A/S NORSKE SHELL E&P

TANANGER

# PRODUCTION TEST PROGRAMME

# INTERNAL GRAVEL PACK COMPLETION

# WELL 31/2-13 (H)

# PART I: PERFORATING/ GRAVEL PACKING

RIG: BORGNY DOLPHIN

10.02.84

OPERATIONS ENG.

SENIOR OPERATIONS ENG.

pp

CHIEF PETR. ENGINEER

DRILLING SUPT.

for OPERATIONS SUPERINTENDENT

TECHNICAL MANAGER

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# 1. OBJECTIVES, TEST OUTLINE, WELL DATA

## 1.1 Objectives

a) To evaluate the impact of overlaying tight streaks on gas coning.

b) To evaluate gravel pack completion in a deviated well.

## 1.2 Test Outline

The oil bearing reservoir section will be tested in the interval 1801 - 1807 m AHBDF in loosely consolidated, highly porous sands. Accordingly, the zone will be perforated, backsurged and flowed at low rate (less than 300 bbl/day) to establish the well's P.I. before gravel packing. Following this short flow test a wire wrapped inner liner will be gravel packed across the interval, the production string installed and the well flow tested.

## 1.3 Sequence of Operations

1.3.1 RIH to bottom with bit, scraper, 6-1/4" DC's and HWDP on 5" drill pipe.

1.3.2 Displace the oil mud with seawater using spacer at interface.

1.3.3 POH and lay down 5" DP and stand back the DC's and HWDP.

1.3.4 RIH to bottom with bit, scrapers, stabs, DC's and HWDP on 3½" drill pipe.

1.3.5 Clean casing with casing wash and acid treatment.

1.3.6 Displace well to 1.15 SG $CaCl_2$ brine and filter brine in hole to a minimum solids level.

1.3.7 POH with 3½" DP and rack same.

1.3.8 Set Model "D" sump packer at 1811 m AHBDF

1.3.9 Run perforating string with hydraulic set packer on 5" tubing.

1.3.10 Perforate 1801 - 1807 m AHBDF with +/- 600 psi drawdown and backsurge 10 bbls fluid only.

1.3.11 Run surface readout pressure gauges and flow well (max rate 300 b/d).

1.3.12 Kill well and retrieve perforating string laying down the 5" tubing.

1.3.13 Run gravel pack assembly on 3½" drill pipe.

1.3.14 Carry out pre acidisation and gravel pack job.

1.3.15 Retrieve GP string and lay down 3½" DP.

1.3.16 Run production test string (5" tubing).

1.3.17 Open well up and produce clean.

1.3.18 Close in well and run gauges.

1.3.19 Carry out main flow test.

1.3.20 Close in well for build-up and retrieve the gauges.

1.3.21 Kill well and retrieve test string.

NOTE : This programme covers steps 1.3.1 through 1.3.15. The production test string and the flow test will be contained in Production Test Programme Part II.

## 1.4 General

The well has been deviated drilled to a Total Depth of 2010 m AHBDF (+/- 1728 m TVBDF). The angle through the reservoir is approximately 45 deg. Subsequently, the 9-5/8" casing will be set prior to starting the test preparation.

## 1.5 Well Data

### 1.5.1 Reservoir Data

| | | |
|---|---|---|
| Top reservoir (good sand) | : | 1733 m AHBDF (1527 m TVBDF) |
| Reservoir pressure | : | 2337 psia at 1803.5 m AHBDF (1578 m TV) |
| Estimated maximum CITHP with oil | : | +/- 525 psi |
| Hydrocarbon Gradient oil | : | 0.35 psi/ft |
| Reservoir Temperature | : | 156 deg F |

### 1.5.2 Completion Fluid

The completion fluid to be used will be clean Calcium Chloride ($CaCl_2$) brine.

Density: 1.15 SG (0.498 psi/ft) - giving +/- 150 psi overbalance on the oil zone when the riser is removed.

The reservoir was drilled with 1.25 SG clean oil mud and the 9-5/8" casing was set in same mud.

### 1.5.3 Perforation Interval

The following perforation interval has been selected:

1801 - 1807 m AHBDF (6 m)
(This corresponds to 1576 - 1580 m TVBDF)

### 1.5.4 Depth Reference

All depths quoted in this programme for packer setting and perforaing refer to the LDT/CNL/GR log, No. 3 of 07.02.84 made from the "Borgny Dolphin".

Drill floor - Mean Sealevel 25 m
Drill floor - Seabed 358 m

1.5.5 Gun Type

Baker tubing conveyed perforating guns will be run on bottom of the pre-test string. Gun specification: 6" Gravel Pack (Big hole), 12 spf, $60^{o}$ Scalloped, Standard RDX 4" charges for $250^{o}$ F.

1.5.6 Gauge Type

Surface read out gauge to be used in pre-flow will be SSDP.

## 2. PREPARATION

### General

### A. Cleanliness

The success of the gravel pack installation is totally dependent on the cleanliness of all the fluids pumped in the hole, and the cleanliness of all the equipment run in the hole. Great care should be taken to achieve the maximum cleanliness possible. Two specific items of concern are as follows:

i) Ensure ALL relevant circulating lines are cleaned of mud, using seawater. This includes choke and kill lines, and all lines which may be used in the brine circulation system. This should be carried out whilst circulating the well clean and before running the gravel pack completion.

ii) DO NOT USE EXCESSIVE D.P. DOPE. - Dope pins only using a small paint brush and wipe off excess dope squeezed out of the connection.

### B. Safety

i) All operations involving tripping with small bore pipe (3½", 2-7/8", etc) should be treated with a maximum of care. Hole fillup volumes are to be calculated and checked and the tallies recorded in a neat format.

ii) If evidence of swabbing is noted during tripping, install an inside BOP on the DP immediately to maintain control over the DP should it come live. Whilst the annulus remains stable, run in hole as deep as possible before shutting in the well and circulating out the influx. If the annulus starts to flow, install kelly, close in well, and circulate/ control well at that depth.

Before starting on point 2.1 below, the well will have been drilled to 2010 m AHBDF, logged and 9-5/8" casing set.

2.1 Run 8½" bit (no nozzles) 9-5/8" casing scraper, 9 x 6½" DC's, and 4 stands 5" heviwate DP on 5" DP and tag the 9-5/8" float collar.

2.2 With the bit just above the float collar displace the oil base mud with seawater using a 80 bbls "SPACER 3001" clean out sweep at interface.

NOTE : i) Displace by pumping spacer and seawater down annulus and return up work string as this will minimize fluid contamination.

ii) Displacement rate +/- 6 BPM.

iii) Composition of "SPACER 3001" per bbl.

- 1.15 SG density
- 39.5 gal freshwater
- 15.7 lbs D115.

- 54.2 lbs Barite
- 1.0 gal F 40 (surfactant).
- (D 47 antifoam may be required).

iv) All the oil base mud will be pumped onboard a supply boat and sent back to CCB.

v) 700 bbls (2 tanks) chalk mud 1.15 SG will be made up and kept as kill mud throughout the test. (See Appendix 6 for recipe).

2.3 Having displaced the well to seawater, then circulate straight at least two hole volumes with seawater, before POH with the string laying down the 5" DP and standing back the BHA.

2.4 RIH with 8½" bit (no nozzles), 9-5/8" casing scrapers, stablizers, 9 x 6½" DC's, and 4 stands 5" HWDP on 3½" plastic coated DP and tag the 9-5/8" float collar. Circulate one hole volume with seawater before pumping the following fluids to clean the casing:

a) 50 bbls chemical wash "CW 7.1" consisting of per bbl:

- 41.0 gal freshwater
- 0.5 gal D122
- 0.50 gal F 40 (F 40 is added last and just before pumping).

b) Circulate one hole volume of seawater.

c) 2000 gals of 7½ % HCl acid containing:

- 0.5 % (by volume) A 200 (inhibitor)
- 0.5 % (by volume) F 40 (surfactant)
  (The chemical aids in oil removal and leaves the casing water wet).

d) 50 bbls seawater.

e) 50 bbls viscous seawater.

NOTE : i) Discard returns of fluids pumped in b), c), d) and e) above. The chemical wash in a) can be kept and re-used if necessary.

ii) The 3½" DP, HWDP and DC's are required later in the gravel packing operation and are run in this trip to be cleaned.

Continue circulating with seawater using rig pumps until the solids level in returned seawater has reached an irreducible minimum concentration as measured by the coulter counter. Samples for coulter counter to be taken at the gumbo box and the seawater returns dumped in the sea. Pumping rate should be as high as practically possible.

2.5 When the solids level in the seawater is at a minimum, displace the seawater with 1.15 SG (0.498 psi/ft) $CaCl_2$ clean brine using the Dowell pump (use a 20 bbls gelled seawater spacer). Having displaced the hole to brine, circulate the brine in the hole via the filters until the solids level has reached an irreducible minimum concentration as measured by the coulter counter.

2.6 POH with the displacement string racking same in the derrick.

2.7 Rig up Schlumberger and run CBL/VDL/CCL/GR log (with maximum thermometer) from the top of the 9-5/8" float collar to 1000 m AHBDF or 100 m above top of cement which ever is lower. POH.

NOTE : Note down the depth of the radioactive tag in the 9-5/8" casing.

2.8 Run gauge ring (OD = 8.30")/ junk basket and tag the float collar. Set Baker Model 'D' size 194 - 47 packer (max OD = 8.124") at 1811 m (top packer 4 m below lowermost perforations according to reference log). POH and rig down Schlumberger.

2.9 Make up 1 stand of 3½" drill pipe, fluted hanger, slick joint, SSTT. At this stage connect hydraulic hoses and test unlatching/ latching feature. Blank off injection and control line ports and run 4½", 19.2 lbs/ft, C-75, PH-6 tubing riser including lubricator valve (+/- 30 m BDF) with blanked off control line ports. Run in and land fluted hanger on wearbushing. Space out so that top of tubing riser is +/- 4 meters above rig floor. Close/ open 5" pipe rams. Pull out and stand 4½" riser back in derrick, including SSTT. Check for ram-impressions on slick joint. See fig. 4 for SSTT space out.

2.10 Make up the flowhead on one single of 4½" PH-6 tubing joint and lay down same on piperack.

## 3. PERFORATING AND BACKSURGING USING TUBING CONVEYED GUNS

NOTE : The complete string is shown in figure 1.

3.1 Make up guns and associated equipment as below:

a) Gun w/ firing head, 6" Big Hole, 12 spf (6 m)
b) Pup joints, 2-3/8" EUE (40 feet)
c) Mechanical Tubing Release, Size 2-3/8" EUE, 1.880" ID
d) Pup joint, 2-3/8" EUE, (10 feet)
e) Ported Sub w/ compensated glass disc, 2-3/8" EUE
f) X-over, 2-3/8" EUE (P) x 2-7/8" EUE (B)
g) Perforated pipe, 2-7/8" VAM (B) x 2-7/8" EUE (P) (10 feet)
h) Pup joint, 2-7/8" VAM (6 feet)
i) "RN" nipple, 2-7/8" VAM
j) Pup joint, 2-7/8" VAM (10 feet)
k) X-over, 2-7/8" VAM (P) x 3½" EUE (B)
l) Pup joint, 3½" EUE (8 feet)
m) Baker "FH" hydraulic set packer, 3½" EUE, size 514A, 3" ID
n) Pup joint, 3½" EUE (8 feet)
o) X-over, 3½" EUE (P) x 3½" IF (B)
p) Dowell SSARV, 3½" IF
q) X-over, 3½" IF (P) x 3½" CS (B)
r) Pup joint, 3½" CS
s) "XN" nipple, 3½" CS
t) Pup joint, 3½" CS
u) Otis XA SSD, 3½" CS
v) Pup joint, 3½" CS
w) X-over, 3½" CS (P) x 5" VAM (B) w/ radioactive clamp on
x) Tubing joint, 5" VAM

NOTE : i) Item o) to x) will be made up, pressure tested to 3000 psi/ 15 min and stood back in the derrick before picking up the guns.

ii) The Sliding Side Door (SSD) will be run in closed position.

iii) The ported sub with compensated glass disc and perforated pipe will allow the string to fill with brine while running the string in the hole.

iv) Value of release shear ring in the "FH" packer is 50.000 lbs.

v) The SSARV (Single Shot Annulus Reversing Valve) will open with approx. 2500 psi on annulus at surface.

3.2 Run 5" tubing in the interval between the top of the sub assemblies and the wellhead.

NOTE : i) The 5" tubing will be picked up while RIH.

ii) The 5" tubing has been blasted clean.

3.3 Rig up wireline and set a 3½" test tool in the 'XN' nipple below the SSD. Pressure test the tubing string to 3000 psi/ 15 min. Retrieve the test tool and rig down the W/L.

3.4 Install the hang off tool complete with crossovers to 5" VAM pin down and 3½" IF box up, on the top of the 5" tubing, such that when the hanger is landed in the wellhead, the gun depth will be +/- 5 m higher than required to avoid accidentally stabbing the gun into the sump packer.

Run in the 5" tubing and hang off tool on 3½" DP and land the hanger in the wearbushing.

3.5 Rig up Schlumberger and run a "slim hole" GR/CCL (1-11/16") correlation log inside the 3½" tubing. Locate the radioactive clamp installed on the X-over above the SSD, and correlate log for correct positioning of the gun. Correlate the log with the LDT/CNT reference log or the radioactive marker installed in the 9-5/8" casing.

3.6 POH with the 3½" DP to the hang off tool. Install fluted hanger and space out with required 5" tubing pup joints to position the guns exactly on depth (1801 - 1807 m MD).

3.7 When the guns are correctly spaced out, RIH with the guns and fluted hanger on the pre made up 4½" tubing riser with the slick joint and SSTT and lubricator valve installed and land the fluted hanger into the wearbushing. Top of the tubing riser should be +/- 5 m above rig floor.

3.8 Rig up Schlumberger and re-run the GR/CCL correlation log for a final depth check.

3.9 Install the circulating sub and circulate to clean any possible fill on top of the glass disc in the ported sub.

3.10 Pull back one joint and hang off string in rotary table. Pick up flowhead and 4½" tubing joint. Install 50 ft x 2½" wire slings between bails and flowhead elevators. Install chicksan lines to flow and kill sides on flowhead. Connect assembly to upfacing tubing connection in rotary table. Land fluted hanger into wearbushing. Connect the kill line to the Dowell unit.

3.11 Rig up wireline lubricator and test same to 3000 psi. RIH with wireline and install a 3½" test tool in the "XN" nipple below the SSD. Pressure test the tubing string to 3000 psi/ 15 min. Retrieve the test tool.

3.12 RIH with test tool and set same in the 'RN' (1.937") nipple.

3.13 Set the Baker "FH" hydraulic packer by pressuring up slowly on the tubing with brine in 500 psi increments, holding each increment for 1 minute. The "FH" packer will set at approximately 1000 psi. Continue pressuring up to 3000 psi and hold pressure for 15 minutes to pressure test the complete tubing string. Release pressure.

3.14 Close lower 5" pipe ram and pressure test annulus to 500 psi to check that the "FH" packer has set. Open the rams.

NOTE : The SSARV will open with approximately 2500 psi at surface.

3.15 Retrieve the test tool in the "RN" nipple. Pressure test tubing and sump below the "FH" packer to 1000 psi.

3.16 Connect flowline chicksans to the sandfilter and then to the 6" flowline, flush lines above closed automatic mastergate and pressure test to 3000 psi/ 15 min. against choke manifold.

3.17 RIH with shifting tool and open the 3½" XA-SSD. POH and close the swab valve on the flowhead.

3.18 Displace the brine in the tubing with diesel to within 1 bbls of the 3½" XA-SSD.

NOTE : This will give approximately 600 psi drawdown on the formation while perforating. Reservoir pressure at 1803.5 m AHBDF MD (1578 m TVBDF) from RFT is 2337 psia.

3.19 RIH with shifting tool and close the 3½" XA-SSD. Bleed off the pressure on the tubing through the separator to ensure that the SSD is closed.

3.20 Close middle 5" pipe rams around slick joint and pressure test annulus to 500 psi/ 10 min down kill line. Bleed pressure down to 200 psi (just to give a gauge reading). Keep the lower 5" pipe rams closed throughout the perforating and subsequent clean up of the well and observe the annulus pressure via the kill line.

3.21 With the swab valve closed, install the detonating bar connected to the slick wireline, in the lubricator. Connect lubricator to the BOP, and pressure test lubricator to 3000 psi.

NOTE : i) The wireline assembly will consist of from bottom:

- detonating bar w/ rollers (1.25" OD)
- fishing tool (running tool) (1.5" OD)
- wireline jar (1.50" OD)
- 12 feet stem (1.50" OD)

The length of this assembly should be such that the top of the assembly is below the ported sub when firing the gun.

ii) At this stage the SSTT, lubricator valve, master valve, swab valve, flow valve should be open. The flowline should be open all the way to the gauge tank bypassing the separator.

3.22 Open the swab valve and RIH with the detonating bar on wireline and fire the gun.

3.23 Backsurge well through open choke flowing to the gauge tank. Allow 10 bbls of unchoked flow.

3.24 After the 10 bbls flow, switch flow through 4/64" choke and bypass the separator to the tank (max rate 300 b/d to avoid sand run in).

3.25 Flow the well through the separator for minimum 30 minutes or until diesel and sand free. Flow rate should not exceed 300 bbls/day.

3.26 While cleaning up the well, pull the wireline assembly back into the lubricator and close the swab valve.

3.27 When flowing clean oil at surface, RIH with pressure gauges with surface read-out to the "RN" nipple.

3.28 Flow well on 4/64" choke through the separator until a steady bottom hole flowing pressure and flow rate are observed. Flow rate should not exceed 300 b/d.

3.29 Close in well and record build up. Retrieve pressure gauge.

3.30 Bullhead oil back with a viscous chalk pill (30 bbl) followed by 1.15 SG brine. (See appendix 6 for recipe).

3.31 Pressure up annulus to 2500 psi (two cycles) to open the SSARV (Single Shot Annulus Reversing Valve) and reverse circulate the well dead with 1.15 SG brine. Observe well dead for 30 mins.

3.32 Unseat the packer with 50,000 lbs overpull and circulate normally and condition well with 1.15 SG brine. Observe well dead.

NOTE : i) 50,000 lbs is required to shear the shear ring in the "FH" packer.

ii) If the well is taking fluid spot a 25 bbls viscous brine pill containing calcium carbonate across the perforations.

3.33 Rig down surface equipment and pull the tubing string. Stand back the 4½" tubing riser in the derrick and lay down the 5" tubing. Both the 4½" tubing and the 5" tubing will be used in the main production string.

3.34 Rig up Schlumberger and run CCL/GR (3-3/8" OD) through the model "D" sump packer to ensure it is open and tag possible fill on top of the float collar. Record hold up depth (HUD). POH and rig down Schlumberger.

NOTE : Exercise extreme care while running the tool through the "D" packer.

4. INSTALLATION OF GRAVEL PACK ASSEMBLY (See Fig. 2)

4.1 Make up 3 joints of 5½" LTC blank pipe (with weld-on centralizers on) in the rotary table. Pick up and run through the 3 joints of 5½" blank pipe the following wash pipe, from bottom up: -

a) Wash pipe 2-3/8" VAM - as required
b) Cross-over 2-3/8" VAM pin x 2-3/8" EU 8RD box
c) Lower indicating collet 2-3/8" EU 8RD pin x box
d) Pup joint 2-3/8" EU 8RD pin x box (6' long)
e) Middle indicating collet 2-3/8" EU 8RD pin x box
f) Pup joint 2-3/8" EU 8RD pin x box (3' long)
g) Spacer pup 2-3/8" EU 8RD pin x box (for handling).

Item b, c, d, e and f are already preassembled. Clamp off the 2-3/8" EU 8RD spacer pup onto the top joint of blank pipe.

4.2 Pick up the 3 joints of 5½" blank pipe with the 2-3/8" tubing clamped to the top joint of blank pipe and stand back this assembly in the derrick.

4.3 Pick up the Gravel Pack (GP) screen assembly and hang off in the rotary table. The assembly consists of, from bottom up: -

a) 190-47 Baker Model - B indicating seal assy w/ 5½" STC box by full muleshoe kick over guide for 4-3/4" seal bore.
b) Bakerweld screen, 5½" LTC pin x box 1.88 m long (tell-tale with weld-on centralizers)
c) GP O-ring seal sub, 5½" LTC pin x box, 2-3/8" bore.
d) Bakerweld screens 5½" LTC pin x box (+/- 9 m length).

NOTE: i) The screens should be steam cleaned on the drill floor before being run in the hole.

4.4 Install the "slick" wash pipe assembly into the GP assembly and locate it into the seal bore.

The slick wash pipe assembly will consist of from bottom up:-

a) Polished stinger 2-3/8" OD with turned down locator and 2 3/8" Vam box. (Stinger is 4' 8" long)
b) Wash pipes, 2-3/8" VAM pin x box where the collars are tapered to ensure easy passage through the flapper valve.
c) Wash pipe pup joint 2-3/8" VAM pin x box.(For handling).

4.5 With the wash pipe protruding from the screen assembly take the 5½" Reverse Flapper valve LTC pin x box and stab it over the wash pipe. Make up the flapper valve onto the top of the upper screen.

NOTE: The flapper valve and its seal are made from "MICARTA" a special material designed to shatter on impact. Therefore the utmost care should be exercised when making pipe movements of the 2-3/8" wash pipe through this valve so as not to prematurely shatter the flapper valve or its seat and thus make it redundant.

4.6 Pick up the three joints of blank pipe with indicating collets and wash pipe made up and stood back and position just above GP assembly. Make

up the 2-3/8" VAM wash pipe pin protruding from the blank pipe onto the 2-3/8" VAM wash pipe box inside the GP assembly.

4.7 Whilst holding the blank pipe in the elevator lift up the 2-3/8" wash pipe, with an air winch, so that the 2-3/8" EU 8RD spacer pup can be removed. With the pup joint removed clamp the 2-3/8" EU 8RD wash pipe to the top joint of blank pipe.

4.8 Lower the 3 joints of 5½" blank pipe, together with the 2-3/8" wash pipe, and make up the blank pipe onto the top of the GP assembly. Lower the complete assembly and set the 5½" blank pipe with slips in the rotary table.

NOTE: Ensure that the polished stinger is correctly spaced in the GP seal bore receptacle above the lower tell tale screen.

4.9 Pick up the following preassembled Baker GP assembly:

a) Model "SC-1" gravel pack packer (OD = 8.440")
b) Model "S" gravel pack extension with sliding sleeve (extra long stroke).
c) Crossover sub - 6-5/8" box x 5½" pin
d) Indicating coupling 5½" LTC box x box
e) X-over 5½" LTC pin x pin.
f) Model GP shear-out safety sub 5½" LTC pin x box

Preassembled and connected also will be:

a) Model "SC" setting tool (3½" IF box up)
b) Model "SC" crossover seal assembly
c) Pup joint 2-7/8" EU 8RD (4 ft long)
d) Model "S-1" shifting tool (extra long stroke)
e) Pup joints 2-3/8" EU 8RD
f) Upper indicating collet 2-3/8" EU 8RD pin x box

4.10 Connect the 2-3/8" EU 8RD box wash pipe sticking out from the 5½" blank pipe to the 2-3/8" EU 8RD pin protruding from the "SC-1" packer assembly and remove the clamp from the 2-3/8" wash pipe. Connect the "SC-1" packer assembly to the top joint of blank pipe.

NOTE: i) See Note to steps 4.5 and 4.8 above.

ii) Check and note the free hanging weight of the entire assembly.

4.11 RIH with the complete GP assembly, using 9 x 6½" DC's, 4 stands of HWDP and 3½" DP as the running string.

NOTE: i) The same collars, HWDP and DP should be used which were cleaned during the preparation phase.

ii) Running speed - 60 seconds per stand.

iii) Set slips slowly and avoid jarring the assembly to prevent shearing of the shear out safety joint.

iv) DO NOT USE EXCESSIVE DP DOPE! - dope pins only using a small paint brush and wipe off excess dope squeezed out of the

connection. This is of the utmost importance in ensuring a successful gravel pack.

4.12 Complete RIH with gravel pack assembly to +/- 10 m above the sump packer. Open heave-compensator and record up and down weight. Locate the sump packer and set down approx. 5000 lbs to force the multiacting collect through the packer. Set down on packer with landing shoulder with approx. 20,000 lbs and note depth. Pick up +/- 1 m and notice overpull (+/- 10,000 lbs) when collet snaps out of packer. Check free hanging weight. Space out drill pipe to give +/- 4 m overstand on derrick floor. Re-land string.

4.13 Install Kelly Cock and circulating head on top of drill pipe. Hook up Dowell lines and pressure test same to 3000 psi. Circulate with brine one string volume.

4.14 Drop the 1-7/16" kirksite packer setting ball. When packer setting ball is estimated to have landed pressure up on drill pipe slowly with brine in 500 psi increments, holding each increment for 1 minute. The "SC-1", GP packer will set at approximately 1500 psi. Continue pressuring up to shear ball seat and blow ball out at approximately 2500 psi.

NOTE : <u>If packer does not set, circulate one complete hole volume to clean the annulus for any viscous pill before slowly POH.</u>

4.15 Pull 20,000 lbs over whole string weight to check packer set and then slack off (use heave compensator). With drill pipe circulating valve on top of the 3½" DP open, and upper annular closed, pressurise annulus to 500 psi down kill line to check packer element sealing. Open upper annular.

4.16 Using heave compensator, slack down to neutral point at packer. Rotate DP, with chain tong, 10-12 turns to the right at the packer to back out with the crossover tool.

4.17 When the crossover tool comes free, set back down on packer with 30,000 lbs weight to ensure location of squeeze position, with the left hand running thread of the setting tool located on the top of the packer. Mark the pipe - this mark will be referred to as mark (1) for the squeeze position.

4.18 Pick up approximately 1 m at the packer and set back down with the upper indicator collet on the indicating coupling, using sufficient weight (10,000 lbs) to ensure definite location of the coupling. Mark the pipe - this mark will be referred to as mark (2) for circulating through the tell-tale screen.

4.19 Pick up a further 2 m at the packer and set down with the middle indicator collet on the indicating coupling using sufficient weight (10,000 lbs) to ensure definite location of the coupling. Mark the pipe - this mark will be referred to as mark (3) for circulating through the production screen.

4.20 Pick up a further +/- 3 m at the packer and set back down with the lower indicator collet on the indicating coupling using sufficient weight (10,000 lbs) to ensure definite location of the coupling. Mark

the pipe - this mark will be referred to as mark (4) for reverse circulating above the packer.

NOTE: The above pipe manipulations should be carried out as smoothly as possible so as not to prematurely shatter the reverse flapper valve assembly by the 2-3/8" wash pipe hanging up or jarring it. When locating the reverse circulating position do not pull up so far as to pull the polished stinger out of the reverse flapper; - total pipe movement from position (1) to position (4) is +/- 6 m.

4.21 Slack off weight to push upper, middle and lower indicator collets through the indicating coupling (approximately 15,000 to 20,000 lbs will be required) and re-stab work string stinger into GP lower seal bore. When mark (1) has been definitely re-located, pick up and locate mark (2). Set 10,000 lbs weight on indicating coupling/ indicator collet to ensure definite location of the position for circulating through the tell-tail screen.

At this stage the string is in position to commence the preacidization and gravel packing operations and the following points are to be noted: -

a) Following four work string positions have been established:

Position (1): Squeeze to formation.
Position (2): Circulating through tell-tale screen, Gravel Pack position.
Position (3): Circulating through production screen (low density pack).
Position (4): Reverse circulating above packer.

b) It is essential that marks (1), (2), (3) and (4) are unambiguous, hence they should be painted on the DP at mid heave with simultaneous reading of the derrick floor tide indicator recorded.

c) When relocating marks (2), (3) and (4) it must be remembered that the particular indicator collet has to be pulled up past the indicating coupling to meet it going down.

d) All lines must be arranged so that all operations can be performed via the Dowell manifold without shutting down for repositioning.

e) Sufficient chicksans must be available to the drill pipe circulating valve to accommodate the necessary pipe movements (+/- 6m)

f) All piping, chicksans, hoses, tanks, pumps etc. assosiated with the GP operation must be clean.

g) All piping for reversing out excess gravel, must be rigged up before the start of the gravel packing job, so that gravel can be collected in the sand trap.

h) Make sure that annular preventer operating pressure is sufficient to close around 3½" DP.

## 5. GRAVEL PACKING (SLURRY PACK)

NOTE: Take care not to fracture formation. Expected fracture gradient is 1.57 SG (.680 psi/ft), giving a maximum allowable bottom hole pressure of +/- 3520 psi at 1576 m TVD (top perforations) or 3320 psi with 200 psi safety margin. Maximum allowable surface pressure with 1.15 SG brine in the tubing is thus +/- 750 psi with safety margin.

5.1 With the work string in position (2), establish circulation with brine through the tell-tale screen and the 2-3/8" wash pipe, to a maximum of 2 BPM, or a maximum of 750 psi, whichever occurs first. Monitor returns closely for losses and plot surface pressures versus pump rates.

5.2 Mix acid in acid tanks as follows: -

50 bbls of 15 % HCL containing (density of acid 1.075 SG).

0.5 bbl A200 inhibitor (1 % by volume already in the acid)
5.0 bbl U66 mutual solvent (10 % by volume)
150 lbs L41 iron sequestering agent (3 lb per bbl of acid).

5.3 Mix breaker and gravel into previously gelled fluid in paddle mixer as follows - (see Figs. 2.0 and 2.1 for fluid formulations and specifications).

a) 20 bbls "water pack" 1.15 SG (.498 psi/ft).

b) 16 bbls "water pack" slurry containing 15 lbs/gallon fluid of Baker "Low Fines", 12-20 mesh gravel. The slurry density will be 1.75 SG (0.758 psi/ft).

NOTE : i) The breaker should be added approximately 5 minutes before the fluids are pumped down hole.

5.4 Carry out the pre-gravel pack 50 bbl acidisation. Circulate the acid mixed in step 5.2 through the work string (+/- 40 bbls) and to the tell-tale screen. Continue pumping at maximum rate (max surface pressure 900 psi with acid in the string) until +/- 5 bbls of acid have been circulated past the lowermost perforated section (total 50 bbls acid pumped). At this point, stop pumping, change to position (1) (squeeze position) and soak the acid for 30 minutes. Pull back to position (2) (gravel packing position) and continue immediately with the gravel pack (step 5.5).

NOTE : The HCl acid, brine spacer and the "water pack" fluids should be pumped in a continuous phase, therefore arrange the mixing of fluids storage, manifolds etc. accordingly.

5.5 With the work string in position (2), close the annular preventer around the 3½" DP, taking returns over fully open choke and carry out the gravel pack, pumping the following fluids in a continous operation, as follows:

a) Pump 5 bbls 1.15 SG $CaCl_2$ brine spacer.

b) Pump 15 bbls "water pack" pre pad 1.15 SG (item 5.3 a).

c) Start pumping the 16 bbls "water pack" slurry (item 5.3 b). At this stage choke the returns to give approximately 200 psi back pressure at the choke.

d) Pump the 5 bbls post pad 1.15 SG.

e) Displace the slurry with brine (1.15 SG) at max surface pressure of 750 psi. After pumping 4 bbls of brine, the pre-pad should arrive at the crossover tool and the pumping rate should be reduced to approximately 2 BPM. After displacing a further 21 bbls the gravel slurry should completely cover the screen and a pressure rise should be noted at surface - do not exceed 750 psi.

f) Open the annular preventer.

g) Slack off work string down to mark (1), the squeezing position. Reduce pump rate to maintain surface pressure below 750 psi as long as possible but ultimately let pump pressure increase to 1500 psi for the final squeeze (final screen out).

h) Close annular preventer and pressurise the annulus to 500 psi to prevent excess gravel from falling into the annulus while picking up to position (4).

i) Pick up the work string to position (4), the reverse circulating position, and reverse out excess gravel/ fines from above the SC-1 packer.

NOTE : The amount of gravel/fines returned should be measured as accurately as possible therefore returns should be switched to a holding tank (i.e. gumbo box) when gravel/fines reach surface. Add breaker to the returned slurry to allow for quick setting out of gravel/fines and quantify the amount returned. Before adding breaker take a sample of the slurry and place it in a hot water bath to get an idea of the breaking time.

5.6 Having finished the pack and reverse circulated all the gravel out, wait with the work string still in the hole, until the breaker has broken down the gel supporting the gravel slurry. When the slurry is broken, position the string in position (3) and attempt to circulate clean brine through the production screen to check the pack, up to a maximum pressure of 750 psi. If free circulation is possible, a Low Density gravel pack top up will be carried out as outlined in Appendix 12.

When circulation is not possible, a successful pack will have been accomplished, in this case proceed to step 5.7.

5.7 Open annular preventer, then pull out with SC crossover/setting tool and 2-3/8" wash pipe until the polished stinger is out of the flapper valve.

NOTE: Exercise extreme care when pulling back so as to not cause the 2-3/8" wash pipe to prematurely shatter the reverse flapper valve assembly. When the wash pipe is above the valve and it is judged to have closed and sealed monitor the hole static for 30 mins. If continual severe losses are

observed, indicating that the flapper valve has malfunctioned, spot 50 bbls of viscous brine (200 sec MF) made using brine and HEC to stabilize the well and advise Base where upon a revised programme will be issued. (This spotting fluid should be mixed up prior to gravel packing).

5.8 With the well observed static for 30 mins. and the reverse flapper valve functioning pull back until the crossover port in the crossover tool is +/- 50 m above the SC-1 packer. Circulate well clean.

NOTE : The surface pumping pressure when circulating clean is to be such that the differential pressure across the reverse flapper valve is kept below 750 psi, to prevent its premature rupturing.

5.9 Continue out of the hole and lay down the 3½" drill pipe and the GP running tool and stinger.

NOTE : From this period until the complete test string is run and landed the well SHALL BE CONTINUOUSLY observed for losses. The hole is to be kept full with brine and a record is to be made of the amount and rate of losses, if any. If losses are observed inform Base immediately.

APPENDIX 1

## PREPARATION OF TUBING

1. Offload and rack tubing, separating each layer with at least three evenly spaced wooden strips.

2. Number and measure each joint. WSPE and Production Test Supervisor to make separate tubing tallies.

3. Remove pin and box protectors, inspect threads for damage, clean with solvent, and if possible, with steam.

4. Brush each joint to remove scale and loose solids: if any joint has excessive scale it should be rejected. (All tubing has been sand blasted clean on shore).

5. Drift each joint with appropriate 42" long tubing drift. All drifts should be fitted with a fishing neck.

6. Reclean pins and boxes and replace protectors. (N.B. Protectors should also be clean and only lightly doped).

7. Check that there are a reasonable number of pup joints for spacing.

8. Inform shore of any further tubing requirements.

9. Return any unsatisfactory joints.

## PREPARATION OF TUBING SUB-ASSEMBLIES/GP EQUIPMENT

1. Physically check all tubing and GP accessories and inspect and clean threads with solvent.

2. Ensure that spares of each item are available on the rig.

3. Function test all equipment (sliding sleeves, nipples, etc.)

4. Make up tubing sub-assemblies.

5. Run wireline drift through each sub-assembly paying particular attention to polished sections as these can easily be squeezed in make up. N.B. Separate drift runs should be made down to and through No-Go nipples.

6. Carry out API pressure test on each sub-assembly to 3,000 psi (to be witnessed by WSPE, TP and Production Test Supervisor).

   NOTE: Items 2 through 6 only when not carried out on-shore and witnessed by PTS.

7. Accurately measure each tubing sub-assembly and GP equipment item and note the position of all accessories.

8. Replace protectors on each end of the tubing sub-assemblies and GP items.

9. Examine sub-assemblies for tong damage. If excessive, a new sub-assembly should be made up as above.

10. TP and WSPE to carry out final dimensions check.

## PRESSURE TESTING SURFACE LINES AND EQUIPMENT

Before the well is flow tested (preferably prior to installation of the string) the following equipment will have been function/pressure tested on the deck as follows:

### Flowhead

Install a single joint of 4½" PH-6 tubing on the lower end of the flowhead. All inlet/outlet connections are to be blanked off with testsubs. Pressure test body with all valves open.

Close wingvalves and swabvalve. Open downstream of the valves to atmosphere. Pressure test. Close the mastergate and pressure test the valve from below. Close the swabvalve and pressure test from above. Drift the vertical bore of the tree/joint with a 2.797" OD drift. All the pressure tests to be 5000 psi/15 mins.

### EZ Tree

Install a 4½" PH-6 pupjoint and the lubricator valve on the upper end of the EZ tree and the slick joint, fluted hanger and X-over to 5" VAM on the lower end of the EZ tree. With testsubs installed pressure test the body to 5000 psi.

Check the non-return valve in the chemical injection line as follows: Bleed off the body pressure from 5000 to 4500 psi and re-pressure to 5000 psi through the chemical injection hose. Bleed-off the injection line and observe for returns. Close the ball valve and pressurize from below with the upper tree section open to atmosphere.

Test latching/unlatching with the EZ tree assembly in the rotary table prior to running it in the hole. Drift assembly with a 2.797" OD drift.

### Lubricator Valve

Install X-overs on lubricator valve to 4½" PH6 box (up) and 4½" PH6 pin (down). Install 4½" PH6 pup joints either end, drift assembly with a 2.797" drift and pressure test to 5000 psi.

### Production Test Equipment

The following tests should be carried out before the installation of the test string in order to save rig time. Connect the cement discharge line to the permanent 6" rig test line and pressure test as follows:

| | | |
|---|---|---|
| Lines to burners | : | 1000 psi/15 min |
| Lines to T-manifold against bulk head | : | 1000 psi/15 min |
| Separator | : | 1350 psi/15 min |
| Relief valve(s) on separator | : | +/- 1450 psi (only if not recently done onshore and witnessed by Shell representative). |

Flush the valves clean by pumping +/- 1 bbl of water and close the valve by bleeding the pressure to zero.

Lines to upstream inlet of separator and
By-pass valve : 1350 psi/15 min
Check "P" pilot trips at +/- 1350 psi
Lines downstream of steam heat exchanger: 3000 psi/15 min
Lines upstream of steam heat exchanger : 3000 psi/15 min

With 3000 psi through the choke manifold close all valves on same and bleed off the pressure between the upstream and downstream valves. Observe for leakages.

Calibrate the oil and water meters while hooked-up to the pump line.

TESTS TO BE CARRIED OUT AFTER THE INSTALLATION OF THE PRODUCTION EQUIPMENT

With the flowhead mastergate closed and the kill line/flowline chicksan loops installed pressure test against the closed choke manifold to 3000 psi/15 mins.

Check the automatic flow wing shut off valve is operational from the following area:

1. Separator
2. Dog house
3. "P" pilot

Checks should be carried out to ensure the following auxiliaries are operational:

1. Steam supply to the steam heat exchanger, the condensate feed back line to the rig system, and the steam degasser system.

2. Rig air supply to the burners.

3. Water sprays to burnerheads. Cooling water to the rig's hull/cranes etc readily available and at sufficient pressure.

NOTE: After pressure testing the burner boom oil and gas lines all valves downstream of the T-manifold must be kept open to allow for quick change-over of burners.

APPENDIX 3

## SAFETY PROCEDURE FOR HANDLING MERCURY

Mercury is used offshore for re-combination surface sampling and transfer of bottom hole samples in order not to modify the composition of the sample.

### Mercury Handling Equipment to be used

1. The test operators who are to perform the operations utilizing mercury must report with all necessary protective equipment. Protective equipment is defined as follows:

   a) Coveralls without pockets.
   b) Snugly fitting splash goggles.
   c) Suitable breathing mask.

   Any other person(s) in the area who may come in contract with mercury or mercury vapor will be required to utilize similar protective equipment.

   d) Mercury exposure control form.
   e) Drager tube colormetric kit for checking the presence of mercury vapor.
   f) SRM Mercury spill control center.

2. The personal protective equipment shall be left separate from other items of equipment or clothing and on completion of work will be placed in sealed plastic bags which are to be labelled "Mercury Contaminated" and returned to Flopetrol for handling in accordance with statutory requirements and safety standards.

3. Used breathing masks will be handled in the same manner as equipment in item 2.

4. The test operators shall refrain from smoking, drinking or eating during rest break while engaged in testing or sampling operations. In the event that any of the prementioned are required, then a shower and change of clothing is essential.

5. Entrance to the work area will be roped off and appropriate signs displayed. No person shall enter the area without the approved equipment. The area shall remain roped off until a Dragertube colormetric environmental test is taken, within one (1) foot of the mercury source to indicate that no mercury vapor is present.

6. Should mercury come in direct contact with the skin of any person, it must be reported immediately to the operator's supervisor, who will inform the medic, the client representative, the safety officer and the company Drilling Supervisor.

   NOTE : Further procedures for operating of sampling equipment will be sent to the rig separately from the test programme.

APPENDIX 4

## SAFETY PROCEDURE FOR HANDLING EXPLOSIVES

### Safety during loading and firing

Before gun/setting tool is armed all transmitters, cranes, welding machines, radar etc. must be switched off and remain switched off until the gun/packer is fired/set. After firing/setting, transmission can be resumed until the gun/packer setting tool has been pulled to about 100 m below the seabed, but must then cease until the gun/packer setting tool has been laid down and checked.

Portable transmitters should be placed in one room to prevent accidental transmission.

Helicopters should not be permitted to land on the platform during perforations, or to approach closer than 150 m.
Supply and standby boats to be advised that this operation is to take place, and to shut down their transmitters and stand off from the rig at this time.

### Work involving explosives

Work involving the use of explosives should be carried out only by specialist personnel and should never be done during an electrical storm.

During any job involving the use of explosives, the number of personnel employed should be kept to a minimum. All other persons should be excluded from the danger area (e.g. walkway and derrick floor) throughout the operation.

Warning signs should be placed on access routes to the danger area to prevent access by unauthorised persons.

The Platform Manager (Captain) is to inspect equipment and check safety procedures.

Two hours before each perforating/packer setting run the Petroleum Engineer will telex Base with an estimate of when the radio beacon, VHF transmitter, etc. will be closed down and for how long. Actual times will be advised by the Radio Operator.

This is particulary important if a helicopter flight is scheduled for the rig concerned.

The first perforation must be carried out in daylight but later runs and packer settings may be carried out at night. However, if in the course of the production test a well is killed due to unforeseen circumstances, the first of any subsequent perforations must also be carried out in daylight.

A constant check must be made to ensure that no voltage is measured between the riser and the rig at surface. In the event that voltage is measured, all sources of electrical energy must be switched off. (N.B. This may preclude perforating/packer setting at night).

## FLOWING THE WELL

Opening up a well to bleed off, or initial start up of a separator, must be carried out in daylight; production testing may then continue into the night.

Flaring operations may be carried out under the following conditions:

a) Weather suitable for rescue operations.

b) Wind force sufficient to carry gases away from the platform.

c) Shipping and aircraft warned to stand clear during blowing off.

d) Standby boat and supply boat(s) advised that this operation is to take place and to take the action and precautions necessary for this operations.

## HYDRATE PREVENTION

To prevent hydrate formation during the flow testing, pump facilities should be hooked up to the following injection points:

a) E/Z Tree
b) Flowhead
c) Data Header
d) Gasline downstream of the separator

c) and d) may be fed by one pump with a T-manifold to allow for changeover.

In order to safeguard against hydrate formation during shut-in periods it is recommended to continuously inject glycol in the vertical run of the flowhead as well as at the EZ tree.

NOTE: Triethylene Glycol to be used for hydrate prevention.
Methanol to be used when hydrates have been formed.

## HANDLING AND MIXING OF CALCIUM CHLORIDE BRINE

A) Handling of CaCl2 brine.

$CaCl_2$, both as brine and powder can cause unpleasant skin irritation and even blistering if allowed to remain in contact with the skin. It is therefore important that personnel involved in work where they may be exposed to the brine or powder should be protected as follows:

a) Rubber gloves (gauntlet type to cover wrists).

b) Waterproof slicker suits with hoods.

c) Rubber boots (leather boots are shrivelled by the brine).

d) Full face masks for use when mixing powdered $CaCl_2$.

e) Barrier cream (e.g. "Vaseline") for use on exposed skin, particularly face, neck and wrists, to prevent direct skin contact with the brine.

Additionally, whenever brine/powder is inadvertently splashed onto clothing then the affected clothes should be changed and washed forthwith. Never allow brine to dry on the skin or clothes. If brine is splashed into the eye, wash the eye at once with copious amount of fresh water.

B) Mixing of a CaCl2 brine pill (1.15 SG) using CaCl2 powder:

The following instructions are for the mixing of 50 bbls of Calcium Chloride brine in the slug pit, the formulation is to be verified by a pilot check performed at the wellsite.

1. Thoroughly clean the slug pit and flush all the mixing lines and hoppers that are to be used for mixing with water. Also flush clean with water the transfer lines from the slug pit to the Halliburton unit.

2. Add 46 bbls of drillwater to the slug pit.

3. Add +/- 3500 lbs of Calcium Chloride (Peladow) (70 lbs/bbl) to the drill water while circulating through the mixing hopper.

NOTE: a) Fluid in the slug pit is to be thoroughly agitated during mixing or the Calcium Chloride flakes will drop out and settle on the bottom of the tank.

b) This mixing process is a exothermic reaction therefore as the brine is quite hot while being mixed it will weigh less when initially mixed than when cooled down.

C. To viscosify the above pre-mixed (50 bbls) Calcium Chloride brine.

1. Reduce the pH of the brine to below 7.8 by the addition of J286 powder or HCl acid.

2. Add +/- 50 lbs (50 lbs/1000 gal) of J164 (HEC) to the brine.

NOTE: The J164 is to be added SLOWLY to the brine while circulating through the mixing hopper. If not added SLOWLY "fish eyes" will form which could possibly cause formation damage later.

Agitate for 30 mins to ensure the J164 (HEC) is fully dispersed and hydrated. The viscosity should start to build after 15 - 30 mins dependent upon pH and ambient temperature.

3. Add caustic soda (while taking the standard precautions for handling) to the brine and increase the pH to around 8.5.

NOTE: Ensure that the caustic soda is fully dispersed in the gelled brine before adding more as precipitates will form if the pH increases above 10.

The Wellsite Petroleum Engineer is to conduct and monitor the above brine mixing and gelling procedures to ensure correct formulation etc.

D) Formulation Calcium Chloride brine containing sized Calcium Carbonate

The formulation for 1 bbl of 1.15 SG brine containing 42 ppb sized Calcium Carbonate is: -

0.49 bbls 1.00 SG fresh water
0.51 bbls 1.15 SG Calcium Chloride brine
(To give 0.96 bbl of 1.076 SG brine)
1 ppb HEC and 0.3 ppb Enorflo "S"
20 ppb Norcal N 40 Calcium Carbonate
20 ppb Norcal N 15 Calcium Carbonate
2 ppb Norcal N 5 Calcium Carbonate

The mixing procedure for 1 bbl of brine containing 42 ppb sized Calcium Carbonate is: -

1. Dilute the 1.15 SG brine in the above ratio with freshwater to give the desired volume.

2. Add J286 to the 1.076 SG brine and adjust its pH to +/- 5.

3. Add (slowly) the required amount of HEC and Enorflo "S" and mix throughly. Increase the pH to 8 - 9 using caustic soda solution (while taking standard precautions for handling).

NOTE: Ensure that the caustic soda is fully dispersed in the gelled brine before adding more as precipitates will form if the pH increases above 10.

4. Add the required amount of sized Calcium Carbonate and agitate well to ensure it is fully dispersed through out the brine.

NOTE: a) For ease of shipping/handling the base Calcium Chloride brine will be sent to the rig at 1.15 SG and diluted back to 1.076 SG with freshwater.

## CONTINGENCY MEASURES

### A. Surface Leaks/Malfunctions

1. Minor surface leak/malfunction:

   a) Close the well in at surface by activating the automatic gate valves on the flowhead.

   b) Bleed off the pressure trapped in the surface test lines and equipment.

   c) Repair the minor leak/malfunction and re-pressure test the relevant surface equipment as required.

   d) Open up the well and resume testing.

2. Major surface leak/malfunction (assuming the automatic shut down system has activated).

   a) Bullhead tubing contents back into the formation with brine.

   b) Observe the well dead.

   c) Rig up W/L and pressure test lubricator. RIH and open the SSD.

   d) Condition the well by reverse circulating.

   e) RIH and close the SSD. Pressure test annulus to 500 psi.

   f) Complete repairs and re-pressure test the relevant surface equipment.

Re open the well as follows:

   a) RIH with RN-test tool and set same in 2-7/8" RN-nipple. POH. RIH and open the SSD. POH.

   b) Circulate diesel into the tubing string to within 4 bbls of the SSD.

   c) RIH and close the SSD. Pressure test annulus to 500 psi/15 mins.

   d) RIH and retrieve the RN-test tool.

   e) Carry on and complete the testing programme.

   NOTE : Above is designed for the perforating string. When using the main test string the PCT (Dowell ball valve) will be closed instead of running the plug.

### B. Subsurface Tubing Leaks

1. If a tubing leak is suspected the following procedure is to be carried out:

   a) Close in the well at the flowhead and observe tubing and annulus pressures.

   b) Bullhead tubing contents with brine.

   c) RIH with RN-test tool and set same in RN-nipple. POH. RIH and open the SSD. POH.

   d) Reverse circulate the tubing contents to brine and observe tubing dead. RIH and close the SSD. Pressure annulus to 500 psi/15 mins.

   e) Attempt to pressure test the tubing to 3000 psi. If this test is OK then proceed with the test programme, if not carry out step g) below.

   f) If either of the tubing or annular pressure tests fail then pull the test string and inspect the tubing and sub assemblies closely for leaks.

   g) The further test programme will be advised and will obviously be dependent on what is found to be the cause of the leak.

   NOTE : See note under section A.2.

C. HYDROGEN SULPHIDE (H2S)

1. If H2S is monitored in the hydrocarbons produced while testing (H2S is to be checked for immediately hydrocarbons reach surface) the following will apply.

   a) Inform Shell Drilling Supt. and Platform Manager.

   b) Air breathing apparatus is to be readily available on the rig floor and rig personnel are to be directed to keep clear of areas down wind of the test equipment and pipework.

   c) A constant check is to be kept around the rig for H2S, if detected advise the Shell Drilling Supt. and Platform Manager immediately. If the presence of H2S is confirmed (in whatever quantities) the well is to be immediately closed in at the flow head and any leaks in the system traced and remedied.

      NOTE: Breathing apparatus to be worn while checking for leaks.

   d) If the H2S persists the test will be terminated by bull heading the tubing contents into the formation.

D. Deteriorating Weather

1. The test string will only be run once an acceptable weather window has been forecast for the duration of the test. If the weather begins to deteriorate rapidly once the string has started to be run a hang off tool will be picked up and the string hung off.

   If deteriorating weather is expected once the flow testing has commenced the test will be suspended. The well will be secured as outlined below:

   a) Close in well at the flowhead and bleed off pressure trapped in the surface lines.

   b) Bullhead the tubing contents back into the formation with brine, using a 50 bbl slightly viscous brine pill ahead of the brine. See Appendix 5 for formulation. Observe the tubing dead.

   c) Close the EZ tree, bleed off any pressure in the annulus and monitor tubing pressure via the glycol injection line. Be prepared to unlatch the EZ tree.

APPENDIX 8

WELL STATUS 31/2-13

1. The well has been drilled directionally to a total along hole depth of 2010 m (+/- 1728 m TVBDF).

2. Casing Data

| Size | Weight | Grade | Coupling | Depth m (AHBDF) | Depth m (TVBDF) | Collapse Strength | Internal Yield | Capacity BBL/FT |
|---|---|---|---|---|---|---|---|---|
| 30" | 310 | X-52 | Vetco ATD-RB | 455.5 | 455.5 | - | - | - |
| 20" | 129 | X-52 | Vetco LS-LH | 806 | 802 | 1410 | 2930 | - |
| 13-3/8" | 72 | N-80 | BTC | 1700 | 1504 | 2670 | 5380 | - |
| 9-5/8" | 47 | N-80 | VAM | +/- 2000 | +/- 1720 | 4750 | 6870 | 0.0732 |

3. Tubing Data

| | | | | Make up torque | | | |
|---|---|---|---|---|---|---|---|
| 3-1/2" | 9.3 | C-75 | Hydril CS | 3000 ft/lbs | 10040 | 9520 | 0.0087 |
| 4-1/2" | 19.3 | C-75 | Hydril PH6 | 7500 ft/lbs | 12960 | 12540 | 0.0126 |
| 5-1/2" | 15.5 | J-55 | LTC | 2170 ft/lbs | 4040 | 4810 | 0.0238 |
| 5" | 24.2 | L-80 | VAM | 10800 ft/lbs | 14400 | 14000 | 0.0155 |
| 2-3/8" | 4.6 | P-105 | VAM | 2150 ft/lbs | 15460 | 14700 | 0.00387 |

NOTE: No safety factors included in the pressure ratings. For make up torque correction factor for the particular dope used, has to be applied.

4. Drill Pipe Data

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3½" | 15.5 | - | 3½" IF | - | | - | 0.00658 |

## MEASUREMENTS REQUIRED

### A. During flow periods

The following data should be recorded during flowing periods every 15 mins, or whenever a change occurs:

WHP, WHT, choke size flowline pressure
Separator pressure, separator temperature
Flowrate (gas) and condensate gas ratio CGR
Annulus pressure (via kill line)

In addition, all produced fluids should be measured for density. Gas should be analysed via the mud logging unit's gas chromatograph, with H2S measured with Draeger tubes. Produced water should be measured for salinity.

### B. During BHP surveys

During all BHP surveys the following deadweight THP measurements are required:

a) Every 1 minutes during initial lubricator calibration stop.

b) Every 15 minutes during flow period.

c) After closing in for build up, every 1 minutes for the first hour, thereafter every ½ hour.

d) Every 5 minutes during the gradient stops at 100 m and 200 m above the mule shoe and at seabed.

e) Every 1 minutes during the final lubricator calibration stop.

## SAMPLING REQUIREMENTS

No sampling is required during the pre-flow after perforating.

Sampling requirements during the main flow period will be advised in part II of the test programme.

## SAND DETECTION DURING OIL TESTS

Strict monitoring of the flowstream for sand will be performed using:

a) A sand trap will be installed in the flowline and should be used whenever possible.

b) Erosion probes with pressure gauges will be placed at crucial elbows etc. Additional erosion probes connected up to the automatic shut down system will also be installed.

c) Maintain record of filter size used in the sandtrap and collect and mark all sand filtered out by the sandfilter.

## PROCEDURE FOR RECOMBINATION SAMPLES

### A. Gas Sample

1. The bottles should be properly evacuated with a vacuum pump.
2. The Wellsite Petroleum Engineer ensures that bottles are filled up slowly and are at separator pressure prior to being closed.
3. Check container and valves for leaks.
4. Mark bottles with sample number.
5. Fill in surface PVT sampling forms.

### B. Oil/Condensate

1. Oil/Condensate sample container to be filled with mercury.
2. Slowly displace 500 cc mercury from 600 cc container with oil/condensate from separator.
3. The Shell Petroleum Engineer ensures that bottles are at separator pressure prior to being closed.
4. Draw off 50 cc of mercury to create gas cap.
5. Check containers and valves for leaks.
6. Mark bottles with sample number, date, time and well no.
7. Fill in surface PVT sampling forms.

### Sample Bottle Working Pressure

| Capacity | W.P. |
|---|---|
| 20 litres (gas) | 2,800 psi |
| 0.7 litres (condensate) | 10,000 psi |

## LOW DENSITY GRAVEL PACK TOP UP

With the work string in position (3) proceed as follows:

1. Establish circulation through the production screen increasing circulation up to 4 BPM. Continue circulating brine for a complete drill pipe volume (+/- 40 bbls). If losses are observed reduce circulation rate until full returns are regained.

2. While circulating at 2 BPM, mix gravel sand at 1/4 lb/gal concentration and pump down hole. After pumping 10 bbls, and no obstruction or bridging of the gravel has occured, increase gravel concentration gradually to 1 lb/gal at 2 BPM pumping rate.

3. Continue circulating sand until the pressure starts increasing. Reduce sand concentration to a minimum and slow down pumping rate. Stop pumping at a maximum surface pressure of 950 psi.

   NOTE : If losses are observed, during the gravel placement, stop gravel injection and regain full returns by circulating brine alone. Once loss of fluid is stopped, continue gravel packing with a reduced gravel concentration.

4. Pick up work string to position (4) and reverse out excess gravel in the drillpipe.

   NOTE : Pressurise the annulus to 500 psi before picking up to position (4).

APPENDIX 13

## TESTING ORGANIZATION

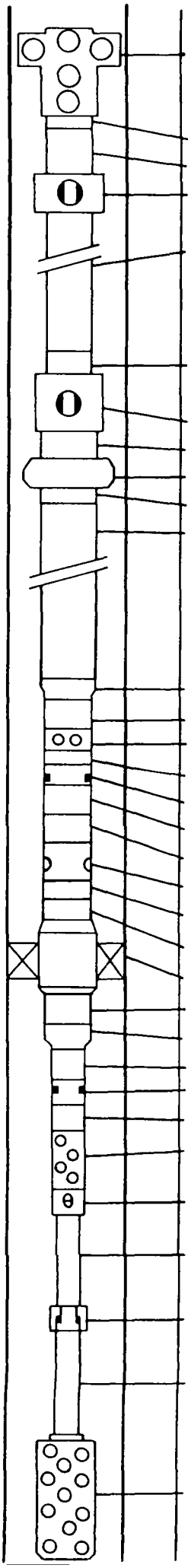
The Shell Toolpusher will be in overall charge throughout the test. The Shell Toolpusher will be advised and assisted during the test by the Well Site P.E. The Reservoir Engineer will advise the Shell Toolpusher and/or Well Site P.E. on the reservoir engineering aspects of the test. The Shell production Test Supervisor will advise and assist the Toolpusher and Well Site P.E. as and when requested by them.

## SAFETY MEETINGS

Safety Meetings for each crew are to be held prior to testing activity. All personnel to be informed of the possible dangers related to explosives, mercury, hydrocarbons and hydrogen sulphide. Company representatives should be present at these meetings.

FIG. I.

# 3 1/2-13 TUBING CONVEYED PERFORATING STRING



| | MIN I D | MAX OD |
|---|---|---|
| FLOPETROL FLOWHEAD 3 1/8" 10000 psi | 3.000 | |
| X-OVER 6 1/2" ACME (B) X 4 1/2" PH-6 (P) C-75 | 3.515 | |
| 4 1/2" PH-6 19.2 LBS/FT L-80 TBG JWT | 3.515 | 5. 313 |
| FLOPETROL LUBRICATOR VALVE | 3.000 | 10. 750 |
| 4 1/2" PH-6 19.2 LBS/FT L-80 TB 6 | 3.515 | 5. 313 |
| X-OVER 4 1/2" PH-6 (B) X 4 1/2 "ACME (P) C-75 | 3.515 | 5. 313 |
| FLOPETROL E-Z TREE | 3.000 | 10. 750 |
| 5" SLICK JOINT | 3.000 | 5.000 |
| FLUTED HANGER | 3.000 | 15.000 |
| X-OVER 4 1/2" ACME (P) X 5" VAM (P) | 3.000 | 5. 563 |
| 5" VAM 24.2 LBS/FT TUBING | 3.875 | 5. 563 |
| X-OVER 5" VAM (B) X 3 1/2" CS (P) | 2.797 | 5. 563 |
| 3 1/2" CS 10.3 LBS/FT PUP JNT | 2.797 | 3.915 |
| OTIS XA-SSD | 2.750 | 4.280 |
| 3 1/2" CS 10.2 LBS/FT PUP JWT 10+10 FT | 2.797 | 3.915 |
| 3 1/2" XN - NIPPLE | 2.635 | 3.915 |
| 3 1/2" CS PUP JWT | 2.797 | 3.915 |
| X-OVER 3 1/2" CS (B) X 3 1/2" IF (P) | 2.500 | 4.500 |
| DOWELL SINGLE SHOT REVERSING VALVE | 2.250 | 5.000 |
| X-OVER 3 1/2" IF (B) X 3 1/2" EUE (P) | 2.500 | 4.500 |
| 3 1/2" EUE PUP JNT 8 FT | 2. | 4.500 |
| BAKER FH - PACKER | 2.992 | 8.437 |
| 3 1/2" EUE PUP JNT 8FT | 2. | 4.500 |
| X-OVER 3 1/2 " EUE X 2 7/8" VAM (P) | 2.342 | 4.500 |
| 2 7/8" VAM 6.4 LBS/FT PUP JWT | 2.342 | 3.197 |
| OTIS RN - NIPPLE | 1.937 | 3.76 |
| 2 7/8" VAM 6.4 LBS/FT PUPJWT | 2.342 | 3.197 |
| 2 7/8" PERF.-PIPE VAM (B) X EUE (P) | 2.342 | 3.668 |
| BAKER PORTED SUB W/GLAS DISC | 2.000 | 3.379 |
| 2 3/8" EUE PUP JWTS | | |
| BAKER MECHANICAL TUBING RELEASE | 1. 88 | 3.125 |
| 2 3/8" EUE PUP JWTS | | |
| BAKER 6" 12 SPF, GUN | | 6.000 |

# GRAVEL PACK ASSEMBLY SCHEMATIC FOR 6m IGP IN 31/2-13

FIG. 2

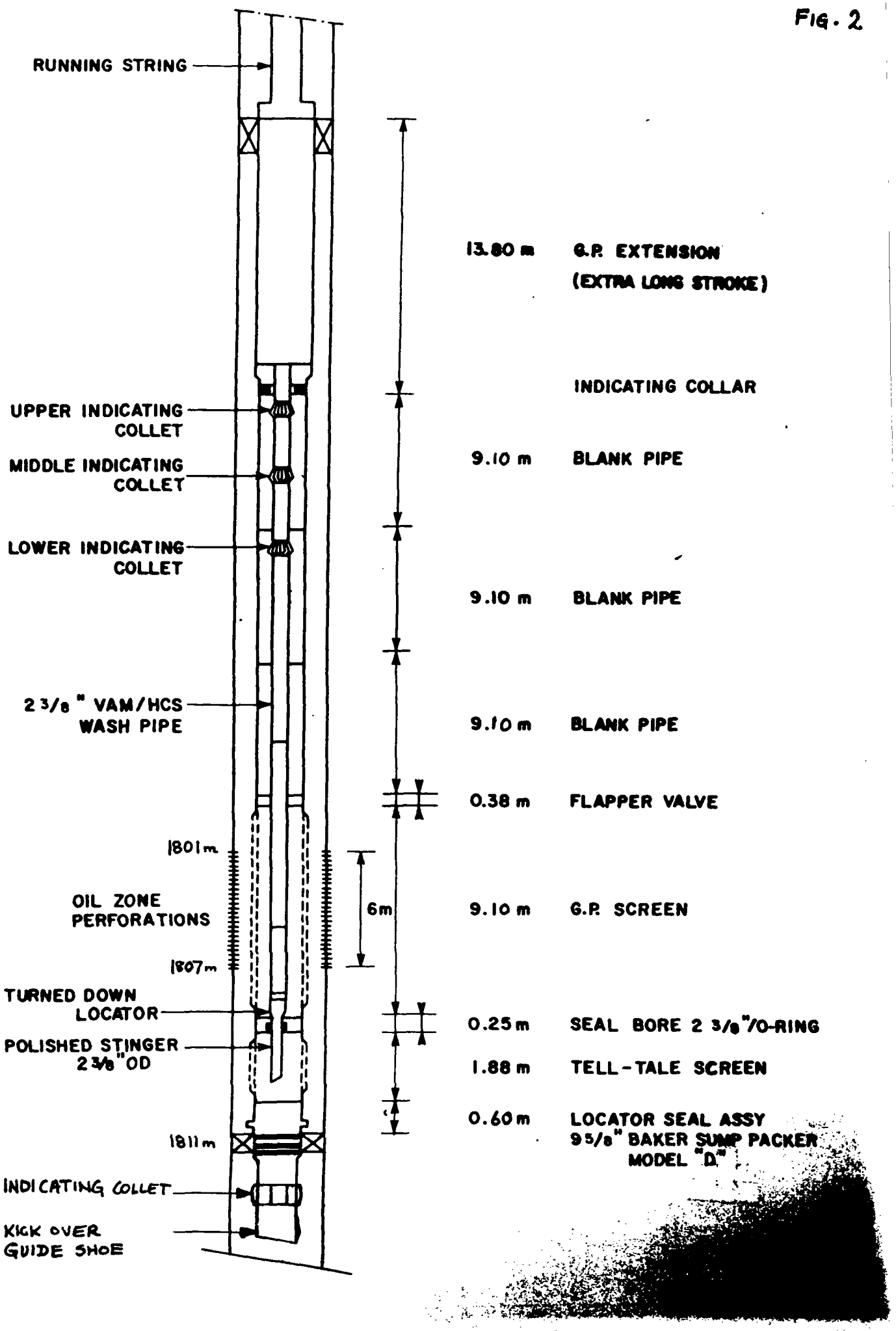
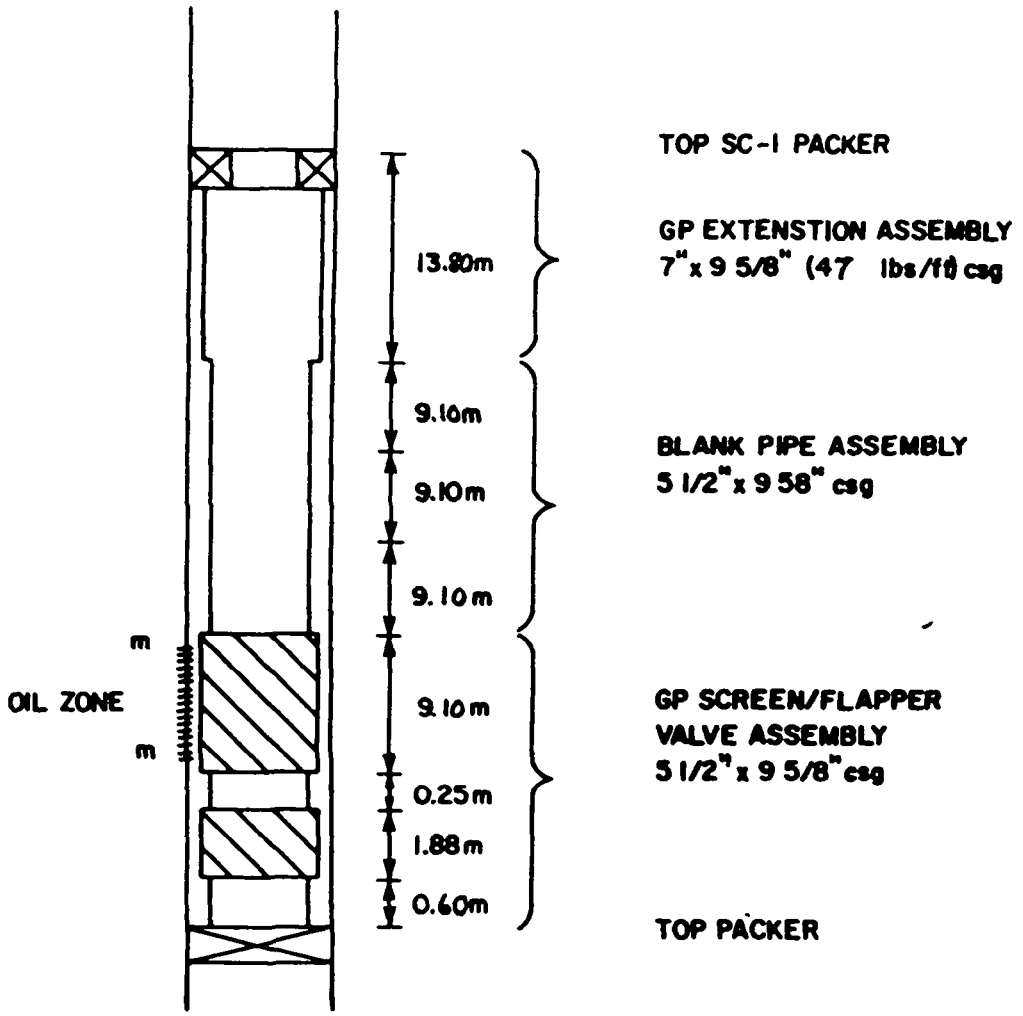


FIG. 3.0

# GP VOLUMES - OIL ZONE 31/2-13

## (NB. ALL CALCULATION TO BE CHECKED ON WELLSITE)




GRAVEL TO FILL ANNULUS

| | | | |
|---|---|---|---|
| 7" GP Extension x csg: | 13.80 m x 3.281 x 0.1438 cuft/ft | = | 6.51 cuft |
| 5½" Blank Pipe x csg : | 27.30 m x 3.281 x 0.2460 cuft/ft | = | 22.03 cuft |
| 6" GP Screen x csg : | 11.53 m x 3.281 x 0.2147 cuft/ft | = | 8.12 cuft |
| | Total | = | 36.66 cuft |

| | | | |
|---|---|---|---|
| Sand requirement : | 36.66 cuft x 105 lbs/cuft | = | 3850 lbs |
| With 50 % excess | | = | 5775 lbs |

Figure 3.1.

GRAVEL PACK FLUID FORMULATION

(NOTE: All calculations to be checked on site).

1. "Pre-Pad" gelled brine: 15 bbls, 1.15 SG.

| | | | |
|---|---|---|---|
| 15 bbls | - | 1.15 SG $CaCl_2$ brine | |
| 50.4 lbs | - | J164 gelling agent | (80 lbs/1000 galls) |
| 1.26 lbs | - | J218 breaker | (2.0 lbs/1000 galls) |

2. "Water Pack" slurry: Mix 20 bbls, 1.75 SG density

| | | |
|---|---|---|
| 11.9 bbls | - | 1.15 SG $CaCl_2$ brine |
| 40.0 lbs | - | J164 gelling agent (80 lbs/ 1000 galls) |
| 1.0 lbs | - | J218 breaker (2.0 lbs/ 1000 galls) |
| 7500 lbs | - | 12-20 mesh gravel (at 15 ppg concentration) |

Theoretical sand requirement is 3850 without excess. Due to the possibility of producing sand while flowing the well after perforating, approximately 50 % excess sand will be pumped during the gravel packing (ie. 16 bbls slurry will be pumped). 7500 lbs of sand yields 20 bbls of slurry containing 15 ppg at 1.75 SG. (The capacity of one tank on the paddle mixer is +/- 23.8 bbls).

3. "Post Pad" gelled brine: 5 bbls, 1.15 SG.

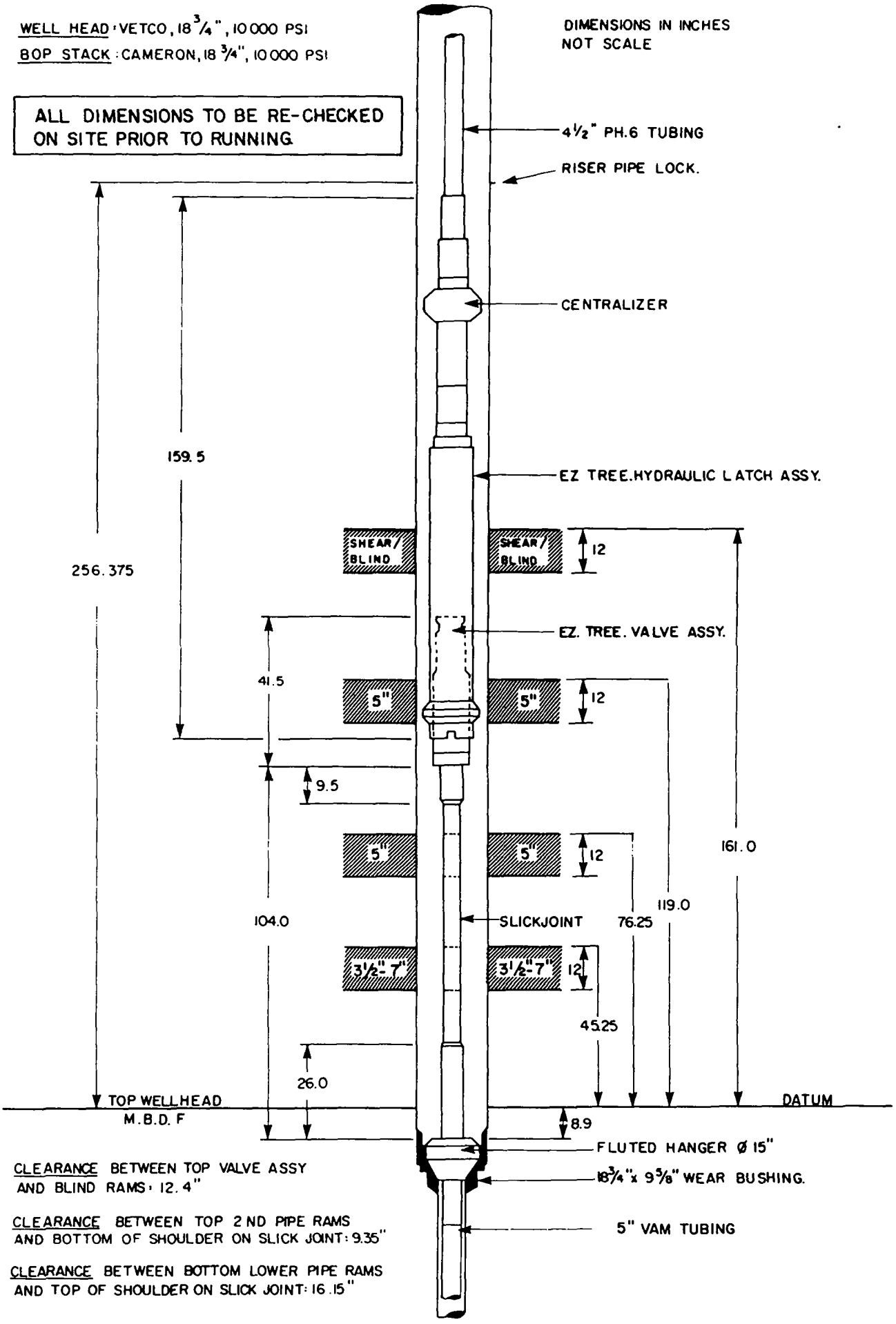
| | | | |
|---|---|---|---|
| 5 bbls | - | 1.15 brine | |
| 16.8 lbs | - | J164 gelling agent | (80 lbs/ 1000 galls) |
| 0.42 lbs | - | J218 breaker | (2.0 lbs/ 1000 galls) |

NOTE : i) Check the pH of the brine. Adjust to pH of 4-5. Add the required amount of J164. The J164 is to be added in small amounts and in a continuous manner - do not dump into tank. Allow a few minutes for the gell to disperse. Adjust the pH to 8-8.8 with a solution of caustic (observe all safety procedures). Add this in small amounts so as not to bring up the "local" pH too much. The viscosity should start to build up after 15 - 30 mins. (Actual time is dependent on ambient temperature and brine pH).

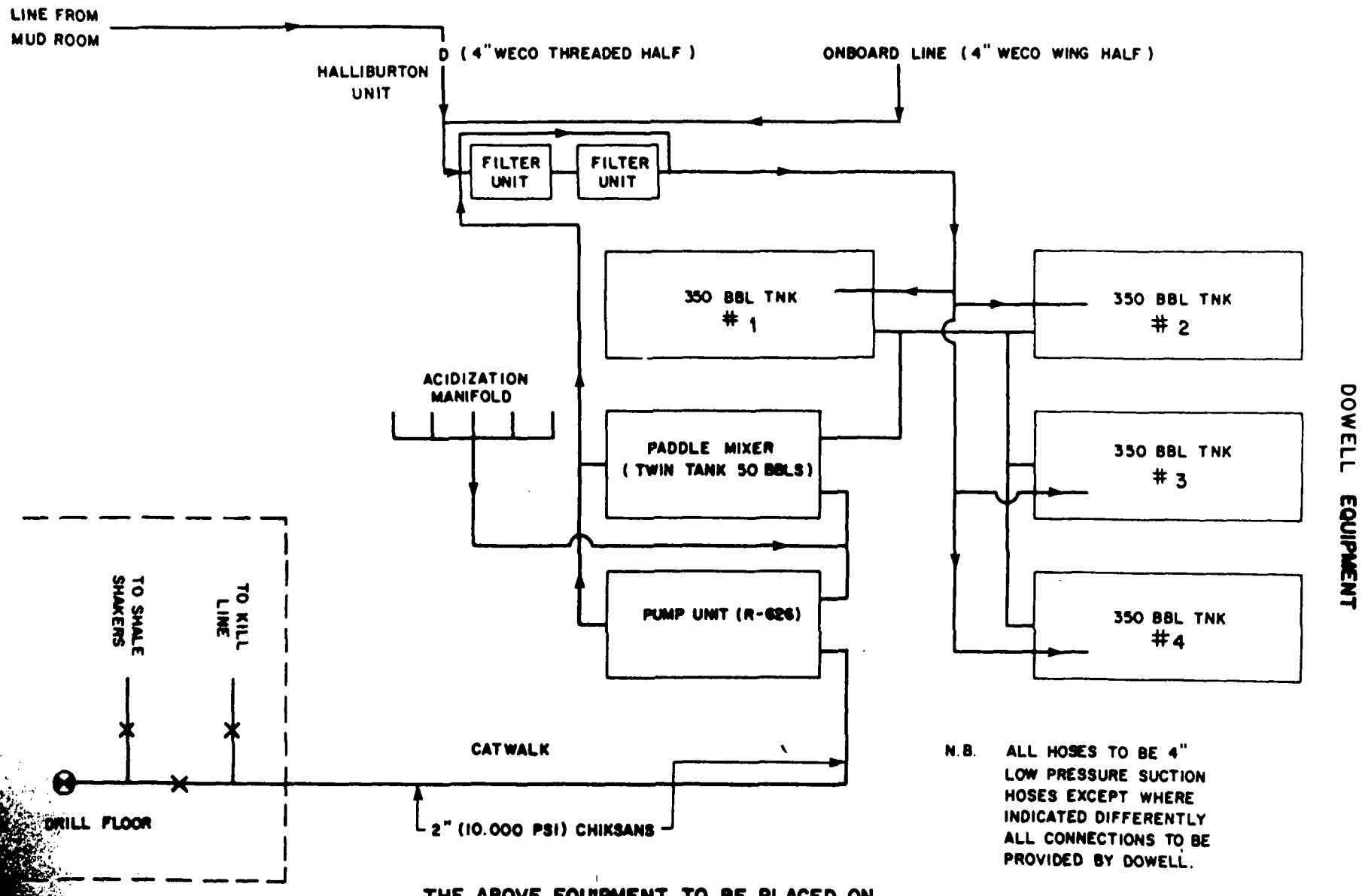
ii) Add the gravel with the paddles turning. The J218 breaker is to be added 5 - 10 mins prior to pumping the fluids downhole. Breakdown time for this job is designed to be +/- 3 hrs.

iii) Use D47 antifoam as required to remove entrapped air from the slurry.

# EZ TREE SPACE OUT WELL 31/2-13 RIG BORGNY DOLPHIN



# LAYOUT OF DOWELL / SCHLUMB. SUPPLIED EQUIPMENT FOR BRINE STORAGE, GRAVEL PACKING AND ASSOCIATED STIMULATIONS ON BORGNY DOLPHIN.




N.B. ALL HOSES TO BE 4" LOW PRESSURE SUCTION HOSES EXCEPT WHERE INDICATED DIFFERENTLY ALL CONNECTIONS TO BE PROVIDED BY DOWELL.

THE ABOVE EQUIPMENT TO BE PLACED ON THE AFT STARBOARD PIPEDECK

FIG. 5