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Austral Oil Company Incorporated

PROJECT RULISON

POST-SHOT INVESTIGATIONS  
Summary of Re-Entry Operations

January 1971  
Miles Reynolds, Jr.



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# PROJECT RULISON POST-SHOT INVESTIGATIONS

## Summary of Re-Entry Operations

COPY

### I. Introduction

Project Rulison, an underground nuclear gas stimulation experiment located in Garfield County, Colorado (Figure 1), was detonated on September 10, 1969. Commencement of the re-entry into the chimney was intentionally delayed for a period of six months in order to let the gaseous fission products of biological significance, namely Iodine-131, to decay. Drilling operations were not able to actually commence until April 28, 1970, because of adverse weather conditions.

The original plan of re-entry called for a simple cleanout of the emplacement well to the deepest possible point, then milling out of the 10-3/4" casing and drilling on to the chimney region essentially parallel to the original borehole. It became necessary, however, to modify these plans when gas pressure appeared at the surface of the emplacement well approximately six days following the detonation. It became apparent that under this condition gaseous radioactivity would have to be dealt with from the very onset of operations, and, because of the intended use of air to remove the dry stemming material, there was a potential hazard of forming explosive mixtures of air and gas. The alternate route chosen to effect the re-entry was through the site exploratory well, (R-EX), Hayward #25-95. This well had been stemmed with cement plugs prior to the detonation as shown in Figure 2.

### II. Re-entry Operations

#### A. Organization

Austral Oil Company Incorporated contracted with Signal Drilling Company to furnish the rig and associated drilling equipment for the re-entry. In addition, Austral secured the special services and equipment necessary to support and accomplish the planned re-entry. Supervision of the drilling operations was furnished by Austral.

The Los Alamos Scientific Laboratory was delegated the responsibility for on-site radiation safety by the AEC Nevada Operations Office Test Manager.

Eberline Instruments Corporation, working through contractual arrangements with the Atomic Energy Commission, furnished the personnel and equipment necessary for performance of the on-site radiation safety activities.

### B. Drilling Preparations

The basic philosophy around which preparations were made for the re-entry was that there would be the capability to deal with radioactivity from the very onset of operations. There was a requirement to inventory all radioactivity released to the atmosphere in addition to providing on-site radiation protection for personnel. These requirements necessitated the installation of shrouds around the pressure control equipment (blowout preventers) and over the drilling fluid circulation tanks. These shrouds were connected to a ventilation system which continually removed any gases that might be discharged into the shrouds from either the drilling fluid or pressure control equipment.

Snubbing equipment which might be needed to remove the drill string from the hole under pressure was stored on-site for immediate availability. In the event it became necessary to control the well because of high volumes of gas entrainment in the drilling fluid from below, a Drilling Well Control separator unit was installed in the well control system and kept ready for use at all times.

Both the ventilation system discharge and the discharge line from the Drilling Well Control unit were tapped for radiation monitoring by Eberline.

A light density drilling fluid, 8.6 to 9.0#/gallon, was employed in the re-entry.

### C. Drilling History

Entry into the R-EX well was accomplished by first drilling out the upper cement plug and bridge plug. The water which was left between the two cement plugs was circulated out of the hole and became part of the drilling fluid system. The second cement plug was drilled out from inside the 7-5/8" casing and from inside the 5-1/2" liner to a depth of 6520'. The upper portion of the 5-1/2" liner was then milled out to a depth of 6520' and a cement plug set and dressed off to a depth of 6470' preparatory to commencing the sidetrack hole. A caliper log of the 7-5/8" casing was run prior to drilling the 5-1/2" liner.

Both whipstocks and a Dyna-Drill were used to deviate the sidetracked hole in the desired manner. Drilling progressed satisfactorily and reasonably well along the planned deviated path to a depth of 7624' (Exhibit C). At this point a new 5-1/2" liner was set and cemented in a 6-3/4" hole. The 7-5/8" casing was again calipered prior to drilling out below the new 5-1/2" liner (Exhibit B-2).

Drilling continued below the 5-1/2" liner with a 4-3/4" hole. During this stage of the drilling operations, back pressure valves were installed at the bottom of the drill string during removal and running of the drill pipe. Circulation was lost while drilling at a depth of 8270' and drilling continued without circulation to a total depth of 8354'. Control of the well was maintained by pumping drilling fluid into the hole and maintaining a hydrostatic head greater than the chimney pressure.

Control of the well in the manner mentioned above was maintained through its completion. The 4-3/4" hole was not cased. A production packer was installed at a depth of approximately 7500' and a string of 3-1/2" tubing equipped with an expansion joint was installed from the packer back to the surface. Wellhead equipment (Christmas tree) rated at 3000 psi working pressure was installed at the surface.

When the initial attempt was made to flow the well, the adjustable choke at the separator inlet became plugged with drill cuttings. Testing was halted temporarily while the Drilling Well Control separator unit was reinstalled in order to handle any additional quantities of drill cuttings that might reach the surface. When the second attempt was made to flow the well it was found that the well itself was plugged below the surface.

Remedial efforts were then undertaken to remove the obstruction which was determined to be below the production packer. Once again Signal Drilling Company was contracted to furnish the rig and associated drilling equipment. The shrouds and ventilation system were also reinstalled and, in addition, drip pans were installed below the rig floor and substructure and under one of the pipe racks as additional fluid containment measures. The tubing and packer were removed from the well with minimum difficulties, again using a light density drilling fluid. Additional 5-1/2" casing was installed from 5961' (liner top) back to the surface. Several small obstructions were found in the open hole section, the most resistant of which was at a depth of approximately 8243'. Circulation was lost when this lowermost plug was removed. The original total depth was then

reached without further hindrance and the well kept under control by maintaining a sufficient hydrostatic head of drilling fluid. A new 3-1/2" liner was installed without cementing through the open hole section and the well again completed with production packer and 3-1/2" tubing.

The calibration flow period was commenced immediately after completion of the well with no further downhole mechanical problems being encountered.

### III. Discussion

The re-entry operations as a whole were conducted with relatively few problems but required considerably more time to accomplish than was anticipated. Preparations for the re-entry actually commenced late in March 1969 and were concluded on April 28, 1969. Approximately 90 days were required to make the re-entry and complete the well. Approximately 3 weeks were consumed in the testing attempts, and 5 weeks consumed in the preparations and conduct of the remedial operations. An analysis of the activities and time for the period April 27-August 2, 1970, is presented in Figure 3. A chronological summary of the drilling activities is given in Exhibit A.

Due to the small bit size, some difficulty was experienced in controlling the direction of the hole along the desired path (Exhibits C and D). The greatest difficulty in this respect was encountered in the 4-3/4" hole below the new 5-1/2" liner, and, as a result, it is believed that the path of the borehole passed over the top of the chimney and was terminated in extensively fractured rock at a point below the actual top of the chimney. Figure 4 illustrates the re-entry configuration.

Only two minor fishing jobs were required during the drilling operation. In both instances the material left in the hole had to be milled up.

The use of plugs at the base of the drill string for removal and running of the drill pipe during the latter stages of drilling resulted in a considerable amount of lost time. On several occasions these plugs could not be pulled with wireline tools because of foreign materials in the drilling fluid which necessitated pulling the drill string in order to dislodge the plug.

When loss of circulation was encountered indicating the intersection of fractures, it was most encouraging to observe the ease with which the well could be contained and controlled by maintaining the hydrostatic head of drilling fluid.

AUSTRAL OIL COMPANY  
INCORPORATED

PROJECT RULISON

SUMMARY OF RE-ENTRY

WELL: Austral Oil Company, Incorporated, Hayward #25-95 (R-EX)  
FIELD: Rulison  
DRILLING BLOCK: 65-41  
LOCATION: 2,235.93' east of west line and 1,694.81' north of south line  
of Section 25, T-7-S, R-95-W of 6th P.M., Garfield County,  
Colorado  
ELEVATION: GL: 8199.16'  
KDB: 23' above GL  
DRILLING CONTRACTOR: Signal Drilling Company, Denver, Colorado

SUMMARY OF INITIAL  
RE-ENTRY:

4-28-70 Rigged up. Started drilling cement.  
5-1-70 Drilled cement and bridge plug 1450'-1517'.  
5-4 - 6-70 Milled up liner hanger from 5863' to 5874'.  
5-7 - 29-70 Milled up 5-1/2" liner from 5874' to 6517'. Ran Sperry-Sun Multi-  
Shot Log in interval 100-6517'. Spotted 125 sks. Class H cement  
plug w/10% sand from 5953'-6517'. Drilled out. Spotted 100 sks.  
Class G cement w/15% 20-40 sand and 0.75% D-6 in interval 6237-  
6517'.  
5-31 - 6-14-70 Drilled out cement to 6470' and commenced sidetrack operations with  
Dynadrill. Drilled to 6575'. Ran Sperry-Sun Directional Survey  
in interval 6575-6520'. Continued drilling to 7250' with Dynadrill.  
6-15-70 Set whipstock (#1) at 7250', drilled off to 7263'. Opened 4-5/8"  
hole to 6-3/4" from 7250-7259'. Continued drilling.  
6-16-70 Set whipstock (#2) at 7296', drilled off to 7311'.  
6-17-70 Opened 4-3/4" hole to 6-3/4" from 7296-7311'. Resumed drilling.  
6-20-70 Set whipstock (#3) at 7423', drilled off to 7438'. Opened 4-3/4"  
hole to 6-3/4" from 7423-7435'. Resumed drilling.  
6-22-70 Set whipstock (#4) at 7454', drilled off to 7466'.  
6-24-70 Opened 4-3/4" hole to 6-3/4" from 7454-7463'. Left pilot in hole.  
Milled and reamed hole to 7469'. Resumed drilling.  
6-26-70 Set whipstock (#5) at 7496', drilled off to 7508'.  
6-27-70 Opened 4-3/4" hole to 6-3/4" from 7496-7506'. Resumed drilling.  
6-30-70 Depth 7624'. Set 5-1/2" 17# N-80 Hydril FJ Liner (1661.79') at  
7621.69' with top at 5959.93'.

SUMMARY OF RE-ENTRY  
PAGE TWO

SUMMARY OF INITIAL  
RE-ENTRY (Continued):

7-2 - 4-70 Ran Dialog casing caliper in 7-5/8" casing. Ran Johnston test tool and pressure tested casing as follows:

PACKER DEPTH	PRESSURE (psi)	REMARKS
4100'	225	Pressure applied below packer.
4100'	875	Pressure applied to annulus.
3500'	1100	" " " "
3000'	1340	" " " "
2500'	1575	" " " "
2000'	1800	" " " "
1500'	2050	" " " "
1000'	2275	" " " "
500'	2500	" " " "

Resumed drilling.

7-7-70 Set whipstock (#6) at 7760', drilled off to 7771'. Opened 3-1/2" hole to 4-3/4" from 7760-7771'. Resumed drilling.

7-19-70 Set whipstock (#7) at 8172', drilled off to 8182'. Opened 3-1/2" hole to 4-3/4" from 8172-8181'. Left pilot in hole.

7-22-70 Recovered milled up portions of pilot. Resumed drilling.

7-26-70 Lost returns at 8270'. Drilled to 8278' without returns. Started out of hole and well began to flow. Shut-in well and pressure immediately increased from 250 psi to 850 psi. Killed well with 220 bbls. of 8.6#/gal. mud.

7-27 & 28-70 Drilled interval 8278-8294' without returns - used 410 bbls. mud. From 8294-8314' used 360 bbls. mud. From 8314-8354' used 480 bbls. mud. All mud used was 8.6#/gal. Reached total depth 8354' on 7-28-70. Lost a total of 1782 bbls. mud to formation while drilling.

7-30-70 Ran 53 jts. 8.81# Hydril FJ J-55 tubing and 182 jts. 9.3# CS Hydril J-55 tubing and set Guiberson "WT" 5-1/2" production packer at 7500'.

7-31 - 8-2-70 Displaced mud with clean water. Tubing tested to 4000 psi. Displaced water with nitrogen. Pressured tubing to 2500 psi with nitrogen. Removed OCT back pressure valve and Otis plug. On test with 26/64" choke, FTP 2000 psi flowing at rate of 7200 MCF/D. Shut well in 10 mins. SITP 2300 psi. Pumped 68,000 cu. ft. of nitrogen in 3-1/2" tubing. Final pressure 3200 psi. Set OCT back pressure valve in BO-2 coupling. Removed BOP and installed tree. Released rig at 12:00 noon, 8-2-70.

SUMMARY OF REMEDIAL  
WORK:

9-11 - 13-70 Attempted to rotate packer. Pulled 116,000# - packer failed to release. Fired 80 grams jar shot with center of shot at 7495' - packer failed to release. Made chemical cut at 7489'. Pulled tubing.

9-14-70 Set Johnston retrievable bridge plug at 6150'. Spotted 2 sks. sand on top of plug.

9-16-70 Set 5-1/2" 15.5# K-55 production casing at 5940'.

9-17 & 18-70 Drilled cement from 5937-5940'. Washed sand 110'.

SUMMARY OF RE-ENTRY  
PAGE THREE

SUMMARY OF REMEDIAL  
WORK (Continued):

9-19 - 24-70 Ran pulling tool - failed to retrieve bridge plug. Ran oil jars and bumper jars - failed to pull bridge plug. Milled and recovered bridge plug.

9-25 & 26-70 Milled over and recovered production packer.

9-27 - 29-70 Encountered first bridge at 7638'. Washed and reamed small bridges to 8243'. Lost circulation while washing at 8243'. Continued in hole to total depth 8354' without hindrance.

9-30-70 Ran 3-1/2" 9.3# A-95 & CS Hydril liner with BOT type CM hanger (802.86') and set at 8348.82' with top of liner at 7545.96'.

10-1-70 Ran Baker Model FB-1 packer on wireline with top at 7520.80'. (Drill pipe measurement top at 7514.80'). Detail as follows:

Baker 5-1/2" x 3" EUE Model FB-1 packer	2.34'
4" x 3.476" Mill out ext.	5.82'
Seal Bore ext. 4" OD x 3.00" ID	10.01'
Otis Flow coupling, 2-7/8"	2.84'
Otis S-1 Nipple, 2-7/8"	1.41'
Otis Flow coupling, 2-7/8"	2.84'
Otis S-2 Nipple, 2-7/8"	1.41'
Otis Flow coupling, 2-7/8"	3.03'
Total Length	<u>29.70'</u>

10-3-70 Ran 3-1/2" 9.3# FJ Hydril tubing and set at 7488.54'. Tubing tested to 4000 psi.

10-4-70 Pumped in 180 bbls. of 8.4#/gal. 30 visc. mud followed with 32 bbls. of water w/1-1/2% KCL. Displaced water in tubing w/90,000 cu. ft. of nitrogen. Released rig.

CASING RECORD:

5-1/2" LINER

	1 - 5-1/2" BOT Float shoe	1.54'
1 jt.	5-1/2" 17# N-80 Hydril FJ casing	41.28'
	1 - 5-1/2" BOT stop collar	0.72'
38 jts.	5-1/2" 17# N-80 Hydril FJ casing	1596.49'
	1 - 5-1/2" BOT Type MC Liner Hanger	<u>21.73'</u>
		1661.76'
	Bottom of liner at	7621.69'
	Top of liner at	5959.93'

Cemented w/139 sks. Class G cement w/35% silica flour 0.2% D-8 retarder plus .1% of 65 TIC.

5-1/2" CASING TIE-BACK

	1 - 5-1/2" BOT Proven nose	0.53'
1 jt.	5-1/2" 15.5# K-55 casing	32.90'
	1 - 5-1/2" BOT float collar	1.03'
184 jts.	5-1/2" 15.5# K-55 casing	<u>5909.10'</u>
		5943.65'

Cemented w/75 sks. Class G cement w/35% silica flour. Pumped 100 bbl. water containing 30 gal. retarder 100 ft. ahead of cement.

SUMMARY OF RE-ENTRY  
PAGE FOUR

CASING RECORD  
(Continued):

3-1/2" LINER

4 jts.	3-1/2" Layne & Bowler wire wrapped screen	120.84'
	4" OD CI Knockout plate (ID 2.92" after knockout)	0.97'
22 jts.	3-1/2" 9.3# A-95 & CS Hydril tubing	662.65'
	5-1/2" 17# x 3-1/2" Type DRL packer w/CMC Hanger w/Hydril pin, 3" bore	18.40'
	Total Length	<u>802.86'</u>
	Bottom of Liner at	8348.82'
	Top of Liner at	7546.00'

TUBING RECORD:

3-1/2" TUBING SETTING

	Baker 2-7/8" Seal Assembly w/Locator sub	14.52'
	X-Over sub	0.90'
	Otis Flow coupling, 3-1/2"	2.80'
	Otis S-3 Nipple, 3-1/2"	1.40'
50 jts.	3-1/2" Hydril FJ 9.3# tubing	1505.02'
186 jts.	3-1/2" 9.3# tubing and 4 pup joints	5963.90'
	Total Length	<u>7488.54'</u>

Bottom of seal assembly at 7519'.  
Top of packer at 7515' (tubing measurement).  
Top of seal assembly at 7509.50'.

DIRECTIONAL SURVEY  
RECORD:

(SINGLE SHOT)

<u>DEPTH</u>	<u>ANGLE</u>	<u>DIRECTION</u>	<u>TVD</u>
6504'	3-1/4°	S-73-E	6535'
7228'	9-3/4°	N-58-W	7226'
7249'	10°	N-56-W	7242'
7470'	16°	N-58-W	7456'
7510'	17-1/2°	N-51-W	7494'
7607'	22-1/2°	N-53-W	7586'
7776'	20-3/4°	N-53-W	7742'
8038'	15°	N-54-W	7991'
8241'	11-1/4°	N-47-W	8149'

MR, Jr/CCP:cj  
1/18/71

Austral Oil Company  
Hayward 2595 Rex  
Rulison Field  
Garfield County, Colorado  
May 17, 1970  
Log No. 55715

SUMMARY  
GENERAL CONDITION OF CASING

The enclosed Dia-Log Profile Caliper log covers 6,305 ft. or 202 joints of 7-5/8" O.D. 26.4 lbs./ft. casing.

Inspection of the log finds some damage has occurred in the lower section of the casing string. Penetrations in Joints Nos. 200 and 202 have reduced the remaining wall thickness to 5/32" of an inch which is 47.7% of the specified nominal wall thickness for 26.4 lbs./ft. casing. In Joints Nos. 126, 197, and 201 the minimum remaining wall thickness is 6/32" of an inch or 57.1% of the nominal wall thickness. Reportedly a 5-1/2" liner has been milled up from 5,863 ft. to 6,365 ft. The above penetrations, or damage to the 7-5/8" casing, have likely occurred during these milling operations. A considerable amount of steel cuttings were found in the caliper tool following the log run.

In addition to the above noted 5 joints, the log found minimum remaining wall thicknesses of 7/32" (66.7%) in 18 joints, 8/32" (76.2%) in 81 joints, 9/32" (85.8%) in 67 joints and 10/32" (95.2%) in 31 joints of casing. It is also noted that many of the collar recesses below Joint No. 179 are filled with some foreign deposit which prevented the caliper feelers from either entering the recess or entering it the full depth.

D. V. tools are shown on the lower end of Joints Nos. 75 and 133.

In summary, due to 5 joints of casing which have remaining wall thicknesses of 47.7% or 57.1% of the nominal wall this casing string is considered to be only in fair condition.

LHG:am

Austral Oil Company  
Hayward 25-95 Rex  
Rulison Field  
Garfield County, Colorado  
July 2, 1970  
Log No. 55751

SUMMARY  
GENERAL CONDITION OF CASING

The enclosed Dia-Log Casing Profile Caliper covers 5,950 ft. or 189 joints of 7-5/8" O.D. 26.4 lbs./ft. casing. This same string of casing was previously calipered on May 17, 1970, Log No. 55715.

Inspection of the enclosed log shows drill pipe wear on the casing has occurred in selected intervals and generally this wear is the same or only slightly deeper than shown on the May log. The deepest wear recorded on the July log is in Joint No. 126 where the minimum remaining wall thickness is 6/32" or the same as measured on the May log. However, the wear now extends over a longer vertical section than recorded on the May log.

Joints Nos. 127 and 128 have undergone drill pipe wear with the minimum remaining wall thickness being 7/32". For 26.4 lbs./ft. casing 6/32" and 7/32" is respectively 57.1% and 66.7% of the specified nominal wall thickness.

Drill pipe wear is also evident in Joints Nos. 2, 3 and 121 where the minimum remaining wall thickness is 7/32" or 66.7% of the nominal wall thickness.

With the exception of these two intervals - Joints Nos. 2 thru 3 and 126 thru 128 - the remainder of the casing shows no concentrated drill pipe wear and any reduction in casing wall thickness has been from a general erosion action. Except for the above cited six joints, the remainder of the casing covered on the July log have 8/32", 9/32" or 10/32" minimum remaining wall thickness which is respectively 76.2%, 85.8% or 95.2% of the nominal wall thickness.

In summary, comparison of the enclosed July log to the previous May log finds any additional drill pipe wear between the two logs has been very minor and the condition of the casing is virtually unchanged since May.

LHG:am

# SPERRY-SUN

## DIRECTIONAL SURVEY REPORT

FOR

AUSTRAL OIL COMPANY

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TYPE OF SURVEY: GYROSCOPIC MULTISHOT

SURVEY DEPTH: FROM 0 FT. TO 6520 FT.

LEASE: RULISON WELL NO. R-EX

FIELD: RULISON PROJECT

COUNTY/~~STATE~~ GARFIELD STATE COLORADO

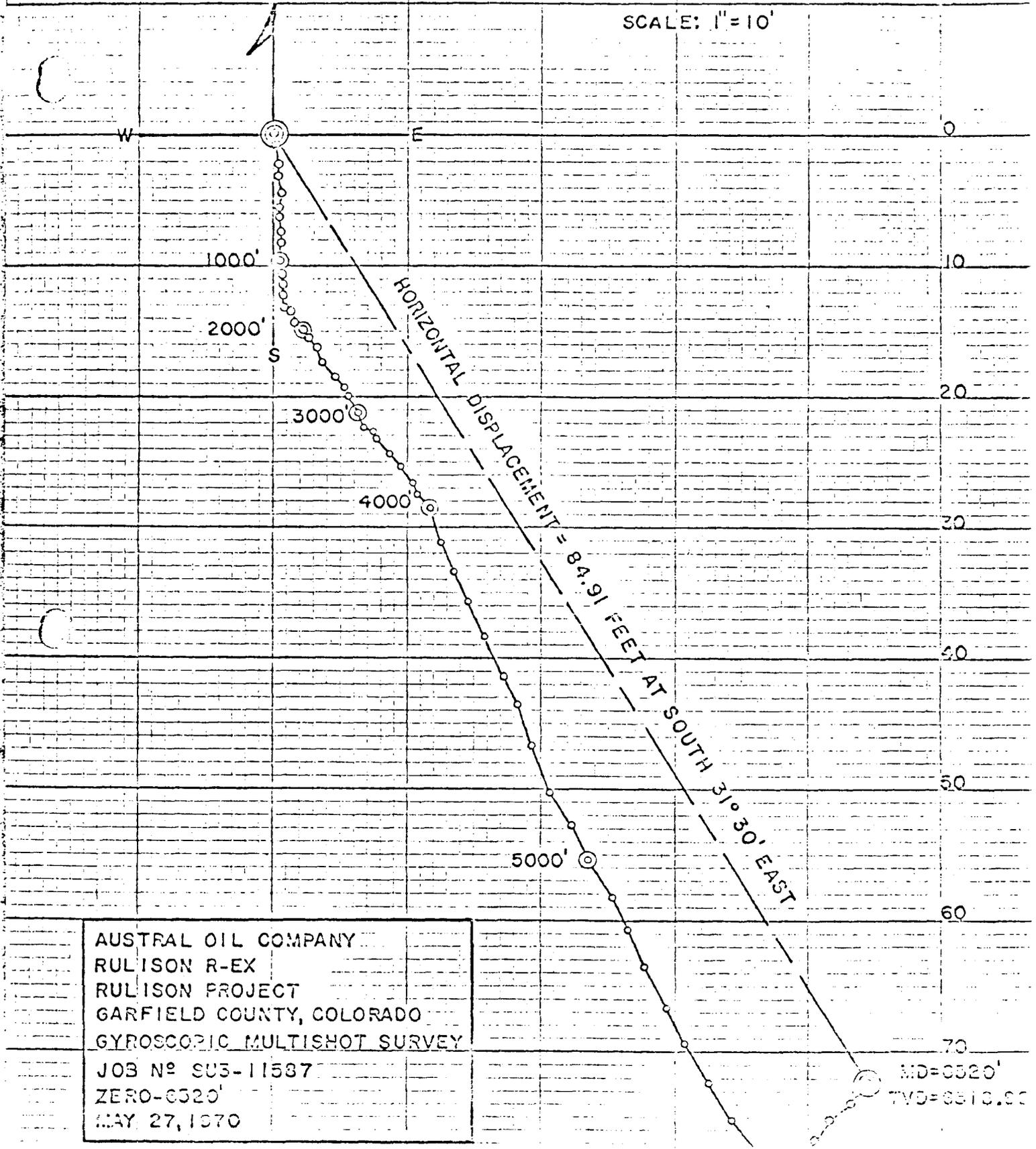
DATE OF SURVEY MAY 27 1954 JOB NO. 100-1000

OFFICE: CASPER, WYOMING

SPERRY-SUN WELL SURVEYING COMPANY  
HORIZONTAL PROJECTION

TRUE NORTH

SCALE: 1" = 10'



AUSTRAL OIL COMPANY  
RULISON R-EX  
RULISON PROJECT  
GARFIELD COUNTY, COLORADO  
GYROSCOPIC MULTISHOT SURVEY  
JOB N° SU3-11537  
ZERO-6520'  
MAY 27, 1970

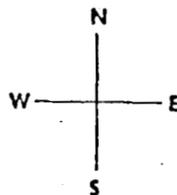
MD=6520'  
TVD=6518.00





# SURVEY TABULATION SHEET

CUSTOMER AUSTRIAL OIL COMPANY



SHEET NO. 3 OF 3

WELL NO. WILSON R-EX

SURVEY JOB NO. SU3-11587

FIELD WILSON PROJECT  
FIELD COUNTY, COLORADO

SURVEY DATE MAY 27, 1970

## GYROSCOPIC MULTISHOT

CORRECTED TIME	MEASURED COURSE	VERTICAL DEPTH	ANGLE OF INCLINATION	COURSE DEV.	DIRECTION OF INCLINATION			MEASURED COURSE DISPLACEMENT				TOTAL DISPLACEMENT			
					OBSERVED	CORR	CORRECTED	NORTH	SOUTH	EAST	WEST	NORTH	SOUTH	EAST	WEST
143-20	00	99.99	5999.06	36'			S 71 E		.34	.99			79.05	28.56	
145-00	00	99.99	6099.05	39'			N 53 E	.68		.91			78.37	29.47	
146-40	00	99.99	6199.04	58'			N 35 E	1.38		.97			76.99	40.14	
148-20	00	99.98	6299.02	1013'			N 31 E	1.82		1.09			75.17	41.53	
154-40	00	99.98	6399.00	1007'			N 53 E	1.17		1.56			74.00	43.09	
156-00	25	24.99	6423.99	1017'			N 42 E	.42		.38			73.58	43.47	
157-00	00	25.00	6448.99	1012'			N 19 E	.50		.17			73.08	43.61	
158-00	00	25.00	6473.99	46'			N 29 E	.29		.16			72.79	43.80	
159-20	25	25.00	6498.99	53'			N 57 E	.21		.32			72.58	44.12	
165-00	20	20.00	6518.99	53'			N 54 E	.18		.25			72.40	44.37	
HORIZONTAL DISPLACEMENT = 84.91 FEET AT SOUTH 31° 20' EAST															
DONE BY: <i>[Handwritten Signatures]</i> CHECKED BY: <i>[Handwritten Signatures]</i>															

# SPERRY-SUN

## DIRECTIONAL SURVEY REPORT

FOR

AUSTRAL OIL COMPANY

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TYPE OF SURVEY: GYROSCOPIC MULTISHOT

SURVEY DEPTH: FROM 6170 FT. TO 0575 FT.

LEASE: RULISON WELL NO. R-EX

FIELD: RULISON PROJECT

COUNTY: CASSIADY STATE: WYOMING

DATE OF SURVEY: JUNE 1, 1966 JOB NO. 66-11110

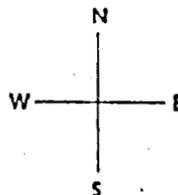
OFFICE: CASPER, WYOMING

# SURVEY TABULATION SHEET

CUSTOMER CENTRAL OIL COMPANY

WELL NO. WELLSON P-EX

FIELD WELLSON  
FIELD COUNTY, COLORADO



SHEET NO. 1 OF 1

SURVEY JOB NO. SU3-11589

SURVEY DATE JUNE 2, 1970

## GYROSCOPIC MULTISHOT

CORRECTED TIME	MEASURED DEPTH	VERTICAL DEPTH		ANGLE OF INCLINATION	COURSE DEV.	DIRECTION OF INCLINATION			MEASURED COURSE DISPLACEMENT				TOTAL DISPLACEMENT						
		COURSE	TOTAL			OBSERVED	CORR.	CORRECTED	NORTH	SOUTH	EAST	WEST	NORTH	SOUTH	EAST	WEST			
	070		6168.99			TAKEN FROM SU3-11587 AT DEPTH OF			6470 FEET						72.85	43.77			
09-00	10	080	10.00 6178.99	1° 45'				N 17 E	.29		.09				72.56	43.86			
15-00	10	090	10.00 6188.99	55'				N 54 E	.09		.13				72.47	43.99			
21-00	10	000	10.00 6198.99	40'				N 81 E	.02		.12				72.45	44.11			
27-00	10	010	10.00 6508.99	1°				S 37 E		.14	.11				72.59	44.22			
33-00	10	020	10.00 6518.99	1°				S 08 E		.17	.02				72.76	44.24			
39-00	5	035	5.00 6523.99	1°				S 14 E		.08	.02				72.84	44.26			
45-00	5	030	5.00 6528.99	1°				S 07 W		.09		.01			72.93	44.25			
51-00	5	035	5.00 6533.99	1° 15'				S 20 W		.10		.04			73.03	44.21			
57-00	5	040	5.00 6538.99	1° 30'				S 26 W		.12		.06			73.15	44.15			
03-00	5	045	5.00 6543.99	2°				S 17 W		.17		.05			73.32	44.10			
09-00	5	050	5.00 6548.99	2° 15'				S 23 W		.18		.08			73.50	44.02			
15-00	5	055	5.00 6553.99	2° 30'				S 30 W		.19		.11			73.62	43.91			
21-00	5	060	4.99 6558.98	2° 45'				S 37 W		.19		.14			73.83	43.77			
27-00	5	065	4.99 6563.97	2° 45'				S 45 W		.17		.17			74.05	43.69			
33-00	5	070	4.99 6568.96	3° 30'				S 52 W		.19		.24			74.24	43.36			
39-00	5	075	4.99 6573.95	3° 45'				S 53 W		.20		.26			74.44	43.10			
						HORIZONTAL DISPLACEMENT = 86.02 FEET AT SOUTH 30° 04' EAST													

# SPERRY-SUN

## DIRECTIONAL SURVEY REPORT

FOR

AUSTRAL OIL COMPANY

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TYPE OF SURVEY: GYROSCOPIC MULTISHOT

SURVEY DEPTH: FROM 6470 FT. TO 6575 FT.

LEASE: RULISON WELL NO. R-EX

FIELD: RULISON PROJECT

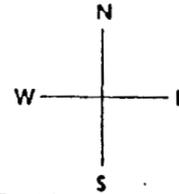
COUNTY, WYOMING GARFIELD STATE COLORADO

DATE OF SURVEY JUNE 2, 1970 JOB NO. WOS-11549

OFFICE: CASPER, WYOMING

# SURVEY TABULATION SHEET

CUSTOMER ANSTRAL OIL COMPANY  
 WELL NO. MILISON R-EX  
 FIELD PROJECT MILISON  
GARFIELD COUNTY, COLORADO



SHEET NO. 1 OF 1  
 SURVEY JOB NO. SU3-11589  
 SURVEY DATE JUNE 2, 1970

## GYROSCOPIC MULTISHOT

CORRECTED TIME	VERTICAL DEPTH	VERTICAL DEPTH		ANGLE OF INCLINATION	COURSE DEV.	DIRECTION OF INCLINATION			MEASURED COURSE DISPLACEMENT				TOTAL DISPLACEMENT				
		COURSE	TOTAL			OBSERVED	CORR	CORRECTED	NORTH	SOUTH	EAST	WEST	NORTH	SOUTH	EAST	WEST	
	6170		6168.99			TAKEN FROM SU3-11587 AT DEPTH OF 6470 FEET								72.85	43.77		
79-00	10	6180	10.00 6178.99	1° 45'				N 17 E	.29		.09			72.56	43.86		
85-00	10	6190	10.00 6188.99	55'				N 54 E	.09		.13			72.47	43.99		
84-20	10	6500	10.00 6198.99	40'				N 81 E	.02		.12			72.45	44.11		
82-10	10	6510	10.00 6508.99	1°				S 37 E		.14	.11			72.59	44.22		
82-10	10	6520	10.00 6518.99	1°				S 08 E		.17	.02			72.76	44.24		
81-20	7	6525	5.00 6523.99	1°				S 14 E		.08	.02			72.84	44.26		
80-10	7	6530	5.00 6528.99	1°				S 07 W		.09		.01		72.93	44.25		
79-10	7	6535	5.00 6533.99	1° 15'				S 20 W		.10		.04		73.03	44.21		
78-20	6	6540	5.00 6538.99	1° 30'				S 26 W		.12		.06		73.15	44.15		
77-10	6	6545	5.00 6543.99	2°				S 17 W		.17		.05		73.32	44.10		
76-10	6	6550	5.00 6548.99	2° 15'				S 23 W		.18		.08		73.50	44.02		
75-20	5	6555	5.00 6553.99	2° 30'				S 30 W		.19		.11		73.69	43.91		
74-10	5	6560	4.99 6558.98	2° 45'				S 37 W		.19		.14		73.88	43.77		
73-10	5	6565	4.99 6563.97	2° 45'				S 45 W		.17		.17		74.05	43.60		
69-10	5	6570	4.99 6568.96	3° 30'				S 52 W		.19		.24		74.24	43.36		
69-00	5	6575	4.99 6573.95	3° 45'				S 53 W		.20		.26		74.44	43.10		
						HORIZONTAL DISPLACEMENT = 86.02 FEET AT SOUTH 30° 04' EAST											

# SPERRY-SUN

## DIRECTIONAL SURVEY REPORT

FOR

WESTERN INDIAN OIL

---



TYPE OF SURVEY      CONDUCTED BY

SURVEY CONTRACT NO.      DATE

HEAD      DATE

BY      DATE

CHECKED BY      DATE

DATE

SPERRY-SUN WELL SURVEYING COMPANY  
HORIZONTAL PROJECTION  
SCALE: 1" = 20'

TRUE NORTH

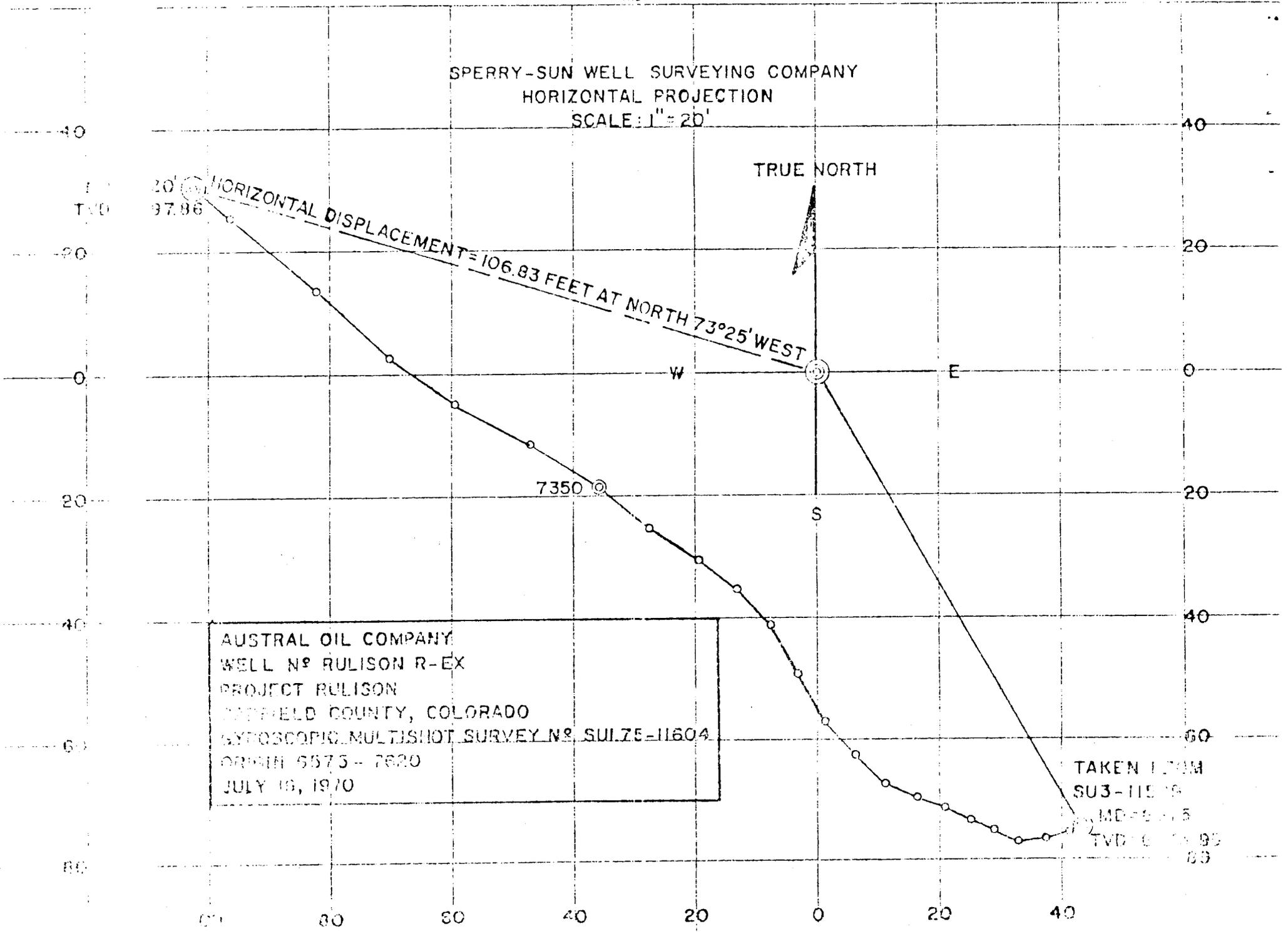
HORIZONTAL DISPLACEMENT = 106.83 FEET AT NORTH 73°25' WEST

20'  
97.86

7350

AUSTRAL OIL COMPANY  
WELL N° RULISON R-EX  
PROJECT RULISON  
SABFIELD COUNTY, COLORADO  
GYROSCOPIC MULTISHOT SURVEY N° SUI.75-11604  
ORIGIN 5575 - 7620  
JULY 16, 1970

TAKEN FROM  
SU3-11575  
MD-5575  
TVD 6 15 95  
89



SURVEY TABULATION SHEET

UTRAH OIL COMPANY

WELL NO. R-12X

WALTER HULISON  
MIDDLE COUNTY, COLORADO



N  
W E

SHEET NO.  
SURVEY  
PLAN  
SURVEY  
DATE

1 OF 1

SUI.75-11604

JULY 16, 1970

GYROSCOPIC MULTISHOT

DESCRIPTION OF INSTRUMENT

MANUFACTURER'S MODEL NO.

TAKEN FROM SUI-11589 DATED JUNE 2, 1970

74.44 23.10

575	6573.95
68-23	800 21.91 6548.89 4
77-48	850 49.79 6648.68 5 1/4
78-06	700 49.81 6698.49 5
78-09	700 49.72 6748.32 4 3/4
78-12	700 49.83 6798.15 4 3/4
78-14	700 49.73 6847.94 5 1/4
80-11	800 49.77 6897.71 5 1/2
80-12	700 49.86 6947.36 6 3/4
80-13	800 49.84 6996.90 7 3/4
80-14	800 49.82 7046.32 8 3/4
80-15	1000 49.84 7095.56 10
80-16	1000 49.08 7144.64 11
80-17	800 49.82 7194.02 9
80-18	800 49.85 7243.37 9 1/4
80-19	800 49.17 7292.53 10 1/2
80-20	800 49.81 7341.25 13
80-21	800 48.74 7389.49 15 1/4
80-22	800 48.66 7437.49 16 1/4
80-23	800 48.18 7485.67 15 1/2
80-24	800 47.75 7533.02 13 3/4
80-25	800 47.84 7580.38 22
80-26	800 48.48 7627.86 22 1/2

S 56	W	.98	1.45	75.42	21.65
S 77	W	1.03	4.46	76.45	27.19
S 86	W	.30	4.35	76.75	22.34
N 69	W	1.48	3.87	75.27	21.97
N 67	W	1.62	3.81	73.65	25.16
N 65	W	1.93	4.15	71.72	21.01
N 62	W	1.80	4.41	69.92	16.57
N 64	W	2.58	5.28	67.34	11.29
N 45	W	4.77	4.77	62.57	6.52
N 42	W	5.65	5.65	56.51	1.13
N 32	W	7.36	4.60	49.26	3.17
N 28	W	8.42	4.48	41.17	7.65
N 44	W	5.63	5.43	35.51	13.05
N 52	W	4.95	6.33	39.56	19.41
N 54	W	5.36	7.27	25.20	26.75
N 53	W	6.77	8.98	18.43	33.76
N 58	W	6.97	11.15	11.15	40.91
N 61	W	6.78	12.24	4.68	49.15
N 56	W	7.47	11.08	2.79	58.23
N 48	W	10.75	11.94	13.54	68.17
N 50	W	12.04	14.35	25.58	79.52
N 50	W	4.92	5.86	30.50	92.39

HORIZONTAL DISPLACEMENT = 106.83 FEET AT NORTH 70° 25' WEST

*Handwritten signatures and initials at the bottom of the page.*

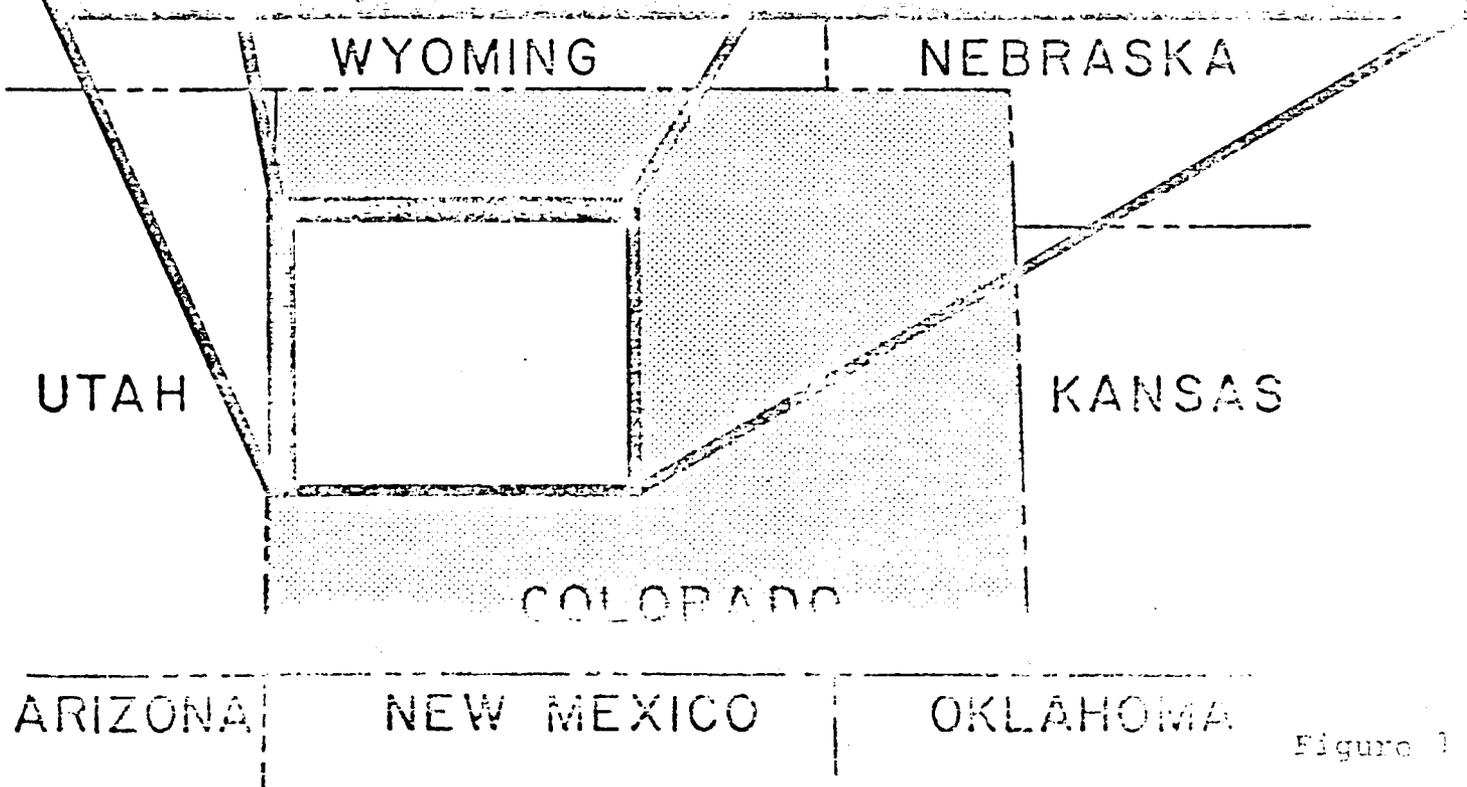
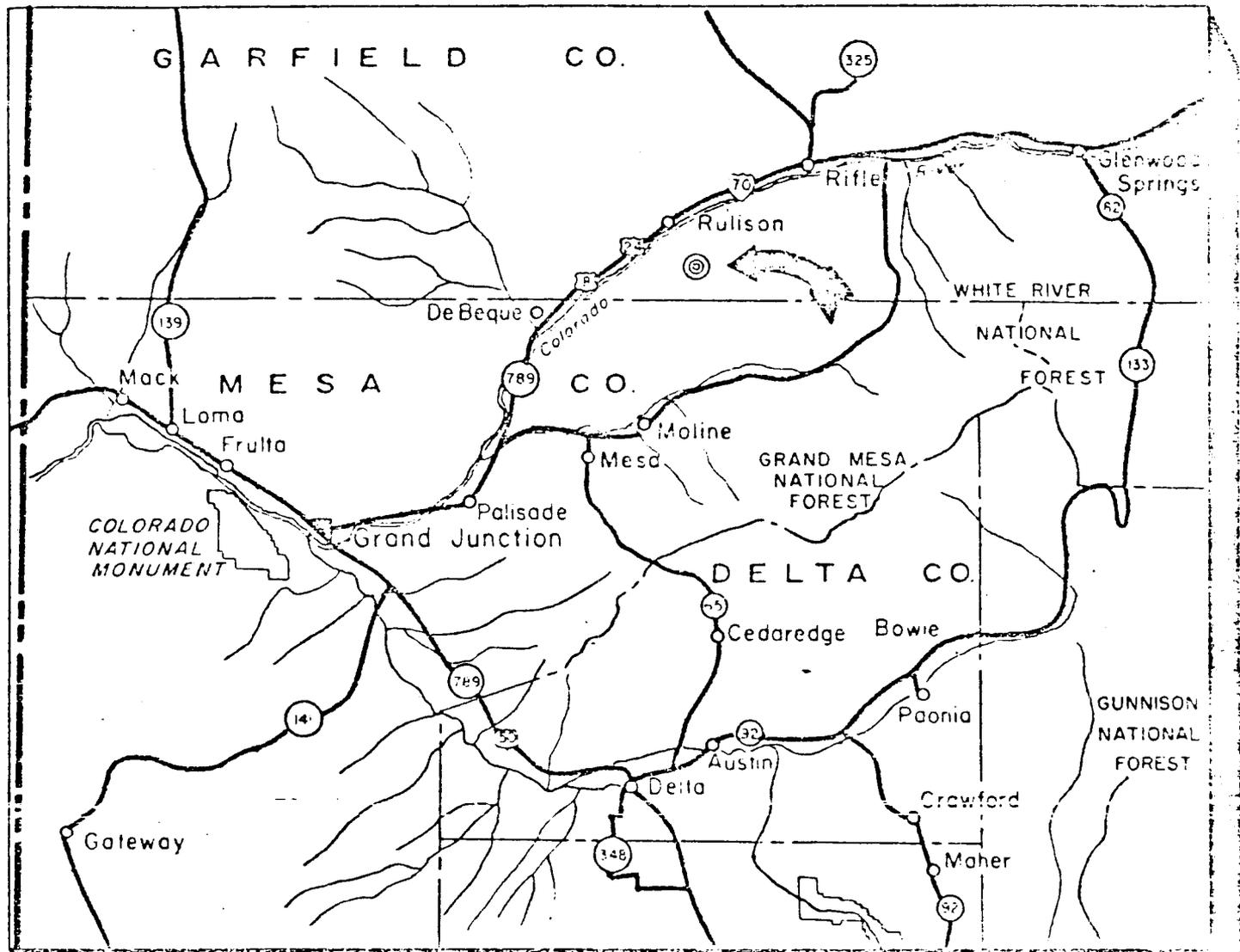


Figure 1

SCHEMATIC CONFIGURATION OF WELL COMPLETION AND STEMMING

R-EX WELL

R-E WELL

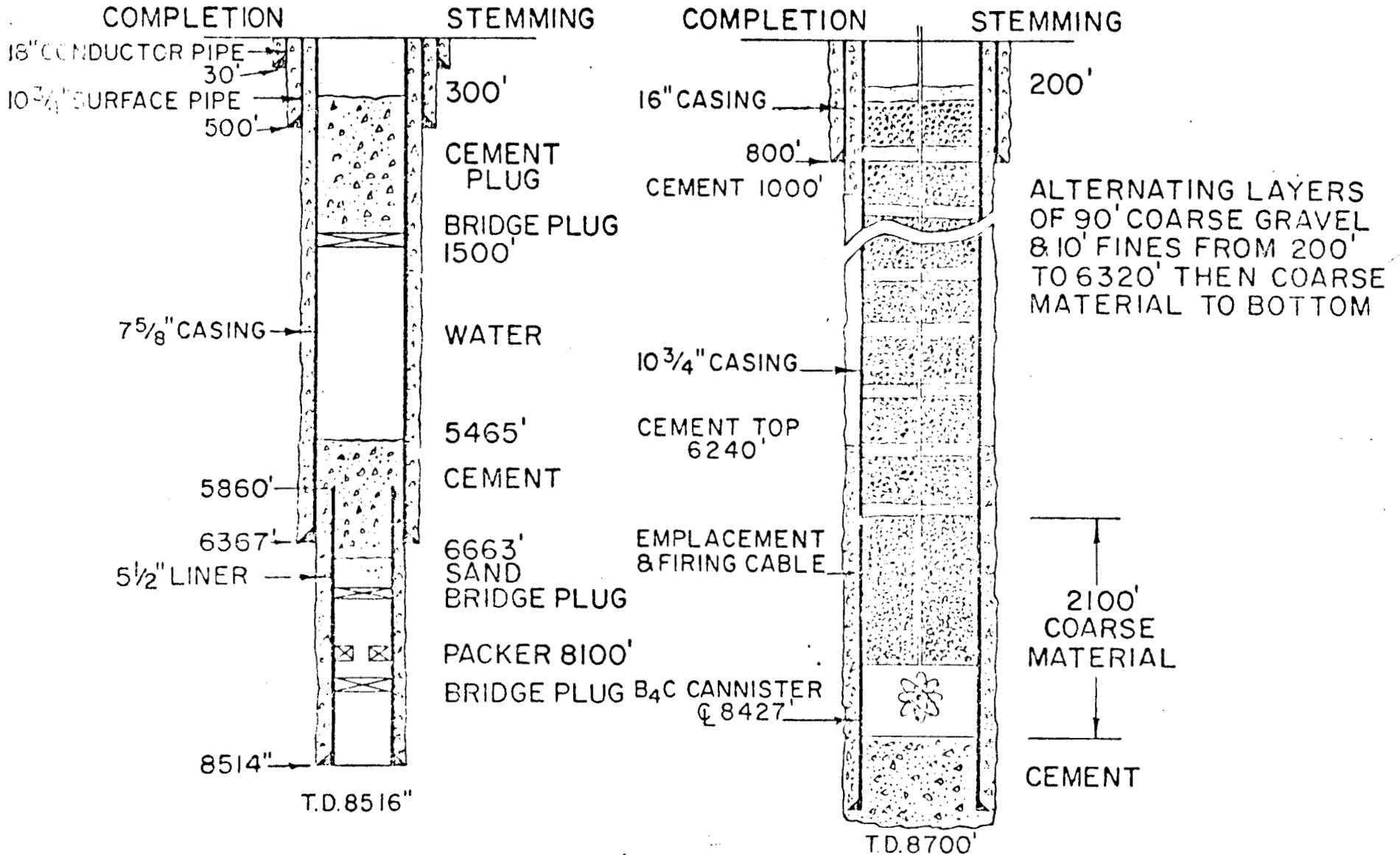


Figure 2

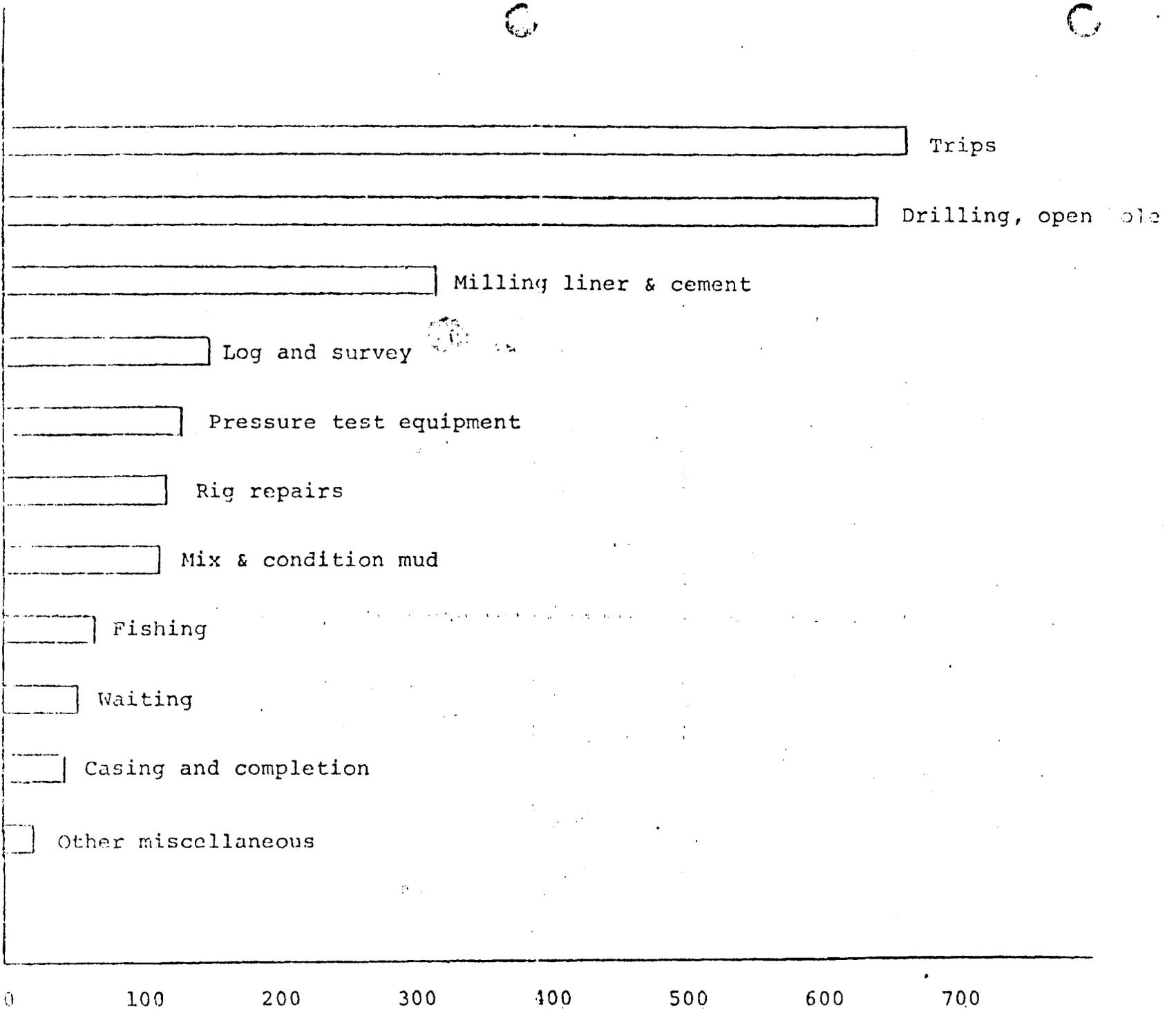


FIGURE 3 - POST-SHOT DRILLING TIME ANALYSIS, Apr.27-Aug.2, 1970

# SCHEMATIC DIAGRAM OF RE-ENTRY WELL

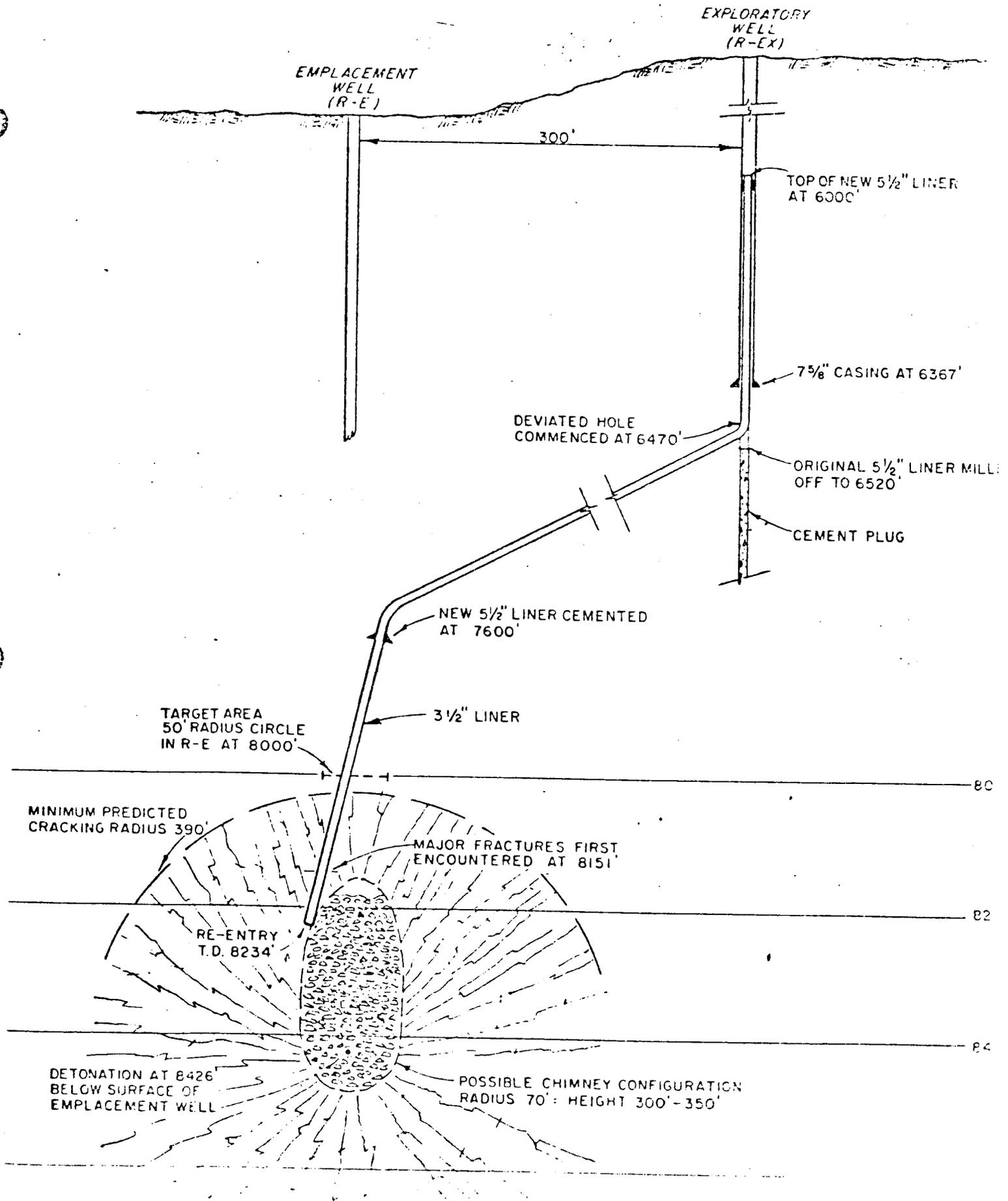


Figure 4