Research Inventy: International Journal of Engineering And Science
Vol.11, Issue 12 (December 2021), PP 32-47
Issn (e): 2278-4721, Issn (p):2319-6483, www.researchinventy.com

Improving Well Performance Using New Completion Techniques

[1]Uti Mark,[2] Akpoturi Peters and[3] Ejelonu Oby Catherine
[1,2]Department of Petroleum Engineering,[3] Department of Petroleum Marketing
[1]NAOK,[2] FUPRE and [3]PTI, Nigeria.

ABSTRACT
XYZ has wells on platforms in water depths of 50 to 165 feet off the southern coast of Nigeria. The majority of wells drilled prior to 2000 were completed in 10-15 feet milled and underreamed windows which were gravel packed with 10/20 mesh sand behind 0.025" slotted liners. Many of these wells eventually had to be severely choked back or shut in due to excessive sand production.
This paper review strategy to re-activate and/or Increase production from these shut in or restricted wells and to effectively complete new wells. It also details the techniques used to do this.
The strategy essentially priorities walkovers according to maximum yield (in geologic/reservoir information and productivity) per Naira invested. The techniques utilized to accomplish this are based on Darcy's Law and JPR analyses (Inflow Performance Relationships) along with, the latest developments in sand control technology.
The new completion and workover techniques have yielded greater producing capacity and have extended the life of many of the older wells. To date, an increase of over 70,000 BOPD of sand-free production is attributable to fourteen such workovers and five development wells.
KEYWORDS; water depth, workover, gravel parked, sand production, wells, shut-in,porosity, permeability, wellbore and formation, reservoirs.

Date of Submission: 12-12-2021 Date of Acceptance: 26-12-2021

I. INTRODUCTION

xyz has 134 active oil producers on 36 well platforms located in the Bight of Benin in water depths of 50 to 165 feet. xyz as the operator, having 40% partnership with the Nigerian National Petroleum Corporation (NNPC), commenced production in the early 70's.

During the past two years xyz has performed fourteen workovers and five new well completions. This aggressive program has given the operator the capability to produce at a sustained daily rate in excess of 200,000 BOPD.

The reservoirs consist primarily of poorly consolidated highly permeable sandstones, similar in Nature to some sands in the Gulf of Mexico. Porosities range from 20% to 32% with permeabilities between 200md and 2 Darcies. Gravel packing is normally required to control sand. Formation thickness in some wellbores is in excess of 600 feet.

PAST COMPLETIONS

Originally, most completion intervals were limited by the regulatory body to less than 15 feet. In an effort to minimize drawdown, the 9-5/8' casing was milled and the cut window underreamed to 15 inches. The wells were then gravel packed with 10-20 sand ad 5" flush joint liners slotted with .025" Slots as shown in the typical well sketch (Figure 2).

Most completions would originally produce over2000 BOPD until water encroachment began. Produced water would frequently cause sand production that the slotted liners and 10-20 sand could not contain. Consequently many completions were either shut-in or choked back to Less than 500 BOPD for sand control.

PRESENT COMPLETIONS

In the past, presentations were made to convince the regulatory body that larger completion intervals in the thick sands could be advantageous. The presentations, founded on Darcy's Law and IPR - tubing performance curves, along with the latest information on sand control technology, were well received. Approvals were given to design for high rate completions that could be choked and regulated at the surface rather than downhole.

Work commenced with the Edop A new well completions . Three Edop wells were completed as dual string completions: a total of six primary zones and two alternates. These wells produced at 30,500 BOPD when streamed.

Three of the eight zones were not gravel-packed based on sand free rate calculations. To date no sand production has been observed from the six zones being produced; however, it should be noted none of these completions produce Water.

Because of the complexity of dual string completions (Figure 3) and the apparent problems associated with working over a deviated dual string well in a sand environment, most completions will be singles. However, due to the necessity of acquiring as much reservoir data as quickly as possible for reservoir management, the Edop A platform wells will all be dual string completions.

The workover program began immediately after the three Edop A completions. The workover philosophy summarized below was developed to optimize rig usage and maximize productivity into the production system:

PRIORITIZE WELL WORK

- Concentrate on single completions to maximize rig usage
- Investigate temporarily abandoned and idle wellbores to maximize the gain in producibility;
- Work over wells in areas that have no producing facility restrictions;
- Include work to increase reservoir and geology knowledge.

INTRODUCE NEW TECHNOLOGY WHERE FEASIBLE

- Complete longer intervals: up to 150 feet in thick sands;
- Perforate underbalanced with tubing conveyed perforating (TCP) 7" guns with at least 0.7" diameter holes and shot density of 12 shots per foot;
- Filter all completion fluids to 2 microns using Diatomaceous earth (DE) and Cartridge filter systems
- Wash perforations with filtered fluid at 3 to 5 BPM subject to a maximum of 10 barrels per foot fluid loss;
- Use .012" stainless steel screen and 20-40 sand mixed in 70 lb/1000 gal HEC 350-400 ep gel at 9-13 lb/gal depending on well conditions;
- Run GR-CNL and OST (carbon/oxygen) logs when needed to verify gas/oil and oil/water contacts prior to perforating;
- Run post gravel pack Nuclear Fluid Density (NFD) logs to determine if major voids exist in the pack and to document the lop of sand in the blank liner;
- Investigate new techniques and/or design tools to eliminate or minimize gravel pack voids if detected;
- Design a method by which logs and other tools can be safely and efficiently run below the milled windows in deviated wells.

II. DISCUSSION OF RESULTS

The fourteen workovers were quite successful. In Edop deed, some previously Idle wellbores were returned to productive status making over 5000 BOPD per well. Initially perforations were added above the existing milled window and the entire interval gravel packed (Figure4). A pre packed screen was normally run across the window in a deviated well to give extra protection should the outside screen wrap be damaged by the lip of the milled casing when running in. Underbalance was obtained using TCP easing guns run on partially filled drill strings below an Annulus Pressure Responsive (APR) valve and firing head; the guns fire simultaneously with the opening of the APR valve at a pre-set pressure in the tubing casing annulus.

Some wells were originally completed low in the sand member and if the milled window had watered out, the window was cement squeezed and perforations were added and gravel packed (Figure 5).

Many wells, however, were not originally completed low within a thick sand (Figure 6) and if logging and perforating were required below the window to maximize reservoir drainage, a means to get below the window was needed. xyz Operations Engineering and Drilling Engineering groups worked together to design a method to work below a window without cement squeezing the window and hence losing production from that interval.

The method called for killing the well and fishing the old slotted linear just as in other workovers. After underreaming the window a water base slurry mixed with epoxy-resin precoated 20-40 sand was spotted across and squeezed into the window (Figure 7)

The slurry was allowed to cure for twenty-four hours and the hole drilled and cleaned out to the old sump packer. If no problems were encountered when drilling out, the sump packer was broken up and pushed to bottom. Logging and other remedial work could be performed without the chance of hanging up in the window and jeopardizing the wellbore (Figure 8). This technique has been performed successfully and may eliminate costs of having to invest in several redrills.

Gravel park logging with the NFD log has been done on the majority of xyz workovers to determine the quality of the pack. Log interpretation has indicated most packs to be very good although occasionally some apparent voids have been spotted. If a log reading of less than 50% pack in ten or more continuous feet is found on the log within ten feet of the producing interval, the following steps are taken;

a) The well is slowly brought on to production to about 2000 BOPD and then slammed shut. This technique has been shown to create some improvement due to the "hammer" effect (Figures 9 & 10).

b) The well is logged again and if the pack is still suspect, Operations personnel are given instructions to slowly open the well when required and to a flow several hours of stabilization between any choke changes. This is in addition to regular checks for sand production.

xyz Operations Engineering is also working on development of a tool to break up voids when detected. One such tool was built on the principal of turbulence and impact (Figure 11) and run in one well with 35 degree deviation but little improvement was observed. Efforts are continuing in this area.

In addition, time lapsed logging with the NFD has shown that, contrary to accepted theory, full break down of the gel and settling of the gravel requires well over 2 hours. For this reason xyz runs the NED log after running the completion string to allow more time to elapse and subsequently get a truer picture. This also improves the efficiency of getting the 1-11/16” X 18’ logging tool through the gravel pack in deviated wells. Typically the sand top will settle ten feet within a four day period (Figures 9, 10, & 12, 13). Returning to a well and re-logging several months later showed no change in the top of the gravel pack sand.

RESULTS

The new completion and workover techniques introduced to xyz development well and workover programs have resulted in greater producing capacity and greater flexibility and have extended the life of many of the older wells.

To date, an increase of over 70,000 BOPD of sand free production is attributable to the 14 workovers and 5 development wells in which these techniques were applied.

FUTURE COMPLETIONS

No major changes are planned for future gravel packed completions since present completions have proven successful.

xyz plan to undertake the drilling and completing of twenty-one Oso gas condensate wells (fifteen producers and six injectors).

These wells are deeper, 10,500 feet TVD, with bottom hole temperatures of 235 degrees F. Permeability varies widely with some Highly permeable layers exceeding 25 Darcies. Sand free rate calculations indicate that gravel packing should not be required.
The 15 Oso producers with 1JT premium thread tubing and large bore packers (Figure 14) will be designed to maintain a Continuous combined production rate of 100,000 BOPD. The gas, along with the majority of the associated gas from present crude production will be injected back into the Oso formation for reservoir pressure maintenance and gas conservation. The six Oso injectors will be completed similarly but with 7" tubing (Figure 15).

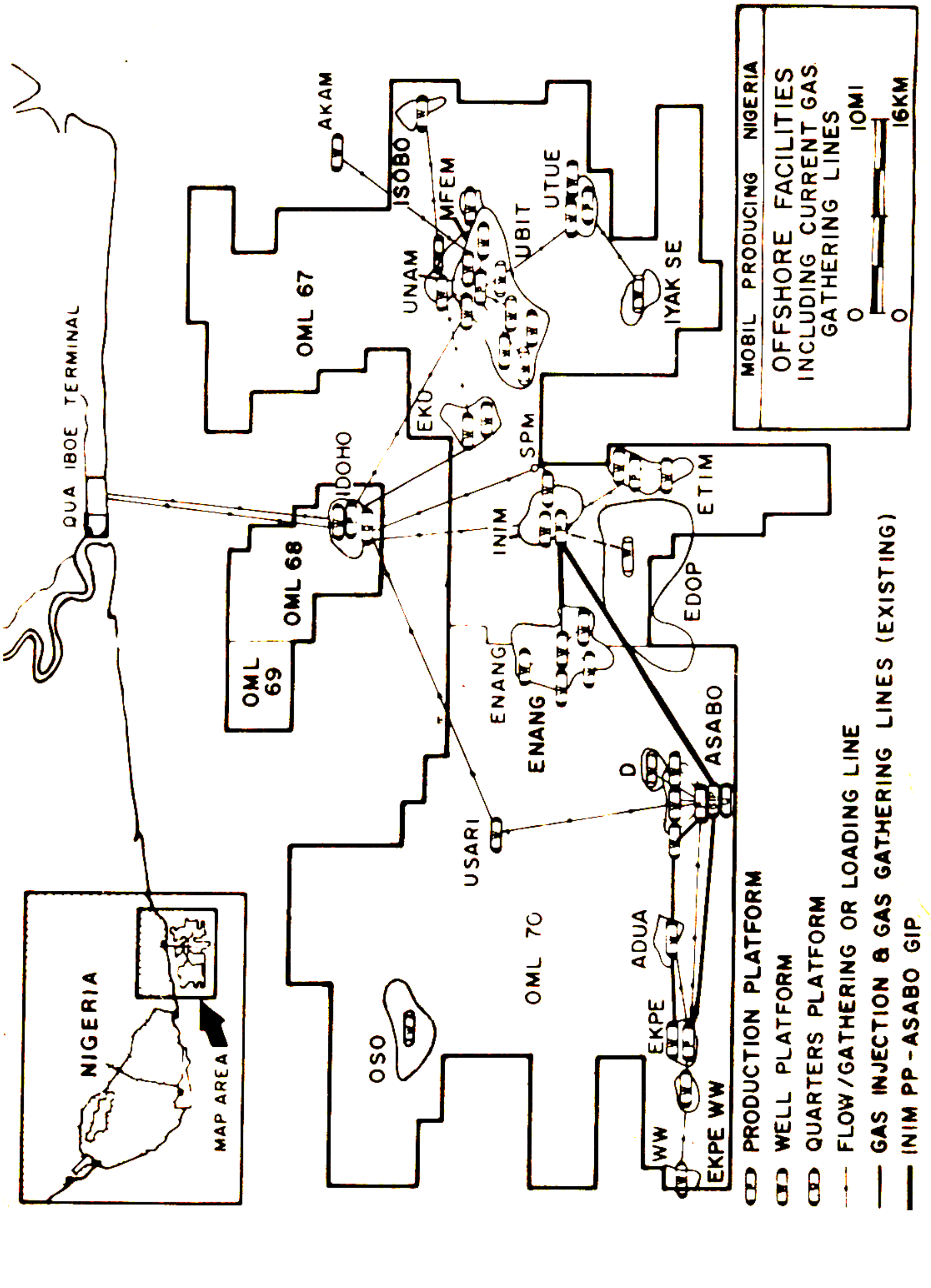
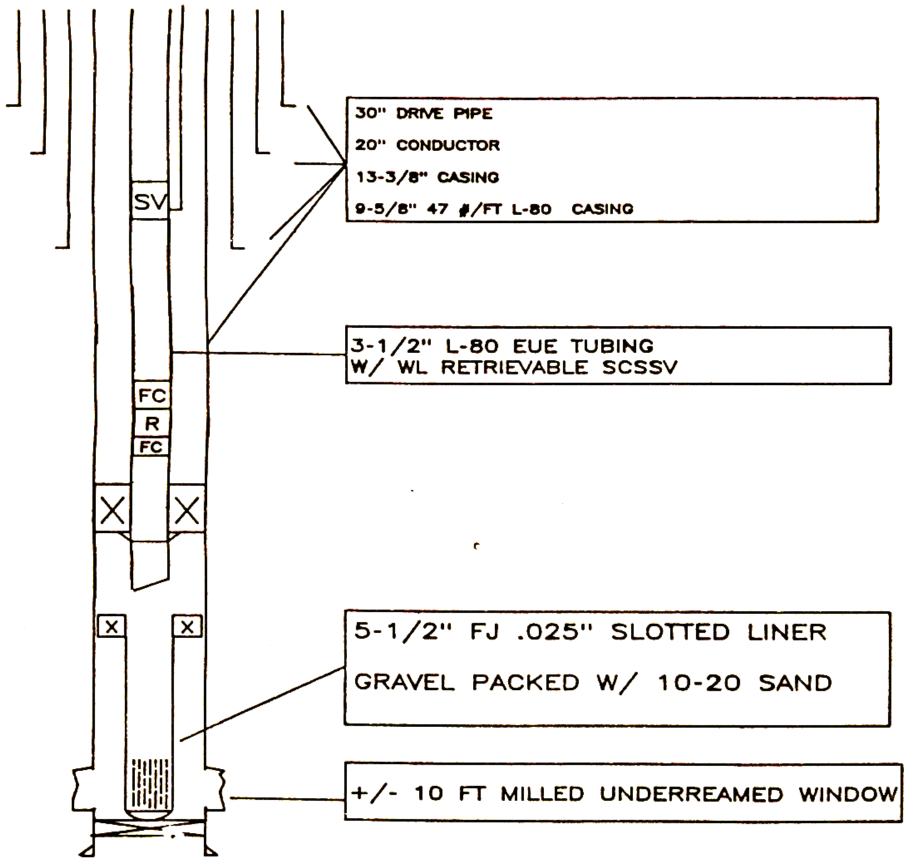

MOBIL PRODUCING NIGERIA
OFFSHORE FACILITIES
INCLUDING CURRENT GAS GATHERING LINES
0 10MI
0 16KM
QUA IBOE TERMINAL
NIGERIA
MAP AREA
OML 67
OML 68
OML 69
OML 70
AKAM
ISOBO
MFEM
UNAM
UBIT
UTUE
IYAK SE
EKU
SPM
IDOHO
INIM
ETIM
EDOP
ENANG
ENANG
ASABO
D
USARI
ADUA
EKPE
OSO
WW
EKPE WW
PRODUCTION PLATFORM
WELL PLATFORM
QUARTERS PLATFORM
FLOW/GATHERING OR LOADING LINE
GAS INJECTION & GAS GATHERING LINES (EXISTING)
INIM PP-ASABO GIP

FIGURE 1

FIGURE 2 TYPICAL COMPLETION OF PRODUCER - PRE 1987



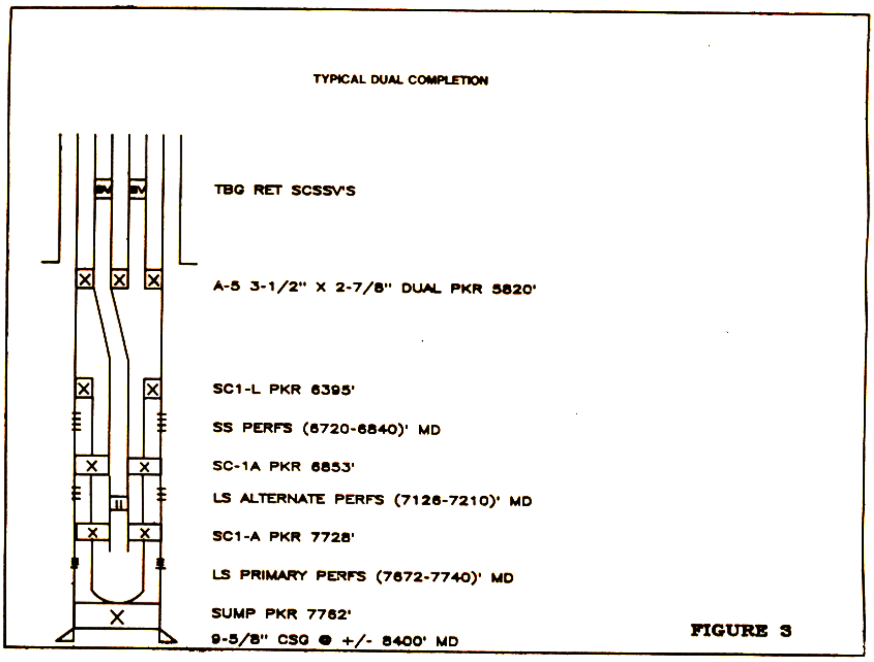


FIGURE 3

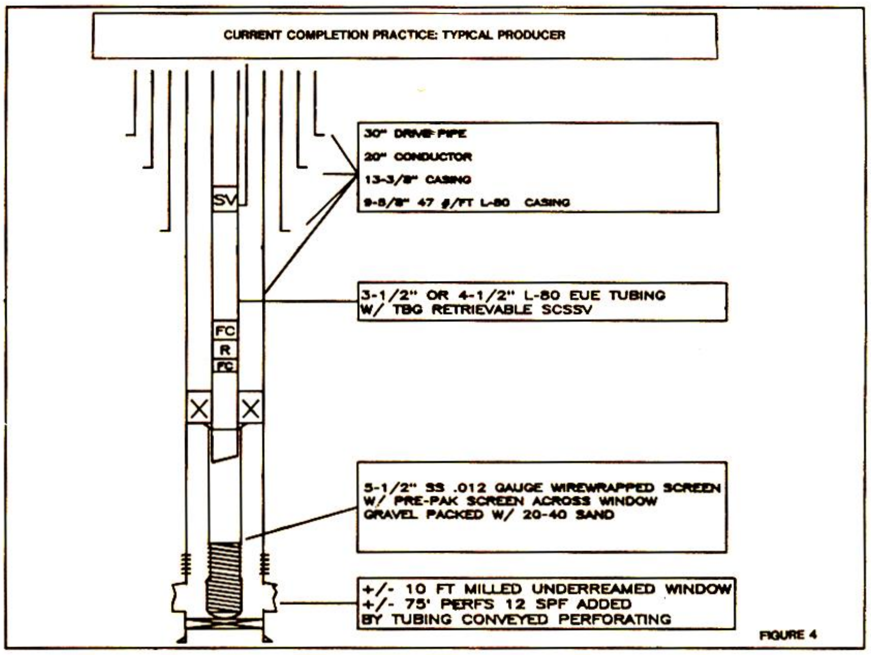


FIGURE 4

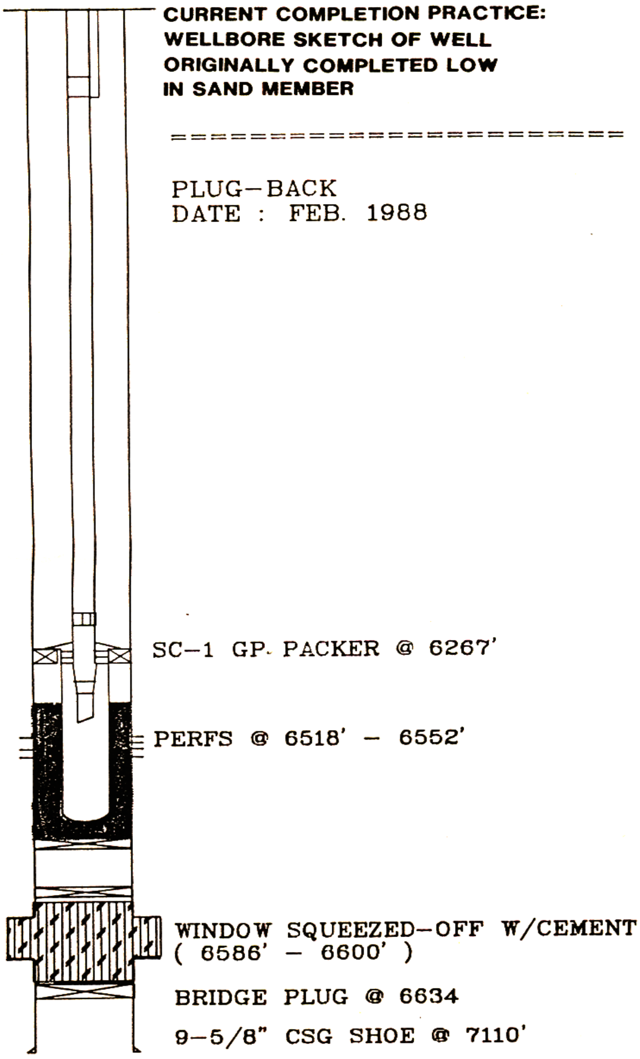
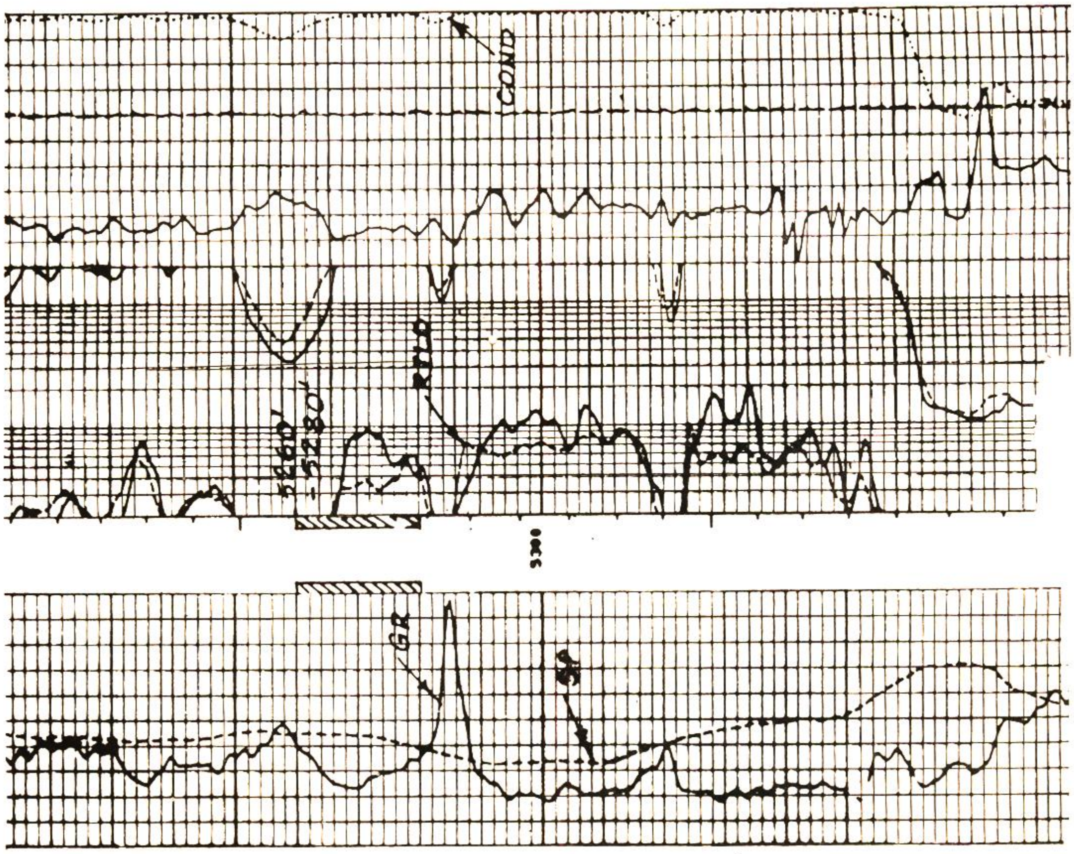


FIGURE 5

INDUCTION LOG FOR WELL
NOT COMPLETED LOW
IN THICK SAND

FIGURE 6



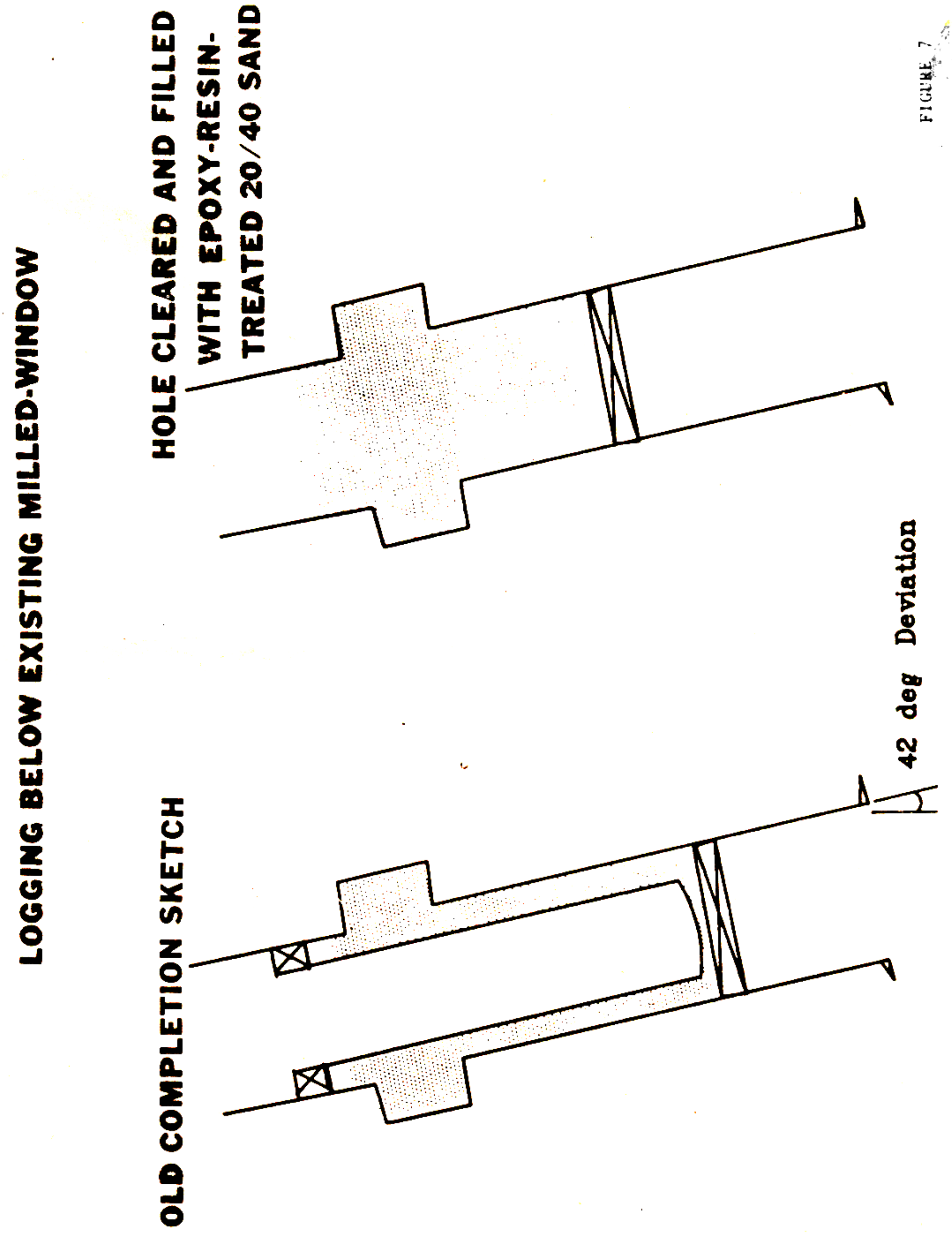

LOGGING BELOW EXISTING MILLED-WINDOW
HOLE CLEARED AND FILLED WITH EPOXY-RESIN-TREATED 20/40 SAND
OLD COMPLETION SKETCH
42 deg Deviation

FIGURE 7

LOGGING BELOW EXISTING MILLED WINDOW

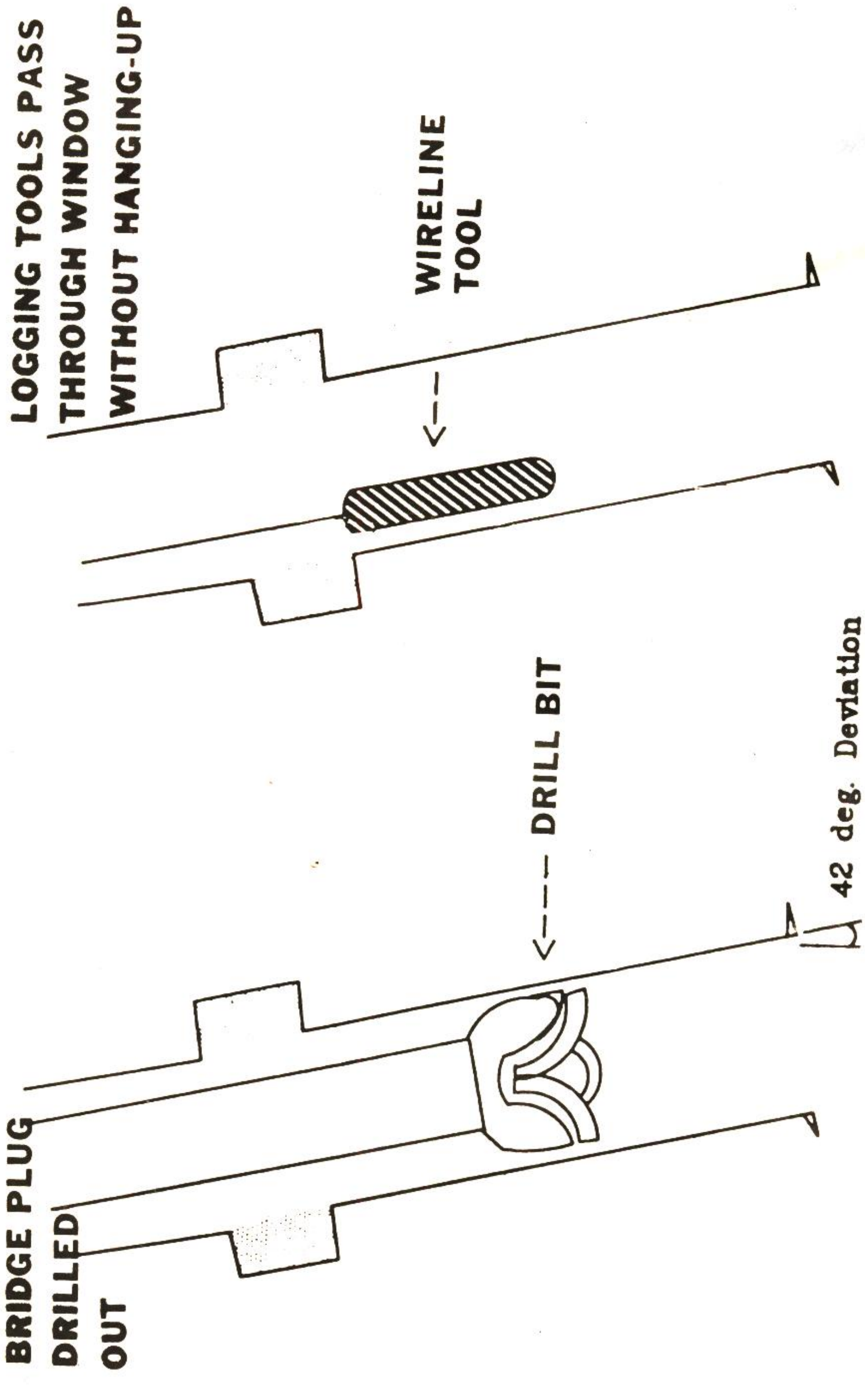


FIGURE 8

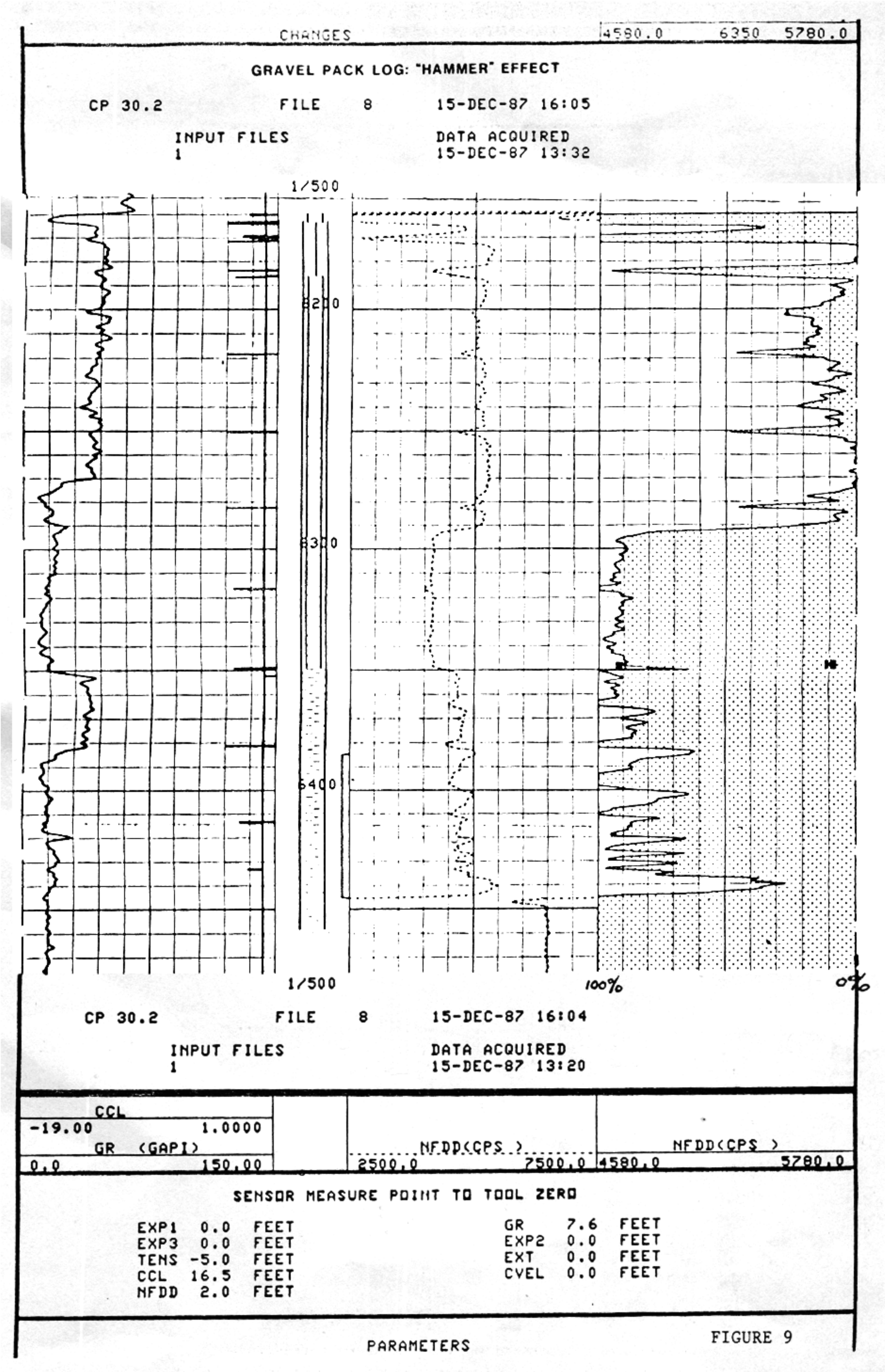

CHANGES
4580.0 6350 5780.0
GRAVEL PACK LOG: "HAMMER" EFFECT
CP 30.2 FILE 8 15-DEC-87 16:05
INPUT FILES
1
DATA ACQUIRED
15-DEC-87 13:32
1/500
8200
8300
8400
1/500
100%
0%
CP 30.2 FILE 8 15-DEC-87 16:04
INPUT FILES
1
DATA ACQUIRED
15-DEC-87 13:20
CCL
-19.00 1.0000
GR (GAPI)
0.0 150.00
NFDD(CPS)
2500.0 7500.0
NFDD(CPS)
4580.0 5780.0
SENSOR MEASURE POINT TO TOOL ZERO
EXP1 0.0 FEET
EXP3 0.0 FEET
TENS -5.0 FEET
CCL 16.5 FEET
NFDD 2.0 FEET
GR 7.6 FEET
EXP2 0.0 FEET
EXT 0.0 FEET
CVEL 0.0 FEET
PARAMETERS

FIGURE 9

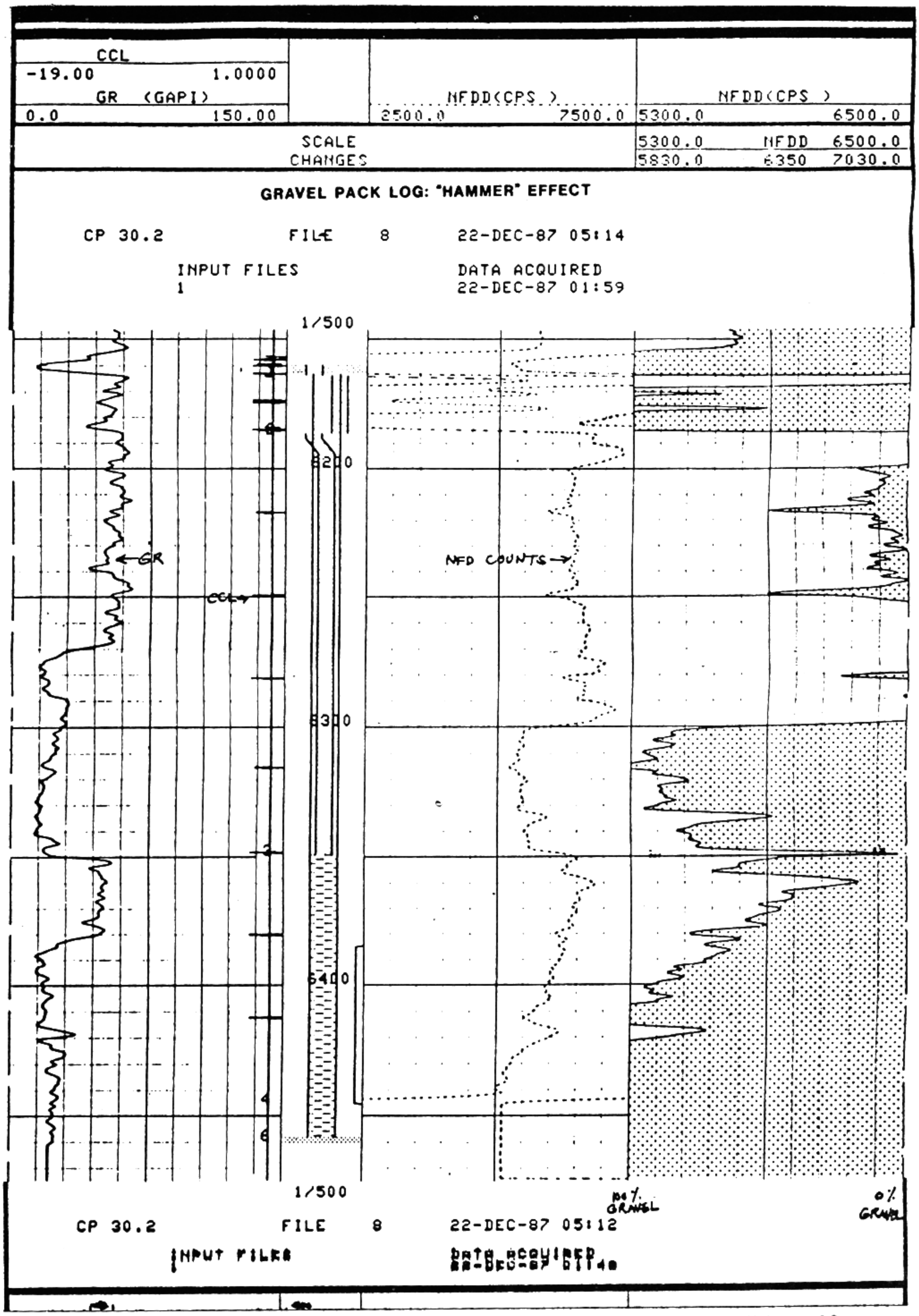

CCL
-19.00 1.0000
GR (GAPI)
0.0 150.00
NFDD(CPS)
2500.0 7500.0
NFDD(CPS)
5300.0 6500.0
SCALE
CHANGES
5300.0 NFDD 6500.0
5830.0 6350 7030.0
GRAVEL PACK LOG: "HAMMER" EFFECT
CP 30.2 FILE 8 22-DEC-87 05:14
INPUT FILES
1
DATA ACQUIRED
22-DEC-87 01:59
1/500
GR
CCL
NFD COUNTS
8200
8300
8400
1/500
CP 30.2 FILE 8 22-DEC-87 05:12
INPUT FILES
DATA ACQUIRED

FIGURE 10

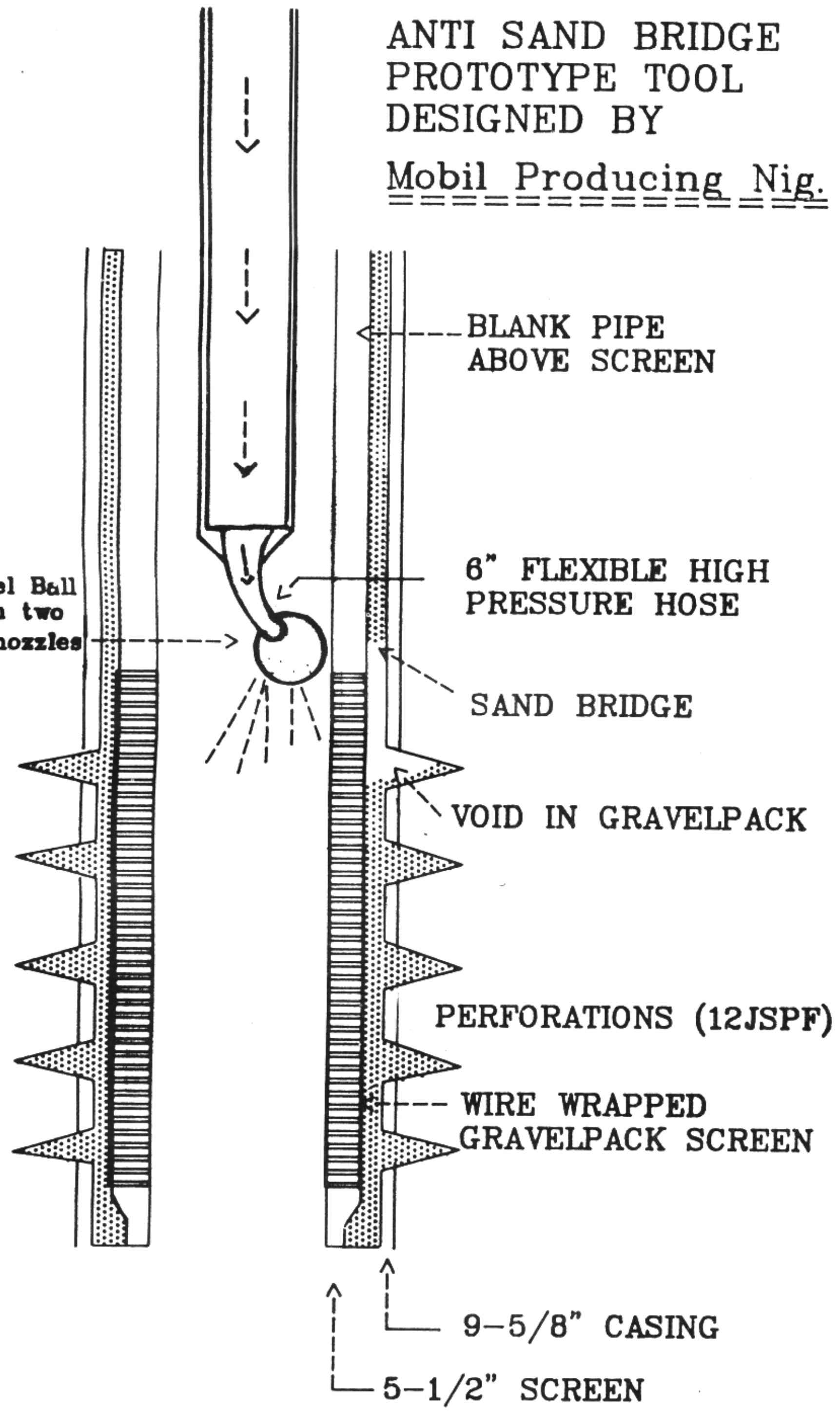

ANTI SAND BRIDGE
PROTOTYPE TOOL
DESIGNED BY
Mobil Producing Nig.
BLANK PIPE
ABOVE SCREEN
Steel Ball
with two
Jet nozzles
6" FLEXIBLE HIGH
PRESSURE HOSE
SAND BRIDGE
VOID IN GRAVELPACK
PERFORATIONS (12JSPF)
WIRE WRAPPED
GRAVELPACK SCREEN
9-5/8" CASING
5-1/2" SCREEN

FIGURE 11

GRAVEL PACK LOG: DAY # 1

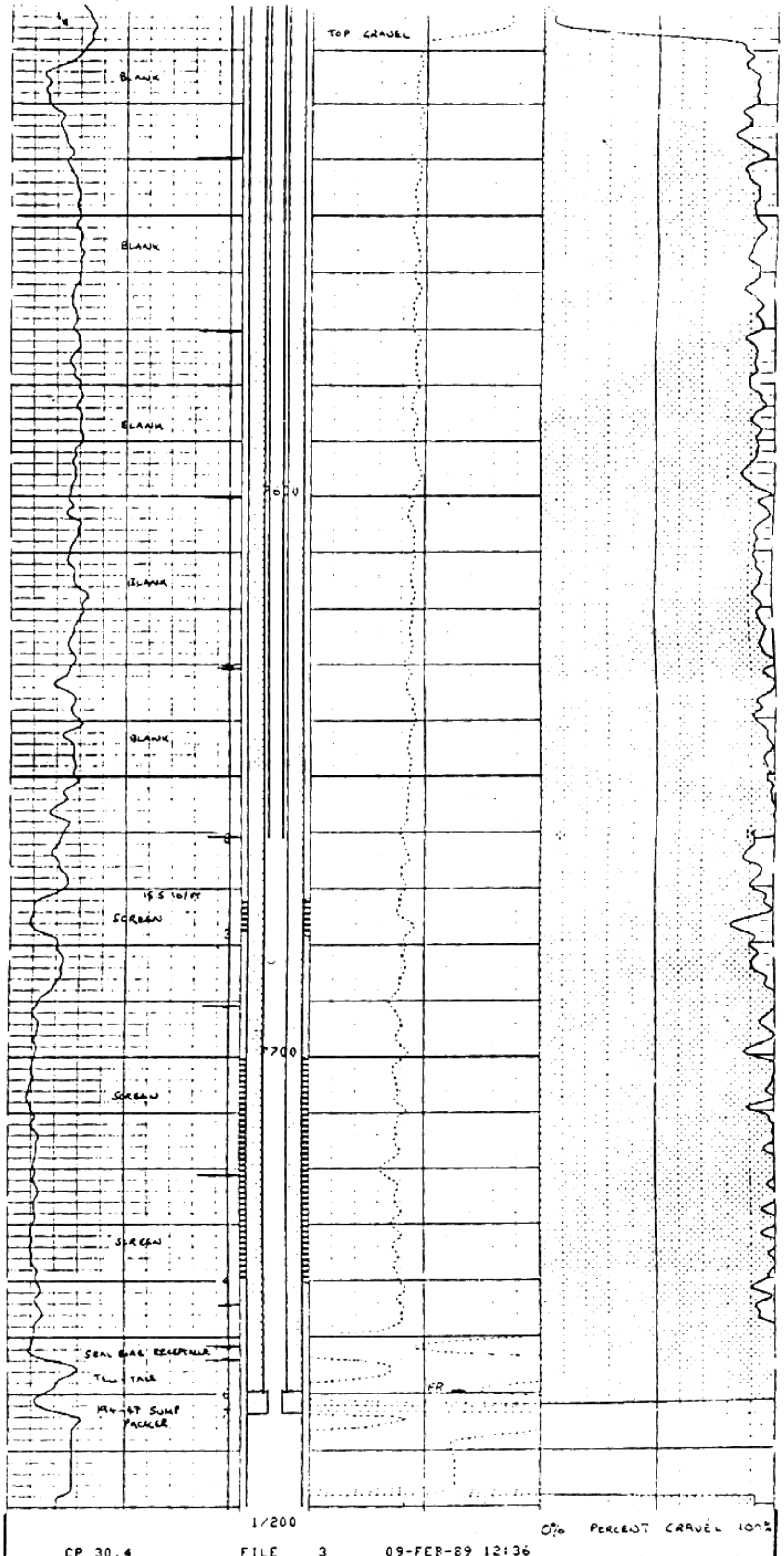


FIGURE 12

GRAVEL PACK LOG: DAY # 10

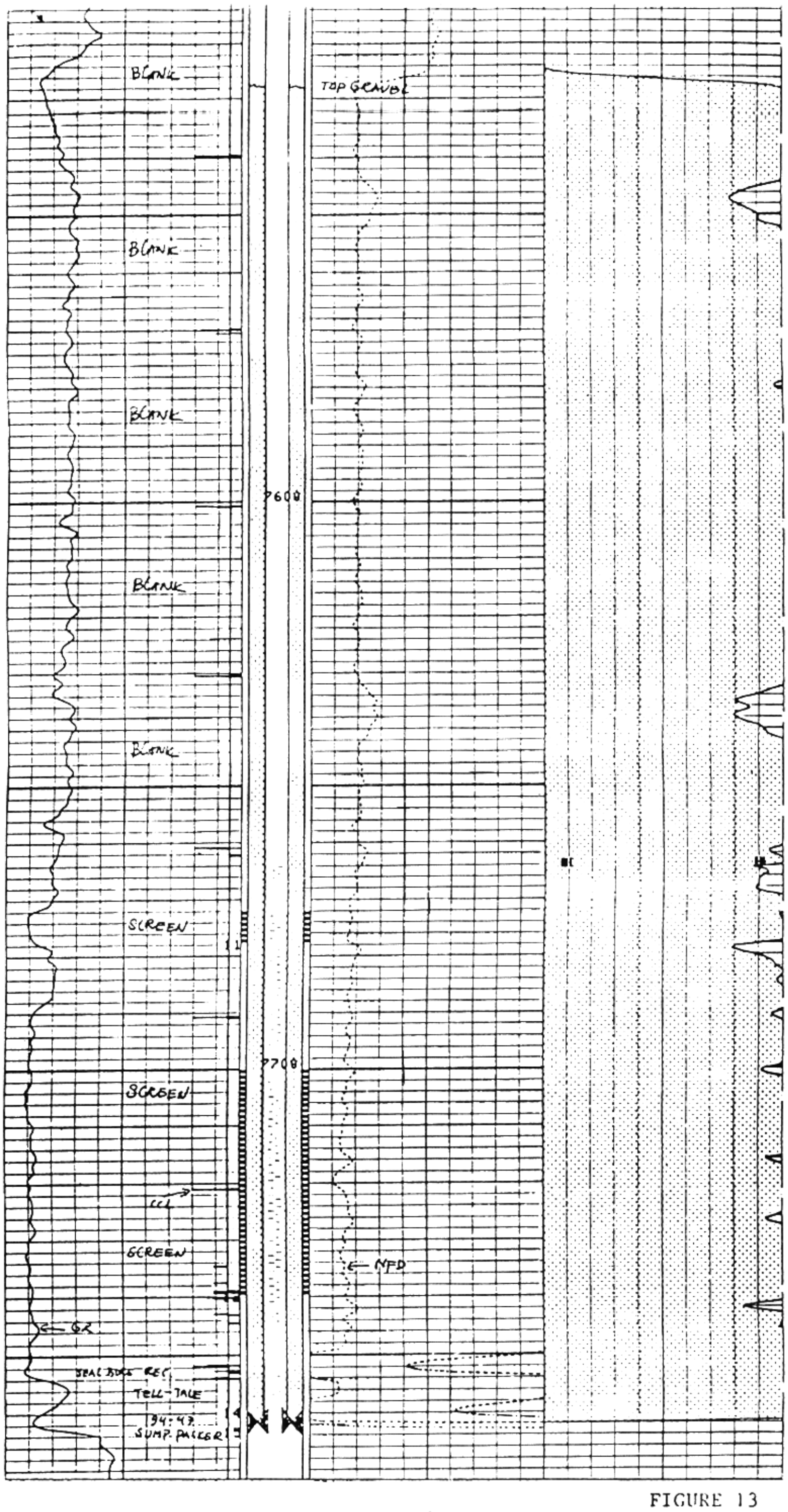
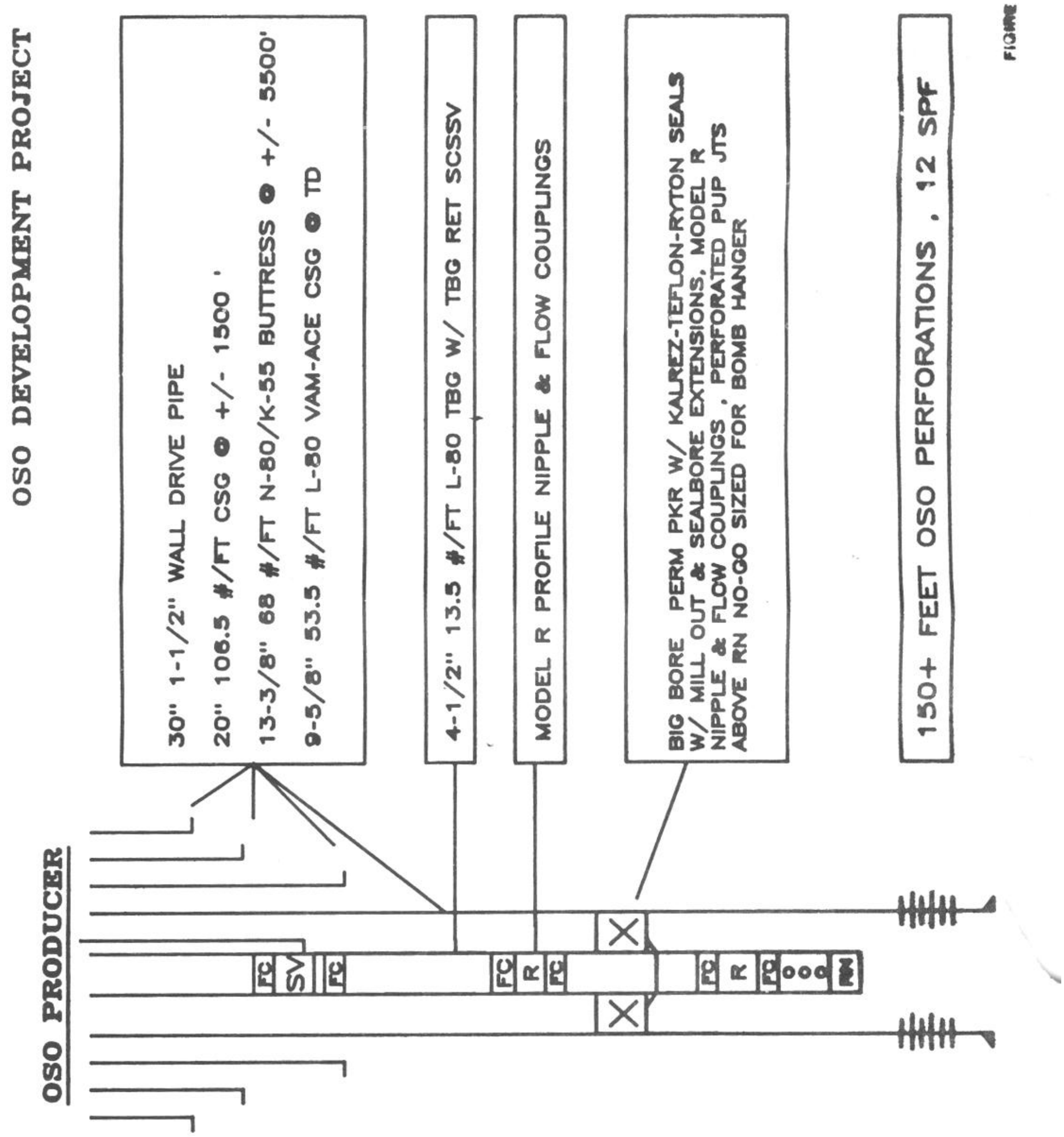
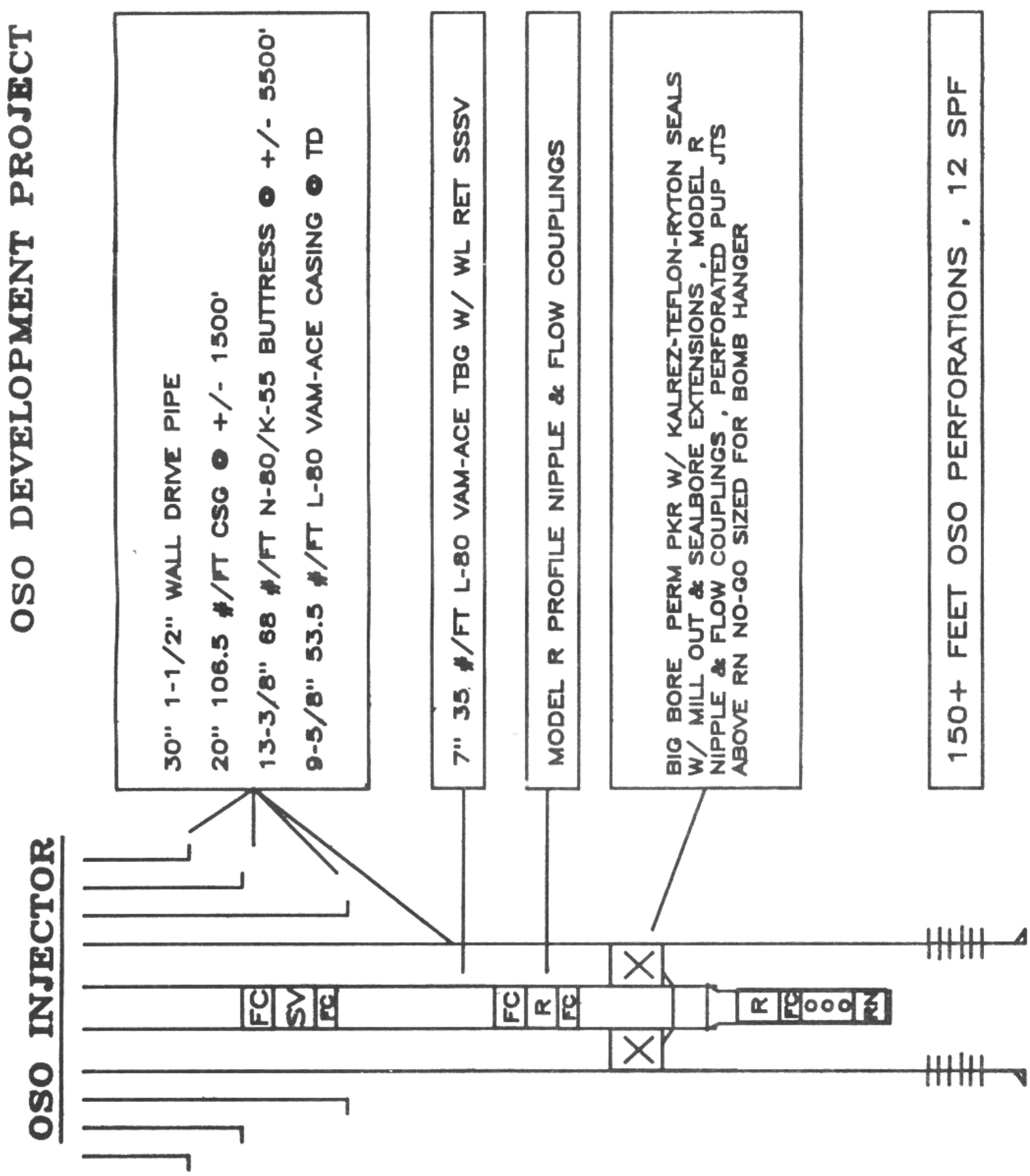


FIGURE 13


OSO DEVELOPMENT PROJECT
30" 1-1/2" WALL DRIVE PIPE
20" 106.5 #/FT CSG @ +/- 1500 '
13-3/8" 68 #/FT N-80/K-55 BUTTRESS @ +/- 5500'
9-5/8" 53.5 #/FT L-80 VAM-ACE CSG @ TD
4-1/2" 13.5 #/FT L-80 TBG W/ TBG RET SCSSV
MODEL R PROFILE NIPPLE & FLOW COUPLINGS
BIG BORE PERM PKR W/ KALREZ-TEFLON-RYTON SEALS W/ MILL OUT & SEALBORE EXTENSIONS, MODEL R NIPPLE & FLOW COUPLINGS , PERFORATED PUP JTS ABOVE RN NO-GO SIZED FOR BOMB HANGER
150+ FEET OSO PERFORATIONS , 12 SPF
OSO PRODUCER
FC
SV
FC
FC
R
FC
FC
R
FC
RN
FIGURE 14



FIGIRE 15

Uti Mark. "Improving Well Performance Using New Completion Techniques." *International Journal of Engineering and Science,* vol. 11, no. 12, 2021, pp. 32-47.