
HOE, COLLAR(S) AND JOINT	STRENGTHENING							
1. Run float collar 4 2. Weld bottom of col	llars on bottom	4 joints						
<ol> <li>Clean and Baker 10</li> <li>Tac-weld top of co</li> </ol>								
		0						
1. Hang liner 100' up								
2. Run rigid centrali	izer cement bask	ets in m	iddle of bot	tom 2 joints and or	ne 10' un insid	$1e^{20''}$ casing	and one	inet
below stage collar	f if a stage is	indicate	d.					Juse
3. Run centralizers e				20" casing.				
1. Attempt to circula	ANTE, PLUGS, REC	IPROCAT	ION, ETC.					
2. Pump 20 cu ft CaCl		cu ft w	ater, follow	ed by 200 cu ft Flo	Chek the 200	cu ft of Geo	-gel, the	en cemen
slurries. 3. See attached progr							-	
RESSURE TESTING AND LAN								······································
		cement f	rom top of 1	3-3/8" liner. Test	· lan to 100 ·	si Saucezo	lan if +	
sary. Clean out a	und retest until	a test	is obtaned.	, 1000		with the second	таћ те п	iccos.
OP PROGRAM	<u>, , , , , , , , , , , , , , , , , , , </u>		<u> </u>				<u> </u>	
API STACK	WORKING	MINIMUM			<u> </u>	TEST PRESSUR	RES . PSI	
ARRANGEMENT CODE	PRESSURE	BORE	1	TYPE	······			

¢

ARRANGEMENT CODE PRESSURE BORE TYPE RAM TYPE ANNUL AR TYPE ROTATING HEAD

	CASIN	IG, CEME	אודא	G AND BOP PROGRA	AMS				
CASING PROGRAM	51	133/	8 <sup>11</sup>	0EPTH 900'±	Ti	e-Back	WEL	кл21	
	VEIGHT	GRAC		JOINT TYPE		CALCU	LATED SAFET	FACTO	
0.900'	68	K-55	;	Buttroop		TOP BURST			TENSION
0900	00	<u> </u>	,	Buttress		1.76	1.67	5.04	25.25
	<u></u>								
·					·······				
		DES	IGN	CONDITIONS				I	
SURFACE BURST PRESSURE -		3000 F	≥SI	OUTSIDE MUD WT. (	COLL	APSEI -		9.5	PPG
INSIDE MUD WEIGHT (BURST) -	(	9.5 F	PPG	INSIDE MUD WT. (CO	DLLA	PSE) -		0	PPG
OUTSIDE MUD WEIGHT (BURST) -	ç	9.5 F	PG	FORM. PRESS. GRA	D. AT	SHOE (COLL	APSE) -	9.5	PPG
FRAC. GRAD. AT SHOE (BURST) -	14	4.5 F	PG	BIAXIAL LOAD: COLL	[X]	BURST [X]	BOUYANCY:	ES	№ [Х]
CEMENTING PROGRAM									
1	SLUR	RY DESC	RIPT	ION AND PROPERT	IES				L.
3LURRY DESCRIPTION LAND NUMBERI		t bland		with 10% addition	£1.				
1059.8 cu ft (666 sx) Class G	Cellen	r preud	leu	WILN 40% SIIICA	110	our and U.	<u>5% CFR-2.</u>	//////////////////////////////////////	
	· · · · · · · · · · · · · · · · · · ·						_ <u>,,.</u>		
					<del>,</del>	DES	RED TOP	EXCESS	
	- <u>I</u>	,·				S	urface	30	%
SLURRY VOL CU FT / (SLURRY NO.)		1059.	8						
SLURRY YIELD - CUBIC FEET/SACK		1.5	<u>9</u>			·			
SLURRY DENSITY - PPG		11	8						
THICKENING TIME - DEPTH SCH/HRS, MIN.	2-	-3 hrs							
COMPRESSIVE STRENGTH - PSI/HOURS	±2323	3/8 hrs							
	RUNN	ING AND	СЕМ	ENTING INSTRUCTIO	DNS				
<ol> <li>COLLARISI AND JOINT STRENGTHENING</li> <li>Run float collar 40' above tie-be</li> <li>Clean and Baker loc threads on bo</li> <li>Tac-weld top and bottom of collar</li> </ol>									
2 ENTRALIZERS AND SCRATCHERS - NUMBER, T 1. Run rigid centralizer in middle o			and c	one every other too	ol joi	nt to surfac	ce except fo	or top 10	œ'.
<ol> <li>Circulate with fresh water.</li> <li>Circulate with fresh water.</li> <li>Run top plug only.</li> <li>See attached program for more det</li> </ol>		ION, ETC.				<u></u>			
RESSURE TESTING AND LANDING			·						
1. Wait on cement 6 hrs before landi	.ng and c	cutting c	off 1	3-3/8" for wellhea	d.				

JOP PROGRAM

	API STACK . ARRANGEMENT CODE	WORKING	MINIMUM	TYPE	TEST PRESSURES + PSI
		PSI	INCHES		RAM TYPE ANNULAR TYPE ROTATING HEAD
ı	·	3000	10 0/-11	l <u>·</u> '	

· · · · · · · · · · · · · · · · · · ·	CASIN	G, CEMENTIN	IG AND BOP PROGRA	MS			
CASING PROGRAM	SI	′ <b>∈</b> 95/8''	DEPTH 7000'	Liner	WE	сс КА21	
r	WEIGHT	GRADE	JOUU JOINT TYPE		JLATED SAFE		)R \$
INTERVAL	LB/FT	GRADE	JOINT ITPE	TOP BURST	BOT. BURST	COLL.	TENSION
33005300 '	40	L80	Buttress	2.04	1.97	1.08	6.08
53006500'	43.5	L80	Buttress	2.17	2.30	1.16	13.71
6500-7000'	47	J80	Buttress	2.30	2.29	1.36	47.74
L							
		DESIGN	CONDITIONS				
SURFACE BURST PRESSURE -	3000	PSI	OUTSIDE MUD WT. (C	COLLAPSE) -		9.5	PPG
INSIDE MUD WEIGHT (BURST) -	9.5	PPG	INSIDE MUD WT. (CO	LLAPSE) -		0	PPG
	9.5	PPG	FORM, PRESS. GRAD	AT SHOE (COL	LAPSE) -	9.5	PPG
FRAC. GRAD. AT SHOE (BURST) -	14.5	PPG	BIAXIAL LOAD: COLL.	X BURST	BOUYANCY:	YES	ио 🚺
EMENTING PROGRAM							
	SLUR	RY DESCRIP	TION AND PROPERTI	ES			
SLURRY DESCRIPTION (AND NUMBER)							
2000 cu ft (810 sx) of Class	<u>G</u> cemen	t blended	1:1 with perlit	<u>e and 40% si</u>	lica flou	r, 4Z	gel
and 0.65% friction reducer, 1	<u>[ailed_w</u>	ith 300 c	u ft (192 sx) of	<u>Class G cer</u>	ent blend	ed with	1_40%
silica flour and friction rec	lucer.	<u>Both slur</u>	ries to be blend	ed with reta	rdant to	<u>sive 2</u>	<u>-3 hrs</u>
<u>pumping time at reservoir tem</u>				1	liner top		
JURRY VOL CU FT / (SLURRY NO.)		2000		30		1 <b>A</b> V	//0
SLURRY YIELD - CUBIC FEET/SACK		2.47		1.5			
LURRY DENSITY - PPG	97 25#	/cu ft (13.0		118#/cu ft			
THICKENING TIME - DEPTH SCH/HRS. MIN		3 hrs		2-3 hr			
COMPRESSIVE STRENGTH - PSI/HOURS		<u>o 1110</u>			5		
	RUNNI		ENTING INSTRUCTIO	 NS	l		
SHOE. COLLARIS AND JOINT STRENGTHENING		·······	<u></u>				
<ol> <li>Run float collar 80' (2 joints)</li> <li>Weld bottom of collars on bottom</li> </ol>			otton.				
<ol><li>Clean and Baker loc threads on t</li></ol>	pottom 4 j	oints as wel	1 as threads on flo	at collar and s	hœ.		
4. Tac weld top of collars on botto	xn 2 joint	s.					
ENTRALIZERS AND SCRATCHERS - NUMBER,	TYPE AND	SPACING	•				•
<ol> <li>Hand liner 200' up inside 13-3/8</li> <li>Run rigid centralizers in middle</li> </ol>	of botto	m 4 jonts ar	npe. Id then 1 turbo type	centralizer ev	ery collar t	to withi	n 200'
of top. 3. Run stage collars and external c					•		
	•••						
PREFLUSH, DISPLACEMENT RATE, PLUGS, RE 1. Attempt to circulate with water.	CIPROCAT	ION, ETC.	, , , , , , , , , , , , , , , , , , ,		**************************************		
2. Pump cement and preflush as in a	ittached p	rocedures.					
RESSURE TESTING AND LANDING							
1. Wait on cement 12 hrs. Clean ou		from top of	9-5/8" liner. Test	lap to 1000 ps	i. Squeeze	lap if r	neces
sary to obtain good pressure tes	SC.	Ņ					
	<u></u>						

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# BOP PROGRAM

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API STACK	WORKING PRESSURE	MINIMUM BORE		1	EST PRESSURES + PSI
ARRANGEMENT CODE	P\$I	INCHES	TYPE	RAM TYPE	ANNULAR TYPE ROTATING HEAD
, 1		37 1			

LASING PROGRAM	SIZ	•	IG AND BOP PROGRAM	J Tie-Back	w.	KA2-1	
INTERVAL	WEIGHT	GRADE	JOINT TYPE		LATED SAFE		T
03300'	40	L80	Buttress	7 10		1	TENSIO
03300	40	L00	Duccress	2.10	1.92	2.34	7.17
			· · · · · · · · · · · · · · · · · · ·				
	i	DESIGN	CONDITIONS		1		I
URFACE BURST PRESSURE -	3000	PSI	OUTSIDE MUD WT. ICC	DLLAPSE) -		9.5	999
NSIDE MUD WEIGHT (BURST) -	9.5	PPG	INSIDE MUD WT. (COL	LAPSE) -		<u></u>	PPO
DUTSIDE MUD WEIGHT (BURST) -	9.5	PPG	FORM, PRESS. GRAD.	AT SHOE (COLI	APSE) -	9.5	PP
RAC. GRAD. AT SHOE (BURST) -	14.5	PPG			1		мο [ <u>χ</u> ]
EMENTING PROGRAM		. <u></u>	L	<u>oo</u>	1		
	cl tint		ION AND PROPERTIES	. <u> </u>			
URRY DESCRIPTION (AND NUMBER)	<u> </u>	TUESCRIP	TION AND PROPERTIES	>			
					RED TOP	EXCESS	
				1	Surface	30	1%
LURRY VOL CU FT / (SLURRY NO.)		1140					
LURRY YIELD - CUBIC FEET/SACK		1.62					
LURRY DENSITY - PPG		116					
HICKENING TIME - DEPTH SCH/HRS, M	N. 2-3	hrs					
OMPRESSIVE STRENGTH - PSI/HOURS	±2323	/8 hrs					
		IG AND CEM	ENTING INSTRUCTION	5			
1. Run float collar 40' above tie- 2. Clean and Baker loc threads on 3. Tac-weld top and bottom of col	back sleeve bottom 4 jo	ints.	s.				
ENTRALIZERS AND SCRATCHERS - NUMBER						1001	
1. Run centralizers in middle of b	ottom joint	and one ev	ery other tool joint	to surface exc	ept for to	р 100'т	
REFLUSH, DISPLACEMENT RATE, PLUGS, I	ECIPROCATI	ON, ETC.	······				•
1. Circulate with fresh water.							
<ol> <li>Run top plug only.</li> <li>See attached program for more d</li> </ol>	etail.						
RESSURE TESTING AND LANDING 1. Wait on cement 6 hrs before land	ding and cu	tting off Q	5/8 <sup>1;</sup> for ourserion of	pool and blar	out provon		
1. Walt of celent of his before fail			-5/0 TOI EXPENSION S	poor and prow	out preven	ters.	

	API STACK	WORKING		ТҮРЕ	т	EST PRESSURES - PSI	
	ARRANGEMENT CODE	PSI	INCHES	1176	RAM TYPE	ANNULAR TYPE ROTATING HEAD	
I		1500	9 1/21	C		111	

# ThermaSource Inc.

D	MUD, LOGGING, WELLHE		ка2-1.			
DEPTH INTERVAL	MUD TYPE	WEIGHT	API FLUID LOSS	YIELD POINT	РН	
0-100'	Gel and water	65#/ft <sup>3</sup>		15	9.0	
100-1000'	Gel and water or air*	70#/ft'	10cc	15	9.0	
1000-3500'	Gel and water or air*	70#/ft'	10cc	15	10.0	
3500-7000'±	Gel and water or air*		3.2cc	15	10.0	
7000-T.D.	Water or air*	65#/ft'	or 3000 cfm	1		

\*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'
350070001	Temperature log & logs as directed	<u>1" and 5" = 100</u>
7000-T.D.	Temperature log & logs as directed	<u>1" and 5" = 100'</u>
0-T.D.	Samples every 10'	
All logs to be de *Apply for waiver	termined by geologist. requiring E-log on these sections of the wel	1.

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	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  $100'\pm$  from 0-7000' and on dull bits after 7000'. 0-3500' maximum deviation to be 5°, maximum rate of change to be  $l\frac{1}{2}^{\circ}$  per 100'. 3500-7000' maximum deviation to be 8°, maximum rate of change to be  $l\frac{1}{2}^{\circ}$  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.

4 1

- 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

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- 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 20,000-40,000 40,000-150,000 150,000+ 5 gal UniSteam-10/BBl water 10-15 gal UniSteam-10/BBl water 20-35 gal UniSteam-10/BBl water 40 gal UniSteam-10/BBl water

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

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- 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.

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- 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

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

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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.

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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

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- 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.

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- 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.

- All parts and number should check with prints. e. HOS Tool has four shear pins that will take 2880 f. 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.
  - Guide shoe. a.
  - Centralizers on two joints. b.
  - Float collar. c.
  - Centralizers as per program. d.
  - e. Casing.
  - CTC Packers 200' off bottom. f.
  - One joint with centralizer in middle. HOS Cementer. α.
  - h.
  - Centralizers as per program run casing adjusters i. located 1500' and 3000' from shoe.
  - Casing to top of liner. Fill liner as going in j. hole.
  - Make up SR Baffle Collar on bottom of liner k. hanger.\*
  - Take O-ring off SR plug set and put on SR Baffle 1. Collar.
  - Make up SR plug set on Baffle Collar and tighten at m. plug set to Baffle Collar. Be sure all parts are tight.
  - Circulate the liner at 3-4 BPM. Stop and circulate n. 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.
  - Calculate volume of cement for bottom stage. (200 a. ft of 12-1/4" hole and 9-5/8" annulus plus shoe joint volume and volume to inflate CTC Packer).
  - Mix cement for above. b.
  - Pump cement for 200' annulus and shoe joint. c. 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.
  - Displace shut off plug at 5-6 BPM until 30 BBls e. 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.
  - Release dart for shut off plug. Pump at 4-5 BPM.
     Pump 10 BBls spacer then mud.
  - 1. 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:

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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:
  - Run a casing scraper. a.
  - Drill open hole section with a stabilized packed b. 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:
  - Minimum wellbore restriction (should be 1/2" a. greater than packer OD).
  - b. If casing damage is suspected, run a microscopic caliper and/or casing scraper.
  - Calipered hole size in zone of interest should not c. exceed maximum recommended hole size. Use "Hole Size vs. Recommended Inflation Pressure Chart" to set pressure control valve.
  - If junk has been lost in hole it should be fished d. or driven to below Payzone setting depth.
  - Clients maximum allowable surface pressure (burst e. strength of casing with a safety factor), should be obtained prior to setting shear pin.
  - If hole size adjacent to end assemblies is more f. than 1" larger than packer OD run one centralizer above and below each packer.
- 5. Inspect auxiliary equipment.
  - Float shoe. a.
  - b. Float collar.
  - Bottom cement wiper plug (proper size, rupture c. diaphragm).
  - Two top cement wiper plugs (proper size, no rupture d. diaphragm).
  - Pressure recorder (5000 psi scale if possible). Chicksan lines. e.
  - f.
  - Cementing head. g.
  - Verify that adequate inflation cement is available. h.
  - Obtain a dry sample of all cements used on the job. i.
- 6. Review primary cementing plans and calculate theoretical bottom hole pressure during cementing operations. Ιf fracture gradient, pressure expected pressures approach 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:
  - Bottom wiper passes packers (knockoff rods). a.
  - Bottom wiper lands in float collar. b.
  - c.
  - First top wiper passes packer. First top wiper lands in float collar, and d.
  - Top of inflation cement (second top wiper plug) e.
    - relative to upper packer.
- 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 8. Total setting depth, 2. pore pressure, 3. fracture pressure, 4. maximum recommended differential inflation pressure from hole size vs pressure chart, 5. resultant effective stress.
  - Total inflation pressure equals: a.
    - Hydrostatic pressure inside casing (packer 1. depth) + Applied surface pressure OR
      - 2. Hydrostatic pressure outside casing (packer depth) + Differential inflation pressure
  - b. Differential inflation pressure equals: Total inflation pressure minus Pressure 1. outside casing (packer depth)
    - OR

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- 2. Applied surface pressure minus Balance pressure
- c. Balance pressure equals:
  - Surface pressure required to offset "U" tube 1. pressure
  - 2. Approximated by surface pressure (pumping at 1/4-1/2 BB1/min) just prior to plug bump.
- đ. 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.

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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:

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- a. Flow rate into Payzone packers is relatively slow (1/4 BB1/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". v

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#### 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.

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# 9-5/8" CASING PROPERTIES

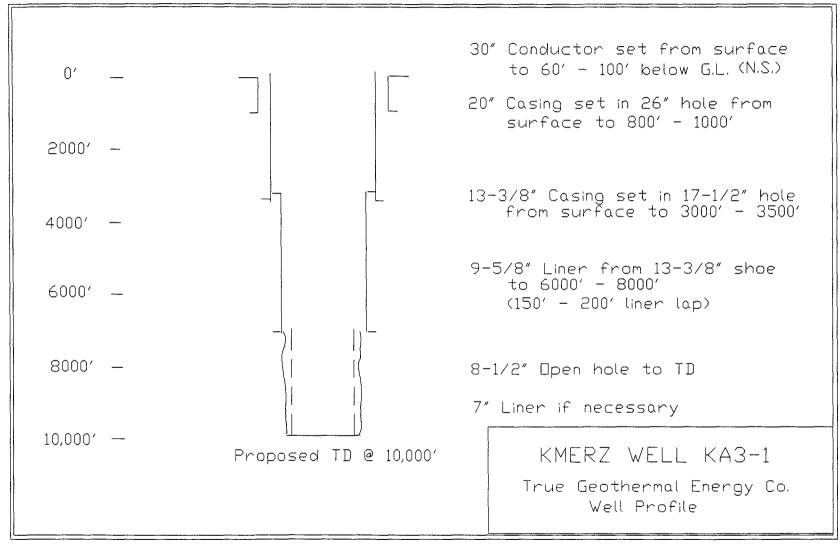
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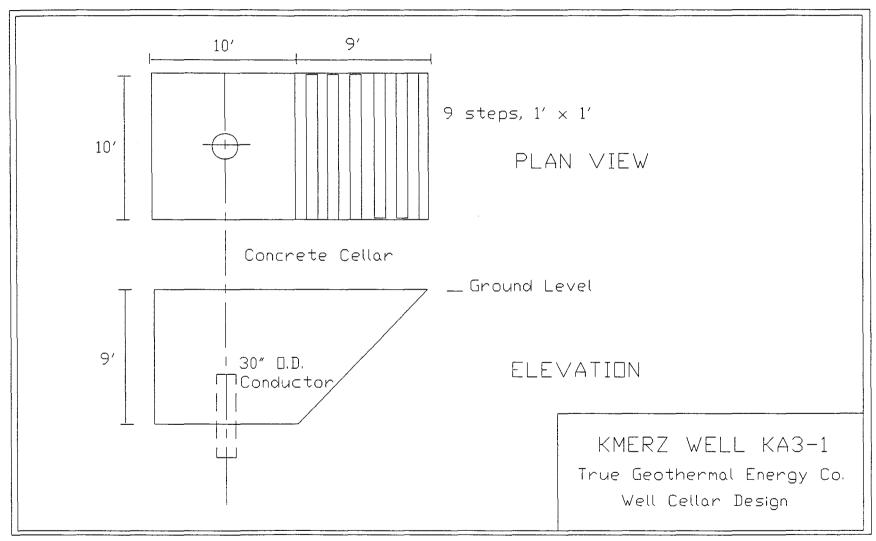
> L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi, Tension: 947,000 lbs.

FIGURES



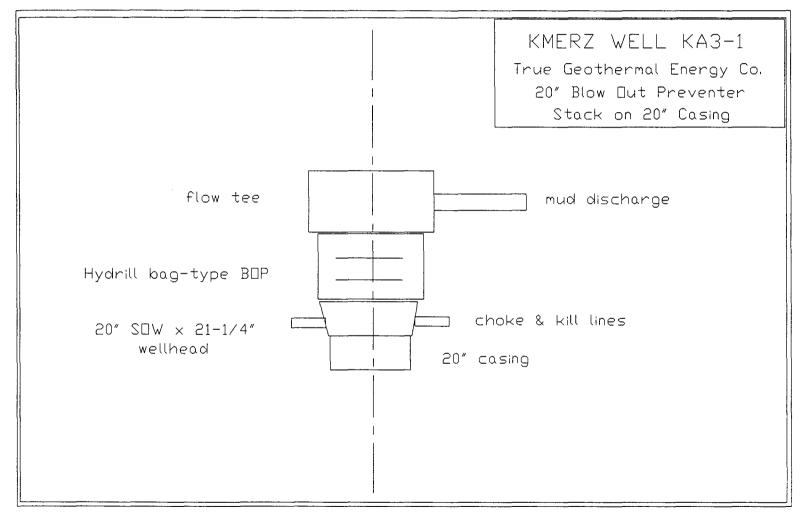
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FIGURE 001



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FIGURE 002



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FIGURE 003

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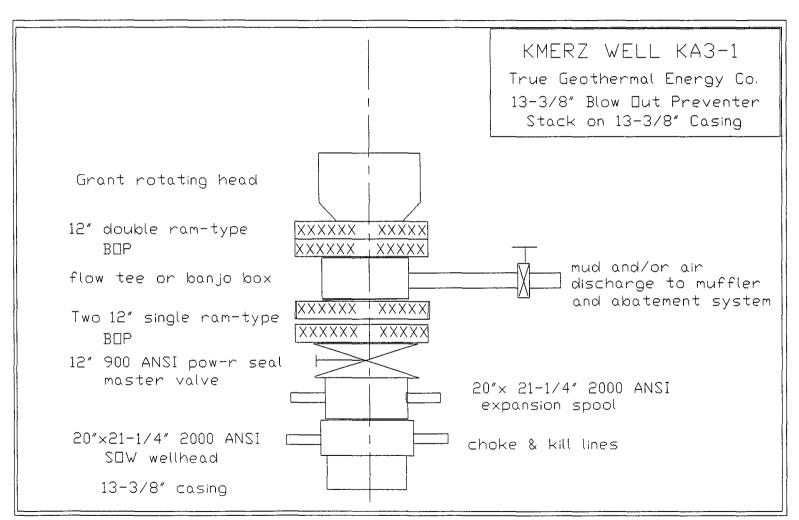


FIGURE 004

TABLES

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'P.O.'Box 1236 🔸 Santa Rosa, CA 95402	51	ZE	G AND BOP PROGRAM		WE	LL	
CASING PROGRAM	,l	20"	1000'			(A3-1	
INTERVAL	WEIGHT	GRADE	JOINT TYPE	TOP BURST	LATED SAFE		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. (CO	DLLAPSE) -	9.9	5	PPG
INSIDE MUD WEIGHT (BURST) -	9.5	PPG	INSIDE MUD WT. (COL	LAPSE) -	0		PPG
OUTSIDE MUD WEIGHT (BURST) -	9.5	PPG	FORM. PRESS. GRAD.	AT SHOE (COL	APSE) -	9.5	. PPG
FRAC. GRAD. AT SHOE (BURST) -	14.5	PPG	BIAXIAL LOAD: COLL.	BURST	BOUYANCY:	YES	NO X
CEMENTING PROGRAM							
	SLUR	RY DESCRIPT	ION AND PROPERTIES	\$			
2690 cu ft (838 sx) of Clas	e C comon	t blondod	with 50 lbs of a	nhorolito r	or eack	of come	nt
40% silica flour, 4% gel, 5						WICH	
400 cu ft (252 sx) of Class	G Cement	. Diended w	ALLI 40% SIIICA I		IRED TOP	EXCESS	
					Surface	100	)%
SLURRY VOL CU FT / (SLURRY NO.)	2	2690		400	)		
SLURRY YIELD - CUBIC FEET/SACK	3.2	21 cu ft/s>	<pre>c</pre>	1.59 cu	ft/sx		
SLURRY DENSITY - PPG	82.2	/cu ft(11 pp	g)	118#/cu_ft(	15.8 ppg)		
THICKENING TIME - DEPTH SCH/HRS, I	MIN. 2-	- <u>3 hrs</u>		<u>2-3 hrs</u>			<u> </u>
COMPRESSIVE STRENGTH - PSI/HOURS		·····					
			ENTING INSTRUCTION	5	<u> </u>		
1. Stab in float collar located			t shoe on bottom.				
<ol> <li>Weld bottom of collars on bott</li> <li>Clean and Baker loc threads or</li> </ol>			as well as bottom 4	ioints			
4. Tac weld top of collars on bot				Johneov			
	R. TYPE AND	SPACING	then one overweither	tool joint to			
1 Dum rigid controligon in mid	He or bould	al 2 junits,	t circulation.			JOISU	lace.
1. Run rigid centralizer in mide 2. Use centralizer cement baskets	s as require	ed due to tos					
1. Run rigid centralizer in mide 2. Use centralizer cement baskets	s as require						
2. Use centralizer cement baskets	s as require						
2. Use centralizer cement baskets PREFLUSH, DISPLACEMENT RATE, PLUGS, 1. Stab into float collar with dr	AECIPROCAT	TION, ETC. Attempt to c	irculate with water.				
<ol> <li>Use centralizer cement baskets</li> <li>PREFLUSH, DISPLACEMENT RATE, PLUGS,</li> <li>Stab into float collar with dr</li> <li>Pump 200 cu ft CaCl2 water fol</li> </ol>	AECIPROCAT	TION, ETC. Attempt to c	irculate with water.		00 cu ft Ge	o-gel, ti	nen
2. Use centralizer cement baskets PREFLUSH, DISPLACEMENT RATE, PLUGS, 1. Stab into float collar with dr	AECIPROCAT	TION, ETC. Attempt to c	irculate with water.		0 cu ft Geo	o-gel, tl	nen
<ol> <li>Use centralizer cement baskets</li> <li>PREFLUSH, DISPLACEMENT RATE, PLUGS,</li> <li>Stab into float collar with dr</li> <li>Pump 200 cu ft CaCl2 water fol</li> </ol>	RECIPROCATILI pipe.	Attempt to c O cu ft of f	irculate with water. resh water, 200 cu f	t Flo-chek, α		p-gel, tl	nen

BOP PROGRAM

APLSTACK	WORKING	MINIMUM		TEST PRESSURES - PSI			
ARRANGEMENT CODE	RANGEMENT CODE PSI INCHES	ТҮРЕ	RAM TYPE	ANNULAR TYPE ROTATING HEAD			
	2000	20''	See attached drawing	1500	1500		

ThèrmaSource Inc. P.O. Box 1236 - Santa Rosa, CA 95402

#### CASING, CEMENTING AND BOP PROGRAMS SIZE DEPTH

WELL

ÀSING PROGRAM			13-3/8"	3300' Ful		ull String		KA3-1	
INTERVAL		WEIGHT	GRADE	JOINT TYPE		CALCULATED S		AFETY FACTORS	
		LB/FT				TOP BURST		1	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:*					Cas	ing Prope	rtires:*	¥	
Collapse-2260 psi					Col	1apse-267	) psi	_	<u> </u>
Burst-5020 psi			L	L	Bur	st-5380 p	5i		<u> </u>
Tension-1,545,000 1bs			DESIGN	CONDITIONS	Ten	sion-1.65	0.000 15	s	
SURFACE BURST PRESSURE	-	3000	PSI	OUTSIDE MUD WT.	COLL	APSE) -		9.5	PPG
INSIDE MUD WEIGHT (BURST)	-	9.5	PPG	INSIDE MUD WT. (C	OLLA	PSE) -		<u> </u>	PPG
OUTSIDE MUD WEIGHT (BURST)	-	9.5	PPG	FORM. PRESS. GRA	D. AT	SHOE (COLL	APSE) -	9.5	PPG
FRAC. GRAD. AT SHOE (BURST)	-	14.5	PPG	BIAXIAL LOAD: COLI	(X)	BURST X	BOUYANCY:	YES	ΝΟ [Ϋ]
CEMENTING PROGRAM									

C BUB YLON LAND 

#### SLURRY DESCRIPTION AND PROPERTIES

SLUHRY DESCRIPTION (AND NUMBER)				
4257 cu ft (1723 sx) Class G c	emetn blended 1:	<u>l with perlite a</u>	nd 40% silica fl	our, 4% gel and
0.65% CRF-2. Tailed with 300	cu ft (192 sx) o	f Class G cement	blended with 40	🛚 silica flour
and friction reducer. Both sl	urries to be ble	nded with retarda		
time at reservoir temperature.			Surface	
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 pr	<u>, , , , , , , , , , , , , , , , , , , </u>	118#/cu ft (15.8 pp	)
THICKENING TIME - DEPTH SCH/HRS, MIN.	2-3 hrs		2-3 hrs	
THICKENING TIME - DEPTH SCH/HRS, MIN.	2-3 hrs		2-3 hrs	

RUNNING AND CEMENTING INSTRUCTIONS

Run stab in float collar 40' (1 joint) above float shoe on bottom. Weld bottom of collars on bottom 4 joints. SHOE, COLLARIS! AND

1. 2.

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.

#### 1. If lost circulation is a problem run casing as directed in attached procedure. Use sodium silicate preflush as 1.directoed.

COMPRESSIVE STRENGTH - PSI/HOURS

Cement through drill pipe.
 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	RRANGEMENT CODE PRESSURE	MINIMUM BORE	TYPE	TEST PRESSURES + PSI				
PS1	INCHES		RAM TYPE	ANNULAR TYPE	ROTATING HEAD			
	3000	12-3/8"	Rotating head & ram	1500	1500	1000		

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# CASING, CEMENTING AND BOP PROGRAMS

			DEPTH		(		
CASING PROGRAM	512	133/8"	3500'±	Liner	WE	KA3-1	
INTERVAL	WEIGHT	GRADE	JOINT TYPE	TOP BURST	LATED SAFE	TY FACTO	TENSION
9003000'	68	L-80	Buttress	2.01	1.95	1	8.68
30003500'	72	L-80 L-80	Buttress	2.01	2.05		45.83
		<u> </u>					
						1	
	<u></u>					+	
		DESIGN	CONDITIONS	I	1		· · · · ·
SURFACE BURST PRESSURE -	300		OUTSIDE MUD WT.	(COLLAPSE) -		9.5	PPG
INSIDE MUD WEIGHT (BURST) -	<u> </u>		INSIDE MUD WT. (CO	OLLAPSE) -		9. <u>5</u> 0	PPG
OUTSIDE MUD WEIGHT (BURST) -	9.		FORM. PRESS. GRA	D. AT SHOE (COL	LAPSE) -		PPG
FRAC. GRAD. AT SHOE (BURST) -	14.	5 PPG					NO [X]
CEMENTING PROGRAM		····					
	SLUR	RY DESCRIPT	TION AND PROPERT	IES	<u> </u>		
3340 CH ft (1041 SV) Class C	Comost	blonded	ith 504	le of another	<i>E</i> _ 1 _ 7		07
<u>3340 cu ft (1041 sx) Class G</u>							
silica flour, 5% hydrated li							
(189 sx) of Class G cement b				DES	SIRED TOP	Excess	rries
retarded to give 23 hrs pum	ping tim	e at rese	rvoir temperatu	re.	900'±	100	%
SLURRY VOL CU FT / (SLURRY NO.)		3340	300				
SLURRY YIELD - CUBIC FEET/SACK		3.21	1.59				
I SLURRY DENSITY - PPG		82.2	118				
THICKENING TIME - DEPTH SCH/HRS, MI	N.	2-3 hrs	2-3 hrs				
COMPRESSIVE STRENGTH - PSI/HOURS							
			ENTING INSTRUCTIO				
3. Clean and Baker loc threads on 4. Tac-weld top of collars on last	bottom 4 j	oints.					
<ol> <li>CENTRALIZERS AND SCRATCHERS - NUMBER,</li> <li>1. Hang liner 100' up inside 20" ca</li> <li>2. Run rigid centralizer cement base below stage collar if a stage is</li> <li>3. Run centralizers every other too</li> </ol>	asing on d skets in m s indicated ol joint to	rill pipe. iddle of bot d. o bottame of		ne 10' up inside	20" casing	and one	jusť
<ul> <li>PREFLUSH. DISPLACEMENT RATE. PLUGS, R</li> <li>1. Attempt to circulate with water</li> <li>2. Pump 20 cu ft CaCl2 water and 10 slurries.</li> <li>3. See attached program for more de</li> </ul>	DO cu ft wa		ed by 200 cu ft Flo	o-Chek the 200 c	u ft of Geo-	-gel, the	en cement
PRESSURE TESTING AND LANDING	, <del></del>						
1. Wait on cement 8 hrs. Clean out sary. Clean out and retest unti	t cement fi il a test :	rom top of l is obtaned.	3-3/8" liner. Tes	t lap to 1000 ps	i. Squeeze	lap if r	eces-

# **JOP PROGRAM**

API STACK.	T CODE PRESSURE BORE TYPE	TEST PRESSURES - PSI				
ARRANGEMENT CODE PRESSURE	INCHES		RAM TYPE	ANNULAR TYPE	ROTATING HEAD	
		No chang	e until tie-back run			

	-		IG AND BOP PROGR	AMS .		<b></b>		
CASING PROGRAM	31	133/8"	оертн 900'±	Ti	eBack	WEL	KA3-1	
INTERVAL	WEIGHT L8/FT	GRADE	JOINT TYPE	••••	CALCU TOP BURST	BOT. BURST	TY FACTO	TENSION
0900'	68	K∵-55	Buttress		1.76	1.67	1	F
1	<del></del>							
			l		<u></u>	ļ		l
		DESIGN	CONDITIONS					
SURFACE BURST PRESSURE -	·	3000 psi	OUTSIDE MUD WT.	COLL	APSE) -		9.5	DAd
INSIDE MUD WEIGHT (BURST) -	(	9.5 PPG	INSIDE MUD WT. (C	OLLA	PSE) -		0	PPG
DUTSIDE MUD WEIGHT (BURST) -	(	).5 PPG	FORM. PRESS. GRA	D. AT	SHOE (COLI	_APSE) ~	9.5	PPG
FRAC. GRAD. AT SHOE (BURST) -	14	4.5 PPG	BIAXIAL LOAD: COLI	L. [X]	BURST 🕅	BOUYANCY:	YES	NO 🚺
EMENTING PROGRAM	<u></u>							
SLURRY DESCRIPTION (AND NUMBERI	SLUR	RY DESCRIP	TION AND PROPERT	IES				
1059.8 cu ft (666 sx) Class	G cement	- blended	with 40% silic	a flo	our and $\Omega$	57 CER. 2		
	<u>o coment</u>	5 brended	WILL 40% BILLE	<u>1 1 1 (</u>	ur and O.	<u>5% 61 (1-2.</u>	- <b>-</b>	
			·					•••••••••••••••••••••••••••••••••••••••
				<u> </u>	DES	RED TOP	EXCESS	
				r	S	Surface	30	%
LURRY VOL CU FT / (SLURRY NO.)		1059.8						<u></u>
SLURRY YIELD - CUBIC FEET/SACK		1.59						
LURRY DENSITY - PPG		118						
THICKENING TIME - DEPTH SCH/HRS, M	IN. 2-	-3 hrs						
COMPRESSIVE STRENGTH - PSI/HOURS	±2323	3/8 hrs						
		ING AND CEM	ENTING INSTRUCTI	ONS				
1. Run float collar 40' above tie	-back slee	ve on bottom	•					
<ol> <li>Clean and Baker loc threads on</li> <li>Tac-weld top and bottom of col</li> </ol>	botton 4 lars on boi	joints. ttom 2 joint	S.					
		Jo						
ENTRALIZERS AND SCRATCHERS - NUMBER								
1. Run rigid centralizer in middl	e of potto	n joint and	one every other to	ol joi	int to surfa	ice except fo	or top l	ω.
PREFLUSH, DISPLACEMENT RATE, PLUGS, 1	ECIPROCAT	ION, ETC.	······					·······
<ol> <li>Circulate with fresh water.</li> <li>Run top plug only.</li> <li>See attached program for more</li> </ol>								
RESSURE TESTING AND LANDING								
1. Wait on cement 6 hrs before la	nding and o	cutting off	13-3/8" for wellhe	ad.				
JOP PROGRAM	····		<u></u>				······································	

API STACK	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	······	ANNULAR TYPE	
	3000	123/8''	See attached drawing	1500	1500	HOTATING HEAD

	CASIN		G AND BOP PROGRA	MS		WE	L.L.	
CASING PROGRÀM	31	95/8"	7000'	Li	ner		KA3-1	
INTERVAL	WEIGHT	GRADE	JOINT TYPE	F	CALCU TOP BURST	BOT. BURST	1	TENSION
33005300'	40	L80	Buttress		2.04	1.97		6.08
53006500'	43.5	L80	Buttress		2.17	2.30		13.71
6500-7000'	47	L80	Buttress		2.30	2.29		47.74
0,500 7000		<u> </u>	Ducciess		2.50	2.2)	1.50	47.74
· · · · · · · · · · · · · · · · · · ·	<u> </u>	DESIGN	CONDITIONS	l_		l		l
URFACE BURST PRESSURE -	3000		OUTSIDE MUD WT. (C	COLLA	APSE) -		9.5	999
NSIDE MUD WEIGHT (BURST) -	9.5		INSIDE MUD WT. (CO		SE) -		0	 PP(
)UTSIDE MUD WEIGHT (BURST) -	9.5		FORM. PRESS. GRAD	). AT :	SHOE (COLL			PP(
FRAC. GRAD. AT SHOE (BURST) -	14.5		BIAXIAL LOAD: COLL.			BOUYANCY:		NΟ [Υ]
EMENTING PROGRAM								
			TION AND PROPERTIE				- <u></u>	
LURRY DESCRIPTION IAND NUMBERI	SLUR	RT DESCRIP	TION AND PROPERTIN	<u> </u>				······
2000 cu ft (810 sx) of Clas	<u>s G cemen</u>	t_blended	1:1 with perlit	e an	d 40% si	lica floi	1r. 4%	gel
and 0.65% friction reducer.	Tailed w	ith 300 c	u ft (192 sx) of	E_Cla	ss <u>G</u> cem	ent blend	led wit	<u>1_40%</u>
silica flour and friction r	educer.	<u>Both slur</u>	ries to be blend	led w	<u>ith reta</u>	<u>rdant to</u>	give 2	<u>-3 hrs</u>
<u>pumping time at reservoir t</u>	omporatur	0			DES	liner_tor	EXCESS	ിഴ
LURRY VOL CU FT / (SLURRY NO.)		2000			30		<i>n</i> 10	<u>_/</u>
SLURRY YIELD - CUBIC FEET/SACK		2.47			1.5			•
LURRY DENSITY - PPG	07.25#	/cu ft (13.0			<u> </u>			
HICKENING TIME - DEPTH SCH/HRS. N		3 hrs			2-3 hr			<u> </u>
COMPRESSIVE STRENGTH - PSI/HOURS	2-	5 11 5			2J III	5	•	··
	RUNNI		ENTING INSTRUCTIO	I				
<ol> <li>Run float collar 80' (2 joints</li> <li>Run float collar 80' (2 joints</li> <li>Weld bottom of collars on both</li> <li>Clean and Baker loc threads on</li> <li>Tac weld top of collars on both</li> </ol>	s) above flo com 4 joints bottom 4	at shoe on l oints as we	pottom.		ollar and s	hœ.		
<ol> <li>ENTRALIZERS AND SCRATCHERS - NUMBE</li> <li>Hand liner 200' up inside 13-2.</li> <li>Run rigid centralizers in mide of top.</li> <li>Run stage collars and external</li> </ol>	8/8" casing lle of botto	with drill p m 4 jonts ar		e cent	ralizer ev	ery collar	to withi	n 200'
1. Attempt to circulate with wate 2. Pump cement and preflush as in	er.			<u></u>				
RESSURE TESTING AND LANDING 1. Wait on cement 12 hrs. Clean	····					·····		

# JOP PROGRAM

API STACK -	WORKING	MINIMUM	MINIMUM BORE TYPE INCHES		EST PRESSURES -	PSI
ARRANGEMENT CODE	ARRANGEMENT CODE PRESSURE PSI				ANNULAR TYPE	ROTATING HEAD
		No char	ge until tie back run			



	CASIN	G, CEMENTIN	NG AND BOP PROGRA	MS				
CASING PROGRAM	5	<sup>ие</sup> '95/8''	3300'±	Ti	e-Back	WEI	 (A31	
INTERVAL	WEIGHT	GRADE	JOINT TYPE			BOT. BURST	T	TENSION
03300'	40	L80	Buttress		2.10	1.92		7.17
······································								
	<b>I</b>	DESIGN	CONDITIONS			<b>.</b>	1	
SURFACE BURST PRESSURE -	3000	000 PSI OUTSIDE MUD WT. (COLL		COLL	_APSE) - 9.5			PPG
INSIDE MUD WEIGHT (BURST) -	9.5			LLAF	(PSE) - ()		PPG	
OUTSIDE MUD WEIGHT (BURST) -	9.5	PPG	FORM. PRESS. GRAD	). АТ	SHOE (COLL	APSE) - C	9.5	PPG
FRAC. GRAD. AT SHOE (BURST) -	14.5	PPG	BIAXIAL LOAD: COLL	· [ɣ]	BURST [X]	BOUYANCY:	YES	NO [X]
CEMENTING PROGRAM								
1	SLUR	RY DESCRIP	TION AND PROPERTI	ES				
SLURRY DESCRIPTION (AND NUMBER)	· · · · · · · · · · · ·	1			- 10 57			
<u>  1140 cu ft (704 sx) Class G</u>	cement D.	lended wit	n 40% silica fi	our	and 0.5%	UFR-2.		
					,,,,,,,,,,,,,,,,,,,,,,,,,,		. <u> </u>	
					DES	IRED TOP	EXCESS	
					5	Surface	30	)%
SLURRY VOL CU FT / ISLURRY 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	±232	3/8 hrs					·	
	RUNN	NG AND CEM	ENTING INSTRUCTIO	NS				
1. Run float collar 40' above tie 2. Clean and Baker loc threads or 3. Tac-weld top and bottom of co	e-back sleev n bottom 4 jo	oints.						
CENTRALIZERS AND SCRATCHERS - NUMB								
1. Run centralizers in middle of	DOLLOW JOIN	L and one ev	ery other tool join	L LO	suriace exc	ept for top	100.1	
		,						
PREFLUSH, DISPLACEMENT RATE, PLUGS	RECIPROCAT	ION. ETC.						
1. Circulate with fresh water.		· - · · · · · · · · ·						
2. Run top plug only. 3. See attached program for more	detail.							
PRESSURE TESTING AND LANDING	anding and a	utting off 0	5/01 for among	00.0-	1 and hlar	out provo-t		· · · · · · · · · · · · · · · · · · ·
1. Wait on cement 6 hrs before 1a	and ci	ucting off A		spoo	u and DTOM	out prevent	ers.	

TEST PRESSURES . PSI

1500

ANNULAR TYPE ROTATING HEAD

1

BOP PROGRAM							
ARRANGEMENT CODE	PRESSURE	MINIMUM BORE INCHES	TYPE	RAM TYPE			
	1500	8-1/2''	See attached drawing	1500			



P.O. Box 1230 + Santa Rosa, CA Y (UD		MUD, LOGGING, WELLHEAD & DIRECTIONAL PROGRAMS			KA3-1	
DEPTH INTERVAL	MUD TYPE	WEIGHT	API FLUID LOSS	YIELD POINT	РН	
0-100'	Gel and water	65#/ft <sup>3</sup>		15	9.0	
100-1000'	Gel and water or air*	70#/ft <sup>3</sup>	10cc	15	9.0	
1000-3500'	Gel and water or air*	70#/ft <sup>3</sup>	10cc	15	10.0	
3500-7000 <b>'</b> ±	Gel and water or air*	70#/ft'	3.2cc	15	10.0	
7000-T.D.	Water or air*	65#/ft'	or 3000 cfm	L		

\*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'
350070001	Temperature log & logs as directed	1" and 5" = 100'
7000-T.D.	Temperature log & logs as directed	1" and 5" = 100'
• O-T.D.	Samples every 10'	
REMARKS	termined by geologist. requiring E-log on these sections of the wel	1

#### WELLHEAD

API NOMINAL SIZE	WORKING PRESSURE	TÝPE	MAKE
26''	100 psi		
20'' S.O.W. x 211/4'' 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	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  $100'\pm$  from 0-7000' and on dull bits after 7000'. 0-3500' maximum deviation to be 5°, maximum rate of change to be  $1\frac{1}{2}^{\circ}$  per 100'. 3500-7000' maximum deviation to be 8°, maximum rate of change to be  $1\frac{1}{2}^{\circ}$  per 100'. 7000-T.D. monitor without control.