GL07320

Casing Failure - RR&E #1

The following is an analysis of the probable causes of the production (13-5/8") casing failure in RR&E #1 which occured on 2/24/75 during cementing of the production casing. Zone of collapse occured at 3,325-3338 ft. and 3584-3591 ft.

Halliburton contends that the lead cement slurry thickened to the point of non-pumpability due to loss of water to the formation. The cement composition shows no water loss control additive in the slurry. Pressure reached 2000 psi & pumping stopped, 45 seconds later the casing parted instantly relieving the pressure inside the casing and trapping the pressure in the annulus between the thickened cement and the float shoe. The 2000 psi trapped pressure exceeded the 1540 psi collapse resistance of the casing resulting in the collapsed casing.

Clarence Mason (Reco Drlg Superintendant) reports the essentially the same analysis but with more detail. Increased cementing pump pressure was due to cement dehydration, most likely occuring due to forcing

the cement through too small annular space resulting in cement bridge. Bottom hole pressure reached 3824 psi at the point pumps were stopped. The casing parted due to difficult "make ups" (which could show wear) on the torque chart at the 6th joint from surface relieving inside casing pressure. Annular pressure was maintained by the differential float collar ~~inserting~~ causing casing to collapse. These events were observed by the casing "pistoning" upward twice and two definite surges of water at the 2" circulating lines.

Reeco's , John Auten analyzed the events somewhat differently. He agrees the casing parted due to "make-up." But casing was off bottom one foot and when it parted the weight, 176,000 pounds, of the casing falling caused ~~collapse~~ buckling. The pistoning action was caused by release of tension on the string & reverse flow of fluid with the pressure drop forcing the parted top casing section up. Although he discribes 3 pluses on the 2" lines, the third caused as the casing fell back down after second ~~uplift~~ pistoning.

These reports are located in Geothermal

Correspondence Log 218.

Casing Failure RRGE #1

Halliburton —

Bridging cement due H_2O loss to fm

2,000 psi trapped inside csg & float shoe

Casing parted reliving inside pressure, the 2,000 psi annular trapped press exceeded the csg 1540 psi collapse result collapsed csg.

Mason —

discribes maj thief zone between 1600-1800 annular rise 1920

Increase pump press due to cement dehydration — most likely occured due to forcing cement thru too small annular space - result bridge. BHP was at 3,824 psi (w/ 2,000 psi at surface). Casing parted due to difficult "make up" on (which could show wear) torque chart at 6th joint reliving inside press. Outside (Annular) press held by float valve (float collar) caused collapse by differential pressure.

1st csg rise due to csg parting, second rise caused by csg collapse by second surge of press against the top parted section.

Auten —

(see pg 2 report)

Collapse caused by casing dropping to bottom hole as casing parted.

Csg parted because csg was torqued too much causing coupling turned on lower section csg.

See 205 - 218 -

Efforts to "kill" the flow by injecting cold water were halted when this activity resulted in development of a major "thief zone," principally between 1600 feet and 1700 feet. The flow was successfully controlled by staging plugs of sand (862 feet), barite (12 feet), and cement (120 feet) pumped down the drill pipe. The top of the cement plug was tagged at 3,642 feet.

Based upon a 4-arm caliper log the average hole diameter from the 13 3/8-inch casing setting depth was approximately 20 1/4 inches, and a minimum diameter of 16 1/2 inches. A 15-inch diameter bit was run to the top of the cement plug at 3,642 feet to assure clearance and to circulate before running the 13 3/8-inch casing. A total of 3,651 feet of 13 3/8-inch, H-40, 54.5 and 61.0-lb/ft casing with float shoe and two collars (see Section 4.2 - Production Casing) were run and set at 3,623 feet (GL).

While cementing the first stage through the shoe with 405.5 barrels of cement displaced and 92 barrels remaining to be displaced, the casing parted at a coupling at approximately 210 feet (seven joints). The casing was successfully screwed back together, torqued and pressure tested. Before proceeding with the second stage, a cement bond log was run which indicated an annulus cement top at approximately 1,820 feet. The second cement stage was pumped through the casing head ports (Braden head) in accordance with the cementing program. A total of 407 barrels of cement slurry were pumped until the pumping pressure rise indicated the annular space was cemented. A cement bond log was run to confirm the cement in place outside the casing from 1,838 feet to the surface.

While drilling out the casing below the tagged top of cement at 2,837 feet, collapsed casing was encountered at 3,325 feet. A total of 13 milling tool runs were made in addition to numerous runs with magnets (11 1/2-inch and

9 inch) and various junk baskets before drilling out of the 13 3/8-inch casing shoe at 3,642 feet. The actual zones of casing collapse were determined to extend from 3,325 feet to 3,338 feet and from 3,584 feet to 3,591 feet. These depths were determined from strapped drill pipe lengths and were at variance with the 4-arm caliper log (Schlumberger) on April 6, 1975. Pressure tests of the hole to 300 psi were conducted during milling operations. The cement plug below the 13 3/8-inch casing shoe was drilled out and the barite and sand plugs were circulated out of the hole to 4,650 feet.

After drilling new formation from 4,651 feet to 4,686 feet, Core #2 was cut with an 8 3/4-inch diamond bit from 4,686 feet to 4,698 feet. Nine feet of core was recovered. The cored interval was reamed to 11 inches and drilled to 5,005 feet. A bottom hole core (#3) was cut with an 8 3/4-inch diamond bit from 5,005 to 5,007 feet with 2 feet of recovery.

Upon completion of the drilling and coring operations, a retrievable bridge plug was set in the hole to allow for removal of the blowout equipment. A master gate valve was installed to allow for future flow tests and temperature measurements.

A summary of the daily drilling reports from mobilization through rig-down is presented as Appendix A.

Figure 4 shows an as-built sketch of the Present Subsurface Well Status of RRGE-1 and figure 5 depicts the Drilling and Operations Summary.

IDAHO GEOTHERMAL R&D PROJECT
DAILY DRILLING REPORT

DATE 2-24-75 LOCATION RRGE-1

PRESENT OPERATION WOC FORMATION _____ HOLE SIZE Same

casing set at 3642
PRESENT T.D. 4650 DRILLED FROM _____ FEET TO _____ FEET: MADE _____ FEET OF HOLE

IN _____ HOURS: TRIPS _____ HOURS: SERVICE RIG _____ HOURS: D.S.T. _____

HOLE SURVEY _____ HOURS: OTHER DOWNTIME: 24 HOURS

MUD LOG TEMPERATURES: MUD IN--HIGH _____ °C @ _____ FEET T.D., LOW _____ °C @ _____ FEET T.D.
MUD OUT--HIGH _____ °C @ _____ FEET T. D., LOW _____ °C @ _____ FEET T.D.

REMARKS: 2 hours rig up to circulate with rig pump and fill casing. 2-1/2 hours circulating and wash casing to bottom from 3621 to 3642. 3-1/4 hours cementing with Halliburton, parted casing while displacing cement at 2:45 PM. 16 hours waiting on cement. Screwed back into casing 16 turns, 6,000 ft lb torque. Picked up 100,000 lb of pipe. Pressure up casing to 500 psi.

(over)

DRILLING INFORMATION: ROTARY RPM _____ PUMP PRESSURE _____ PUMP ON HOLE _____ _____
1 2
PUMP STROKES _____ WEIGHT ON BIT _____ #

MUD INFORMATION: WT. _____ VISCOSITY _____ PLASTIC VISCOSITY _____

WATER LOSS _____ FILTER CAKE _____ PH _____ SAND CONTENT _____

BIT INFORMATION: PRESENT BIT# _____ DEPTH IN _____ MAKE _____ TYPE _____

JET NOZZLES _____ _____

LAST BIT RUN # _____ MAKE _____ TYPE _____

JET NOZZLES _____ _____ DEPTH IN _____

DEPTH OUT _____ FOOTAGE _____ HOURS RUN _____

CONDITION OF BIT _____

DRILL COLLAR INFORMATION: NO. OF COLLARS IN USE _____ _____ O.D. _____ I.D. _____

PLACEMENT OF STABILIZERS _____

FUEL CONSUMPTION: BUTANE 164 GAL. DIESEL 100 GAL.

PUMP NO. 1 LINEAR SIZE 7-1/4 PUMP NO. 2 LINEAR SIZE 7-1/4

FIGURE XI-1--DAILY DRILLING REPORT

Temp 0500 20

Run in hole with sand line, top of cement in casing at 2950.

Cement information - pumped 100 barrels of gel water ahead of cement. Mixed 1500 sacks of 50-50 pos mix with HR-12 (0.5%). 15.1 lb slurry. Mixed 400 sacks of 50-50 pos mix (15.1 lb slurry). Total slurry 568 barrels. Displaced with 454 barrels of water. Pressure increased to 2000 psi. Halliburton stopped pumping. Casing held pressure approximately 45 seconds before parting. Weight indicator showed 6 to 8,000 lbs on hook. Pumped 130 barrels of water to clear parted casing.

IDAHO GEOTHERMAL R&D PROJECT
DAILY DRILLING REPORT

DATE 2-23-75 LOCATION RRGE-1

PRESENT OPERATION Rig up and circulate casing FORMATION _____ HOLE SIZE 15-in 3642 12-1/4 to 4650

PRESENT T.D. 4650 DRILLED FROM _____ FEET TO _____ FEET: MADE _____ FEET OF HOLE

IN _____ HOURS: TRIPS _____ HOURS: SERVICE RIG _____ HOURS: D.S.T. _____

HOLE SURVEY _____ HOURS: OTHER DOWNTIME: 24 HOURS

MUD LOG TEMPERATURES: MUD IN--HIGH _____ °C @ _____ FEET T.D., LOW _____ °C @ _____ FEET T.D.
MUD OUT--HIGH _____ °C @ _____ FEET T. D., LOW _____ °C @ _____ FEET T.D.

REMARKS: 1-1/2 hours levelling rig. 3 hours rigged jacking equipment and load out the same. 2-3/4 hours trip out of hole. 5-1/4 take off Grant rotating head install Grant 13-~~in~~ x 3/8 in. casing stripper. 11-1/2 hours rig up and run ~~13-3/8~~ 13-1/3 in. casing.

(over)

DRILLING INFORMATION: ROTARY RPM _____ PUMP PRESSURE _____ PUMP ON HOLE 1 _____ 2 _____
PUMP STROKES _____ WEIGHT ON BIT _____ #

MUD INFORMATION: WT. _____ VISCOSITY _____ PLASTIC VISCOSITY _____
WATER LOSS _____ FILTER CAKE _____ PH _____ SAND CONTENT _____

BIT INFORMATION: PRESENT BIT# _____ DEPTH IN _____ MAKE _____ TYPE _____
JET NOZZLES _____ _____
LAST BIT RUN # _____ MAKE _____ TYPE _____
JET NOZZLES _____ _____ DEPTH IN _____
DEPTH OUT _____ FOOTAGE _____ HOURS RUN _____
CONDITION OF BIT _____

DRILL COLLAR INFORMATION: NO. OF COLLARS IN USE _____ _____ O.D. _____ I.D. _____

PLACEMENT OF STABILIZERS _____

FUEL CONSUMPTION: BUTANE 246 GAL. DIESEL 100 GAL.

PUMP NO. 1 LINEAR SIZE 7-1/4 PUMP NO. 2 LINEAR SIZE 7-1/4

FIGURE XI-1--DAILY DRILLING REPORT

Temp 0500 12°

The casing data

Total 92 joints, total footage 3651.25 ft
50 joints of 61 lbs J-55
1976.35 ft on bottom from 3642 up to 1665
41 joints of 5450 J55 - footage 1634.84 from 1665 up to 30.81ft
1 joint of 61 lbs J55
40.06 ft from 30.81 to surface.

Centralizers - 1 20 ft up from shoe, then every third collar up to 1497.
Cement Baskets - 1 at 3206, 1 at 2738, 1 at 2302, and 1 at 1829.
Float Equipment consists of 1 guide shoe, 1 differential flow collar on bottom, and No. 2 differential collar, 1 joint up from shoe

HALLIBURTON SERVICES

P. O. Box 339
Vernal, Utah 84078
March 17, 1975

Mr. John Auten
Reynolds Electric and Engineering Co.
P. O. Box 14400
Las Vegas, Nevada 89114

Dear Sir:

The following is an analysis of the probable cause of the collapsed 13 3/8" casing in the RRGE #1 in Cassis County, Idaho:

Hole Data: Plugback TD 3,651'
Hole Size 20" average
20" Casing set to 900'
13 3/8" Casing set to 3,650' ±

Discussion:

After plugging back with sand and cement to 3,651', 13 3/8" casing was run to TD and the hole circulated for approximately 3 hours to stabilize the temperature. Following this, 100 BBL gel water was pumped into the casing. This fluid was to prepare the formation for cementing and to attempt to slow the water loss from the cement into the formation. A high water loss will cause cement to thicken prematurely. The cementing operation commenced with the mixing of 1500 sacks 50-50 Poz-mix containing 60% silica flour and 0.5% HR-12 followed by 400 sacks 50-50 Pozmix containing 60% silica flour. This amount of cement yields 570 BBL of slurry when mixed. The top plug was dropped and displacement started. A pressure rise was encountered with 150 BBL of displacement in. The pressure continued to rise until, with 454.5 BBL pumped, the pressure reached 2000 psi. At this time pumping stopped. Pressure held for approximately 45 seconds. Then the casing parted near the surface, releasing all pressure inside the casing. Later the casing was screwed back together and was determined to be holding.

Conclusions:

The increasing pressure during displacement was

HALLIBURTON SERVICES

probably due in a small part to the changing hydrostatic head and the most part to thickening of the cement slurry due to loss of water into the formation. The first portion of the slurry would thicken to the point of non-pumpability because it had the longer contact time with the formation. When the lead slurry was no longer pumpable at 2000 psi, movement ceased. The 2000 psi was trapped inside the casing and also in the annulus between the thickened slurry at the top and the float shoe at the bottom. When the casing parted, the pressure inside the pipe was relieved to hydrostatic instantly while the pressure in the annulus, trapped between the thickened cement and the float shoe, could not be relieved. At this point the 2000 psi trapped exceeded the 1,540 psi collapse of 13 3/8", 61# casing. This excess pressure collapsed the casing from 3,325' to 3,340'.

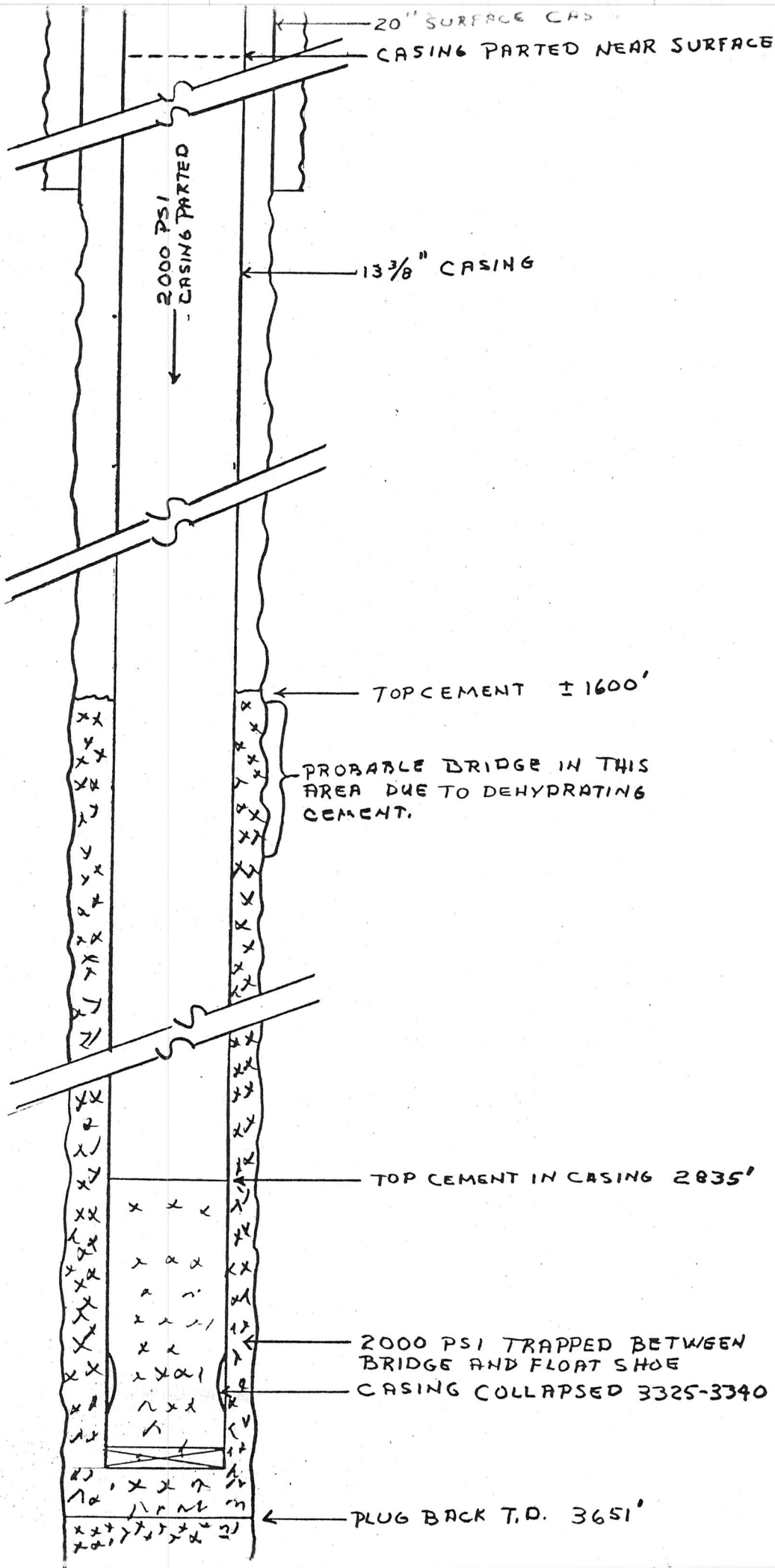
The attached diagram shows graphically the probable cause of the collapsed casing.

Thank you for this opportunity to be of service to you. Should you require further information, please let us know.

Yours very truly,

J. W. Lasater
Dist. Engineer

cc: E. L. McClure
G. G. Stennis
R. L. Spillman


20" SURFACE CAS
CASING PARTED NEAR SURFACE
2000 PSI - CASING PARTED
13 3/8" CASING
TOP CEMENT ± 1600'
PROBABLE BRIDGE IN THIS AREA DUE TO DEHYDRATING CEMENT.
TOP CEMENT IN CASING 2835'
2000 PSI TRAPPED BETWEEN BRIDGE AND FLOAT SHOE
CASING COLLAPSED 3325-3340
PLUG BACK T.D. 3651'

CEMENTING OF THE 13 3/8" CASING
RRGE #1

On February 23, after displacing 405.5 barrels of 15.1 lbs. cement out of the 3,651' of 13 3/8" casing with water, the displacing pump pressure, being applied by Halliburton Oil Well Cementing Co., increased to 2,000 PSI. (as per guage on the pump truck, viewed by the Hawco cementer and Mr. McClure, District Supt. for Hawco). This 2,000 PSI is 73% of the design burst pressure of the 8 round short thread and coupled casing. Halliburton stopped pumping. Pressure held @ 2,000 PSI. Approximately 45 seconds elapsed before the casing "parted" 6 or 7 joints down from the top. The top 6 or 7 joints of casing was "pistoned" up to the hook, (note: the 13 3/8" casing was packed off, about 15' down from the top, with a Grand Oil Tool 13 3/8" casing stripper rubber.. There were three 2" open lines under the pack off to allow circulation while cementing). Some 2 seconds later, as witnessed by the driller, as the top of the casing started downward, it was again "pistoned" upward--then fell free to the elevators. There were also two definite surges of water pressure at the 2" circulating lines. Another 130 barrels of water were pumped into the casing after it parted to clear the top 6 or 7 joints of any possible cement around it.

The weight left hanging on the elevators corresponded to the weight of 6 or 7 joints of casing. (Actual weight made difficult to read by the friction of the casing stripper rubber). The casing was lowered approximately 16" to "tag" the top of the parted casing, then lowered another 4" while screwing the casing back together with 16 turns and 6,000 lbs. torque. 100,000 lbs. of strain was then pulled on the casing and pressured tested to 500 PSI. The second and final stage of the cementing job was later completed without incident.

The top of the cement inside the casing was at 2,835' while drilling out the cement ~~and~~ 3,328', the 12 1/4" drill bit encountered damaged casing. 10' of casing was milled out from 3,328' to 3,338' before proceding to drill out cement

down to 3,585! At 3,585 more damaged casing was encountered. (Note: the 3,328' depth is 7' below a casing coupling. The 3,585' depth is 12' above the first differential float collar).

Pertinent facts relating to the casing and cementing job are as follows:
There was 900' of 20" surface casing set. A 12 1/4" hole was drilled with clear water to 4,650' plugged back with sand and topped off with a cement plug @ 3,642'.

The 12 1/4" hole was originally designed to accomodate 9 5/8" casing.

The caliper log showed the 12 1/4" diameter hole had eroded to an average of 20" diameter due to clear water drilling. A 15" bit run was made prior to running casing--the hole was under 15" and was opened up to 15" from 3,167' to 3,257'.

The normal 17 1/2" hole to accomodate 13 3/8" casing was decided against because of the cost of obtaining and installing 20" blow out equipment that would accept a 17 1/2" hole-opener.

The casing string consisted of a 13 3/8" guide shoe, a 13 3/8" differential float collar, a 13 3/8" - 61 lb. shoe joint, a second differential float collar, 50 joints 13 3/8" 61 lb/ft. casing, 41 joints of 13 3/8" 54.5 lb/ft. casing and a 61 lb/ft. landing joint.

"Mudding up" the hole was recommended by Halliburton representatives and others knowledgable in oil-well drilling technology but was decided against because of the cost of mudding up and sealing off an existing loss circulation zone. The cement was retarded for use in a high temperature environment.

An explanation of "what happened" while displacing is as follows:
The increasing pressure, while displacing, encountered by Halliburton was due to cement dehydration outside the casing. The dehydration was caused by fluid loss out of the cement to the formation. This dehydration would most likely occur at the

3,257' depth, due to forcing cement by the 13 3/8" casing and the 14 1/2" coupling in a 15" diameter hole, and result in a "bridge" or cement flow stoppage. When Halliburton stopped pumping and 2,000 PSI was held at the surface, the bottom hole pressure, both inside and outside, the casing was 3,824 PSI. When the casing parted, the 2,000 PSI inside the casing was released leaving a 2,000 PSI differential on the outside of the casing. The outside pressure couldn't release because of the back pressure valves in the float collars. The first "pistoning" action of the top casing was caused by the parting and the 2,000 PSI released under it. The second "pistoning" action was caused by the collapse of the casing at 3,328'-3,338' level, also explaining the two surges of water pressure at the circulating lines. The cause of the casing parting at a coupling with 27% less than its rated internal yield strength was partly due to a difficult "make up" as the torque chart indicated on the sixth joint down from the landing joint. Also the cold water inside and the warmer water outside of the casing may have contributed to weakening the joint. The event described above was the end result of not applying normal oil well drilling technology. (Note: it is not a normal oil well drilling practice to run 13 3/8" casing in a 15 inch diameter hole. It is not a normal oil well drilling practice to run or cement casing in an "unmudded" hole.

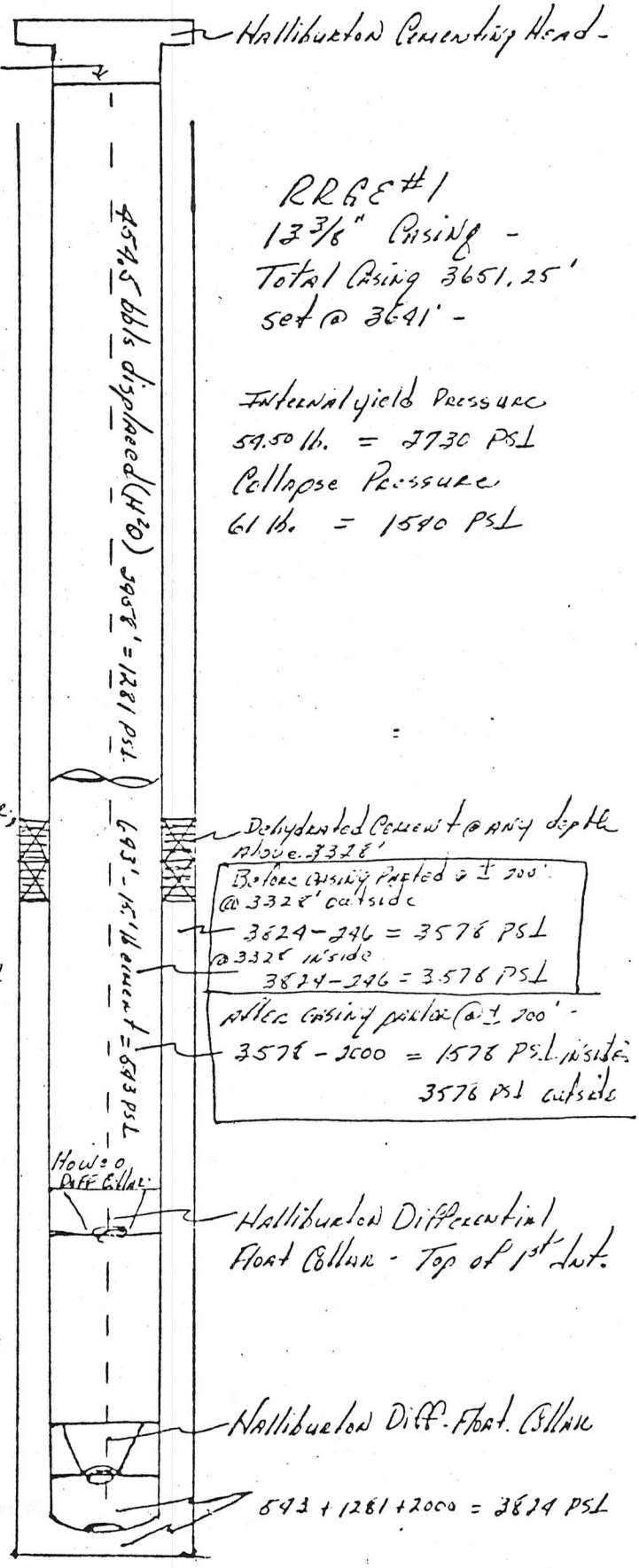
Preceding the casing job, there was a meeting of project personnel, ANC, ERDA, and REECo with Rich Spillman, Assistant District Superintendent of Halliburton at the drill site. The cementing procedure was discussed at length. A second meeting at the drill site with "Mac" McClure, District Superintendent for Halliburton was held. On both occasions, Halliburton representatives recommended "Mudding up" the hole.

It is recommended by the undersigned that future holes, if not drilled using normal oil well drilling techniques, be "mudded up" before running casing and the hole be conditioned to run and cement casing. It is also recommended that

the JAM System on the joint "make up" be used. The "Joint Analyzed Make Up" system integrates the number of turns with the torque. The "wear" coupling would have been rejected by the JAM System.

Attached is a drawing explaining "one theory" of the casing event.

Bob - C. J. Mason



Halliburton had displaced 454.5 bbls of cement out of casing - Pressure climbed To 3000 PSI ---- Howco shut down ---- Approx. 45 sec's later, Casing parted @ ± 200' down from top of casing.

Top ± 200' of casing was "pistoned" up against hook as a result of the 3000 PSI inside the casing - As the pressure bled off, then existing open 2" lines below the 13 3/8" Casing stripper, the top ± 200' started to fall back down toward the elevators - Simultaneously, the 3000 PSI Halliburton was holding on the casing before it parted was bled off @ the 3328' ft. level - leaving a 3000 PSI differential on the outside of the casing - due to the Diff. Float Collar - the casing collapsed @ 3328' causing a second surge of pressure against the top ± 200' of casing - resulting in it again being pistoned up to the hook - before falling face to the Elevators -

RRGE #1
13 3/8" Casing -
Total Casing 3651.25'
set @ 3641' -

Internal yield Pressure
54.50 lb. = 3730 PSI
Collapse Pressure
61 lb. = 1540 PSI

File
Original signed
by J. D. Auten

March 26, 1975

CASING FAILURE AT RRGE-1

A. Historical Record

1. Casing program as run in RRGE-1

1 joint - 40', 13-3/8", 61# K-55 - ST&C On Top
41 joints - 1640', 13-3/8", 54.5# K-55 - ST&C
51 joints - 2040', 13-3/8", 61# K-55 - ST&C

Properties of this casing -

13-3/8", 54.5# K-55 ST&C - Collapse pressure - 1130 psi
Internal yield pressure - 2730 psi
Joint strength - 514,000 lbs.
13-3/8", 61# K-55 ST&C - Collapse pressure - 1540 psi
Internal yield pressure - 3090 psi
Joint strength - 595,000 lbs.

Weight indicator reading with all casing suspended from hook - 196,000 lbs.

2. Depth of hole at time casing was run - 3642' to top of cement plug. Casing was run to bottom and raised off bottom approximately one foot.

3. 570 barrels of cement was pumped into the hole resulting in 6 to 8 barrels in the annulus. Weight indicator reading - 246,000 pounds.

4. Two cementing pump trucks started pumping the plug down. 170 barrels of water was pumped into the hole before pressure started to build up. When the pressure built up, one pump was shut down. The other pump was slowed down as the pressure continued to build up and was stopped when the pressure reached 2000 psi. The weight indicator read 196,000 pounds.

5. About 45 seconds after pumping stopped with the pressure steady at 2000 psi, the top portion of the casing jumped enough for the cementing head to hit the hook. It started to fall back but jumped and hit the hook again before falling back to the elevators. Observers noted three distinct pulses from the three 2-inch lines leading from the well head.

6. After a delay of a few hours the top section of casing was successfully screwed into the lower section (separation was at a threaded joint.) The top section was lowered 16 inches during attachment to the lower section. The top section was rotated 16 turns and a torque of 6000 ft/lbs was applied to make up the connection. 100,000 pounds of pull and held. Additionally, 500 psi of pressure was applied and held.

7. Cement log showed a good cement bond to 1825' with traces of cement to 1500'. Top of cement inside the casing was found to be at 2835'. Cement of the casing was completed through the well head.

8. When drilling was resumed, metal was found from 3328' to 3341'. This metal was drilled out with mills. Junk was cleaned out to the bottom of the hole.

B. Conclusions

1. The string parted 6 joints down from the top. The tong torque indicator strip chart showed that the joint was turned more than normal, indicating the coupling had turned on the lower section casing.

2. The casing dropped the one foot it was off bottom. The weight of 3143' of casing, 176,000 pounds, falling through this one foot caused the casing to buckle between 3328' and 3341'. This buckling occurred 7' below the coupling and effected the shape of the pipe for 13'. It is felt that if the pipe collapsed, the whole joint would be effected.

3. The casing jumped and hit the cementing head the first time due to the tension in the pipe, drilling lines, hook, ect. As it started to fall the reverse flow of fluid caused by the sudden drop of pressure forced the top section against the cementing head a second time. Both of these jumps caused a pulse at the flow lines leading from the well head. The third pulse was caused when the casing fell back into the elevators. These events give no evidence as to the nature of the pipe failure at 3328' to 3341'.

Recommendations

1. Casing must be inspected even if it is new.

2. The "Joint Analysis Make-Up System" (JAM) be used to record the number of turns and torque of each joint.

3. Set 2000' of 20" casing, drill 17" diameter hole to 3600 ± feet, cut 60' cores and ream to an agreeable casing point.

4. Cement 13-3/8" casing to surface using a method agreeable to all.

5. Drill remainder of hole with water with a Polymer added to retard erosion.

MDL:mg