A/S NORSKE SHELL E&P

TANANGER

PRODUCTION TEST PROGRAMME

WELL 31/2-6

RIG: BORGNY DOLPHIN

FINAL COPY 31/8/81

OPERATIONS ENG.

SENIOR OPERATIONS ENG.

DRILLING SUPT.

TECHNICAL MANAGER

DEPTH CONTROL

All depths quoted in this programme for packer setting and perforating refer to the FDC/CNL log, no. 3 of 22.8.81 made from the "Borgny Dolphin".

OBJECTIVES AND GENERAL TEST OUTLINE

1. Objectives

a) To assess the significance and producibility of the indicated oil bearing reservoir section from c. 1576 - 1579 m with regard to water/gas coning and thus enable calibration of a computer simulation model.

b) To obtain accurate data on reservoir fluids, pressures, fluid compositions and trace elements in the indicated oil and gas bearing legs to aid in the determination of reserves.

c) To investigate the inflow performance and sand control effectiveness of a gravel packed completion for both the oil and clean sand gas reservoirs.

2. General Test Outline

a) Oil interval test 1576 - 1579 m.

The oil bearing reservoir section will be tested in the interval 1576 - 1579 m in loosely consolidated, highly porous sands. Accordingly, a wire wrapped inner liner will be gravel packed across the perforated interval prior to performing the actual flow testing. Following the gravel packing, the production string will be installed and the well flow tested as outlined below:

i) Clean up period - open the well up and flow at the following rates and durations:

Rate (bbl/d)	Duration (hrs)
250	3
500	3
1500	3

Close in and run pressure gauges.

ii) Main flow period - open the well up and flow at the following rates and durations:

Rate (bbl/d)	Durations (hrs)
250	2
500	2
1500	168

Close in and retrieve gauges. Rerun gauges. Open well.

2500	120

Close in for build up period. Conclude oil zone test.

N.B. The above rates and durations are test design rates and should be considered as a guide only and may be varied as a result of actual well performance.

b) Gas interval test 1518 - 1537 m

The gas bearing reservoir section will be tested in the interval 1518 - 1537 m in loosely consolidated, highly porous sands. Accordingly, a wire wrapped inner liner will be gravel packed across the perforated interval prior to performing the actual flow testing. Following the gravel packing, the production string will be installed and the well flow tested as follows:

i) Clean up period - open the well up and flow at the following rates and durations:

Rate (MMscf/d)	Durations (hrs)
10	3
20	6 (Thornton sampling trials)
40	3
60 (if possible)	3

Close in and run pressure gauges.

ii) Multiple rate test - open the well up and flow at the following rates and durations:

Rate (MMscf/d)	Durations (hrs)
10	4
20	8 (Thornton sampling)
40	4
60 (if possible)	4

Close in for 2 hour build up period. Retrieve gauges.

iii) Maximum rate-test - open the well up to the maximum flow rate obtainable and flow at this rate for 2 hours. Conclude gas zone test.

On completion of the flow testing, the production string will be pulled and the well abandoned.

PREPARATION OF TUBING

1. Offload and rack tubing, seperating 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.

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 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 section as these can easily be squeezed in make up. N.B. Seperate drift runs should be made down to and through No-Go nipples.

6. Carry out API pressure test on each sub-assembly to 5,000 psi (to be witnessed by WSPE, TP and Production Test Supervisor).

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.

NOTES

A. During the whole course of this production test and its attendant preparation/gravel packing, it is essential that the wellbore and fluids be kept as clean as possible. To this end, a brine filtration system is being employed, filtering out particles as small as 2 microns. It is therefore necessary that the portable brine storage tanks and the associated surface equipment and all related equipment (shale shakers, desanders and desilters, Thule mud cleaner and degasser) be spotlessly clean prior to first circulating brine into the hole from the storage tanks. In addition, the use of pipe dope must be minimized throughout all the necessary trips and pipe make- up, as this dope can be particulary harmful to a gravel pack. Brine should also be circulated down the kill and choke lines.

B. Since the surface equipment mud tanks will be part of the brine circulation system,they must be blocked off from the other mud tanks.

C. $CaCl_2$, 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:

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

ii) Waterproof slicker suits with hoods.

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

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

v) 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 amounts of fresh water.

D. If in the course of the test the well has to be squeeze killed because of deteriorating weather, a 20 bbl pill of viscous brine should be pumped to the perforations ahead of the clear brine to prevent losses. The viscous brine should be made up as follows: add HEC at 4.0-4.5 ppb into brine while stirring vigorously and maintaining a brine pH of 6.0, obtained by addition of Dowell's J286. Thereafter, while continuously stirring the brine, the pH should be increased to 8.5-9.0 with caustic soda (check with pilot test first).

PREPARATION

1. Run a 8½" bit (no nozzles) on 5" DP/6l/4" DC's with a 9-5/8" casing scraper just above the bit. Scrape the packer setting interval 1525 - 1565 m.Continue down to bottom and tag the float collar at +/- 1728 m.

2. With bit at bottom, circulate the well to seawater using a 50 bbl pill of seawater viscosified to 150 secs. MF with 4-5 ppb CMC EHV plus 1 drum F-38 as a spacer ahead of the clean seawater. Continue circulating seawater as fast as possible until the solids level has reached an irreducible minimum as measured by the BS&W test. Repeat hivis pills as necessary. N.B. Rotate and reciprocate pipe intermittently to assist in hole cleaning.

3. Circulate well to filtered (2-micron) 1.15 SG (500 psi/1000 ft) inhibited CaCl2 brine. Dump seawater returns until return fluid weight reaches 1.05 SG (455 psi/1000 ft). Ensure filtering continues throughout to maintain minimum solids concentration in the CaCl2 brine.

4. POH with 8½" bit and 9 5/8" casing scraper.

5. Rig up Schlumberger and run CCL/GR log from the top of the float collar at +/- 1728 m to 1400 m. POH.

6. Rig up and run a junk basket and 9 5/8" gauge ring. POH. RIH and set a Johnston Wasp Mach 11 bridge plug with the top at 1584 m. POH and rig down Schlumberger.

7. RIH with 5" OEDP and spot 50 bbls of viscosified (150 MF) CaCl2 brine bottom.

8. Make up fluted hanger, slick joint, SSTT (blank off injection and control line ports) and 4½", 19.2 lbs/ft, C75, PH6 tubing riser, including riser valve. Run in and land fluted hanger on wearbushing. Space out so that top of riser is +/- 3 metres above rig floor. Pull out and stand 4½" riser back in derrick, SSTT to be laid down on walkway.

N.B.

As a consequence of the 9 5/8" casing being cut and not tied back to the wellhead exercise extreme care when stabbing the bit and scrapper, GP liner etc. into the 9 5/8" casing.

PERFORATION AND BACKSURGING - OIL ZONE 1576 - 1579 M.

(depth reference: FDC/CNL run no. 3 22/8/81)

1. Rig up Schlumberger and run gauge ring/junk basket to 1584 m BDF. POH.

2. RIH and perforate interval 1576 - 1579 m BDF with 5" "Hyperpack" casing guns at 4 shots/foot, 90 deg phasing. Observe well for losses then POH and check gun, noting any misfires.

Note

Extended port plugs are to be used on the 5" "Hyperpack" guns to increase the size of the perforation hole produced in the 9 5/8" casing.

3. Reperforate interval 1576 - 1579 m as in (2) above, to give 12 spf.

4. Rig down Schlumberger.

5. RIH with Halliburton backsurge tool string on 5" DP with 5.6 bbl chamber - see Fig. 1.0 for tool string schematic. Fill the drillpipe with brine above the upper PR valve while RIH. Set the packer at 1544 m (after tagging the Johnston Mach 11 Bridge Plug) so that the bottom of the drill pipe tailpipe is at 1564 m. Close upper annular round DP and install lower kellycock and circulating valve on DP and flange up to choke manifold.

   N.B. (i) Run 2 x 5000 psi Ameradas in the tailpipe bundle carrier (24 hour clocks).

   (ii) Backsurge volume is 2.0 gall/perforation.

6. Open the surge tool by pressuring annulus to approximatly 500 psi to shear the disc then wait one hour. N.B. Increase pressure in 50 psi increments until surface indications that tool has opened are obtained.

7. Open the upper chamber PR valve by pressuring DP to +/- 1500 psi. Unseat the packer, and reverse circulate out the gas influx, over the chokes. Do not open RTTS circulating valves. Report data on sand/gas/pressures during circulating out hydrocarbons. Open upper annular and observe well.

8. RIH very slowly with toolstring to first sign of resistance, close upper annular and reverse out any fill above the Johnston Mach 11 plug report height of fill, if any. Open upper annular. POH with packer to 1544 m (tailpipe shoe at 1564 m BDF) and wait for 2 hours - observe for losses. RIH to bottom again and note any fill on bottom. Reverse clean and report fill. POH.

   Note: In case losses are observed after the backsurge operation, 250 bbls of 4-4.5 ppb HEC viscosified brine should be available on surface for spotting as and when necessary.

GRAVEL PACKING - OIL ZONE

1. Pick up gravel pack assembly consisting of the following (from bottom up).

   a) 5½", LTC box up GP bull plug

   b) 5½", Bakerweld tell tale screen (6' long, LTC pin x box)

   c) 5½" x 3.25" GP seal bore receptacle (LTC pin x box)

   d) 5½", Bakerweld screen (1 x 20' joint LTC pin x box)

   e) 5½" Blank pipe (1 x 30' joint: LTC pin x box)

2. Hang off this section in rotary and then run the following inside the screen and blank pipe:

   a) G22 locator seal assembly, size 80-32, with 6 seal units (2-3/8", Hydril CS box up).

   b) 2-3/8", 4.7 lbs/ft, P105, Hydril CS wash pipe with N80 pup joints as required for correct space out - i.e. to position the G22 locator seal assembly as far as possible in the 5½" x 3.25" GP seal bore receptacle when the entire GP assembly is made up.

3. Hang off wash pipe on the 5½" blank pipe and then pick up the preassembled Model SC-1 gravel pack packer, Model "S" gravel pack extension with sliding sleeve, 6-5/8" x 5½" crossover sub, Model GP shear-out safety joint, upper indicating coupling, 5½" spacer pup joint and lower indicating coupling. Preassembled and connected also will be the Model "SC" crossover/setting tool (4½" IF box up) with Model S-1 shifting tool, 2-3/8" EUE pup joints, multiple acting indicating collet and 2-3/8" EUE (box) by 2-3/8" Hydril CS (pin) crossover.

4. Connect the 2-3/8" washpipe to the 2-3/8" Hydril CS pin protruding from the lower indicating coupling. Then connect the outer blank pipe to the lower indicating coupling.

   Notes

   A. At this point it is worthwhile to recheck all dimensions to ensure that indeed the size 80-32, G22 locator seal assembly is correctly spaced out in the GP seal bore receptacle above the tell-tale screen.

   B. Check the weight of the entire GP assembly after make-up.

5. RIH with the entire GP assembly, using 18 x 6-1/4" DC's and 5" DP as the running string.

N.B.

i) All DP and DC's must be rabbitted to ensure they are clear.

ii) Running speed - 60 seconds per stand.

iii) Set slips slowly and avoid jarring the assembly.

iv) DO NOT USE EXCESSIVE DP DOPE ! - dope pins only and wipe off excess dope squeezed out of the connection, this is of the upmost importance to help ensuring a successful gravel pack.

6. Complete RIH with gravel pack assembly and set down gently on the Johnston Wasp Mach 11 bridge plug at 1584 m - c. 10000 lbs wt. should be adequate: control with heave compensator. Space out DP to place top at +/- 3 m above derrick floor. After spacing out and gently again tagging (do not set down any weight) the bridge plug at 1584 m install circulating valve on top of DP. Hook up Dowell lines and pressure test same to 5000 psi. Circulate DP volume + 20% and then drop 1½" kirksite packer setting ball (allow 5 mins/300 m for ball to fall).

7. When packer ball is estimate to have landed pressure up on DP 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.

8. Pull 15000 lbs over whole string weight to check packer set (use heave compensator). With DP circulating valve open and upper annular closed, pressurise annulus to 500 psi down kill line to check packer element sealing. Open upper annular.

9. Using heave compensator, slack down to 5000 lbs upward pull at packer. Rotate DP 10-12 turns to the right at the packer to back out with the crossover tool . When crossover tool comes free, set back down on packer with 30,000 lbs weight to ensure location of squeeze position, where the left hand running thread of the setting tool locates on the top of the packer. Mark the pipe - this mark will be referred to as mark (1) for the squeeze position. Establish injection rates and pressures - maximum surface pressure +/- 900 psi with 1.15 S.G. brine in the hole, corresponding to a bottom hole pressure of +/- 3475 psi, 200 psi below 1.64 S.G. the estimated fracture gradient.

10. Pick up approximately 1 - 1.5 m at the packer and set back down with indicator collet on lower indicating coupling, using sufficient weight (10000 lbs) to ensure definite location of the coupling. Mark the pipe - this mark will be referred to as mark (2) for circulating through the lower tell tale screen.

11. Pick up approximately 5-6 m at the packer and set back down with indicator collet on upper indicating coupling using sufficient weight (10000 lbs) to ensure definite location of the coupling. Mark the pipe - this mark will be referred to as mark (3) for reverse circulating above the packer.

12. Slack off weight to push indicator collet through upper and lower indicating couplings - approximately 15000 to 20000 lbs will be required. When mark (1) has been definitely located, pick up and locate mark (2). Set 10000 lbs weight on indicating coupling/indicator collet to ensure definite location of the circulating position.

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

    a) It is essential that marks (1), (2) and (3) are unambiguous and hence they should be painted on the DP, 1 m above the DF at mid heave with simultaneous reading of the derrick floor tide indicator recorded in the drillers notebook.

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

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

    d) Sufficient chiksans must be available to the DP circulating valve to accommodate the necessary pipe movements.

13. Establish circulation through lower tell tale screen, increasing pump rates up to maximum surface pressure of 900 psi. Monitor returns closely for losses and plot surface pressures versus pump rates. Estimate friction losses in surface pipe and in DP.

14. Carry out the Pre GP acidization as outlined below:-

    A) Pump and squeeze the following fluids:-

        i) 13 bbls of 15 % HCL containing 10% U66 and 1% A-200 (both by volume).

        ii) 26 bbls of 7.5% HCL plus 1.5% HF acid combined

        iii) 10 bbls of 3.0% NH_4 CL (Ammonia Chloride)

        iv) 26 bbls of HBF_4 (Fluoboric acid)

        v) 10 bbls of 3.0% NH_4 CL (Ammonia Chloride)

    N.B.

        a) Pump the 85 bbls of the above treatment fluids thereafter set down to position no. 1, the squeeze position, and squeeze the treatment fluids into the formation while pumping brine.

        b) Ensure that the pumping pressure is not sufficient to fracture the formation i.e. maximum allowable BHP +/- 3475 psi.

B) Pull back to position no. 2, the circulating position, upon completion of squeezing the above treatment fluids into the formation.

Mix breaker and gravel into previously gelled fluid - see Figs. 2.0 and 2.1 for fluid formulations and specifications.

15. Pump "water pack" fluids as follows:

a) 15 bbls "water pack" pre-pad 9.6 ppg (500 psi/1000 ft).

b) 7.6 bbls "water pack" slurry containing 7 lbs/gallon fluid of Baker "Low Fines", 12-20 mesh gravel. The slurry density is 12.15 ppg (630 psi/1000 ft).

c) 5 bbls "water pack" after pad 9.6 ppg (500 psi/1000 ft).

These slurries will lead to an imbalance between the heavy drillpipe and light annulus fluids of +/- 55 psi while the fluids are in the drillpipe. Therefore, during the first 57 bbls of displacement with brine until the 15 bbl "water pack" pre-pad arrives at the crossover tool, a maximum surface pressure of 845 psi may be used.

16. Displace "water pack" with brine at maximum allowable rate (max surface pressure 845 psi) until pre-pad reaches crossover tool - approximately after 57 bbls of brine. Reduce pump rate to give maximum surface pressure of 200 psi. After pumping a further +/- 19.0 bbls the gravel slurry should cover the tell tale screen and a pressure rise should be noted at surface - do not exceed 900 psi.

17. Slack off work string down to mark (1), the squeezing position, and squeeze slurry out into the formation with a steady pump rate and surface pressure below 900 psi. When final screen-out occurs, reduce pump rate to maintain surface pressure below 900 psi as long as possible but ultimately let pump pressure increase to 1050 psi for the final squeeze. However, if no screen out is obtained, overdisplace with 10 bbls of completion fluid to clear the packer. Mix and prepare additional "water pack" pad and slurry volumes (50% of original job size) and repack. N.B. As tell-tale screen out has occurred, the "water pack" fluids will have to be displaced to the crossover tool with the drill pipe positioned at mark (3) the reverse circulation position, to allow direct circulation into the DP x 9-5/8" casing annulus. The string will then have to be lowered to mark (1), the squeezing position, for the repack.

18. After achieving satisfactory screen out, allow the pressure to bleed off. Close the annular preventer and pressurise the annulus to 500 psi. Pick up to mark (3), the reverse circulation position, and reverse out excess gravel/fines from above the packer.

19. Open the annular preventer, then POH with SC crossover/setting tool, washpipe etc.

INSTALLATION OF PRODUCTION STRING - OIL ZONE

1. Run the test string as per Fig. 3.0 excluding the 4½" tubing riser at this stage. 5" VAM tubing should be run to surface with a white painted single installed at the BOP level for spacing purposes.

   N.B. When the first full joint of the 5" VAM tubing has been run through the rotary table, rig up the wireline unit and install plug in the XN nipple above the perforated joint. Install x-overs and Lo-torq valve and pressure test plug to 3000 psi/15 minutes,recording pressure and observing for flow from annulus. If test satisfactory, recover plug and continue running tubing.

2. Check depth to Baker SC-1 packer by:

   i) Noting entry of mule shoe into packer.

   ii) Noting pressure increase when first seals enter packer seal bore while pumping slowly through tubing string.

   iii) Lowering tubing until locator seal assembly stops on top of packer.

3. With seal assembly fully stabbed into seal bore, close middle 5" pipe rams around painted single for spacing purposes. Pressure test annulus to 500 psi/15 minutes down kill line. If all OK,bleed off pressure and open pipe rams (N.B. Check 5" VAM collar positions before closing rams).

4. Pull back +/- 400 m and calculate spacing requirements so that when fluted hanger lands in the wellhead, the top of the locator seals will be 2.5 - 3.0 m above the top of the packer.

5. Space out 5" VAM tubing. Install the tubing hanger, slick joint and SSTT. Run 4½", PH6 tubing riser, with the Flopetrol riser ball valve installed at +/- 50 m BDF, spaced out so that the top of the tubing riser is +/- 3 m above rig floor.

6. Flange up flow head and install Chiksan lines to flow and kill sides of flow head. Pressure test same to 3000 psi.

7. Stab into packer and land SSTT. Close middle 5" pipe rams around slick joint and pressure test annulus to 500 psi/15 minutes down kill line. Bleed off pressure and open rams.

8. Disconnect elevators, install 40' x 2½" strops and support tubing riser with same from heave compensated travelling block. Install wireline lubricator and wireline BOP and test same to 3000 psi/15 minutes.

9. RIH with 2" drift to tubing shoe. POH then RIH with wireline retained test plug and set same in XN nipple (do not shear off from test plug). Pressure test tubing and tubing riser to 3000 psi/15 minutes. Bleed off pressure slowly to zero and recover test plug.

10. Carry out the Post GP acidization as outlined below:-

    a) RIH and open 3½" XA-SSD. POH.

    b) Pump the following fluids:-

        i) 5 bbls diesel + 10% by volume U66

        ii) 30 bbls 15% HCL containing 10% U66 and 1% A-200 (both by volume).

    c) Displace the above fluids by diesel to within 2 bbls of the 3½" XA-SSD.

    d) RIH and close the 3½" XA-SSD and test the annulus with 500 psi/15 mins. POH.

    e) Bullhead the acid into the formation using diesel at the maximum rate and over-displacing by 20 bbls.

        N.B. Ensure that the pumping pressure is not sufficient to fracture the formation. i.e. maximum allowable BHP +/- 3475 psi.

11. Close middle 5" pipe rams. Pressure up annulus to 500 psi/ 15 minutes. Bleed pressure down to 100 psi (just to give a gauge reading).Keep the middle 5" pipe rams closed throughout the production testing programme and observe the annulus pressure via the kill line. Do not exceed 500 psi annulus pressure.

12. RIH with wireline sandbailer and tag bottom inside gravel pack. Record hold-up depth and retrieve sample of sand (if any).

TEST PROGRAMME - OIL ZONE

Note: This outline programme is a guide only. Specific items e.g. rates and durations, lengths of build ups etc. may be varied in the light of onsite information gained during the test.

1. Open the well up and unload slowly, flow through the separator at the earliest opportunity. Stabilize the flow at +/- 250 bbl/d for 2 hours.

2. Flow the well at the following rates and durations:

Rate (bbl/d)	Duration (hrs)
250	3
500	3
1500	3

Note:
a) Bean up gradually at each rate.

3. Close in the well and make 2" drift run to F nipple. Run 2 x Sperry Sun MRPG gauges, sample interval 8 mins (224 hrs running time) and 1 x Amerada (3000 psi element, 144 hr clock). Make gradient stops in the lubricator and at 600 m and 300 m above the mule shoe while RIH.

4. Open up the well and flow at the following rates and durations:

Rate (bbl/d)	Duration (hrs)
250	2
500	2
1500	168

5. Close in and retrieve the pressure gauges making gradient stops at 300 m and 600 m above the mule shoe, at seabed and in the lubricator.

6. Close in and run 2 x Sperry Sun MRPG gauges, sample interval 8 mins (224 hrs running time) and 1 x Amerada (3000 psi element, 144 hr clock).

7. Open up the well to 2,500 bbl/d gradually i.e. over a one hour period. Flow at this rate for 120 hrs.

8. Upon completion of the 120 hrs flow test at 2,500 bbl/d close in for a 2 hrs build up period.

9. Retrieve pressure gauges making gradient stops as in step 5) above and conclude the oil zone test.

Note:

i) Flow through the sand filter and monitor for sand production via the SANDEC equipment. Calibrate equipment using two probes (ones upstream and one downstream of the filter unit). Once it has been as certained that there is no sand production by pass the sand filter but continue to monitor the SANDEC equipment. Be prepared to switch flow throughout the sand filter if sand production occurs.

ii) Maintain a pressure of at least +/- 1500 psi greater than FTHP on the ball valve of the EZ tree.

ABANDONMENT - OIL ZONE

1. Squeeze tubing contents down to perforations with brine of 1.15 SG (500 psi/1000 ft), using a 50 bbl,HEC viscosified brine pill ahead. Observe tubing dead.

   Note: Take care not to fracture formation. Expected fracture gradient is 1.64 SG (710 psi/1000 ft), giving a maximum allowable BHP (200 psi safety) of +/- 3475 psi. Maximum allowable surface pressure with 1.15 S.G. brine in the tubing is thus +/- 900 psi.

2. RIH with wireline sand bailer and tag bottom again inside gravel pack. Record hold up depth and retrieve sand sample (if any).

3. Pick up seals out of packer and reverse circulate and condition well with 1.15 SG brine. Observe well dead.

4. Flange down Xmas tree and pull production string, standing back the 4½" tubing riser and the 5" tubing.

5. RIH with Baker Model "A" retrieving tool on 5" DP/6 1/4" DC's with fishing jars. Circulate above top of packer then set down onto packer with 15000 lbs to engage anchor latch in left hand square thread at the top of the packer.

6. Pick up on the DP string to release the SC-1 packer. 15000 lbs upstrain is required to free the packer, but overpull will be required to recover the GP assembly complete. However, the GP shear-out safety joint will shear at 60000 lbs upstrain. (If the shear joint shears, the blank pipe and screen remaining in the hole will be recovered after step (7) with a spear).

7. POH with Model "A" retrieving tool and lay down recovered GP equipment.

8. RIH 5" OEDP and 9 5/8" casing scraper. Wash down to the Johnston Wasp Mach 11 bridge plug at 1584 m. Scrape interval 1470 - 1510 m. Continue circulating until the whole hole is displaced back to uniform, conditioned (2 micron) brine of weight 1.15 SG. POH.

9. Rig up Schlumberger. Run gauge ring/junk basket to 1570 m POH. RIH and set Baker Model "K" cement retainer with top at 1565 m. (N.B. Ensure retainer is at least 2 m from a casing collar.) POH and rig down Schlumberger.

10. RIH with a Baker Model "B" snap-latch stinger sub on 5" DP and carry out the following:-

    a) Sting into retainer and perform 20 bbl injection test, establishing injection rates versus pressure. Do not exceed 900 psi surface pressure.

    b) Pull out of retainer - 10.000 lbs overpull being required.

c) Mix and pump +/- 175 sxs class G cement with the following slurry:-

15.80 ppg
4.41 gps freshwater
0.29 gps CFR-2L
0.30 gps HLX-C248
1.14 cuft/sx yield

Use 30 bbls freshwater ahead and 30 bbls behind the slurry.

Note: The cement volume to be pumped may be varied as a result of the injection test.

d) Displace the cement to within 5 bbls of the stinger sub and then sting into the retainer and set down to 15.000 lbs to engage the snap latch.

e) Inject cement at 0.5 bpm through the retainer - cement should hit the top perforations after pumping a further +/- 8 bbls.

f) When the squeeze pressure reaches 250 psi above the initial injection pressure stop pumping for 30 mins, (Do not exceed a bottom hole pressure of +/- 3475 psi at 1576 m) or when half the cement has been pumped out of the stinger.

g) Resume pumping at 0.5 bpm and displace further cement until the squeeze pressure is 500 psi above initial injection pressure or until a further one-quarter of the cement has been displaced. Wait a further 30 mins and resume pumping until the final squeeze pressure of 900 psi has been attained for 30 mins.

NB. Leave a minimum of 3 bbls cement inside the stinger sub/DP.

h) Pull out of the retainer and reverse out the excess cement.

11. Circulate the hole to clean (2 micron) 1.15 SG brine. Spot 50 bbls of viscosified brine on bottom.

12. POH and lay down the Baker Model B snap latch stinger sub.

PERFORATION AND BACKSURGING - CLEAN GAS ZONE 1518 - 1537 M.

(Depth reference: FDC/CNL run no. 3 21/8/81)

1. Rig up Schlumberger and run gauge ring/junk basket to 1545 m BDF. POH. RIH and set a Johnston Wasp Mach II bridge plug at 1543 m. POH.

2. RIH and perforate interval 1518 - 1537 m BDF with 5" "Hyperpack" casing guns at 4 shots/foot, 90 deg phasing. Observe well for losses then POH and check gun, noting any misfires.

Note

Extended port plugs are to be used on the 5" "Hyperpack" guns to increase the size of the perforation hole produced in the 9 5/8" casing.

3. Reperforate interval 1518 - 1537 m as in (2) above, to give 12 spf.

4. Rig down Schlumberger.

5. RIH with Halliburton backsurge tool string on 5" DP with 25 bbl chamber - see Fig. 1.2 for tool string schematic. Fill the drill-pipe with brine above the upper PR valve while RIH. Set the packer at 1436 m (after tagging the Johnston Mach II bridge plug) so that the bottom of the drillpipe tailpipe is at 1466 m. Close upper annular round DP and install lower kellycock and circulating valve on DP and flange up to choke manifold.

   N.B. (i) Run 2 x 5000 psi Ameradas in the tailpipe bundle carrier (24 hour clocks).

   (ii) Backsurge volume is 1.4 gall/perforation.

6. Open the surge tool by pressuring annulus to approximatly 500 psi to shear the disc then wait one hour. N.B. Increase pressure in 50 psi increments until surface indications that tool has opened are obtained.

7. Open the upper chamber PR valve by pressuring DP to 1500 psi. Unseat the packer, and reverse circulate out the gas influx, over the chokes. Do not open RTTS circulating valves. Report data on sand/gas/pressures during circulating out gas. Open upper annular and observe well.

8. RIH very slowly with toolstring to first sign of resistance, close upper annular and reverse out any fill above the Johnston Wasp Mach II bridge plug - report height of fill if any. Open upper annular. POH with packer to 1436 m (tailpipe shoe at 1466 m BDF) and wait for 2 hours - observe for losses. RIH to bottom again and note any fill on bottom. Reverse clean and report fill. POH.

   Note: In case losses are observed after the backsurge operation 250 bbls of 4-4.5 ppb HEC viscosified brine should be available on surface for spotting as and when necessary.

GRAVEL PACKING - CLEAN SAND GAS ZONE

1. Pick up gravel pack assembly consisting of the following (from bottom up):

   a) 5½", LTC box up GP bull plug

   b) 5½", Bakerweld tell tale screen (6' long,LTC pin x box)

   c) 5½" x 3.25" GP seal bore receptacle (LTC pin x box)

   d) 5½" Bakerweld screen (1 x 20' joints and 2 x 30' joints, LTC pin x box)

   e) 5½" blank pipe (1 x 30' joints; LTC pin x box)

2. Hang off this section in rotary and then run the following inside the screen and blank pipe:

   a) G22 locator seal assembly, size 80-32, with 6 seal units (2-3/8", Hydril CS box up).

   b) 2-3/8", 4.7 lbs/ft, P105, Hydril CS wash pipe with N80 pup joints as required for correct space out - i.e. to position the G22 locator seal assembly as far as possible in the 5½" x 3.25" GP seal bore receptacle when the entire GP assembly is made up.

3. Hang off the wash pipe on the 5½" blank pipe and then pick up the preassembled Model SC-1 gravel pack packer, Model "S" gravel pack extension with sliding sleeve, 6-5/8" x 5½" crossover sub, Model GP shear-out safety joint,upper indicating coupling, 5½" spacer pup joint and lower indicating coupling. Preassembled and connected also will be the Model "SC" crossover/setting tool (4½" IF box up) with Model S-1 shifting tool, 2-3/8" EUE pup joints, multiple acting indicating collet and 2-3/8" EUE (box) by 2-3/8" Hydril CS (pin) crossover.

4. Connect the 2-3/8" washpipe to the 2-3/8" Hydril CS pin protruding from the lower indicating coupling. Then connect the outer blank pipe to the lower indicating coupling.

   Notes

   A. At this point it is worthwhile to recheck all dimensions to ensure that indeed the size 80-32, G22 locator seal assembly is correctly spaced out in the GP seal bore receptacle above the tell-tale screen.

   B. Check the weight of the entire GP assembly after make-up.

5. RIH with the entire GP assembly, using 18 x 6½" DC's and 5" DP as the running string.

N.B.

i) All DP and DC's must be rabbitted to ensure they are clear.

ii) Running speed - 60 seconds per stand.

iii) Set slips slowly and avoid jarring the assembly.

iv) DO NOT USE EXCESSIVE DP DOPE - dope pins only and wipe off excess dope squeezed out of the connection.

6. Complete RIH with gravel pack assembly and set down gently on Johnston Mach II plug at 1543 m - c. 10000 lbs wt. should be adequate; control with heave compensator. Space out DP to place top at +/- 3 m above derrick floor. After spacing out and gently tagging (do not set down any weight) the Johnston Mach II plug, install circulating valve on top of DP. Hook up Dowell lines and pressure test same to 5000 psi. Circulate DP volume + 20% and then drop 1-½" kirksite packer setting ball (allow 5 mins/ 300 m for ball to fall).

7. When packer ball is estimated to have landed pressure up on DP 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.

8. Pull 15000 lbs over whole string weight to check packer set (use heave compensator). With DP circulating valve open and upper annular closed, pressurise annulus to 500 psi down kill line to check packer element sealing. Open upper annular.

9. Using heave compensator, slack down to 5000 lbs upward pull at packer. Rotate DP 10-12 turns to the right at the packer to back out with the crossover tool. When crossover tool comes free, set back down on packer with 30,000 lbs weight to ensure location of squeeze position,where the left hand running thread of the setting tool locates on the top of the packer. Mark the pipe - this mark will be referred to as mark (1) for the squeeze position. Establish injection rates and pressures - max surface pressure 846 psi with 1.15 S.G. brine in the hole,corresponding to a bottom hole pressure of +/- 3336 psi,200 psi below 1.64 S.G. estimated fracture gradient.

10. Pick up approximately 1 - 1.5 m at the packer and set back down with indicator collet on lower indicating coupling, using sufficient weight (10000 lbs) to ensure definite location of the coupling. Mark the pipe - this mark will be referred to as mark (2) for circulating through the lower tell tale screen.

11. Pick up approximately 5-6 m at the packer and set back down with indicator collet on upper indicating coupling using sufficient weight (10000 lbs) to ensure definite location of the coupling. Mark the pipe - this mark will be referred to as mark (3) for reverse circulating above the packer.

12. Slack off weight to push indicator collet through upper and lower indicating couplings - approximately 15000 to 20000 lbs will be required. When mark (1) has been definitely located, pick up and locate mark (2). Set 10000 lbs weight on indicating coupling/indicator collet to ensure definite location of the circulating position.
At this stage the string is in position to commence the pre-acidization and gravel packing operations and the following points are to be noted:-

    a) It is essential that marks (1), (2) and (3) are unambiguous and hence they should be painted on the DP, 1 m above the DF at mid heave with simultaneous reading of the derrick floor tide indicator recorded in the drillers notebook.

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

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

    d) Sufficient chiksans must be available to the DP circulating valve to accomodate the necessary pipe movements.

13. Establish circulation through lower tell tale screen, increasing pump rates up to maximum surface pressure of 846 psi. Monitor returns closely for losses and plot surface pressures versus pump rates. Estimate friction losses in surface pipe and in DP.

14. Carry out the Pre GP acidization as outlined below:-

    A) Pump and squeeze the following fluids:-

        i) 80 bbls of 15% HCL containing 10% U66 and 1% A-200 (both by volume)

        ii) 160 bbls of 7.5% HCL acid and 1.5% HF acid combined.

        iii) 10 bbls of 3.0% NH_4 CL (Ammonia Chloride)

        iv) 160 bbls of HBF_4 (Fluoboric acid)

        v) 10 bbls of 3.0% NH_4 CL (Ammonia Chloride)

    N.B.

        a) Pump a total of 80.0 bbls of the above treatment fluids thereafter set down to position no. 1, the squeeze position, and squeeze the treatment fluids into the formation while pumping the remaining treatment fluids. Use brine to squeeze away into the formation the remaining treatment fluids.

        b) Ensure that the pump pressure is not sufficient to fracture the formation i.e. maximum allowable BHP +/- 3336 psi.

B) Pull back to position no. 2, the circulating position, upon completion of squeezing the above treatment fluids into the formation.

Mix breaker and gravel into previously gelled fluid - see Figs. 2.2 and 2.3 for fluid formulations and specifications.

15. Pump "water pack" fluids as follows:

a) 15 bbls "water pack" pre-pad 9.6 ppg (500 psi/1000 ft).

b) 20.16 bbls "water pack" slurry containing 7 lbs/gallon fluid of Baker "Low Fines", 20-40 mesh gravel. The slurry density is 12.15 ppg (630 psi/1000 ft).

c) 5 bbls "water pack" after pad 9.6 ppg (500 psi/1000 ft).

These slurries will lead to an imbalance between the heavy drillpipe and light annulus of +/- 148 psi while the fluids are in the drillpipe. Therefore, during the first +/- 38 bbls of displacement with brine until the 15 bbl "water pack" pre-pad arrives at the crossover tool, a maximum surface pressure of 698 psi may be used.

16. Displace "water pack" with brine at maximum allowable rate (max surface pressure 698 psi) until pre-pad reaches crossover tool - approximately after +/- 38 bbls of brine. Reduce pump rate to give maximum surface pressure of 200 psi. After pumping a further +/- 23.5 bbls the gravel slurry should cover the tell tale screen and a pressure rise should be noted at surface - do not exceed 846 psi.

17. Slack off work string down to mark (1), the squeezing position, and squeeze slurry out into the formation with a steady pump rate and surface pressure below 846 psi. When final screen-out occurs, reduce pump rate to maintain surface pressure below 846 psi as long as possible but ultimately let pump pressure increase to 1050 psi for the final squeeze. However, if no screen out is obtained, overdisplace with 10 bbls of completion fluid to clear the packer. Mix and prepare additional "water pack" pad and slurry volumes (50% of original job size) and repack. N.B. As tell-tale screen out has occurred, the "water pack" fluids will have to be displaced to the crossover tool with the drill pipe positioned at mark (3) the reverse circulation position, to allow direct circulation into the DP x 9-5/8" casing annulus. The string will then have to be lowered to mark (1), the squeezing position, for the repack.

18. After achieving satisfactory screen out, allow the pressure to bleed off. Close the annular preventer and pressurise the annulus to 500 psi. Pick up to mark (3), the reverse circulation position, and reverse out excess gravel/fines from above the packer.

19. Open the annular preventer, then POH with SC crossover/setting tool, washpipe etc.

INSTALLATION OF PRODUCTION STRING - CLEAN SAND GAS ZONE

1. Run the test string as per Fig. 3.0, excluding the 4½" tubing riser at this stage. 5" VAM tubing should be run to surface with a white painted single installed at the BOP level for spacing purposes.

   N.B. When the first full joint of the 5" VAM tubing has been run through the rotary table, rig up the wireline unit and install plug in the XN nipple above the perforated joint. Install x-overs and Lo-torq valve and pressure test plug to 3000 psi/15 minutes,recording pressure and observing for flow from annulus. If test satisfactory, recover plug and continue running tubing.

2. Check depth to Baker SC-1 packer by:

   i) Noting entry of mule shoe into packer.

   ii) Noting pressure increase when first seals enter packer bore while pumping slowly through tubing string.

   iii) Lowering tubing until locator seal assembly stops on top of packer.

3. With seal assembly fully stabbed into seal bore close middle 5" pipe rams around painted single for spacing purposes. Pressure test annulus to 500 psi/15 minutes down kill line. If all OK,bleed off pressure and open pipe rams (N.B. Check 5" VAM collar positions before closing rams).

4. Pull back +/- 400 m and calculate spacing requirements so that when fluted hanger lands in the wellhead, the top of the locator seals will be 2.5 - 3.0 m above the top of the packer.

5. Space out 5" VAM tubing. Install the tubing hanger, slick joint and SSTT. Run 4½", PH6 tubing riser, with the Flopetrol riser ball valve installed at +/- 50 m BDF, spaced out so that the top of the tubing riser is +/- 3 m above rig floor.

6. Flange up flow head and install Chiksan lines to flow and kill sides of flow head. Pressure test same to 3000 psi.

7. Stab into packer and land SSTT. Close middle 5" pipe rams around slick joint and pressure test annulus to 500 psi/15 minutes down kill line. Bleed off pressure and open rams.

8. Disconnect elevators, install 40' x 2½" strops and support tubing riser with same from heave compensated travelling block. Install wireline lubricator and wireline BOP and test same to 3000 psi/15 minutes.

9. RIH with 2" drift to tubing shoe. POH then RIH with wireline retained test plug and set same in XN nipple. Pressure test tubing and tubing riser to 3000 psi/15 minutes (do not shear off from the plug). Bleed off pressure slowly to zero and recover test plug.

10. Carry out the Post GP acidization as outlined below:-

    a) Rig up wireline and RIH and open 3½" XA-SSD. POH.

    b) Pump the following fluids:-

        i) 5 bbls diesel + 10% by volume U66
        ii) 30 bbls 15% HCL containing 10% U66 and 1% A-200 (both by volume)

    c) Displace the above fluids by diesel to within 2 bbls of the 3½" XA-SSD.

    d) RIH and close the SSD and test the annulus with 500 psi/15 mins POH.

    e) Bullhead the acid into the formation using diesel at the maximum rate and overdisplacing by 20 bbls.

        N.B. Ensure that the pumping pressure is not sufficient to fracture the formation i.e. maximum allowable BHP +/- 3336 psi.

11. Close middle 5" pipe rams. Pressure up annulus to 500 psi/ 15 minutes. Bleed pressure down to 100 psi (just to give a gauge reading).Keep the middle 5" pipe rams closed throughout the production testing programme and observe the annulus pressure via the kill line. Do not exceed 500 psi annulus pressure.

12. RIH with wireline sandbailer and tag bottom inside gravel pack. Record hold-up depth and retrieve sample of sand (if any).

TEST PROGRAMME - CLEAN GAS ZONE

Note: This outline programme is a guide only. Specific items eg. rates and durations lengths of build ups etc. may be varied in the light of onsite information gained during the test.

1. Open the well up and unload slowly, flow through the separator at the earliest opportunity. Stabilize the flow rate at +/- 10 MMscf/d for 2 hrs.

2. Flow the well at the following rates and durations:

Rate (MMscf/d)	Duration (hrs)
10	3
20	6 (Thornton trials)
40	3
60 (if possible)	3

Note: If continuous sand production is evident, bean back to previous sand free production rate and advise Base.

3. Close in and make 2" drift run to F nipple. Run 2 x Sperry Sun MRPG gauges, sample period 1 min (28 hrs running time) and 1 x Amerada (3000 psi element, 24 hr clock). Make gradient stops in the lubricator, at seabed 600 m and 300 m above the mule shoe while RIH.

4. Open up the well and flow at the following rates and durations:

Rate (MMscf/d)	Duration (hrs)
10	4
20	8 (Thornton and KSLA sampling)
40	4
60 (if possible)	4

5. Close in for a 2 hrs build up period. RIH and retrieve the pressure gauges performing gradient stops as in step 3 above.

6. Open the well up slowly to 60 mmscf/d, i.e. over a one hour period. Continue to bean up to the maximum attainable flowrate and flow at this stabilized rate for 2 hrs. (Note: Bypass sand filters and Thornton manifold. Measure sand production via SANDEC equipment).

7. Conclude gas zone test and abandon test zone.

Notes:

i) Flow through the 6"/5000 psi flowline and the dual separator/choke manifold arrangement.

ii) Inject glycol via the chemical injection line to the EZ tree and at separators and choke manifolds.

iii) Once it has been ascertained that there is no sand production bypass the sand filter but monitor for sand via SANDEC equipment. Be prepared to switch flow through the sand filter if sand production occurs.

iv) Maintain a pressure of at least +/- 1500 psi greater than FTHP on the ball valve of the EZ tree.

ABANDONMENT - CLEAN SAND GAS ZONE

1. Squeeze tubing contents down to perforations with brine of 1.15 S.G. (500 psi/1000 ft), using a 50 bbl, HEC viscosified brine pill ahead. Observe tubing dead.

   Note: Take care not to fracture formation. Expected fracture gradient is 1.64 S.G. (710 psi/1000 ft), giving a maximum allowable BHP (200 psi safety) of 3336 psi. Maximum allowable surface pressure with 1.15 S.G. brine in the tubing is thus 846 psi.

2. RIH with wireline sand bailer and tag bottom again inside gravel pack. Record hold up depth and retrieve sand sample, (if any).

3. Pick up seals out of packer and reverse circulate and condition well with 1.15 S.G. brine. Observe well dead.

4. Flange down Xmas tree and pull production string, laying down 4½" tubing riser and the 5" tubing.

5. RIH with Baker Model "A" retrieving tool on 5" DP/6-1/4" DC's with fishing jars. Circulate above top of packer then set down onto packer with 15000 lbs to engage anchor latch in left-hand square thread at the top of the packer.

6. Pick up on the DP string to release the SC-1 packer. 15000 lbs upstrain is required to free the packer, but overpull will be required to recover the GP assembly complete. However, the GP shear-out safety joint will shear at 60000 lbs upstrain. (If the safety joint shears, the blank pipe and screen remaining in the hole will be recovered after step (7) with a spear).

7. POH with Model "A" retrieving tool and lay down recovered GP equipment.

8. RIH with 150 m, 2 7/8" tubing stringer on 5" DP. Wash down to Jonston Mach II bridge plug at 1543 m (WV), circulating with mud. Continue circulating with mud until the whole hole is displaced back to uniform, conditioned mud of weight 1.20 S.G.

9. With the tubing stinger shoe at 1540 m set a 125 m cement plug using the following slurry:-

   15.80 ppg Class G
   5.08 gps Freshwater
   1.15 cuft/sx yield.

   Displace with mud. POH slowly to place the tubing shoe +/- 30 m above the TOC and reverse the tubing and DP clean. Close BOP,s and attempt to squeeze cement through the perforations using a maximum surface pressure of 1000 psi. POH.

10. After WOC for 12 hours, RIH and tag plug with 8½" bit, using 2000 lbs weight.

11. Pressure test plug to 2000 psi/15 mins.

12. POH with 8½" bit and commence well abandonment programme (to be advised seperately).

SAFETY PROCEDURE FOR HANDLING EXPLOSIVES AND FLOWING WELL

SAFETY DURING LOADING AND FIRING

Before gun is armed all transmitters, cranes, welding machines, radar etc. must be switched off and remain switched off until the gun is fired. After firing, transmission can be resumed until the gun has been pulled to about 100 m below the seabed, but must then cease until the gun 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 must also 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 empolyed 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 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 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 casing 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 at night).

APPENDIX B

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.

Blowing off 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 advised that this operation is to take place and take the action and precautions necessary for this operation.

APPENDIX C

WELL STATUS 31/2-6

1. The well has been drilled vertically to a TD of 1760 m.

2. Casing and Tubing Data

Size	Weight	Grade	Coupling	Depth (m BDF)	Collapse Strength	Internal Yield	Capacity BBL/FT
30"	310	X-52	Vetco ATD-RB	448			-
20"	133	K-55	BTC	810	1500	3060	-
13-3/8"	72	L-80	BTC	1475	2670	5380	-
9-5/8"	47	N-80	BTC	1752	4750	6870	0.0732
9-5/8"	47	L-80	VAM	1377	4750	6870	0.0732
3½"	10.2	C-75	VAM	Make up 4700ft/lbs	11360	10480	0.0083
3½"	9.3	C-75	Hydril CS	3000ft/lbs	10040	9520	0.0087
4½"	19.2	C-75	Hydril PH6	7500ft/lbs	12960	12540	0.0126
5½"	15.5	J-55	LTC	2170ft/lbs	4040	4810	0.0238
2-7/8"	6.5	C-75	Hydril CS	2100ft/lbs	10470	9910	0.0058
5"	15.0	L-80	VAM	6500ft/lbs	7250	8290	0.0188
2-3/8"	4.7	P-105	Hydril CS	1500ft/lbs	15460	14700	0.00387

Note: No safety factors included in the pressure ratings.

When the collapsed section of 9 5/8" casing is retrieved and the exact depth of the dressed off stump becomes known a well status diagram will be issued showing the well configuration.

PROVISIONS FOR LOST CIRCULATION/BRINE LOSSES

a) If low losses are expected when the well is perforated then the CaCl2 brine may be slightly gelled using 1 lb J-164 (HEC) per bbl of brine. This would give a Marsh funnel viscosity of approx 50 at 80 degs F, 45 at 100 degs F and 38 at 150 degs F. Greater quantities of J-164 (HEC) can be used to give better fluid loss control but this could cause problems if the brine were required to be refiltered.

b) If high losses are expected when the well is perforated then slugs of CaCl2 brine gelled with J-164 (HEC) and containing CaCO3 can be spotted across the perforations until the losses stop.

If CaCO3 is used as a fluid loss additive then this can be cleaned up before the gravel pack by matrix acidizing with a mixture of Hydrochloric Acid and U66 (ethylene glycol monobutyl ether) which combined the normal characteristics of HCl with the U66 which reduces surface tension and thus aids the clean up.

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
Seperator pressure, separator temperature
Flowrate (liquid) and GOR
Sand concentration (see Appendix F)
Annulus pressure (via kill line)

In addition, all produced fluids should be measured for density. Gas should be analysed via the mud logging gas chromatograph, with H_2S 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 5 minutes during initial lubricator calibration stop.

b) Every 15 minutes during flow period.

c) After closing in for build up, every 5 minutes for the first hour, thereafter every ½ hour.

d) Every 5 minutes during the gradient stops at 300 m and 600 m above XN nipple and at seabed.

e) Every 5 minutes during the final lubricator calibration stop.

APPENDIX F

SAND DECTECTION DURING OIL TEST

Materials required

1. Acetone, toluene and paraffin
2. 10 x 63 sieves
3. 1 gallon cans
4. Electrically driven centrifuge and 50 centrifuge tubes
5. Watch glasses
6. Glass funnel

Procedure

a) Collect one imperial gallon crude oil from choke manifold as fast as possible in a clean container.

b) Shake the sample vigorously and slowly pour the contents over the sieve.

c) Wash the residue on top of the sieve with paraffin, toluene and acetone in that order and allow acetone to evaporate.

d) With the fine brush transfer the residue from the the top of the sieve into a graduated conical centrifuge tube, wash the glass funnel and brush with toluene so that particles are flushed into the tube. (It is unsafe to centrifuge with acetone).

e) Centrifuge for about 3 minutes and determine the volume in cubic ceintimetres of solids collected at the bottom of the tube. The tube should be clearly marked with sample number, date, zone on test, production rate, concentration of sand, well number.

f) Estimated sand concentration in lbs/1000 lbs: Sand content = 102 x No. of cc volume of solids centrifuged out. (For more accuracy, multiples of imp. gallons could be processed and the concentration devided appropriately).

g) To establish whether the sediment is partially wax, pour off excess toluene and add acetone, shake and pour off sediment free acetone. Drain sediment onto a watch glass, allow it to dry and heat to above 100 degs C. Observe for melting. This can also be verified under a microscope.

h) Carefully store samples and send ashore for analysis.

i) If wax is found to be a large percentage in item (d) the screen contents can be flushed with water so that the wax will lie above the sand and can be easily distinguished.

SAND CONCENTRATION - CRITERIA

The maximum allowable sustained concentration is 50 lbs/1000 bbls for all tests, including maximum rate tests. If the concentration exceeds this, the well should be beaned back and a further sample taken after 1½ tubing volumes. In the case of a maximum rate test, the test can be terminated once sustained sand production has been established. N.B. Some sand can always occurs after bean change.

In general:

25 lbs/1000 bbls	-	continue with programme
25 - 50 lbs/1000 bbls	-	maintain the rate steady.
50 lbs/1000 bbls	-	bean back rate by half and repeat beaning back until concentration declines.

It is expected that, during clean up, bursts of high sand concentration may be detected. These should not cause undue concern if they are not sustained.

APPENDIX G

SAND DETECTION DURING GAS TESTS

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

i) The Flopetrol "SANDEC" sand detection probe installed in the flowline.

ii) A "NAM" type sand trap will be installed in the flowline.

iii) Erosion probes will be placed at crucial elbows etc.

iv) A wall thickness meter will be used to detect abnormal wear on the chicksans.

APPENDIX H

SAMPLING REQUIREMENTS

a) The Thornton probe manifold will be included in the production test flowline to permit detailed onsite flow stream analyses. In addition KSLA will perform trace element analyses on produced fluids during the gas test.

b) No bottom hole samples are required for the oil zone test. 1 set of separator recombination samples plus 1 x 45 gallon of oil should be taken every 12 hrs.

c) No bottom hole samples are required for the gas tests. 6 sets of separator recombination samples should be taken when a constant CGR has been obtained.

d) 10 x 45 gallon of stabilized condensate (gas tests) should be collected if possible.

APPENDIX I

PROCEDURE FOR RECOMBINATION SAMPLES

A. Gas Sample

1. The bottles should be properly evacuated with a vacuum pump.

2. The Shell Petroleum Engineer ensures that bottles are filled up slowly and are at seperator 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 should be filled with mercury.

2. Displace slowly 500 cc mercury from 600 cc container with oil/condensate from seperator.

3. The Shell Petroleum Engineer ensures that bottles are at seperator pressure prior to being closed.

4. Draw off 50 cc of mercury to create gas cap.

5. Check containers and valves for leaks.

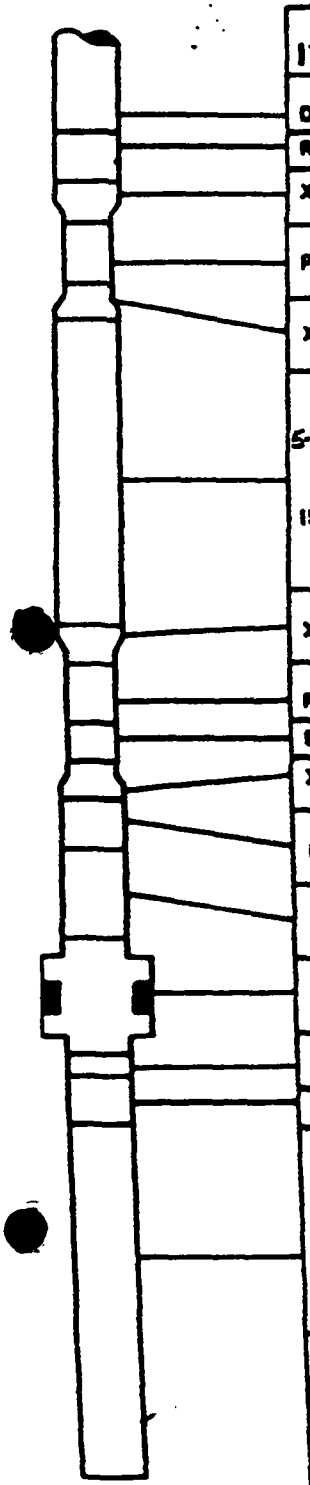
6. Mark bottles with sample number, date, time and well no.

7. Fill in surface PVT sampling forms.

Sample Bottle Working Pressure

Capacity	W.P.
5 litres	2,800 psi
0.6 (0.7) litres	10,000 psi

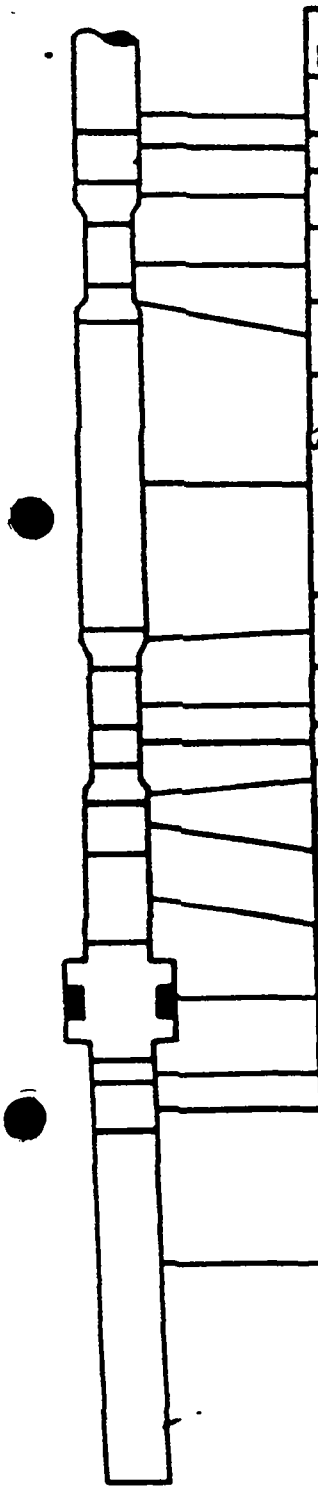
OIL ZONE BACKSURGE TOOL STRING (HALLIBURTON)



ITEM DESCRIPTION	MIN. I.D	MAX. O.D
DP, 5", 19.5 LBS/FT, 4½" IF (B) x (P)	3.687"	6.375"
RTTS CIRCULATING VALVE, 4½" IF (B) x (P)	3.000"	6.120"
X-OVER, 4½" IF (B) x 3½" IF (P)	2.347"	6.375"
PR DISC VALVE, 3½" IF (B) x (P)	1.870"	4.620"
X-OVER, 3½" IF (B) x 5" VAM (P)	2.347"	6.375"
5-6 BBL AIR CHAMBER, 91 m 5", 15.0 LBS/FT, TUBING 5" VAM (B) x (P)	4.285"	5.563"
X-OVER, 5" VAM (B) x 3½" IF (P)	2.347"	6.375"
PR DISC VALVE, 3½" IF (B) x (P)	1.870"	4.620"
BIG JOHN JARS, 3½" IF (B) x (P)	2.370"	4.620"
X-OVER, 3½" IF (B) x 4½" IF (P)	2.347"	6.375"
RTTS CIRCULATING VALVE, 4½" IF (B) x (P)	3.000"	6.120"
RTTS SAFETY JOINT, 4½" IF (B) x (P)	3.120"	6.120"
RTTS PACKER, 4½" IF (B) x 4½" DP (P)	3.440"	8.150"
X-OVER, 4½" DP (B) x 4½" IF (P)	3.687"	6.370"
"FUL-FLO" RUNNING CASE (BUNDLE CARRIER), 4½" IF (B) x (P)	2.250"	6.375"
18m, 5", 19.5 LBS/FT, DP, 4½" IF (B) x (P)	3.687"	6.375"
AS TAILPIPE, OPEN-ENDED.		

FIG. 1.1

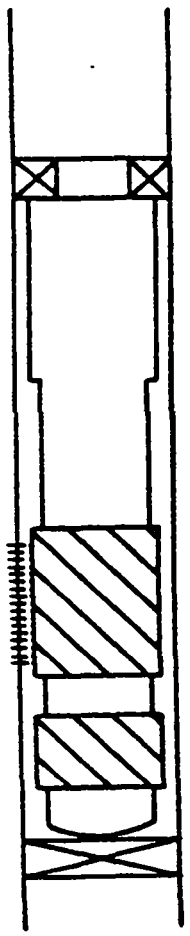
CLEAN GAS ZONE BACKSURGE TOOL STRING



ITEM DESCRIPTION	MIN. I.D	MAX. O.D
DP, 5", 19.5 LBS/FT, 4½" IF (B) x (P)	3.687"	6.375"
RTTS CIRCULATING VALVE, 4½" IF (B) x (P)	3.000"	6.120"
X-OVER, 4½" IF (B) x 3½" IF (P)	2.347"	6.375"
PR DISC VALVE, 3½" IF (B) x (P)	1.870"	4.620"
X-OVER, 3½" IF (B) x 5" VAM (P)	2.347"	6.375"
25 BBL AIR CHAMBER, 404 m 5", 15.0 LBS/FT, TUBING 5" VAM (B) x (P)	4.283"	5.563"
X-OVER, 5" VAM (B) x 3½" IF (P)	2.347"	6.375"
PR DISC VALVE, 3½" IF (B) x (P)	1.870"	4.620"
BIG JOHN JARS, 3½" IF (B) x (P)	2.370"	4.620"
X-OVER, 3½" IF (B) x 4½" IF (P)	2.347"	6.375"
RTTS CIRCULATING VALVE, 4½" IF (B) x (P)	3.000"	6.120"
RTTS SAFETY JOINT, 4½" IF (B) x (P)	3.120"	6.120"
RTTS PACKER, 4½" IF (B) x 4½" DP (P)	3.440"	6.150"
X-OVER, 4½" DP (B) x 4½" IF (P)	3.687"	6.310"
"FUL-FLO" RUNNING CASE (BUNDLE CARRIER), 4½" IF (B) x (P)	2.250"	6.375"
27 m, 5", 19.5 LBS/FT, DP, 4½" IF (B) x (P) AS TAILPIPE, OPEN-ENDED.	3.687"	6.375"

GP VOLUMES - OIL ZONE 31/2-6

(NB. All calculation to be checked on wellsite)



1552m TOP SC 1 PACKER

1566m TOP BLANK PIPE

1575m TOP GP SCREEN

1581m BASE GP SCREEN

1584m TOP WASP PACKER

GRAVEL TO FILL :

9.93 x 3.281 of 6.090 x 8.681 = 6.81 cu ft
10.36 x 3.281 of 5.500 x 8.681 = 8.36 cu ft
TOTAL = 15.17 cu ft

Therefore use 15.17/0.93 = 17 sxs gravel
(1700 lbs)

DP/DC Volume to packer = 85.0 bbls
Annuar volume around GP liner = 3.97 bbls

Therefore brine volume for tell tale screen out = 88.95 - (5+ 7.61)
= 76.34 bbls

FIG. 2.1

GRAVEL PACK FLUID FORMULATIONS/SPECIFICATIONS - OIL ZONE

"Pre-Pad" gelled fluid: 15 BBL, density 9.6 ppg

15 BBL - 9.6 ppg CaCl2 solution
51 lb - J164, gelled agent
Caustic soda as required to adjust pH to 8.5 - 9.0
19.5 lb - J286, breaker
2.5 gal - A200, inhibitor
(0.5 gal - D47, antifoam agent if required)

"Water Pack" slurry: 7.6 BBL, density 12.15 ppg

3.47 BBL - 9.6 ppg CaCl2 solution = 5.78 BBL of
2.31 BBL - Fresh water 9.0 ppg CaCl2 solution
10.5 lb - J164, gelling agent
Caustic soda as required to adjust pH to 8.5 - 9.0
4.1 lb - J286, breaker
0.5 gal - A200, inhibitor
(0.1 gal - D47, antifoam agent if required)
1700 lb - 12-20 mesh gravel (7 ppg)

"Post Pad" gelled fluid: 5 BBL, density 9.4 ppg

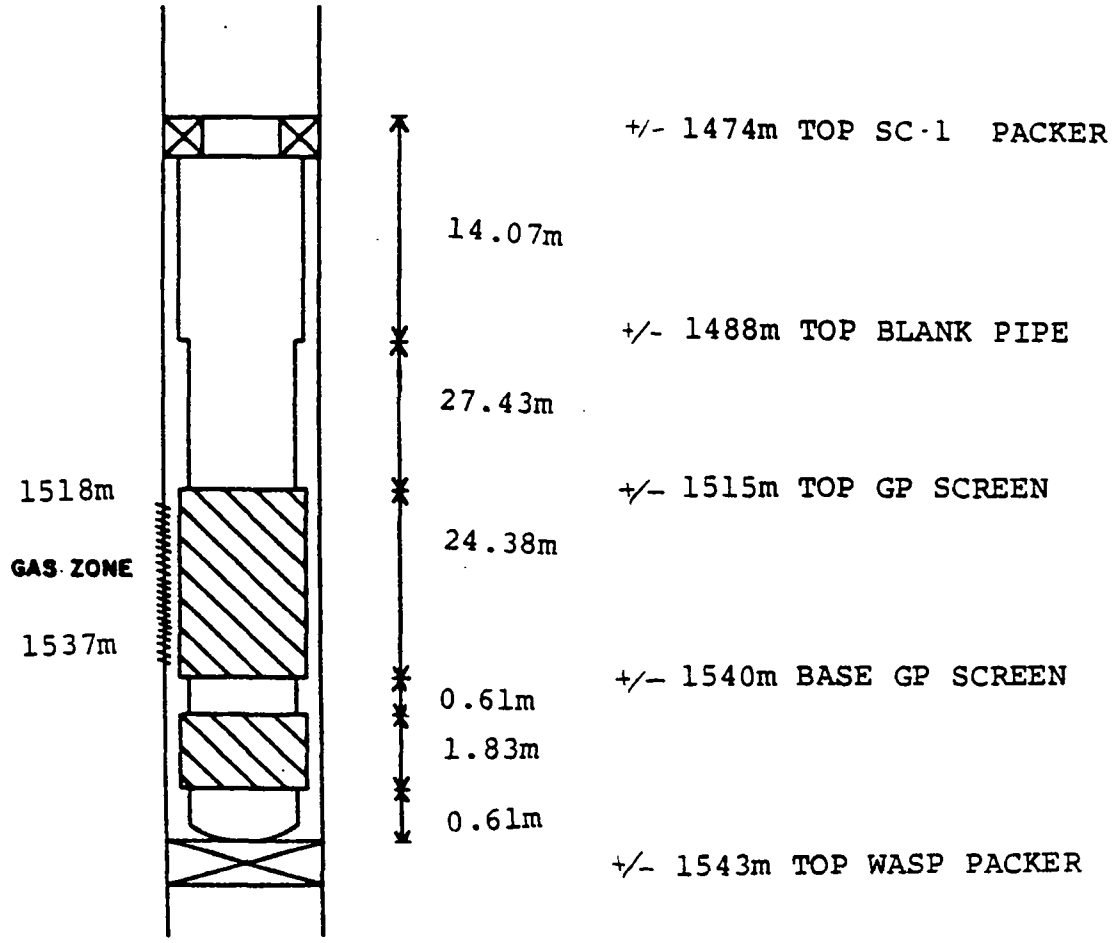
5 BBL - 9.6 ppg CaCl2 solution
17 lb - J164, gelling agent
Caustic soda as required to adjust pH to 8.5 - 9.0
6.5 lb - J286, breaker
0.8 gal - A200, inhibitor
(0.2 gal - D47, antifoam agent if required)

Note

1. All fluids to be filtered to 2 microns prior to mixing.
2. The use of D47 is recommended to ensure that all air is removed from the slurry.
3. Extra caustic soda may be required to adjust the pH of the fluid when mixing the gel.

GP VOLUMES - GAS ZONE 31/2-6

(NB. All calculations to be checked onsite)



GRAVEL TO FILL :

26.21 x 3.281 of 6.090 x 8.681	= 17.98 cu ft
28.65 x 3.281 of 5.500 x 8.681	= 23.13 cu ft
TOTAL	= 41.11 cu ft
Therefore use 41.11/0.93	= 45 sxs Gravel (4500 lbs)

DP/DC Volume to packer = 78.88 bbls
Annual volume around GP liner = 8.57 bbls

Therefore brine volume for tell tale screen out = 87.45 - (5+ 20.16)
= 62.29 bbls

FIG. 2.3

GRAVEL PACK FLUID FORMULATIONS/SPECIFICATIONS - GAS ZONE

"Pre-Pad" gelled fluid: 15 BBL, density 9.6 ppg

15 BBL - 9.6 ppg CaCl2 solution
51 lb - J164, gelled agent
Caustic soda as required to adjust pH to 8.5 - 9.0
19.5 lb - J286, breaker
2.5 gal - A200, inhibitor
(0.5 gal - D47, antifoam agent if required)

"Water Pack" slurry: 20.16 BBL, density 12.15 ppg

9.19 BBL - 9.6 ppg CaCl2 solution = 15.31 BBL of
6.13 BBL - Fresh water 9.0 ppg CaCl2 solution
10.5 lb - J164, gelling agent
Caustic soda as required to adjust pH to 8.5 - 9.0
4.1 lb - J286, breaker
0.5 gal - A200, inhibitor
(0.1 gal - D47, antifoam agent if required)
4500lb - 20-40 mesh gravel (7 ppg)

"Post Pad" gelled fluid: 5 BBL, density 9.6 ppg

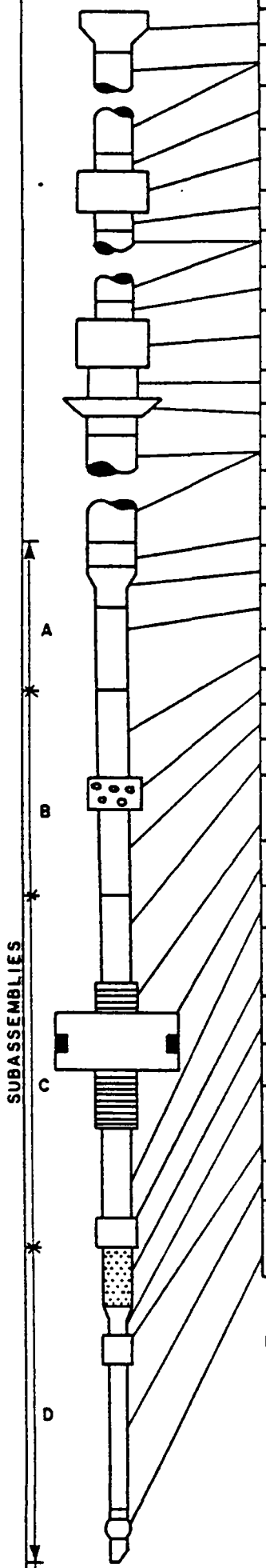
5 BBL - 9.6 ppg CaCl2 solution
17 lb - J164, gelling agent
Caustic soda as required to adjust pH to 8.5 - 9.0
6.5 lb - J286, breaker
0.8 gal - A200, inhibitor
(0.2 gal - D47, antifoam agent if required)

Note

1. All fluids to be filtered to 2 microns prior to mixing.
2. The use of D47 is recommended to ensure that all air is removed from the slurry.
3. Extra caustic soda may be required to adjust the pH of the fluid when mixing the gel.

9 5/8 CASING BY 5" TUBING PRODUCTION TEST STRING

FIG. 3



ITEM DESCRIPTION	MIN. I.D	MAX. O.D.
X-OVER, 6 1/2" ACME (B) x 4 1/4" PH6(P); C75	3.515"	
TUBING; 4 1/2", 19.2 LBS/FT, PH6, C75	3.515"	5.313"
X OVER; 4 1/2" PH6(B) x 4 1/2", ACME (P); C75	3.515"	5.513"
FLOPETROL LUBRICATOR VALVE; H2S SERVICE; 10000 PSI W.P; 4 1/2" AMCE (B) x (B)	3.000"	10.750"
X OVER; 4 1/2", AMCE (P) x 4/", PH6(P); C75	3.515"	5.513"
TUBING; 4 1/2", 19.2 LBS/FT, PH6, C75	3.515"	5.513"
X OVER; 4 1/2", PH6 (B) x 4 1/2" AMCE (P); C75	3.515"	5.513"
FLOPETROL EZ TREE; H2S SERVICE; 10000 PSI W.P.; 4 1/2" AMCE (B) x (B).	3.000"	10.750"
SLICK JOINT; 4 1/2", ACME (P) x (P); C75	3.000"	5.000"
FLUTED TUBING HANGER; 4 1/2", ACME (B) x (B); C75	3.000"	
X-OVER, 4 1/2", ACME (P) x 5", VAM (P); C75	3.000"	5.000"
TUBING; 5", 15 LBS/FT, VAM, L80	4.283"	5.563"
PUP JOINT (5'); 5", 15 LBS/FT, VAM, L80	4.283"	5.563"
X-OVER, 5", VAM (B) x 3 1/2", CS (P); C75	2.867"	5.563"
TUBING JOINT; 3 1/2", 9.3 LBS/FT, CS; C75	2.867"	3.905"
PUP JOINT; 3 1/2", 9.3 LBS/FT, CS, C75	2.867"	3.905"
OTIS 3 1/2" SSD; 2.75" SEAL BORE, 3 1/2" CS (B) x (P), C75	2.750"	4.280"
PUP JOINT; 3 1/2", 9.3 LBS/FT, CS, C75	2.867"	3.905"
PUP JOINT; 3 1/2", 9.3 LBS/FT, CS, C75	2.867"	3.905"
BAKER G-22 LOCATOR SEAL ASSEMBLY 20FT LONG. SIZE 190-47; 3 1/2" CS (B) x 3 1/2" EU (P)	3.000"	4.750"
BAKER SC-1GP PACKER; SIZE 96A4-47	4.750"	8.440"
PUP JOINT, 3 1/2", 9.3 LBS/FT, CS, C75	2.867"	3.905"
OTIS 3 1/2" "XN" NIPPLE, NO GO 2.635; SEAL BORE 2.750; 3/", CS (B) x (P); C75	2.635"	4.280"
10FT. PERFORATED JOINT; 3 1/2", 10.3 LBS/FT	2.867"	3.905"
X-OVER 3 1/2" CS (B) x 2 7/8" CS (P)	2.440"	3.905"
BAKER 2 7/8" "F" NIPPLE; NO GO 2.250; 2 7/8" CS (B) x (P), C75	2.250"	3.250"
TUBING JOINT; 2 7/8", 6.5 LBS/FT, CS, P105	2.347"	3.220"
BARREL SHAPED / HALF MULE SHOE 2 7/8" CS (B); P105	2.347"	3.400"

NB. ALL DIMENSIONS TO BE CHECKED PRIOR TO RUNNING.

a·s Norske Shell
EXPLORATION & PRODUCTION FORUS

AUTHOR	ENCL	DATE
REPORT NO		DRAW NO

PROPOSED FLOWSCHEME ON DERRICKFLOOR "BORGNY DOLPHIN"

1 3 1/16" /10.000 W.P. FLOWHEAD WITH AUT. WINGVALVE.
2 2" TXT SWING CHECK VALVE.
3 2"/1502 KILL LINE.
4 90° ANGLE BLOCK WITH 4"/1002 MALE (NUT) OUTLET.
5 HYDRAULIC SHUT DOWN LINE TO M.G. AND FLOW WINGVALVE.
6 GUIDE CLAMP FOR LUBRICATOR.
7
8 4"/1002 ELBOW.
9
10
11 SAND DETECTION SPOOL + PROBE (SANDEC) 4"/1002 CONNECTIONS.
12 NAM TYPE SANDFILTER SKID (See separate sketch). HORIZONTALLY INSTALLED.
13 SAND DETECTION MONITOR (SANDEC).
14 3"/1502 THORNTON MANIFOLD
15 4"/5000 W.P. BY.PASS MANIFOLD (See separate sketch)
16 4"/1502 CHICKSANS.
17 3"/1502 CHICKSANS.
18 3"/1502 10.000 W.P. PERMANENT LINE.
19 6"/5000 W.P. PERMANENT LINE ENDCONNECTIONS TO BE CHANGED TO 4"/1002 WECO (ARE 3"/1502)
20 E/Z TREE AND LUBRICATOR VALVE CONTROL UNIT.
21 GLYCOL INJECTION PUMP.

NOTE: Sketch shows top view of skids and are installed flat on drillfloor.

4" NOMINAL LINES, HOSES AND CONNECTIONS.

3" NOMINAL LINES (WECO 3"/1502)