RULISON PROJECT

Austral Oil Company

25-95 A Hayward

Rulison Field

Garfield County, Colorado

Emplacement & Cementing of

10 3/4" Casing to 8701 Feet

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Authorizing Official

Date: 05/17/2007

P3149

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The inspection was made to assure the AEC that all possible precautions were taken to insure ultimate safety under the safety standards of the AEC for the detonation of underground nuclear explosives.

Representatives Present During Operations

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RULISON PROJECT

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FOR
U.S. ATOMIC ENERGY COMMISSION
NEVADA OPERATIONS OFFICE
LAS VEGAS, NEVADA

CASING SCHEMATIC DIAGRAM

DRAWING NO.
DIAGRAM NO. 1

DRAWN
R. FISHER

CHECKED

DATE
2/19/69

SCALE
NONE

SUMMARY

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This interim report, on the Rulison Project, covers the casing emplacement and cementing operations on the Austral Oil Co.'s Number 25-95 A Hayward Well in Garfield County, Colorado. A string of 10-3/4" casing was placed to a total depth of 8701' and cemented in three stages. Cement quality was verified by the use of an acoustic bond log and a density log. *(auth.)*

The package envelope, 5.2' long and containing boron carbide in its annulus, was included in the 10-3/4" casing string so as to be in the Mesa Verde Section at 8442-1/2'*. Inside the 10-3/4" casing, the cement was drilled out to a depth of 10-1/2' below centerline of the boron carbide envelope. This total depth was confirmed by wire line measurements, and a casing collar locator, to be 8453'.

A 900 CFM air compressor was used in conjunction with gas lift valves, appropriately placed in a string of 2-3/8" tubing, for the removal of all fluid from the 10-3/4" casing. Dryness of the casing was tested by dumping a 100# sack of micro-cel in the annulus between 2-3/8" tubing and 10-3/4" casing and observing the dust ejected from the "Blooie" line.

Strength of the cement plug in the 10-3/4" casing, at 8453'*, was tested by an applied load of 84,000#. Diameter uniformity and casing straightness were checked by running a 9" diameter, 15' long mandrel to the total depth of 8453'*. Dryness was double checked by a bailer, filled with sample sacks of micro-cel, run on sand line to 8453'*. Smoothness of the cement top in the casing was inspected by a 9" diameter lead impression block with 20,000# applied pressure.

All tests were favorable and acceptable to participating parties.

* Wire line measurements used zero at kelly bushing. Ground level is 15.5' below K.B.

A total depth of 8701' (drill pipe measurements) was attained on January 18, 1969. The drilling mud was circulated three hours in preparation for a suite of open hole logs. A gamma ray neutron, caliper, multi-shot directional survey, and compensated density logs were completed on January 21. Immediately following the logging operation, a trip was made to total depth.

Eight feet of soft fill was detected on bottom. The mud was circulated for four hours. A precaution of pulling ten stands of drill pipe, establishing circulation then returning to total depth and again establishing circulation, was followed. Mud and hole conditions were found ready to accept 10-3/4" casing. The drill pipe was pulled from the hole and preparations were made for using the joint analyzed casing make up.

The casing equipment, Lamb, Inc., was rigged up for J.A.M. operation. Eight turns and 7500 foot pounds of torque were set on the computer that was tied into the power tongs. A recording was made of each joint as the connection was made. Baker LOK was used only for the shoe joint and float joint make up, whereas the special compound provided by Lamb, Inc. was used on all additional collar and joint connections.

Casing emplacement was initiated at 2200 hours, January 21. The casing string make up is shown in Chart #1 with the exception that the two top joints are S-95 - 55.5# pipe.

CHART I

<u>Interval</u>	<u>Weight</u>	<u>Type Casing</u>	<u>Amount</u>
0 - 2500 Ft.	51#	N-80	2500 Ft.
2500 - 3500 Ft.	51#	J-55	1000 Ft.
3500 - 4700 Ft.	51#	N-80	1200 Ft.
4700 - 5700 Ft.	51#	P-110	1000 Ft.
5700 - 6500 Ft.	51#	S-95	800 Ft.
6500 - 8700 Ft.	55.5#	S-95	2200 Ft.

Ruff coated casing was placed in the interval 8049.42' to 7618.87'*. The casing shoe was set at 8701* with 10,000 lbs. of weight. A float collar was placed at 8652.40'*. After some modification, a baffle plate was set at 8609.34'*. The lower DV tool was set at 7358.37'* and a second DV tool was set at 1024.98'*. The center line of the boron carbide container was placed at 8450.08'*. A distance of 1091.71'* was noted between the lower DV tool and boron carbide container. Distance to be drilled from lower DV tool to 10-1/2' below center line of boron carbide envelope was 1102.21'*. Centralizers, when placed, were positioned 10' to 15' below the collars except at DV tool, then the spacing interval was the middle of the joint (see Chart #2 for all centralizer depths*).

Casing shoe was placed to a total depth of 8701'* on January 22 at 2100 hours, with drill pipe measurements and casing measurements in agreement. Casing measurements were made on the rack. Mud was circulated through the casing shoe for five hours prior to cementing the first stage, during which time the cement computations were double checked and the operating plan was outlined.

The first stage of cement would be the shoe stage. Cement was to be pumped through the casing shoe in sufficient quantity so as to reach 6000' in the annulus between the 10-3/4" casing and open hole. A safety precaution was provided by placing a DV tool at 7358'*. Remedial action could be taken through this lower DV tool should problems develop on the first stage. Two additional precautions were observed. The mud tanks were measured and marked, and two cementing trucks would be pumping while the third truck would monitor the mud during mixing & displacement operations.

A second DV tool was set at 1025'* for cementing the 10-3/4" casing from 1025' to the surface.

Cement volumes as determined by Austral and Dowell for annulus fill up plus a 100' height in the casing was computed as 1837 sacks of expanding cement - chem. comp. - 14.1#/Gal. - yield 1.5 Cu.Ft./sack - with additives of 12.5 lbs. of Kolite per sack of cement and 3/10 of 1% D74R. Allotment of cement to volumes was as follows; annulus outside casing from 8701' to 6000', 1707 sacks or 2560.5 Cu.Ft.; volume inside casing from baffle plate to casing shoe, 30 sacks or 45 Cu.Ft.; volume inside casing from top of cement to baffle plate, 100 sacks or 150 Cu.Ft.

* Measurements were made on casing while racked, with the K.B. as zero reference.

Cement Stage #1

The first stage of cement was initiated on January 23 at 0400 hours, with the plug down at 0615. All first stage annulus cement was placed through the casing shoe with 10 bbls. lost during cementing. Since the lower DV tool was not needed, a bomb actuator was used to open and immediately close the cement ports for a safe drill out operation. Six hours was spent waiting on cement.

Cement Stage #2

A bomb actuator was used to open the upper DV tool and begin Stage #2, with circulation established for three hours. Cementing the interval 1025' to the surface with 700 sacks of 15.8#/Gal. - 1% calcium chloride - yield 1.14 Cu.Ft. per sack, Class "G" cement was started on January 23 at 1310 hours with the plug down at 1400 hours. The plug closed the DV tool for safe drill out operation. A pressure of 2000# was held for five minutes and released. Mud returns were lost when 47 barrels or 264 Cu.Ft. remained in displacement. Cement rise was calculated to be approximately 234' from surface when the formation broke. Eleven hours was spent waiting on cement. Stage two cement top was located at 677' by a temperature survey.

Cement Stage #3

Stage two cement top was tagged with 1" tubing at 682' in annulus between 10-3/4" casing and 16" casing. The mud was displaced with water, using the 1" tubing. Cement Stage #3, 0 - 682', was accomplished through one inch tubing. A total of 425 sacks of 15.8#/Gal., yield 1.14 Cu.Ft./sack, 2% calcium chloride, Class "G" cement was used. A minimum of 25 sacks were circulated. The third stage was started on January 24 at 1250 hours and completed at 1330 hours. Seven and one half hours was spent waiting on cement, during which time the casing hanger was installed - dropped slips - cut casing - removed blowout preventer and installed tubing head.

The upper DV tool at 1025' was drilled out and circulation established from total depth of 1060'. A temperature survey was run from the surface to 7353'.

Temperature of mud in interval (0 - 1060') was not allowed time to reach cement temperature after circulation. The second cement stage, which covered the interval 1025' to 682', was recognizable by temperature rise immediately below circulated zone and temperature decrease from 1800' to 1850'. A normal gradient was experienced from 1850' to 6130' where a slight increase in gradient is evident with the cement top of Stage #1 indicated at 6240'. It was notable that the cement top on this first stage could be detected after an elapsed time of 52 hours.

The lower DV tool at 7358' was drilled out and the cement top inside casing was found at 8238' (drill pipe measurement). This was 114' higher than calculations indicated. Cement was drilled out to a point estimated at 5' below center line of boron carbide envelope (drill pipe measurements). Circulation was continued for two hours prior to pulling the drill pipe from the hole (pipe strapped in and out of hole).

* Measurements were made on casing while racked, with the K.B. as zero reference.

A density log, an acoustic cement bond log, and a casing collar log were completed on January 26 as a check on total depth and cement integrity. The boron carbide container, casing collars, and total depth were identified from the casing collar log and verified by the density and acoustic cement bond log. It was decided that the total depth of 10-1/2' below the center line of the boron carbide envelope could be attained by drilling two feet deeper. Additional footage was drilled on January 27 and the drilling mud was displaced with water before pulling out of the hole laying down drill pipe.

Two hundred seventy joints of 2-3/8" tubing was placed in the hole with gas lift valves installed at 8422.55', 8010.47', 7192.95', 6412.14', 5595.85', 4714.61', 3715.03', 2716.94' and 1469.52' (tubing measurements).

A Dresser Magcobar 900 CFM air compressor was placed in operation on January 28. Air (860 psi) was injected into annulus between the tubing and 10-3/4" casing. Continuous air injection was used January 28, 29 and 30. The "Blooie" line exhaust indicated the casing was dry at 1800 hours on January 30. Drying operations were continued until 2100 hours. A check on moisture content was made by dumping a sack of micro-cel in the annulus between the tubing and casing with dust soon seen in the "Blooie" line exhaust. A second check was made for possible water by running a casing collar locator, with a short-out switch on bottom, inside the 2-3/8" tubing to total depth. No water was detected. Tubing was pulled from hole and laid down.

A third check for possible moisture was made by filling a metal basket (5' length of slotted 7" casing) with sample bags of micro-cel and lowering the basket to total depth on the sand line. No water was detected.

A mandrel 9" in diameter and 15' long was run on the sand line to total depth as a check on the drift of the casing. No tight spots were indicated.

An open end drill collar (9" diameter) with additional drill collars and drill pipe were used to apply 84,000# load on cement in casing. Support properties of the cement were satisfactory. Some asphalt sediment, probably Kolite from the cement, was removed from the hole by the open end drill collar.

A 9" diameter lead impression block was run to total depth for a check on smoothness of cement. Results obtained were quite satisfactory with an applied load of 20,000#.

A barrel was placed over the casing preparatory to installing a blanking flange.

The logging, casing running and cementing operations, conducted after total depth had been reached, were witnessed on a continuous basis by F&S drilling and logging engineers. We are of the opinion that this was a well planned operation executed in a workmanlike manner by competent technical personnel.

CHART 2

CENTRALIZER DEPTHS

Approximate Attachment Points
(not measured)

1. Baker LOK pins used to attach the hinged centralizers to the casing.
2. Depths approximated from casing measurements.

<u>Number</u>	<u>Depth</u>	<u>Number</u>	<u>Depth</u>
1	8675	22	7196
2	8630	23	7068
3	8533	24	6938
4	8462	25	6809
5	8435	26	6680
6	8318	27	6551
7	8189	28	6422
8	8060	29	6293
9	8006	30	6164
10	7963	31	6034
11	7920	32	5806
12	7877	33	1049
13	7834	34	1005
14	7791	35	871
15	7748	36	760
16	7705	37	633
17	7662	38	507
18	7619	39	383
19	7500	40	256
20	7380	41	130
21	7336		

CHART 3

CEMENT COMPUTATIONS

STAGE #1 - 8701 to 6000'

<u>Depth</u>	<u>Total Volume In Cubic Feet</u>
8701 - 8600	157.63
8600 - 8500	157.63
8500 - 8400	157.63
8400 - 8300	162.30
8300 - 8200	167.03
8200 - 8100	157.63
8100 - 8000	157.63
8000 - 7900	157.63
7900 - 7800	157.63
7800 - 7700	157.63
7700 - 7600	148.49
7600 - 7500	157.63
7500 - 7400	157.63
7400 - 7300	157.63
7300 - 7200	148.49
7200 - 7100	143.34
7100 - 7000	144.02
7000 - 6900	148.49
6900 - 6800	148.49
6800 - 6700	148.49
6700 - 6600	144.02
6600 - 6500	139.63
6500 - 6400	135.30
6400 - 6300	148.36
6300 - 6200	147.15
6200 - 6100	146.24
6100 - 6000	145.46
<hr/>	
Total Open Hole Volume	4099.23 Cubic Feet
Less 10-3/4" Volume	- 1765.47 Cubic Feet
<hr/>	
Annulus To Be Cement Filled	2333.76 Cubic Feet
Plus 10%	+ 234.00
<hr/>	
Computed Cement Volume	2567.76 Cubic Feet
Cement Used	2560.5 Cubic Feet

CHART 4

CEMENT COMPUTATIONS

STAGE #2 - Surface to 1025'

1. Volume 0' - 800' 15 1/4" Diameter (I.D. of 16" casing)	+ 1014.72 Cubic Feet
2. Volume 800' - 1025' 16" Diameter Open Hole	+ 314.17 Cubic Feet
Total Volume	1328.89 Cubic Feet
3. Volume 0' - 1025' 10-3/4" Casing Displacement	- 646.06 Cubic Feet
4. Computed Volume of Cement Required for Annulus 0' - 1025'	682.83 Cubic Feet
Add 10%	68.3 Cubic Feet
5. Total Volume of Cement Required	751.13 Cubic Feet
6. Cement Used - 700 Sacks - 15.8#/Gal. Slurry Yield of 1.14 Cubic Feet Per Sack	798.00 Cubic Feet
7. Mud returns lost when 47 Bbls. displacement remained for plug to be down.	
47 bbls. = 264 Cubic Feet	
8. Computations for height of cement in annulus at the time of lost mud returns.	
Total Volume Cement Used	798 Cubic Feet
Volume of Cement Not Displaced	- 264 Cubic Feet
Volume of Cement in Annulus	534 Cubic Feet
Annulus Volume 800' - 1025'	172 Cubic Feet
Annulus Volume 234' - 800'	362 Cubic Feet
	534 Cubic Feet
9. Computed Cement Rise in Annulus at the Time of Formation Breakdown.	234' From Surface

10. Cement top found with temperature survey at 677' in annulus. This was confirmed with 1" tubing measurements.

11. Computations for cement volume in annulus outside 10-3/4" casing below the DV tool at 1025'.

Volume of Cement From 677' - 800'
Volume of Cement From 800' - 1025'

79 Cubic Feet
172 Cubic Feet

- 251 Cubic Feet

Total Volume of Cement Used
Stage #2

+ 798 Cubic Feet

12. Volume of cement below DV tool and outside 10-3/4" casing.

547 Cubic Feet

13. Temperature Log indicates possible cement to 1850'.

14. Volume of annulus outside 10-3/4" casing from 1025' - 1850'.

369 Cubic Feet

15. It is concluded that apparently some cement went into the formation.

CHART 5

CEMENT COMPUTATIONS

STAGE #3 - Surface to 682'

1.	0 - 682 - (682 x .6381) -	435.18 Cubic Feet
	Annulus between	
	10-3/4" casing and 16" casing	

Plus 10%

43.50

478.68 Cubic Feet

2.	Used 425 sacks - 1.14 yield =	
	and circulated cement	485 Cubic Feet

CHART 6

MUD TANK VOLUMES

#1 Tank	7.10' x 36.40 =	3.8 bbls/inch
#2 Tank	9.50' x 29.95 =	4.2 bbls/inch
#3 Tank	7.95' x 27.85 =	3.2 bbls/inch
#4 Tank	9.4' x 30.00 =	4.2 bbls/inch

LOST CIRCULATION ZONES DURING OPEN HOLE DRILLING

<u>Depth</u>	<u>Fluid Lost</u>
1342'	20 bbls.
6162'	25 bbls.
6430'	30 bbls.
6630'	20 bbls.
7028'	75 bbls.
7473'	25 bbls.
7565'	25 bbls.

CHART #7

JOINT BREAKDOWN

10 3/4" EMPLACEMENT CASING

	Howco Type F Guide Shoe	3.83'
1 Jt.	10 3/4" OD 55.5# S-95 ST & C R-3 Casing	43.15
	Howco Type F Float Collar	1.62
1 Jt.	10 3/4" OD 55.5# S-95 ST & C R-3 Casing	43.06
13 Jts.	10 3/4" OD 55.5# S-95 ST & C R-3 Casing	559.92
10 Jts.	10 3/4" OD 55.5# S-95 ST & C R-3 (Ruff-Cote) Csg.	430.55
6 Jts.	10 3/4" OD 55.5# S-95 ST & C R-3 Casing	258.42
	Howco DV Stage Collar	2.08
21 Jts.	10 3/4" OD 55.5# ST & C R-3 Casing	903.71
21 Jts.	10 3/4" OD 51# S-95 ST & C R-3 Casing	904.70
29 Jts.	10 3/4" OD 51# P-110 ST & C R-3 Casing	1,106.17
30 Jts.	10 3/4" OD 51# N-80 ST & C R-3 Casing	1,224.86
29 Jts.	10 3/4" OD 51# K-55 ST & C R-3 Casing	1,128.46
26 Jts.	10 3/4" OD 51# N-80 ST & C R-3 Casing	1,063.41
	Howco Stage Collar	2.08
23 Jts.	10 3/4" OD 51# N-80 ST & C R-3 Casing	946.80
<u>2 Jts.</u>	10 3/4" OD 55.5# S-95 ST & C R-3 Casing	<u>86.09</u>
212 Jts.	Total	8,708.91'
	Less Casing Above KDB	<u>(7.91)</u>
	Casing set with respect to KDB	8,701.00'

MULTISHOT DIRECTIONAL SURVEY

1. Readings taken every 100' from 8700' to surface.
2. True vertical depth - approximately 8700.9'.
3. Calculated distance of the 8701' point is 41.2' N. 70° E. from surface entrance point.
4. Calculated distance of the 800' point. (Bottom of surface casing) is 19.3' N. 80.2° E. of surface entry point.

RULISON PROJECT

PREPARED BY
FENIX & SCISSON, INC.
ENGINEERS & CONTRACTORS
LAS VEGAS, NEVADA

FOR
U.S. ATOMIC ENERGY COMMISSION
NEVADA OPERATIONS OFFICE
LAS VEGAS, NEVADA

MULTISHOT DIRECTIONAL SURVEY

DRAWING NO.
DIAGRAM NO. 2

DRAWN
B. FISHER

CHECKED

DATE
2/20/69

SCALE
NONE

SHEET _____ OF _____

THIS ENVELOPE WILL HOUSE EMPLACEMENT PACKAGE

SMOOTH CEMENT BOTTOM TO BE $10\frac{1}{2}'$ BELOW
CENTER LINE OF THIS ENVELOPE.

CENTER LINE OF CONTAINER
8442.5'
10.5
*8453'

COLLAR CHECK ABOVE
CONTAINER
8428.5'
11.0
*8439.5

*WIRE LINE MEASUREMENTS USING
KELLY BUSHING AS ZERO REFERENCE.
GROUND LEVEL IS 15.5' BELOW
KELLY BUSHING.

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FOR
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NEVADA OPERATIONS OFFICE
LAS VEGAS, NEVADA

BORON CARBIDE ENVELOPE

DRAWING NO.
DIAGRAM NO. 3

DRAWN
R. FISHER

CHECKED

DATE
2/24/69

SCALE
NONE