MERRION OIL & GAS CORPORATION

PAPERS WASH FIELD

FEDERAL 15-2

HORIZONTAL REDRILL

DRILLING & COMPLETION PROGRAM

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TABLE OF CONTENTS

I. SUMMARY INFORMATION

Well Name	:	Federal 15 No. 2
Surface Location	:	McKinley County, New Mexico 1960' FNL, 999' FWL Sec 15, T 19 N, R 5 W
Elevations	:	6,616' RKB 6,604' GL
Target Locations		
Top	:	2,435' FNL, 727' FWL 525' in direction S30°W
Bottom	:	3,604' FNL, 52' FWL 1,875' in direction S30°W
Target Depths		
Top	:	5,179' TVD RKB 5,475' MD RKB
Bottom	:	5,191' TVD RKB 6,825' MD RKB
Target Tolerance	:	10' vertical window, 3' above proposed line, 7' below proposed line.
Total Depth	:	5,191' TVD RKB 6,825' MD RKB
Well Objective	:	Entrada Sandstone Oil Producer
Rigs		
Preparation	:	Ram Service Co Rig 1
Drilling	:	Unknown
Testing/Completion	:	Ram Service Co Rig 1
Estimated Rig Arrival		
Preparation	:	November 13, 1989
Drilling	:	January 16, 1990
Testing/Completion	:	January 30, 1990
Estimated Time on well		
Preparation	:	10 days
Drilling	:	15 days
Testing/Completion	:	7 days
Estimated Well Cost	:	$ 580,095

II. DISCUSSION

The Papers Wash oil pool is located in McKinley County, New Mexico, approximately 75 miles southeast of Farmington, New Mexico. It lies in the Chaco Slope province of the San Juan Basin, and was discovered by Dome Petroleum, in October 1976 with the Federal 15 No. 1 well. Papers Wash is typical of Entrada oil pools in the basin, in that it is an oil accumulation in what was once a large Entrada sand dune. The reservoir rock is a very clean, fine to medium grained sandstone with porosity of 25% and air permeabilities between 300 and 800 md. The oil has a gravity of around 32° API, GOR too small to measure, and viscosity of around 8 cp under reservoir conditions. The reservoir drive is base water.

Production histories of this and similar Entrada reservoirs, are characterized by early water cuts which rapidly exceed 99%, often requiring the lifting of fluid volumes in excess of 4,000 BPD to maintain economic oil rates. Well production ceases when the high water cut causes poor economics. The mechanism believed to be responsible for the high water cut during production is the formation of an extensive water cone around the wellbore. This is due to the unfavorable mobility ratio in combination with a thin oil column and the highly permeable reservoir rock, and there is a further possibility that the problem was aggravated by formation damage caused by poor drilling practices.

Based upon studies of previously drilled and tested Entrada wells, there is evidence of severe formation damage, with calculated skins of around +12. The damage mechanism is thought to be principally reduction in relative permeability to oil, due to the increased water saturation around the wellbore caused by filtrate invasion from the drilling fluid. A secondary, and potentially more serious damage mechanism is plugging of the sand face by particles from the mud. Pore sizes measured in a detailed reservoir study of the nearby Eagle Mesa field suggest that the Entrada sandstone may be particularly susceptible to this type of damage.

The objective of the Federal 15 No. 2 horizontal redrill is to determine the economic impact of a horizontal completion on the ultimate recovery of the original oil in place. Intuitive thinking leads to the belief that the low unit pressure drawdown of a horizontal wellbore will greatly retard the onset of high water cuts, assuming that the wellbore is placed in a manner which allows it to avoid intersecting existing water cones, and that it is placed as high as possible above the base of the movable oil. This placement will also allow the well to drain the portion of the reservoir which lies undrained due to the formation of the water cones around the existing wells.

The structure map and reservoir profile clearly illustrate this strategy. The Federal 15 No. 2 well was chosen so that the horizontal wellbore can be drilled across the top of the structure, approximately parallel to the oil water contact, but staying a maximum distance above it. The path of the well takes it between the 16-2, the 15-4 and the 16-1 wells, but by staying between the wells and high in the structure, it is not anticipated that any water cones will be intersected by the well. The same reasoning applies for the cone surrounding the 15-2 wellbore; the horizontal wellbore will be approximately 500 feet away from the vertical 15-2 wellbore by the time the Entrada is encountered, and it is believed that this should place the well outside the existing water cone.

The Federal 15 No. 2 horizontal well is intended as a pilot project for the future development or the re-development of Entrada reservoirs, and this places more stringent than normal requirements on the drilling and completion process. As well as changing earlier practices which damaged the reservoir rock, it is necessary to gather sufficient information during drilling and completion to be able to effectively evaluate the success or otherwise of the project. To this end, it is planned to obtain a detailed mud log, a standard set of electric logs, and to perform a diagnostic well test that will allow the well's productivity and damage to be quantified. In the case of a marginal performer, this information becomes vital to the decision making process, since it allows objective evaluation of whether the problem lay in the assumptions made about the reservoir, or in the practices used to drill and complete the well.

The Federal 15 No. 2 well was shut in November 1984, after producing almost 120,000 bbls of oil. At the time of shut-in, the well had been producing at a water cut of 99.75%. The well is cased with 7", 23 lb/ft, K-55 grade casing, and has a Reda G-110 electric submersible pump at 3073' on a string of 3-1/2" 9.3 lb/ft J-55 tubing. The work plan calls for moving in a completion rig and pulling this completion equipment, and then preparing the wellbore for the horizontal redrill. In order to do this, the Entrada perforations will be cemented off, the casing will be inspected for corrosion using wireline logs, and repaired if necessary. Remedial cementation will be performed in the area where the well will be kicked off, and a gyro survey will then be conducted to accurately position the wellbore.

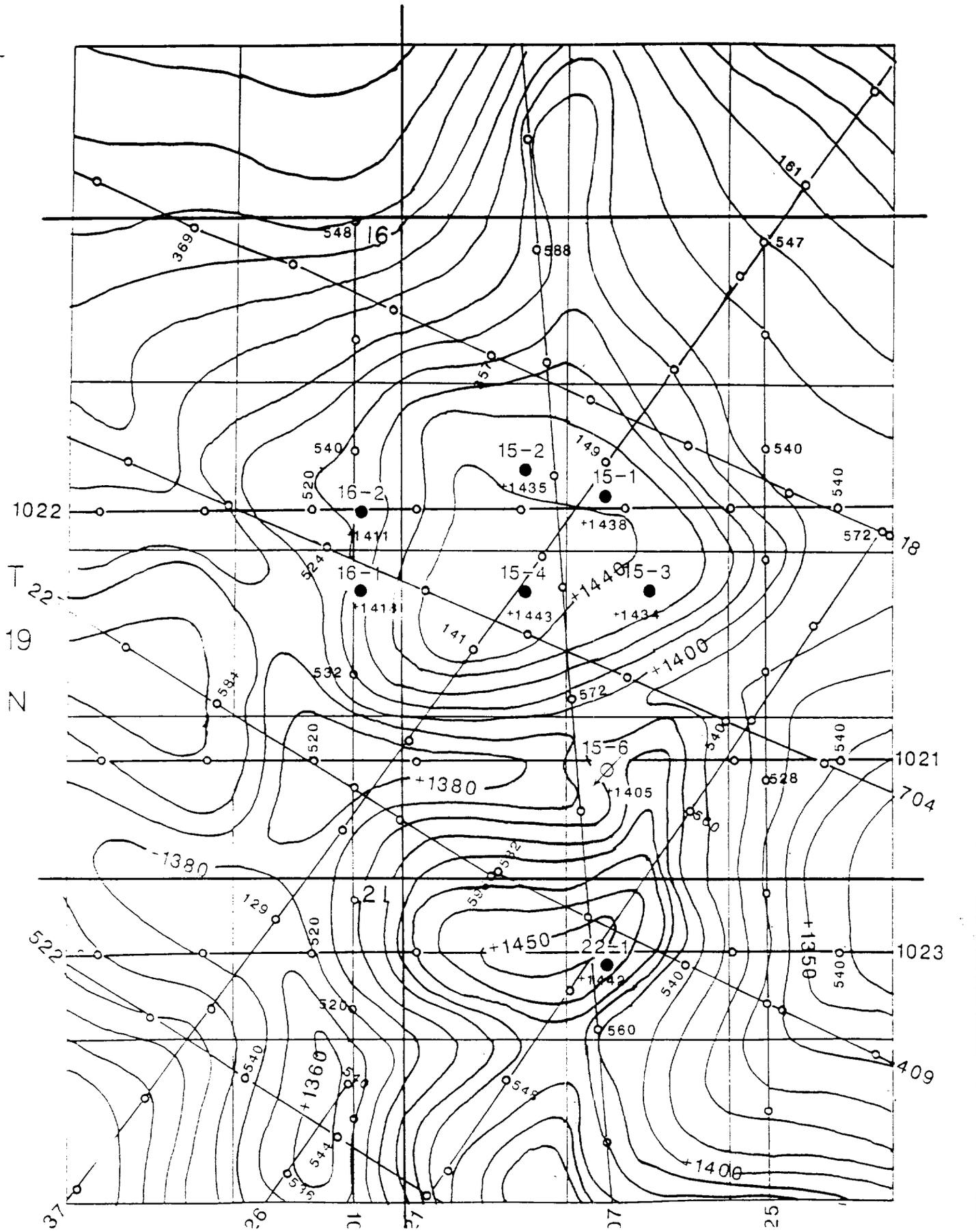
After the preliminary work is complete, a drilling rig will be moved in, and a window will be cut in the casing, using a casing whipstock system, to allow the well to be sidetracked at 4,650' RKB. Angle will be built to horizontal using double bend, steerable motors controlled by a wireline

steering tool. The plan calls for the well to be horizontal 5' vertically below the Entrada top. Near horizontal wellbore will then be drilled across the structure until the overlying Todilto Limestone is encountered on the south flank of the structure, allowing about 1,350 feet of near horizontal wellbore to be drilled in the Entrada sandstone. The drilling system will be a steerable, stabilized motor assembly, using an MWD tool for directional control.

The drilling fluid system used will be designed to be as non-damaging as possible, by carefully controlling the solids content below 3% and maintaining tight fluid loss control. Fluid density will be controlled at 8.6 lb/gal or less, using a high speed, fine screen shaker and a hydrocyclone desilter. After drilling is complete, the well will be logged using conventional tools conveyed on drillpipe. Following logging, a 4-1/2" liner will be run. This liner will be pre-perforated in the Entrada sandstone interval, but will be cemented back into the 7" casing through the Morrison formation. A newly designed system, consisting of a cement filled external packer, a port collar, an internal tubing stinger and a conventional mechanical liner hanger, will be utilized to accomplish this objective. The cement slurry will be designed to satisfy the special requirements of a near horizontal well.

After the liner cementation, the drilling rig will be released and the completion rig will be moved back in. Before normal production is initiated, the well will be tested to ascertain productivity and damage. A simple, but unique test string will be used to obtain a stabilized flow period and a diagnostic build-up test. Design problems involved placing the gauges at the rock face in a horizontal well, and being able to run a diagnostic test with the well under artificial lift. The results of the well test will be used to determine the completion technique for ultimate production, and the economic viability of future Entrada horizontal wells.

Figure 1. Location Map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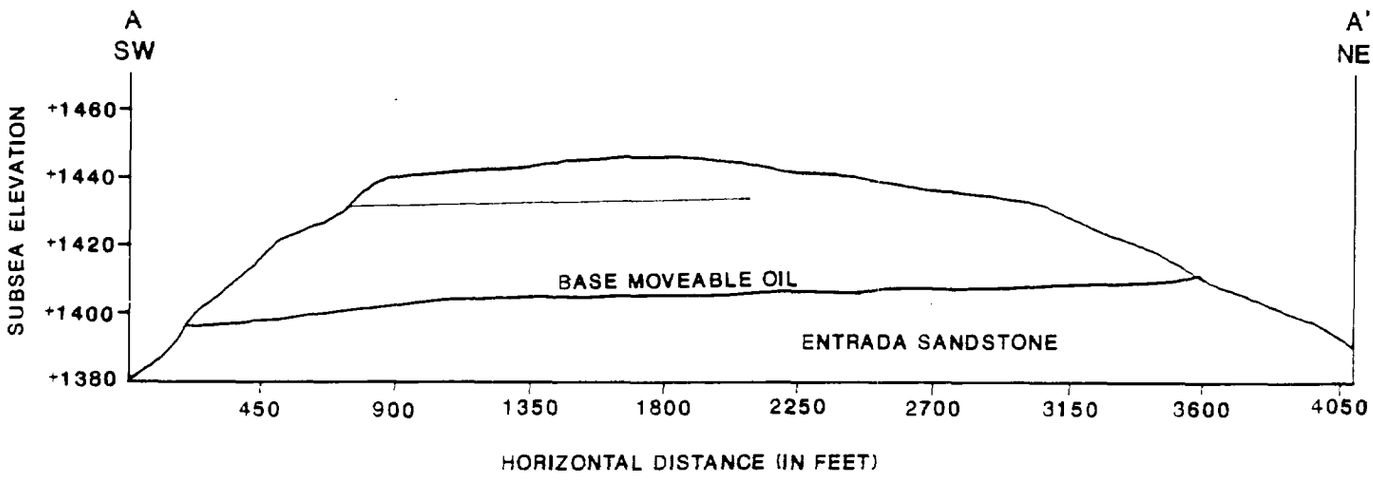
PAPERS WASH ENTRADA FIELD

RESERVOIR PROFILE

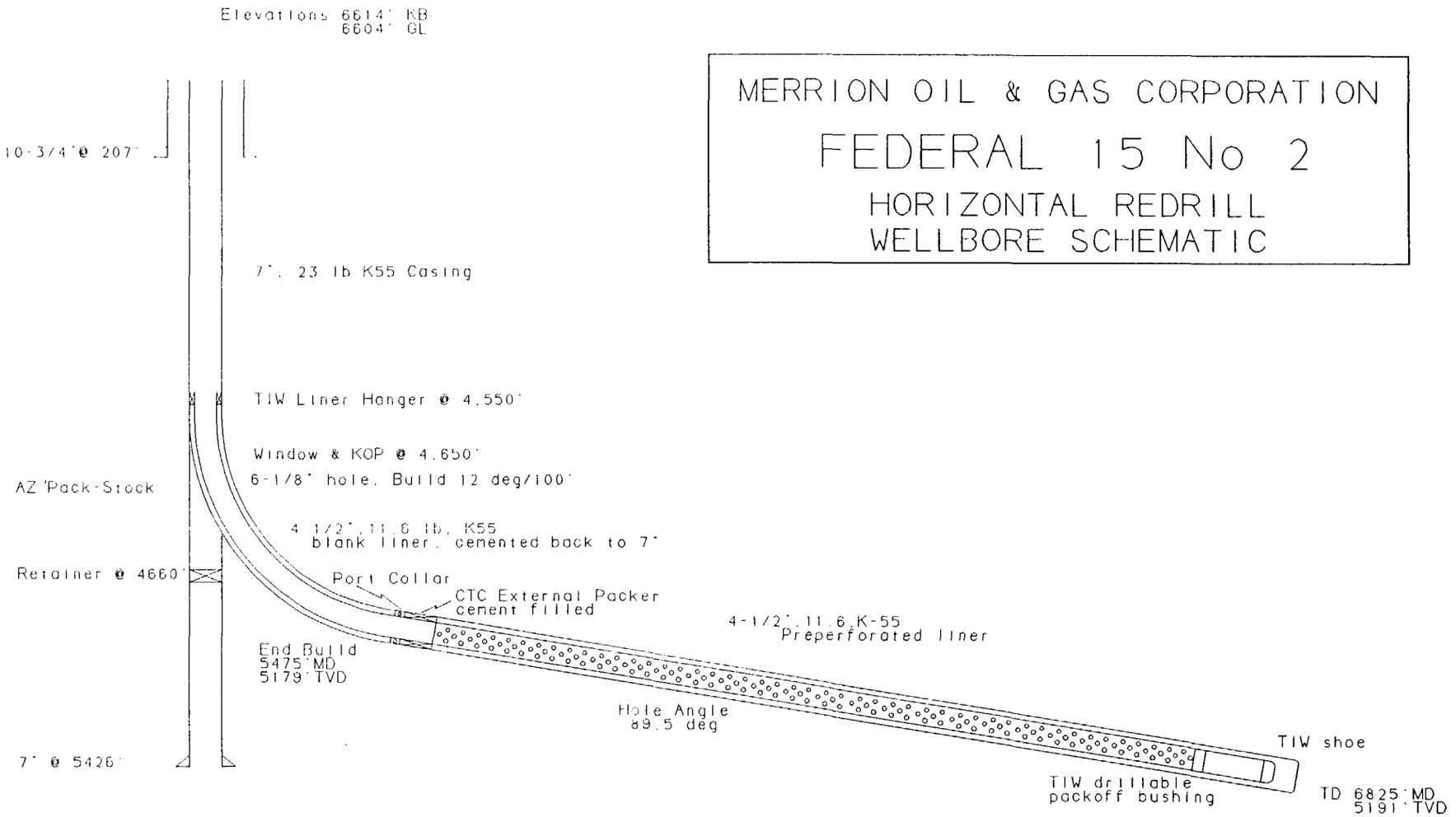


VERTICAL EXAGGERATION = 11.25 X

MERRION OIL & GAS CORPORATION

FEDERAL 15 No 2

HORIZONTAL REDRILL
WELLBORE SCHEMATIC



III. DETAILED OPERATIONS PLAN

1. PRE-SPUD MEETINGS

1) A pre-spud meeting will be held in Farmington for Merrion, Drilling Contractor and Service Company personnel. Any final modifications required in the drilling program will be agreed upon at that time. It is particularly important that all material requirements are verified at this meeting. All planned tool strings should be reviewed to identify any needed cross over subs.

2) A pre-spud meeting will be held at the rig for all well site personnel. This meeting will be conducted as early as possible after the rig moves in to location.

2. WELLBORE PREPARATION

a. General Remarks

The wellbore preparation phase will be conducted using a small completion rig, Ram Rig 1. The 3-1/2" tubing and Reda pump will be pulled and laid down. A Schlumberger corrosion log (METT) will be run to determine the condition of the casing in the kick-off zone, and to determine whether or not casing repairs will be necessary further up the hole. The Entrada perforations will be cemented off with a balanced plug, after which a remedial cement job will be attempted in the kick-off zone. The original CBL, run in 1977, shows no cement in that area. After this, the casing will be repaired by backing off and pulling the old casing in the case of severe damage, or by squeeze cementing in the case of minimal damage. Finally, a cased hole gyro survey will be run, and the rig moved out.

b. Procedure

1. Prepare surface location, set anchors if necessary. Build small reserve pit for fluids.

2. MIRU Ram workover rig w/ reverse equipment, catwalk and BOPS.

3. Truck out, from Piedra, 5,500 ft of 2-7/8" EUE 6.5 lb/ft J-55 tubing for use as a work string.

4. Blow down well to mud pit or down flowline if necessary. Unset 3-1/2" tubing and POH. (rig up cable spooler if needed) Tally tubing and lay down. Remove

submersible pump and prepare for storage.

5. Haul 3-1/2" and pump to Lybrook yard for temporary storage.

6. Pick up, tally and RIH w/ casing scraper and 2-7/8" tubing toPBTD (Est. 5,370' KB). Circulate well to remove oil and load with produced water. POH and stand back.

7. Rig up Schlumberger cased hole services. Run ETT corrosion log from 4,550' - 4,750' across kickoff point and from DV tool @ 2,785' KB. (Run to surface if necessary)

8. RIH w/ 2-7/8" tubing open ended to PBTD. Spot 70 sx class "B" or equivalent (1.18 ft3/sx) from PBTD to ~ 5,000' KB to plug off existing Entrada perfs. POH w/ 2-7/8" tubing. WOCT.

9. Rig up Wireline. perforate 4 squeeze holes @ 4,665' KB and 4 squeeze holes @ 4,610' KB.

10. Run 7" cement retainer on wireline and set @ 4,660' KB.

11. RIH w/ 2-7/8" tubing and sting into cement retainer @ 4,660' KB. Attempt to establish circulation.

12. If able to circulate, batch mix 25 sx of cement slurry, class "G" w/ 0.6% flac, yield 1.18 cu ft/sx. Displace thru perfs @ 4,665' KB back up outside of 7" back into casing. Sting out of retainer, pull to 4,580' KB and reverse clean. (Spot cmnt and squeeze upper holes if deemed necessary) POH w/ 2-7/8" tbg.

13. Based on results of corrosion log, run 7" RCP and isolate bad casing if deemed necessary.

14. If casing must be replaced, RIH w/ 2-7/8" tubing and stack out on cement top. Leave in 7" casing at a convenient height. Rig down, move rig out of way.

15. Dig out around wellhead. Remove casinghead cap on Bradenhead to allow 7" slips to move. Collapse 10-3/4" surface w/ welder by cutting windows. Reweld 10-3/4" collar onto surface casing after 7" is unset. Reinstall Bradenhead.

16. Fill back in around surface casing. Move rig back and rig up. POH w/ 2-7/8" tubing.

17. Rig up backoff truck. Take free point below bad casing and above cement squeeze @ 1,894' - 1,926', if needed. Back off 7" casing.

18. Run 2-7/8" tubing into PBTD prior to complete back off to act as a guide. Circulate hole full of drilling mud, displace water and oil. Complete backoff. Haul replacement 7" 23 lb/ft casing to location.

19. Rig up casing crew. POH w/ 7" casing and lay down. (tally) Roll out of way.

20. Pick up 7" replacement casing and tally into hole over 2-7/8" tubing guide. Screw into 7" casing looking up. Circulate well to clean up. POH. Install 3,000 psi wellhead for drilling operation.

21. If casing in good shape w/ minimal holes, squeeze w/ cement and drill out.

22. Rig up Scientific Drilling International. Run Gyro survey from PBTD to surface.

23. Lay down 2-7/8" work string if necessary. Shut-in well. Wait on drilling rig. RDMO.

c. Materials and Services

1.	Tubulars	Piedra Supply: Mark Merrion	327-8475
2.	Cementing	Dowell-Schlumberger Sid Christenson	325-5096
3.	Logging	Schlumberger Bill Kelt	325-5006
4.	Gyro Survey	SDI (Midland, Texas) George Moody (915)	563-1339

3. SIDETRACKING PROCEDURE

a. General Remarks

The A-Z Pack Stock tools were selected as the most efficient means to cut a window. Since the anchor, whipstock and starter mill are all run together, at least one round trip is eliminated with these tools. The technique has been used with an extremely good success record by Amoco in Norway, with only one tool failure in 16 runs. It is essential, however, that there is good cement outside the casing. The CBL run in 197? after the primary cementation shows poor cement in the area, so remedial cementation will be performed during the wellbore preparation with the completion rig.

If severe problems are encountered with the window procedure, a backup set of section milling equipment will have been sourced and will be available in Farmington.

b. Preparation of Pack Stock Components

c. Window Milling

a. Caliper OD of mills. They should be 6.125".

2. Check hydraulic hose on Pack-Stock for punctures.

3. Inspect the shear bolt block and the shear bolt for damage during shipment. The shear bolt thread should be free of dings and burrs that would prevent the nut from torquing up properly.

   NOTE: If the Pack-Stock assembly is shipped without the shear bolt block welded to the whip-stock, see the following drawing for block location:

   7" Pack-Stock type DPS70 10

   Please note that the larger bevel of the shear bolt block should be located toward the top of the whip-stock.

4. Prepare Running Tool (Figure 5).

   a) Break off crossover (1).
   b) Remove piston (2).
   c) Replace crossover.
   d) Check position of sleeve (3).

d. Pack Stock Running & Setting Procedure

1. Condition drilling fluid to a minimum viscosity of 45 seconds. Mud weight should be maintained at around 8.5 to 9.0 lb/gal.

2. Pick up a single joint of 3-1/2" Grade S-135 drill pipe with elevator.

3. Suspend drill pipe in the mouse hole and make up the running assembly onto the drill pipe in the following order:

   Orientation Sub (connection chain tong tight.)
   Crossover Sub
   By-Pass Valve
   Running Tool, Crossover on Running Tool should be chain tong tight only.
   Starter Mill

4. Using air tugger or hoist line, pick up the Pack-Stock and hang through the rotary. Set drill collar slips and safety clamp.

5. Make up Starter Mill to Pack-Stock. Tighten shear bolt to 100 ft-lbs. Connect hydraulic hose.

6. Remove catline hook, drill collar slips and safety clamp.

7. Lower assembly. Set drill collar slips and safety clamp on Running Tool body just below Running Tool crossover. See Figure 6

8. Break crossover/body connection on Running Tool. Fill with clean hydraulic fluid to a depth of 25" from the box shoulder, see Figure 5. Allow five minutes for entrapped air to be released.

9. Break the pipe cap off the nipple end of the Running Tool piston. Cover open end of nipple with a cloth and install the piston into the Running Tool piston. Cover open end of nipple with a cloth and install the piston into the Running Tool until the top of the piston is 22-1/4 from the box shoulder, see Figure 5.

10. Replace pipe cap.

11. Make up the Running Tool connection.

12. Pick the assembly up and scribe a line, which aligns with the face of the whipstock, along the assembly up to the orientation sub.

13. Set the slips on the orientation sub. Break out the single joint of drill pipe and orient the key with the scribed line.

14. Make up single joint of drill pipe onto orientation sub.

15. Make up drill collars equivalent to recommended milling weight plus 25%. See Table I, for recommended milling weights and rpm for Starter Mill.

16. Trip in the hole with the hook on the block in the unlocked position using drill pipe and kelly to setting depth.

17. When the setting depth is reached, work the string up and down to determine hole drag. See figure 9 for details of the hole at the setting depth.

18. Break out kelly and run SDI surface readout gyro to orient the Pack-Stock to S30.0°W.

19. Make up kelly and lower to setting depth. Mark kelly for Starter Mill distance per Table I.

20. Apply mud pressure gradually to 3000/3500 psi through the drill string and hold one minute. WATCH THE PRESSURE GAGE. Between 1800 and 2200 psi a bobble of the needle can be observed. This indicates the packer has begun to set. A minimum of 3000 psi is required to ensure complete setting of the packer.

21. While maintaining 3000/3500 psi, pull and slack off 30,000 lbs. three to five times over drag weight. Hold each strain for 1 minute. Finally, pull until Starter Mill/Pack-Stock connection shears (approximately 50,000 to 60,000 lbs.).

e. Starter Mill Operation

1. Position Starter Mill 2 to 3 feet above the Pack-Stock. Begin rotation. Record rotary speed, torque, circulation rate and pressure.

2. Slowly lower the Starter Mill and mill per Table I recommendations.

   NOTE: Table I contains two mill travel distances. One column for mill travel measured from original location of Starter Mill before shearing the bolt. The other column measured from the point where the Starter Mill begins taking torque. Both of these dimensions are for reference only. If milling weight or torque increase

before traveling this distance, pull out of hole. An increase in weight or toque or decrease in milling rate indicates the start of milling of the whipstock.

3. Pull out of hole with Starter Mill.

4. When out of hole, remove Starter Mill, By-Pass Valve, Running Tool and Orientation Sub.

TABLE I

STARTER MILL OPERATION

Casing size & weight	7" 23.0 lb/ft
Mill Diameter	6.125"
Mill travel from Shear Block	31" (Note 1)
Mill Travel from Torque	22" (Note 2)
Weight on Bottom	1000 - 6000 lbs
Starter Mill RPM	60 - 90

Note 1: This distance measured from the original location of the mill before shearing the bolt.

Note 2: This distance measured from point mill begins taking torque.

NOTE: Both these dimensions are for reference only. An increase weight or torque or decrease in milling rate indicates the start of milling of the whipstock.

f. Window Mill Operation

1. Make up Window Mill, Watermelon Mill, Crossover Sub, single joint of high grade drill pipe, collars, drill pipe and kelly per Figure 7.

2. Lower Window Mill in position 2 to 3 feet above the Pack-Stock. Start rotation and circulation. Record rotary speed, torque, circulation rate and pressure.

3. Lower the Window Mill until it contacts the PackStock. Mill per Table II recommendations.

   NOTE: When the center point is reached, a decrease in torque and/or penetration may be experienced. Should this occur, increase the weight on the mill and decrease rpm. This will cause the Window Mill to flex out away from the face of the Pack-Stock and off the

center point. When the center is passed, an increase in penetration and torque will be recognizable. After one foot of penetration at the increased weight, bring the drilling weight and rpm back to that previously used and continue milling the window.

4. If penetration rate falls to zero for more than one hour, pull out of hole and replace Window Mill. Begin milling with replacement mill using light weight and high rpm for 30 minutes. Resume normal weight and rpm. Continue milling.

5. After milling the length of the Pack-Stock face, mill 10 feet of formation. This provides length for the String Mill to travel the full length of the window on the successive run.

6. Make several passes through the window to clean up any burrs and check against possible fill.

7. Pull out of the hole.

TABLE II

WINDOW MILL OPERATION

Pack Stock Size	7"
Weight on Bottom - Normal	6,000 - 12,000 lbs
- Maximum	20,000 lbs
Window Mill RPM - Normal	60 - 90
- Maximum	90
Whipstock Face Taper Length	7 ft 10.5".

g. Sidetracking Taper Mill Operation

1. When out of the hole, pick up the following in the order given. (See Figure 8)

   Sidetracking Taper Mill
   String Mill and/or Watermelon Mill (Optional)
   Crossover or Bit Sub as required
   24 4-3/4" Drill Collars
   3-1/2" Grade E drill pipe as required to reach setting depth.

2. Lower the Sidetracking Taper Mill in position 2 to 3 feet above the Pack-Stock. Start rotation and circulation. Ream the window very slowly which will clean up the window to facilitate running any BHA

through the window during future operations. Make several passes.

3. After reaming, stop rotary and slack off through window. If unusual drag is encountered, ream until smooth.

4. Pull out of the hole. Do not attempt to drill ahead with the Taper Mill.

h. Drilling Notes

1) Do not rotate a bit or stabilizer down the face of the Packstock.

2) If the window and the open hole have to be squeezed, the window must be reopened with a Window Mill, not a roller bit.

3) Leave the hook unlocked on all trips out of the hole.

4) Pass through the window very slowly on all trips.

5) The following are the make-up torque ranges for the Pack Stock running tool connections:

3-1/2" API Regular	9,200-10,100 ft/lbs
3-1/2" IF	12,300-13,600 ft/lbs

i. Drilling Fluid Program

The use of ditch magnets is strongly recommended to exclude steel cuttings from the mud tanks and pump suctions.

Suggested Mud Properties

Mud weight	8.5 - 9.0 lb/gal
Funnel Viscosity	> 45, adjust as dictated by operations
API Fluid Loss	No control

Volume Requirements

Hole Volume	180 bbls
Surface Volume	200 bbls
Contingency	120 bbls
	500 bbls

Formulation

Gel	22 lb/bbl
Caustic Soda	0.7 lb/bbl
Lime	1.2 lb/bbl

j. Materials and Services

SDI
1 ea Monoconductor Wireline Unit
1 ea Bottom Hole Orienting Sub
1 ea SDI Surface readout gyro

Oilfield Rentals / Dotco
1 ea ditch magnet
24 ea 4-3/4 x 2-1/4" drill collars
1 set handling equipment for collars (lift subs, safety clamp, slips)

Drilex
1 ea 7" Pack-Stock assemblies, c/w shear bolt blocks.
1 ea Pack Stock tool box, c/w shear bolt and hex nuts.
1 ea Pack Stock repair kit
1 ea Running Tools for Pack Stock
1 ea By-Pass Valve Assembly

1 ea Starter Mill
2 ea Window Mill
2 ea Watermelon Mill
2 ea String Taper Mill
2 ea Sidetracking Taper Mill
1 ea Crossover Sub
Hydraulic oil

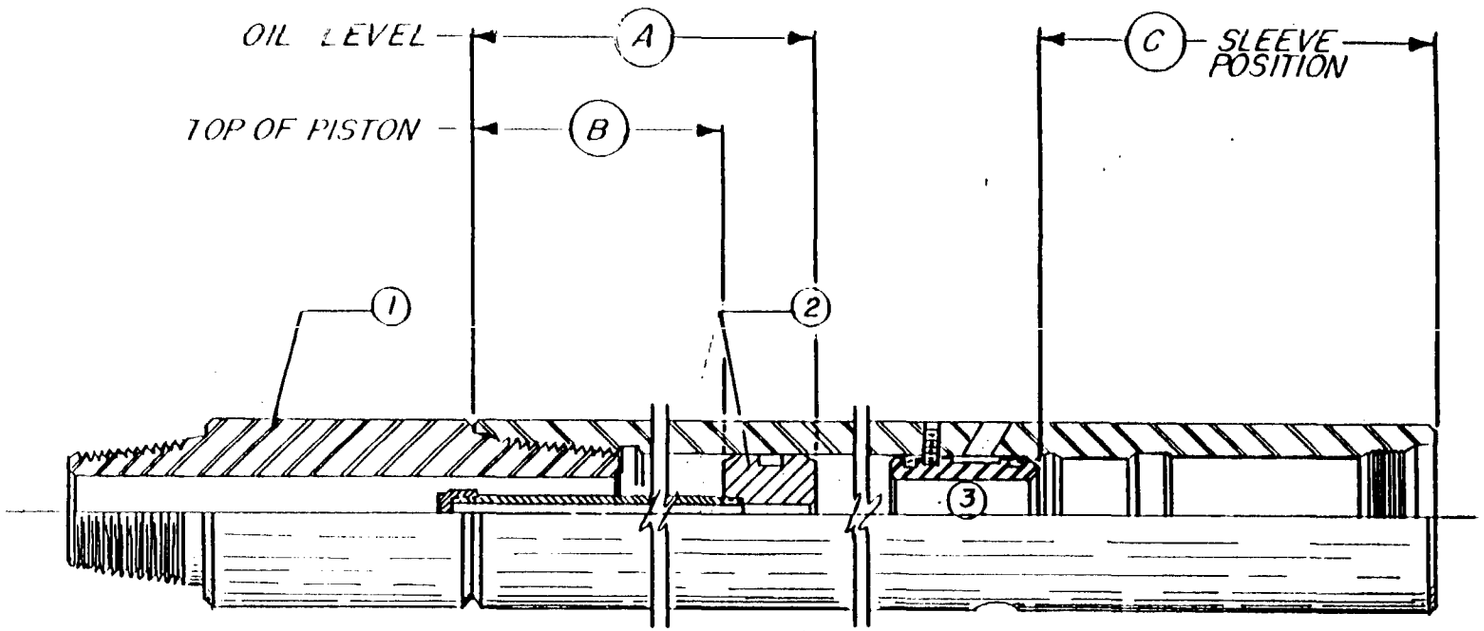
Mud Materials- Milpark

Item	Unit	Quantity
Bentonite	100 lb	110
Caustic Soda	50 lb	7
Lime	50 lb	12

Mud Test Equipment

Personnel

SDI Engineer and wireline crew
Mud Engineer
AZ service man
Mud Logger



SIZE	A	B	C
13 3/8"	25"	21 1/2"	19 3/4"
7"@ 7 5/8"	25"	22 1/4"	11 9/16"
9 5/8"	25"	22 1/4"	11 3/4"
5 1/2"	25"	22 1/2"	10 1/2"

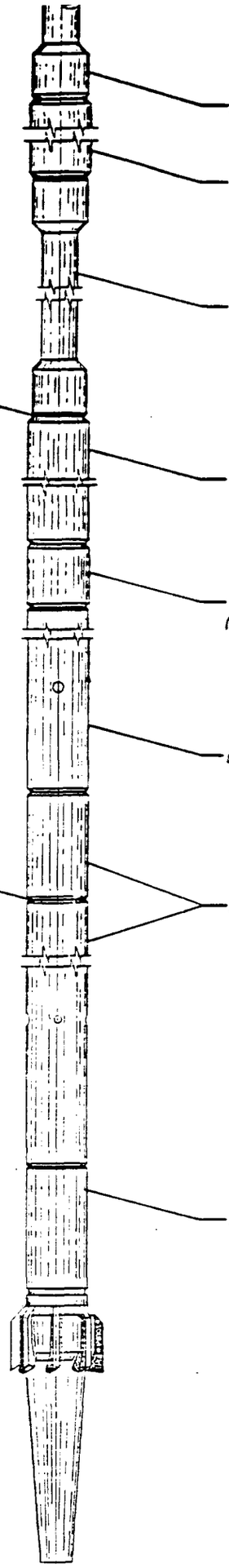
BREAK OFF CROSSOVER (1)
REMOVE PISTON (2)
REPLACE CROSSOVER
CHECK POSITION OF SLEEVE (3)

A-Z RUNNING TOOL PREPARATION

FIG.

NOTE: PISTON TO BE REINSTALLED AFTER RUNNING TOOL IS FILLED WITH FLUID

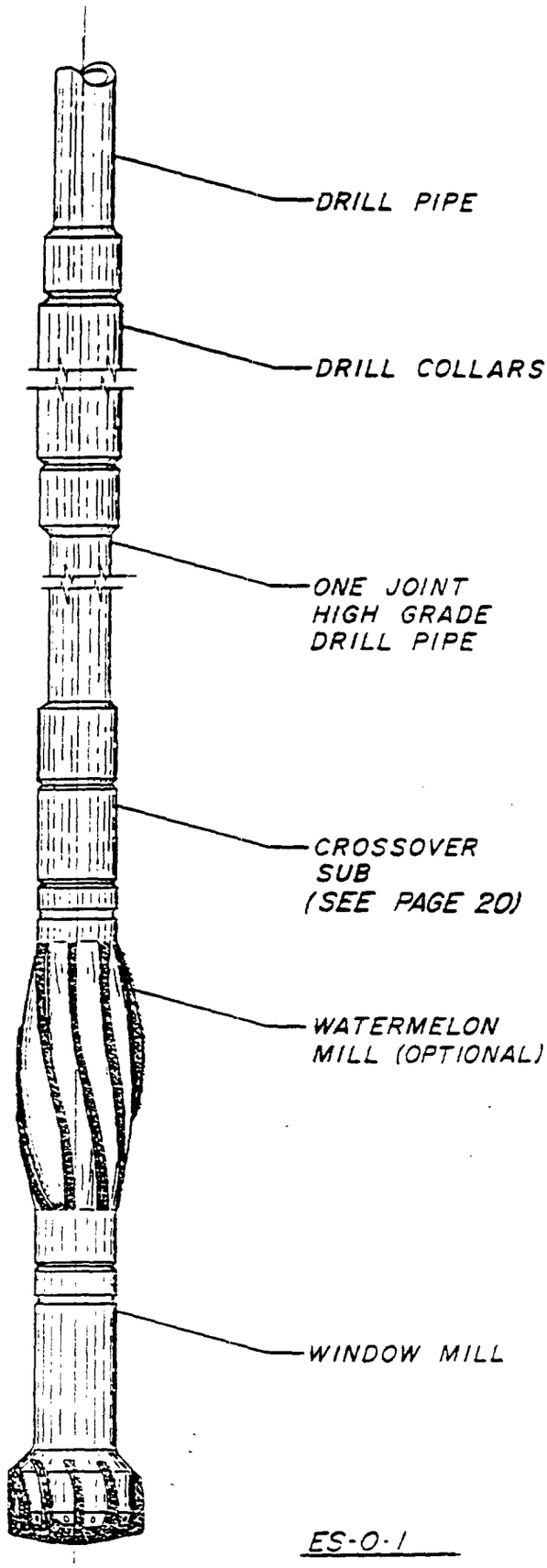
ESO-O-1



A-Z PACK-STOCK RUNNING ASSEMBLY

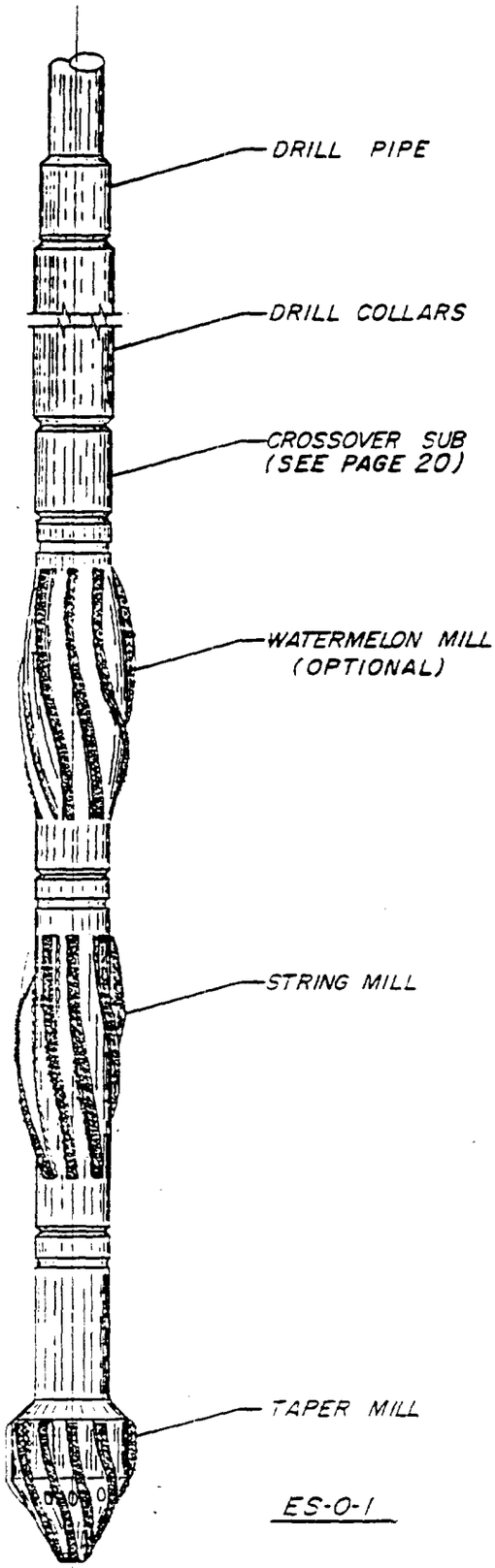
FIG.

ES-O-1



A-Z WINDOW MILL ASSEMBLY

FIG. ES-0-1



A-Z SIDETRACKING
TAPER MILL
FIG.

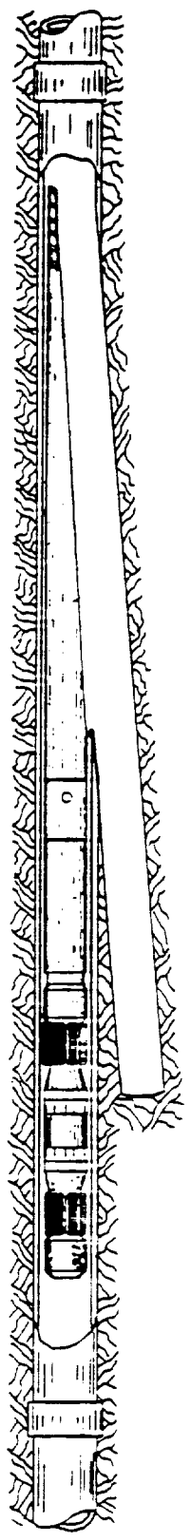
ES-0-1

CASING

SIZE 7"

WEIGHT 23 lb/Ft

GRADE K-55



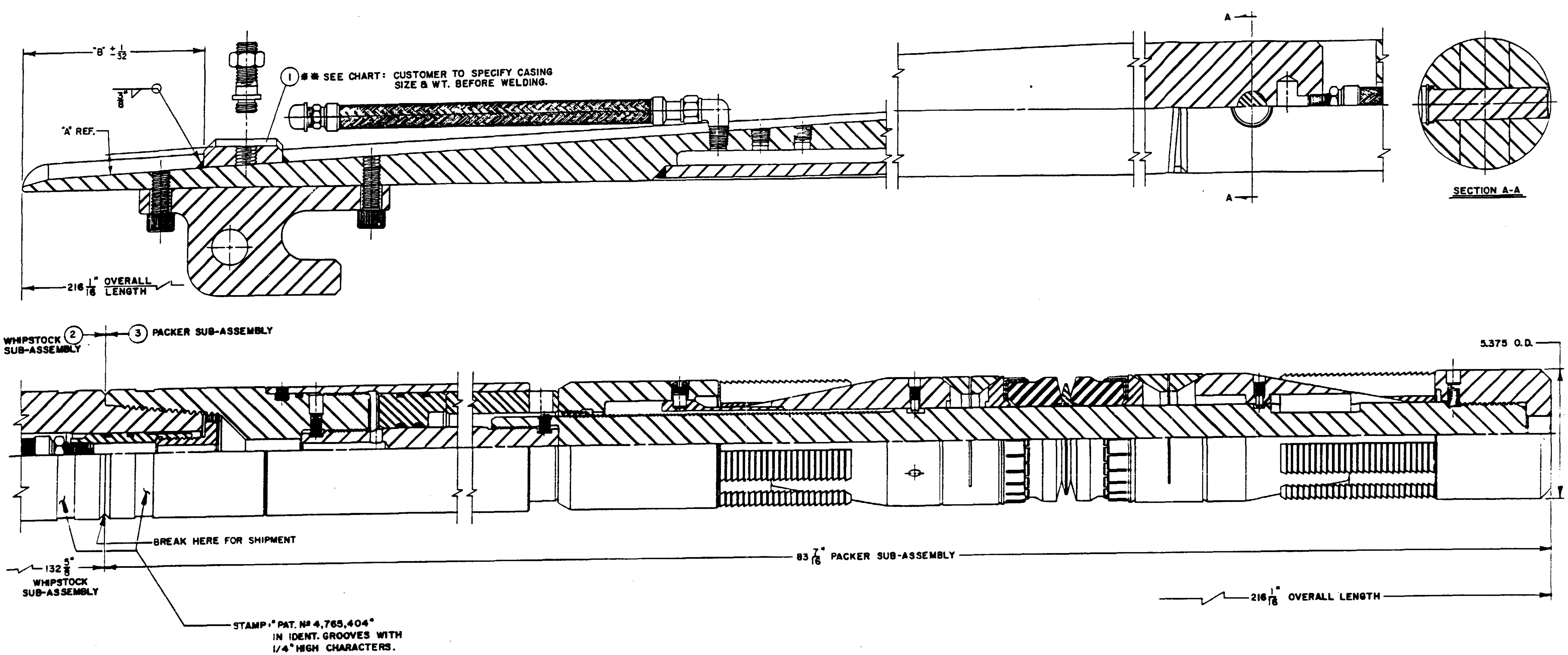
4631' DEPTH
CASING COLLAR

4639' DEPTH
TOP OF WINDOW

4650 DEPTH
BOTTOM OF WINDOW

4657' DEPTH
BOTTOM OF PACKSTOCK

4669' DEPTH
CASING COLLAR



OVERALL LENGTH — 216 1/16" (18'-0 1/16")

O.D. — 5.375"

EST. WEIGHT — 980 lbs.

STANDARD

ITEM	PART NO.	DESCRIPTION	QTY.	DWG. NO.
3	DP970-3	PACKER SUB-ASSEMBLY	1	D-8942
2	DP970-6	WHIPSTOCK SUB-ASSEMBLY	1	D-8990
1	DP970-5-**	SHEAR BOLT BLOCK (SEE CHART)	1	C-7043

BILL OF MATERIAL

** NOTE: CUSTOMER TO SPECIFY CASING SIZE & WEIGHT

CASING WT.	SHEAR BOLT BLOCK PART NO.	"A"	"B"	MILL O.D.
35#, 38#	DP970-5-3	.781	7.687	5.750
29#, 32#	DP970-5-2	.875	5.906	5.937
20#, 23#, 26#	DP970-5-1	.968	4.125	6.125

SHEAR BOLT BLOCK LOCATION

PROPRIETARY INFORMATION

C	ECN 4683	1-23-89 GP
B	ECN 4339	KR
A	ECN 2592	1-24-86

ENGINEERING CHANGE RECORD

A-Z INTERNATIONAL TOOL CO.
HOUSTON, TEXAS

ASSEMBLY
7" PACKSTOCK TYPE DP970

1-24-86 — NOTED — NONE

DP970 — D-9010 C

4. ANGLE BUILD INTERVAL

a. General Remarks

A Drilex D475SB mud motor assembly (see figure 11) will be used to drill the curved interval of the well. The motor is a specially shortened hybrid version of the standard D475 Drilex motor. The wear pad, instead of being behind the bend in the motor housing, has been moved to the front of the bend to shorten the distance from the bit to the next contact point, and thereby increase the build tendency. This assembly has not been used before in this size of hole, however based upon runs with a very similar assembly in 6-1/4" hole, and computer calculations, it should produce build rates of between 13° and 15°/100 ft.

Due to the uncertainty, a tangent interval has been programmed in the trajectory, to allow the target to be achieved with an average build rate as low as 10.9°/100 ft. This tangent interval will be drilled at an inclination of around 45°-50°, and the length will be determined at wellsite, based on the actual performance of the 4-3/4" build motor.

A steering tool will be used for directional information during the angle build. The high data rates, and instantaneous readout, make this a sensible choice for the critical first well in a new area. Future wells, having the advantage of prior knowledge, can use an MWD for directional control. The tangent interval, since it requires surface rotation of the pipe, cannot use a steering tool, and will be surveyed using an electronic single shot tool on wireline.

The tangent interval will be drilled with a stabilized, steerable mud motor assembly, and is expected to be quite short, between 70 and 100 feet total length.

b. Procedure

The following should be used as a guide to the selection of BHA and drill string to initiate the angle build: (top down)

Drill Pipe, 3-1/2" Grade E	
Heavy weight drill pipe, 3-1/2" OD	90′
Drill Collars, 4-3/4"	720′
Heavy weight drill pipe, 5" OD	180′
Non Magnetic Drill Collars, 6-1/2" OD	60′
UBHO sub	2′
Short Non-magnetic drill collar	10′
Drilex motor, 4-3/4" with 1°BH & 0.75° BS	18′
Bit, 6-1/8" OD, IADC series 5-1-7X	

Exercise extreme care when entering the window in the 7" casing. Initially, time drilling will result in the most efficient kickoff. Due to the fragile nature of the 6-1/8" bit bearings, the first bit run should not exceed 150 feet, or 8 hours drilling time, whichever comes first.

At each bit or assembly change during the build, add heavy weight pipe between the collars and the non-magnetic collars, to accomodate the planned length of the next bit run, without letting the collars pass through the window. The proposed configuration may build angle at a higher rate than desired, but it is critical to achieve a fast kickoff and not to fall behind the planned 12°/100 ft build rate. After the initial kickoff, a specially modified Hughes B35M polycrystalline diamond bit will be used, and it is anticipated that this bit should drill the entire angle build interval, with trips necessary only to drill a tangent interval.

If the build rate, once reasonably stable, is averaging more than 11°/100 ft, then a tangent section will be drilled at an inclination of about 50°. This will be accomplished with a conventional Drilex steerable motor (see figure 12). The following should be used as a guide to the selection of BHA and drill string to drill the tangent section: (top down)

Drill Pipe, 3-1/2" Grade E	
Heavy weight drill pipe, 3-1/2" OD	90′
Drill Collars, 4-3/4"	720′
Heavy weight drill pipe, 5" OD	480′
Non Magnetic Drill Collars, 6-1/2" OD	60′
Non Magnetic IB stabilizer, 6" OD	5′
Short Non-magnetic drill collar	10′
Drilex steerable BH motor, 4-3/4"	18′
Bit, 6-1/8" OD, IADC series M6-4-6	

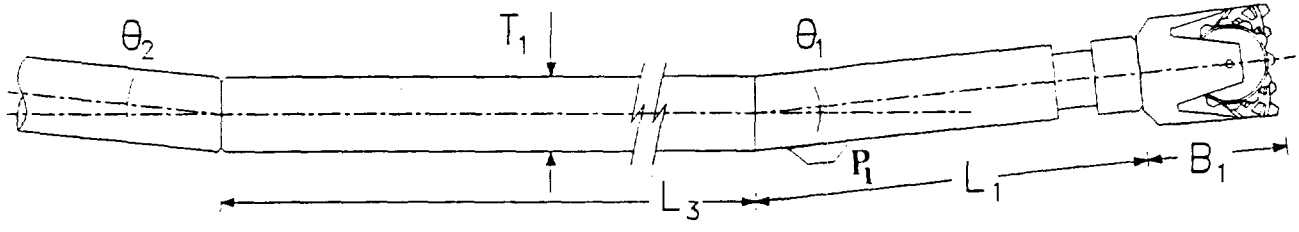
If deemed necessary, a less aggressive double bend motor may be picked up to complete the balance of the build interval. The aggressiveness of the double bend angle build motor assembly is normally controlled by adjusting the degree of the bent housing or the thickness of the wear pad, but in the case of the hybrid motor, it is not possible to increase the bend in the housing past 1 degree.

If drag problems develop during the build, short trips will be made back into the 7" casing each 90 feet drilled. A stabilized hole opener run will be made if the problems persist. Drilling with the double bend motor assembly will be stopped when the inclination has reached about 85 degrees to allow for the projected on-bottom survey and follow through. Circulate a minimum of two bottoms up while working the string, to ensure that the hole is cleaned of cuttings.

DRILEX SYSTEMS, INC.

Tool Configuration and Dog Legs

D475SB for Build #1 Interval



Measurements and Configuration Results:

L_1 = 3.67 ft.	L_3 = 6.2 ft.	B_1 = 0.8 ft.
T_1 = 4.75 in.	P_1 = 0.375 in.	θ_1 = 1 degs.
θ_2 = ¾ degs.		

Hole size = 6⅛ in.

Overall Length of System (incl. bit) = 10.67 ft.

Calculated Dog Leg for above configuration = 13.57°/100' (100% sliding)

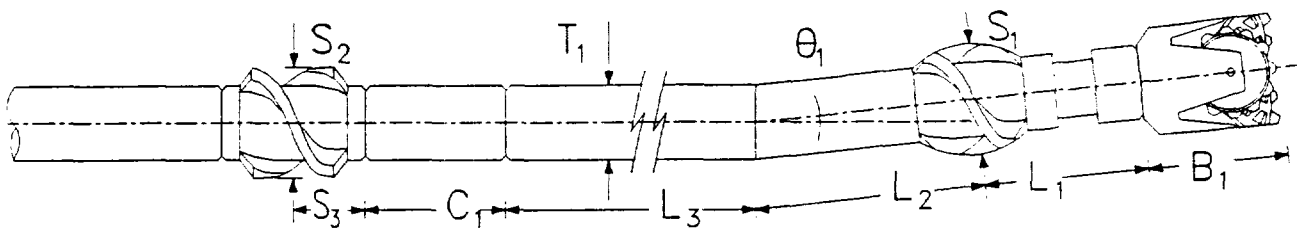
Notes on Dog Leg Expectancy Predictions

1) Predictions are based on 100% sliding mode.
2) While the motor is sliding, it is assumed that an in-gauge hole is drilled.
3) The formation is assumed to be homogenous.
4) A short gauge bit will produce better directional tendancies than an extended gauge bit.
5) The dogleg prediction figures should be regarded as *rules of thumb*, as formation characteristics, bit profile, and drilling parameters can all affect the directional response.
6) Final field-use motor configuration recommendations may differ from the above due to changes because of actual experienced drilling conditions.

DRILEX SYSTEMS, INC.

Tool Configuration and Dog Legs

D475 for Tangent Interval



Measurements and Configuration Results:

L_1 = 1.68 ft.	L_2 = 7.09 ft.	L_3 = 10.11 ft.
B_1 = 0.8 ft.	T_1 = 4.75 in.	C_1 = 10. ft.
S_1 = 6 in.	S_2 = 6 in.	S_3 = 1.75 ft.
θ_1 = ¾ degs.		

Hole size = 6⅛ in.
Spacing between stabilizers = 24.95 ft.

Overall Length of System (incl. bit) = 27.43 ft.

Calculated Dog Leg for above configuration = 3° 7' (100% sliding)
2° 20' (75% sliding)
1° 33' (50% sliding)
0° 46' (25% sliding)

Additional Dog Leg Calculations for D475

θ_1 Bend Angle (degs.)	S_1 Bottom Stabilizer (in.)	C_1 Pony Collar Length (ft.)	Distance Between Stabilizers (ft.)	S_2 Top Stabilizer (in.)	Dog Leg Expectancy (deg./100 ft.)
¾	6	0.	18.95	6	3° 15'
				5⅞	3° 26'
				5⅝	3° 47'
¾	6	10.	28.95	6	2° 55'
				5⅞	2° 60'

DRILEX SYSTEMS, INC.

Technical Specifications

Drilex D475 PDM

Outside Diameter	4¾ in.	120 mm
Overall Length (approx.)	21.3 ft.	6.49 m
Weight	770 lbs.	350 Kg
Top Connection (Box Up)	3½ in. IF	
Make Up Torque	8300 ft.-lbs.	11,200 Nm
	3½ in. REG.	
Make Up Torque	8000 ft.-lbs.	10,800 Nm
Bit Connection (Box Down)	3½ in. REG.	
Make Up Torque	8000 ft.-lbs.	10,800 Nm
	4½ in. REG.	
Make Up Torque	15,000 ft.-lbs.	20,300 Nm
Bit Size Range	5⅞ in. - 7⅞ in.	149.2 - 200.0 mm
Bit Type	Rollercone, PDC, Diamond	
Maximum Bit Pressure Drop	1500 psi	10,300 kPa
Lobe Configuration	5/6	
Operating Fluid	Water/Oil Base Mud	
Maximum Mud Weight	17 ppg	2040 kg/m^3
Maximum Sand Content	2% (by volume)	
Maximum Bottom Hole Circulating Temperature	240°F	115°C
Maximum Weight On Bit	25,000 lbs.	11,125 daN
Flow Range	100 - 250 gpm	380 - 950 l/min
Output Shaft Speed	140 - 350 rpm	
Flow To Output Shaft Speed Ratio (approx. value for no load situation)	0.72 gal/rev (1.4 rev/gal)	2.7 l/rev (2.7 rev/l)
Pressure Drop at Maximum Torque	1000 psi	6900 kPa
Maximum Operating Torque	1800 ft.-lbs.	2436 Nm
Output Torque per 100 psi Delta Pressure	166 ft.-lbs.	225 Nm
Maximum Power Output	120 hp	
Maximum Overpull Without POOH	50,000 lbs.	22,680 Kg
Maximum Permissible Overpull	100,000 lbs.	45,360 Kg

DRILEX SYSTEMS, INC.

Well Plan Profile

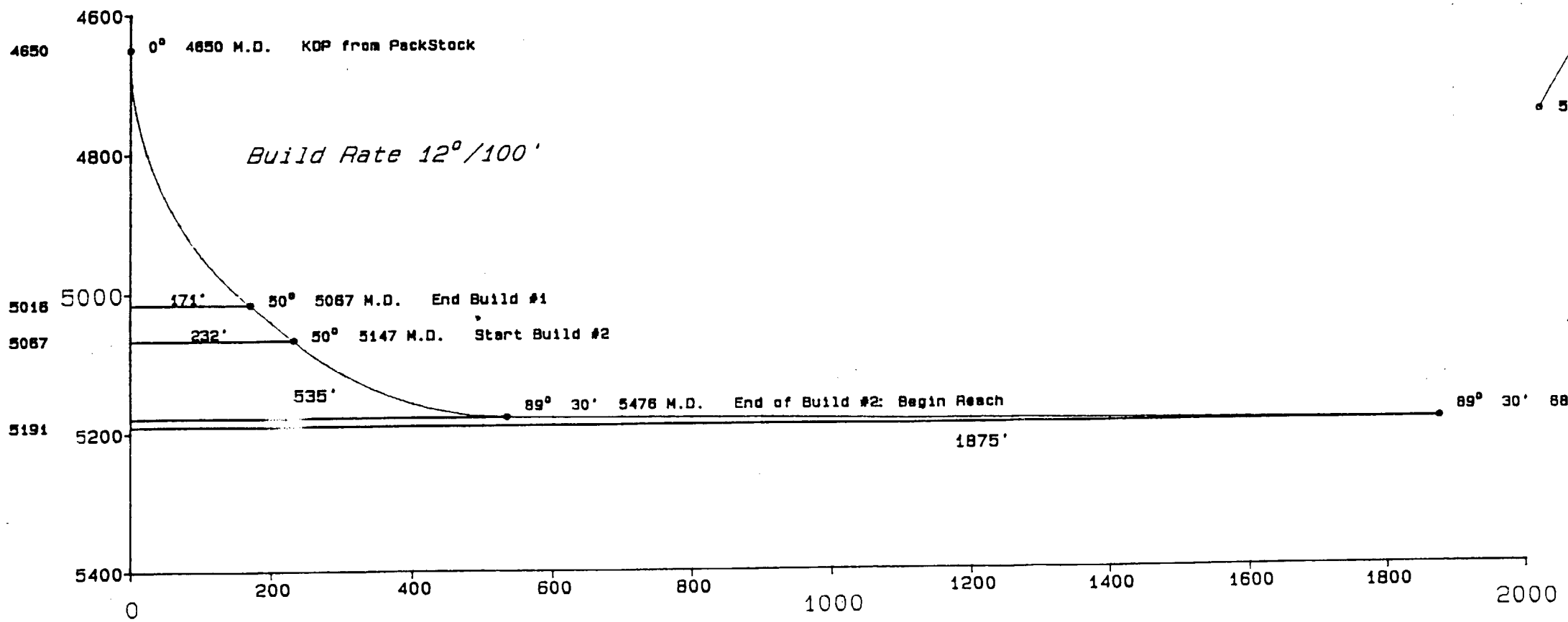
Merrion Oil & Gas
Papers Wash Field, McKinley County, New Mexico
Federal 15 #2

MD (FT)	INC. (DEG)	AZIMUTH (BEARING)	TVD (FT)	RECTANGULAR COORD N(+) S(-) (FT)	E(+) W(-) (FT)	CLOSURE (FT)	DOGLEG /100')
			Start Build #1, course length, 417'				
4650.	.00	S 30.0 W	4650.0	.0	.0	.0	.00
4750.	12.00	S 30.0 W	4749.3	-9.0	-5.2	10.4	12.00
4850.	24.00	S 30.0 W	4844.2	-35.7	-20.6	41.3	12.00
4950.	36.00	S 30.0 W	4930.6	-79.0	-45.6	91.2	12.00
5050.	48.00	S 30.0 W	5004.8	-136.8	-79.0	158.0	12.00
5067.	50.00	S 30.0 W	5015.8	-147.7	-85.3	170.6	12.00
			Start Tangent, course length 80'				
5067.	50.00	S 30.0 W	5015.8	-147.7	-85.3	170.6	.00
5147.	50.00	S 30.0 W	5067.2	-200.8	-115.9	231.9	.00
			Start Build #2, course length 329'				
5147.	50.00	S 30.0 W	5067.2	-200.8	-115.9	231.9	.00
5150.	50.40	S 30.0 W	5069.3	-203.0	-117.2	234.4	12.00
5250.	62.40	S 30.0 W	5124.5	-275.0	-158.8	317.5	12.00
5350.	74.40	S 30.0 W	5161.3	-355.4	-205.2	410.4	12.00
5450.	86.40	S 30.0 W	5177.9	-440.6	-254.4	508.8	12.00
5476.	89.50	S 30.0 W	5178.9	-462.9	-267.3	534.6	12.00
			Begin Lateral Reach, course length 1340'				
5476.	89.50	S 30.0 W	5178.9	-462.9	-267.3	534.6	.00
5550.	89.50	S 30.0 W	5179.5	-527.2	-304.4	608.7	.00
5750.	89.50	S 30.0 W	5181.3	-700.4	-404.4	808.7	.00
5950.	89.50	S 30.0 W	5183.0	-873.6	-504.4	1008.7	.00
6150.	89.50	S 30.0 W	5184.8	-1046.8	-604.4	1208.7	.00
6350.	89.50	S 30.0 W	5186.6	-1220.0	-704.4	1408.7	.00
6550.	89.50	S 30.0 W	5188.3	-1393.2	-804.4	1608.7	.00
6750.	89.50	S 30.0 W	5190.1	-1566.4	-904.4	1808.7	.00
6816.	89.50	S 30.0 W	5190.7	-1623.5	-937.3	1874.7	.00

Merrion Oil & Gas
Federal 15 #2
Papers Wash Field
McKinley County, New Mexico

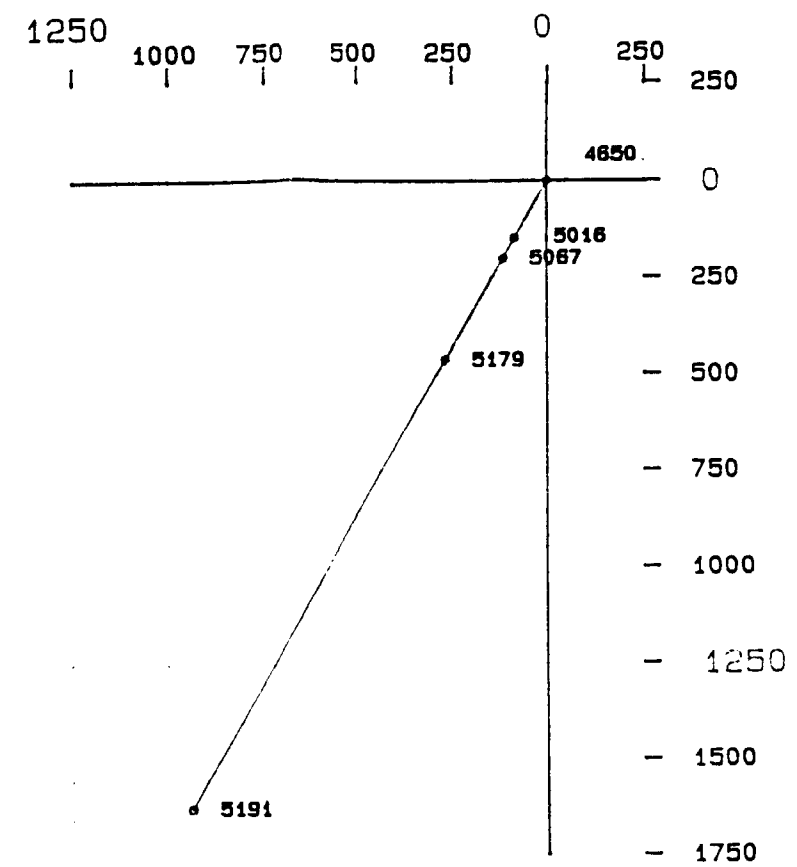
PLANE OF PROPOSAL
S 30° 0'W

VERTICAL SECTION
Scale 1" = 200'



N
North

HORIZONTAL PLAN
Scale 1" = 500'



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d. Drilling Fluid Program

The drilling fluid used to drill the Morrison and Entrada intervals will be a light weight, low solids, gel polymer mud. A minimum of clay solids will be used in formulation, and it is essential that the tanks are thoroughly cleaned prior to mixing the new mud. Weight should be controlled at 8.6 lb/gal or less, and fluid loss should be kept below 6 ml/30 min once the top of the Entrada is reached. Prior to reaching the Entrada, the API fluid loss should be maintained between 10 and 15 ml/30 min.

Hole cleaning in horizontal wells presents unusual problems, in that there are three different intervals in the well, each requiring different fluid rheological properties. The best cleaning in the horizontal interval comes from turbulent flow, but this results in poor cleaning in the angle build and vertical intervals. Accordingly, a compromise rheology will be used, with the yield value of the mud maintained between 10 and 18 lb/100 ft^2. The planned flow rates of 200 gal/min will give annular velocities of about 195 ft/min between the hole and the 3-1/2" pipe.

Good solids control will be essential to an economic and non-damaging mud. A Cagle high thrust, fine screen shaker will be used, with initial screen sizes of 200 mesh or finer. The rig desilter should be checked to ensure that the inlet manifold pressure is at least 35 lb/in^2. If it is not possible to keep the mud weight within specification while drilling, due to high ROP or any other reason, additional solids control equipment will be rented.

Suggested Mud Properties

Mud weight	8.5 - 8.6 lb/gal
Funnel Viscosity	33 - 36 sec/qt
Yield value @ 125°F	10 - 15 lbs/100 ft^2
API Filtrate (Morrison)	10 - 15 ml/30 min.
(Entrada)	< 6 ml/30 min.
pH	8.5 - 9.0
Solids Content	< 4% by volume
Excess PHPA	0.5 - 1.0 lb/bbl

Volume Requirements

Hole Volume @ 6,815'	265 bbls
Surface Volume	600 bbls
Dilution/contingency	485 bbls
	1,350 bbls

Formulation

Wyoming Bentonite	8.0 lb/bbl
PHPA	1.0 lb/bbl
PAC-Regular	0.5 lb/bbl
PAC-LoVis	0.5 lb/bbl
Caustic Soda	0.3 lb/bbl
Leonardite	4.0 lb/bbl

e. Bit and Hydraulic Program

Bit No.	Make	Type	IADC Code	Jets	Depth In
1	Reed	HP51A	5-1-7X	10,10,10	4,650
2	Hughes	B35M	M6-4-6	11,11,11	4,800

Anticipated Hydraulics

Pump rates	180 - 200 gal/min
Standpipe Pressure	1600 - 2400 lb/in^2

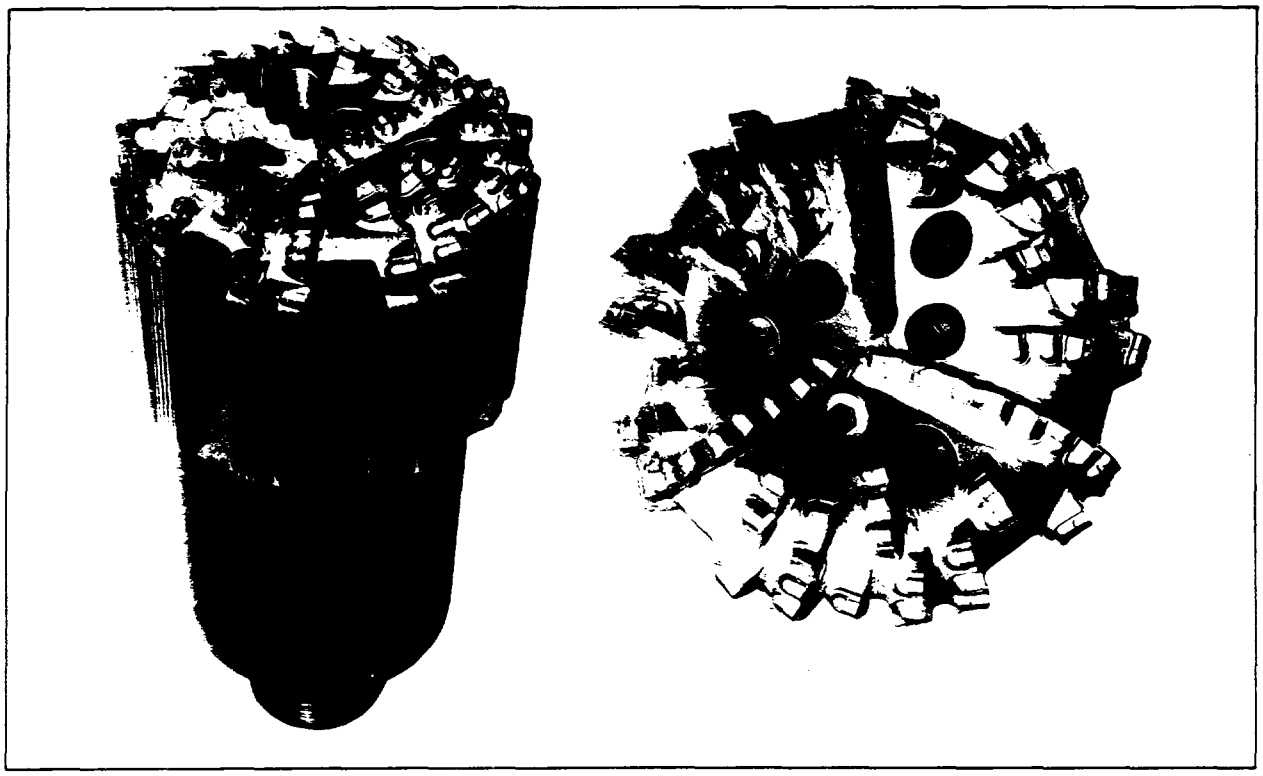
These numbers should be used as a rough guide only, as hydraulics will be altered at wellsite as dictated by hole conditions.

Offset Well Bit Information

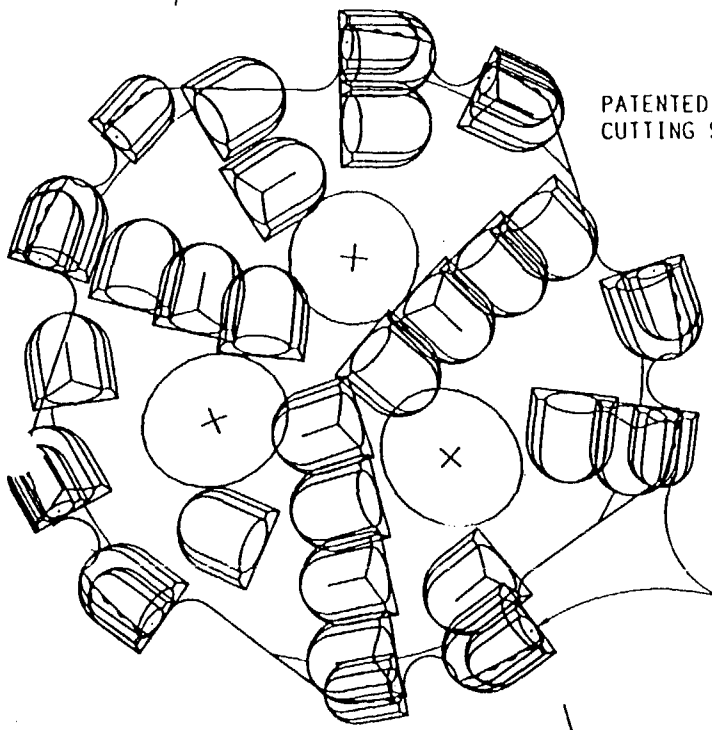
Morrison / Entrada (all 8-3/4" size)

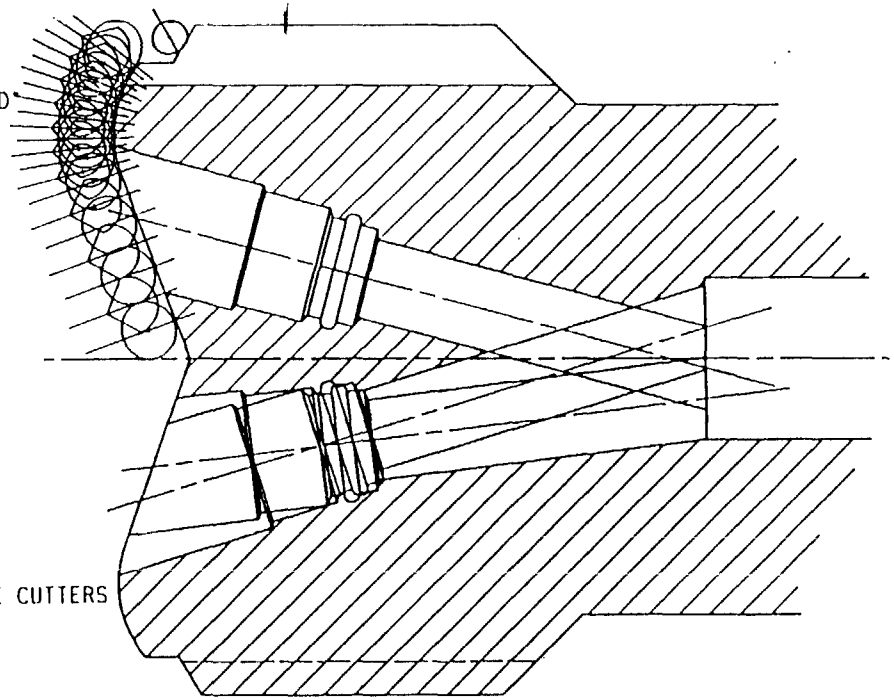
Well	Type	Feet	Hours	Ft/hr	WOB/RPM
15-6	F3	1251	84.75	14.8	35/60
21-3	J33	1439	143.75	10.0	40/50
16-2	F3	960	57.0	16.8	
1 SF	S86	800	82.0	9.8	
20-4	F3	1102	59.25	18.6	
21-4	F3	1056	68.0	15.5	
AB 1	FP52	1149	70.75	16.2	
15-2	F3	1272	84	15.0	35/50

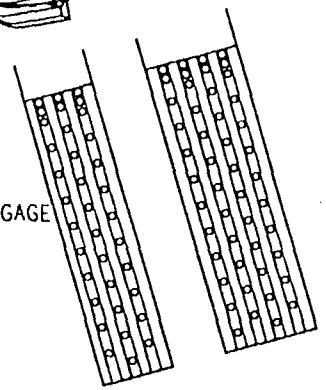
B35M
Polycrystalline Diamond Bit



- Unique medium formation bit that incorporates a patented intermixing of scribe and round cutters to set up a kerfing action enhancing penetration rates.
- Cutter shape variation and resultant cutting action increase bit life by overcoming harder transitions more effectively.
- Ribbed cutter placement controls drilling fluid to efficiently cool cutting elements.
- Shallow cone profile distributes weight on bit and cutter loading extremely well upon encountering harder transitions.
- Large number of primary tip ground PDC gage cutters are augmented by backup PDC gage cutters to maximize full hole protection.
- The B35M provides an extremely durable PDC drilling bit for rotary and motor applications. It can be used to drill friable sands, durable shales, limestones and medium dolomites and to maintain gage through abrasive stringers. It is aimed at applications where penetration rates of 10 to 20 feet per hour are expected.







NATURAL DIAMOND GAGE
42.5 cts.

6-1/4" B35M

36 TOTAL CUTTERS
16 STD. ROUND
10 SCRIBE
10 "BACK-UP" GAGE CUTTERS
3 STD. REPLACEABLE NOZZLES (TFA RANGE: .15 to .83 sq. in.)
3-1/2" REG. A.P.I. CONNECTION

CARL KEITH 11-2-88

6-1/4" B35M PROPOSAL HDP219

6-1/8" B35M

PRODUCT SPECIFICATIONS:	STANDARD MODEL
IADC CODE	M646
PROFILE	Shallow Cone
BODY MATERIAL	Matrix
CUTTER - SET	Bladed
- FACE NO.	21
- GAGE NO.	15
- TOTAL NO.	36
NO. STD. BODY NOZZLES	3
NO. "HEXFLOW" BODY NOZZLES	0
JUNK SLOT AREA(IN^2)	3.1
LENGTH - MAKEUP FACE TO NOSE	11-3/8"
- OVERALL	15"
- GAGE	2-3/4"
API REGULAR PIN	3-1/2"
SHANK O.D.	4-3/4"
APPROX. SHIPPING WT. (LBS)	95

OPERATING SPECIFICATIONS:	
FLOWRATE (GPM)	162 - 206
HYDRAULIC HORSEPOWER/IN^2(HSI)	2.0 - 4.0
BIT WEIGHT - NORMAL (LBS)	9,187 - 18,375
- MAXIMUM (LBS)	21,437
ROTARY SPEED (RPM)	80 - Turbine

Hughes Diamond Products models are constantly reviewed and refined. Product improvements may alter a particular specification.

f. Materials and Services

Drilling Tools

Drilex
1 ea Drilex 4.75" hybrid motor with 1.25° BH and 0.75° BS
2 ea Drilex 4.75" Steerable motor with 0.75° BH and 6" bottom stabilizer.
2 ea motor dump valves for Drilex motors

SDI
2 ea 4-3/4" x 2-1/4 x 30 ft long non magnetic drill collars
1 ea 4-3/4" x 2-1/4 x 10 ft long non magnetic drill collar
1 ea 4-3/4" x 2-1/4 x 6 ft long non magnetic drill collar
2 ea 6" OD IB non-magnetic string stabilizers
1 ea 5-7/8" OD IB non-magnetic string stabilizers
2 ea 3-1/2" IF double pin non-magnetic crossover subs
2 ea 3-1/2" IF double box non-magnetic crossover subs
1 ea Champ II electronic multishot tool
1 ea film recording magnetic single shot kit
1 ea Wireline pump down circulating head, with 3-1/2" IF connection
1 ea SDI Eye-3 steering tool, c/w side entry sub
1 ea monel sensor for single shot.
2 ea PMS timer-camera for single shot
1 ea NM survey catcher, 3-1/2" IF
1 ea monoconductor wireline truck

Baker Hughes Drilling Systems
2 ea Baker MWD tools, c/w surface equipment
1 ea 4-3/4" x 2-11/16 x 30 ft non magnetic drill collar
1 ea flow sub, 3-1/2"IF box x 3-1/2" IF pin
1 ea mule shoe sub, 3-1/2"IF box x 3-1/2" IF pin
1 ea 6-1/8" bit, Hughes B35M PDC, with 1" long gauge
1 ea bit breaker for 6-1/8" Hughes PDC bit

Drill Bit & Supply
3 ea 6-1/8" bits, IADC series 5-1-7X
3 ea 6-1/8" bits, IADC series 5-3-7
2 sets Jet Nozzles for bits, size 10/32
2 sets Jet Nozzles for bits, size 12/32
1 ea Jet Nozzle pliers
1 ea bit breaker for 6-1/8" roller cone bit

Oilfield Rentals/Dotco
42 jts 3-1/2" 13.3 lb/ft Grade S drill pipe
30 jts 3-1/2" Heavy weight drill pipe, with 2-1/4" ID

Mud Materials - Milpark

Item	Unit	Quantity
Bentonite	100 lb	110
Caustic Soda	50 lb	8
Newdrill	5 gal	55
Drispac	50 lb	15
Drispac Superlo	50 lb	15
Ligco	50 lb	100
New Thin	5 gal	10

Personnel

Directional Driller
2 Baker MWD Engineers
Mud Logging Crew
SDI Wireline Operator
SDI Surveyor
TIW service man
CTC service man
Cementer
Casing Crew

5. LATERAL INTERVAL

a. Procedure

The lateral section will be drilled maintaining an angle of approximately 89.5°, so that 12' vertically of the Entrada Sandstone is drilled over the planned 1350' interval. The section will be drilled using a fully stabilized bent housing steerable system, which will allow drill string rotation for normal drilling. This system will allow directional corrections to be made without tripping out of the hole, by orienting and drilling without surface rotation.

It is important to drift all pipe, collars, subs and tools to 2.25" as they are first picked up. The ability to wireline retrieve the Baker MWD tool in the event of stuck pipe depends on a clear 2-1/4" ID drill string.

Two sets of drilling jars will be run in the string, one located immediately above the non-magnetic drill collars in the BHA segment, and a second set in the lower part of the drill collars in the vertical part of the well. The lower jars are for jarring a stuck BHA, which is most likely to occur because of cuttings accumulation. The upper set of jars are for jarring the string loose from the angle build interval, where keyseat formation is most likely. The upper jars are normally unable to deliver enough force to free the BHA due to lowside friction dissipating the energy. Individual settings for the jars will be decided at wellsite, after observation of the magnitude of up and down drags.

It is **extremely important** to ensure that at no time are the steel drill collars allowed to enter the casing window or be rotated on the whipstock face. Likewise, the drilling jars should never be run in a position where they are subjected rotation in the build curvature.

The following should be used as a guide to the selection of BHA and drill string to drill the lateral interval of the well: (top down)

Drill Pipe, 3-1/2" Grade E	
Heavy weight drill pipe, 3-1/2" OD	60'
Drill Collars, 4-3/4"	600'
Jars, Houston Engineers, 4-2/4" OD	30'
Drill Collars, 4-3/4"	120'
Heavy weight drill pipe, 3-1/2" OD	720'
Drill Pipe, 3-1/2" Grade S	1260'
Jars, Houston Engineers, 4-2/4" OD	30'
Non Magnetic Drill Collars, 4-3/4" OD	30'

Baker Flow sub	3′
Baker MWD non-mag collar, 4-3/4" OD	30′
Baker mule shoe sub	3′
Non Magnetic IB stabilizer, 6" OD	5′
Short Non-magnetic drill collar	6′
Drilex steerable BH motor, 4-3/4"	18′
Bit, 6-1/8" OD, IADC series M6-4-6	

The quantity of grade S pipe shown is for the well at total depth. This pipe should be added in approximately 450′ increments as the lateral interval is drilled. The drill string should be set up at all times so that the steel drill collars remain inside the 7" casing. This will require a minimum of three trips during the drilling of the lateral interval.

Each connection, reciprocate the pipe and circulate at least 10 minutes. Short trips will be made back to the 7" casing window at intervals not to exceed 300′ or 12 hours, whichever comes first. Additional short trips will be made if the surface torque and weight readings indicate impending hole problems. These short trips materially assist in removing the cuttings bed, and give good indication of imminent hole problems, such as keyseat formation in the curve.

When drilling of the hole is complete, circulate at least two full circulations, or until the hole cleans up; reciprocation of the pipe will help. When the hole is clean, pump down the survey instrument for the definitive wellbore directional survey. This will be a Champ II electronic multishot, with a conventional film multishot as backup. POH surveying on 30 foot stations for the entire lateral and angle build intervals. Run back to bottom and circulate at least one full circulation, POH to log. If there were any problems with the multishot survey, it can be rerun when the hole is conditioned for casing after logging.

b. Bit and Hydraulic Program

Bit No.	Make	Type	IADC Code	Jets	Depth In
RR2	Hughes	B35M	M6-4-6	11,11,11	5,450

Anticipated Hydraulics

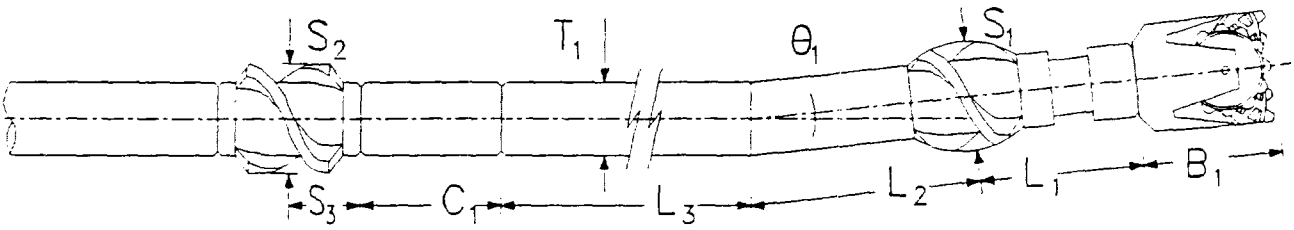
Pump rates	180 - 200 gal/min
Standpipe Pressure	1800 - 2400 lb/in^2

These numbers should be used as a rough guide only, as hydraulics will be altered at wellsite as dictated by hole conditions.

DRILEX SYSTEMS, INC.

Tool Configuration and Dog Legs

D475 for Lateral Reach Interval



Measurements and Configuration Results:

L_1 = 1.68 ft.	L_2 = 7.09 ft.	L_3 = 10.11 ft.
B_1 = 0.8 ft.	T_1 = 4.75 in.	C_1 = 10. ft.
S_1 = 6 in.	S_2 = 6 in.	S_3 = 1.75 ft.
θ_1 = ¾ degs.		

Hole size = 6⅛ in.
Spacing between stabilizers = 24.95 ft.

Overall Length of System (incl. bit) = 27.43 ft.

Calculated Dog Leg for above configuration = 3° 7' (100% sliding)
2° 20' (75% sliding)
1° 33' (50% sliding)
0° 46' (25% sliding)

Additional Dog Leg Calculations for D475

θ_1 Bend Angle (degs.)	S_1 Bottom Stabilizer (in.)	C_1 Pony Collar Length (ft.)	Distance Between Stabilizers (ft.)	S_2 Top Stabilizer (in.)	Dog Leg Expectancy (deg./100 ft.)
¾	6	10.	28.95	6	2° 55'
				5⅞	2° 60'
				5⅝	3° 9'
¾	6	0.	18.95	6	3° 15'
				5⅞	3° 26'
				5⅝	3° 47'

6. LOGGING

After drilling is complete, the well will be logged with a standard lithology / porosity / saturation log suite, consisting of gamma ray, dual induction, density and neutron porosity. Since conventional wireline techniques cannot be used in a horizontal well, the logs will be conveyed in the hole on drillpipe, using the Schlumberger TLC tools.

Essentially, the technique consists of making up the log sondes to each other with special flex joints to allow them to pass through the curve, and then making up a special adaptor head to the toolstring. This adaptor has a drillpipe thread looking up, and contains a male wet connector internally. The logging tools are run into the hole on drillpipe for a distance equal to the length of the open hole to be logged. At that time, a female connector is run on the wireline and latched to the male connector, and the tool operation is checked.

The wireline passes through a side entry sub to the outside of the drill string, and the remainder of the drill string is run into the hole, with the wireline being strapped to the outside of the pipe as it is run. The hole can be logged either running in or pulling out.

Following logging, make up a cleanout assembly, consisting of the last BHA used to drill, without the motor or MWD, and RIH to bottom. Circulate the hole clean, and POH to run the liner.

Figure 17 Drill Pipe Conveyed Logging Schematic

7. LINER PROCEDURE

a. Discussion

The liner will be a string of 4-1/2", 11.60 lb/ft, K-55, 8rd LT&C, Range 3 casing. The portion of the liner which will be situated in the producing formation will be pre-perforated with 4 each 1/2" diameter holes per foot. Above the Entrada top, conventional plain pipe will be cemented back into the 7" production casing.

A unique system has been designed to enable the liner to be run in the hole, circulated to bottom, hung, and cemented from the Entrada top back to the 7" casing, all with just one trip in the hole. The system consists of an internal tubing string which connects from the bottom of the liner hanger running tool to a packoff bushing located just above the liner shoe. At the junction of the plain and the pre-perforated liner, there is a port collar and an external casing packer. The tubing string has a swab assembly, a set of closing dogs, and a plug landing seat, all of which are located initially in the vicinity of the external casing packer. The tubing string will be 2-7/8", 6.4 lb/ft, N-80 Armco Sealock.

b. Procedure

1. Tally all casing and tubing upon arrival at location, and remove all thread protectors and clean pins and boxes with wire brush and diesel. Drift all tubulars on rack, or when picked up.

2. Pick up TIW type LA set shoe, make it up to the 10' casing pup joint and set in slips.

3. Make up the TIW drillable packoff bushing to the top of the pup joint. Use thread locking compound on this connection.

4. Pick up required number of joints of pre-perforated liner and run in the hole. The number of joints will be determined at location after logging, but will be approximately 34.

5. Make up the CTC Payzone external casing packer to the liner in slips.

6. Make up the locator collar to the top of the CTC packer.

7. Make up the port collar (**open position**) to the locator collar.

8. Make up and run plain casing in the hole.

9. Make up adaptor plate to the liner in slips, to act as a work surface for running the internal tubing string.

10. Pick up TIW slick joint, set in slips, and make up 6' long tubing pup joint.

11. Make up and run required amount of 2-7/8" tubing.

12. Pick up TIW swab assembly with 6' long tubing pup joint and closing dog assembly. Make up to inner string and run in hole.

13. Make up and run required space-out amount of 2-7/8" tubing.

14. Make up J-Hanger with left hand jay, Type L setting collar and liner swivel, with running tool installed. Make up inner string connection to tubing string, pick up and remove tubing slips and adaptor plate. Lower and make up liner hanger connection to the liner in slips. Lower liner with running tool, set slips on the 8' handling nipple which is made up to the running tool.

15. Run the liner in the hole on 30 joints of 3-1/2" heavyweight pipe, and 3-1/2" Grade E drill pipe. Circulate as needed to wash liner down until it reaches setting depth.

16. Circulate hole at least 2 full circulations, reciprocating liner slowly in 40' strokes, until the shakers clean up completely. The mud should be according to specification at this time.

17. Set the liner hanger by left hand rotation, 3/4 turn at the hanger. After the liner is set, get off the hanger by rotating 21 turns to the right at the Type L setting collar.

18. Pick up plug dropping head and make up to the drill string. Pressure test the cementing lines to the rig floor to 3500 psi.

19. Drop first dart, chase with batch mixed cement slurry. When the dart lands in its seat, pressure up to 500 psi to shift sealing iron dogs into locating position.

20. Continue to pressure up and open CTC packer for inflation with cement.

21. Inflate packer with cement, and operate closing valve. When finished, bleed down tubing string to 100 psi.

22. Pick up slowly, locating sealing dogs in locator sub. Continue to pick up slowly, when the top swab passes the port collar, the pressure will bleed off. Continue to pump cement, drop second dart, and displace cement.

23. Pick up slowly until closing dogs locate port collar inner sleeve, and close port collar.

24. Pressure up on tubing string to 3500 psi. The plug seat will shear out and allow the string to be pulled dry. Pull out of the hole with the running string, laying down work string, running tool, swab assembly and inner string.

25. Lay down remaining drill pipe and drill collars. Pump remaining mud from tanks into frac tank for later use during the testing phase. RDMO.

c. Cementing Program

d. Materials and Services

Piedra Supply
36 jts 4-1/2", 11.6 lb/ft, K-55, 8rd LT&C Range # casing, pre-perforated with 4 each 1/2" holes per foot.
25 jts 4-1/2", 11.6 lb/ft, K-55, 8rd LT&C Range # casing
85 jts 2-7/8", 6.4 lb/ft, N80 NUE tubing with Armco Seal Lock connections.
1 can Thread locking compound
3 ea Klampon protectors for 4-1/2" casing
5 gal API modified thread compound

TIW
1 ea TIW LA liner setshoe, with aluminum nose guide, 4-1/2" 8rd LT&C box up..
1 ea TIW drillable packoff bushing with 4-1/2" 8rd LT&C box up, pin down
1 ea slick joint for drillable packoff bushing, 15' long with 2-7/8" Armco Seal Lock box up
1 ea Locator sub, with 4-1/2" 8rd LT&C box up, pin down
1 ea cementing port collar, with 4-1/2" 8rd LT&C box up, pin down
1 ea liner swivel
1 ea TIW single cone mechanical liner hanger, with 4-1/2" 8rd LT&C pin down, LH jay
1 ea 5-1/2" TIW Type L setting collar, with 4-1/2" 8rd LT&C thread down
1 ea TIW 5-1/2" mechanical liner hanger running tool.

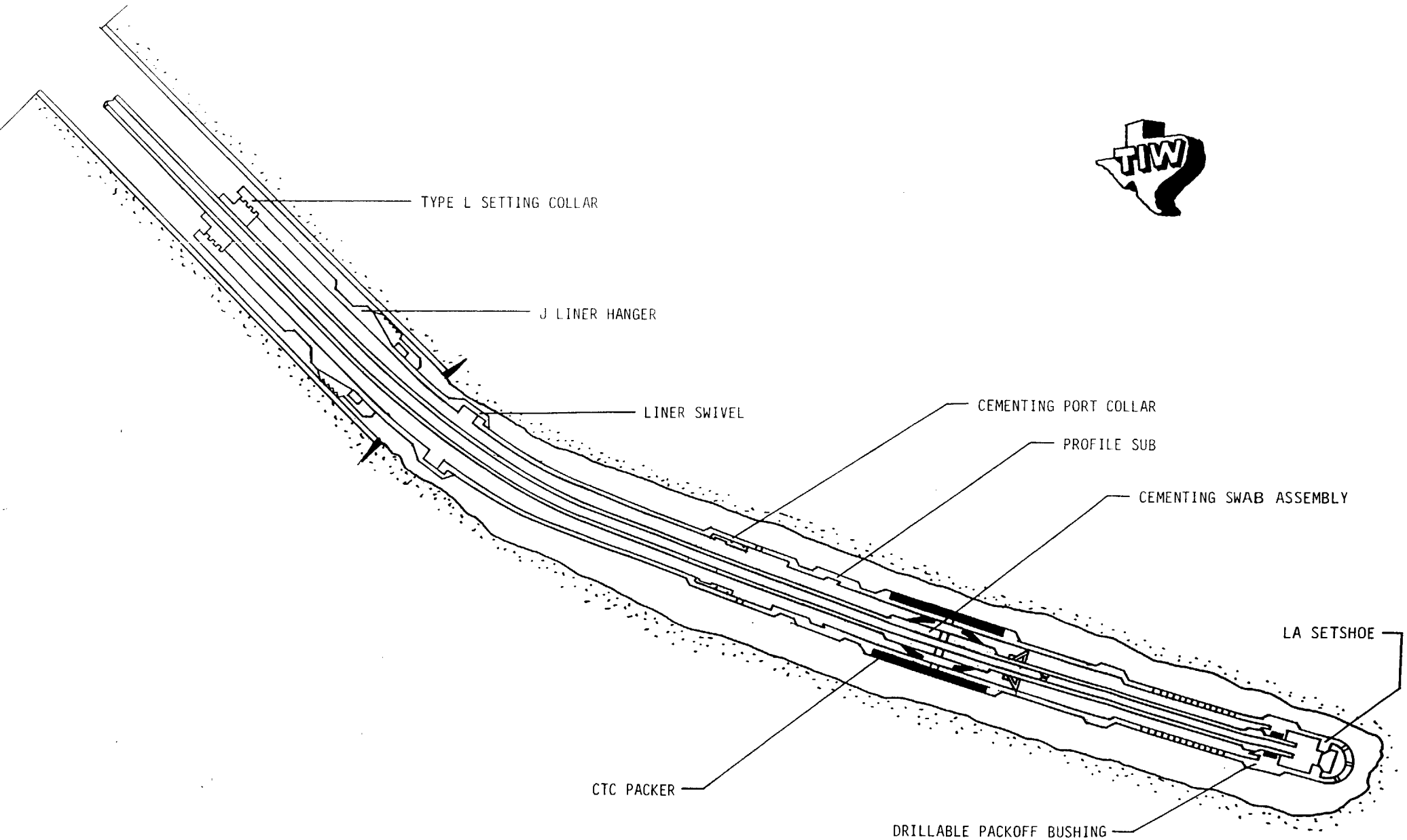
1 ea TIW swab assembly for inflation of CTC packer and primary cementation, c/w hydraulic dogs for closing port collar, and drillpipe dart landing seat.
2 ea TIW pump down plugs with 2-7/8" and 3-1/2" rubbers.
1 ea plug dropping head, with 3-1/2 IF connection

Completion Tool Company
1 ea 4-1/2" CTC Payzone packer, with 20' seal length, 11.6 lb/ft, K-55 grade.
1 ea 4-1/2" sub set, 8' long top sub LT&C box up, 2' bottom sub, LT&C pin down.

Oilfield Rentals / Dotco
1 set Handling tools for 4-1/2" LT&C casing
1 set slip type handling tools for 2-7/8" tubing
1 ea stabbing guide for 2-7/8" tubing
6 ea 3-1/8" OD drill collars with 2-3/8" IF connections
1 ea 3-7/8" OD flat bottom junk mill with 2-3/8" Regular pin
1 ea bit sub, 2-3/8" regular box X 2-3/8" IF box

Justis Supply
1 ea 4-1/2" casing pup joint, 10' long, with 8rd LT&C connections (wt & grade unimportant)
1 ea 2-7/8", 6.4 lb/ft, N80 NUE tubing pup joint, 10' long with Armco Seal Lock connections.
1 ea 2-7/8", 6.4 lb/ft, N80 NUE tubing pup joint, 15' long with Armco Seal Lock connections.
2 ea 2-7/8", 6.4 lb/ft, N80 NUE tubing pup joint, 5' long with Armco Seal Lock connections.
1 ea crossover sub, 3-1/2 IF box X 2-7/8" Armco Seal Lock pin
1 ea crossover sub, 2-7/8" Armco Seal Lock box X 2-3/8" IF pin
1 ea slotted adaptor plate for handling 2-7/8" tubing

Dowell Schlumberger
Cement & additives


TIW
TYPE L SETTING COLLAR
J LINER HANGER
LINER SWIVEL
CEMENTING PORT COLLAR
PROFILE SUB
CEMENTING SWAB ASSEMBLY
LA SETSHOE
CTC PACKER
DRILLABLE PACKOFF BUSHING

ENGINEERING SPECIFICATION DRAWING

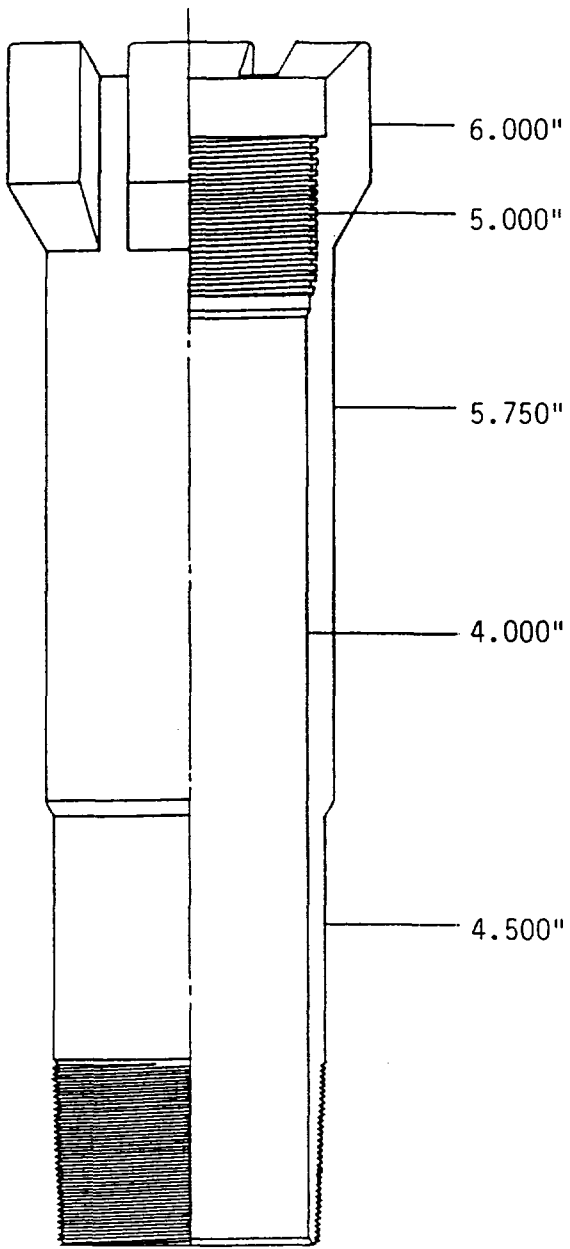
TEXAS IRON WORKS, INC.

Drawing No. 1501-107

Sheet ___ of ___ Date 11-21-89

Reference No. 512895

T.I.W. TYPE L SETTING COLLAR



SIZE: 5-1/2" X 7" 26#

GRADE: K-55

THREAD:

PIN DOWN- 4-1/2" 11.6# 8RFL

BURST (P.S.I.) 6,110

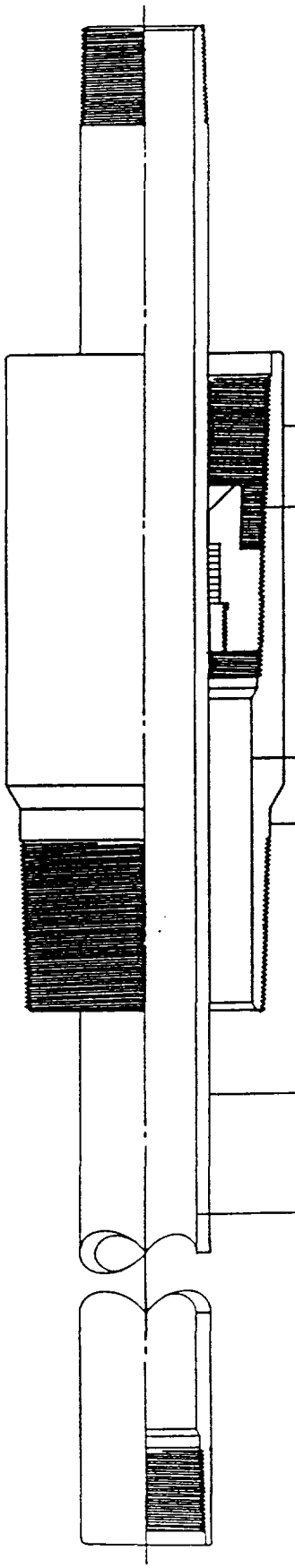
COLLAPSE (P.S.I.) 5,770

ENGINEERING SPECIFICATION DRAWING

TEXAS IRON WORKS, INC.

Drawing No. 1203-157
Sheet ___ of ___ Date 11-21-89
Reference No. 506358

T.I.W. DRILLABLE PACKOFF BUSHING



SIZE: 4-1/2" 11.6#

GRADE: J-55

THREAD:
BOX UP- 8RFL
PIN DOWN- 8RFL

BURST (P.S.I.) 6,110

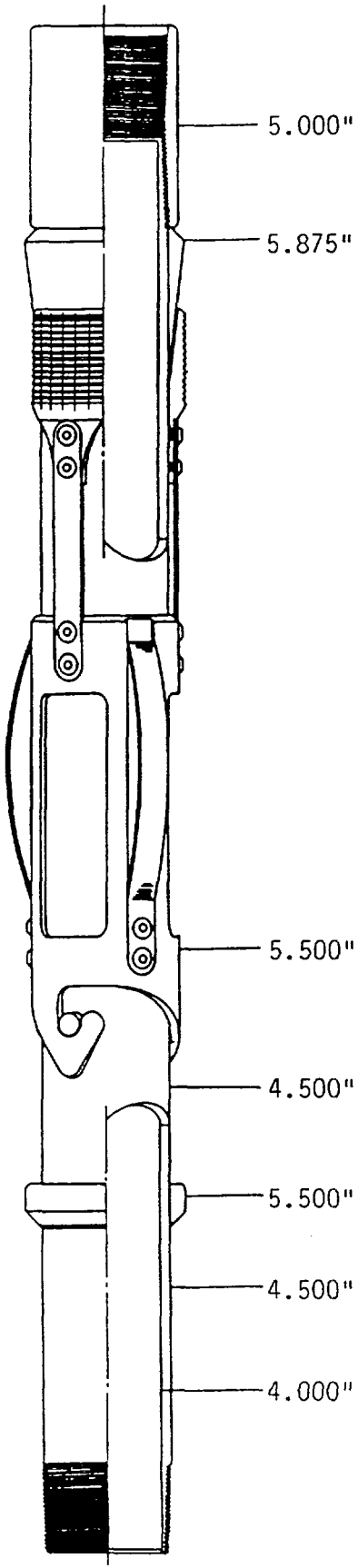
COLLAPSE (P.S.I.) 5,770

T.I.W. TYPE J LINER HANGER

ENGINEERING SPECIFICATION DRAWING

TEXAS IRON WORKS, INC.

Drawing No. 1700-108
Sheet ___ of ___ Date 11-21-89
Reference No. 512895



SIZE: 4-1/2" 11.6# X 7" 20-26#
GRADE: K-55

THREAD:
BOX UP- 8RFL
PIN DOWN- 8RFL

BURST (P.S.I.) 6,110
COLLAPSE (P.S.I.) 5,770

BY-PASS AREA In^2:
SET: 1.11
UNSET: 4.42

HANGING CAPACITY (lbs.)
137,110

ENGINEERING SPECIFICATION DRAWING

TEXAS IRON WORKS, INC.

Manufacturing and Servicing Oil Well Equipment

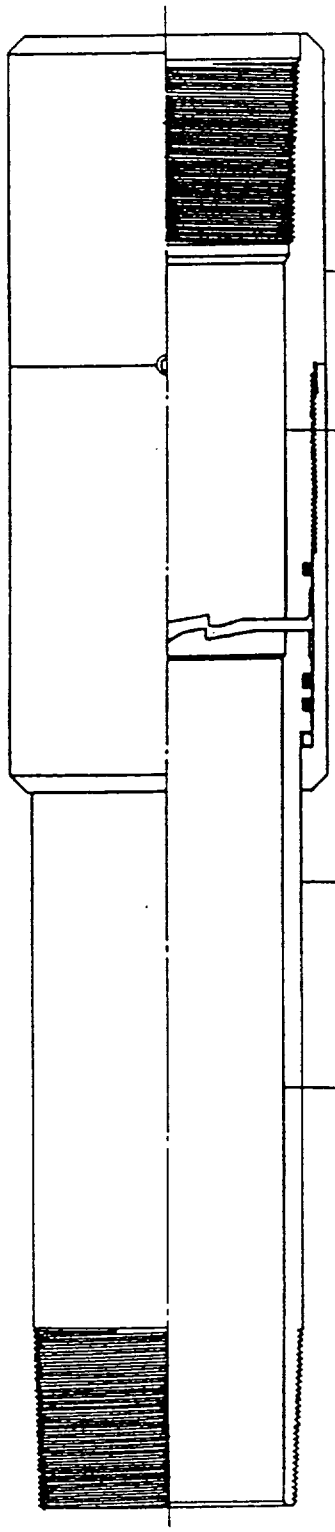
P. O. BOX 35729 • HOUSTON TEXAS 77235

Drawing No. 1775-164

Sheet ___ of ___ Date 11-21-89

Reference No. 501010

T.I.W. LINER SWIVEL



SIZE: 4-1/2" 11.6# X 7" 20-26#

GRADE: K-55

THREAD:

BOX UP- 8RFL

PIN DOWN- 8RFL

BURST (P.S.I.) 6,820

COLLAPSE (P.S.I.) 6,390

TENSILE. (lbs.) 246,675

T.I.W. CEMENTING SWAB ASSEMBLY

w/ SEALING IRON

ENGINEERING SPECIFICATION DRAWING

TEXAS IRON WORKS, INC.

A PEARCE INDUSTRIES COMPANY

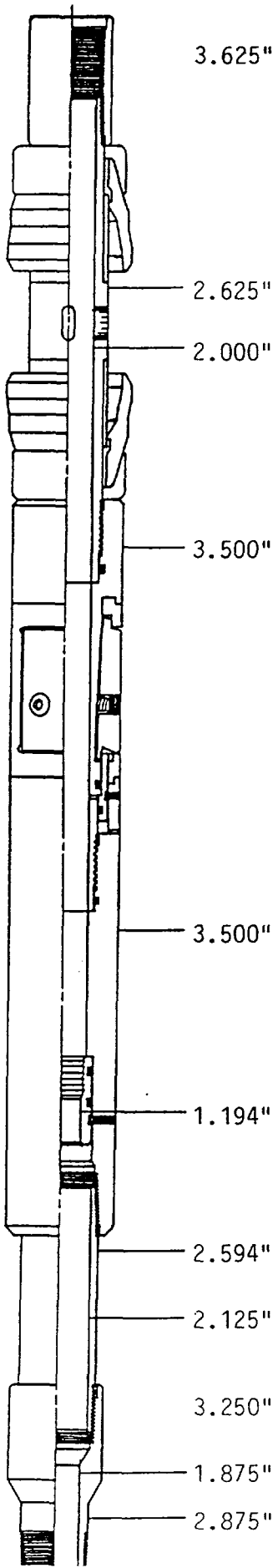
Manufacturing and Servicing Oil Field Equipment

P. O. BOX 35729 • HOUSTON, TEXAS 77235-5729

Drawing No. _____

Sheet ____ of ____ Date 11-21-89

Reference No. _____



SIZE: 4-1/2" 11.6#

THREAD:

BOX UP- 2-7/8" 6.4# ARMCO SEAL LOCK

PIN DOWN- 2-7/8" 6.4# ARMCO SEAL LOCK

T.I.W. CEMENTING PORT COLLAR

ENGINEERING SPECIFICATION DRAWING

TEXAS IRON WORKS, INC.

A PEARCE INDUSTRIES COMPANY

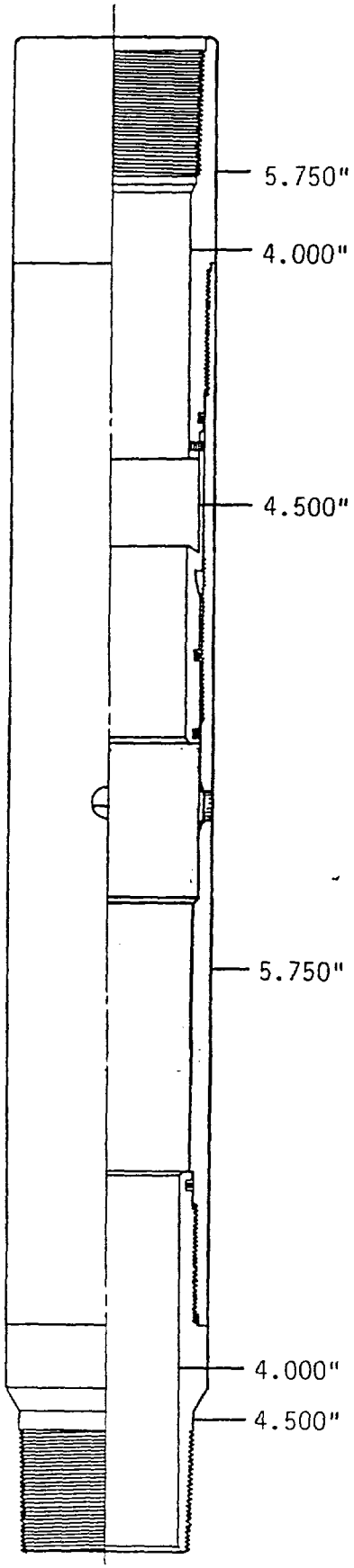
Manufacturing and Servicing Oil Field Equipment

P O BOX 35729 • HOUSTON, TEXAS 77235-5729

Drawing No. 0757-104

Sheet ___ of ___ Date 11-21-89

Reference No. 608275



SIZE: 4-1/2" 11.6#

GRADE: K-55

THREAD:

BOX UP- 8RFL

PIN DOWN- 8RFL

BURST(PSI): 6,110

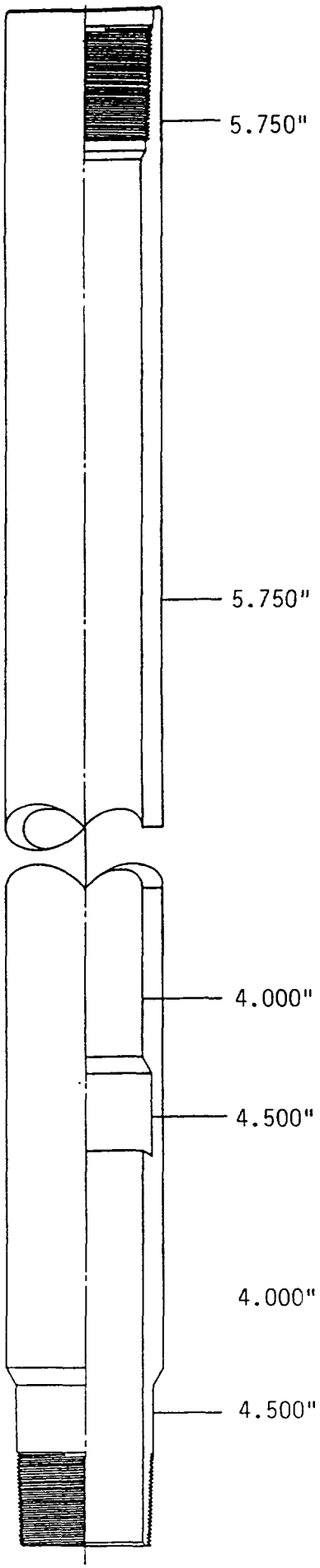
COLLAPSE(PSI): 5,770

T.I.W. PROFILE SUB f/
SEALING IRON

ENGINEERING SPECIFICATION DRAWING

TEXAS IRON WORKS, INC.

Drawing No. 8130-103
Sheet ___ of ___ Date 11-21-89
Reference No. 036071



SIZE: 4-1/2" 11.6#

GRADE: J-55

THREAD:

BOX UP- 8RFL

PIN DOWN- 8RFL

BURST (P.S.I.) 6,110

COLLAPSE (P.S.I.) 5,770

T.I.W. TYPE LA SETSHOE

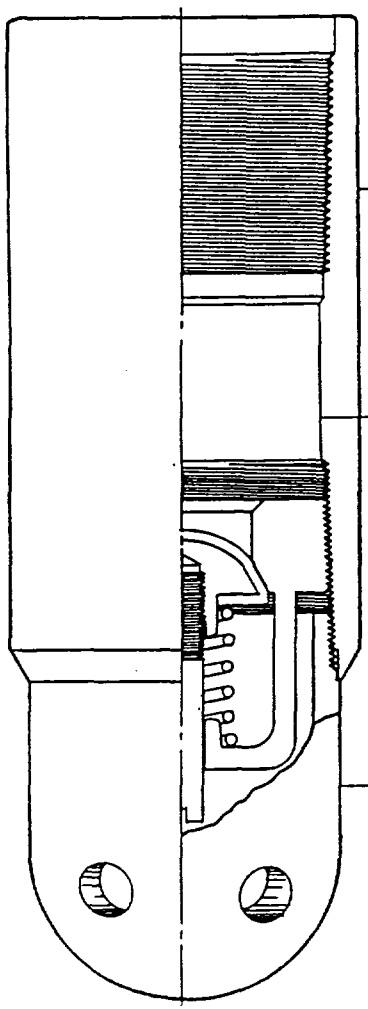
ENGINEERING SPECIFICATION DRAWING

TEXAS IRON WORKS, INC.

Drawing No. 1902- 106

Sheet ___ of ___ Date 11-21-89

Reference No. 608273



SIZE: 4-1/2" 11.6#

GRADE: K-55

THREAD:
BOX UP— 8RFL

BURST (PSI) 6,110

COLLAPSE (PSI) 5,770

T.I.W. TYPE CROSS-OVER COLLAR

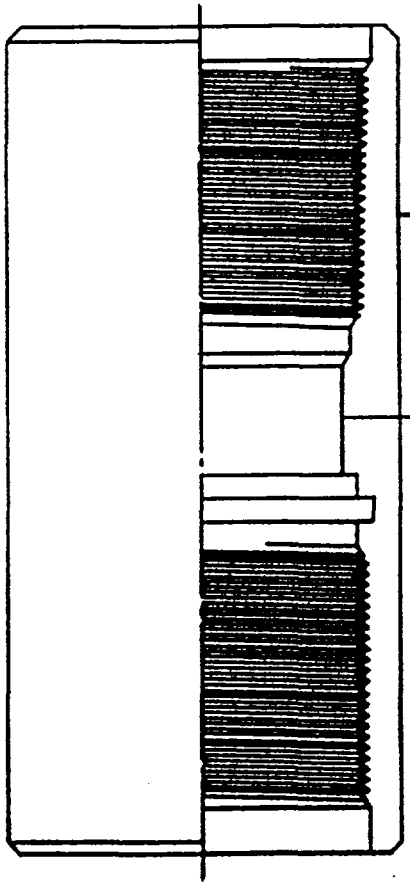
ENGINEERING SPECIFICATION DRAWING

TEXAS IRON WORKS, INC.

Drawing No. 2025-153

Sheet ___ of ___ Date 11-21-89

Reference No. 036033



Thread

Box Up 2-7/8" 6.5# EU

Box Down 2-7/8" 6.4#

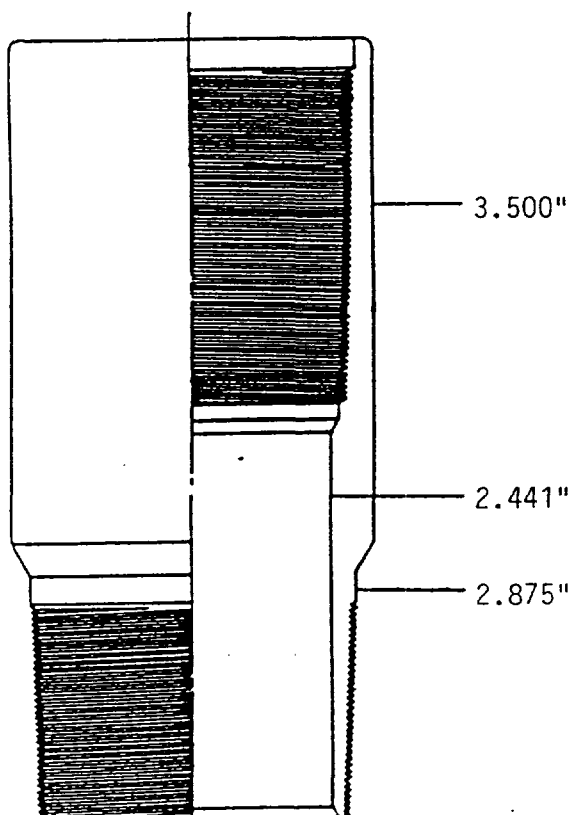
ARMCO SEAL LOCK

T.I.W. CROSSOVER SUB

ENGINEERING SPECIFICATION DRAWING

TEXAS IRON WORKS, INC.

Drawing No. 2025-155
Sheet ___ of ___ Date 11-21-89
Reference No. 036031



SIZE: 2-7/8" 6.4# X 2-7/8" 6.5#

GRADE: N-80

THREAD:

BOX UP- 2-/8" 6.4# ARMCO SEAL LOCK

PIN DOWN- 2-7/8" 6.5# EU

BURST (P.S.I.) 12,070

COLLAPSE (P.S.I.) 11,160

T.I.W. TYPE CROSS-OVER COLLAR

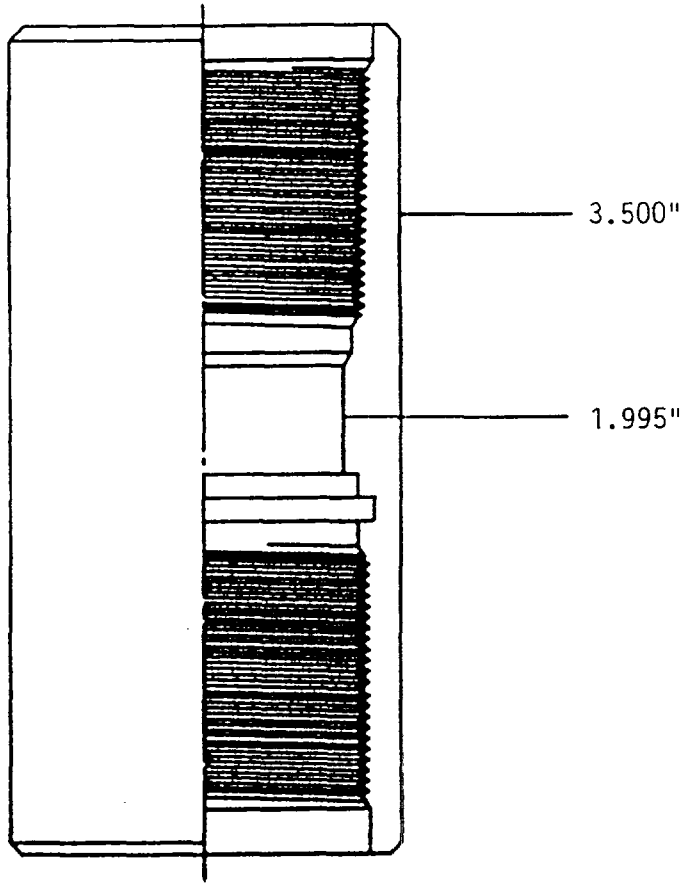
ENGINEERING SPECIFICATION DRAWING

TEXAS IRON WORKS, INC.

Drawing No. 2025-154

Sheet ___ of ___ Date 11-21-89

Reference No. 036032



Thread

Box Up 2-7/8" 6.4# ARMCO SEAL LOCK

Box Down 2-3/8" 4.7# EU

8. TESTING PROCEDURE

a. Discussion

The completion and testing phase will be performed using Ram Rig 1. A cleanout run will be made with bit and scraper to the liner top, and a second scraper run will then be made to the liner shoe. The test program has the objective of determining productivity and quantifying damage, but the design is complicated by the horizontal wellbore.

Horizontal well testing, using pressure build-up data, is characterized by longer than normal well bore storage effects, and by sometimes very long times required to reach infinite acting radial flow. These difficulties are compounded by the geometry of the well, and the problems that presents in the mechanical string design. The Federal 15-2 test design is further complicated by the need to artificially lift the well for the stabilized flow period.

In order to get a satisfactory test, the following requirements need to be satisfied. Surface readout of downhole pressures, with real time diagnostic plotting, derivative and type curve matching, is essential to ensure that the test is long enough to get the data, without being excessively long. The test tools should be in the vertical portion of the well, where they can be reliably operated. A set of gauges must be located in the lateral interval, to read the downhole pressures at the rock face. It must be possible to kill the well after the test without incurring formation damage. The string design must be compatible with both artificial lift **and** use of SRO gauges.

It is usual to set the test packer and down-hole shut-in valve above the liner top, due to size and operating constraints. This means, however, that the surface read-out gauge is then located some distance away from the rock face, limiting the valuee of the pressure data thus obtained. Killing the well after a test, with up to 2200 feet of hole below the packer, is also a problem in many circumstances, and the usual technique of bullheading can cause major problems.

To overcome the problems, but simultaneously satisfy the requirements, an innovative test string has been designed, see figure 19. Two sets of gauges will be used, a set of memory gauges conveyed on tubing into the lateral interval, and a conventional wireline SRO in the vertical hole. The downhole shut-in device is a wireline run and actuated tool, the Johnston PRST, see figure 20.

b. Procedure

1. Make up 6-1/8" bit and 7" scraper, RIH on 3-1/2" tubing and clean out to liner top. Use the mud left over from drilling operations. POH.

2. Make up 3-7/8" flat bottom mill and 4-1/2" casing scraper on 6 ea 3-1/8" drill collars and 2000' 2-7/8" Armco Seal Lock tubing, RIH and clean out liner to drillable pack-off bushing.

3. Displace lateral interval to oil.

4. Make up test string as follows:
   Gauge carrier
   Joint of perforated 2-7/8" tubing
   2-7/8" N80 Armco Seal Lock tubing
   XO sub
   Test Packer
   PRST seating nipple
   12 jts 3-1/2" HWDP
   XO sub
   3-1/2" EUE tubing
   Gas lift mandrel
   3-1/2" EUE tubing
   Surface tree and lubricator

5. When at setting depth, set packer and begin swabbing the well until oil is being swabbed, or the well begins to flow.

6. Begin gas lifting well. Lift at steady rate of approx 500 BFPD until well cleans up. This will be when the water cut is steady and produced solids are less than 0.5% by volume.

7. Run and latch PRST with SRO gauge. With PRST valve open, continue to lift well.

8. Run stabilized flow period for ?? hours. It is essential during this time that the flow rate is held as constant as possible.

9. Shut well in downhole at PRST. Monitor build-up via SRO gauge, watching diagnostic plots to pick end of test.

10. When test is complete, cycle PRST until it unlatches, and POH with same.

11. Unseat packer and observe well. If no tendency to flow, POH with test string. If flowing, kill well with drilling mud, circulating the long way. DO NOT REVERSE.

12. POH with test string.

13. Pick up completion string, RIH.

c. Material and Services

Schlumberger
1 ea SPRO tool c/w surface computer
1 ea PRST tool
2 ea Quartz memory gauges
1 ea bundle carrier
1 ea test packer for 7" 23 lb/ft casing
1 ea SPRO wireline truck

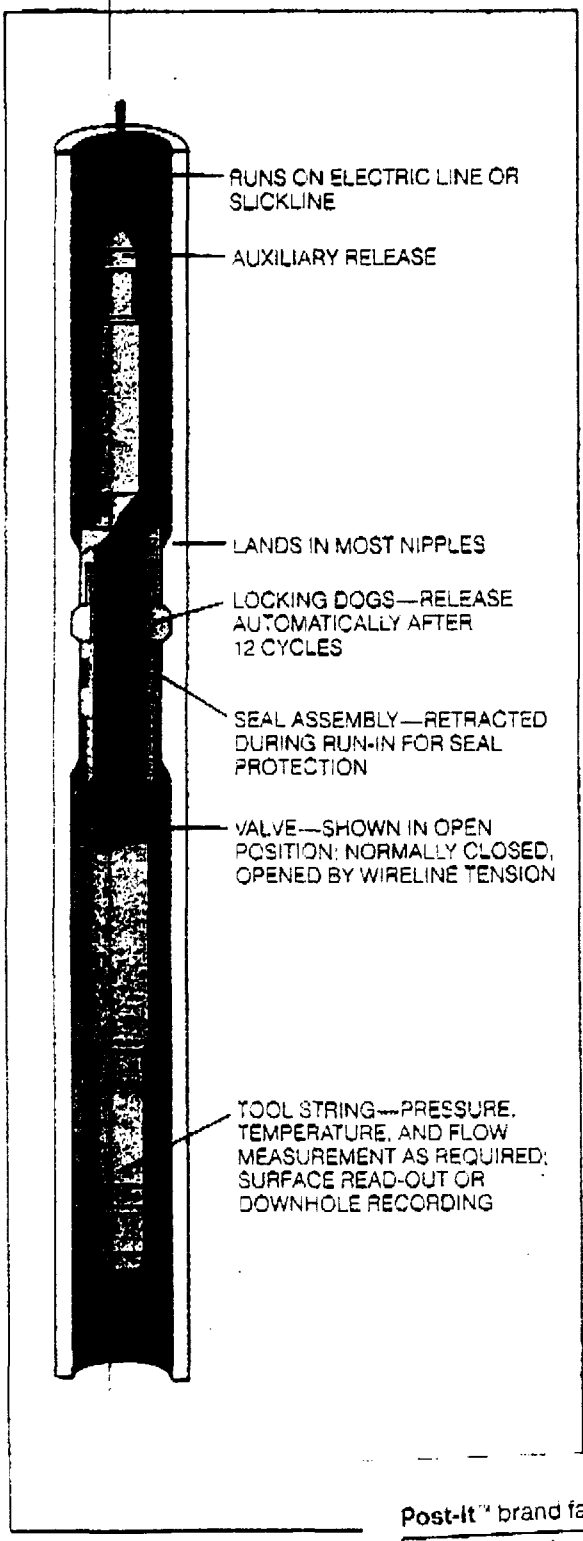
Piedra
4600' 3-1/2" EUE tubing
2000' 2-7/8" 6.4 lb/ft N80 Armco Seal Lock tubing
1 ea gas lift mandrel

Figure 19 Schematic of Test String

FLOPETROL JOHNSTON*
PRST* PRESSURE READ-OUT SHUT-IN TOOL

Schlumberger

TECHNICAL DATA SHEET WT 02 01



The Pressure Read-Out Shut-In Tool is a wireline-conveyed shut-in valve which is landed in the commercial seating nipples found in most completions. It permits downhole shut-in of a well close to the producing interval. As a result, wellbore storage effects are minimized and the pressure response obtained allows a better reservoir analysis to be performed. The PRST tool can also be used in wells which do not naturally flow to the surface (gas lift, for example) where a surface shut-in is meaningless. Under normal conditions it can also be used for fall-off tests in injection wells.

The PRST tool can be run on slickline with downhole recording or on electric line for real-time surface read-out. Simple and efficient in operation, the tool requires only one wireline run to land, latch, operate, unlatch, and retrieve it. The tool can be cycled up to 12 times on each trip into the well without equalizing the pressure across the valve. Rugged, reliable seals are protected while the tool is being run in. The seals are designed to hold 5000 psi differential in normal operation. In reverse operation, they will seal up to 1.5 times the low-side pressure to a maximum of 5000 pounds.

Specifications

Maximum differential pressure: 5000 psi.

Flow area: 1.34 square inches.

Length: 90 inches.

Weight: 50 pounds.

Landing nipple sizes: 2.25, 2.31, 2.75, or 2.81 inches.

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To Tony Beckett	From Joe Colbert
Co. Merrion	Co. Schlumberger
Dept.	Phone # (303) 398-5727
Fax # 326-5900	Fax # (303) 375-8135

*Mark of Schlumberger

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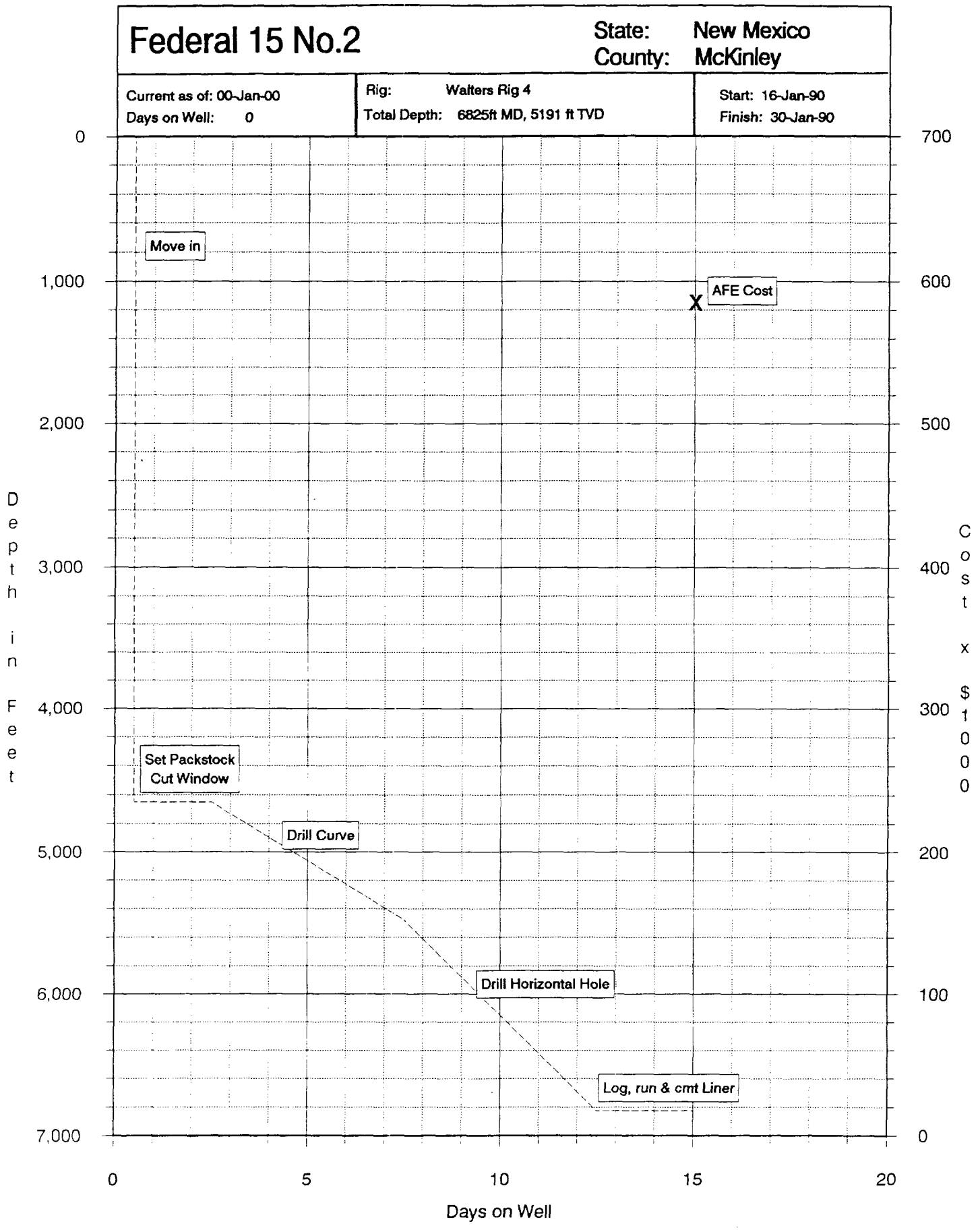
IV. AFE AND DRILLING TIME CURVE


Federal 15 No.2
State: New Mexico
County: McKinley
Current as of: 00-Jan-00
Days on Well: 0
Rig: Walters Rig 4
Total Depth: 6825ft MD, 5191 ft TVD
Start: 16-Jan-90
Finish: 30-Jan-90
Move in
AFE Cost
Set Packstock
Cut Window
Drill Curve
Drill Horizontal Hole
Log, run & cmt Liner
Depth in Feet
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
Cost x $1000
700
600
500
400
300
200
100
0
0
5
10
15
20
Days on Well

V. VENDORS CONTACT NUMBERS

Vendor	Contact Name	Phone Number
AB Engineering	Tony Beckett	(713) 370-5356
AZ Well Services	Tony Zaremba	(505) 325-8961
Baker MWD	Ed Chiaramonte	(318) 837-1145
CTC	Ed Woods	(713) 961-3336
Dowell Schlumberger	Sid Christensen	(505) 325-5096
Drilex Systems	David Henry	(307) 472-1011
	Chip Abrant	(713) 880-8888
Hughes Tool Co.	Larry ??	(505) 325-3670
Justis Supply		(505) 325-3551
Milpark	Don Walters	(303) 830-7300
Oilfield Rentals	Ben Reese	(505) 327-4421
Piedra Supply	Mark Merrion	(505) 327-8475
Schlumberger (log)	Larry Ludwick	(303) 375-8118
Schlumberger (test)	Joe Corbett	(303) 375-8118
SDI	George Moody	(915) 563-1339
TIW	Sam Baker	(713) 729-2110
	John Hughes	(512) 992-1819
Walters Drilling	Herman Walters	(505) 327-5218