Blackback A-2



# ESSO AUSTRALIA LTD.

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| Technology Manager | Cindy Reece | Room 738<br>16945 Northchase Dr.<br>Houston, TX 77060-2108 USA |

# ESSO AUSTRALIA LIMITED

# BLACKBACK PHASE 1 SUBSEA DEVELOPMENT

## Completion Program
## Well A-2

☐ Preliminary Draft:
☒ Original Issue: 4 May 1999
☐ Revision No __:

**NOTICE: This Completion Program supercedes completion information in previous Drilling Programs.**

PREPARED BY:

Completions Engineer: C. M. Shaughnessy CMS Date: 4 May 1999

REVIEWED AND APPROVED BY:

Engineering Supervisor: D J Parker Date: 13/5/99

Subsea Supervisor: Jamie Williams Date: 13/5/99

Operations Superintendent: L Mid Pearce Date: 12/5/99

Area Drilling Manager: D T Dineen Date: 14/5/99

**NOTE: This program is to be used in conjunction with the Floating Drilling Operations Manual and the Blackback Subsea Equipment Installation Procedures Manual.**

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# 1.0 Introduction

## 1.1 Completion Objectives

The Blackback Phase 1 Development on license VIC L-20 in the Bass Strait is located in 395m of water approximately 20 km SE of the Mackerel platform. It will consist of three subsea wells in a daisy chain arrangement drilled and completed from the Sedco 702 semisubmersible. The Blackback A-2 well will twin the Blackback-2 exploration well and is expected to encounter high-quality Paleocene age sands -- with a gross oil column from 2801 m TVD SS to the oil-water contact at 2836 m TVD SS. Production will be via an 8" pipeline to host facilities on the Mackerel platform. Blackback A-2 is the middle well in the daisy-chain and is expected to produce at a rate of 6,000 BOPD.

The main objective of the completion program is to ensure that the Blackback A-2 well is completed and made ready for production in a safe, efficient and cost effective manner. The completion has been designed to maximize well productivity and mechanical reliability for the 15-year field life. CRA materials and completion jewelry have been selected to minimize future requirements for workover intervention.

The completion will commence immediately after the well is cased. After installing the subsea tree, the well will be perforated in an underbalanced condition against a closed wing valve and left ready to produce. Flexible jumpers were previously installed to connect the three subsea wells to the pipeline; the jumpers will be pressure tested through the subsea tree on well A-2. Production clean up and well testing will be directly to the pipeline. First oil is targeted for June 1999.

## 1.2 Safety

The Esso Operations Supervisor in accordance with Esso's requirements will hold safety meetings and Job Safety Analysis (JSA) and Step Back 5X5. As a minimum, safety meetings should be held prior to starting the operations of each section of this completion program. A Job Safety Analysis will be conducted for each non-routine or critical operation and for all simultaneous operations. All simultaneous operations require a work permit.

## 1.3 Sequence of Activities and Time Estimate

| Activity | Time (days) |
|---|---|
| Run Completion Guide Base (completed) | 0.75 |
| Clean-up and Displace Fluids | 1.00 |
| Run Perforating Guns | 0.75 |
| Run Completion String on Tubing Riser | 3.00 |
| Pull BOP and Drilling Riser | 1.00 |
| Run Subsea Tree on Tubing Riser | 3.75 |
| Fire Perforating Guns (monitor DHPT gauge) | 0.25 |
| Pull Tubing Riser and Install Tree Cap | 1.75 |
| TARGET | 12.25 |
| Non-Productive Time Allowance | 2.75 |
| TOTAL | 15.00 |

## 1.4 Reference Documents

- Blackback A-2 Well, Subsea Development Drilling and Evaluation Program
- Blackback Subsea Completions Procedures
  Procedures from this document are referenced as SCP-XXX-YYY, where XXX is the section number and YYY is the procedure number
- Blackback Phase 1 Reservoir Project Development Memorandum
- Esso Australia Ltd. Completions Manual
- ABB Vetco Gray Field Service Manual (FSM 98128 Volume I-IV)

# 1.0 Introduction

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The Blackback Phase 1 Development on license VIC L-20 in the Bass Strait is located in 395m of water approximately 20 km SE of the Mackerel platform. It will consist of three subsea wells in a daisy chain arrangement drilled and completed from the Sedco 702 semisubmersible. The Blackback A-2 well will twin the Blackback-2 exploration well and is expected to encounter high-quality Paleocene age sands -- with a gross oil column from 2801 m TVD SS to the oil-water contact at 2836 m TVD SS. Production will be via an 8" pipeline to host facilities on the Mackerel platform. Blackback A-2 is the middle well in the daisy-chain and is expected to produce at a rate of 6,000 BOPD.

The main objective of the completion program is to ensure that the Blackback A-2 well is completed and made ready for production in a safe, efficient and cost effective manner. The completion has been designed to maximize well productivity and mechanical reliability for the 15-year field life. CRA materials and completion jewelry have been selected to minimize future requirements for workover intervention.

The completion will commence immediately after the well is cased. After installing the subsea tree, the well will be perforated in an underbalanced condition against a closed wing valve and left ready to produce. Flexible jumpers were previously installed to connect the three subsea wells to the pipeline; the jumpers will be pressure tested through the subsea tree on well A-2. Production clean up and well testing will be directly to the pipeline. First oil is targeted for June 1999.

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## 1.3 Sequence of Activities and Time Estimate

| Activity | Time (days) |
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| Run Completion Guide Base (completed) | 0.75 |
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| Pull BOP and Drilling Riser | 1.00 |
| Run Subsea Tree on Tubing Riser | 3.75 |
| Fire Perforating Guns (monitor DHPT gauge) | 0.25 |
| Pull Tubing Riser and Install Tree Cap | 1.75 |
| TARGET | 12.25 |
| Non-Productive Time Allowance | 2.75 |
| TOTAL | 15.00 |

## 1.4 Reference Documents

- Blackback A-2 Well, Subsea Development Drilling and Evaluation Program
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  Procedures from this document are referenced as SCP-XXX-YYY, where XXX is the section number and YYY is the procedure number
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- Esso Australia Ltd. Completions Manual
- ABB Vetco Gray Field Service Manual (FSM 98128 Volume I-IV)

# 2.0 General Well Information

## 2.1 Reservoir Parameters

The reservoir parameters expected at Blackback A-2 are listed in the *Blackback Phase 1 Reservoir Project Development Memorandum*. Depths and perforation intervals for Location D are provided by Reservoir Engineering.

| Main Objective | | Paleocene Location D |
|---|---|---|
| Top Latrobe | | 3630 m MD DF<br>2791 m TVD DF<br>2765 m TVD SS |
| Top Oil Reservoir | | 3685 m MD DF<br>2827.3 m TVD DF<br>2801.3 m TVD SS |
| Perforation Interval #1 | 9.0 m MD<br>5.8 m TVD | 3685 - 3694 m MD DF<br>2801.4 - 2807.2 m TVD SS |
| Perforation Interval #2 | 9.0 m MD<br>5.8 m TVD | 3699 - 3708 m MD DF<br>2810.5 - 2816.3 m TVD SS |
| Oil-Water Contact | | 3738 m MD DF<br>2861 m TVD DF<br>2835 m TVD SS |
| Reservoir Pressure at 2826 m TVD DF<br>(Oil Gradient = 0.78 psi/m) | | Max = 4035 psig (4050 psia)<br>Min = 3980 psig (3995 psia) |
| Reservoir Temperature | | 90°C (194°F) |
| $H_2S$ | | 400 ppm - partial pressure 1.6 psi |
| $CO_2$ | | 0.5 mol% - partial pressure 20 psi |

## 2.3 Well Status Prior to Completion

Blackback Well A-2 will be drilled and completed from the Sedco 702 Semisubmersible drilling rig. The drilling plans are described in the *Blackback A-2 Well, Subsea Development Drilling and Evaluation Program*. At the end of the drilling phase, the well status will be as follows:

| | |
|---|---|
| Water Depth | 395 m |
| Rig Drill Floor to Sea Level | 26 m |
| Total Depth | 3811 m MD DF<br>2909 m TVD DF<br>2883 m TVD SS |
| Maximum Well Angle | 50° |
| Well Angle Through Reservoir | 49° |
| 10 3/4" x 9 5/8" Production Casing Shoe | 3803 m MD DF |
| 10 3/4" x 9 5/8" Casing Crossover Depth | 1164 m MD DF |
| 10 3/4" x 9 5/8" Production Casing Test Pressure | 5000 psi |
| Fluid Inside Casing | Seawater |

Figure 2-1 shows a well schematic at the end of the drilling phase.

The three flexible jumpers will be connected to the flowline hubs on the CGB's and PTA, ready for pressure testing. The umbilical jumpers for well A-2 will have one end connected to the UTA/EDU and the other end parked on CGB A-2, ready for connection to the A-2 subsea tree.

| | |
|---|---|
| Flexible Jumpers #1, #2, #3 | Connected to CGB's & PTA (ready for pressure testing) |
| Electrical Umbilical Jumper for Well A-2 | Parked on CGB A-2 |
| Hydraulic Umbilical Jumper for Well A-2 | Parked on CGB A-2 |

## 2.3 Well Status After Completion

The well will be completed according to the following schematics:

- Figure 2-2 Blackback Well A-2 Completion Sketch
- Figure 2-3 Blackback Subsea Tree Valve Status Sheet **SCP 000-010**

Actual depths may be adjusted according to the geology determined during drilling.

The upper portion of the tubing will be filled with approximately 100 bbl of Baroid XP-07 Sarapar 147 base oil blend, which will result in a pressure of about 970 psi at the subsea tree for initiating production to the pipeline.

The flexible and umbilical jumpers will be fully connected and tested during the completion operations. Their status will be as follows:

| | |
|---|---|
| Flexible Jumpers #1, #2, #3 | Connected to CGB's & PTA (pressure tested) |
| Electrical Umbilical Jumper for Well A-2 | Connected to SCM A-2 |
| Hydraulic Umbilical Jumper for Well A-2 | Connected to SCM A-2 |

## 2.4 Pressure Test Summary

The mechanical complexity and remoteness of subsea installations requires a concerted effort to achieve pressure integrity. Pressure test procedures and acceptance criteria are documented in **SCP 000-040**. The key pressure tests that will be conducted to verify the integrity of the completion are summarized in Table 2-1. For specific information about each test, refer to the step number provided in the Table.

Table 2-1
Pressure Test Summary

| STEP | CONNECTION | ΔP | TIME | CHART | ACCEPT | COMMENT |
|---|---|---|---|---|---|---|
| **CONTROL LINES** | | | | | | |
| 5.1 | Control line tubing | 7500 psi | 10 min | No | Zero Leak | Test on reel |
| 5.3.11 | Connections to TRC | 5000 psi | 10 min | No | Zero Leak | Test through reel |
| 5.3.13 | Connection to RH2 | 5000 psi | 10 min | No | Zero Leak | Test through reel |
| 5.4.3 | Connection to TRM | 5000 psi | 10 min | No | Zero Leak | Test through reel |
| 57.4.1 | Tbg Hgr Connections TRC/RH2/TRM | 4500 psi | | Yes | 15 min straight line | 4800 psi ΔP downhole |
| **TUBING HANGER** | | | | | | **SCP 400-020** |
| 5.4.8 | Tbg Hgr to THROT - Prod Bore | 5000 psi | | Yes | 15 min straight line | Test against plug in TH |
| 5.4.8 | Tbg Hgr to THROT - Annulus Bore | 4000 psi | | Yes | 15 min straight line | Test against test cap |
| 5.5.9 | Tbg Hgr to Wellhead from Above | 3500 psi | | Yes | 15 min straight line | Thru kill line against annular closed on THROT |
| 5.6.13 | Tbg Hgr to Wellhead from Below | 2800 psi | | Yes | 15 min straight line | 3000 psi below/ 200 above |
| **PRODUCTION TUBING** | | | | | | |
| 7.6.7 | Production Tubing @ Tbg Hgr<br>to Annulus @ Packer | 3300 psi<br>2500 psi | | Yes | 15 min straight line | 3500 psi at surface |
| **PRODUCTION PACKER** | | | | | | |
| 5.6.9 | Packer from Below | 2500 psi | | Yes | 15 min straight line | 3500 psi at surface |
| 5.6.13 | Packer from Above | 3000 psi | | Yes | 15 min straight line | 3000 psi annulus<br>-1000 psi tubing<br>+1000 psi underbalance |
| **SAFETY VALVES** | | | | | | |
| 5.6.4 | PSCSSV Inflow - low P (std EAL test) | 300 psi | 30 min | Yes | 8 psi/min (API 14B | 2000psi below/1700 above |
| 5.6.10 | PSCSSV Inflow - high P | 3250 psi | 30 min | Yes | 8 psi/min (API 14B | 3500 psi below/ 250 above |
| 5.6.14 | ASCSSV Inflow | 2800 psi | 30 min | Yes | API RP14B Leak | 3000 psi below/ 200 above |
| **TUBING HANGER PLUG** | | | | | | |
| 5.6.17 | Wireline Plug in Tbg Hgr from Above | 3200 psi | | Yes | 15 min straight line | |

Pressure Test Criteria: 15 min Straight Line = 1% loss over 15 min with decreasing trend

| Reference Data | | |
|---|---|---|
| | SITP = 3250 psi @ 395 m TVD SS | FWHP = 1800 psi @ 395 m TVD SS |
| | BHP = 3980 psig @ 2800 m TVD SS | Gas Lift = 1900 psi |
| | BHP = 3995 psia @ 2800 m TVD SS | Seawater Hydrostatic = 577 psi @ 395 m TVD SS |

Table 2-1 Continued
Pressure Test Summary

| STEP | CONNECTION | ΔP | TIME | CHART | ACCEPT | COMMENT |
|---|---|---|---|---|---|---|
| **TREE / LWRP / EDP / RISER** | | | | | | **SCP 500-010 & 020** |
| 6.3.5 | Before running subsea | 5000 psi | | Yes | 15 min straight line | 5000 psi to fire perf gun |
| 6.3.22 | After landing subsea | 5000 psi | | Yes | 15 min straight line | 5000 psi to fire perf gun |
| **TREE CONNECTIONS** | | | | | | **SCP 500-020** |
| 6.3.20 | Tree to Tubing Hanger - Control Lines | 4500 psi | | Yes | 15 min straight line | 5000 psi ΔP downhole |
| 6.3.21 | Tree to Wellhead (VX gasket) | 5000 psi | | Yes | 15 min straight line | |
| 6.4.1 | Tree to Tubing Hanger - Prod Bore | 3000 psi | | Yes | 15 min straight line | 3200 ΔP on PXX plug |
| 6.4.2 | Tree to Tubing Hanger -Annulus Bore | 2700 psi | | Yes | 15 min straight line | Max SITP = 3250 psi |
| 6.4.2 | Tree to Flowline - Production | 2700 psi | | Yes | 15 min straight line | SW Hydrostatic = 572 psi |
| 6.4.2 | Tree to Flowline - Annulus | 2700 psi | | Yes | 15 min straight line | ax operating ΔP=2678 psi |
| **TREE VALVES** | | | | | | **SCP 500-040** |
| 6.4.3 | Annulus Master Valve - from below | 2500 psi | | Yes | 15 min straight line | 2700 psi below/ 200 above |
| 6.4.5 | Production Master Valve - from below | 2800 psi | | Yes | 15 min straight line | 3000 psi below/ 200 above |
| 6.5.6 | Production Swab Valve -- from below | 2900 psi | | Yes | 15 min straight line | 3337 psi below/ 454 above |
| 6.5.6 | Production Wing Valve | 2700 psi | | Yes | 15 min straight line | |
| 6.5.7 | Annulus Swab Valve - from below | 1000 psi | | Yes | 15 min straight line | Read annulus pressure |
| 6.5.7 | Crossover Valve | 600 psi | | Yes | 15 min straight line | transducer from Mackerel |
| **FLEXIBLE JUMPERS** | | | | | | |
| 6.4.4 | Production Flex. Jumpers #1, #2, #3 | 3250 psi | | Yes | 15 min straight line | Pump/bleed at 44 psi/min |
| 6.4.4 | Gas Lift Flexible Jumpers #1, #2, #3 | 3250 psi | | Yes | 15 min straight line | Pump/bleed at 44 psi/min |
| **TREE CAP** | | | | | | **SCP 600-010** |
| 7.2.4 | Tree Cap Connect to Tree | 5000 psi | | Yes | 15 min straight line | |

Pressure Test Criteria: 15 min Straight Line = 1% loss over 15 min with decreasing trend

| | | |
|---|---|---|
| Reference Data | SITP = 3250 psi @ 395 m TVD SS | FWHP = 1800 psi @ 395 m TVD SS |
| | BHP = 3980 psig @ 2800 m TVD SS | |
| | BHP = 3995 psia @ 2800 m TVD SS | Gas Lift = 1900 psi |

Figure 2-1

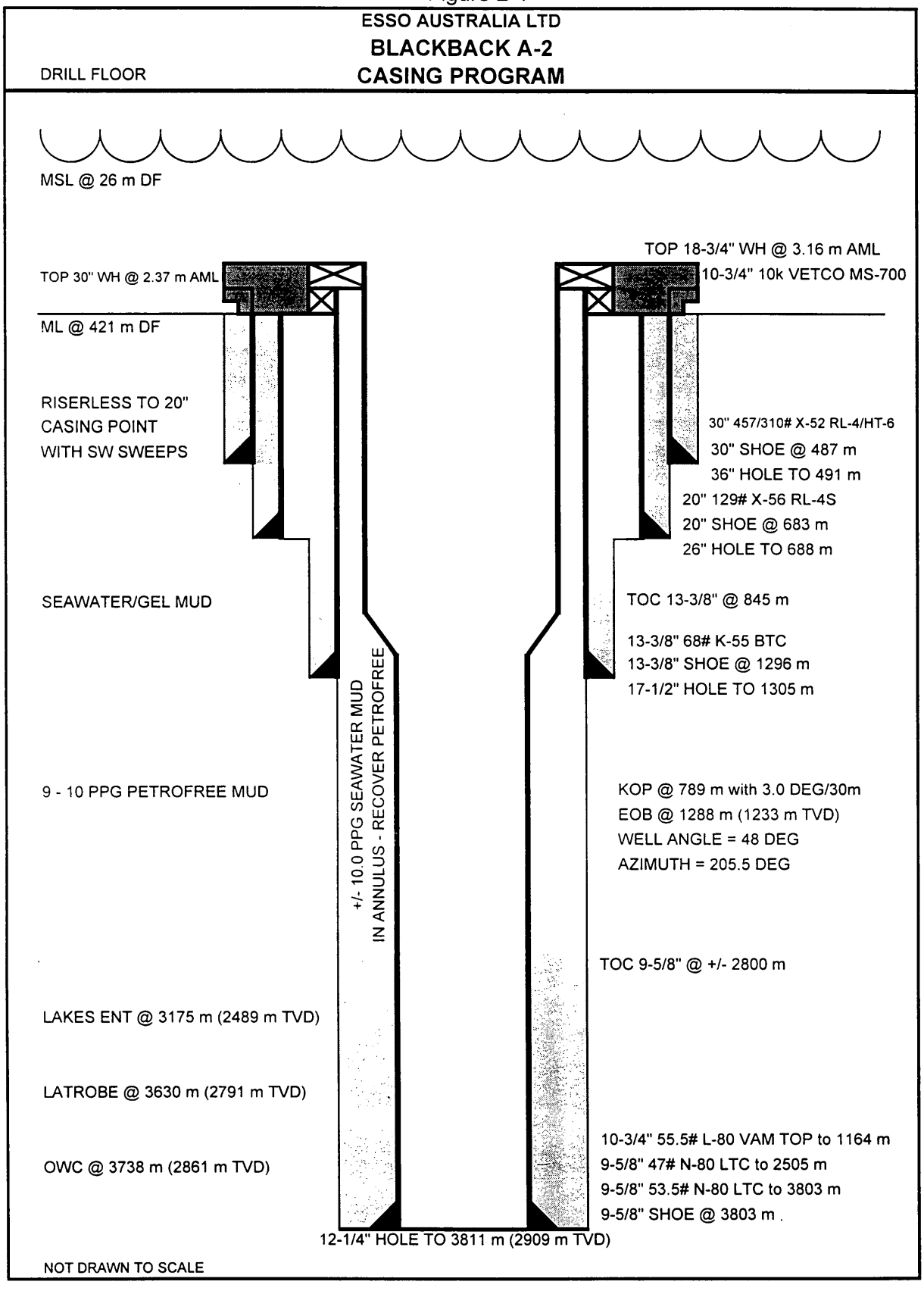

ESSO AUSTRALIA LTD
BLACKBACK A-2
CASING PROGRAM
DRILL FLOOR
MSL @ 26 m DF
TOP 30" WH @ 2.37 m AML
ML @ 421 m DF
RISERLESS TO 20"
CASING POINT
WITH SW SWEEPS
SEAWATER/GEL MUD
9 - 10 PPG PETROFREE MUD
LAKES ENT @ 3175 m (2489 m TVD)
LATROBE @ 3630 m (2791 m TVD)
OWC @ 3738 m (2861 m TVD)
+/- 10.0 PPG SEAWATER MUD
IN ANNULUS - RECOVER PETROFREE
12-1/4" HOLE TO 3811 m (2909 m TVD)
NOT DRAWN TO SCALE
TOP 18-3/4" WH @ 3.16 m AML
10-3/4" 10k VETCO MS-700
30" 457/310# X-52 RL-4/HT-6
30" SHOE @ 487 m
36" HOLE TO 491 m
20" 129# X-56 RL-4S
20" SHOE @ 683 m
26" HOLE TO 688 m
TOC 13-3/8" @ 845 m
13-3/8" 68# K-55 BTC
13-3/8" SHOE @ 1296 m
17-1/2" HOLE TO 1305 m
KOP @ 789 m with 3.0 DEG/30m
EOB @ 1288 m (1233 m TVD)
WELL ANGLE = 48 DEG
AZIMUTH = 205.5 DEG
TOC 9-5/8" @ +/- 2800 m
10-3/4" 55.5# L-80 VAM TOP to 1164 m
9-5/8" 47# N-80 LTC to 2505 m
9-5/8" 53.5# N-80 LTC to 3803 m
9-5/8" SHOE @ 3803 m

Figure 2-2

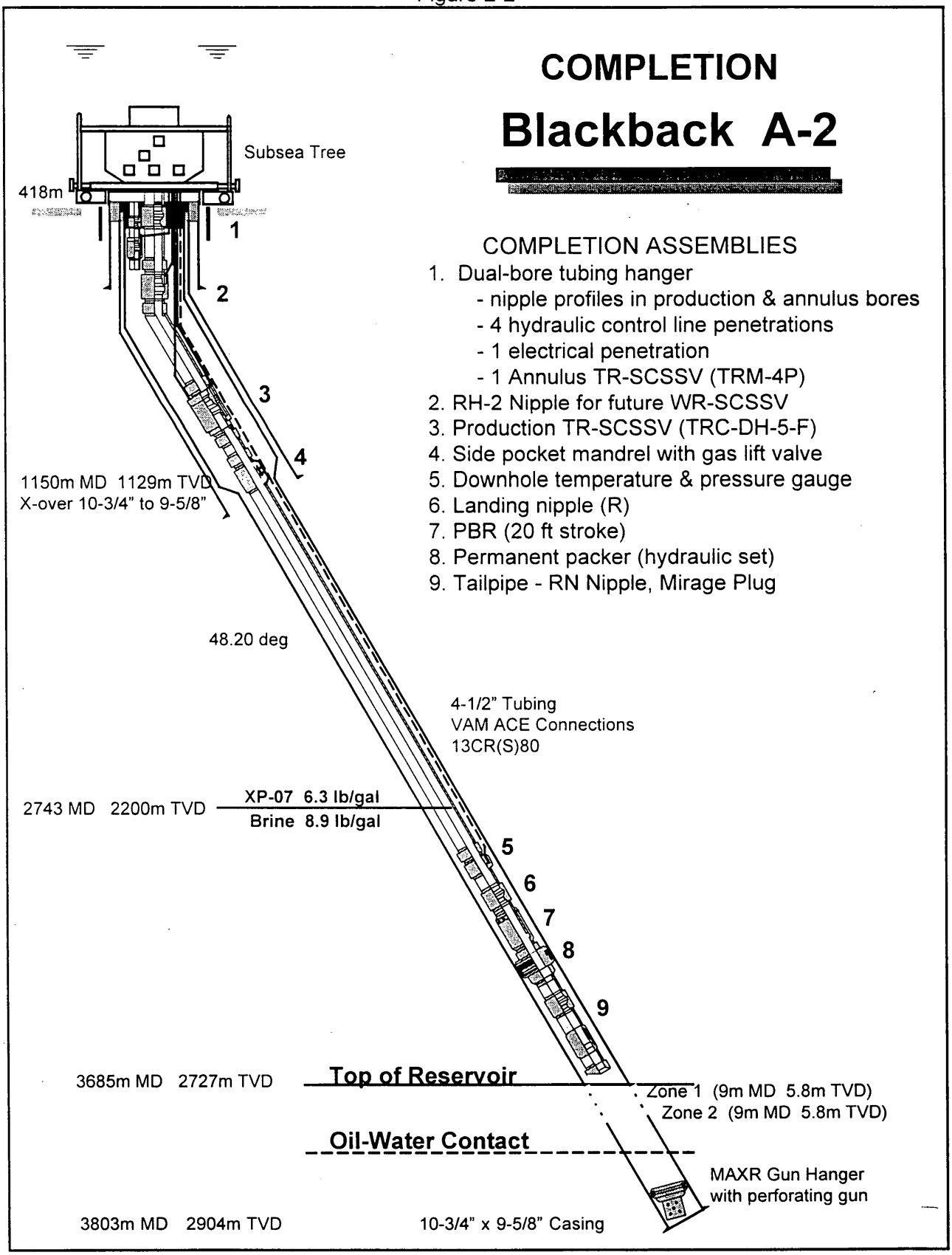

COMPLETION
Blackback A-2
COMPLETION ASSEMBLIES
1. Dual-bore tubing hanger
- nipple profiles in production & annulus bores
- 4 hydraulic control line penetrations
- 1 electrical penetration
- 1 Annulus TR-SCSSV (TRM-4P)
2. RH-2 Nipple for future WR-SCSSV
3. Production TR-SCSSV (TRC-DH-5-F)
4. Side pocket mandrel with gas lift valve
5. Downhole temperature & pressure gauge
6. Landing nipple (R)
7. PBR (20 ft stroke)
8. Permanent packer (hydraulic set)
9. Tailpipe - RN Nipple, Mirage Plug
Subsea Tree
418m
1
2
3
4
5
6
7
8
9
1150m MD 1129m TVD
X-over 10-3/4" to 9-5/8"
48.20 deg
4-1/2" Tubing
VAM ACE Connections
13CR(S)80
2743 MD 2200m TVD
XP-07 6.3 lb/gal
Brine 8.9 lb/gal
3685m MD 2727m TVD
Top of Reservoir
Zone 1 (9m MD 5.8m TVD)
Zone 2 (9m MD 5.8m TVD)
Oil-Water Contact
MAXR Gun Hanger
with perforating gun
3803m MD 2904m TVD
10-3/4" x 9-5/8" Casing

Figure 2-3

## WELL HANDOVER FORM

# VALVE STATUS SHEET

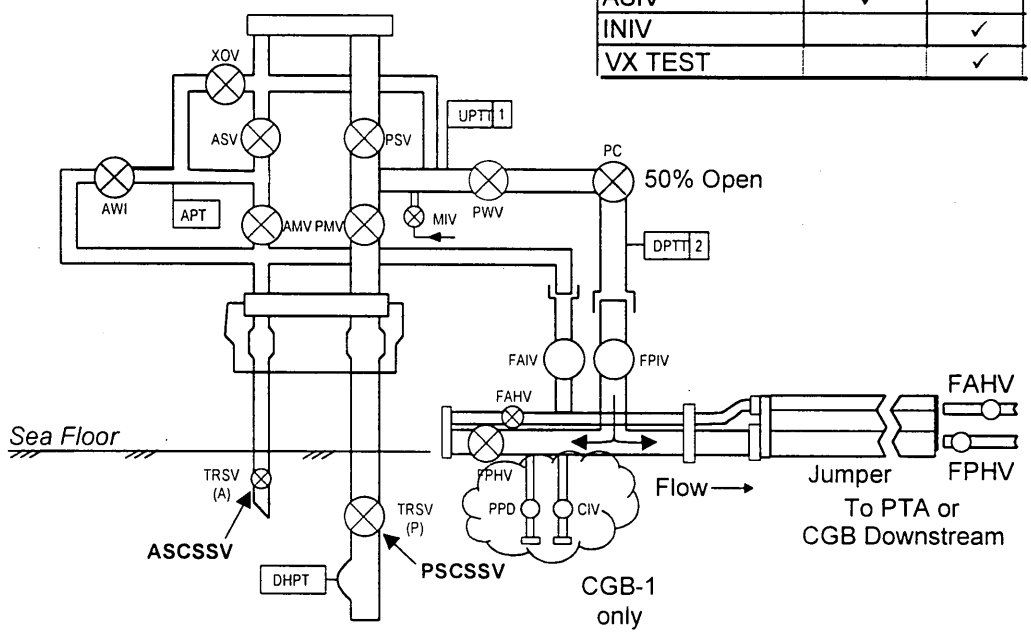
### SCP 000-010

**WELL NUMBER:**
**DRILLING RIG: SECDO 702**

| TREE VALVES | Open | Closed |
|---|---|---|
| PSCSSV | | ✓ |
| ASCSSV | | ✓ |
| PMV | | ✓ |
| AMV | | ✓ |
| ASV | | ✓ |
| PSV | | ✓ |
| AWV | | ✓ |
| PWV | | ✓ |
| XOV | | ✓ |
| MIV | | ✓ |

| Gauges | Working Y/N |
|---|---|
| DHPTT | Y |
| UPTT1 | Y |
| DPTT2 | Y |
| APT | Y |

| Needle Valves | Open | Closed |
|---|---|---|
| PSIV1 | ✓ | |
| PSIV2 | ✓ | |
| ASIV | ✓ | |
| INIV | | ✓ |
| VX TEST | | ✓ |




| Flowbase Valves | Open | Closed |
|---|---|---|
| FAIV | ✓ | |
| FPIV | ✓ | |
| FPHV | | ✓ |
| FAHV | | ✓ |
| PPD | ✓ | |
| CIV | ✓ | |

Date:_____ Time:_____

EAL Rep._____

_____

_____

_____

## 3.0 Clean-up and Fluid Displacement

Clean fluids are needed in order to minimize the potential for plugging the gas lift valve and to prevent particulates from settling on the tubing hanger profile, perforating gun, or production packer. The 10-3/4" x 9-5/8" production casing will be scraped, washed with a surfactant, and circulated clean with seawater. The seawater will be displaced to filtered, inhibited 8.9 lb/gal NaCl completion fluid, which will provide at least 150 psi overbalance at the perforations with the BOP/tree removed.

The sequence of operations is summarized as follows:

- RIH with riser wash tool below wear bushing running tool
- Wash BOP and casing hanger
- Set wear bushing on top of casing hanger
- Wash BOP and riser while POOH
- RIH with casing scrapers and scrape casing to TD
- Circulate viscous pill
- Pump Baraklean NS and Baraklean FL casing wash
- Make short trip to scrape casing again
- Circulate seawater until fluid returns are clean (NTU 70 or less)
- Circulate filtered completion brine until fluid returns are clean (NTU 70 or less)

### 3.1 Preparations

- ☐ Displace Petrofree from riser prior to POOH with PADPRT

- ☐ When testing the BOP after running casing, function all the BOP rams to dislodge any mud solids that may be present in the cavities. Note: Shear rams will be functioned during the casing pressure test.

- ☐ Clean surface pits and piping prior to filling with seawater or completion fluid. Remove drilling fluid residue from tanks, slugging pits, manifolds, lines, pumps, etc. Use 10% Baraklean NS in water to wash mud residue from surface equipment.

- ☐ Mix Baraklean NS and Baraklean FL wash pills

- ☐ R/U pod filter unit with 25 micron filters --be prepared to use 10 micron filters

- ☐ Plan to mix sufficient 8.9 lb/gal NaCl brine (Composition A) to fill well and riser

| | | |
|---|---|---|
| 21" Riser Volume: | 528 bbl | |
| 10-3/4" Casing Volume: | 222 bbl | |
| 9-5/8" Casing Volume: | 621 bbl | |
| Surface Equipment Fill up: | 529 bbl | |
| Total Completion Brine: | 1900 bbl | (drill pipe displacement = 88 bbl) |

- ☐ Set up a turbidity meter to measure fluid cleanliness.

- ☐ Filter as much brine as possible to 50 NTU -- use 10 micron filters if necessary. Filter the remainder of the brine on the fly. (50 NTU is approx. 50-200 ppm)

- ☐ Prepare jet tool for riser.

## 3.2 Fluid Compositions

Fluid Composition A -- inhibited 8.9 lb/gal NaCl brine, pH 9.0-9.5

| | |
|---|---|
| Seawater | 0.98 bbl/bbl finished brine |
| NaCl to weight to 8.9 lb/gal @20°C | 25 lb/bbl |
| Caustic Soda to give pH of 9.0-9.5 | 0.1 lb/bbl |
| Corexit 2748 Corrosion Inhibitor -- add after brine is filtered and ready to pump.<br>Pump downhole within 30 minutes of adding inhibitor to maximize oxygen scavenging. | 0.5% v/v<br>(2 gal/10 bbl)<br>(0.8 liters/bbl) |

Fluid Composition B -- 5% Baraklean NS (Petrofree clean up)

| | |
|---|---|
| Seawater | 400 bbl (1 pit) |
| Baraklean NS | 16 drums (21 bbl) |

Fluid Composition C -- 5% Baraklean FL (water wet solids clean up)

| | |
|---|---|
| Seawater | 60 bbl (slug pit) |
| Baraklean FL | 3 drums (3.9 bbl) |

Fluid Composition D -- viscous seawater pill

| | |
|---|---|
| Seawater | |
| XCD Polymer (shear thoroughly) | 5 lb/bbl |
| Caustic Soda | as needed |

## 3.3 Procedure

3.3.1 Prepare riser clean up string consisting of (from bottom up):

- jet tool (fit inside 10-3/4" casing)
- 2 stands of HWDP
- wear bushing running tool
- 5" drill pipe

3.3.2 Wash riser with seawater while RIH

- wash riser and BOP
- wash casing hanger (wear bushing running tool will be above BOP)

3.3.3 Land wear bushing

- stop wash operations
- RIH and land wear bushing
- release running tool from wear bushing

3.3.4 Wash riser and BOP with seawater while POOH

- POOH 25 m so that wear bushing running tool is above BOP
- wash BOP and riser while POOH

3.3.5 Prepare string to scrape casing from PBTD (3795 m±) to wellhead (418 m):

- 8-1/2" rock bit (open)
- 9-5/8" casing scraper to suit 55.3 lb/ft 8.500" special clearance casing
- 5" drill pipe -- ±1300 m
- 9-5/8" casing scraper to suit 47 lb/ft casing
- 5" drill pipe -- ±1350 m -- space out so that 10-3/4" scraper reaches just above 10-3/4" x 9-5/8" crossover
- 10-3/4" 55.5 lb/ft casing scraper
- 5" drill pipe to surface -- ±1150 m

NOTE: Dope pin ends only to avoid excess dope.

3.3.6 Scrape casing to PBTD and wash with seawater

- RIH to just above 10-3/4" x 9-5/8" crossover
- begin scraping and washing casing
- continue to RIH
- insert second 9-5/8" scraper at the appropriate point
- insert 10-3/4" scraper at the appropriate point
- scrape and wash casing near setting depth for production packer (3575 - 3625m)
- continue to RIH washing and scraping to PBTD

3.3.7 Circulate well clean

- mix 60 bbl XCD pill -- 100+ vis (Fluid Composition D)
- pump XCD pill
- circulate around with seawater until pill returns -- check returns
- pump a second XCD pill if needed and circulate around

3.3.8 Wash casing with Baraklean chemicals at 10 bbl/min

- line up to pump down both drill pipe and choke/kill line
- pump 20 bbl Baraklean NS (Composition B) down choke line
- pump 20 bbl Baraklean (Composition B) down kill line
- pump 100 bbl Baraklean NS (Composition B) down drill pipe
- pump 60 bbl Baraklean FL (Composition C) down drill pipe
- pump 100 bbl Baraklean NS (Composition B) down drill pipe
- pump 750 bbl seawater down drill pipe (200 bbl of chemical returns in riser)
- pump remainder of Baraklean NS (±120 bbl) down choke/kill line - continue seawater down drill pipe
- continue pumping seawater down choke/kill line and drill pipe until chemicals out

3.3.9 Make short scraper trip

- POOH until 10-3/4" scraper is at the BOP
- RIH to PBTD

3.3.10 Circulate well with seawater until clean

- pump seawater down drill pipe at 15 bbl/min
- measure cleanliness of returns with turbidity meter
- circulate until returns are below 70 NTU on turbidity meter

3.3.11 Pump 1400 bbl (well volume + riser - drill pipe + 113 bbl) completion brine -- Composition A -- at 10 BPM. Continue to measure cleanliness of fluid returns.

3.3.12 Circulate completion brine - catch and filter returns - until returns cleaner than 70 NTU

3.3.13 R/D wash operation

- stop pumping
- POOH
- fill riser with completion brine

# 4.0 Perforating Gun Installation

The well will be perforated with a MAXR automatic release gun hanger with a Hydraulic Delay Firing (HDF) head (primary and back-up) and a 7" High Shot Density (HSD) perforating gun with 12 shots/ft. The gun and hanger will be set with drill pipe (wireline can not be used because of the gun weight and hole angle). The gun will be fired with tubing pressure after running the subsea tree. In the event of a misfire, the gun hanger can be mechanically released by slickline, and the well perforated with a 2-1/8" Enerjet through tubing gun.

Figure 4-1 shows a schematic of the perforating string in the well.

## 4.1 Preparations

- PIP tag should have been placed in casing at ±3513 m (100 m above top Latrobe)
- Use HMX prima cord and charges due to long delay (10+ days) between running and firing the gun.
- Reservoir will advise final perforating depths based on formation evaluation data.
- Once depths are known, Schlumberger perforating personnel will
  - generate a schematic of the perforating string
  - caliper OD of gun hanger to ensure it will run inside the production casing
- When ready to run the guns, Schlumberger perforating personnel will
  - load perforating guns
  - set firing head pressure -- 7880 psi nominal
  - set time delay -- 30 minutes

## 4.2 Operational & Installation Data

| Firing head pressure (absolute) | Firing pressure at firing head setting depth 2832 m TVD | **Tubing Hanger Mode** | **Subsea Tree Mode** |
|---|---|---|---|
| | | Surface pressure to accidentally fire | Surface pressure to intentionally fire |
| Maximum (+7%) | 8427 psi | 5152 psi | 4969 psi |
| Nominal | 7880 psi | 4605 psi | 4422 psi |
| Minimum (-5%) | 7491 psi | 4216 psi | 4033 psi |

- Radio silence is not required for MAXR perforating.

## 4.3 Perforating Gun Procedure (Drill Pipe Set)

4.3.1 Make junk basket / gauge ring / GR / CCL run

- R/U conductor line
- RIH w/ GR-CCL / 8.25" gauge ring / junk basket
- tie in to PEX log and log the PIP tag
- POOH

4.3.2 Make up gun assembly per Schlumberger TCP specialist (do not need radio silence)

- make up guns in 20 ft sections
- support guns with drill collar slips to suit 7.00" OD -- use dog collar as back up
- make up MAXR anchor assembly, Baker model J setting tool, x-over to 5" drill pipe

NOTE: Adjust blank length if necessary so that MAXR is not set in casing collar.

4.3.3 Run 1 stand of drill pipe

- make up 1 stand of drill pipe to top of gun assembly
- check gun assembly weight
- strap drill pipe to get accurate distance from PIP tag to top shot
- place PIP tag in top of this stand -- verify proper installation with Geiger counter

NOTES: Drift drill pipe to 2-3/4" while RIH.
Limit running speed to 1 stand per minute.
Ensure pipe has stopped before setting slips to avoid jarring string.

4.3.4 RIH with drill pipe

- take care through BOP -- ensure flex joint angle is less than 1-1/2°
- go slowly through crossover from 10-3/4" to 9-5/8" casing

4.3.5 RIH to approximate depth, record pick-up and slack-off weights

4.3.6 Position guns on depth by correlating with logs and PIP tags

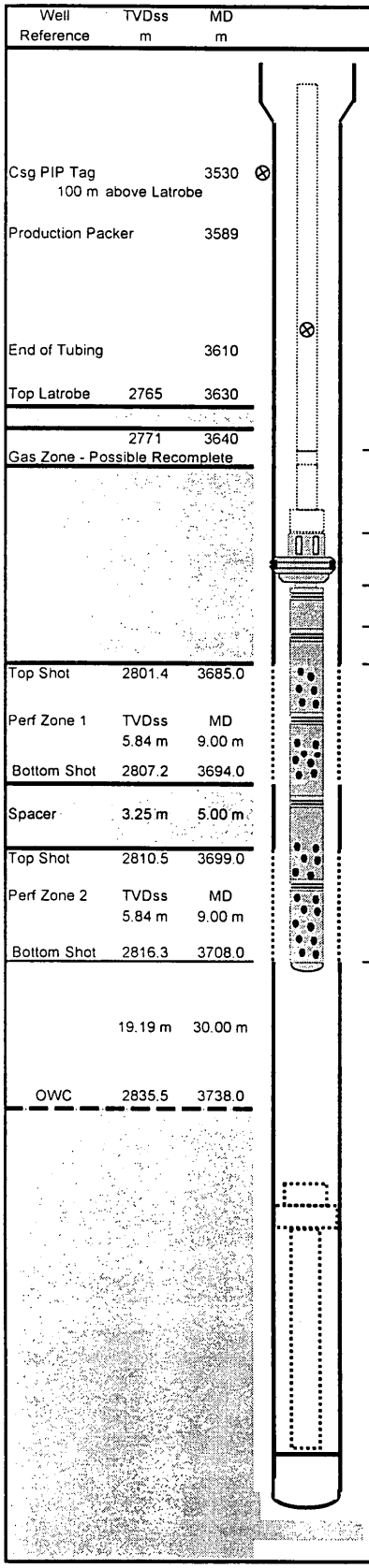
- run 1-11/16" GR-CCL on conductor line inside drill pipe
- correlate depth of drill pipe PIP tag against casing PIP tag and well log
- adjust drill pipe depth to correctly position guns
- POOH with GR-CCL
- R/D conductor line

4.3.7 Set the gun hanger

- drop 1-7/16" ball in drill pipe (fall rate = 1000m / 15 min) -- OK to pump down slowly
- make up circulating head (safety valve/side entry sub/safety valve) to top drill pipe
- line up to cement unit
- pressure drill pipe per Baker procedure (±2400 psi) to set the MAXR gun hanger.
- use compensator to get upward tension to set MAXR and release running tool
- verify loss of tension when drill pipe releases from gun hanger

4.3.8 POOH with drill pipe.

Figure 4-1
Perforating Schematic



| Well Reference | TVDss m | MD m | Description | Size | Supplier | Max OD in. | Length m | MD m | TVD DF m | TVDss m |
|---|---|---|---|---|---|---|---|---|---|---|
| Csg PIP Tag | | 3530 | | | | | | 155.0 m | Csg PIP to Top shot | |
| 100 m above Latrobe | | | | | | | | | | |
| Production Packer | | 3589 | | | | | | | | |
| | | | | | | | | 79.5 m | DP PIP to Top shot | |
| | | | Drill Pipe PIP Tag | | | | | 3605.51 | 2776 | |
| End of Tubing | | 3610 | | | | | | | | |
| Top Latrobe | 2765 | 3630 | | | | | | | | |
| | | | Drill Pipe | | | | 66.60 | | | |
| | 2771 | 3640 | | | | | | | | |
| Gas Zone - Possible Recomplete | | | | | | | | | | |
| | | | Crossover | 4-1/2" IF Box x 2-3/8" EUE Pin | Baker | | 2.43 | 3672.11 | 2819 | |
| | | | Model J Hydraulic Setting Tool | | Baker | | | | | |
| | | | Adapter Kit | | Schlum | | | | | |
| | | | Dual HDF Firing Head | | Schlum | | 3.46 | 3674.54 | 2821 | |
| | | | MAXR Anchor w/Auto Release | | Schlum | 7.620 | | | | |
| | | | Intercarrier | | Schlum | | 4.00 | | | |
| | | | Safety Spacer | | Schlum | | | | | |
| | | | Intercarrier | | Schlum | | 3.00 | | | |
| | | | No Charges Above Top Shot | | Schlum | | | | | |
| Top Shot | 2801.4 | 3685.0 | | | | | 23.00 | 3685.00 | 2827.4 | 2801.4 |
| | | | Perf Gun | 7" HSD 12 SPF 51J Ultrajet HMX | Schlum | 7.000 | | | | |
| Perf Zone 1 | TVDss | MD | | | | | | | | |
| | 5.84 m | 9.00 m | Intercarrier | | Schlum | | | | | |
| Bottom Shot | 2807.2 | 3694.0 | Perf Gun | 7" HSD 12 SPF 51J Ultrajet HMX | Schlum | 7.000 | | 3694.00 | 2833.2 | 2807.2 |
| Spacer | 3.25 m | 5.00 m | Intercarrier | | Schlum | | | | | |
| | | | Perf Gun | 7" HSD 12 SPF 51J Ultrajet HMX | Schlum | 7.000 | | | | |
| Top Shot | 2810.5 | 3699.0 | | | | | | 3699.00 | 2836.5 | 2810.5 |
| | | | Intercarrier | | Schlum | | | | | |
| Perf Zone 2 | TVDss | MD | | | | | | | | |
| | 5.84 m | 9.00 m | Perf Gun | 7" HSD 12 SPF 51J Ultrajet HMX | Schlum | 7.000 | | | | |
| Bottom Shot | 2816.3 | 3708.0 | | | | | | | | |
| | | | Bull Nose | | Schlum | | 0.15 | 3708.00 | 2842.3 | 2816.3 |
| | | | Bottom of Perforating Assembly | | | | | 3708.15 | 2842 | |
| | 19.19 m | 30.00 m | | | | | | | | |
| OWC | 2835.5 | 3738.0 | Depth of OWC | | | | | 3738.00 | 2861.5 | 2835.5 |
| | | | 7.5m | | | | | | | |
| | | | Top of Gun Hanger After Release | | | | 33.61 | 3745.48 | 2867 | 2841 |
| | | | Bottom of Gun After Release | | | | | 3779.09 | 2888 | 2862 |
| | | | PBTD | | | | | 3779.09 | 2888 | 2862 |
| | | | 9-5/8" Casing Shoe | | | | | 3803.58 | 2904 | 2878 |
| | | | TD | | | | | 3811.00 | 2909 | 2883 |

## 5.0 Completion String Installation

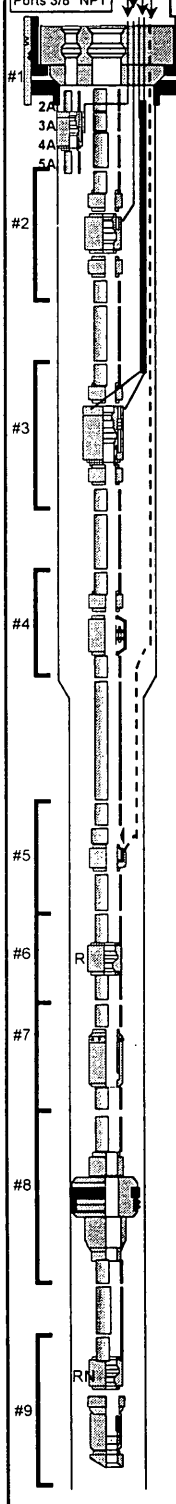
The upper completion is run on a dual-bore (production side and annulus side) tubing hanger landed in an ABB VG MS-700 18-3/4" subsea wellhead. The production string will consist of 4-1/2" Super 13 Chrome tubing with a hydraulic-set permanent packer, downhole pressure/temperature gauge, side pocket mandrel with gas lift orifice, safety valve, and a hydraulic communication nipple for a future wireline-set safety valve. The annulus bore has a 2-3/8" Super13 Chrome tubing pup and a safety valve. No space-out is required to land the completion. A single-tubing riser will connect to the production bore and 5 hoses from the control umbilical will connect to the annulus (pressure monitoring/limited pump-in). A dual-tubing riser can be run as a contingency.

A schematic of the completion string is shown in Figure 5-1. A schematic of the riser and surface equipment is shown in Figure 5-2.

The sequence of operations is summarized as follows:

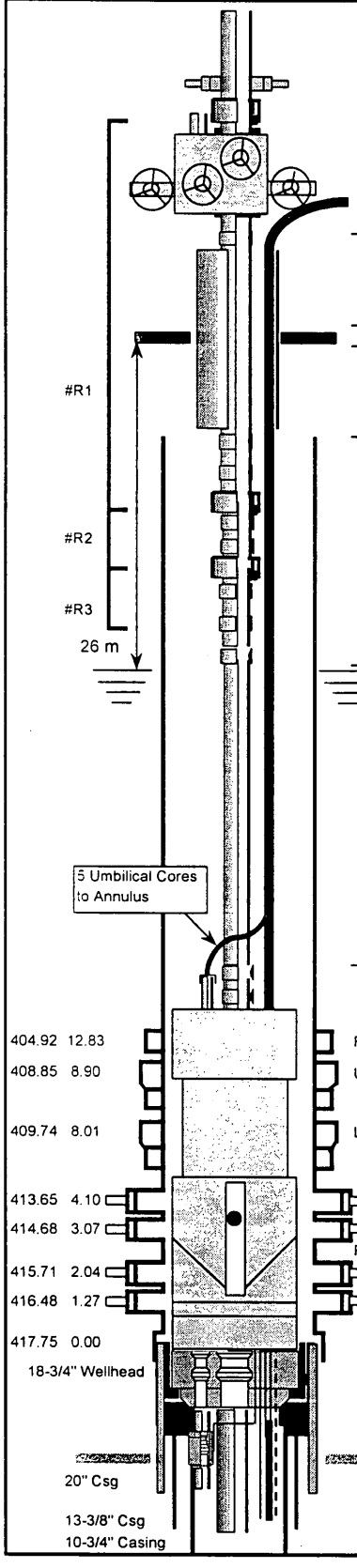
- Pull wear bushing (TH elevation check tool was run after cementing)
- Run completion string (fill with brine / XP-07)
- Make-up tubing hanger
- Make-up electrical penetrator - test
- Make-up THROT to tubing hanger - test
- Make-up hydraulic control lines - test
- Run string and tubing hanger on single-tubing riser
- Make-up landing (slick) joint and surface tree to riser
- Land tubing hanger (not oriented)
- Orient tubing hanger
- Land tubing hanger in oriented position - lock
- Test tubing hanger (overpull and pressure test 3500 psi differential from above)
- Low pressure inflow test production safety valve (300 psi differential)
- Set production packer (2500 psi differential)
- Pressure test tubing (3500 psi at surface; 2500 psi differential at bottom)
- Expend Mirage plug with wireline then apply pressure (2500 psi differential)
- Test packer from below (2500 psi differential)
- High pressure inflow test production safety valve (3250 psi differential)
- Test tubing hanger annulus seal (2800 psi differential)
- Inflow test annulus safety valve (2800 psi differential)
- Set plug in production bore of tubing hanger
- Pressure test tubing hanger plug from above (3200 psi differential)
- Release THROT
- Recover XP-07 in riser by u-tubing to surface
- Pull tubing-riser and THROT
- Pull drilling riser and BOP
- Clean debris from wellhead
- Install debris cap on wellhead

Figure 5-1
Completion String




| Assembly | Item | Qty | Description | Size | Material | Supplier | CONNECTION UP | CONNECTION DOWN | Max OD in. | Min ID in. | Length m | MD m | TVD m |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2A | 1 | Pup Joint | 2-3/8" 4.6 lb/ft | 13Cr(S)80 | | V ACE Pin | V ACE Pin | 2.697 | 1.995 | 3.05 | | |
| | 3A | 1 | TR-SCSSV | 2-3/8" TRM-4P 1.875"X" Prof | 13Cr/410S | Camco | V ACE Box | V ACE Pin | 3.640 | 1.875 | 1.28 | | |
| | 4A | 1 | Pup Joint | 2-3/8" 4.6 lb/ft | 13Cr(S)80 | | V ACE Box | V ACE Pin | 2.697 | 1.995 | 3.05 | | |
| | 5A | 1 | Mule Shoe | 2-3/8" | 13Cr(S)80 | | V ACE Box | | | | 0.15 | | |
| | | | | | | | | | | | 7.53 | | |
| | | | 18-3/4" Welhead - Top | | | | | | | | 0.25 | 417.75 | |
| #1 | 1 | 1 | Tubing Hanger | Prod - Hbtn 3.813" X Profile<br>Ann - Hbtn 1.875" X Profile | | ABB<br>VG | | V ACE Box | | 3.813 | 0.72 | 418.00 | |
| | 2 | 1 | Tubing | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | | V ACE Pin | V ACE Pin | 4.961 | 3.958 | 9.5 | 418.72 | 419 |
| | 3 | 1 | Pup Joint | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | | V ACE Box | V ACE Pin | 4.961 | 3.958 | 1.22 | 418.72 | 419 |
| | 4 | 6 | Tubing | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | | V ACE Box | V ACE Pin | 4.961 | 3.958 | 57.00 | 419.94 | 420 |
| | 5 | 1 | Pup Joint | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | | V ACE Box | V ACE Pin | 4.961 | 3.958 | 1.83 | 476.94 | 477 |
| | 6 | 1 | Flow Coupling | 4-1/2" Part# 811 FN 38117 | Inc-925 | Hbtn | V ACE Box | V ACE Pin | 5.250 | 3.865 | 1.83 | 478.77 | 479 |
| #2 | 7 | 1 | Comm Nipple | 4-1/2" RH-2 Hyd Com Nipple Hbtn 3.813" "X" Profile | Inc-925 | Camco | V ACE Box | V ACE Pin | 6.813 | 3.813 | 0.93 | 480.60 | 481 |
| | 8 | 1 | Flow Coupling | 4-1/2" Part# 811 FN 38117 | Inc-925 | Hbtn | V ACE Box | V ACE Pin | 5.250 | 3.865 | 1.83 | 481.53 | 482 |
| | 9 | 1 | Pup Joint | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | | V ACE Box | V ACE Pin | 4.961 | 3.958 | 1.83 | 483.36 | 483 |
| | 10 | 55 | Tubing | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | | V ACE Box | V ACE Pin | 4.961 | 3.958 | 522.50 | 485.19 | 485 |
| | 11 | 1 | Pup Joint | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | | V ACE Box | V ACE Pin | 4.961 | 3.958 | 1.83 | 1007.69 | 1003 |
| | 12 | 1 | Flow Coupling | 4-1/2" Part# 811 FN 38117 | Inc-925 | Hbtn | V ACE Box | V ACE Pin | 5.250 | 3.865 | 1.83 | 1009.52 | 1005 |
| #3 | 13 | 1 | TR-SCSSV | 4-1/2" TRC-DH-5-F 3.75" "DB" Profile | Inc-925 | Camco | V ACE Box | V ACE Pin | 7.437 | 3.750 | 3.83 | 1011.35 | 1007 |
| | 14 | 1 | Flow Coupling | 4-1/2" Part# 811 FN 38117 | Inc-925 | Hbtn | V ACE Box | V ACE Pin | 5.250 | 3.865 | 1.83 | 1015.18 | 1010 |
| | 15 | 1 | Pup Joint | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | | V ACE Box | V ACE Pin | 4.961 | 3.958 | 1.83 | 1017.01 | 1012 |
| | 16 | 5 | Tubing | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | | V ACE Box | V ACE Pin | 4.961 | 3.958 | 47.50 | 1018.84 | 1014 |
| | 17 | 1 | Pup Joint | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | | V ACE Box | V ACE Pin | 4.961 | 3.958 | 1.83 | 1066.34 | 1057 |
| | 18 | 1 | Flow Coupling | 4-1/2" Part# 811 FN 38117 | Inc-925 | Hbtn | V ACE Box | V ACE Pin | 5.250 | 3.865 | 1.83 | 1068.17 | 1059 |
| #4 | 19 | 1 | Side Pocket Mandrel | 4-1/2" MMRG-4,1.5" Pocket, SO2-30R Valve w/RKP Latch | Inc-925 | Camco | V ACE Box | V ACE Pin | 7.250 | 3.855 | 3.01 | 1070.00 | 1061 |
| | 20 | 1 | Pup Joint | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | | V ACE Box | V ACE Pin | 4.961 | 3.958 | 1.83 | 1073.01 | 1063 |
| | 21 | 262 | Tubing | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | | V ACE Box | V ACE Pin | 4.961 | 3.958 | 2489.00 | 1074.84 | 1065 |
| | 22 | 1 | Pup Joint | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | | V ACE Box | V ACE Pin | 4.961 | 3.958 | 1.83 | 3563.84 | 2750 |
| | 23 | 1 | Tubing Couplin | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | | V ACE Box | V ACE Box | 4.961 | 3.958 | 0.24 | 3565.67 | 2751 |
| #5 | 24 | 1 | Solid Gauge Mandrel | 4-1/2" Solid Gauge Mandrel, w/Perm Quartz Gauge | Alloy 450 | Schlum | V ACE Pin | V ACE Pin | 6.023 | 3.958 | 2.47 | 3565.91 | 2751 |
| | 25 | 1 | Pup Joint | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | | V ACE Box | V ACE Pin | 4.961 | 3.958 | 1.83 | 3568.38 | 2753 |
| | 26 | 1 | Pup Joint | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | | V ACE Box | V ACE Pin | 4.961 | 3.958 | 1.83 | 3570.21 | 2754 |
| #6 | 27 | 1 | Landing Nipple | 4-1/2" R Profile, 3.688" bore | Inc-925 | Hbtn | V ACE Box | V ACE Pin | 4.991 | 3.688 | 0.45 | 3572.04 | 2755 |
| | 28 | 1 | Pup Joint | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | | V ACE Box | V ACE Pin | 4.961 | 3.958 | 1.83 | 3572.49 | 2756 |
| | 29 | 1 | Pup Joint | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | | V ACE Box | V ACE Pin | 4.961 | 3.958 | 1.83 | 3574.32 | 2757 |
| #7 | 30 | 1 | PBR | 5" Seal Bore, 20' Stroke, Shear 73,200 lb 4½" Conn | Inc-925 | Hbtn | V ACE Box | V ACE Pin | 5.875 | 3.850 | 8.22 | 3576.15 | 2758 |
| | 31 | 1 | Pup Joint | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | | V ACE Box | V ACE Pin | 4.961 | 3.958 | 1.83 | 3584.37 | 2764 |
| | 32 | 1 | Pup Joint | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | | V ACE Box | V ACE Pin | 4.961 | 3.958 | 1.83 | 3586.20 | 2765 |
| | 33 | 1 | Ratch Latch | 4-1/2" Ratch Latch Seal Ass Shear 120,000 lb 3040 psi | Inc-925 | Hbtn | V ACE Box | Latch | 5.290 | 3.938 | 1.14 | 3588.03 | 2766 |
| #8 | 34 | 1 | Prod Packer | 9-5/8" 36-59.4lb/ft MHP | Inc-925 flow wet | Hbtn | Latch | 5" 15# VA Box | 8.125 | 3.875 | 1.98 | 3589.17 | 2767 |
| | 35 | 1 | Mill Out Exten | 5" | Inc-925 | Hbtn | 5" VA Pin | 5" VA Pin | 5.036 | 4.250 | 2.55 | 3591.15 | 2768 |
| | 36 | 1 | Crossover | 5" 15# to 4-1/2" 12.6# | Inc-925 | Hbtn | 5" VA Box | V ACE Pin | 5.593 | 3.958 | 0.30 | 3593.70 | 2770 |
| | 37 | 1 | Pup Joint | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | | V ACE Box | V ACE Pin | 4.961 | 3.958 | 1.83 | 3594.00 | 2770 |
| | 38 | 1 | Tubing | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | | V ACE Box | V ACE Pin | 4.961 | 3.958 | 9.50 | 3595.83 | 2771 |
| | 39 | 1 | Pup Joint | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | | V ACE Box | V ACE Pin | 4.961 | 3.958 | 1.83 | 3605.33 | 2778 |
| RN | 40 | 1 | Landing Nipple | 4-1/2" RN Prof, 3.437" bore 3.260" NoGo | Inc-925 | Hbtn | V ACE Box | V ACE Pin | 4.991 | 3.260 | 0.51 | 3607.16 | 2779 |
| #9 | 41 | 1 | Crossover | 4-1/2" V ACE to NEW VAM | 9Cr 1Mo | Hbtn | V ACE Box | NEW V Pin | 4.961 | 3.958 | 0.36 | 3607.67 | 2779 |
| | 42 | 1 | Plug | 4-1/2" Mirage Tailpipe Plug puncture w/ slickline | 13Cr | Hbtn | NEW V Bo | NEW V Pin | 5.880 | 3.880 | 1.50 | 3608.03 | 2779 |
| | 43 | 1 | Wireline Guide | 4-1/2" | 13Cr | Hbtn | NEW V Box | | 5.875 | 3.984 | 0.22 | 3609.53 | 2780 |
| | | | End of Tubing | Target Depth = 3610 m | | | | | | | | 3609.75 | 2781 |

Figure 5-2
Riser for Running Tubing Hanger




| Qty | Description | Size | Material | CONNECTION UP | CONNECTION DOWN | Max OD in. | Min ID in. | Length m | MD m |
|---|---|---|---|---|---|---|---|---|---|
| | Bails | | | | | | | 12.80 | 20.58 |
| | Wireline Lubricator | | | | | | | | |
| | Wireline BOP | | | | | | | | |
| | Quick Union | 8-1/4" | | | | | | | |
| | Surface Tree | | | | | | | 1.54 | 7.78 |
| | Pup Piece | | | | V ACE Pin | | | 0.40 | 6.24 |
| 0.6 | Tubing | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | V ACE Box | V ACE Pin | 4.961 | 3.958 | 5.84 | 5.84 |
| | DRILL FLOOR | | | | | | | | 0.00 |
| 0.4 | Tubing | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | V ACE Box | V ACE Pin | 4.961 | 3.958 | 3.38 | 0.00 |
| 1 | Pup Joint | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | V ACE Box | V ACE Pin | 4.961 | 3.958 | 1.22 | 3.38 |
| 1 | Coupling | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | V ACE Box | V ACE Box | 4.961 | 3.958 | 0.00 | 4.60 |
| 1 | Quick Union | 7" Bowen | L80 | V ACE Pin | 7" Bowen | | | 0.61 | 4.60 |
| 1 | Quick Union Spool Piece | 4-1/2" 12.6 lb/ft | L80 | 7" Bowen | 7" Bowen | 4.961 | 3.958 | 7.00 | 5.21 |
| 1 | Quick Union | 7" Bowen | L80 | 7" Bowen | V ACE Pin | | | 0.61 | 12.21 |
| 1 | Tubing | 4-1/2" 12.6 lb/ft | L80 | V ACE Box | V ACE Pin | 4.961 | 3.958 | 9.50 | 12.82 |
| | Pup Joints for Space Out | 4-1/2" 12.6 lb/ft | L80 | V ACE Box | V ACE Pin | | | 1.22 | 22.32 |
| 40 | Tubing | 4-1/2" 12.6 lb/ft | L80 | V ACE Box | V ACE Pin | 4.961 | 3.958 | 380.00 | 23.54 |
| 1 | Pup Joint | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | V ACE Box | V ACE Pin | 4.961 | 3.958 | 1.22 | 403.54 |
| | Flex Joint - Top | | | | | | | | |
| | Upper Annular | | | | | | | | |
| | Lower Annular | | | | | | | | |
| | Tubing Hanger Orienting Tool | | | | | | | 11.76 | |
| | Tubing Hanger Running Tool | | | | | | | 1.48 | |
| | Total THROT | | | | | | | 13.24 | 404.76 |
| | Ram Preventers | | | | | | | | |
| | Bottom THROT | | | | | | | | 418.00 |
| | Tubing Hanger | | | | | | | 0.72 | 418.00 |
| | Bottom Tubing Hanger | | | | | | | | 418.72 |
| | Sea Floor 421 m | | | | | | | | |

STICK UP

## 5.1 Preparations

□ Make up and test pre-assemblies at Halliburton facility

| | Assembly | Measure | Drift to | Pressure Test to |
|---|---|---|---|---|
| #1 | Tubing Hanger<br>w/ 2-3/8" Safety Valve | Length | 3.800"<br>1.870" | 5000 psi body<br>+ Function/Inflow |
| #2 | RH-2 Hyd Comm Nipple | Length | 3.800" | 5000 psi |
| #3 | 4-1/2" Safety Valve | Length | 3.833"<br>(did not drift profile) | 5000 psi body<br>+ Function/Inflow |
| #4 | Side pocket Mandrel w/ Orifice | Length | 3.833" | 5000 psi |
| #5 | Solid Gauge Mandrel | Length | 3.833" | 5000 psi |
| #6 | R Nipple | Length | 3.533" | 5000 psi |
| #7 | PBR | Length | 3.800" | 1000 psi |
| #8 | Packer | Length | 3.833" | 500 psi |
| #9 | Tailpipe w/ Mirage Plug | Length | 3.833"<br>(did not drift Mirage) | DO NOT Test |

□ Prepare tubing
- clean threads
- drift to 3.833"
- number each joint
- measure length

□ Weatherford set up tubing handling and make-up equipment for CRA tubulars
- Microgrip dies on make-up equipment
- Dual 4-1/2" tubing slips -- one side for tubing; the other w/o inserts for umbilical
- Scissor hoist, rubber matting on catwalk and V-door, poly rope slings
- Install PVC pipe in mouse hole

□ R/U to fill tubing with XP-07 from 3 x 1.5 m3 (9 bbl) tanks (2" Camlock connection)
- pump XP-07 from boat bulk tank to clean rig tank
- position 3 x 1.5m3 tanks to gravity feed XP-07 thru 30ft fill-up hose into tubing
- R/U to fill 1.5m3 tanks by pumping XP-07 out of rig rank

□ Camco prepare hydraulic control lines
- Fill and flush with Marston Bentley HW 525 hydraulic fluid -- NAS 8 or cleaner
- Pressure test to 7500 psi for 10 min -- zero leak
- Rig up spooler and sheave for running dual encapsulated line

□ Schlumberger rig up spooler and sheave for downhole gauge cable

□ Prepare surface tree and riser landing joint

□ Prepare auxiliary umbilical and IWOCS

□ Prepare TH orientation system
- Function test tubing hanger orientation pin in BOP. Observe with ROV.
- Orient THROT for CGB heading (initial BOP/THROT set-up per **SCP 100-015**).

- ☐ Prepare tubing hanger
  - Shim TH seal based on Tubing Hanger Elevation Check Tool run after cementing
  - M/U Schlumberger upper sealing nut into electrical bore of tubing hanger
  - M/U hydraulic fittings to bottom of tubing hanger
  - M/U test cap to bottom of annulus string
  - Install PXX plug in production bore nipple
  - M/U Tubing Hanger Emergency Recovery Tool to drill pipe x 4-1/2" tubing pup
  - M/U TH Emergency Recovery Tool to tubing hanger

- ☐ Prepare emergency equipment
  - Prepare and check the drill pipe hang off tool (hang off on 10-3/4" hanger).
  - Have available x-over from 4-1/2 VAM ACE to 4-1/2 IF drill pipe for TIW valve

- ☐ Prepare 0.108" slickline unit for expending Mirage plug & setting tubing hanger plug

## 5.2 Operational & Installation Data

| Component | Target Depth | |
|---|---|---|
| | TVD, DF | MD, DF |
| Drill Floor | 0 m | 0 m |
| Sea Level | 26 m | 26 m |
| Top 18-3/4" Wellhead | 418 m | (3 m stick up) 418 m |
| Mud Line | 421 m | (WD = 395 m) 421 m |
| RH-2 Hydraulic Comm Nipple | 471 m | (50 m BML) 471 m |
| 4-1/2" Safety Valve | Min = 999 m | Min = 1003 m |
| Side Pocket Mandrel | Max = 1068 m | Max = 1078 m |
| 10-3/4 x 9-5/8" casing crossover | 1129 m | 1150 m |
| XP-07 Fluid Level | Min = 2200 m | (137 bbl) Min = 2743 m |
| Solid Gauge Mandrel | as deep as practical | (23 m above pkr) 3566 m |
| Packer | 2763 m | 3589 m |
| End of Tailpipe | 2777 m | (30 m above gas) 3610 m |
| Top of MAXR Perforating Gun | 2821 m | 3675 m |

| Component | String Wt, KIPS | | |
|---|---|---|---|
| | Air Weight | Buoyed Weight | P/U Load (0.25 Friction) |
| Completion String | 139 | 109 | 115 |
| Tbg Hgr + THROT | 14 | 14 | 14 |
| Riser | 17 | 15 | 15 |
| Surface Tree | 10 | 10 | 10 |
| Total | 180 | 148 | 154 |

| Tubing Connection | M/U Torque | | | M/U Loss |
|---|---|---|---|---|
| | Minimum | Optimum | Maximum | |
| 2-3/8" 4.6 lb/ft 80 ksi VAM ACE | 910 ft-lb | 1010.ft-lb | 1110 ft-lb | 2.630 in (6.68 cm) |
| 4-1/2" 12.6 lb/ft 80 ksi VAM ACE | 3260 ft-lb | 3620 ft-lb | 3980 ft-lb | 3.662 in (9.30 cm) |

| Component | Working Pressure | Tensile strength |
|---|---|---|
| Tubing Hanger | 5000 psi | N/A |
| PXX Plug 3.813" | from below 6620 psi | N/A |
| PXX Plug 1.875" | from below 10,000 psi | N/A |
| 4-1/2" tubing 12.6 lb/ft 13(S)Cr-80 VAM ACE | (1.25 DF) 6744 psi | (1.33 DF) 216,000 lb |
| RH-2 Hyd Comm Nipple | 5000 psi | (excl connection) 342,000 lb |
| 4-1/2" Safety Valve | 5000 psi | (excl connection) 401,000 lb |
| Side pocket Mandrel w/valve | 5000 psi | (excl connection) 669,000 lb |
| Solid Gauge Mandrel | (1.25 DF) 6744 psi | (1.33 DF) 216,000 lb |
| PBR | test press= 5000 psi | Shear@ 73,200 lb |
| Packer & Ratch Latch | test press= 5000 psi<br>start to set ΔP= 1560 psi<br>fully set ΔP= 2500 psi | Shear@ 120,000 lb<br>(3040 psi plugged)<br>(8430 psi unplugged) |
| R and RN Landing Nipple | 8950 psi | |
| Mirage Plug | 5000 psi<br>(3000 psi to ratchet) | 86,000 lb |
| 2-3/8" Tubing, 4.6 lb/ft 13Cr-80 | (1.25 DF) 8960 psi | (1.33 DF) 78,000 lb |
| 2-3/8" Safety Valve | 5000 psi | (excl connection) 108,000 lb |
| 10-3/4" Casing 55.5 lb/ft, L-80 | (1.25 DF) 5160 psi | N/A |
| 9-5/8" Casing, 47 lb/ft, N-80 | (1.25 DF) 5496 psi | N/A |

| SUBSURFACE SAFETY VALVES | | |
|---|---|---|
| EAL Allowable Leak Rate<br>Follows API RP 14B | 400 cc/min<br>6.3 gal/hr | |
| Normal EAL Test Differential | 290 psi<br>(2000 kPa) | |
| Blackback Shut-in Tubing Press | 3250 psi | |

| Control Lines | Working Pressure | Reel Length |
|---|---|---|
| Encapsulated Dual 1/4" | 10,000 psi | 650 m (50 m spare) |
| Bare 1/4" (vol = 1.3 l per 100 m) | 10,000 psi | 488 m (400+m spare) |
| Encapsulated Electrical | 10,000 psi | 3500 m (350 m spare) |

| Vessel Motion for Running Tubing Hanger | Max Allowable |
|---|---|
| Flex Joint Angle - relative to wellhead angle | 1/2° |
| Heave (double amplitude) | 1.5 m |

| Fluid | Density | |
|---|---|---|
| XP-07 / SARAPAR 147 Blend | 6.32 lb/gal 0.757 g/cc @ 70°F<br>6.05 lb/gal 0.725 g/cc @ 150°F | |

| PRESSURE TEST ACCEPTANCE | |
|---|---|
| 15 minutes straight line -- rigid piping | No more than 1% pressure loss over 15 minutes<br>AND<br>Decreasing loss trend in successive 5 min intervals |
| 15 minutes straight line -- flexible control lines | No more than 2% pressure loss over 15 minutes<br>AND<br>Decreasing loss trend in successive 5 min intervals |

## 5.3 Completion String Procedure

5.3.1 Pull flex joint wear bushing

5.3.2 Pull wellhead 10-3/4" wear bushing

5.3.3 Pull diverter insert packer

CAUTION: Post notice on rig floor: INSERT PACKER REMOVED

5.3.4 Mark index line for tide reference when pulling wear bushing

5.3.5 Run completion assemblies per tally list:

- tailpipe assembly -- fill Mirage plug with fresh water
- joint of 4-1/2" tubing
- packer assembly
- PBR assembly
- R nipple assembly
- Schlumberger gauge mandrel assembly

5.3.6 Install Schlumberger gauge in mandrel

- verify electrical connection
- pressure test

5.3.7 Run 87 joints 4-1/2" tubing (approximately 825 m)

- run electrical cable and monitor signal while running in hole
- install cable protector on each joint

- fill tubing with 8.9 lb/gal brine every 5 joints

5.3.8 Continue running 4-1/2" tubing per tally list

- FILL TUBING WITH XP-07 FLUID EVERY JOINT FROM THIS POINT ONWARD
- TAKE RISER RETURNS TO TRIP TANK TO COLLECT XP-07 THAT MAY OVERFLOW TUBING AND ENTER RISER

CAUTION: Personnel wear protective gear in case of over filling and "burping" from trapped air. Contain any splash or spill; recover with absorbents or flush to drain designated for oily waste.

CAUTION: Run packer carefully through BOP stack at 405 m MD and 10-3/4 x 9-5/8" X-over at 1150 m MD

5.3.9 Run side pocket mandrel assembly. Use "special SPM" cable protectors.

5.3.10 Run 4-1/2" tubing per tally list

5.3.11 Run safety valve assembly

- flush and connect control lines (flatpack)
- function valve
- pressure test control lines to 5000 psi for 10 minutes -- zero leak
- use "special SCSSV" cable protectors

5.3.12 Run 4-1/2" tubing per tally list

- use cable protectors for electrical + flatpack +1/4" control line (will be empty)
- maintain 4500 psi on control lines and monitor electrical signal while running in hole

5.3.13 Run RH-2 nipple assembly

- flush and connect control line
- pressure test control line to 5000 psi for 10 minutes -- zero leak
- use "special RH-2" cable protectors

5.3.14 Run 4-1/2" tubing per tally list

- use cable protectors for electrical + flatpack + 1/4" control line
- maintain 4500 psi on control lines and monitor electrical signal while running in hole

NOTE: Use pup joints to space out packer so it doesn't set in a collar.

## 5.4 Tubing Hanger Make-up Procedure

5.4.1 Prepare rig to run tubing hanger

- trim rig and center over well
- increase riser tension to 400-480 kips
- check flex joint angle with ROV -- max 1/2° relative to wellhead

NOTE: Wellhead will not be perfectly vertical. Flex joint angle should be adjusted so the relative angle between the wellhead and the riser is 1/2° or less. (For a 1° wellhead angle, the flex joint angle should be 1/2° to 1-1/2°)

5.4.2 Make up tubing hanger to top of string -- reference **SCP 400-010**

- rotate tubing with Weatherford unit; ensure elevators rotate & THERT not binding
- pick up from slips
- centralize string in rotary by trimming the rig
- record pick-up and slack-off weight (COMPLETION WEIGHT used later in program)

5.4.3 Install control line for annulus safety valve

- lower string to working height for bottom of annulus string

CAUTION: Ensure hole is properly covered to avoid dropped objects.

- install clamp 0.5 m above end of annulus string -- run control lines through clamp
- lower string to working height for safety valve
- install clamp below annulus safety valve -- run control lines through clamp
- flush and connect control line to annulus safety valve
- function valve
- pressure test control line to 5000 psi for 10 minutes -- zero leak
- install clamp above annulus safety valve -- run control lines through clamp

5.4.4 Make up electrical penetrator (per Schlumberger procedure)

- space out electrical cable
- pick up completion string so that cable can be spliced to the electrical penetrator away from rotary
- make up penetrator to bottom of tubing hanger

5.4.5 Land tubing hanger in false rotary

- install false rotary table
- protect tubing hanger seal surfaces
- land tubing hanger on landing plate
- slack off entire string weight
- remove THERT
- inspect top of tubing hanger

5.4.6 Make up top of electrical penetrator to tubing hanger. Check gauge signal.

5.4.7 Prepare THROT

- make up umbilical to top of THROT
- make-up 5 cores of THROT umbilical to annulus bore
- make up test plug and small pressure test hose to production bore
- pick up THROT and remove nose protector
- function test per **SCP 400-020**

5.4.8 Land THROT on tubing hanger -- reference **SCP 400-020**

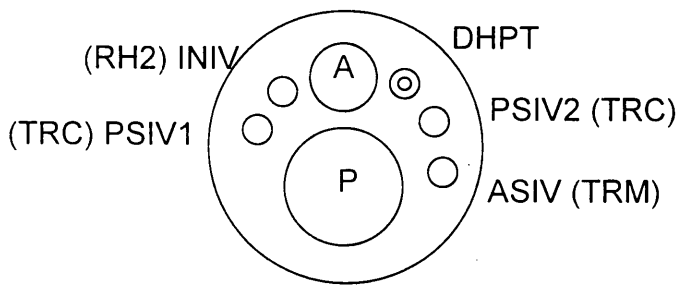
- align slot in THROT re-entry sleeve with the key in the tubing hanger outer sleeve
- land THROT and latch to tubing hanger per **SCP 400-020**
- pump thru hose to test production bore to 3200 psi -- accept 15 min straight line
- pump thru 5 umbilical cores to test annulus bore to 4000 psi -- accept 15 min st line
- remove test plug and hose from top of THROT production bore

5.4.9 Make up hydraulic control lines to tubing hanger

- flush hydraulic fluid through THROT and tubing hanger stabs until clear

  NOTE: Collect and dispose of hydraulic fluid flushed through THROT

- measure and cut hydraulic control lines
- make up control lines to bottom of tubing hanger




View of Tubing Hanger from Below

5.4.10 Pressure test hydraulic control lines -- 4500 psi ΔP at surface = 4800 psi ΔP at valve

- apply 4500 psi and chart record -- accept 15 minutes straight line
- block in 4500 psi at control panel and maintain -- both safety valves open

5.4.11 Make up mule shoe to bottom of annulus string

- pick up string until bottom of annulus string is at working height
- clear away false rotary
- remove test cap
- make up mule shoe to bottom of string

5.4.12 Complete THROT preparations

- lower string through rotary until tubing hanger is at working height
- orient THROT 20° off to the LEFT (anti-clockwise) so that THROT will apply make-up torque to completion string when orienting
- lock block to prevent string rotation
- verify hydraulic controls are set for running mode
- remove protective cover from tubing hanger seals
- complete pre-submergence checklist per **SCP 400-025**

5.4.13 Run tubing hanger into riser while paying out umbilical -- reference **SCP 400-030**

- remove slips, insert bowls, and master bushings

- center completion string over rotary
- lower tubing hanger through rotary
- re-install master bushing when THROT casing extension is in the rotary
- re-install bowls and dual slips when 4-1/2" tubing pup on THROT reaches rotary
- feed umbilical through side of slips without inserts

CAUTION: Use care not to damage control lines or let TH seal contact rotary.

5.4.14 Pull plug from tubing hanger

- rig up slickline
- pull plug (and prong) from tubing hanger production bore

## 5.5 Tubing Hanger Running Procedure

5.5.1 RIH with completion string and tubing hanger on 4-1/2" VAM ACE single-tubing completion riser per riser tally list

- lock top drive to prevent rotation
- lock and mark rotary
- mark riser as it goes into hole -- prevent riser from rotating
- remove slips after making up each stand to allow 12" OD clamps to pass thru rotary
- clamp umbilical to each joint of riser
- fill riser with XP-07 base oil every stand

NOTE: Monitor pressure on safety valve control lines.
Maintain correct pressure on THROT control functions.
Note any rotation of riser while running (if riser has rotated, it will NOT be intentionally rotated to restore orientation)

5.5.2 Prepare to land tubing hanger -- reference **SCP 400-030**

- make up riser joint with lower portion of quick union attached
- fill riser with XP-07 base oil
- rig down 4-1/2" tubing elevators and remove short bails
- rig up long (42 ft) bails and 13-3/8" casing elevators (for surface tree)

NOTE: Use side door elevators to fit around tree. Maximum string load is 77 tons.

- set surface tree with landing (slick) joint in elevators; latch and tie-off elevators
- make up landing joint extension to landing joint (quick union on both ends)
- P/U surface tree/landing joint
- stab landing joint into quick union and make up (support 10,000 lb with elevators)
- check riser angle (1/2° max relative to well) & vessel heave (1.5m max double amp)
- position ROV to observe BOP pin -- be prepared to record on videotape
- use passive heave compensation -- ensure HP air bottles are charged

NOTE: Space out such that tubing hanger is above BOP and flex joint when making up surface tree and quick unions.

5.5.3 Land the tubing hanger (not oriented) -- reference **SCP 400-035**

- P/U string and remove slips
- unlock the compensator
- record pick-up and slack-off weight = LAND OUT WEIGHT

NOTE: Expect maximum pick up weight to be 154,000 lb (0.25 friction factor).

- lower tubing hanger and THROT through BOP -- check for weight loss
- land tubing hanger in 10-3/4" casing hanger
- slack off 10,000 lb
- verify depth with index line
- mark around riser at rotary, also make vertical mark

5.5.4 Orient the tubing hanger -- reference **SCP 400-035**

- extend BOP pin -- observe with ROV
- unlock blocks to allow tubing to rotate
- pick up string per **SCP 400-035** -- observe 1/2" BOP pin travel with ROV
  -- observe riser rotation (may not see at this WD)

CAUTION: Maximum pick up weight on BOP pin is 40,000 lb DO NOT EXCEED

5.5.5 Land the tubing hanger in oriented position -- reference **SCP 400-035**

- lower string to land out tubing hanger
- set down 10,000 lb on tubing hanger
- check space out mark on riser
- set down COMPLETION WEIGHT plus 10,000 lb on tubing hanger

5.5.6 Lock tubing hanger per **SCP 400-035** -- observe BOP pin with ROV

5.5.7 Confirm lock with overpull test

- pull LAND OUT WEIGHT plus 25-50,000 lb with compensator

CAUTION: Do not exceed 200,000 lb string tension. The tensile capacity of the tubing riser is 216,000 lb (after applying 1.33 design factor).

- set down COMPLETION WEIGHT plus 10,000 lb

5.5.8 Recheck tubing hanger lock and orientation per **SCP 400-035** (end with BOP pin retracted)

5.5.9 Test tubing hanger seal from above -- reference **SCP 400-036**

- set pressure in tubing hanger running tools per **SCP 400-036** -- monitor during test
- line up cement unit on kill line
- pump 10 bbl brine down kill line / up riser to establish circulation - check w/ trip tank
- determine annular BOP closing pressure to use for THROT diameter
- close lower annular BOP around THROT to previously determined closing pressure
- pressure up kill line in 1000 psi increments to 3500 psi -- record volumes pumped

CAUTION: Monitor annulus pressure through umbilical for leak. Do not exceed 2000 psi on annulus because perf guns may fire.

NOTE: Annular preventer may not seal completely around THROT. Monitor drilling riser on the trip tank for indication of a leak.

- chart record the test -- 15 minutes straight line
- bleed off pressure through kill line
- open annular BOP
- close kill line valve

## 5.6 Procedure for Securing the Well

SPECIAL NOTE: Because the tubing was run partially filled with oil, there is an underbalance between the tubing and annulus that must be accounted for during pressure operations in this entire section of the procedure.

CAUTION: XP-07 in tubing will migrate up into surface equipment -- lubricator, cement hose, etc. Need to catch fluid when venting or breaking surface connections to prevent oil spill. Ensure rig floor drain is connected to system that can handle oil waste.

5.6.1 Rig up surface equipment to pressure up riser and production tubing

- fill riser landing joint with XP-07 base oil through swab valve on surface tree
- close swab valve
- line up cementing unit to pump 8.9 lb/gal completion brine to surface tree
- fill cementing line with 8.9 lb/gal completion brine
- connect cementing line to tree wing valve
- pressure cementing line to 5000 psi against closed wing valve

5.6.2 Configure to monitor annulus pressure

- set pressure on ASIV to 5000 psi
- attach gauge to annulus monitoring lines
- open annulus monitoring lines
- pump 0.1 bbl down annulus to verify system is open
- bleed annulus to 25 - 50 psi and observe pressure during production tubing tests

5.6.3 Test tubing integrity (against Mirage plug) prior to setting packer

- slowly pump brine to pressure production bore to 2000 psi (1000 psi $\Delta$P at packer)
- measure volume pumped -- expect 1.9 bbl
- monitor 10 minutes to verify tubing is holding

5.6.4 Low pressure inflow test production safety valve

- close production safety valve by bleeding both PSIV1 and PSIV2 to zero
- bleed down production bore to 1700 psi (300 psi $\Delta$P)
- record volume of returns -- expect 0.1 bbl

- chart record pressure for 30 min — accept pressure build less than 8 psi/min if leaking, will equalize at 1900 psi

5.6.5 Function test production safety valve -- confirm both control lines open the valve

- equalize across safety valve by pressuring production bore to 2000 psi
- open safety valve by applying 4000 psi to PSIV1
- bleed down production tubing to 1000 psi -- record volume -- expect 1.0 bbl
- close safety valve by bleeding PSIV1 to zero
- open safety valve by applying 4000 psi to PSIV2
- bleed down production tubing to zero -- record volume -- expect 1.0 bbl
- apply 4000 psi to PSIV1

5.6.6 Set the production packer (2500 psi ΔP across packer)

- increase pressure to 3500 psi for setting the packer -- expect to pump 3.3 bbl
- hold for 15 minutes to set packer -- check annulus gauge for pressure buildup

5.6.7 Pressure test tubing

- continue to hold 3500 psi on tubing
- chart record tubing pressure -- accept 15 minutes straight line
- bleed pressure to zero

5.6.8 Expend Mirage plug with wireline

- R/U wireline unit, lubricator, and wireline BOP -- test to 3500 psi
- RIH with membrane puncturing tool -- modified gauge cutter
- land on Mirage to puncture trash cap and protective membrane (pick-up / land several times)
- pick up wireline tools 100 m
- pressure tubing to 3500 psi and hold for 20 minutes -- expect to pump 3.3 bbl
- record pressure vs time

NOTE: 300 psi drop in tubing pressure may be seen when Mirage plug expends

- bleed off pressure
- RIH with wireline to Mirage plug depth to confirm plug has expended
- POOH with wireline

NOTE: ABB personnel to monitor IWOCS during all wireline work.

5.6.9 Test packer from below

- pressure tubing to 3500 psi with completion brine (2500 psi ΔP across packer)
- record volume pumped -- expect to pump 3.8 bbl
- monitor annulus pressure
- chart record -- accept 15 minutes straight line

5.6.10 High differential pressure inflow test of PSCSSV (shut-in tubing pressure differential)

- close production safety valve by bleeding both PSIV1 and PSIV2 to zero

- bleed pressure in tubing above PSCSSV to 250 psi (3250 psi differential) -- record volume bled off (expect 1.0 bbl)
- chart record pressure for 30 min — accept pressure build less than 8 psi/min if leaking, will equalize at 2600 psi
- pressure tubing to 3500 psi to equalize across PSCSSV (expect to pump 1.0 bbl)
- open PSCSSV by applying 4000 psi to both PSIV1 and PSIV2

5.6.11 Bleed tubing pressure to 1000 psi. Record volume of returns (expect 2.7 bbl). Maintain 1000 psi tubing pressure while pressure testing annulus to prevent premature shearing of the gas lift orifice.

5.6.12 R/U to pressure test annulus

- line up cement unit on kill line
- pump 2 bbl brine down kill line and up drilling riser -- check returns w/ trip tank
- close lower annular BOP around THROT to previously determined closing pressure
- pressure kill line to 1000 psi and hold for 10 minutes to verify annular seal
- bleed down kill line pressure to 200 psi
- rig up to monitor kill line pressure
- rig up to monitor riser/tubing pressure
- line up cement unit to hose adapter from umbilical reel ports marked A
- confirm ASIV pressure is 5000 psi to hold open ASCSSV
- confirm PSIV1 and PSIV2 are still pressured to 4000 psi

5.6.13 Pressure test annulus, packer from above, and tubing hanger seals from below

- pump 8.9 lb/gal completion brine down the umbilical lines connected to annulus
- increase pressure in 500 psi steps to 3000 psi (2800 psi differential on TH seal)

NOTE: Pump 0.9 bbl for each 500 psi or 5.3 bbl brine to reach 3000 psi.

- monitor kill line pressure (200 psi if no tubing hanger leak)
- monitor riser/tubing pressure (1000 psi if no packer/tubing leak)
- chart record -- accept 15 minutes straight line

5.6.14 Inflow test ASCSSV

- close ASCSSV by bleeding ASIV control line to zero psi
- bleed pressure in umbilical above ASCSSV to 200 psi (2800 psi differential)
- chart record pressure for 30 min — accept pressure build less than 50 psi/min (20 cc/min, which is 5% of API 14B) if leaking, will equalize at 3000 psi

NOTE: If valve passes test in 5.6.14, go directly to 5.6.15.

If valve fails test in 5.6.14, use alternative test method in 5.6.14A.

5.6.14A Because of the small volume in the umbilical, even a small safety valve leak may produce a pressure increase greater than 50 psi/min. In that case, use the alternate procedure for measuring the leak volume:

- bleed pressure in umbilical above ASCSSV to zero psi (3000 psi differential)

- disconnect one (or more) annulus umbilical line(s) at the reel
- measure volume returning through umbilical — accept flow less than 1.0 gal/10 min or 4 liters/10 min
- reconnect annulus umbilical line(s) to the reel

5.6.15 R/D pressure testing equipment

- equalize pressure across ASCSSV by pressuring umbilical lines to 3000 psi
- open ASCSSV by pressuring ASIV control line to 5000 psi
- bleed down annulus through umbilical lines -- measure returns (expect 5.3 bbl)
- bleed down kill line
- open annular preventer
- bleed down riser/tubing to cementing unit -- measure returns -- expect 1.1 bbl
- close PSCSSV by bleeding PSIV1 and PSIV2 to zero
- close ASCSSV by bleeding ASIV to zero

5.6.16 Set tubing hanger plug

- RIH with production bore tubing hanger plug on slick line
- set PXX plug
- set prong (use special short prong)
- POOH with slick line

NOTE: ABB personnel to monitor IWOCS during all wireline work.

5.6.17 Test tubing hanger plug

- pump brine to test plug from above to 3200 psi -- record volume pumped
- chart record pressure -- accept 15 minutes straight line
- bleed off pressure -- record volume returned

5.6.18 R/D lubricator and slick line unit.

## 5.7 Completion Riser and BOP Pulling Procedure

5.7.1 Prepare to circulate XP-07 from riser

- line up flow path from surface tree wing valve to catch XP-07 (expect 21 bbl)
- line up to pump brine down kill line

5.7.2 Prepare to retrieve riser and THROT -- reference **SCP 400-040**

- verify with ROV that BOP pin is retracted
- verify all four safety valve control lines are bled to zero
- trim rig to centralize riser in rotary
- confirm flex joint angle (less than 1/2° relative to wellhead angle) and riser tension

5.7.3 Release and pick up THROT

- verify vessel heave less than 1/2 m -- to avoid THROT heaving down on TH

- release THROT from tubing hanger per **SCP 400-040**
- pick up tubing riser 1-1/2 m to lift THROT clear of tubing hanger

5.7.4 Recover XP-07 from riser

- close upper annular around THROT -- low pressure close
- pump brine down kill line to circulate XP-07 from tubing riser -- riser volume 21 bbl
- open upper annular
- R/D line from surface tree

5.7.5 R/D landing joint and quick union spool piece

- pick up tubing riser until landing joint quick union is above rotary
- install slips in rotary
- set riser in slips
- break out landing joint quick union
- lay down landing joint with surface tree
- pick up string and break out quick union spool piece

NOTE: Before pulling remainder of riser with THROT, consider closing BOP shear rams to ensure debris scraped from riser does not fall on tubing hanger. Verify BOP controls can open shear rams after disconnect from wellhead.

5.7.6 POOH with riser and THROT

- break out tubing riser in stands -- install thread protectors and rack in derrick

NOTE: Dope pins and fully make up thread protectors on bottom of each stand.

- split slips to allow umbilical clamps to pass through
- remove umbilical clamps
- spool umbilical

5.7.7 Retrieve THROT through rotary

- remove slips and master bushings
- pick up THROT until umbilical connections are at working height
- ensure all functions are vented
- disconnect umbilical
- cap THROT fittings and umbilical hoses
- pick up THROT through rotary
- fit nose protector
- lay down THROT
- re-install master bushings

5.7.8 Retrieve BOP and drilling riser

NOTE: If shear rams were closed while retrieving THROT, the rams will need to be opened again after disconnecting the BOP and moving of location.

NOTE: New BOP VX gasket installed on A-2 is not locked to BOP (due to problems during installation). Need to:
1. Have ROV M/U gasket retainers and recover gasket with BOP
OR
2. Leave gasket in top of wellhead and recover with ROV

- release BOP from wellhead
- move rig 30 m off location
- retrieve BOP

5.7.9 Inspect and remove debris from wellhead, tubing hanger and flowline mandrel with ROV per **SCP 500-006**

5.7.10 If heavy debris, remove debris from inside annulus tubing down to safety valve flapper.

5.7.11 Install debris cap over wellhead with ROV.

## 6.0 Subsea Tree Installation

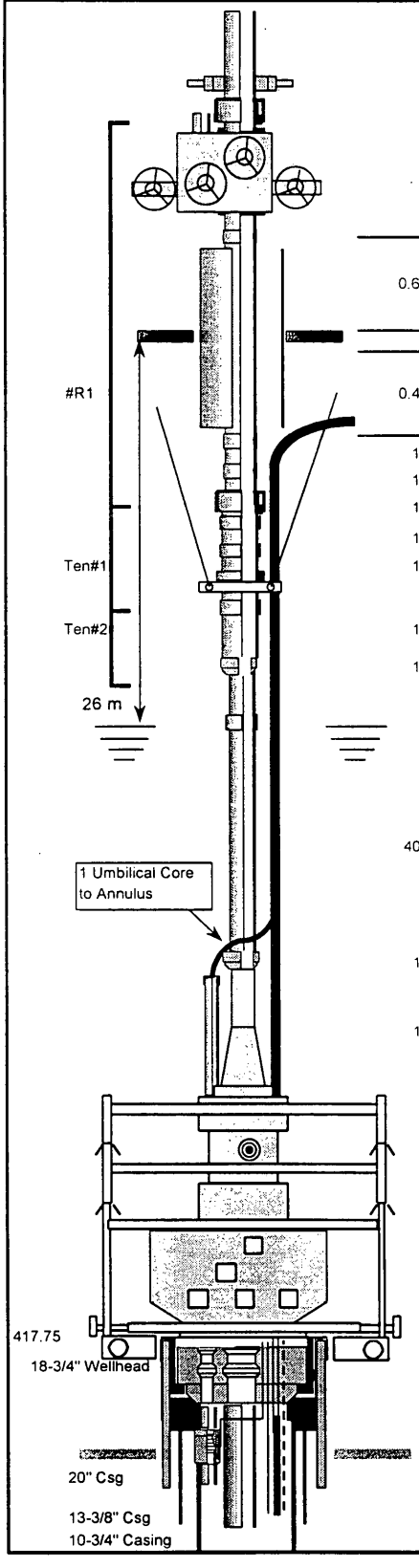
The subsea tree is extensively tested at the surface and then run on a single tubing riser. One core in the control umbilical is connected to the tree annulus bore to serve as a pressure monitoring line. After landing and locking the tree to the wellhead, pressure tests verify the integrity of tree connections to the control lines, wellhead, tubing hanger, and flowline stabs. The flexible jumpers that connect the subsea tree to the flowline are pressure tested for all three wells. Selected tree valves undergo inflow (leak) testing. When the tree is ready for service, the production bore is pressured to fire the pressure-activated perforating gun. After firing, the hanger holding the perforating gun releases and the perforating assembly falls to the rat hole. Annulus pressure is used to shear a bar in the gas lift valve and allow the orifice to open. XP-07 that has migrated into the riser is recovered, and the riser is retrieved.

A schematic of the riser and tree is shown in Figure 6-1.

The sequence of operations is summarized as follows:

- Run Tubing Hanger Orientation Check Tool
- Skid tree and EDP/LWRP into moonpool
- Make-up stress joint to tree - test
- Run tree
- Rig up riser tension joint, landing joint, and surface tree
- Position rig over well
- Land tree - lock
- Transfer riser load to riser tensioners
- Test control line connections (4500 psi differential)
- Test tree VX gasket seal and tree stabs (external) (5000 psi differential)
- Test tree seal to production bore of tubing hanger (3000 psi differential)
- Test tree seal to annulus bore of tubing hanger (2700 psi differential)
- Test flowline connections (2700 psi differential)
- Inflow (leak) test annulus master valve (2500 psi differential)
- Test flexible jumpers (3250 psi differential)
- Test CGB A-2 header valves (3250 psi differential)
- Inflow (leak) test production master valve (2800 psi differential)
- Confirm annulus pressure at 2500 psi (back up tubing when perforating)
- Pressure production bore to fire perforating guns (5000 psi) -- confirm fire
- Pressure annulus to shear open gas lift orifice (4000 psi differential)
- Configure safety valves for production
- Test production swab valve (2900 psi differential) and production wing valve
- Test annulus swab valve (1000 psi differential) and crossover valve
- Transfer riser weight to drilling compensator
- Unlatch LWRP from tree
- Recover XP-07 base oil
- Pull riser and EDP/LWRP

Figure 6-1
Riser for Running Subsea Tree




| Item | Qty | Description | Size | Material | CONNECTION UP | CONNECTION DOWN | Max OD in. | Min ID in. | Length m | MD m |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Bails | | | | | | | 12.80 | 20.27 |
| | | Wireline Lubricator | | | | | | | | |
| | | Wireline BOP | | | | | | | | |
| | | Quick Union | 8-1/4" | | | | | | | |
| | | Surface Tree | | | | | | | 1.54 | 7.47 |
| | | Pup Piece | | | | V ACE Pin | | | 0.40 | 5.93 |
| | 0.6 | Tubing | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | V ACE Box | V ACE Pin | 4.961 | 3.958 | 5.53 | 5.53 |
| | | DRILL FLOOR | | | | | | | | 0.00 |
| | 0.4 | Tubing | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | V ACE Box | V ACE Pin | 4.961 | 3.958 | 3.69 | 0.00 |
| | 1 | Pup Joint | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | V ACE Box | V ACE Pin | 4.961 | 3.958 | 1.22 | 3.69 |
| | 1 | Coupling | 4-1/2" 12.6 lb/ft | 13Cr(S)80 | V ACE Box | V ACE Box | 4.961 | 3.958 | 0.00 | 4.91 |
| | 1 | Quick Union | 7" Bowen | L80 | V ACE Pin 4-1/2" | V TOP Pin 5-1/2" | | | 0.61 | 4.91 |
| | 1 | Top Tension | 5-1/2" 23 lb/ft | L-80 | V TOP Box | V TOP Pin | 6.156 | 4.670 | 3.66 | 5.52 |
| | 1 | Middle Tension | 5-1/2" 23 lb/ft | L-80 | V TOP Box | V TOP Pin | | | 4.27 | 9.18 |
| | | with Primary Support Yoke at | 12.53 m | | | | | | | |
| | 1 | Bottom Tension | 5-1/2" 23 lb/ft | L80 | V TOP Box | V TOP Pin | 6.156 | 4.670 | 6.71 | 13.45 |
| | 1 | Crossover | 5-1/2" 23# x 4-1/2" 12.6# | | V TOP Box 5-1/2" | V ACE Pin 4-1/2" | | | 0.46 | 20.16 |
| | | Pup Joints | 4-1/2" 12.6 lb/ft | L80 | V ACE Box | V ACE Pin | 4.961 | 3.958 | 1.83 | 20.62 |
| | 40 | Tubing | 4-1/2" 12.6 lb/ft | L80 | V ACE Box | V ACE Pin | 4.961 | 3.958 | 380.00 | 22.45 |
| | 1 | Crossover | 4-1/2" 12.6# x 5" 20# | | V ACE Box | | | 3.958 | 0.43 | 402.45 |
| | 1 | Stress Joint | | | | | | | 9.77 | 402.88 |
| | | Emergency Disconnect Package | | | | | | | 5.10 | 412.65 |
| | | Lower Workover Riser Package | | | | | | | | |
| | | Subsea Tree | | | | | | | | |
| | | Top Wellhead | | | | | | | | 417.75 |
| | | Sea Floor 421 m | | | | | | | | |

STICK UP

## 6.1 Preparations

- ☐ Prepare subsea system tree per **SCP 100-025 / 100-026 / 100-040**
  - function test tree
  - function test subsea control module
  - stack up tree and tree cap on test stump; pressure test
- ☐ Prepare main umbilical and IWOCS
- ☐ Prepare EDP/LWRP system per **SCP 100-030 / 100-031**
- ☐ Stack up EDP/LWRP/tree and complete presubmergence check per **SCP 500-009**
- ☐ Prepare ROV with tools needed tools for the operation
- ☐ Prepare Tubing Hanger Orientation Check Tool (THOCT)
- ☐ Prepare tubing riser tension joint
- ☐ Confirm readiness of tubing riser landing joint and surface tree (used to land TH)
- ☐ Prepare wireline with production bore tubing plug pulling tools
- ☐ Position rig 30 m off location for running tree
- ☐ Check current profile / cascade current forecast to ensure sufficient time to run tree

## 6.2 Operational & Installation Data

- Riser space out -- 6 m stick up from rig floor at zero tide

| Vessel Motion for Running Tree | Max Allowable |
|---|---|
| Pitch / roll | 3° |
| Heave (double amplitude) | 1.5 m |

| Component | Working Pressure |
|---|---|
| Subsea Tree | 5000 psi |
| Completion Guide Base Piping Downstream of FPIV and FAIV | 3250 psi |
| Flexible Jumpers | 3250 psi |

| Riser Connection | M/U Torque | | | M/U Loss |
|---|---|---|---|---|
| | Minimum | Optimum | Maximum | |
| 4-1/2" 12.6 lb/ft 80 ksi VAM ACE | 3260 ft-lb | 3620 ft-lb | 3980 ft-lb | 3.662 in (9.30 cm) |
| 5-1/2" 23.0 lb/ft 80 ksi VAM TOP | 7470 ft-lb | 8300 ft-lb | 9130 ft-lb | 4.382 in (11.13 cm) |

## 6.3 Tree Installation Procedure

6.3.1 Run Tubing Hanger Orientation Check Tool (THOCT) -- reference **SCP 500-005**

- reposition rig over well
- orient and prepare THOCT per **SCP 500-005**
- make up THOCT flange sub to stand of HWDP
- skid THOCT into moonpool and center under rotary
- make up flange on HWDP to top of THOCT per **SCP 500-005**
- insert guidelines into THOCT guide funnels
- run THOCT to within 10 m of wellhead
- adjust drill string compensator to support 5000 lb string weight
- remove by ROV the wellhead debris cap
- confirm by ROV the correct alignment of THOCT and tubing hanger
- pump brine down drill pipe at 200-500 psi (±15 stroke/min) while landing THOCT
- lower THOCT over CGB guideposts and land on wellhead - stop pump when landed
- observe THOCT indicators per **SCP 500-005**
- use drill string compensator to pick up THOCT approximately 10 m
- install by ROV the wellhead debris cap
- pull and R/D THOCT
- reposition rig 30 m off location

NOTE: If the THOCT indicates tubing hanger is not oriented correctly, the tubing hanger measurement tool can be run (consult Subsea Supervisor).

6.3.2 Make up tubing riser stress joint

- pick up stress joint and inspect seals
- make up 2 joints 4-1/2" riser to stress joint
- pull back stress joint until 13-3/8" flange is at diverter housing below rotary

NOTE: Stress joint will have umbilical attached.
Stress joint will have bulls eye attached.

6.3.3 Skid tree/LWRP/EDP to moonpool and center under rotary per **SCP 500-010**

- ensure orientation is correct

6.3.4 Make up stress joint to EDP per **SCP 500-010**

- land stress joint on EDP
- make up flanged connection
- pressure test connection externally
- clamp umbilical to stress joint
- connect 3/8" annulus monitoring line from stress joint to EDP

6.3.5 Pressure test tree/LWRP/EDP/stress joint per **SCP 500-010**

- rig hose to top 4-1/2" riser & fill riser/EDP/LWRP/tree with water (vent 2-3/8" riser)
- close 2-3/8" vent
- install plug on top of 4-1/2" riser

- pressure test to 5000 psi through annulus monitoring line
- chart record pressure -- accept 15 minutes straight line
- bleed off pressure
- remove plug in 4-1/2" riser

6.3.6 Check tree / LWRP /EDP configuration for running per **SCP 500-010**

- check valve positions
- check connector positions

6.3.7 Position tree for running -- reference **SCP 500-010**

- restrain EDP/LWRP/tree with tuggers
- pay out sufficient umbilical to run through splash zone
- pick up EDP/LWRP/tree with riser
- remove skid assembly and skid beams
- open spider beams to tree width
- lower tree to within 1" of spider beams
- install guidelines into guide funnels and make up gates
- fully open moonpool spider beams
- tension guidelines to 4000 lb with compensator at mid-stroke

6.3.8 Lower tree through splash zone

- begin lowering tree
- remove tuggers as EDP/LWRP/tree goes through moonpool
- lower tree through splash zone without delay
- hang off top of riser in slips (EDP will be approx. 3-4 m below splash zone)
- make up stand of tubing riser and run one joint through rotary
- slack off guideline tension

6.3.9 Run tree on 4-1/2" L80 tubing riser per riser tally list

- clamp umbilical to each joint

6.3.10 Run 5-1/2" tension joint (with quick union facing up)

- R/U equipment to handle and make up 5-1/2" tension joint
- make up tension joint and run through rotary
- attach riser tensioner lines to yokes on tension joint
- pay out sufficient tensioner line to land tree

6.3.11 Confirm with ROV the distance from the tree to the sea floor

6.3.12 Rig up landing joint and surface tree -- reference **SCP 500-020**

- rig down riser elevators and remove short bails
- rig up long bails and 13-3/8" casing elevators (for surface tree)
- set surface tree with landing (slick) joint in elevators; latch and tie-off elevators
- connect cementing unit line to production bore wing valve of surface tree

- P/U surface tree/landing joint
- stab landing joint into quick union and make up (support 10,000 lb with elevators)
- lock heave compensator -- ensure HP air bottles are charged
- ensure top drive is unlocked and free to rotate

6.3.13 Check and reconfigure control functions per **SCP 500-020**

- confirm the 4 SCSSV lines and VX test are vented at IWOCS
- confirm with ROV the EDP/LWRP/tree valve positions -- bore valves open
- confirm with ROV that the FAIV and FPIV valves on the CGB are closed
- pay out sufficient umbilical to land tree and provide a storm loop

6.3.14 Pressure test riser (low pressure to find any major problem) -- reference **SCP 500-020**

- pressure test cement unit line to 5000 psi against closed surface tree wing valve
- open surface tree production bore wing valve (close all other surface tree valves)
- pump 21 bbl brine with cement unit through surface tree, riser, and subsea tree
- confirm by ROV that fluid is exiting the bottom of the subsea tree
- close the subsea tree valves per **SCP 500-020**
- pick up riser out of slips
- pressure test riser to 1000 psi -- accept 15 minutes straight line
- bleed off pressure (leave cement line vented to atmospheric pressure)
- open subsea tree valves per **SCP 500-020** (observe with ROV)

6.3.15 Position rig over well -- reference **SCP 500-020**

- pick up surface tree until riser tension ring is just below diverter / drip pans

  NOTE: Bottom subsea tree is 6 - 7 m above guideposts
  9 - 10 m above wellhead
  12 - 13 m above sea floor

- move rig over well while taking up slack in guidelines
- when in position, tension guidelines to 5000 lb and adjust to mid stroke
- flush through VX test port until fluid is seen by ROV
- vent VX test port to atmospheric and leave vented
- confirm by ROV that tree is oriented correctly with respect to CGB
- confirm by ROV that tree connector and flowline connector are unlocked
- remove by ROV the wellhead debris cap -- clean wellhead with ROV
- remove by ROV the flowline hub cover -- clean flowline connection with ROV

6.3.16 Land tree -- reference **SCP 500-020** (bore valves open)

- unlock drill string compensator and adjust to safe stroke
- pick up string and record weight (use in subsequent weight calculations)
- lower tree within 2-3 m of CGB and check guide funnels relative to guide posts
- adjust rig position to align funnels with posts
- lower tree over guide posts
- use drill string compensator to land tree on wellhead -- observe with ROV

- slack off 60,000 lb
- confirm by ROV that tree has landed out fully
- confirm by ROV that flowline connector has engaged fully

6.3.17 Lock tree to wellhead per **SCP 500-020**

6.3.18 Conduct overpull test to confirm tree is locked -- reference **SCP 500-020**
- use compensator to apply 25,000 overpull above string weight recorded earlier
- relax overpull to neutral weight at subsea tree

6.3.19 Transfer riser weight to tensioners - support weight above tension ring w/ compensator

6.3.20 Test hydraulic and electrical stabs from tree to tubing hanger per **SCP 500-020**
- move by ROV the electrical jumpers from the CGB to the subsea control module
- verify signal from tree transducers & downhole P/T gauge; coordinate with Mackerel
- test control lines (PSIV2/INIV & ASIV/PSIV1) to 4500 psi (5000 psi ΔP at PSCSSV)
- bleed off control line pressure to 3000 psi and block in

6.3.21 Test tree VX gasket seal and tree stabs (external) per **SCP 500-020**
- pressure VX test line to 5000 psi to test tree-to-wellhead connection, tree stabs (external), control line stabs (external) - record volume pumped
  - monitor annulus pressure, control line pressure, downhole P/T gauge
  - chart record -- accept 15 minutes straight line
- bleed off PSIV2/INIV & ASIV/PSIV1 control line pressure to zero

6.3.22 Pressure test riser (high pressure)
- close the subsea tree valves per **SCP 500-020**
- pressure test riser to 5000 psi -- accept 15 minutes straight line
- bleed off pressure
- open subsea tree valves per **SCP 500-020**

6.3.23 Deploy ROV to close INIV and PSIV1 needle valves on subsea tree

## 6.4 Tree and Flexible Jumper Test Procedure

6.4.1 Test tree seal to production bore of tubing hanger -- reference **SCP 500-020**
- line up cement unit to pump brine to surface tree -- retest surface lines to 5000 psi
- configure tree valves as shown in Figure 6-2
- pressure to 3000 psi down riser against production bore tubing hanger plug
- chart record -- accept 15 minutes straight line -- monitor VX test line on IWOCS
  - monitor production bore pressure with downhole gauge from Mackerel
- bleed off pressure and measure returns

6.4.2 Test the following: tree seal to annulus bore of tubing hanger, production flowline connection, annulus flowline connection -- **SCP 500-020**

- configure tree valves as shown in Figure 6-3
- pressure ASIV/PSIV1 to 5000 psi to open ASCSSV (PSIV1 needle valve closed)
- pressure down riser to 2700 psi -- record volume pumped -- expect 4.8 bbl
- chart record -- accept 15 minutes straight line
  - monitor annulus tree seal with VX test through IWOCS
  - monitor flowline connections with ROV
  - monitor production bore pressure with downhole gauge from Mackerel
- close annulus master valve to remove annulus volume from system
- chart record another 10 minutes

Figure 6-2
Step 6.4.1 - Test Tree Seal to Production Bore of Tubing Hanger

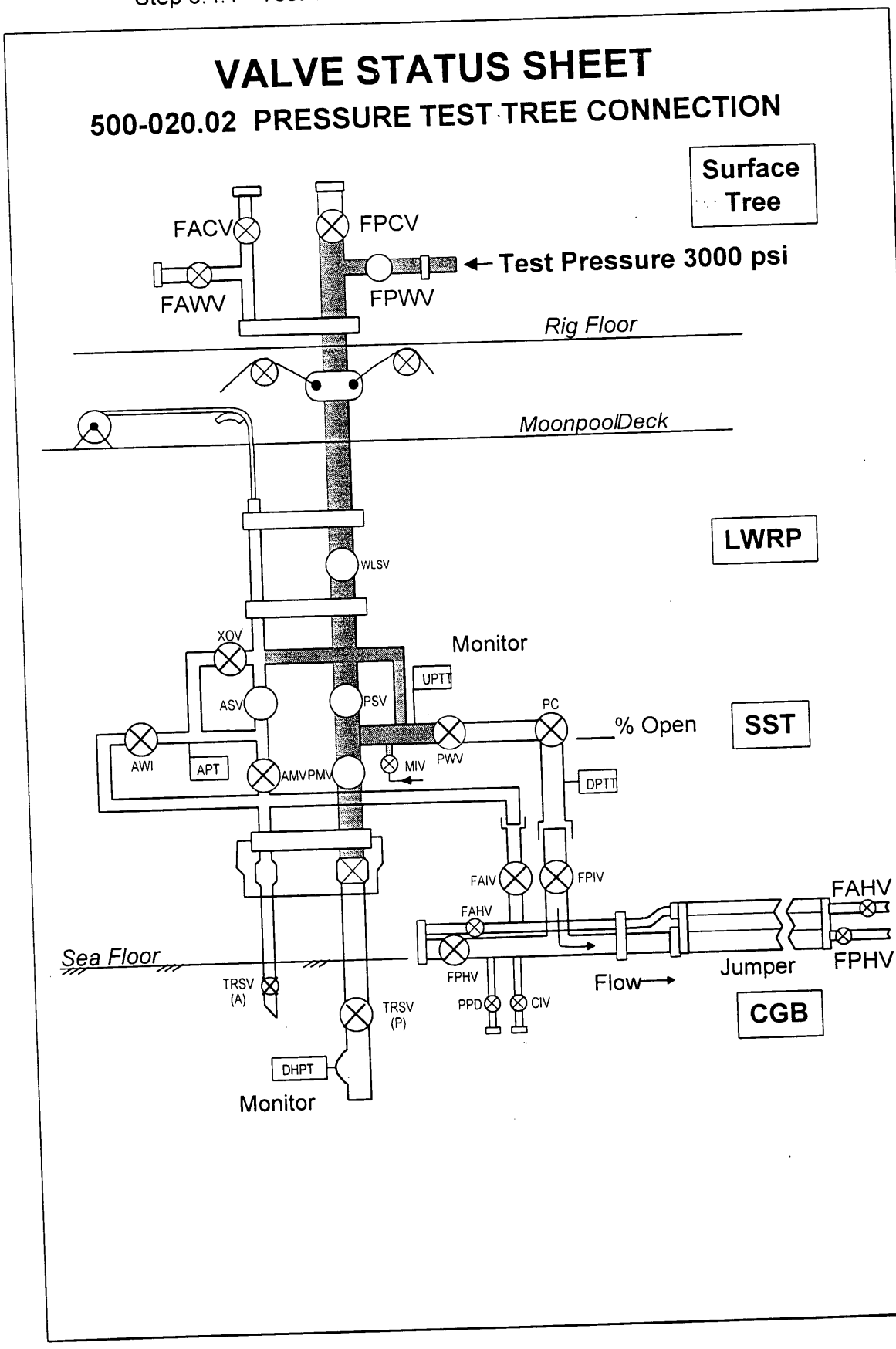
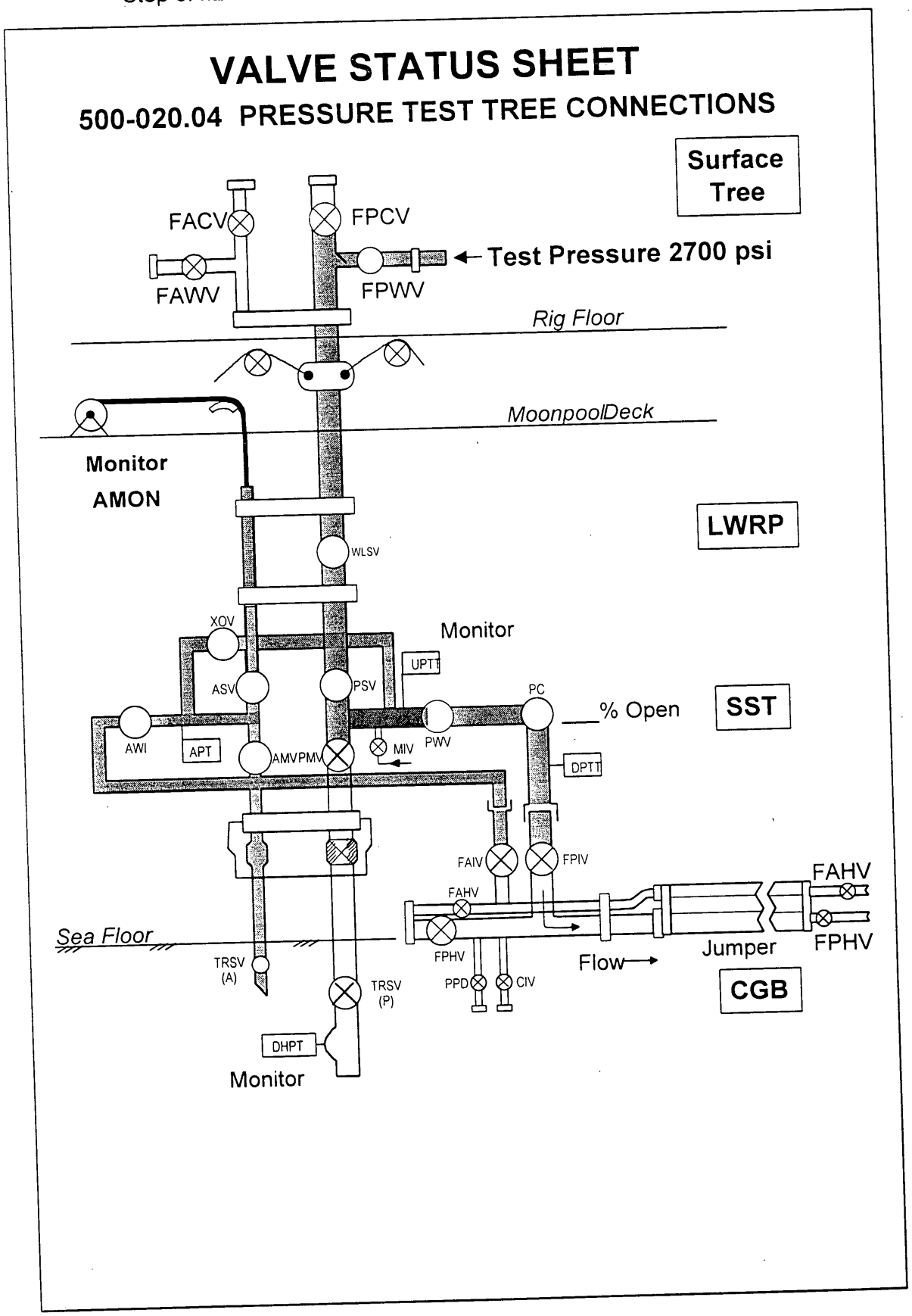


Figure 6-3
Step 6.4.2 - Test Tree Seal to Annulus Bore, Flowline Connections



6.4.3 Inflow (leak) test annulus master valve

- bleed riser pressure down to 200 psi (2500 psi differential on AMV)
- close XOV
- chart record on annulus monitoring line -- accept 15 minutes straight line

NOTE: Do not bleed annulus - keep 2700 psi annulus pressure until perf guns fire

6.4.4 Pressure test production and gas lift flexible jumpers per **SCP 500-035**

- configure tree valves as shown in Figure 6-4
- configure CGB valves as follows (adjust if all flexible jumpers are not installed)

CONFUGURATION BEFORE TEST

| | PTA | CGB A-1 | CGB A-2 | CGB A-3 |
|---|---|---|---|---|
| Production Isolation FPIV | N/A | Closed | Open | Closed |
| Production Header FPHV | P-1 Closed | Open | Open | Closed |
| Annulus Isolation FAIV | N/A | Closed | Open | Closed |
| Annulus Header FAHV | G-4 Closed | Open | Open | Closed |

- pressure jumpers to 3250 psi - record volume (may need low volume pump)

NOTE: Limit build rate to 44 psi/min to avoid jumper damage -- 1-1/4 hr to build. Chart record entire build up and bleed off process.

- chart record pressure test at 3250 psi -- accept 15 minutes straight line
- bleed off pressure -- measure returns

NOTE: Limit bleed rate to 44 psi/min to avoid jumper damage -- 1-1/4 hr to bleed

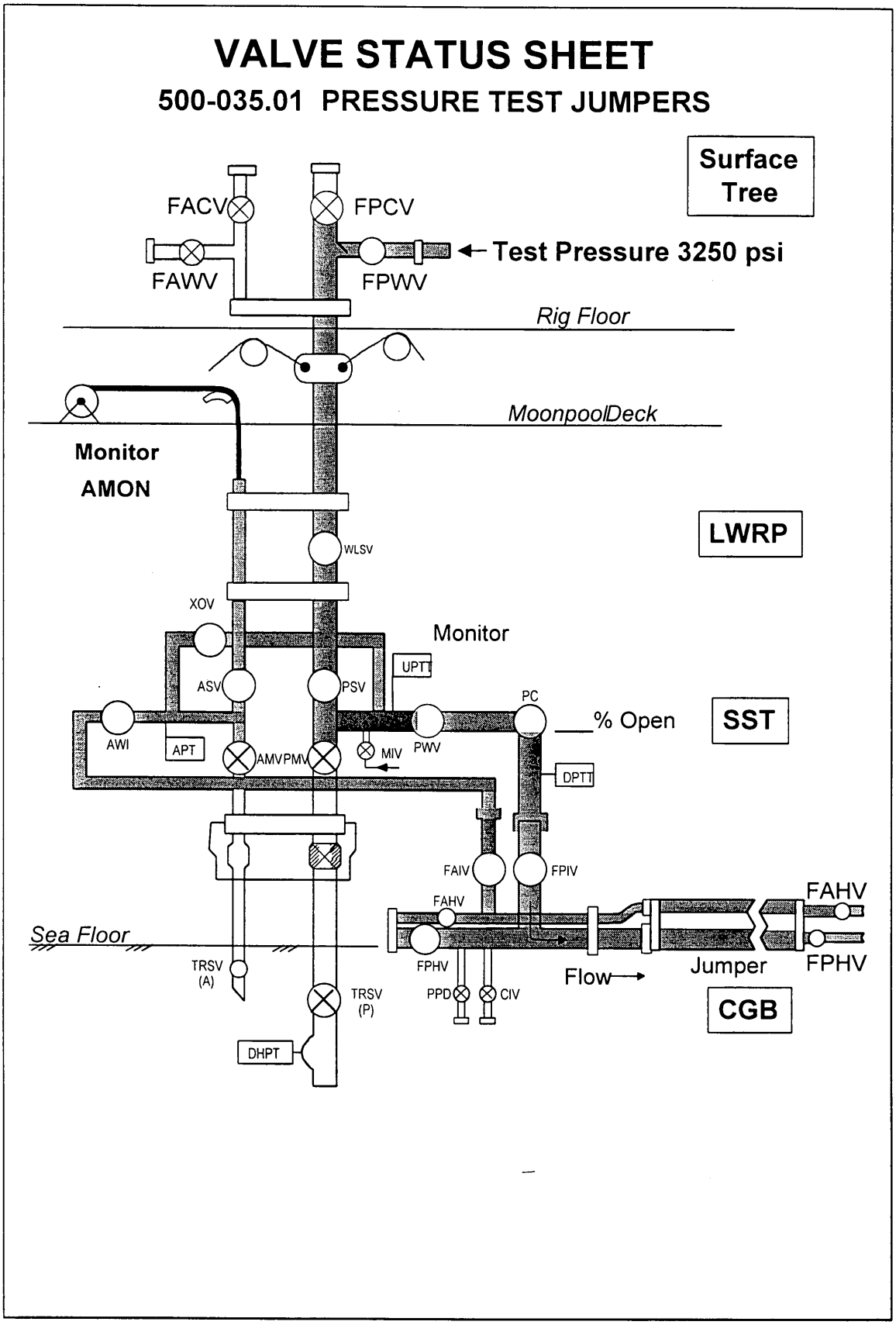
- close FPHV and FAHV on CGB A-2

CONFUGURATION AFTER TEST

| | PTA | CGB A-1 | CGB A-2 | CGB A-3 |
|---|---|---|---|---|
| Production Isolation FPIV | N/A | Closed | Open | Closed |
| Production Header FPHV | P-1 Closed | Open | Closed | Closed |
| Annulus Isolation FAIV | N/A | Closed | Open | Closed |
| Annulus Header FAHV | G-4 Closed | Open | Closed | Closed |

NOTE: After the flexible jumpers have been pressure tested, the pipeline commissioning team may inject methanol from the Mackerel platform into the jumpers. ROV and other support would be needed from the Sedco 702. If this operation proceeds, a supplemental procedure would be issued.

Figure 6-4
Step 6.4.4 - Pressure Test Flexible Jumpers



6.4.5 Inflow (leak) test production master valve -- reference **SCP 500-040**

- configure valves as shown in Figure 6-5
- R/U slickline unit, wireline BOP, and lubricator
- pressure PSIV2/INIV to 4000 psi to open PSCSSV (INIV needle valve is closed)
- open PMV
- pull prong to equalize pressure across plug
- pull plug

NOTE: XP-07 will migrate up riser (brine going down) once plug is pulled.

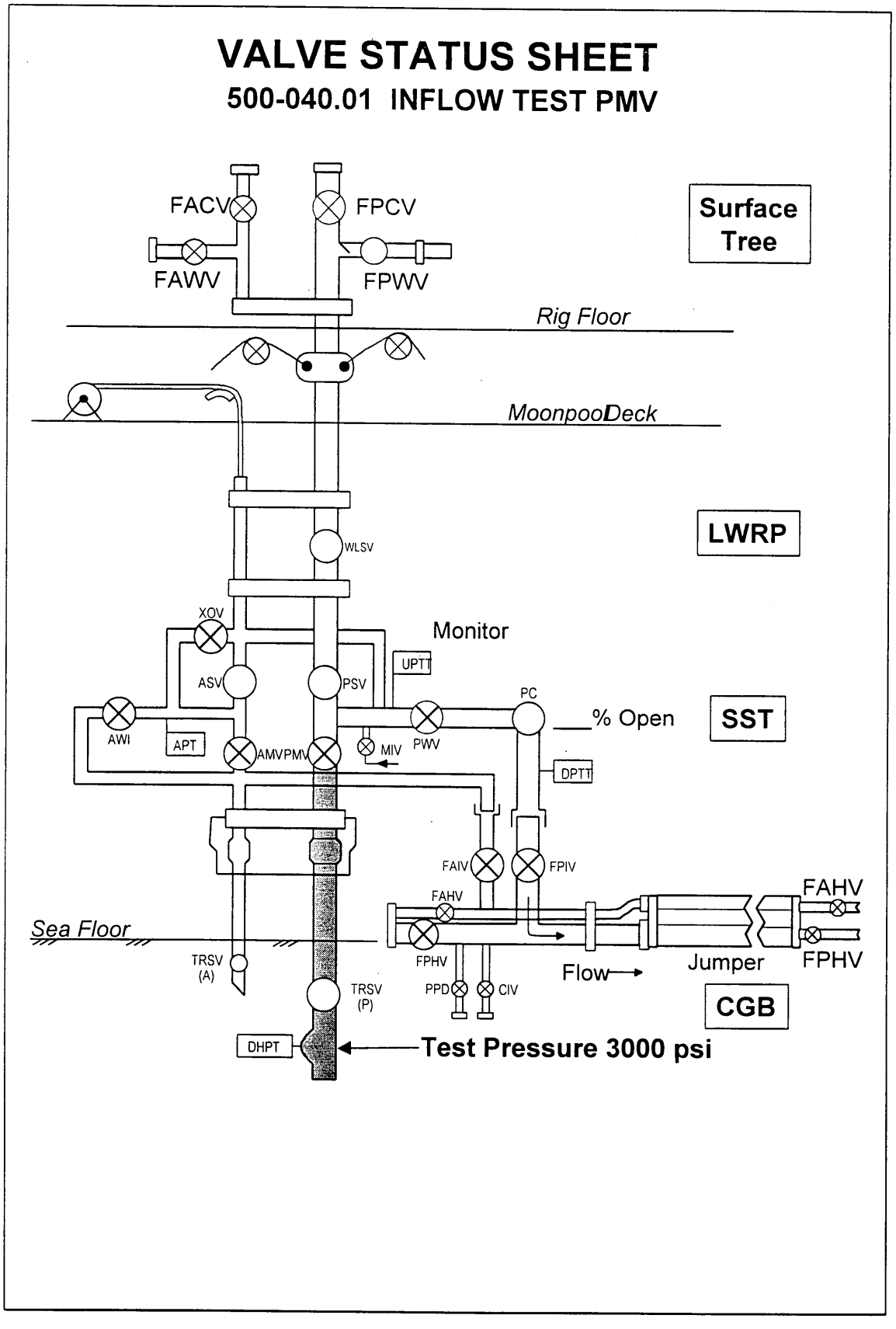
- close PMV
- R/D slickline equipment

NOTE: ABB personnel to monitor WOCS during all wireline work.

- open PMV
- pressure tubing to 3000 psi
- close PMV
- bleed riser back to 200 psi (2800 psi differential on PMV)
- chart record -- accept 15 minutes straight line

NOTE: If Mackerel readout of Upstream T/P gauge is available, an alternative is to close the WLSV and monitor pressure in tree cavity from Mackerel.

Figure 6-5
Step 6.4.5 - Inflow (Leak) Test Production Master Valve



## 6.5 Perforating Procedure

6.5.1 Confirm 2500 psi in annulus to back-up tubing during perforating

- ensure XOV is closed
- equalize across AMV by pressuring down annulus monitoring line to 2700 psi
- open AMV
- bleed 0.25 bbl from annulus through monitoring line to confirm AMV and ASCSSV are open -- pressure should stabilize at 2500 - 2700 psi
- monitor annulus pressure during perforating -- should be 2500 - 2700 psi

6.5.2 Fire perforating guns

- open PSV with ROV
- open PMV
- pressure production tubing to 5000 psi (expect guns to trigger at ±4500 psi)
- hold for 5 minutes
- bleed pressure to zero at surface
- close PMV

6.5.3 Confirm perforating guns fired

- wait for 30 minute delay, monitor DHPT gauge at Mackerel for 500 psi pressure increase after guns fire
- equalize across PMV by pressuring riser to 500 psi
- open PMV -- expect to continue seeing 500 psi at surface
- bleed 1.0 bbl from tubing to confirm perf/PSCSSV open -- expect no pressure loss
- close PMV

6.5.4 Shear out gas lift orifice in side pocket mandrel

- monitor production tubing pressure with DHPT gauge from Mackerel
- pressure riser to equalize across XOV -- approximately 2700 psi
- open XOV
- pressure annulus to 4000 psi (expected shear pressure) or until shear is observed

NOTE: Annulus safety valve opening pressure is 1537 psi + bore pressure
Annulus safety valve closing pressure is 890 psi + bore pressure

NOTE: If orifice shear pressure is higher than expected, it may be necessary to bleed pressure from IWOCS to keep control line pressure from exceeding 5000 psi. Should this occur, the safety valve will close, but continue to pump through safety valve to shear gas lift orifice. Once orifice shears, annulus pressure will drop and safety valve will open. Some annulus fluid will flow through orifice and push fluid from tubing into reservoir.

- bleed down annulus to zero -- check valves will close in orifice preventing back flow
- close AMV

6.5.5 Configure safety valves for production

- bleed PSIV2/INIV pressure to zero -- will close PSCSSV

- open PSIV1 needle valve on tree with ROV - monitor ASIV/PSIV1 for pressure drop
- bleed ASIV/PSIV1 pressure to zero -- will close ASCSSV

NOTE: ASCSSV and PSCSSV are closed and all SSV control pressures are zero.

NOTE: Needle valve for INIV (RH-2 nipple) is closed on tree.

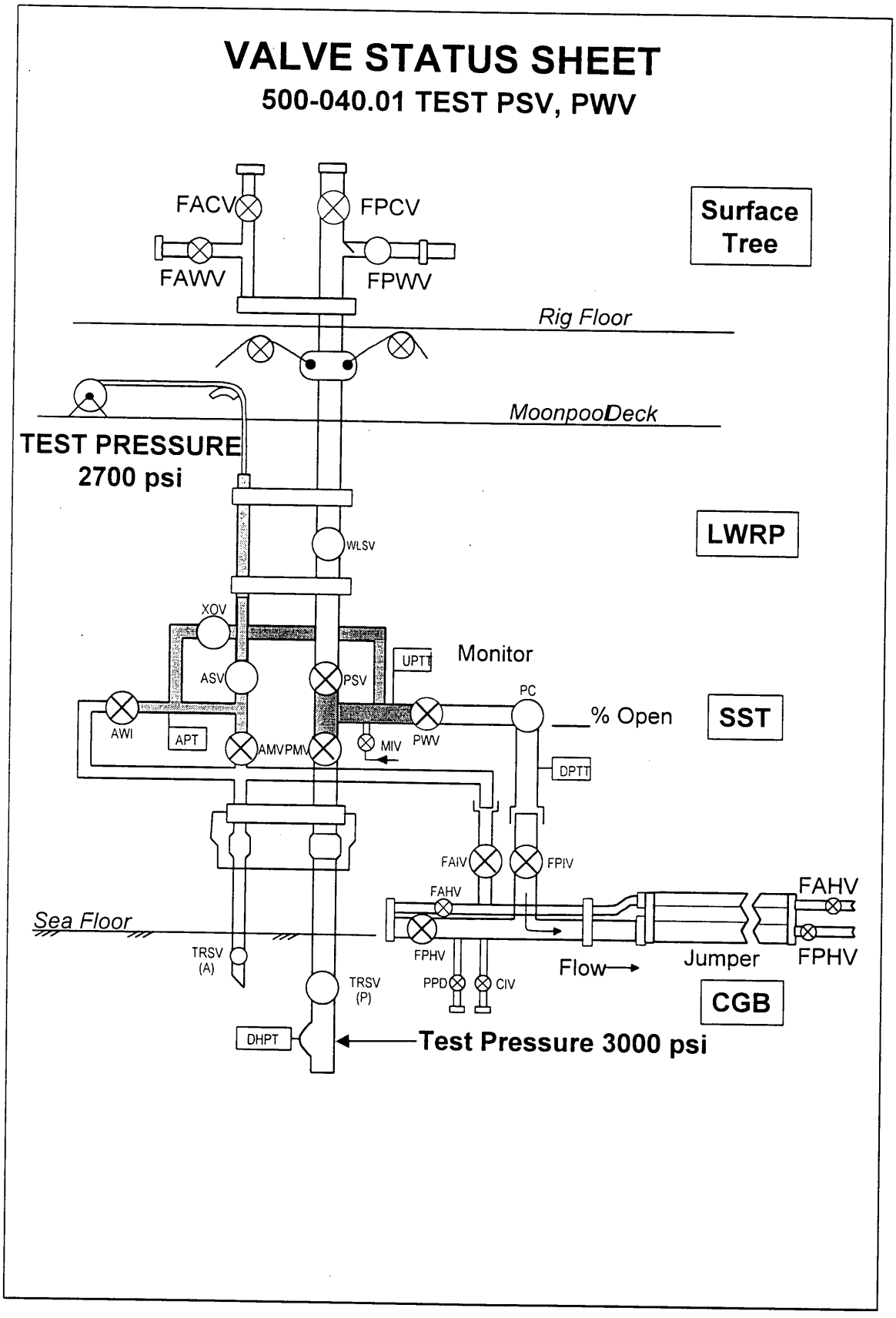
6.5.6 Test PSV, PWV -- reference **SCP 500-040**

- configure tree valves per Figure 6-6 -- close PSV with ROV
- pressure through annulus monitoring line to 2700 psi
- chart record -- accept 15 minutes straight line
- bleed pressure to 400 psi (equalzes pressure across master valve)
- close XOV

6.5.7 Test ASV and XOV -- reference **SCP 500-040**

- pressure through annulus monitoring line to 1000 psi
- close ASV with ROV
- bleed off annulus monitoring line
- record pressure on Annulus Pressure Transducer at Mackerel Platform -- 15 min

Figure 6-6
Step 6.5.5 - Test PSV, PWV



## 6.6 EDP/LWRP Retrieval Procedure

SPECIAL NOTE: Some XP-07 oil from the downhole completion will have migrated upward during tree testing and perforating activities. This oil must be removed prior to retrieving the riser.

6.6.1 Prepare to recover EDP/LWRP

- R/D surface lines
- configure IWOCS controls for EDP/LWRP retrieval per **SCP 500-045**
- check by ROV bullseye on EDP (adjust rig position to bring within acceptable limit)

6.6.2 Line up flow path from surface tree wing valve to empty XP-07 tanks (max. 20 bbl)

- place empty XP-07 tanks at or below rig floor level

6.6.3 Transfer riser weight from tensioners to compensator

- set drill string compensator at mid stroke
- support weight of riser/EDP/LWRP while reducing riser tensioner support
- slack off riser tensioners
- disconnect riser tensioner yokes

6.6.4 Unlatch LWRP from tree **per SCP 500-045**

- adjust compensator to string weight (see 6.3.16) minus tree weight
- unlatch LWRP
- pick up LWRP clear of tree and guideposts -- observe with ROV
- install tree mandrel debris cap by ROV

6.6.5 Recover XP-07 from riser

- allow XP-07 to U-tube up tubing riser, through surface tree to XP-07 tanks

NOTE: The air gap between the rig floor and sea level prevents full recovery of the XP-07 by the U-tube method.

6.6.6 Clear riser of remaining XP-07 (approximately 5.5 bbl)
THIS PROCEDURE SUBJECT TO APPROVAL FROM DNRE -- DO NOT PROCEED UNLESS APPROVAL HAS BEEN OBTAINED

- line up the cement unit to pump brine through surface tree and down riser
- pump 30 bbl brine down riser to expel oil
- R/D line from surface tree

6.6.7 Pull landing and 5-1/2" tension joints

- hang off riser tension joint in slips
- disconnect landing joint quick union
- lay down landing joint with surface tree
- remove 40 ft bails
- rig up normal bails and tubing handling equipment

- pull tension joint through rotary -- ensure tension ring does not hang under rotary
- install 4-1/2" slips and tubing breakout equipment
- break out tension joint -- leave one 4-1/2" pup joint on bottom

6.6.8 Pull riser with EDP/LWRP

- move rig 30 m off location
- pull riser -- removing umbilical clamps and spooling umbilical on to reel

NOTE: Break out riser joints as singles -- will be sent back to BBMT

- when stress joint is visible, pull EDP/LWRP through splash zone without stopping

6.6.9 R/D EDP/LWRP -- reference **SCP 500-045**

- raise LWRP to moonpool level
- remove guidelines
- attach tugger lines to prevent LWRP from swinging
- pick up LWRP to 4 m above moonpool deck
- close moonpool spider beams
- install skid beams across moonpool
- move skid assembly until centered under LWRP
- lower LWRP on to skid
- separate flange connector between EDP and stress joint
- skid EDP/LWRP from moonpool

# 7.0 Tree Cap Installation

The tree cap is run on heavy weight drill pipe, landed on top of the tree, and pressure tested. Hydraulic stabs in the tree cap connect the subsea control system to the tree hydraulic valves.

The sequence of operations is summarized as follows:

- Prepare tree cap and tree cap running tool
- Run tree cap on HWDP
- Land tree cap
- Pressure test tree cap (5000 psi)
- Disconnect running tool
- Pull running tool
- Install tree protective cap

## 7.1 Preparations

- ☐ Prepare Tree Cap per **SCP 100-035**, which includes
  - make up Tree Cap Running Tool (TCRT) to tree cap
  - make up auxiliary umbilical to TCRT
  - place tree cap on skid in correct orientation
- ☐ Make up Tree Cap quick connection to stand of HWDP
- ☐ ROV to have tree cap protective cover in tool basket
- ☐ Position rig 30 m off location for running tree cap

## 7.2 Tree Cap Procedure

7.2.1 Prepare tree cap/TCRT for running

- skid tree cap/TCRT in to moonpool area centered under rotary
- run quick connect flange on stand of HWDP through rotary
- make up flange to top of TCRT per **SCP 600-010**
- pick up assembly -- restrain with tuggers as required
- remove skid assembly and skid beams
- close moonpool spider beams to TCRT width
- lower TCRT until tagging spider beams
- install guidelines into TCRT (secure gates)
- tension guidelines to 4000 lb -- ROV to ensure subsea tree is not snagged

7.2.2 Run tree cap -- reference **SCP 600-010**

- pick up tree cap/TCRT
- open spider beams
- lower tree cap/TCRT through splash zone

- install umbilical clamp on pod line
- continue running on HWDP -- install umbilical clamp every 1/2 stand
- stop when tree cap is 10 m above tree
- reposition rig over well
- tension guidelines to 5000 lb -- tensioners at mid-stroke

7.2.3 Land tree cap

- remove with ROV the debris cap from tree mandrel -- jet/suction mandrel until clean
- confirm control functions set correctly per **SCP 600-010**
- lower tree cap slowly over the re-entry spool
- set down 10,000 lb

CAUTION: Do not allow tree cap to bounce.

- verify landing with ROV
- lock tree cap to tree per **SCP 600-010**
- use motion compensator to pull up on tree cap with 20,000 lb overpull
- set down 10,000 lb

7.2.4 Pressure test tree cap through umbilical

- test annulus and production bores to 5000 psi -- accept 15 minutes straight line
- bleed off pressure
- close the TCIV with the ROV -- record turns and torque

7.2.5 Disconnect TCRT

- adjust set down weight on TCRT to 5000 lb
- unlock TCRT per **SCP 600-020**
- use motion compensator to lift TCRT clear of tree and guideposts

7.2.6 Pull TCRT

- move rig 30 m off location (slack guidelines)
- pull TCRT to surface -- removing clamps and spooling umbilical
- pick up clear of spider beams
- remove guide wires
- install moonpool skid beams
- move skid assembly under TCRT
- lower TCRT on to skid
- break out quick connection flange

7.2.7 Install tree cap protective cover with the ROV

7.2.8 Check CGB valve status with ROV and configure as agreed with Production.

At this point the well is complete and ready for commissioning process to begin.

# GLOSSARY

The following terms and abbreviations are used within this Completion Program or the Subsea Completion Procedures.

| | |
|---|---|
| ABB | ABB Vetco Gray |
| AIV | Annulus Isolation Valve |
| AMON | Annulus Monitoring |
| AMV | Annulus Master Valve |
| ANN | Annulus |
| API | American Petroleum Institute |
| Approx. | Approximately |
| ASCSSV | Annulus Safety Valve |
| ASIV | Annulus Surface Isolation Valve |
| Assy | Assembly |
| ASV | Annulus Swab Valve |
| AWV | Annulus Wing Valve |
| bbl | Barrel |
| BOP | Blowout Preventer |
| BOPD | Barrels Oil per Day |
| BPM | Barrels per Minute |
| C | Centigrade |
| CCL | Casing Collar Locater |
| CGB | Completion Guidebase |
| CGBRT | CGB Running/Retrieving Tool |
| CIV | Corrosion Inhibitor Valve |
| CI | Corrosion Inhibitor |
| C/L | Control Line |
| Comm | Communication |
| Conn. | Connector |
| CPLG | Coupling |
| DF | Drill Floor |
| DF | Design Factor |
| DFCS | Diverless Flowing Connection System |
| DHPT | Downhole Pressure/Temperature |
| DTH | Dummy Tubing Hanger |
| EDP | Emergency Disconnect Package |
| EDU | Electrical Distribution Unit |
| EQD | Emergency Quick Disconnect |
| ESD | Emergency Shut Down |
| F | Fahrenheit |
| FAHV | Flowbase Annulus Header Valve |
| FAIV | Flowbase Annulus Isolation Valve |
| FCS | Flow Control System |
| Fig. | Figure |
| FPHV | Flowbase Production Header Valve |
| FPIV | Flowbase Production Isolation Valve |
| FRT | Flowbase Running/Retrieval Tool |
| FSC | Fail Safe Close |
| Ft (ft) | Foot |
| Ft-lbs | Foot-pounds |
| GR | Gamma Ray |
| HDF | Hydraulic Delay Firing |
| Hgr | Hanger |
| HP | High Pressure |
| HPU | Hydraulic Power Unit |
| HRV | Hydraulic Return Valve |
| HSD | High Shot Density |
| Hyd | Hydraulic |
| ID | Inner Diameter |
| IF | Internal Flush |
| In | Inch |
| INIV | Insert Nipple Isolation Valve |
| IWOCS | Installation Workover Control System |
| JSA | Job Safety Analysis |
| KSI | thousands *psi |
| Lbs | pounds |
| LP | Low Pressure |
| LWRP | Lower Workover Riser Package |
| Max/max | Maximum |
| MD | Measured Depth |
| MIV | Methanol Injection Valve |
| M/U | Make Up |
| MVB | Master Valve Block |
| MWP | Maximum Working Pressure |
| NaCl | Sodium Chloride |
| NAS | National Aircraft Standard |
| NTU | Nephelometric Turbidity Unit |
| OD | Outer Diameter |
| PBR | Polish Bore Receptacle |
| PBTD | Plug Back Total Depth |
| PC | Production Choke |
| PMV | Production Master Valve |
| P/W | Production/Workover |
| POOH | Pull Out of Hole |
| PPD | Pour Point Depressant |
| PROD | Production |
| PSCSSV | Production Safety Valve |
| PSIV1 | Production Safety Isolation Valve One |
| PSIV2 | Production Safety Isolation Valve Two |
| PSD | Production Shut Down |
| PSI (psi) | Pounds per Square Inch |
| PSIG (psig) | Pounds per Square Inch gauge |
| PSV | Production Swab Valve |
| PTA | Pipeline Termination Assembly |
| PTT1 | Upstream Pressure & Temp.Transducer 1 |
| PTT2 | Upstream Pressure & Temp.Transducer 2 |
| PWV | Production Wing Valve |
| QD | Quick Disconnect |
| RIH | Run in Hole |
| ROV | Remote Operated Vehicle |
| RSA | Running Skid Assembly |
| R/D | Rig Down |
| R/U | Rig Up |
| SCM | Subsea Control Module |
| SCMMB | Subsea Control Module Mounting Base |
| SCMRT | Subsea Control Module Running Tool |
| SCSSV | Surface Control Sub-Surface Safety Valve |
| SPM | Side Pocket Mandrel |

| | | | |
|---|---|---|---|
| TBA | To Be Advised | UMB | Umbilical |
| Tbg | Tubing | UTA | Umbilical Termination Assembly |
| TC | Tree Cap | VSP | Vertical Seismic Profile |
| TCRT | Tree Cap Running Tool | w/ | with |
| TH | Tubing Hanger | WCP | Workover Control Panel |
| THECT | Tubing Hanger Elevation and Check Tool | WH | Wellhead |
| THERT | Tubing Hgr Emergency & Recovery Tool | WHPU | Workover Hydraulic Power Unit |
| THOCT | Tubing Hanger Orientation Check Tool | WLS | Wireline Shear |
| THROT | Tubing Hanger Running/Orientation Tool | WO | Workover |
| THRT | Tubing Hanger Running Tool | WOR | Workover Riser |
| THTT | Tubing Hanger Handling/Test Tool | WP | Working Pressure |
| TTRT | Test Tree Running Tool | X-over | Crossover |
| TVD | True Vertical Depth | XOV | Crossover Valve |
| TVD SS | True Vertical Depth Subsea | | |