AKPO Subsea Reference Manual

CONTENTS

Definitions and Abbreviations Production, Water Injection and Gas Injection Flowlines Data

- Section 1 Subsea System Overview
- Section 2 Subsea Production System
- Section 3 Production Control/Distribution System
- Section 4 Umbilical Data/Volumes
- Section 5 ROV Intervention Tooling
- Section 6 Subsea CHC Connection System Tooling
- Section 7 Auxiliary Equipment/Tooling
- Section 8 MSV Trieste Data
- Section 9 Riser Monitoring Systems
- Section 10 Subsea Intervention Work Packages Equipment Lists

Abbreviations used throughout the AKPO Field Development Project are listed in the following table.

AKPO Subsea Reference Manual Section 1 Subsea System Overview

CONTENTS

- 1.1 Umbilicals, Flowlines and Risers (UFR) Field Layout General Layout
- 1.2 AKPO Field Development Project System Block Diagram Overall Field Layout
- 1.3 Umbilicals, Flowlines and Risers (UFR) Production Flowline P10 Drill Centre MP11– Interface Drawing
- 1.4 Umbilicals, Flowlines and Risers (UFR) Production Flowline P10 Drill Centre MP12 – Interface Drawing
- 1.5 Umbilicals, Flowlines and Risers (UFR) Production Flowline P20 Drill Centre MP21 – Interface Drawing
- 1.6 Umbilicals, Flowlines and Risers (UFR) Production Flowline P20 Drill Centre MP22 – Interface Drawing
- 1.7 Umbilicals, Flowlines and Risers (UFR) Production Flowline P30 Drill Centre MP31 – Interface Drawing
- 1.8 Umbilicals, Flowlines and Risers (UFR) Production Flowline P30 Drill Centre MP32 – Interface Drawing
- 1.9 Umbilicals, Flowlines and Risers (UFR) Production Flowline P40 Drill Centre MP41 – Interface Drawing
- 1.10 Umbilicals, Flowlines and Risers (UFR) Production Flowline P40 Drill Centre MP42 – Interface Drawing
- 1.11 Umbilicals, Flowlines and Risers (UFR) Production Flowline P40 Drill Centre MP43 – Interface Drawing
- 1.12 Umbilicals, Flowlines and Risers (UFR) Water Injection WI10 Drill Centre FW13 – Interface Drawing
- 1.13 Umbilicals, Flowlines and Risers (UFR) Water Injection WI10 Drill Centre TW14 – Interface Drawing

CONTENTS (cont'd)

- 1.14 Umbilicals, Flowlines and Risers (UFR) Water Injection WI10 Drill Centre TW13 – Interface Drawing
- 1.15 Umbilicals, Flowlines and Risers (UFR) Water Injection WI10 Drill Centre TW12 – Interface Drawing
- 1.16 Umbilicals, Flowlines and Risers (UFR) Water Injection WI10 Drill Centre TW11 – Interface Drawing
- 1.17 Umbilicals, Flowlines and Risers (UFR) Water Injection WI10 Interconnection Spool FW11/FW12
- 1.18 Umbilicals, Flowlines and Risers (UFR) Water Injection WI20 Drill Centre FW21 – Interface Drawing
- 1.19 Umbilicals, Flowlines and Risers (UFR) Water Injection WI20 Drill Centre TW24 – Interface Drawing
- 1.20 Umbilicals, Flowlines and Risers (UFR) Water Injection WI20 Drill Centre TW23 – Interface Drawing
- 1.21 Umbilicals, Flowlines and Risers (UFR) Water Injection WI20 Drill Centre TW22 – Interface Drawing
- 1.22 Umbilicals, Flowlines and Risers (UFR) Water Injection WI20 Drill Centre TW21 – Interface Drawing
- 1.23 Umbilicals, Flowlines and Risers (UFR) Water Injection WI30 Drill Centre FW31 – Interface Drawing
- 1.24 Umbilicals, Flowlines and Risers (UFR) Water Injection WI30 Drill Centre TW33 – Interface Drawing
- 1.25 Umbilicals, Flowlines and Risers (UFR) Water Injection WI30 Drill Centre TW32 – Interface Drawing
- 1.26 Umbilicals, Flowlines and Risers (UFR) Water Injection WI30 Drill Centre TW31 – Interface Drawing

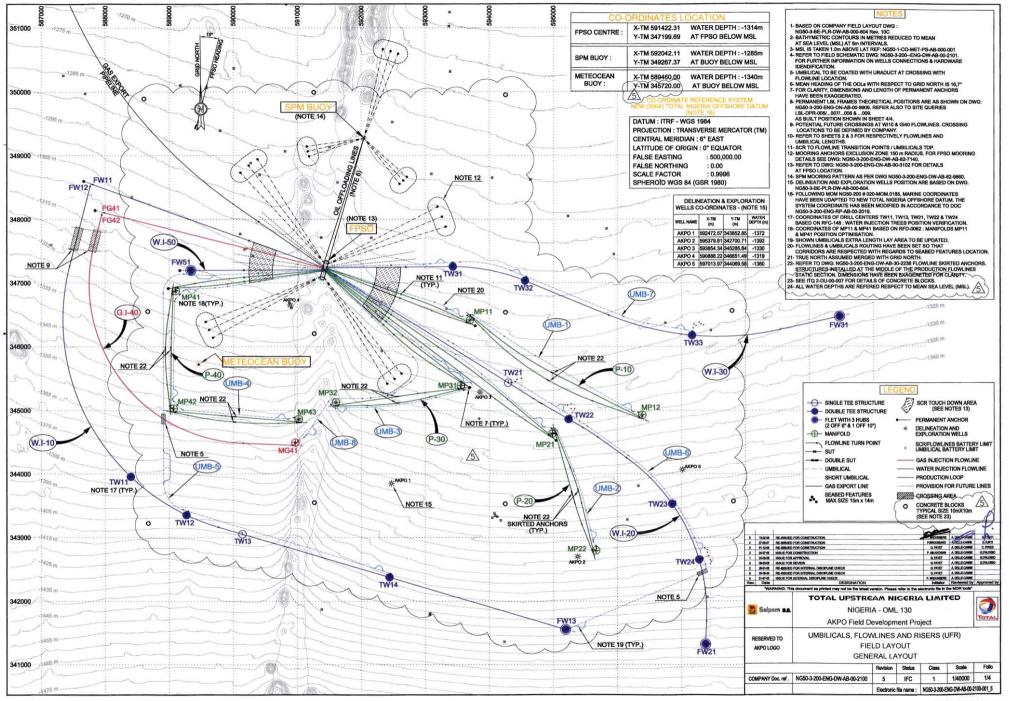
CONTENTS (cont'd)

- 1.27 Umbilicals, Flowlines and Risers (UFR) Water Injection WI50 Drill Centre FW51 – Interface Drawing
- 1.28 Umbilicals, Flowlines and Risers (UFR) Gas Injection GI40 Drill Centre MG41 – Interface Drawing
- 1.29 Umbilicals, Flowlines and Risers (UFR) Gas Injection GI40 Interconnection Spool FG41/FG42
- 1.30 Umbilicals, Flowlines and Risers (UFR) Production Loops Process Flow Diagrams (PFD)
- 1.31 AKPO Field Development Projects WI10 Water Injection String
- 1.32 AKPO Field Development Projects WI20 Water Injection String
- 1.33 AKPO Field Development Projects WI30 Water Injection String
- 1.34 AKPO Field Development Projects WI50 Water Injection String
- 1.35 AKPO Field Development Projects Gas Injection Manifold P&ID

The following drawing provides an overview for the Akpo field subsea layout, Production Wells, Flowlines and Umbilicals.

Refer to:

• NG50-3-200-ENG-DW-AB-00-2100 - General Layout



AKPO_SS_01_01.png

1.1 Umbilicals, Flowlines and Risers (UFR) Field Layout General Layout

Drawing Supplementary Information

The block diagram of the overall field layout, shows the main equipment for the following:

Oil Production Wells and Flowlines consisting of:

- 22 x Well Completions
- 22 x Production Trees and Jumpers
- 9 x Production Manifolds
- 8 x Flowlines and Risers P10, P20, P30, P40

Water Injection Wells and Flowlines consisting of:

- 20 x Water Injection Well Completions (plus slots for 12 future injection wells)
- 20 x Injection Trees and Jumpers
- 2 x Single tee assembles (1 completion, 1 spare slot)
- 9 x Double tee assembles (11 completions, 7 spare slots)
- 4 x End tee assembles (8 completions, 4 spare slots)
- 4 x Flowlines and Risers WI10, WI20, WI30, WI50

Gas Injection Wells and Flowline GI40 consisting of:

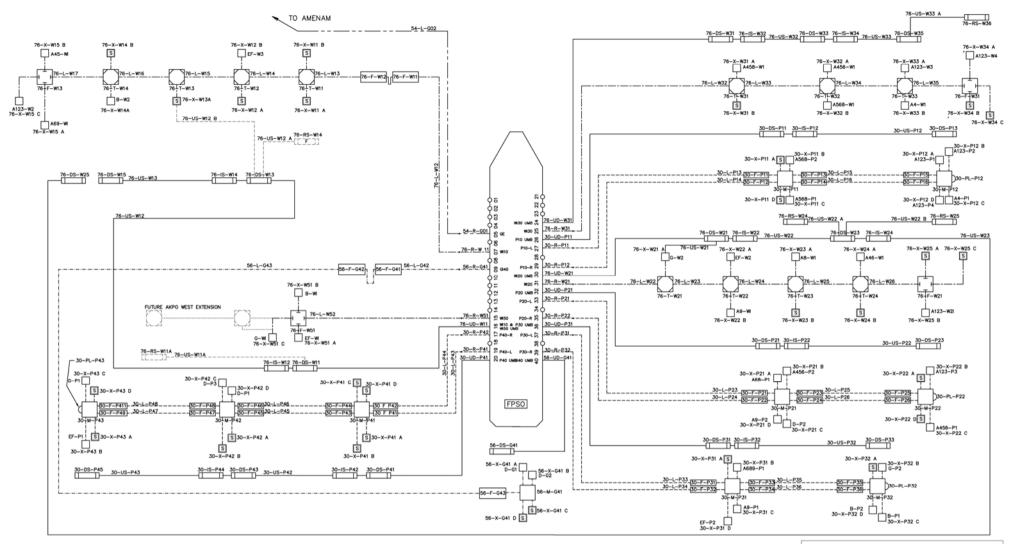
- 4 x Injection Trees and Jumpers (plus 2 for future use)
- 1 x Gas Injection manifold
- 1 x 8in spool
- 3 x Gas Injection FLETs

Subsea Control System consisting of:

- 4 x Umbilicals
- Distribution Subsea Umbilical Terminations (DSUT)
- Intermediate Subsea umbilical Terminations (ISUT)
- Flying Leads

Refer to:

NG50-2-300-SPS-DW-AB-30-0117 - Overall Field Layout



| 0 70' | | BR PETROBRAS |
|---|---|--|
| CONTRACT NUMBER: | | CLIENT DOCUMENT NUMBER: |
| APO/C007/03 | | NG50-2-300-SPS-DW-AB-30-0117 |
| OF COOPER CAMERON CORPORT DISCLOSE SAID INFORMATION R MICH SAID INFORMATION RAS IS TO BE RETURNED TO CAM | TON AND REDEPT I PRODUCTION OR US SUPPLIED IS PROHIB ERON UPON REQUE | E SICRET INFORMATION WHON IS THE PROPERTY OF CAMERICH, A DIVISION OF POSSESSION DOES NOT CONNEY ANY REPORTS TO LOAK, SQL, OR OPECHNEZ E of Lab properties that the properties of the sol of properties TOD WHON CONNECTION OF ANY PROPERTIES FOR MACHINE SOCIALET IS OF UPON CONNECTION OF THE PURPONE FOR MACHINE SUPPLIES. |
| woorr sow ∼ lbs ∼ kg | ~ | CAMERON Cooper Comeron (U.K.) Limited Queen Street Stourton, LSV0 158 Leeds England |
| CHANN BY E.RICHARDSON OHOXED C.BICKERSTETH | 047E | AKPO FIELD DEVELOPMENT PROJECT SYSTEM BLOCK DIAGRAM OVERALL FIELD LAYOUT |
| R.EMPTAGE D SIZE | 22.11.04 E 8,44 ~ | 1 gr 2 SK-119255-95 09 |

AKPO_SS_01_02.ai

Drawing Supplementary Information

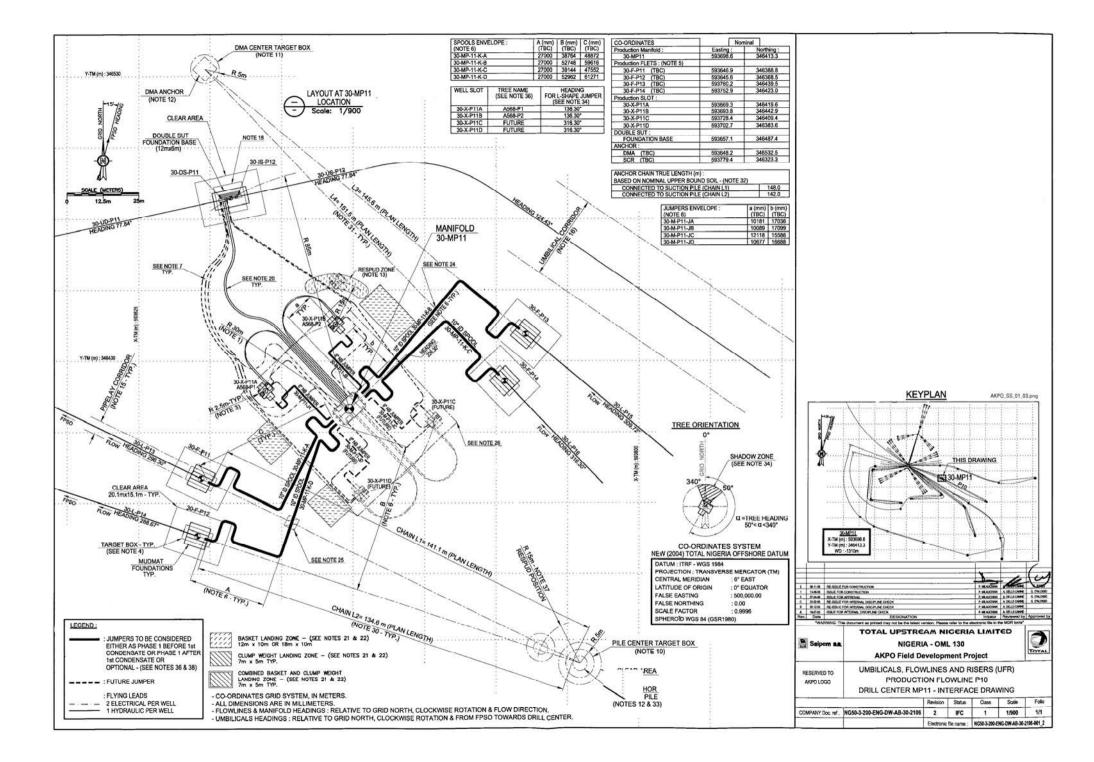
The following layout drawings show Drill Centre locations and equipment interfaces for the Production Flowlines P10.

MP11 Drill Centre

The MP11 Drill Centre consists of:

- 4 x Production Trees 30-X-P11A/B (C/D for future use)
- 4 x 6in Jumpers 30-M-P11-JA/JB (JC/JD for future use)
- Production Manifold 30-M-P11(with Gas Lift)
- 4 x 10in spools 30-MP-11-K-A/B/C/D
- 4 x Production FLETs 30-F-P11/12/13/14

1.2 AKPO Field Development Project System Block Diagram Overall Field Layout



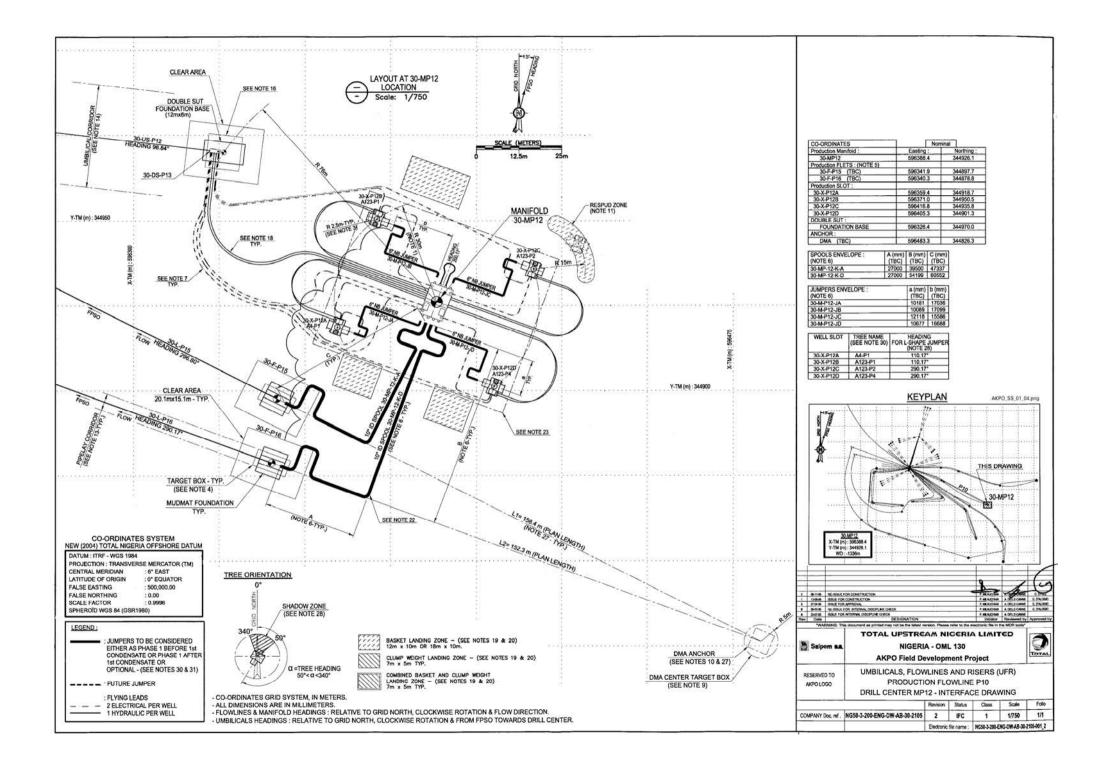
1.3 Umbilicals, Flowlines and Risers (UFR) – Production Flowline P10 Drill Centre MP11– Interface Drawing

Drawing Supplementary Information

MP12 Drill Centre

The MP12 Drill Centre consists of:

- 4 x Production Trees 30-X-P12A/B/C/D
- 4 x 6in Jumpers 30-M-P12-JA/JB/JC/JD
- Production Manifold 30-M-P12 with Pigging Loop 30-PL-12
- 2 x 10in spools 30MP-12-K-A/K-D
- 2 x Production FLETs 30-F-P15/P16



1.4 Umbilicals, Flowlines and Risers (UFR) – Production Flowline P10 Drill Centre MP12 – Interface Drawing

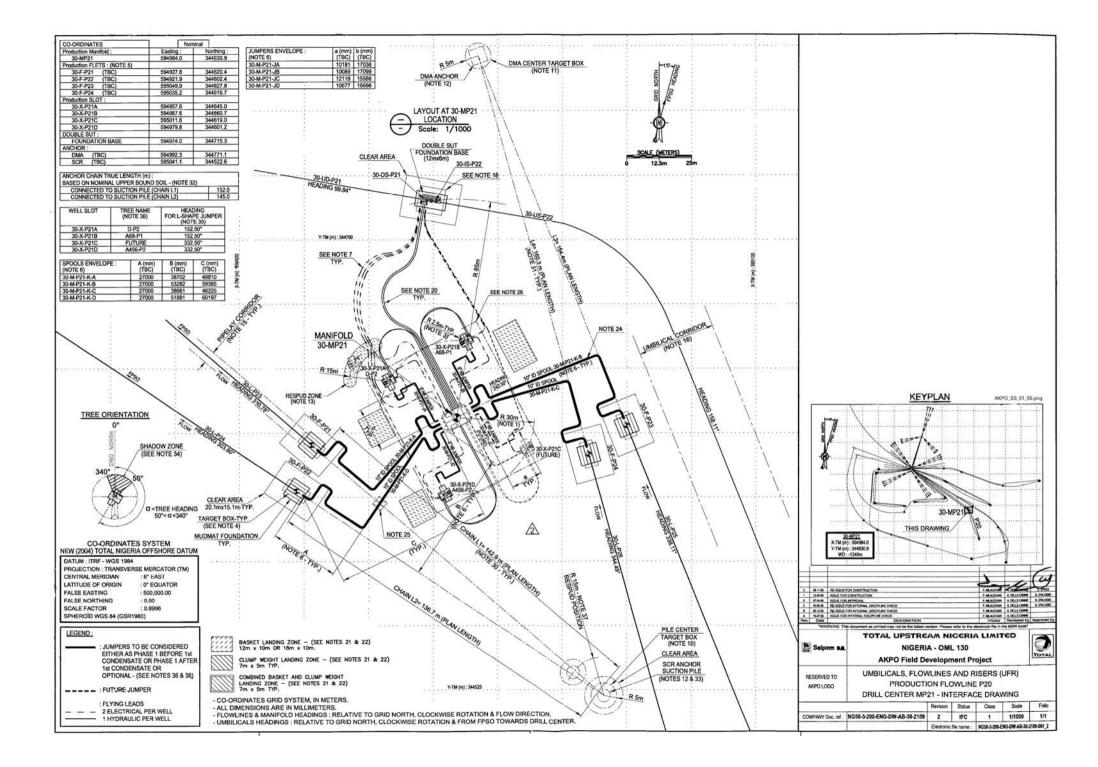
Drawing Supplementary Information

The following layout drawings show Drill Centre locations and equipment interfaces for the Production Flowlines P20.

MP21 Drill Centre

The MP21 Drill Centre consists of:

- 4 x Production Trees 30-X-P21A/B/D (C for future use)
- 4 x 6in Jumpers 30-M-P21JA/JB/JD (JC for future use)
- Production Manifold 30-M-P21(with Gas Lift)
- 4 x 10in spools 30-M-P21-K-A/B/C/D
- 4 x Production FLETs 30-F-P21/22/23/24



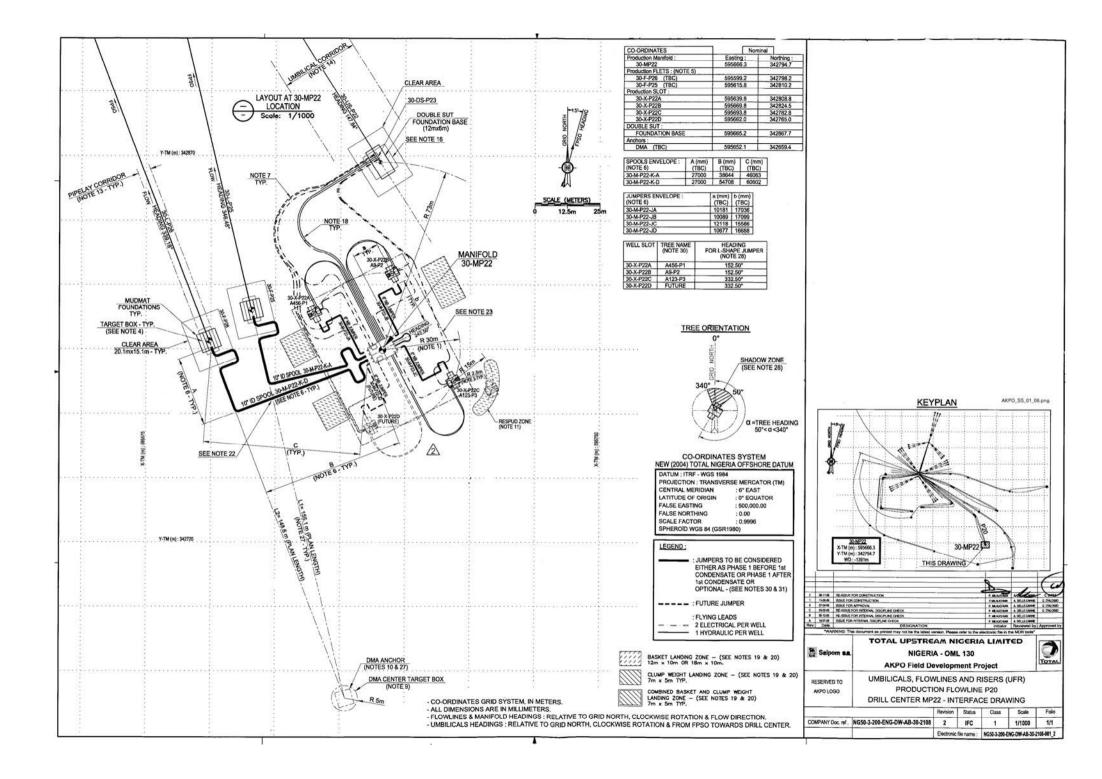
1.5 Umbilicals, Flowlines and Risers (UFR) – Production Flowline P20 Drill Centre MP21 – Interface Drawing

Drawing Supplementary Information

MP22 Drill Centre

The MP22 Drill Centre consists of:

- 4 x Production Trees 30-X-P22A/B/C (D for future use)
- 4 x 6in Jumpers 30-M-P22JA/JB/JC (JD for future use)
- Production Manifold 30-M-P22 with Pigging Loop 30-PL-22
- 2 x 10in spools 30-M-P22-K-A/K-D
- 2 x Production FLETs 30-F-P25/26



1.6 Umbilicals, Flowlines and Risers (UFR) – Production Flowline P20 Drill Centre MP22 – Interface Drawing

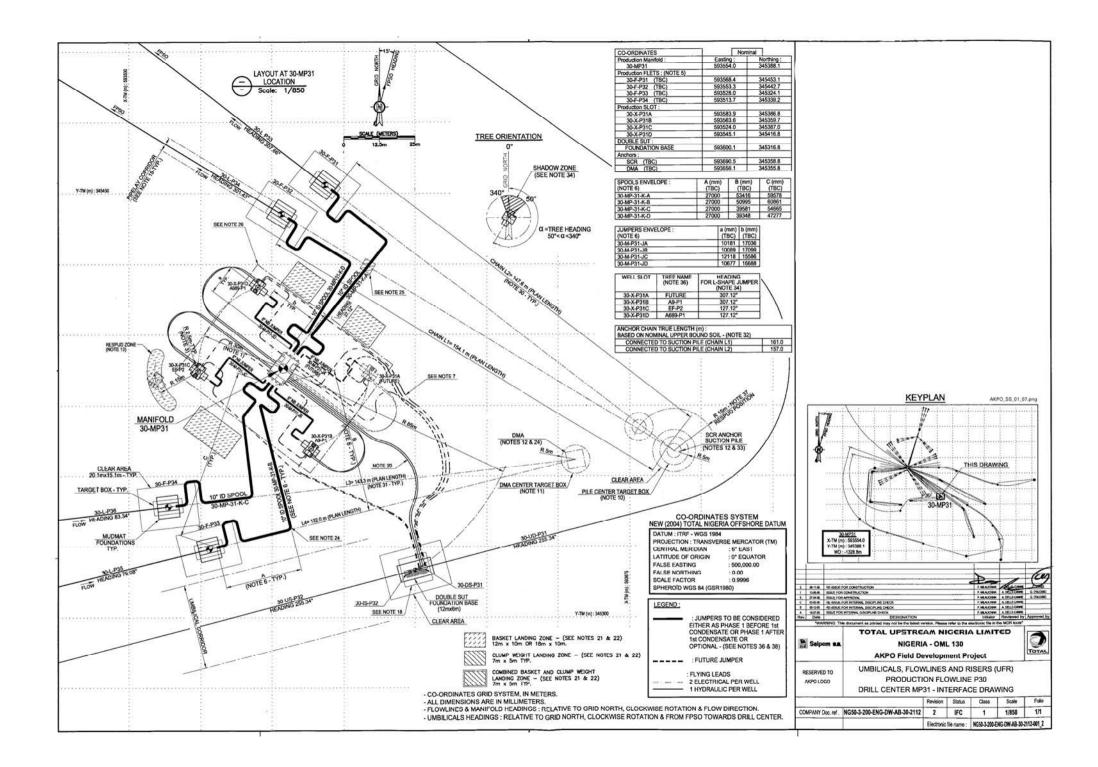
Drawing Supplementary Information

The following layout drawings show Drill Centre locations and equipment interfaces for the Production Flowlines P30.

MP31 Drill Centre

The MP31 Drill Centre consists of:

- 4 x Production Trees 30-X-P31B/C/D (A for future use)
- 4 x 6in Jumpers 30-M-P31JB/JC/JD (JA for future use)
- Production Manifold 30-M-P31(with Gas Lift)
- 4 x 10in spools 30-M-P31-K-A/B/C/D
- 4 x Production FLETs 30-F-P31/32/33/34



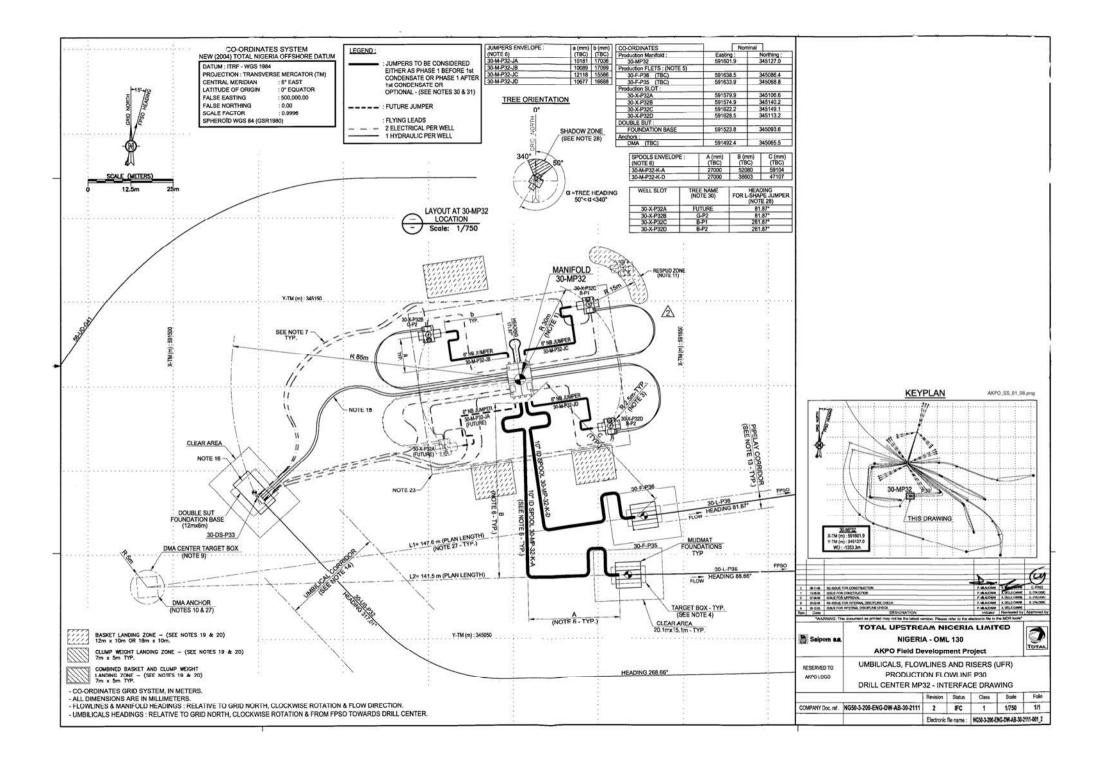
1.7 Umbilicals, Flowlines and Risers (UFR) – Production Flowline P30 Drill Centre MP31 – Interface Drawing

Drawing Supplementary Information

MP32 Drill Centre

The MP32 Drill Centre consists of:

- 4 x Production Trees 30-X-P32B/C/D (A for future use)
- 4 x 6in Jumpers 30-M-P32JB/JC/JD (JA for future use)
- Production Manifold 30-M-P32 with Pigging Loop 30-PL-32
- 2 x 10in spools 30-M-P32-K-A/K-D
- 2 x Production FLETs 30-F-P35/36



1.8 Umbilicals, Flowlines and Risers (UFR) – Production Flowline P30 Drill Centre MP32 – Interface Drawing

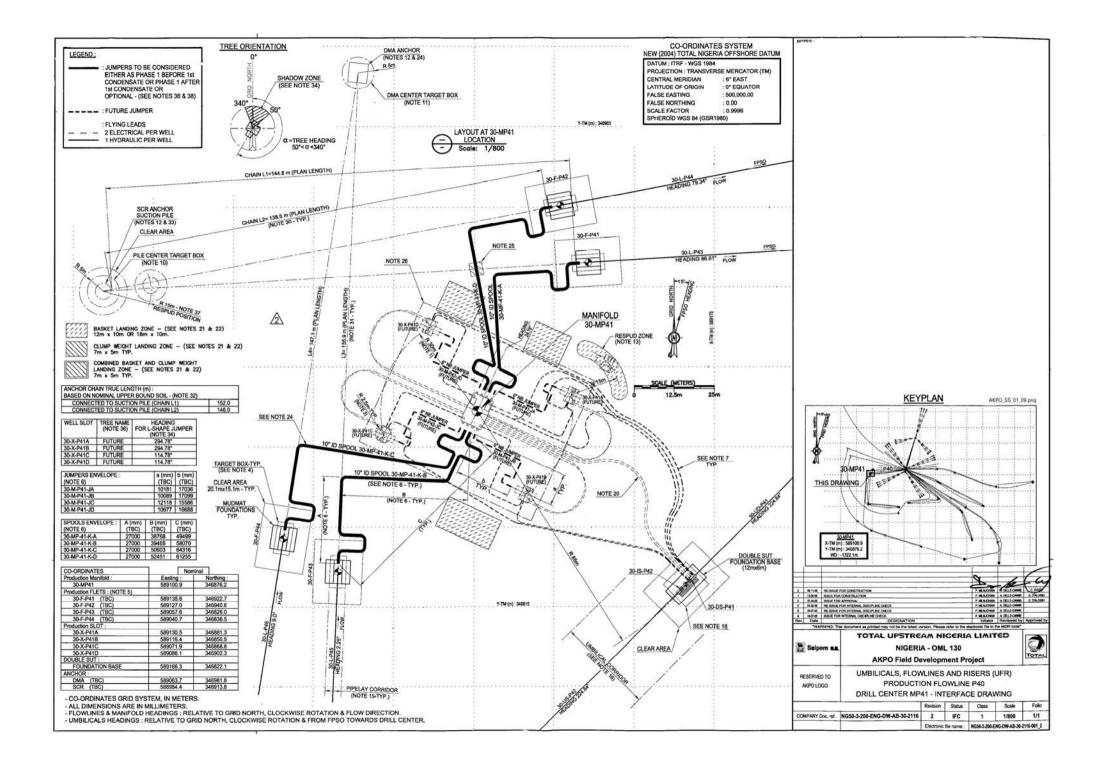
Drawing Supplementary Information

The following layout drawings show Drill Centre locations and equipment interfaces for the Production Flowlines P40.

MP41 Drill Centre

The MP41 Drill Centre consists of:

- 4 x Production Trees 30-X-P41A/B/C/D for future use
- 4 x 6in Jumpers 30-M-P41 JA/JB/JC/JD for future use
- Production Manifold 30-M-P41(with Gas Lift)
- 4 x 10in spools 30-M-P41-K-A/B/C/D
- 4 x Production FLETs 30-F-P41/42/43/44



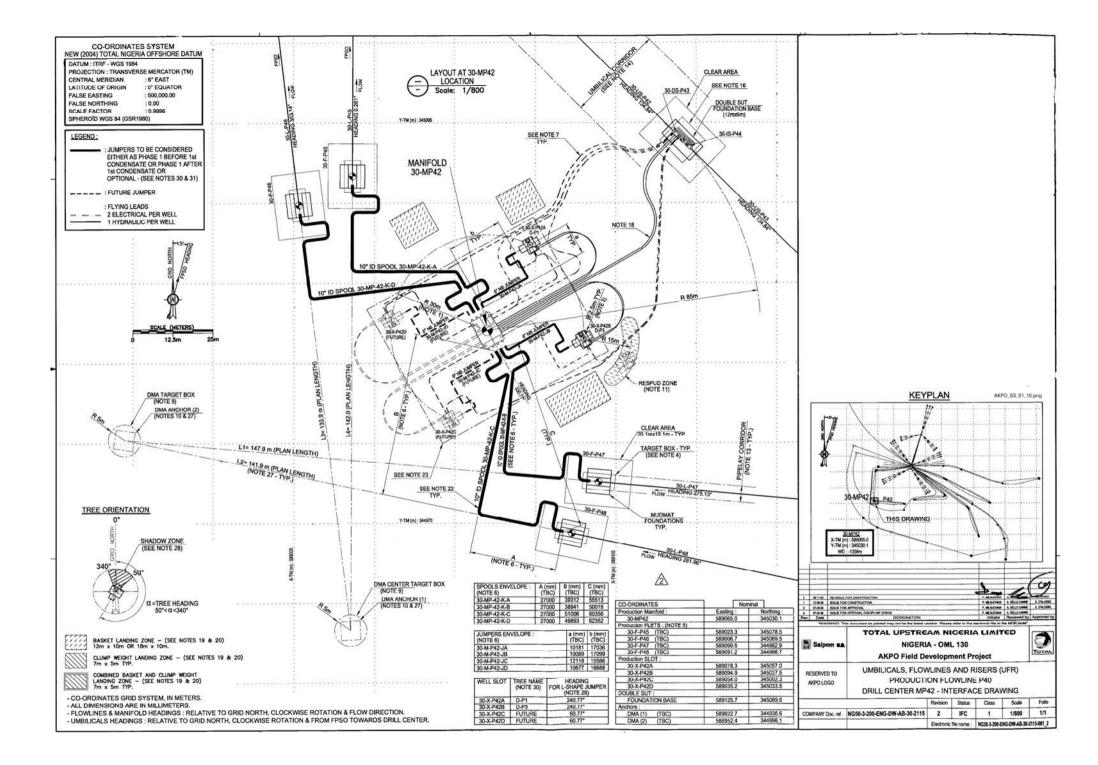
1.9 Umbilicals, Flowlines and Risers (UFR) – Production Flowline P40 Drill Centre MP41 – Interface Drawing

Drawing Supplementary Information

MP42 Drill Centre

The MP42 Drill Centre consists of:

- 4 x Production Trees 30-X-P42A/B (C/D for future use)
- 4 x 6in Jumpers 30-M-P42 JA/JB (JC/JD for future use)
- Production Manifold 30-M-P42 (In-line Manifold W/O Gas Lift)
- 4 x 10in spools 30-M-P42-K-A/B/C/D
- 4 x Production FLETs 30-F-P45/46/47/48



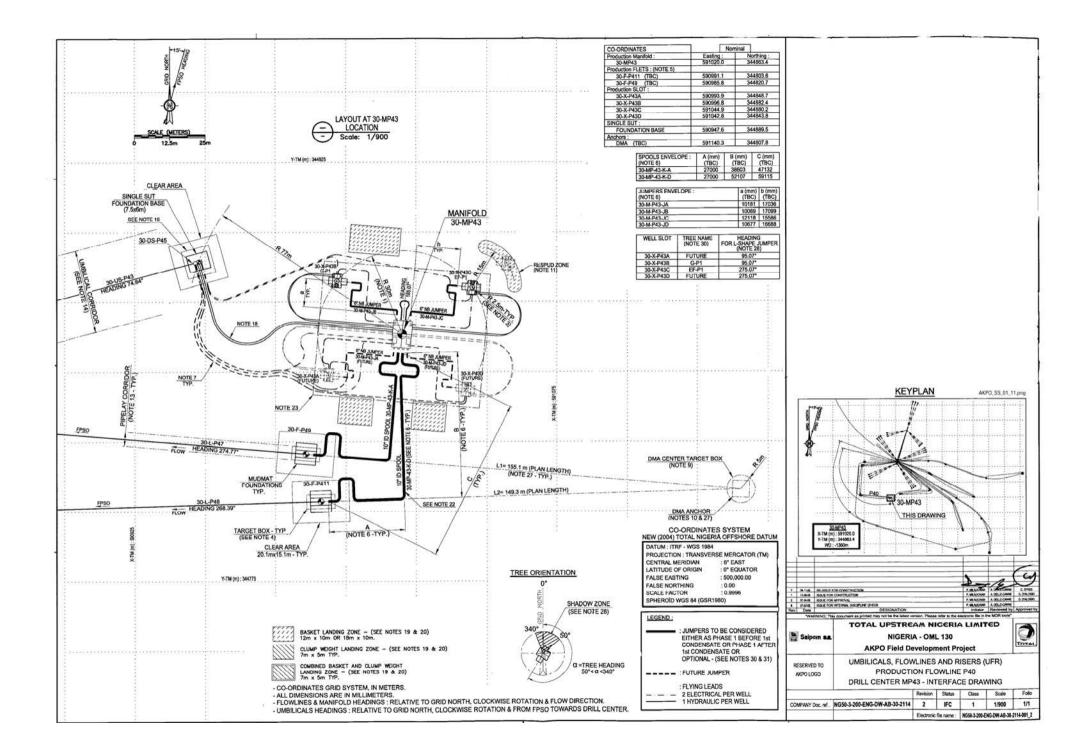
1.10 Umbilicals, Flowlines and Risers (UFR) – Production Flowline P40 Drill Centre MP42 – Interface Drawing

Drawing Supplementary Information

MP43 Drill Centre

The MP43 Drill Centre consists of:

- 4 x Production Trees 30-X-P43B/C (A/D for future use)
- 4 x 6in Jumpers 30-M-P43 JB/JC (JA/JD for future use)
- Production Manifold 30-M-P43 with Pigging Loop 30-PL-43
- 2 x 10in spools 30-M-P43-K-A/K-D
- 2 x Production FLETs 30-F-P411/49



1.11 Umbilicals, Flowlines and Risers (UFR) – Production Flowline P40 Drill Centre MP43 – Interface Drawing

Drawing Supplementary Information

Seawater treated topsides, is injected into the reservoirs via four 10in flowlines connected to the FPSO. Inline tees are incorporated at intervals into the flowlines to allow direct connection via hardpipe well jumpers. Each intermediate water injection tee is designed to allow connection of up to two water injection wells, end water injection tees may be connected to three.

Main equipment of the Water Injection Wells, Flowlines and Controls consists of:

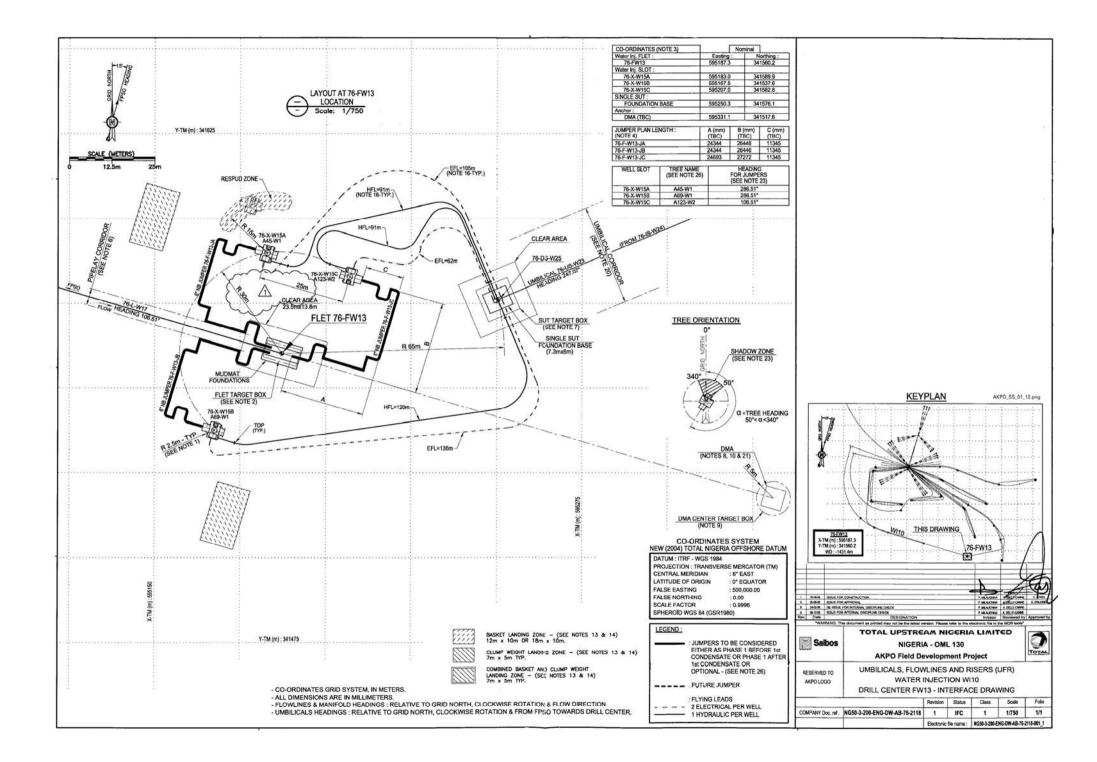
- 20 x Water Injection Well Completions (plus slots for 12 future injection wells)
- 20 x Injection Trees and Jumpers
- 15 x Flowline inline tee assemblies, including:
- 2 x Single tee assembles (1 completion, 1 spare slot)
- 9 x Double tee assembles (11 completions, 7 spare slots)
- 4 x End tee assembles (8 completions, 4 spare slots)
- 4 x Flowlines and Risers WI10, WI20, WI30, WI50

The following layout drawings show Drill Centre locations and equipment interfaces for the Water Injection Flowlines WI10.

FW13 Drill Centre

The FW13 Drill Centre consists of:

- 3 x Injection Trees 76-X-W15A/B/C
- 3 x 6in Jumpers 76-F-W13JA/JB/JC
- 1 x Water Injection FLET 76-FW13



Drawing Supplementary Information

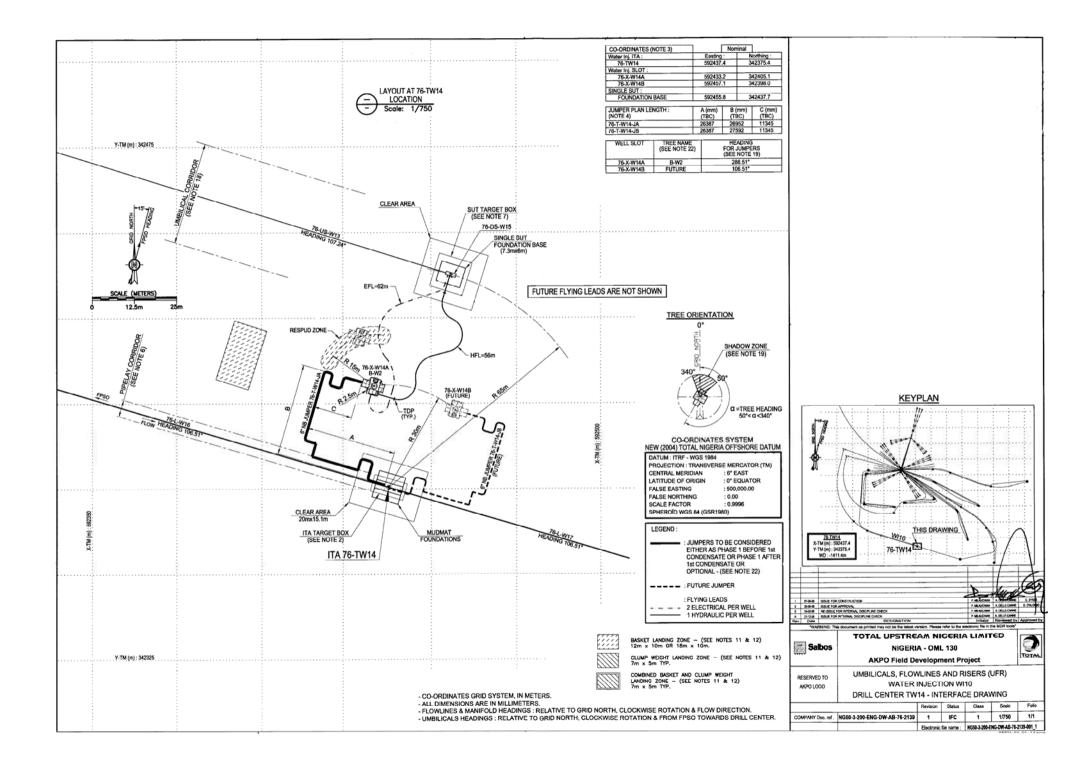
The following layout drawings show Drill Centre locations and equipment interfaces for the Water Injection Flowlines WI10.

TW14 Drill Centre

Main equipment of the TW14 Drill Centre consists of:

- 2 x Injection Tree 76-X-W14A (B for future use)
- 2 x 6in Jumper 76-T-W14-JA (JB for future use)
- 1 x Water Injection ITA 76-TW14

1.12 Umbilicals, Flowlines and Risers (UFR) – Water Injection WI10 Drill Centre FW13 – Interface Drawing



Drawing Supplementary Information

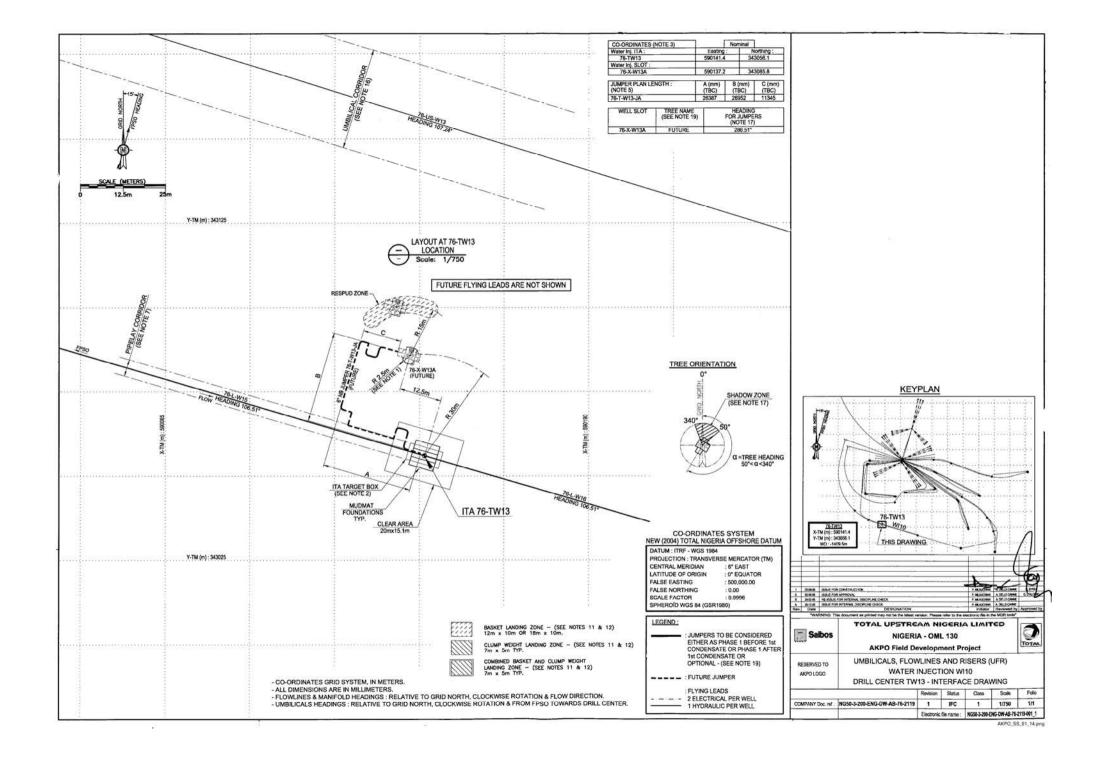
The following layout drawings show Drill Centre locations and equipment interfaces for the Water Injection Flowlines WI10.

TW13 Drill Centre

The TW13 Drill Centre consists of:

- 1 x Injection Tree 76-X-W13A (For future use)
- 1 x 6in Jumper 76-T-W13-JA (For future use)
- 1 x Water Injection ITA 76-TW13

1.13 Umbilicals, Flowlines and Risers (UFR) – Water Injection WI10 Drill Centre TW14 – Interface Drawing



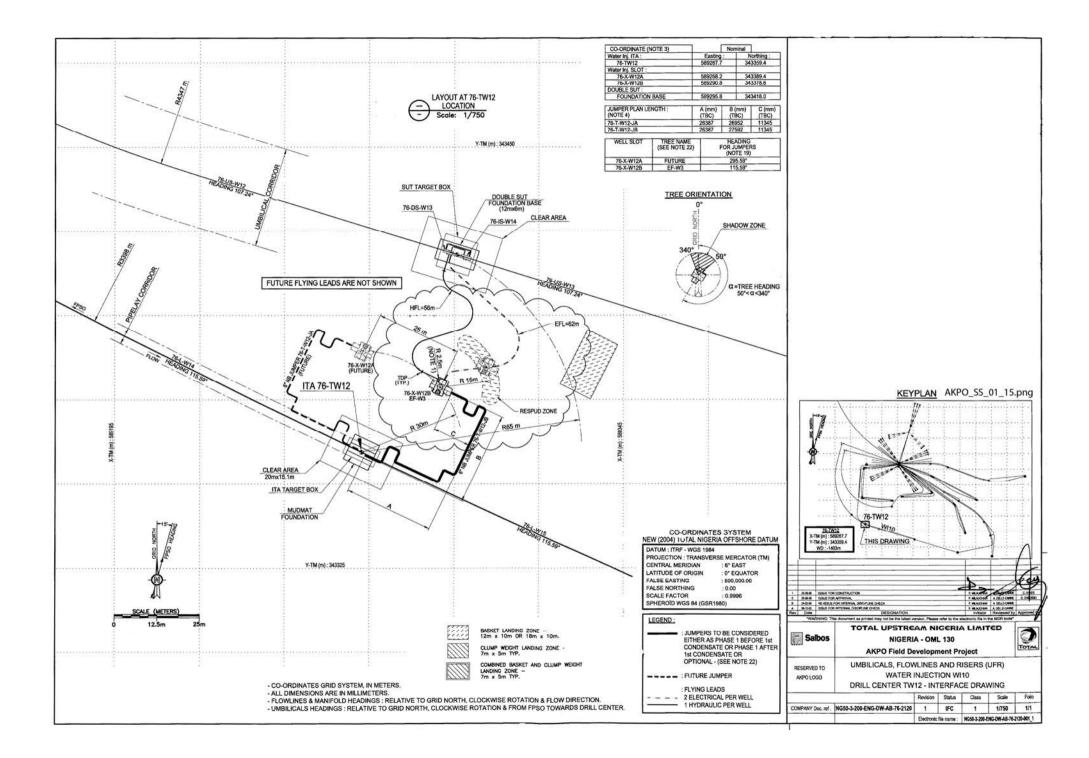
The following layout drawings show Drill Centre locations and equipment interfaces for the Water Injection Flowlines WI10.

TW12 Drill Centre

The TW12 Drill Centre consists of:

- 2 x Injection Tree 76-X-W12B (12A for future use)
- 2 x 6in Jumper 76-T-W12-JB (JA for future use)
- 1 x Water Injection ITA 76-TW12

1.14 Umbilicals, Flowlines and Risers (UFR) – Water Injection WI10 Drill Centre TW13 – Interface Drawing



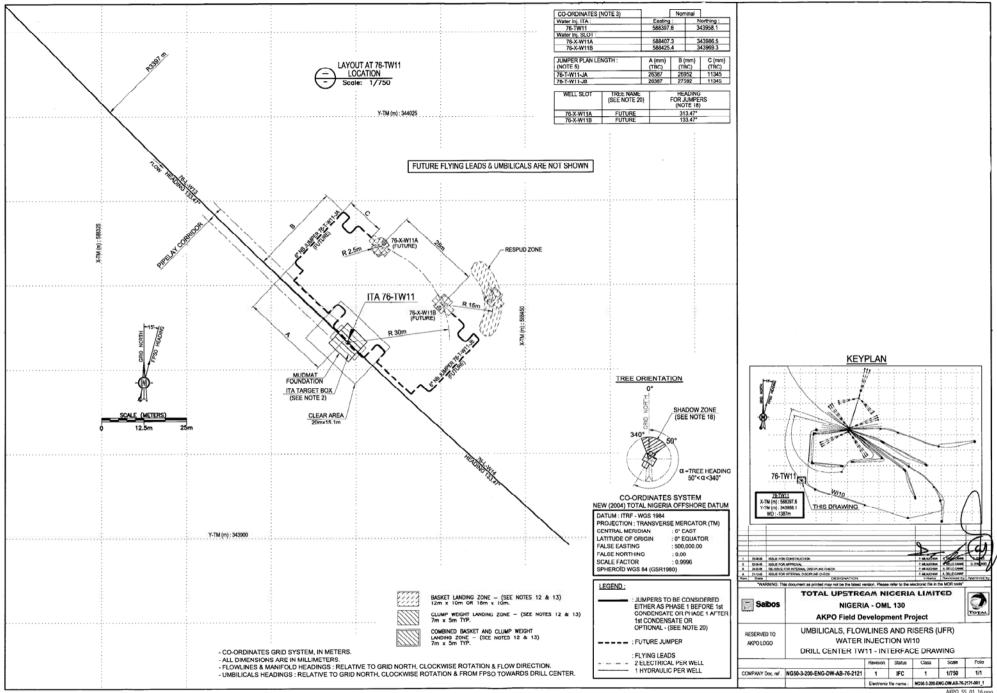
The following layout drawings show Drill Centre locations and equipment interfaces for the Water Injection Flowlines WI10.

TW11 Drill Centre

The TW11 Drill Centre consists of:

- 2 x Injection Tree 76-X-W11A/B (For future use)
- 2 x 6in Jumper 76-T-W11-JA/JB (For future use)
- 1 x Water Injection ITA 76-TW11

1.15 Umbilicals, Flowlines and Risers (UFR) – Water Injection WI10 Drill Centre TW12 – Interface Drawing



AKPO 55 01 16.png

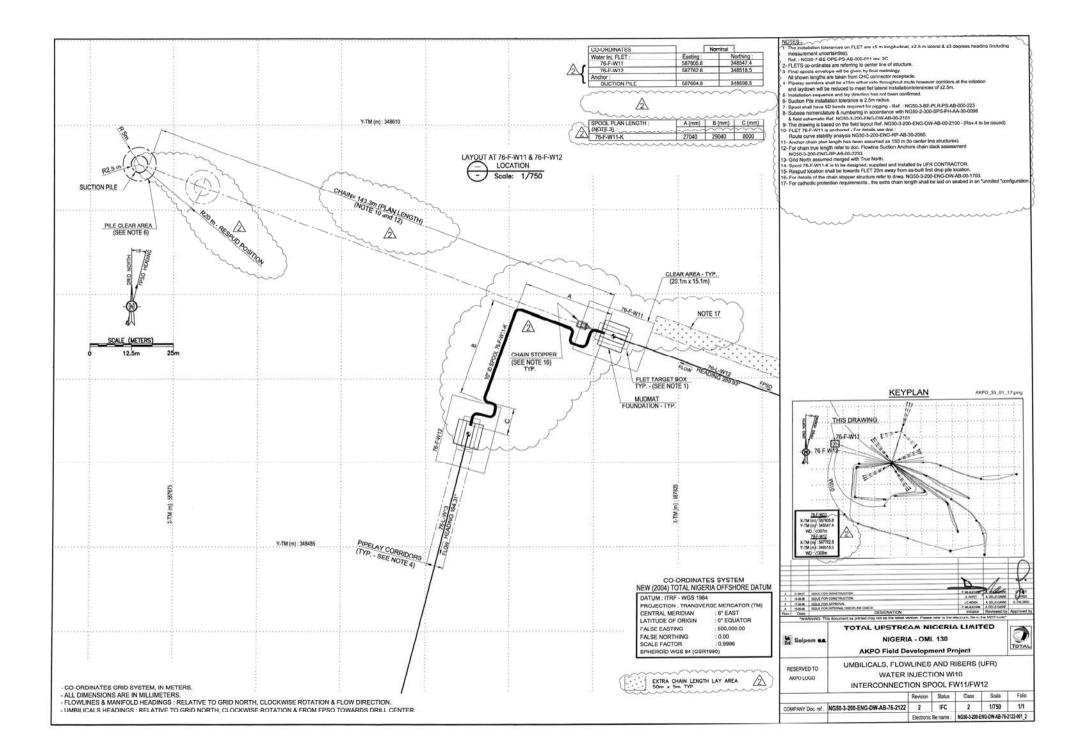
The following layout drawings show Drill Centre locations and equipment interfaces for the Water Injection Flowlines WI10.

FW11/FW12 Interconnection

The FW11/FW12 Interconnection consists of:

- 1 x 10in spool 76-F-W11-K
- 2 x Water Injection FLETs 76-F-W11/W12

1.16 Umbilicals, Flowlines and Risers (UFR) – Water Injection WI10 Drill Centre TW11 – Interface Drawing



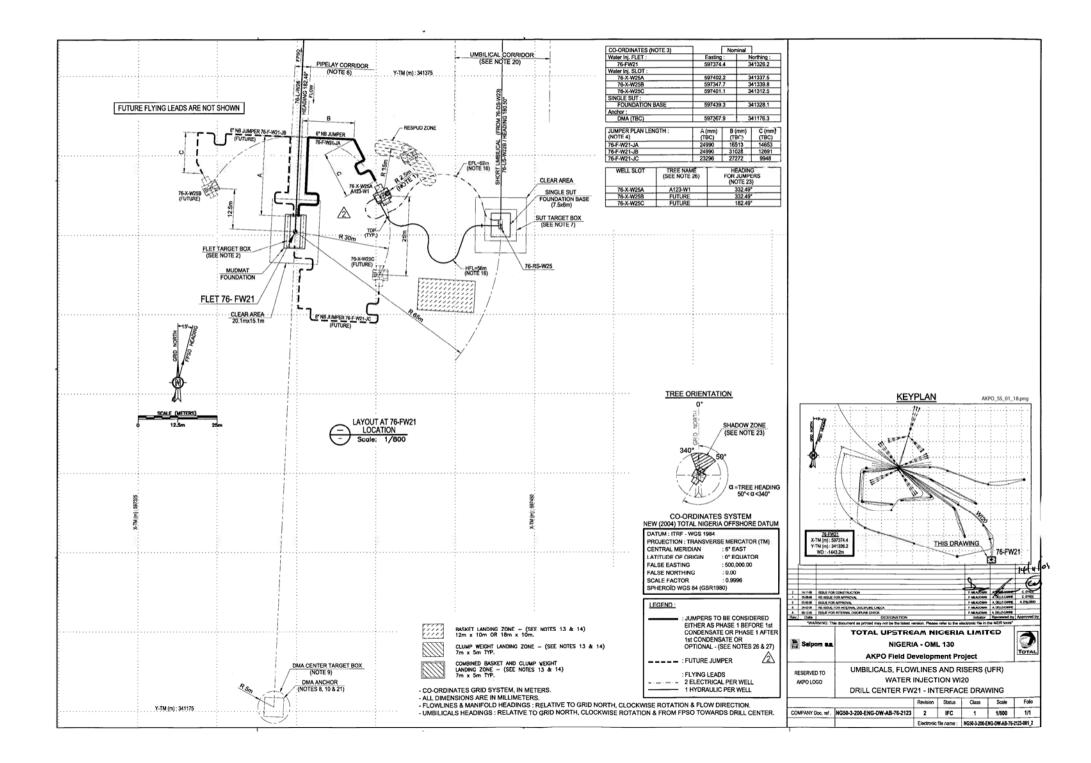
The following layout drawings show Drill Centre locations and equipment interfaces for the Water Injection Flowlines WI20.

FW21 Drill Centre

The FW21 Drill Centre consists of:

- 3 x Injection Tree 76-X-W25A (B/C for future use)
- 3 x 6in Jumper 76-F-W21- JA (JB/JC for future use)
- 1 x Water Injection FLET 76-FW21

1.17 Umbilicals, Flowlines and Risers (UFR) – Water Injection WI10 Interconnection Spool FW11/FW12



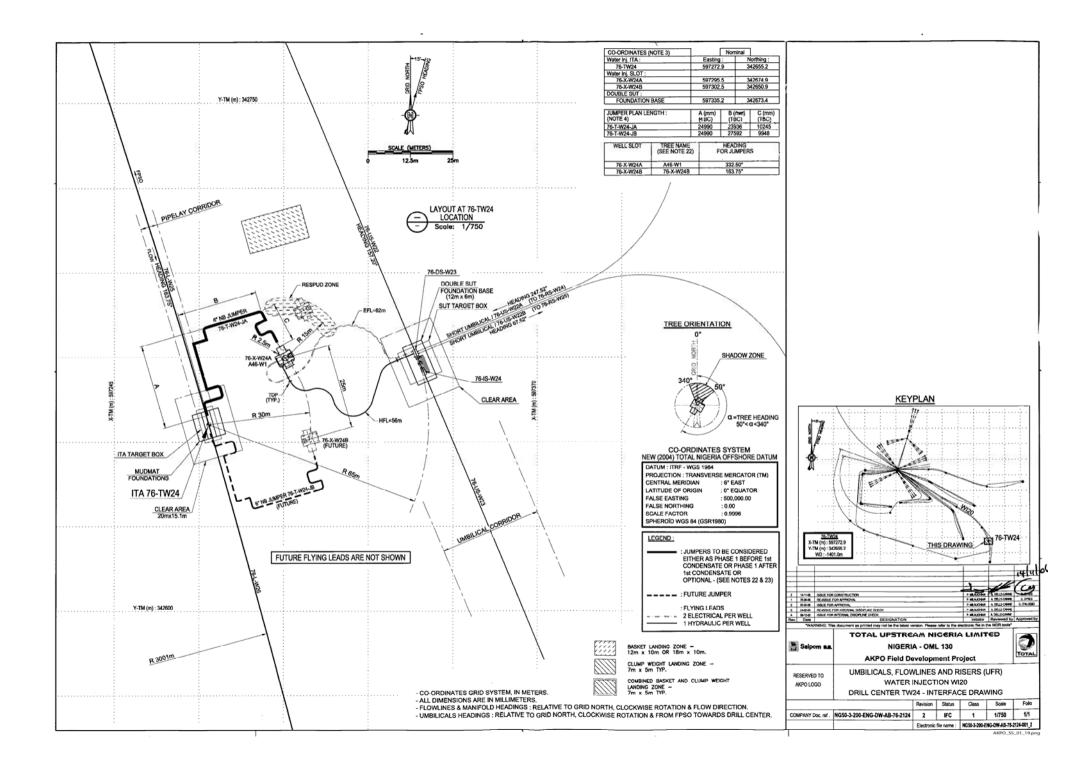
The following layout drawings show Drill Centre locations and equipment interfaces for the Water Injection Flowlines WI20.

TW24 Drill Centre

The TW24 Drill Centre consists of:

- 2 x Injection Tree 76-X-W24A (B for future use)
- 2 x 6in Jumper 76-T-W24-JA (JB for future use)
- 1 x Water Injection ITA 76-TW24

1.18 Umbilicals, Flowlines and Risers (UFR) – Water Injection WI20 Drill Centre FW21 – Interface Drawing



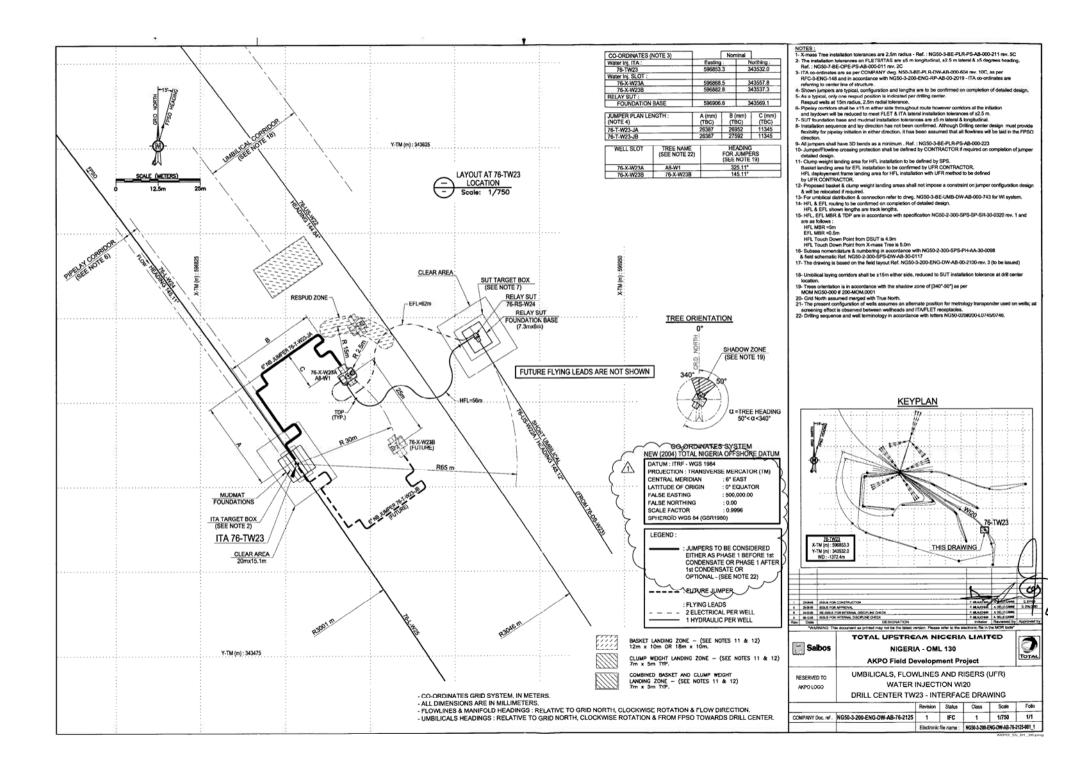
The following layout drawings show Drill Centre locations and equipment interfaces for the Water Injection Flowlines WI20.

TW23 Drill Centre

The TW23 Drill Centre consists of:

- 2 x Injection Tree 76-X-W23A (B for future use)
- 2 x 6in Jumper 76-T-W23-JA (JB for future use)
- 1 x Water Injection ITA 76-TW23

1.19 Umbilicals, Flowlines and Risers (UFR) – Water Injection WI20 Drill Centre TW24 – Interface Drawing



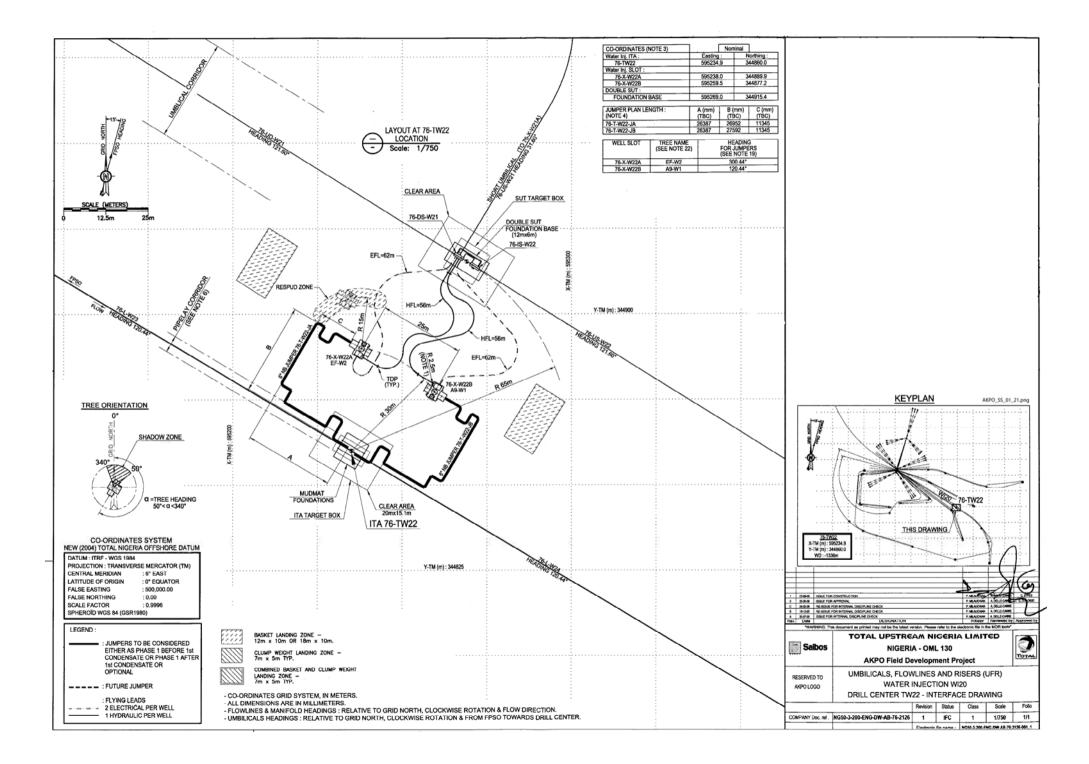
The following layout drawings show Drill Centre locations and equipment interfaces for the Water Injection Flowlines WI20.

TW22 Drill Centre

The TW22 Drill Centre consists of:

- 2 x Injection Tree 76-X-W22A/B
- 2 x 6in Jumper 76-T-W23-JA/JB
- 1 x Water Injection ITA 76-TW22

1.20 Umbilicals, Flowlines and Risers (UFR) – Water Injection WI20 Drill Centre TW23 – Interface Drawing



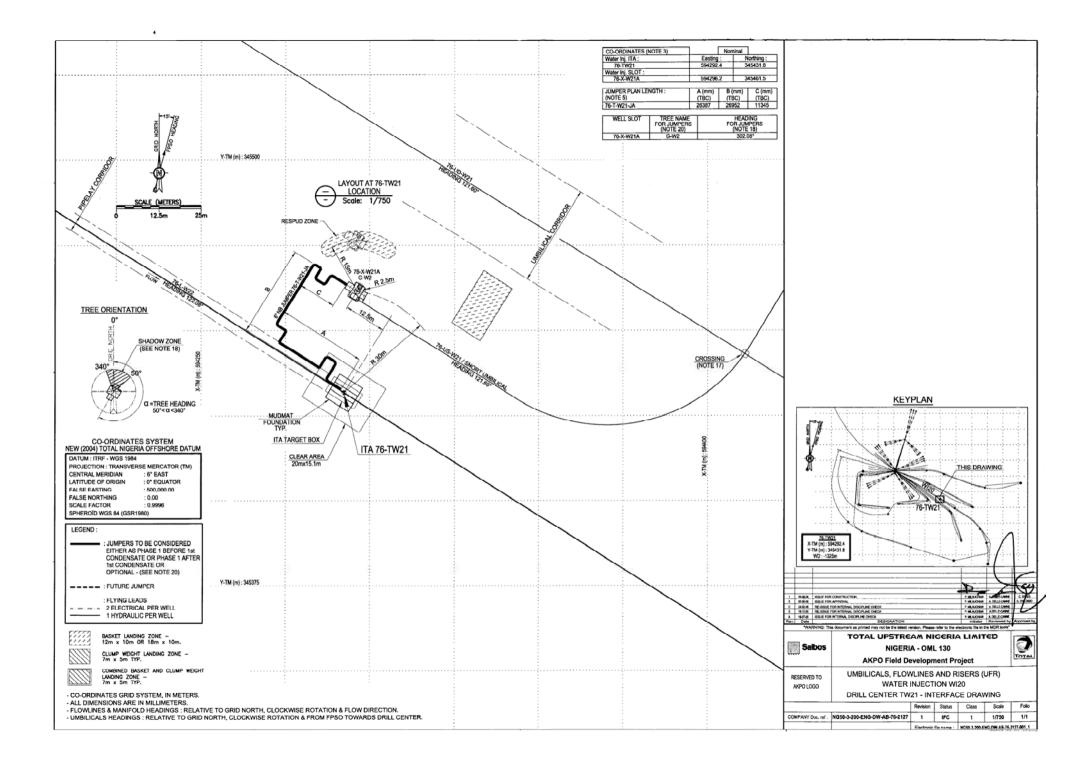
The following layout drawings show Drill Centre locations and equipment interfaces for the Water Injection Flowlines WI20.

TW21 Drill Centre

The TW21 Drill Centre consists of:

- 1 x Injection Tree 76-X-W21A
- 1 x 6in Jumper 76-T-W21-JA
- 1 x Water Injection ITA 76-TW21

1.21 Umbilicals, Flowlines and Risers (UFR) – Water Injection WI20 Drill Centre TW22 – Interface Drawing



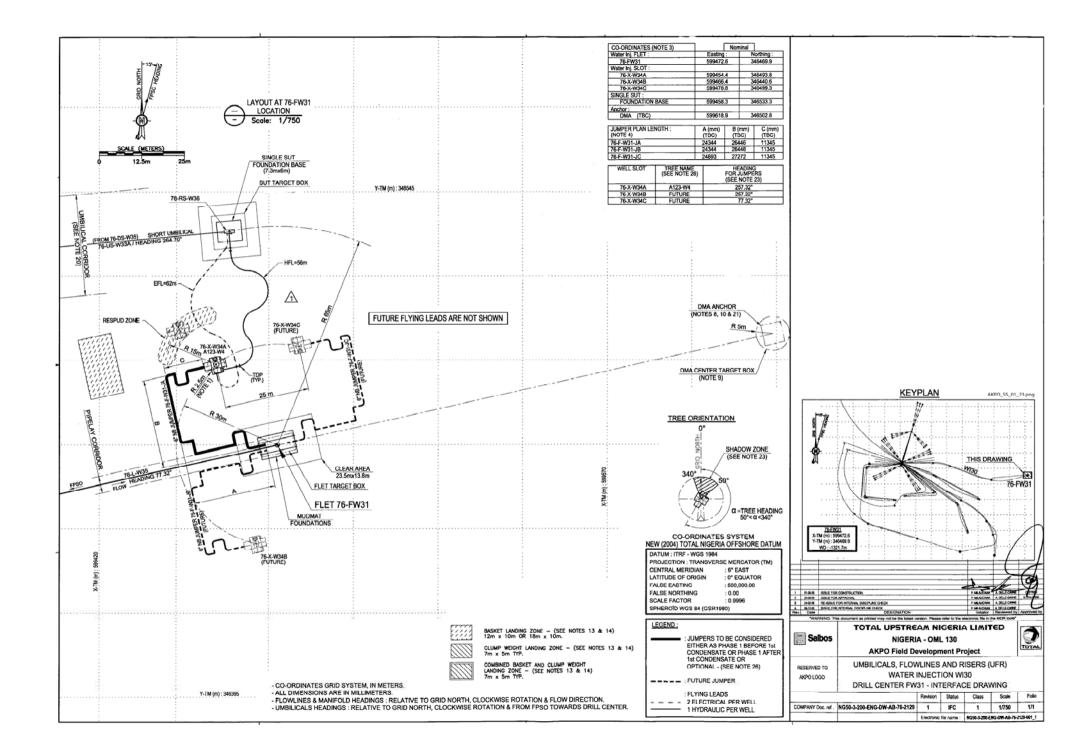
The following layout drawings show Drill Centre locations and equipment interfaces for the Water Injection Flowlines WI30.

FW31 Drill Centre

The FW31 Drill Centre consists of:

- 3 x Injection Tree 76-X-W34A (B/C for future use)
- 3 x 6in Jumper 76-F-W31-JA (JB/JC for future use)
- 1 x Water Injection FLET 76-FW31

1.22 Umbilicals, Flowlines and Risers (UFR) – Water Injection WI20 Drill Centre TW21 – Interface Drawing



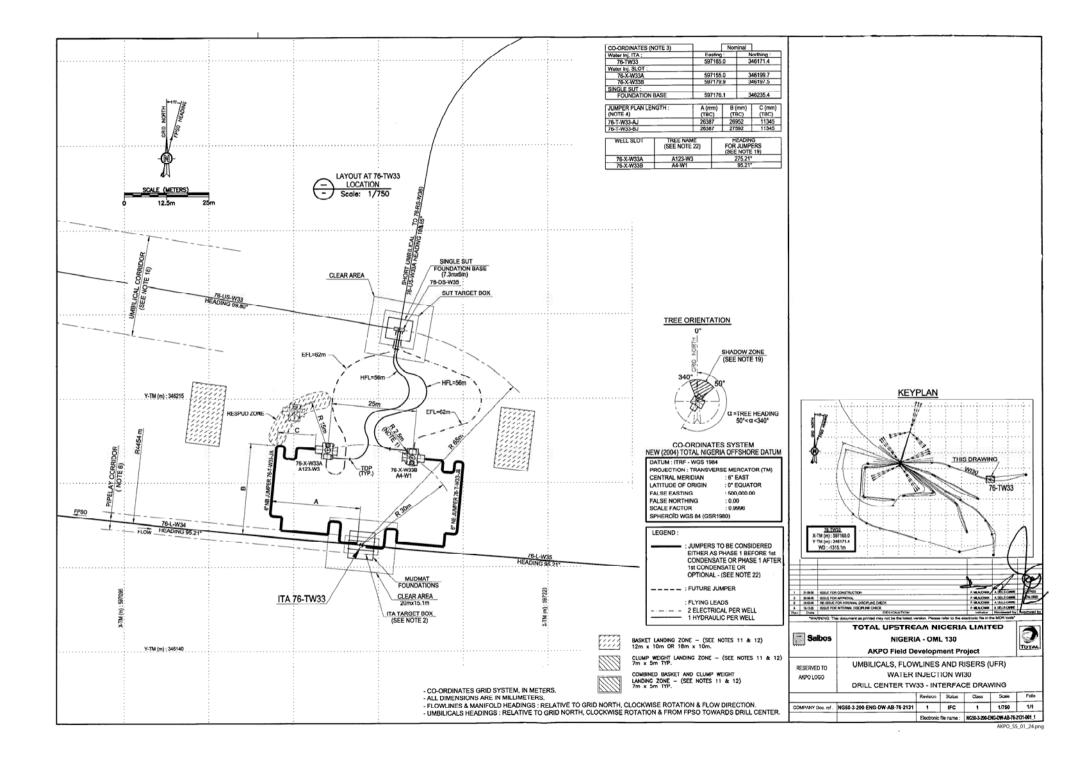
The following layout drawings show Drill Centre locations and equipment interfaces for the Water Injection Flowlines WI30.

TW33 Drill Centre

The TW33 Drill Centre consists of:

- 2 x Injection Tree 76-X-W33A/B
- 2 x 6in Jumper 76-T-W33-JA/JB
- 1 x Water Injection ITA 76-TW33

1.23 Umbilicals, Flowlines and Risers (UFR) – Water Injection WI30 Drill Centre FW31 – Interface Drawing



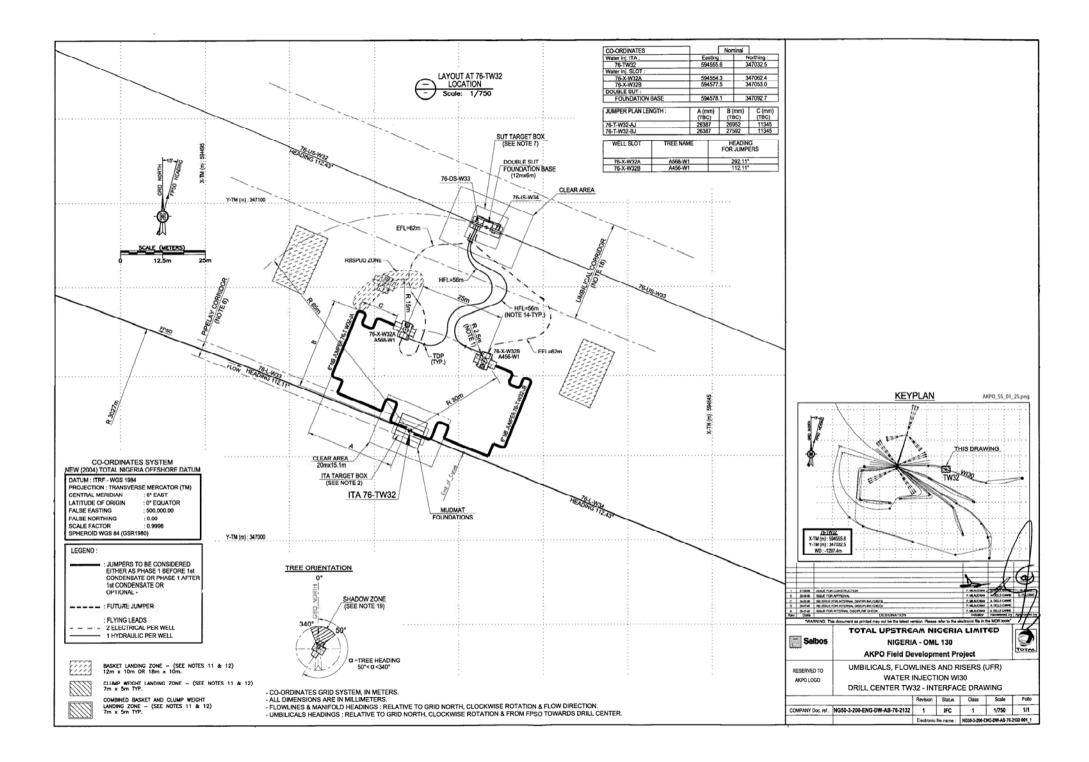
The following layout drawings show Drill Centre locations and equipment interfaces for the Water Injection Flowlines WI30.

TW32 Drill Centre

The TW32 Drill Centre consists of:

- 2 x Injection Tree 76-X-W32A/B
- 2 x 6in Jumper 76-T-W32-JA/JB
- 1 x Water Injection ITA 76-TW32

1.24 Umbilicals, Flowlines and Risers (UFR) – Water Injection WI30 Drill Centre TW33 – Interface Drawing



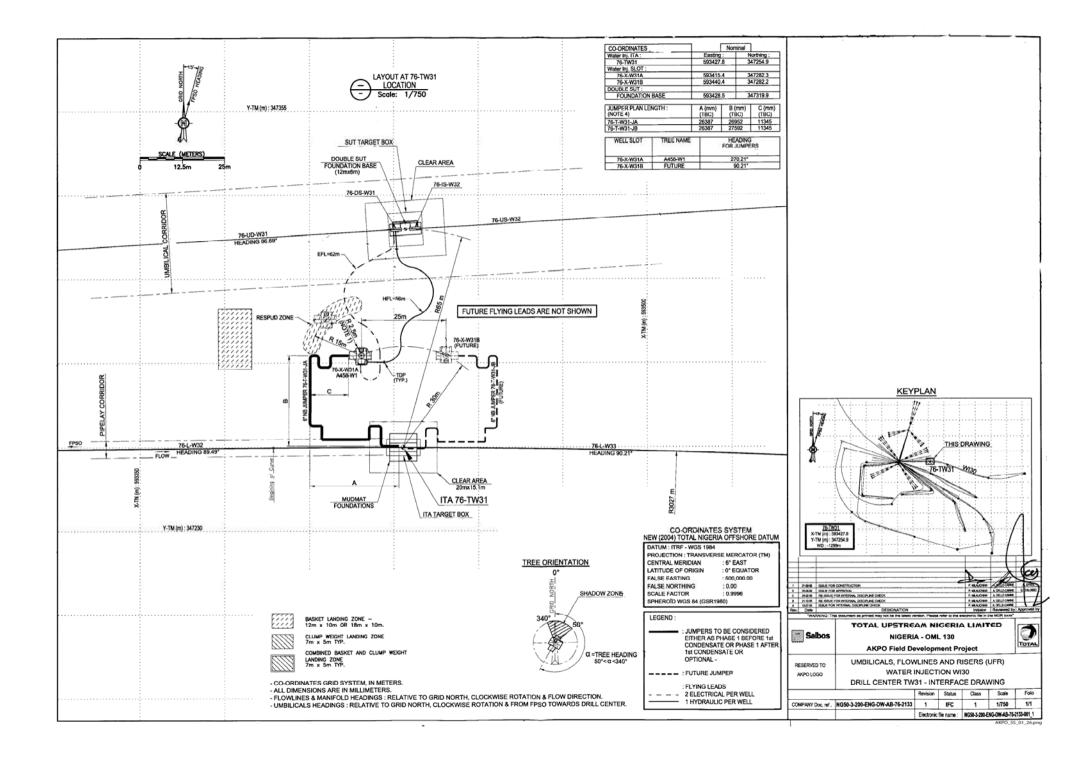
The following layout drawings show Drill Centre locations and equipment interfaces for the Water Injection Flowlines WI30.

TW31 Drill Centre

The TW31 Drill Centre consists of:

- 2 x Injection Tree 76-X-W31A (B for future use)
- 2 x 6in Jumper 76-T-W31-JA (JB for future use)
- 1 x Water Injection ITA 76-TW31

1.25 Umbilicals, Flowlines and Risers (UFR) – Water Injection WI30 Drill Centre TW32 – Interface Drawing



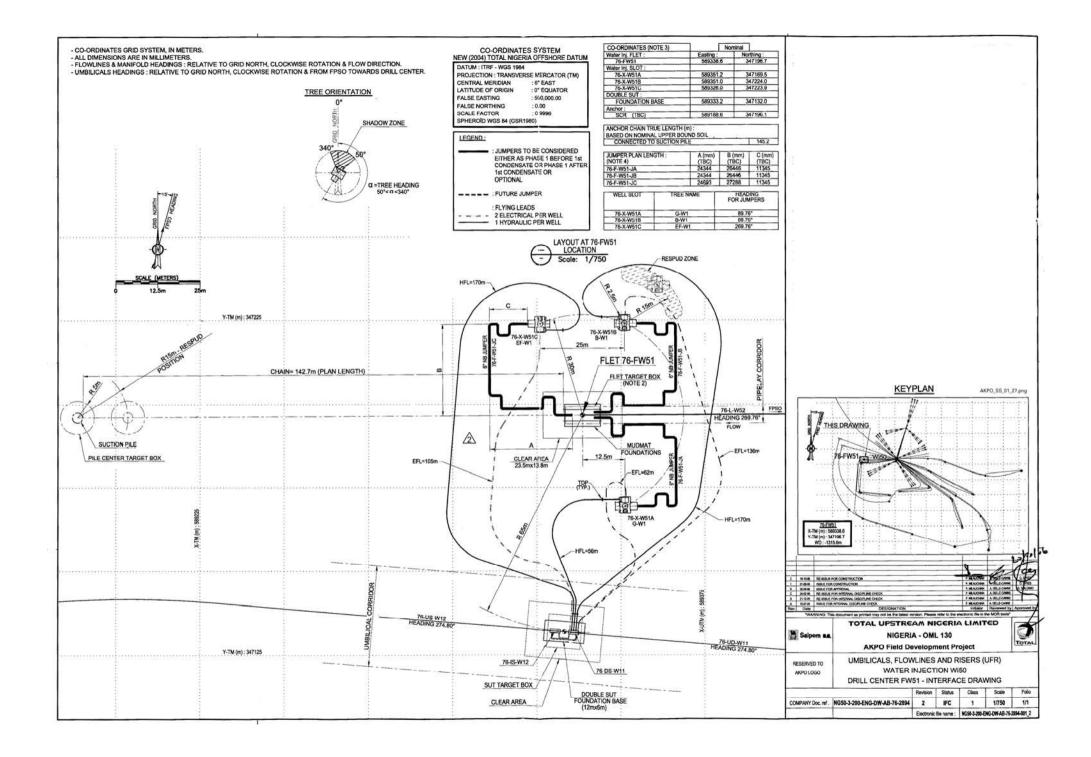
The following layout drawings show Drill Centre locations and equipment interfaces for the Water Injection Flowlines WI50.

FW51 Drill Centre

The FW51 Drill Centre consists of:

- 3 x Injection Tree 76-X-W51A/B/C
- 3 x 6in Jumper 76-F-W51-JA/JB/JC
- 1 x Water Injection FLET 76-FW51

1.26 Umbilicals, Flowlines and Risers (UFR) – Water Injection WI30 Drill Centre TW31 – Interface Drawing



1.27 Umbilicals, Flowlines and Risers (UFR) – Water Injection WI50 Drill Centre FW51 – Interface Drawing

Drawing Supplementary Information

The purpose of the Gas Injection Wells, Flowlines and Controls System is to re-inject compressed gas from the production separators back into the reservoir for pressure maintenance. Excess gas not required for injection, is exported to the Bonny LNG plant onshore (via the Amenam platform).

During plateau production years, the normal operating philosophy is to prioritise Gas Injection to be able to inject a minimum of 180MMscfd and route the excess gas to the Gas Export Pipeline with respect to a maximised gas flow of 320MMscfd. Then in later production years, the philosophy will be to maximise gas flow to the Gas Export Pipeline (capacity of 320MMscfd), with excess gas routed to the Gas Injection wells (capacity of 220MMscfd).

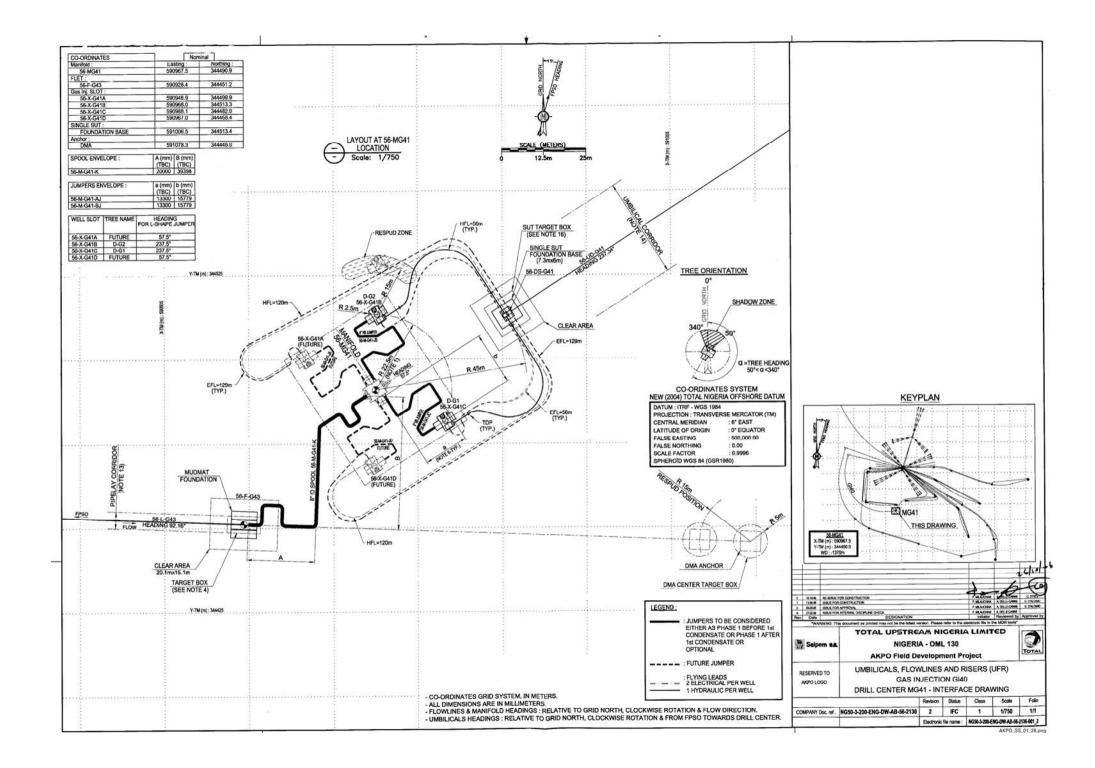
Gas injection is used in conjunction with Water Injection as a means of maintaining reservoir pressure to allow effective recovery of the potential hydrocarbon reserves.

The following layout drawings show Drill Centre locations and equipment interfaces for the Gas Injection Flowlines GI40.

MG41 Drill Centre

The MG41 Drill Centre consists of:

- 4 x Injection Trees 56-X-G41B/C (A/D for future use)
- 2 x 8in Jumpers 56-M-G41-JB/JC (JA/JD for future use)
- Gas Injection manifold 56-MG41
- 1 x 8in spool 56-M-G41-K
- 1 x Water Injection FLET 76-FW51



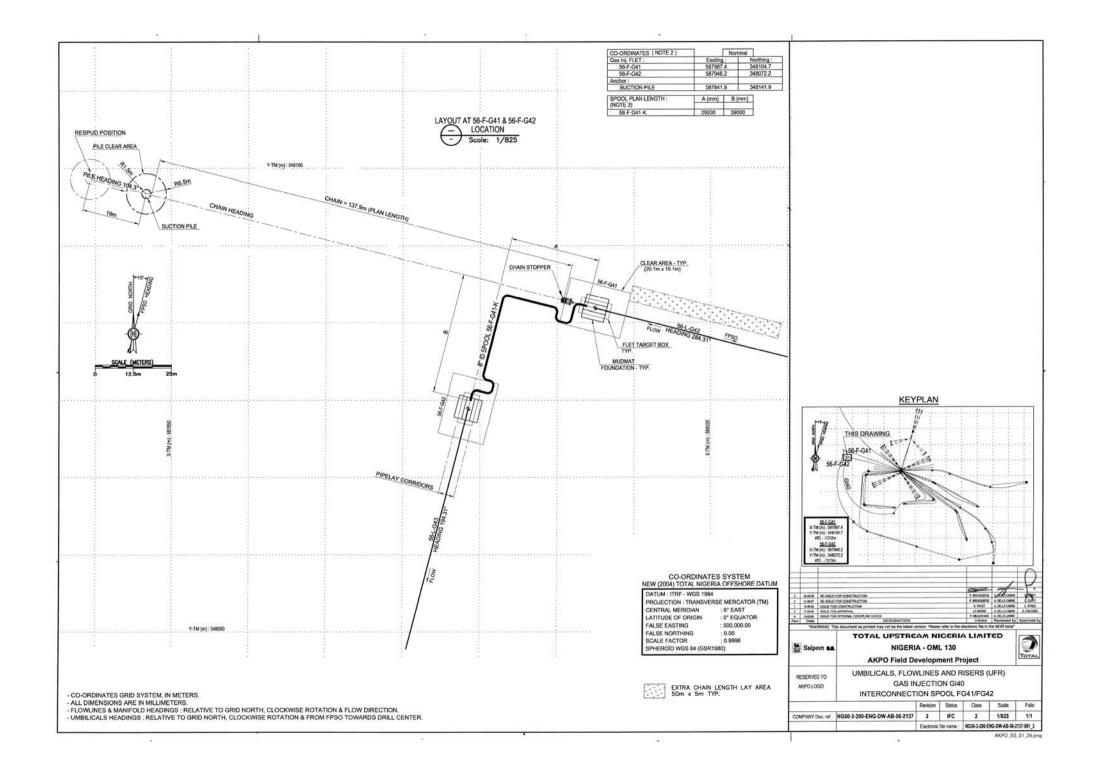
The following layout drawings show Drill Centre locations and equipment interfaces for the Gas Injection Flowlines GI40.

FG41/FG42 Interconnection Spool

The FG41/FG42 Interconnection consists of:

- 1 x 8in spool 56-F-G41-K
- 2 x Gas Injection FLETs 56-F-G41/G42

1.28 Umbilicals, Flowlines and Risers (UFR) – Gas Injection GI40 Drill Centre MG41 – Interface Drawing



The production loop manifolds at the nine Akpo drill centres are identical steel structures, which house the manifold headers and well slots for the individual production wells. Each production manifold is tied-in to a pair of production flowlines via separate flowline jumper spools.

Each manifold allows the production from up to four wells to be produced into the flowline system. Well slots are connected via four duel valve blocks (MPVs). Each of the four dual blocks is provided with two outlet ports, one to take flow to the Left Header Manifold and the other to the Right Header Manifold.

Flow from all wells entering the Right Header is collected in one forged block. The combined flow is directed through a 10in line to tie into the Right Header through a forged barred T piece. The flow into the Left Manifold is directed in two pairs, rather than all four into one connection. Flow from each of the pairs flows into a forged block, and is then carried to a common forged Y piece, which is directly connected to a forged barred T for connection to the Left Header. An interlock system between corresponding valve blocks is provided to ensure both valves are not opened simultaneously.

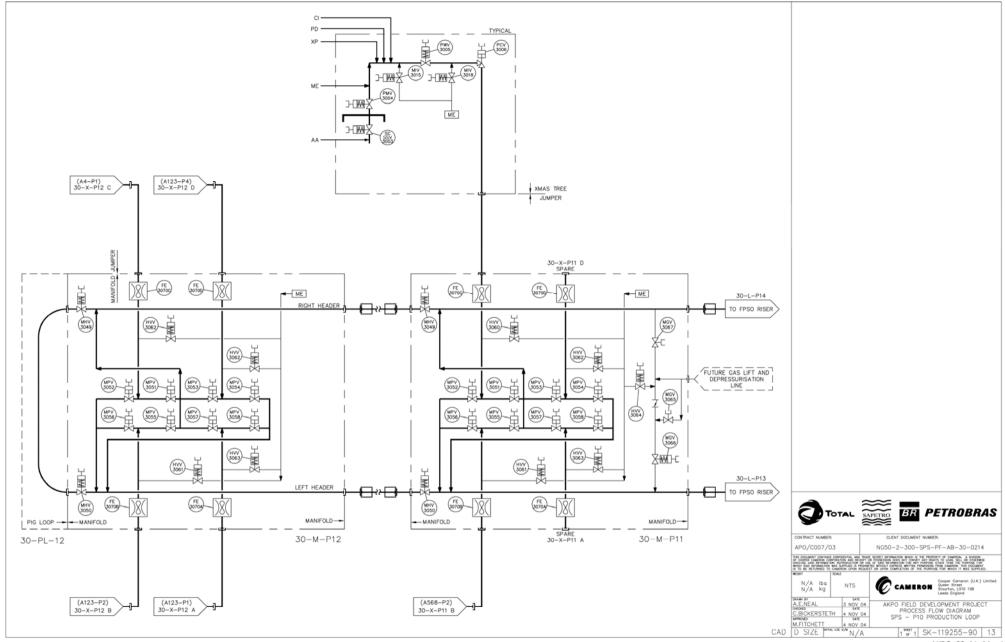
Dedicated methanol injection lines are routed via Isolation Valves (HVV) to the manifolds to allow methanol to be injected downstream of each MPFM.

Future gas lift tie-ins are provided at the 1st manifold on each loop for left and right flowlines. A methanol Injection facility is provided into this line for pressure equalisation and hydrate mitigation, should it be required.

Refer to the following PFDs:

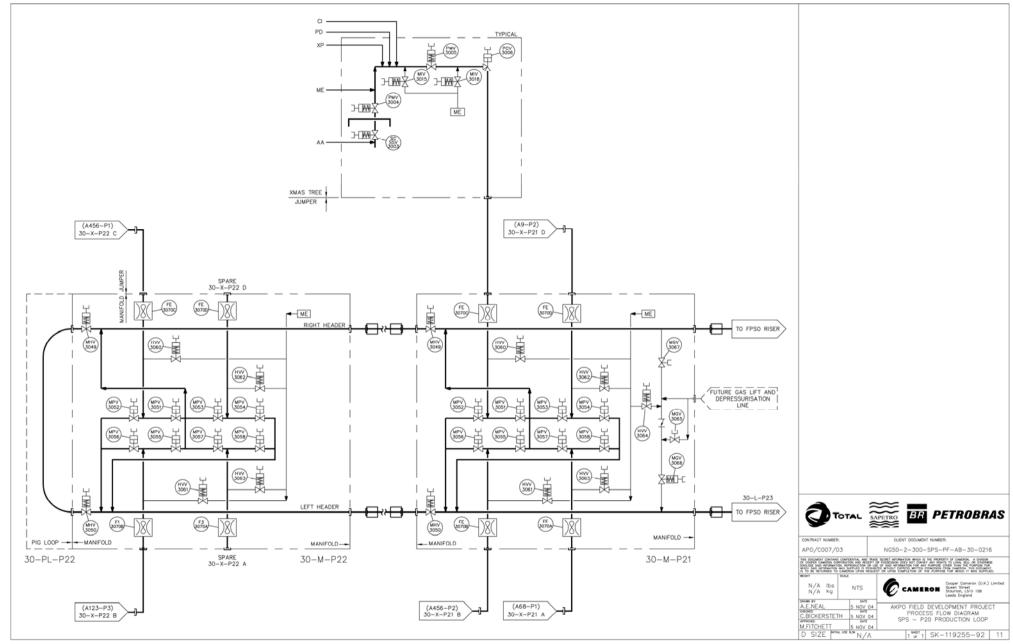
- NG50-2-300-SPS-PF-AB-30-0214 SPS P10 Production Loop
- NG50-2-300-SPS-PF-AB-30-0216 SPS P20 Production Loop
- NG50-2-300-SPS-PF-AB-30-0220 SPS P30 Production Loop
- NG50-2-300-SPS-PF-AB-30-0221 SPS P40 Production Loop

1.29 Umbilicals, Flowlines and Risers (UFR) – Gas Injection GI40 Interconnection Spool FG41/FG42



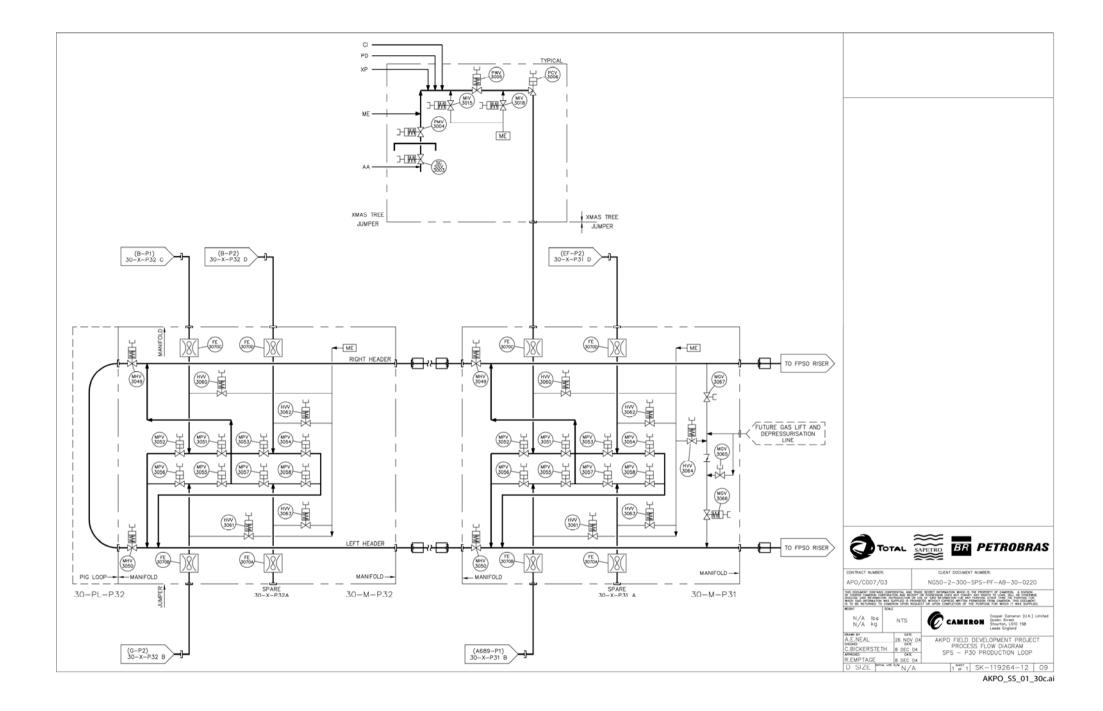
AKPO_SS_01_30a.ai

1.30 Umbilicals, Flowlines and Risers (UFR) – Production Loops Process Flow Diagrams (PFD) (Page 1 of 4)

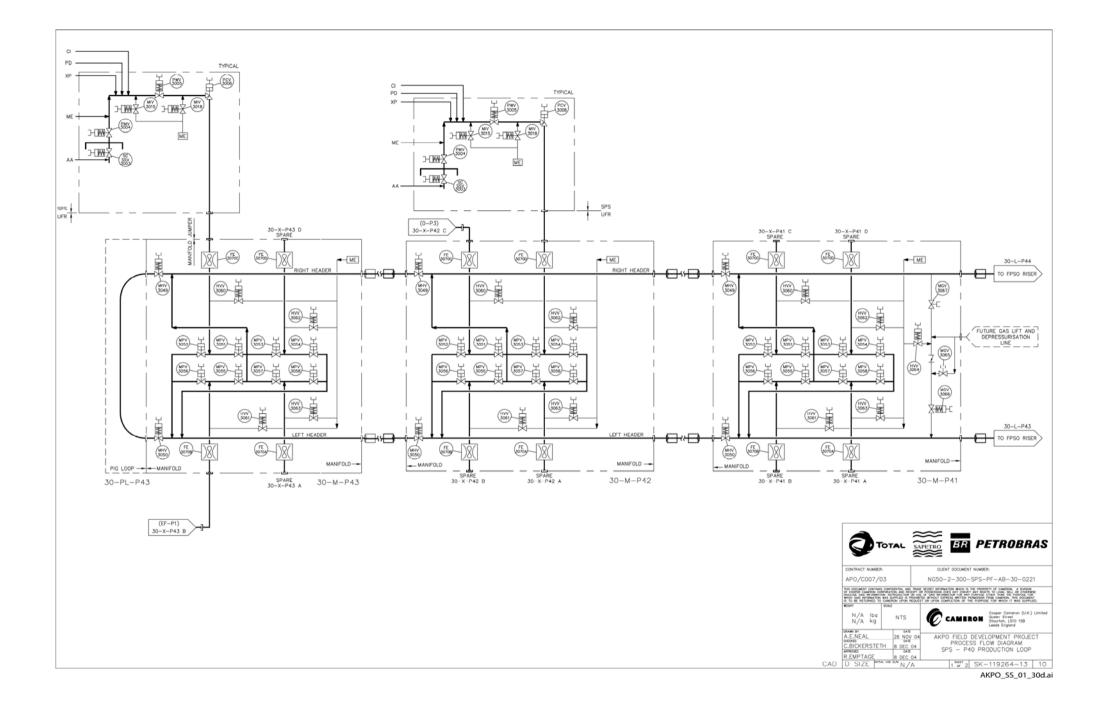


AKPO_SS_01_30b.ai

1.30 Umbilicals, Flowlines and Risers (UFR) – Production Loops Process Flow Diagrams (PFD) (Page 2 of 4)



1.30 Umbilicals, Flowlines and Risers (UFR) – Production Loops Process Flow Diagrams (PFD) (Page 3 of 4)



1.30 Umbilicals, Flowlines and Risers (UFR) – Production Loops Process Flow Diagrams (PFD) (Page 4 of 4)

Drawing Supplementary Information

Carbon steel flowlines carry the injection water from the FPSO to the associated injection wells. The system comprises 4 x 10in up sloping Injection Flowlines WI10/20/30/50 with 6in jumpers between flowlines and associated trees. The total length of the injection flowlines is 35.7km and individual flowline lengths varies from 3.3km to 17km.

The flowline inline tee assemblies contain forged T blocks and Flowline End Terminations (FLETs) welded directly into the flowline and laid with it.

The number of potential spurs that can be taken from each string varies. The forged T blocks have the capability of serving one or two spurs and the end terminations can feed three spurs. Each water injection well is tied in to the injection string via separate tie-in hubs and rigid jumper spools.

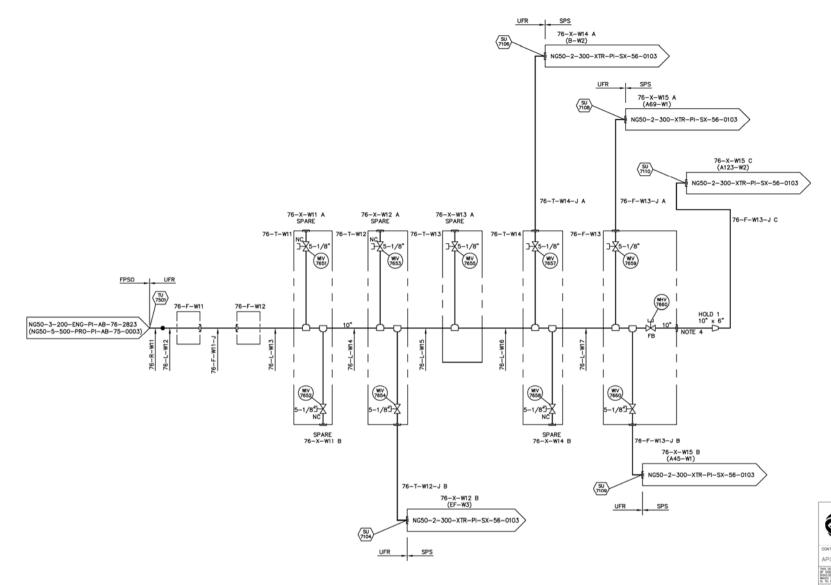
There are four water injection flowlines and each has up to five tee assemblies. Each tie-in branch includes a manual ROV operable Water Inlet Valve (WIV) for commissioning purposes.

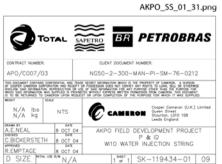
The FLET assemblies on each injection string are a tie-in hub suitable for connection of a future flowline, a pig receiver or potentially an additional well (as utilised by Water Injection Flowlines WI10 and WI50). A manual ROV operable Water Hub Valve (WHV) is included in the flowspool, and the hub will be provided with a pressure cap.

The following drawings show Water Injection Strings.

Refer to:

• NG50-2-300-MAN-PI-SM-76-0212 - WI10 Water Injection String





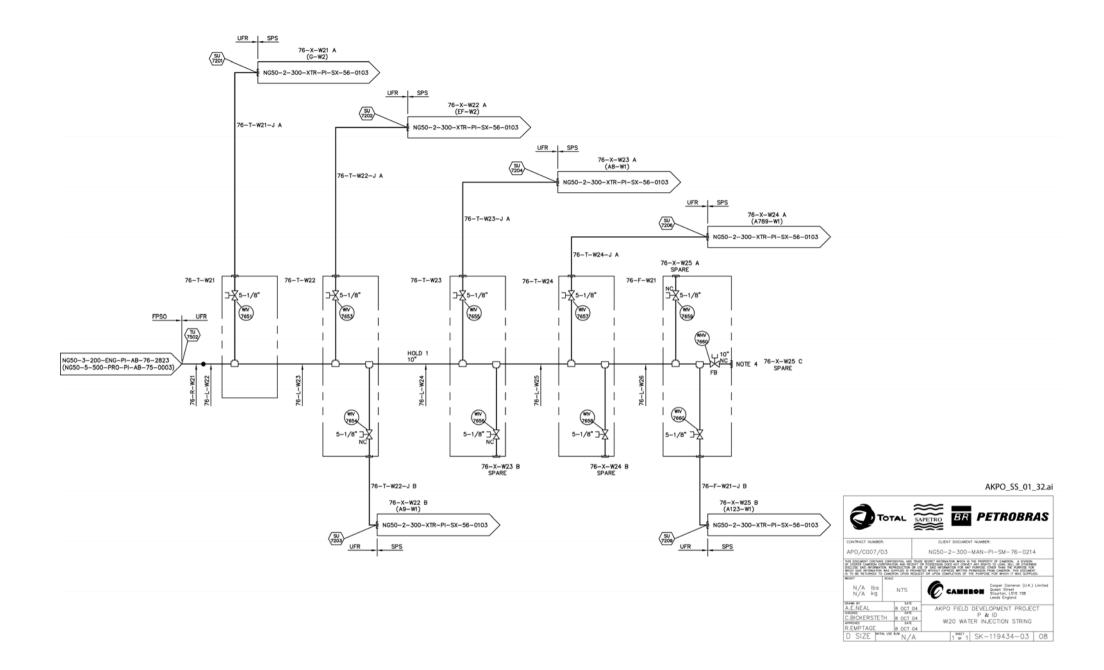
1 of 1 SK-119434-01 09

The following P&ID illustrates WI20 Water Injection String. Refer to:

• NG50-2-300-MAN-PI-SM-76-0214 – WI20 Water Injection String

1.31

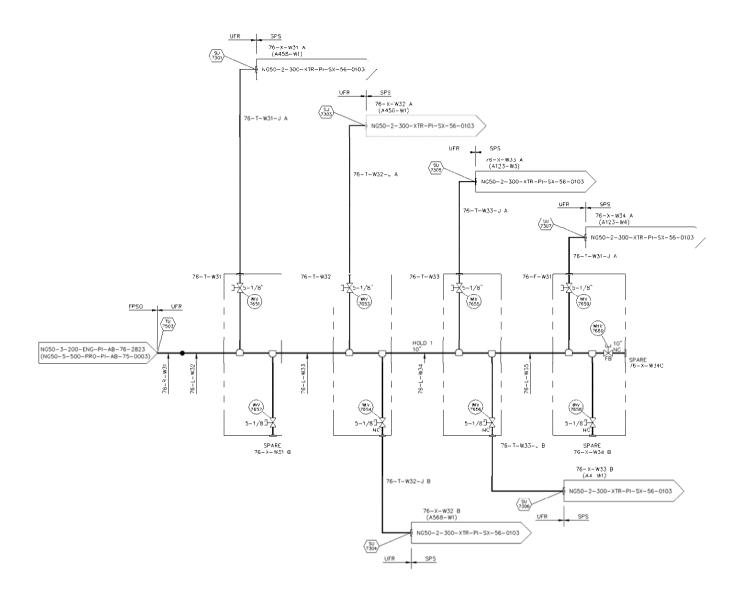
AKPO Field Development Projects WI10 Water Injection String

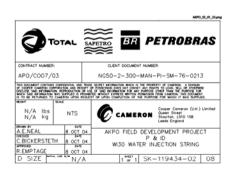


The following P&ID illustrates WI30 Water Injection String. Refer to:

• NG50-2-300-MAN-PI-SM-76-0213 – WI30 Water Injection String

1.32 AKPO Field Development Projects WI20 Water Injection String

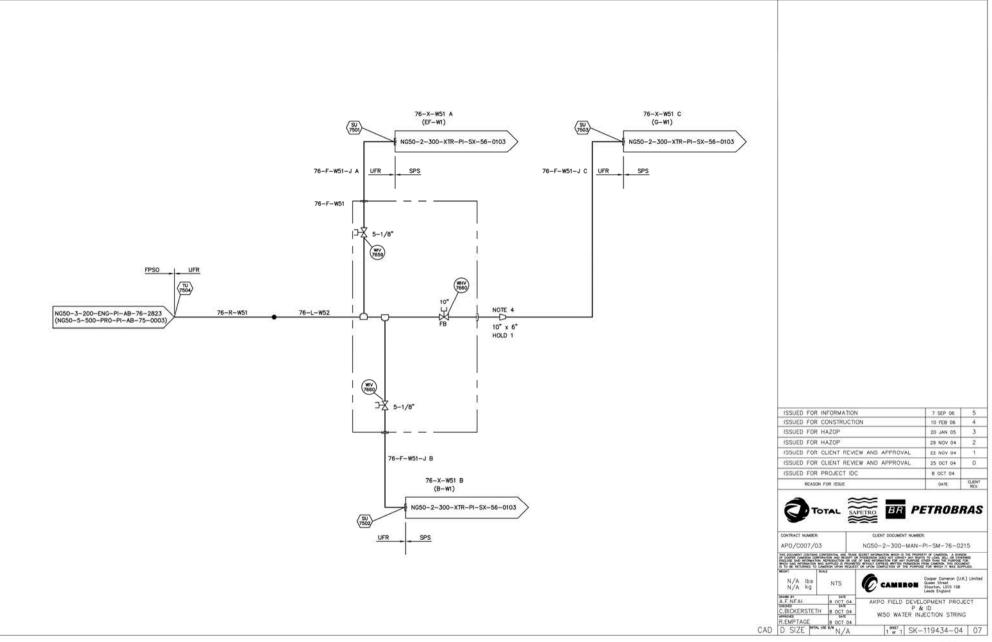




The following P&ID illustrates WI50 Water Injection String. Refer to:

• NG50-2-300-MAN-PI-SM-76-0215 – WI50 Water Injection String

1.33 AKPO Field Development Projects WI30 Water Injection String



AKPO_SS_01_34.ai

In the initial phase of production there are only two gas injection wells, fed from a single manifold. The manifold has the capability to service 4 wells.

Injection Gas is diverted into the jumpers from the Injection Gas Flowline through a forged cross piece, and two forged tees, allowing distribution to the flowline branches. Each line off the manifold has two Remote Operate Vehicle (ROV) operated isolation valves which, under normal operating conditions, will be permanently open on the 'live' lines and closed on the two spare lines.

The manifold has piping and valves to allow the injection of methanol between the double block valves. However there is no permanent methanol supply to the manifold. It is not expected that this facility will be required frequently

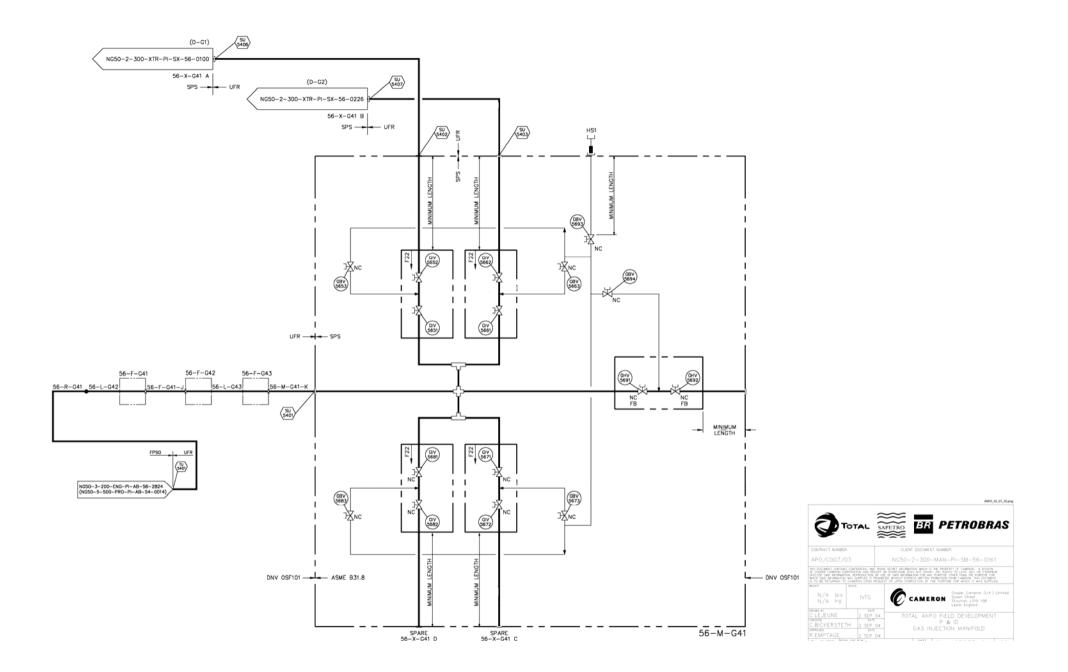
The Inline tees allow direct flowline connection via hardpipe well jumpers, installed on tubing hanger spool assemblies on the injection wells. The two gas injection tees are located within the manifold and are designed to allow connection of up to two gas injection wells via a 90° bend. The inline tees are connected to the flowline via a crosspiece, which allows connection of a further injection well.

The following drawing illustrates GI40 Gas Injection Manifold.

Refer to:

• NG50-2-300-MAN-PI-SM-56-0161 - Gas Injection Manifold

1.34 AKPO Field Development Projects WI50 Water Injection String



1.35 AKPO Field Development Projects Gas Injection P&ID

AKPO Subsea Reference Manual Section 2 Subsea Production System

CONTENTS

- 2.1 Subsea Production System Assembly Drawing: Tree Guide Base
- 2.2 Subsea Production System Assembly – Production Xmas Tree (Typical)
- 2.3 Subsea Production System Diagram of Typical Production Tree (On/Off Type IWC)
- 2.4 Subsea Production System Diagram of Typical Production Tree (No IWC)
- 2.5 Subsea Production System Assembly Water Injection Xmas Tree
- 2.6 Subsea Production System Simplified Flow Diagram Typical Water Injection Tree
- 2.7 Subsea Production System Assembly Gas Injection Xmas Tree
- 2.8 Subsea Production System Simplified Flow Diagram Typical Gas Injection Tree
- 2.9 Subsea Production System Assembly Production Manifold (W/out Gas Lift)
- 2.10 Subsea Production System Valve List Typical Production Manifold (W/out Gas Lift)
- 2.11 Subsea Production System Assembly Production Manifold (with Gas Lift)
- 2.12 Subsea Production System Valve List Typical Production Manifold (with Gas Lift)
- 2.13 Subsea Production System Assembly Production Manifold (W/out Gas Lift) Pigging Loop

CONTENTS (cont'd)

- 2.14 Subsea Production System Assembly Gas Injection Manifold
- 2.15 Subsea Production System Valve List Typical Gas Injection Manifold
- 2.16 Subsea Production System 6in 10k CHC Connector (Production)
- 2.17 Subsea Production System 10in 10k CHC Connector
- 2.18 Subsea Production System 12in 10k CHC Connector (Production and WI)
- 2.19 Subsea Production System Production Jumper Type A & C Long Configuration – GA and Isometric
- 2.20 Subsea Production System Production FLET Type FP1 General Arrangement
- 2.21 Subsea Production System Water Injection FLET Type FW1 General Arrangement
- 2.22 Subsea Production System Water Injection FLET Type FW2 General Arrangement
- 2.23 Subsea Production System Water Injection ITA Type TW1 General Arrangement
- 2.24 Subsea Production System Water Injection ITA Type TW2 General Arrangement
- 2.25 Subsea Production System Gas Injection FLET Type FG1 General Arrangement
- 2.26 Subsea Production System System FR Production Riser P10 General Arrangement

CONTENTS (cont'd)

- 2.27 Subsea Production System SCR 10in Production FlexJoint Cross Section
- 2.28 Subsea Production System SCR 10in Water Injection FlexJoint Cross Section
- 2.29 Subsea Production System SCR 8in Gas Injection FlexJoint Cross Section
- 2.30 Subsea Production System 3D View of Production Tree (XT))
- 2.31 Subsea Production System 3D View of Production Manifold
- 2.32 Subsea Production System 3D View of SUT (DSUT, ISUT) and Bridge Jumper

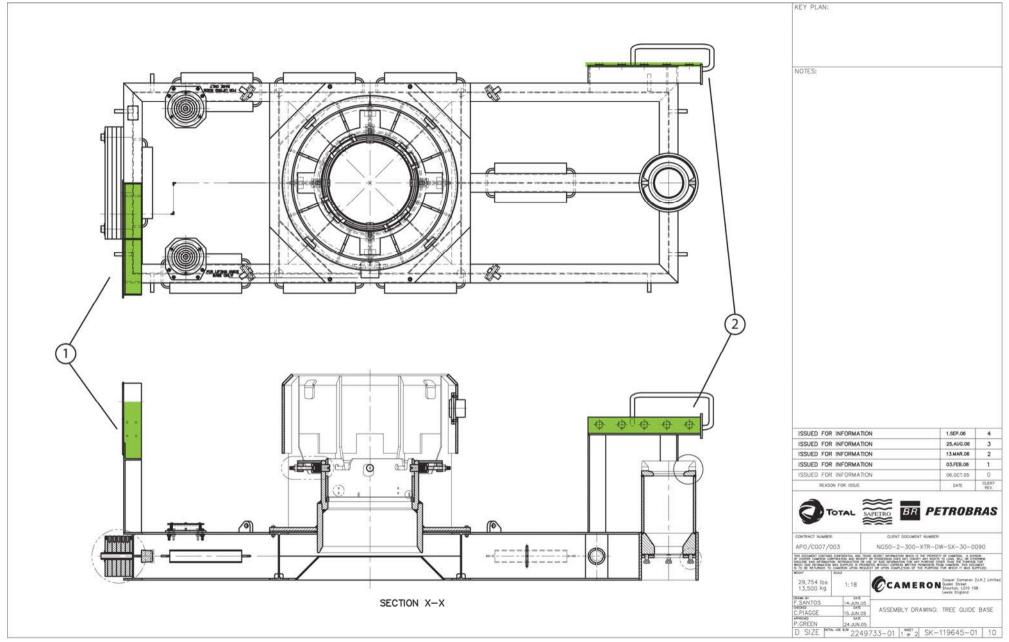
The Production Tree Guide Base (TGB) establishes structural support and final alignment for the production tree and subsequent well components. At one end of the TGB a porch acts as a receptacle for the CHC. The following assembly drawing is of a typical production tree guidebase.

Electrical Flying Leads (EFL) and Hydraulic Flying Leads (HFL) parking positions are highlighted.

- 1 HFL parking positions
- 2 EFL parking positions

Refer to:

 NG50-2-300-XTR-DW-SX-30-0090 – Assembly Drawing Tree Guide Base



AKPO_SS_02_01.ai

The subsea trees connect production wells to the production jumper on the associated subsea manifold. All valves have visual position indicators and their tag name clearly marked for ROV observation. Each tree is provided with a choke valve. Tree operations are controlled and monitored via dedicated TCM.

Remotely operated valves on the subsea tree are provided with local Remote Operated Vehicle override for opening or closing operation.

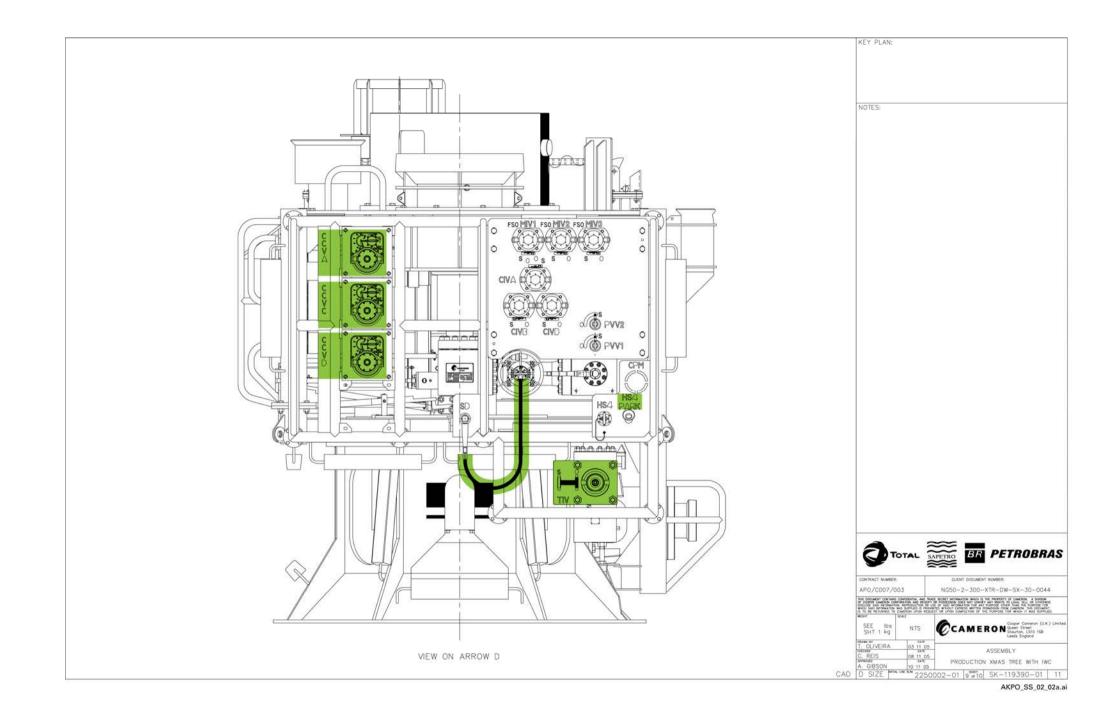
The following drawings are of a typical Production Tree highlighting the locations of:

- (1) Sand Detector (SD).
- (2) Chemical Injection Choke Valves (CCV).
- (3) Tree Isolation Valve (TIV).

Refer to:

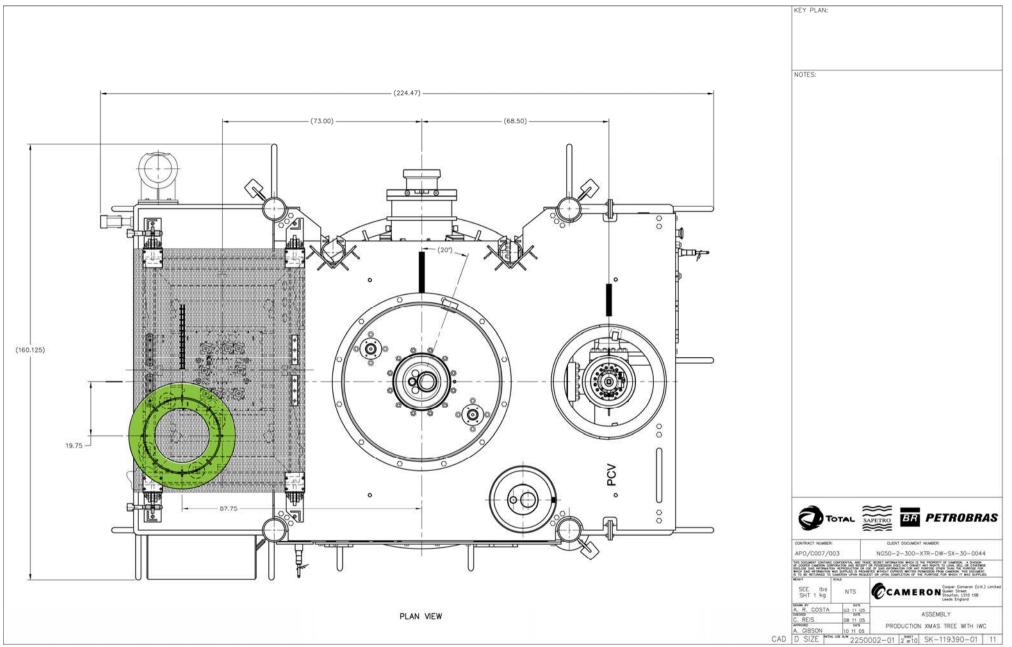
• NG50-2-300-XTR-DW-SX-30-0044 – Production Xmas Tree with IWC

2.1 Subsea Production System – Assembly Drawing: Tree Guide Base



The following drawing highlights the T cosy parking position. The parking receptacle is located on top of the SCM protective cover. When all subsea operations are completed, the T cosy is then moved by ROV, to its final position.

2.2 Subsea Production System – Assembly – Production Xmas Tree (Typical) (Page 1 of 2)



AKPO_SS_02_02b.ai

2.2 Subsea Production System – Assembly – Production Xmas Tree (Typical) (Page 2 of 2)

Drawing Supplementary Information

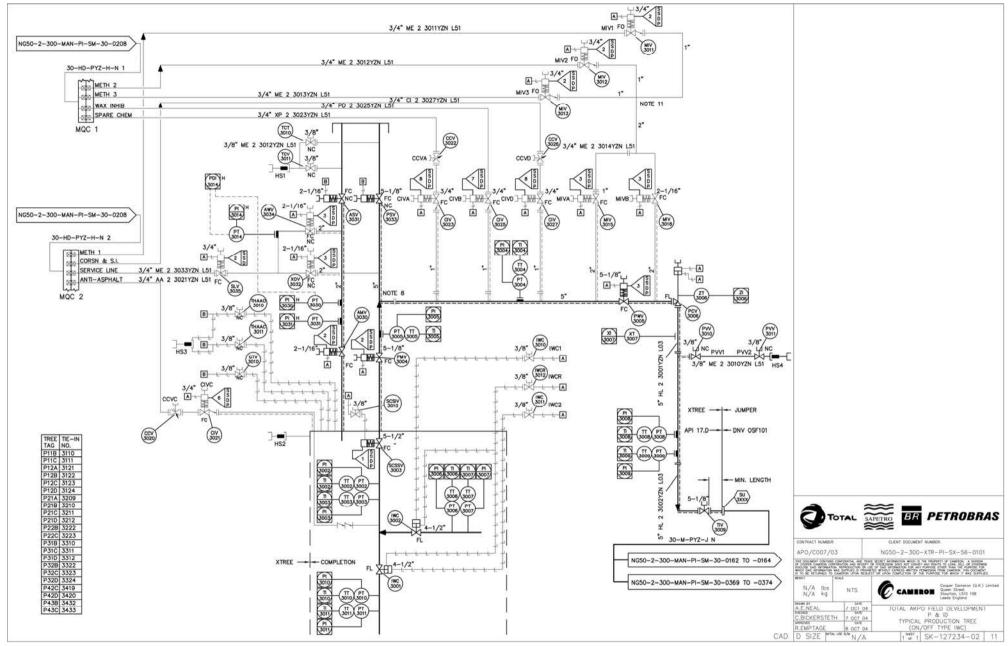
The tree choke valves control the overall well flowrate. The downhole Intelligent Well Completion (IWC) valves control flow from two separate zones within the well (if provided). The flow within individual flowline branches and production loops is controlled within operating parameters that ensures any slugging is within the capabilities of the topside equipment and that the fluids arrive at the FPSO at or above 48°C. The flow of hydrocarbons from an individual flowline branch is ultimately controlled from the choke valve on the FPSO at the top of the riser.

The on/off IWCs allow the operator to select which zone is to be produced, completely shutting off one zone while allowing the other to flow, should a zone be determined to have an adverse impact to the overall production of that well (a high water cut, for example). These zone valves are interlocked so that only one IWC per well can be operated at any given time.

The following diagram is of a Production Tree with On/Off Intelligent Well Control (ON/OFF IWC).

Refer to:

 NG50-2-300-XTR-PI-SX-56-0101 – Typical Production Tree (On/Off Type IWC)





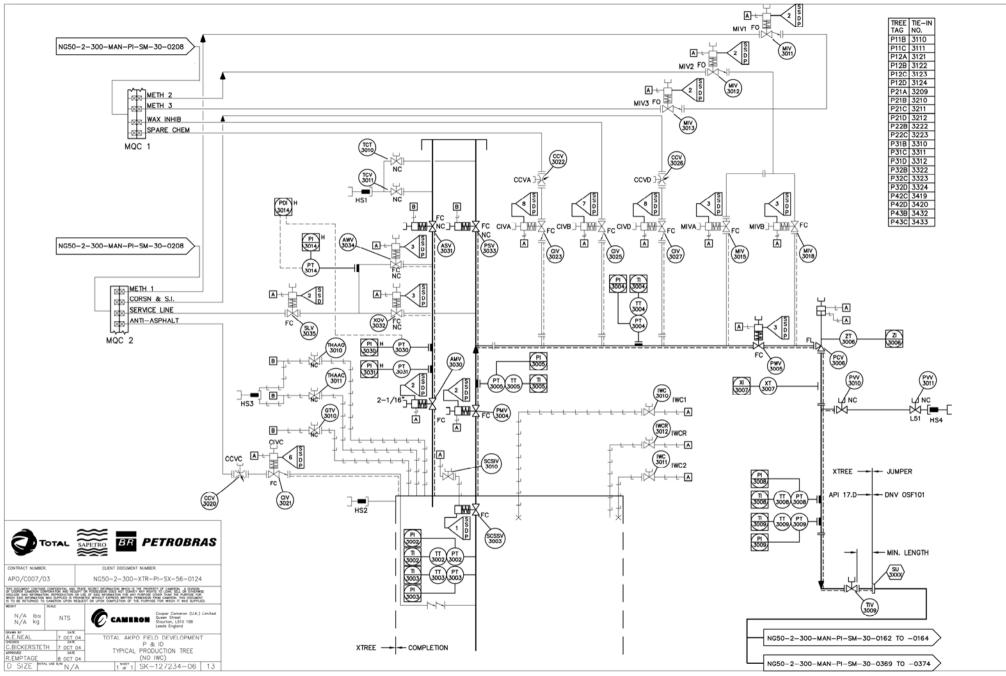
2.3 Subsea Production System – Diagram of Typical Production Tree (On/Off Type IWC)

Drawing Supplementary Information

The following diagram is of a Production Tree with No Intelligent Well Control (NO IWC).

Refer to:

• NG50-2-300-XTR-PI-SX-56-0124 – Typical Production Tree (No IWC)



AKPO_SS_02_04.ai

The subsea trees connect water injection wells to the water injection jumper via the associated subsea tee assembly. Water injection trees are fitted with single injection master, wing, swab and choke valves and single annulus master, wing and swab valve. There is a crossover valve installed allowing connection between injection and annulus. The tree has been provided with fully clad injection bore and cavities, but unlike the production trees, there is no cladding on the annulus bore. There are injection facilities for methanol upstream of the choke valve well injection tubing and into the annulus. All tree valves are fitted with ROV operable interfaces to allow operation of overrides.

The remotely operated tree valves include:

- Injection Master Valve (IMV)
- Injection Wing Valve (IWV)
- Injection Choke Valve (ICV)
- Annulus Master Valve (AMV)
- Annulus Wing Valve (AWV)
- Crossover Valve (XOV)
- Chemical Injection Valve (CIV)
- Service Line Valve (SLV)

Each water injection tree is also provided with the following Remote Operated Vehicle (ROV) operable valves, which are operated via the tree valve panel. The hydraulic supply for the valve operation may be supplied from the workover umbilical or the Installation/Workover Control System (IWOCS):

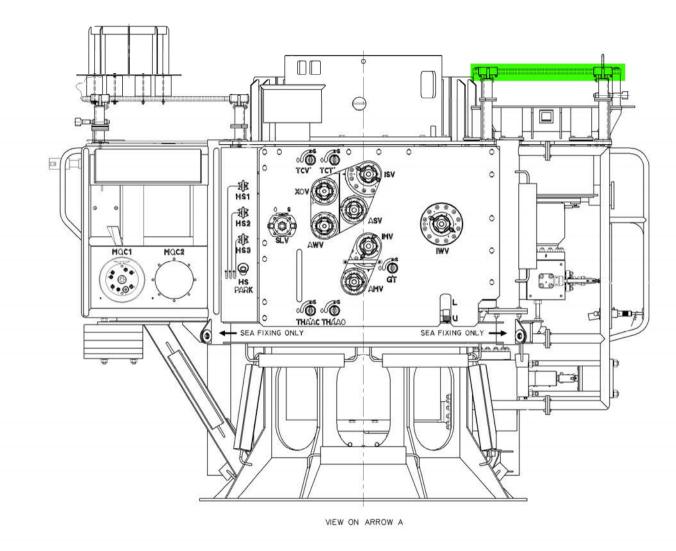
- Tree Cap Test (TCT)
- Tree Cap Valve (TCV)
- 2 x hot stab plate Injection Vent Valves (IVV)
- Hot stab plate Injection Test Valve(ITV)
- Tree Isolation Valve (TIV)
- Injection Swab Valve (ISV)
- Annulus Swab Valve (ASV)

All tree valves are fitted with ROV operable interfaces.

Refer to:

 NG50-2-300-XTR-DW-SX-76-0050 – Assembly Water Injection Xmas Tree

2.4 Subsea Production System – Diagram of Typical Production Tree (No IWC)





AKPO_SS_02_05

All valves have visual position indicators and their tag name clearly marked for ROV observation. Each tree is provided with a choke valve. Tree operations are controlled and monitored via dedicated Tree Control Modules (TCM).

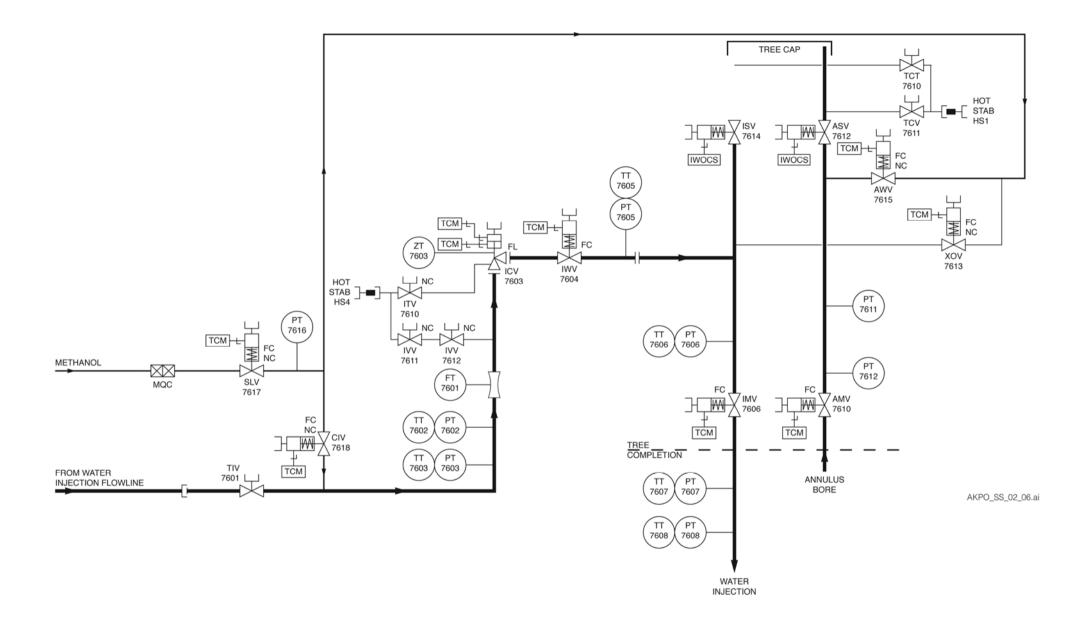
The Crossover Valve (XOV) connects the annulus to injection and allows the annulus pressure to be regulated. Provision for Methanol injection is provided through the tree. A Methanol injection port with valve is provided for hydrate inhibition and tree/tubing pressurisation located between the IMV and the IWV. A second methanol injection port is provided for start-up preservation and downstream pressurisation and is located between the ICV and the TIV.

The following simplified flow diagram illustrates the valves and instrumentation associated with a Water Injection Tree.

Refer to:

• NG50-2-300-XTR-PI-SX-56-0103 – Typical Water Injection Tree

2.5 Subsea Production System – Assembly – Water Injection Xmas Tree



2.6 Subsea Production System – Simplified Flow Diagram Typical Water Injection Tree

Drawing Supplementary Information

The subsea trees connect gas injection wells to the gas injection jumper via the associated subsea tee assembly Gas injection trees are fitted with single injection master, wing, swab and choke valves and single annulus master, wing and swab valve. There is a crossover valve installed allowing connection between injection and annulus. The tree has been provided with fully clad injection bore and cavities, but unlike the production trees, there is no cladding on the annulus bore. There are injection facilities for methanol upstream of the choke valve and into the annulus. All tree valves are fitted with ROV operable interfaces.

Remotely operated valves on the subsea tree are provided with Remote Operated Vehicle facility for opening or closing operation and include:

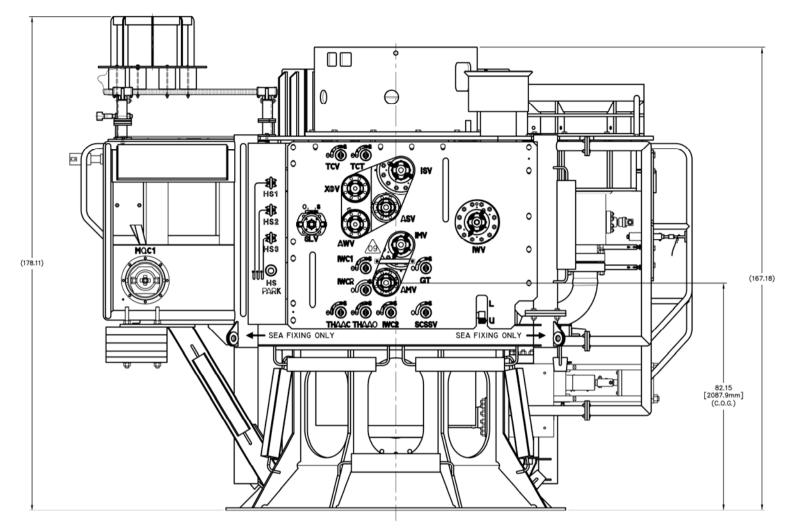
- Injection Master Valve (IMV)
- Injection Wing Valve (IWV)
- Injection Choke Valve (ICV)
- Injection Swab Valve (ISV)
- Annulus Master Valve (AMV)
- Annulus Swab Valve (ASV)
- Annulus Wing Valve (AWV)
- Crossover Valve (XOV)
- Chemical Injection Valve (CIV)
- Service Line Valve (SLV)

Each gas injection tree is also provided with the following Remote Operated Vehicle (ROV) operable valves, which are operated via the tree valve panel. The hydraulic supply for the valve operation may be supplied from the umbilical or the Installation/Workover Control System (IWOCS):

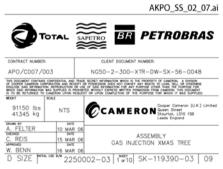
- Tree Cap Test (TCT)
- Tree Cap Valve (TCV)
- 2 x hot stab plate Injection Vent Valves (IVV)
- Tree Isolation Valve (TIV)

The following drawing illustrates a typical Gas Injection Tree assembly. Refer to:

• NG50-2-300-XTR-PI-SX-56-0103 – Assembly Gas Injection Tree



VIEW ON ARROW A



All remote actuated valves on the tree are gate valves which Fail Closed (FC), except the Injection Choke Valve which is a plug and cage type valve, operating on stepping principle of the plug, covering and uncovering holes in the cage to control the fluid flow.

There are two separate pistons (open and close) that turn a gear to operate the choke valve. To open the choke one step, a pressure pulse is sent to the 'open' piston and the piston extends past the teeth of the gear.

When the pressure is bled off, the piston spring returns and a tooth on the end of the piston engages the gear and pulls the gear with it on the return stroke, moving the choke one step. The valve operates in the same way to close. Gas injection choke valves are Fail As-Is.

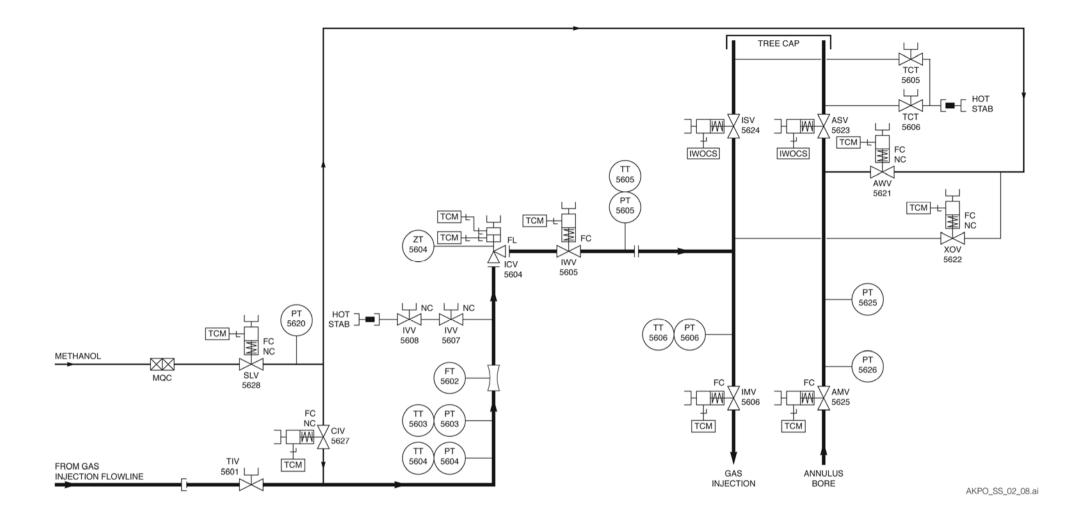
All valves have visual position indicators and their tag name clearly marked for ROV observation. Each tree is provided with a choke valve. Tree operations are controlled and monitored via dedicated Tree Control Modules (TCM).

The following simplified flow diagram illustrates the valves and instrumentation associated with a Gas Injection Tree.

Refer to:

NG50-2-300-XTR-PI-SX-56-0103 – Typical Gas Injection Tree

2.7 Subsea Production System -Assembly – Gas Injection Xmas Tree



The 10in production manifolds at the nine Akpo drill centres are identical steel structures, which house the 10in ID manifold headers and well slots for the individual production wells. Each production manifold is tied-in to a pair of production flowlines via separate flowline jumper spools.

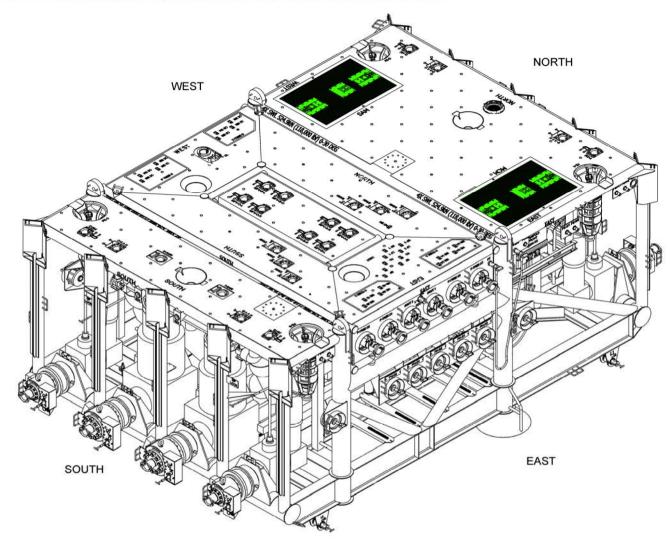
Each manifold allows the production from up to four wells to be produced into the flowline system. Well slots are connected via four duel valve blocks (MPVs). Each of the four dual blocks is provided with two outlet ports, one to take flow to the Left Header Manifold and the other to the Right Header Manifold.

The right branch will be the flowline on the right when viewed from the FPSO.

The following drawing illustrates a Production Manifold without gas lift, (eg M42 Inline Production Manifold).

2.8 Subsea Production System -Simplified Flow Diagram **Typical Gas Injection Tree**

| AKPO # | PART NUMBER | DWG # | FE-A | FE-B | FE-C | FE-D | P-TREE A1 | P-TREE A2 | P-TREE B1 | P-TREE 82 | P-TREE C1 | P-TREE C2 | P-TREE D1 | P-TREE D2 |
|--------|-------------|--------------|------|------|------|------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| M12 | 2247442-01 | SK-127704-01 | (2) | 2 | 2 | 2 | (17) | (18) | (17) | (18) | (17) | (18) | (17) | (18) |
| M22 | 2247442-02 | SK-127704-02 | 2 | 2 | 2 | 3 | 17 | (18) | 17 | (18) | (17) | (18) | 4 | (19) |
| M32 | 2247442-03 | SK-127704-03 | 3 | 2 | 3 | 2 | (4) | (19) | 17 | 18 | 4 | (19) | 17 | 18 |
| M42 | 2247442-04 | SK-127704-04 | 2 | 2 | 3 | 3 | 17 | 18 | 17 | 18 | 4 | (19) | 4 | (19) |
| M43 | 2247442-05 | SK-127704-05 | (3) | (2) | 3 | 3 | (4) | (19) | (17) | (18) | (4) | (19) | (4) | (19) |





Manifold operations are controlled and monitored via dedicated Manifold Control Modules (MCM).

Dedicated methanol injection lines are routed via Isolation Valves (HVV) to the manifolds to allow methanol to be injected downstream of each MPFM. The methanol injection lines may be reconfigured to allow depressurisation of the flowline through the umbilical via the service line.

The following valve list is for a typical Production Manifold without gas lift.

2.9 Subsea Production System – Assembly – Production Manifold (W/out Gas Lift)

| Valve | Manifold Markings | Description |
|----------|-------------------|---|
| MHV3049R | MHV-R | Manifold Header Isolation Valve (10in) – Right Header |
| MHV3050L | MHV-L | Manifold Header Isolation Valve (10in) – Left Header |
| MPV3051 | MPV-C-R | Manifold Production Valve (51/sin) |
| MPV3052 | MPV-C-L | Manifold Production Valve (51/sin) |
| MPV3053 | MPV-D-R | Manifold Production Valve (51/sin) |
| MPV3054 | MPV-D-L | Manifold Production Valve (51/sin) |
| MPV3055 | MPV-B-R | Manifold Production Valve (51/sin) |
| MPV3056 | MPV-B-L | Manifold Production Valve (51/sin) |
| MPV3057 | MPV-A-R | Manifold Production Valve (51/sin) |
| MPV3058 | MPV-A-L | Manifold Production Valve (51/sin) |
| PIV3071 | PIV-B | Production Isolation Valve (51/sin) |
| PIV3073 | PIV-A | Production Isolation Valve (51/sin) |
| PIV3070 | PIV-C | Production Isolation Valve (51/sin) |
| PIV3072 | PIV-D | Production Isolation Valve (51/sin) |
| HVV3060 | HVV-C | Hydraulic Vent valve (1in) |
| HVV3062 | HVV-D | Hydraulic Vent valve (1in) |
| HVV3061 | HVV-B | Hydraulic Vent valve (1in) |
| HVV3063 | HVV-A | Hydraulic Vent valve (1in) |
| LPV1 | LP1 | SAM Valve |
| LPV2 | LP2 | SAM Valve |

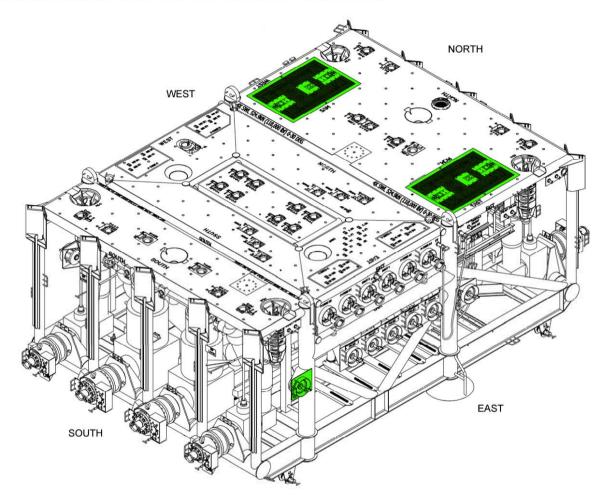
Future gas lift tie-ins are provided at the 1st manifold on each loop for left and right flowlines. The gas injection will be used if production requires stimulation in later life due to an increase in hydrostatic head in the flowlines and risers, or after shutdown to help 'kick-off' a production well. Gas lift can be provided at the moment by back flowing gas down one header through the lines within the first manifold installed for future gas lift. A methanol Injection facility is provided into this line for pressure equalisation and hydrate mitigation, should it be required.

The following drawing illustrates a Production Manifold with gas lift, with the additional Manifold Quick Connection (MQC) highlighted.

2.10 Subsea Production System -Valve List **Typical Production Manifold (W/out Gas Lift)**

Drawing Supplementary Information

| AKPO # | PART NUMBER | DWG # | FE-A | FE-B | FE-C | FE-D | P-TREE A1 | P-TREE A2 | P-TREE B1 | P-TREE 82 | P-TREE C1 | P-TREE C2 | P-TREE D1 | P-TREE D2 |
|--------|-------------|--------------|------|------|------|------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| M11 | 2247440-01 | SK-127703-01 | (2) | (2) | (3) | (3) | (17) | (18) | (17) | (18) | (4) | (19) | (4) | (19) |
| M21 | 2247440-02 | SK-127703-02 | 2 | 2 | 3 | 2 | (17) | 18 | (17) | 18 | 4 | (19) | 17 | 18 |
| M31 | 2247440-03 | SK-127703-03 | 3 | 2 | 3 | 2 | 4 | (19) | 17 | 18 | 4 | (19) | 17 | 18 |
| M43 | 2247440-04 | SK-127703-04 | (3) | (3) | (3) | (3) | (4) | (19) | (4) | (19) | (4) | (19) | (4) | (19) |





AKPO_55_02_11.prg

The following valve list is for a typical Production Manifold with gas lift.

2.11 Subsea Production System – Assembly – Production Manifold (with Gas Lift)

| Valve | Manifold Markings | Description |
|----------|-------------------|---|
| MHV3049R | MHV-R | Manifold Header Isolation Valve (10in) – Right Header |
| MHV3050L | MHV-L | Manifold Header Isolation Valve (10in) – Left Header |
| MPV3051 | MPV-C-R | Manifold Production Valve (51/sin) |
| MPV3052 | MPV-C-L | Manifold Production Valve (51/sin) |
| MPV3053 | MPV-D-R | Manifold Production Valve (51/sin) |
| MPV3054 | MPV-D-L | Manifold Production Valve (51/sin) |
| MPV3055 | MPV-B-R | Manifold Production Valve (51/sin) |
| MPV3056 | MPV-B-L | Manifold Production Valve (51/sin) |
| MPV3057 | MPV-A-R | Manifold Production Valve (51/sin) |
| MPV3058 | MPV-A-L | Manifold Production Valve (51/sin) |
| PIV3071 | PIV-B | Production Isolation Valve (51/2 in) |
| PIV3073 | PIV-A | Production Isolation Valve (51/2 in) |
| PIV3070 | PIV-C | Production Isolation Valve (51/2 in) |
| PIV3072 | PIV-D | Production Isolation Valve (51/2 in) |
| HVV3060 | HVV-C | Hydraulic Vent valve (1in) |
| HVV3062 | HVV-D | Hydraulic Vent valve (1in) |
| HVV3061 | HVV-B | Hydraulic Vent valve (1in) |
| HVV3063 | HVV-A | Hydraulic Vent valve (1in) |
| LPV1 | LP1 | SAM Valve |
| LPV2 | LP2 | SAM Valve |
| HVV3064 | HVV-G | Hydraulic Vent Valve (1in) |
| MGV3067 | MGV-1 | Manifold Gate Valve (Gas Lift Valves – Manually Operated) – 2 ¹ /16in |
| MGV3065 | MGV-2 | Manifold Gate Valve (Gas Lift Valves – Manually Operated) – 2 ¹ /16in |
| MGV3066 | MGV-3 | Manifold Gate Valve (Gas Lift Valves – Hydraulically Operated) – 2 ¹ /16in |

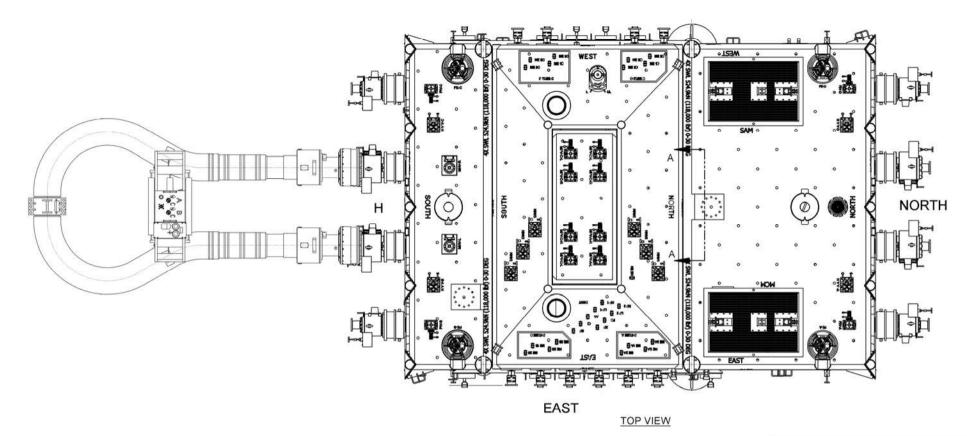
Production flowline branches are connected at the furthest most manifold by a retrievable pigging loop. During normal operation, Manifold Header Isolation Valves (MHV) isolate the branches from the pigging loop. MHVs are hydraulically actuated full-bore gate valves (piggable) and are normally closed on the last manifold and open on the others.

The pigging loop is provided with bends of 50in radius (5D) to ensure smooth flow for the round trip pigging operation of the dual flowlines from the FPSO. Pig detectors are located on both headers on the downstream side of the end loop MHVs. There are no valves or instrumentation within the pigging loop.

The following drawing illustrates a Production Manifold (w/o gas lift), with the pigging loop attached.

2.12 Subsea Production System – Valve List Typical Production Manifold (with Gas Lift)

WEST

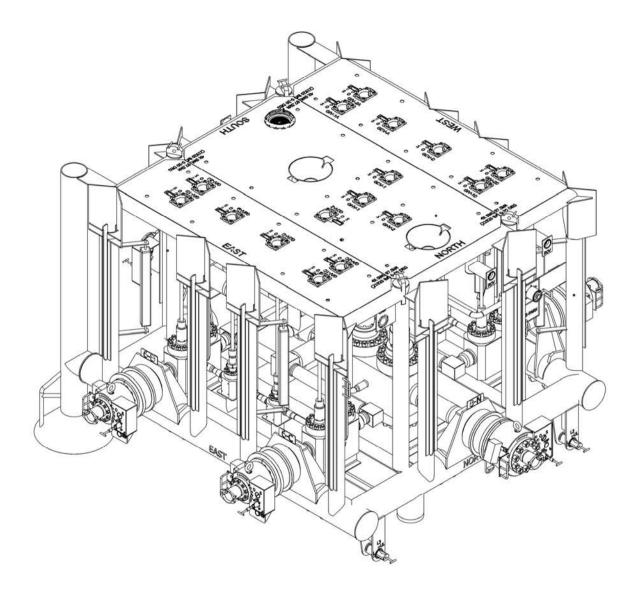


SAPETRO BR PETROBRAS TOTAL APO/C007/03 NG50-2-300-MAN-DW-SM-30-0093 CAMERON CAMERON Common Compared Common Commo NTS H MOLDER 7 MAR 06 ASSEMBLY, MPRODUCTION MANIFOLD, WOUT GAS LIFT, TOTAL, AKPO M. HERROLD 11 MAR 06 M. HERROLD 11 MAR 06 D SIZE 2248227-() 3 = 5 SK-127704 03 AKPO_55.02,13.pmg

The gas injection flowline has one manifold containing two tee assemblies, taken from a forged cross piece within the manifold. The two tee assemblies allow four gas injection wellslots to be tied in via separate tie-in hubs that make-up to the rigid jumper spools from each well. Each of the four tie-in branches includes two manual ROV operable Gas Inlet Valves (GIVs) for commissioning and methanol injection purposes. Unused tie-in hubs are provided with a pressure cap.

The following drawing illustrates a typical Gas Injection Manifold.

2.13 Subsea Production System – Assembly – Production Manifold (w/o Gas Lift) Pigging Loop





The following valve list is for a typical Gas Injection Manifold.

2.14 Subsea Production System – Assembly – Gas Injection Manifold

| M-G41 Gas Inje | ction Manifold | | |
|----------------|-------------------|---|-----------------|
| Tag No | Manifold Markings | Valve | Size |
| GIV 5651 | GIV-1A | Manifold Gas Injection Valve to 56-X-G41A | 51⁄₃in – 10Kpsi |
| GIV 5652 | GIV-1B | Manifold Gas Injection Valve to 56-X-G41A | 51⁄₃in – 10Kpsi |
| GIV 5661 | GIV-2A | Manifold Gas Injection Valve to 56-X-G41B | 51⁄₃in – 10Kpsi |
| GIV 5662 | GIV-2B | Manifold Gas Injection Valve to 56-X-G41B | 51⁄₃in – 10Kpsi |
| GIV 5671 | GIV-2C | Manifold Gas Injection Valve (Spare) | 51⁄₃in – 10Kpsi |
| GIV 5672 | GIV-1C | Manifold Gas Injection Valve (Spare) | 51⁄₃in – 10Kpsi |
| GIV 5681 | GIV-2D | Manifold Gas Injection Valve (Spare) | 51⁄₃in – 10Kpsi |
| GIV 5682 | GIV-1D | Manifold Gas Injection Valve (Spare) | 51⁄₃in – 10Kpsi |
| GHV 5691 | GHV-1 | Manifold Header Valve (Spare) | 8in – 10Kpsi |
| GHV 5692 | GHV-2 | Manifold Header Valve (Spare) | 51⁄₅in – 10Kpsi |
| GBV 5653 | GBV-A | Methanol Injection Valve, Slot A | |
| GBV 5663 | GBV-B | Methanol Injection Valve, Slot B | |
| GBV 5673 | GBV-C | Methanol Injection Valve, Slot C | |
| GBV 5683 | GBV-D | Methanol Injection Valve, Slot D | |
| GBV 5694 | GBV-2 | Methanol Injection Valve, Manifold Header | |
| GBV 5693 | GBV-1 | Manifold Service Line Isolation Valve | |

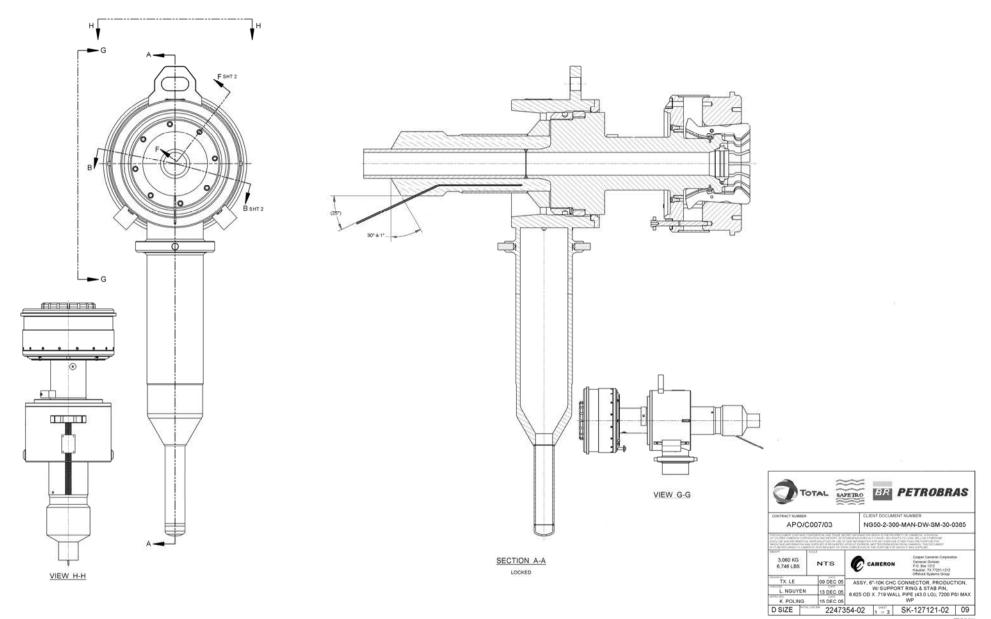
The Cameron Horizontal Connection (CHC) is made by hydraulically operated actuator yoke locks pivoting collet segments under tapered profile of hub, forming strong connection capable of handling high bending loads

The following drawing illustrates a 6in – 10k CHC connector (Production) with support ring and stab pin.

Refer to:

• NG50-2-300-MAN-DW-SM-30-0385

2.15 Subsea Production System Valve List Typical Gas Injection Manifold



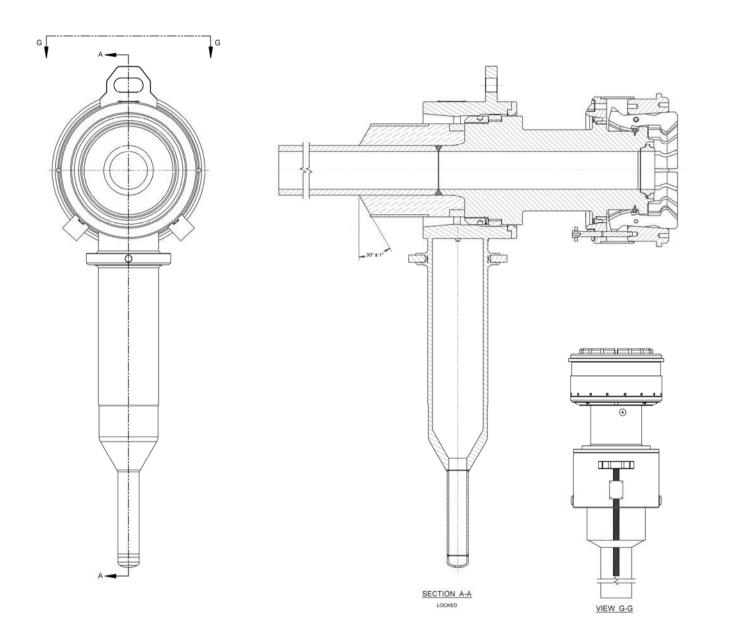
2.16 Subsea Production System 6in 10k CHC Connector (Production)

Drawing Supplementary Information

The following drawing illustrates a 10in – 10k CHC connector with support ring and stab pin.

Refer to:

• NG50-2-300-MAN-DW-SM-30-0267



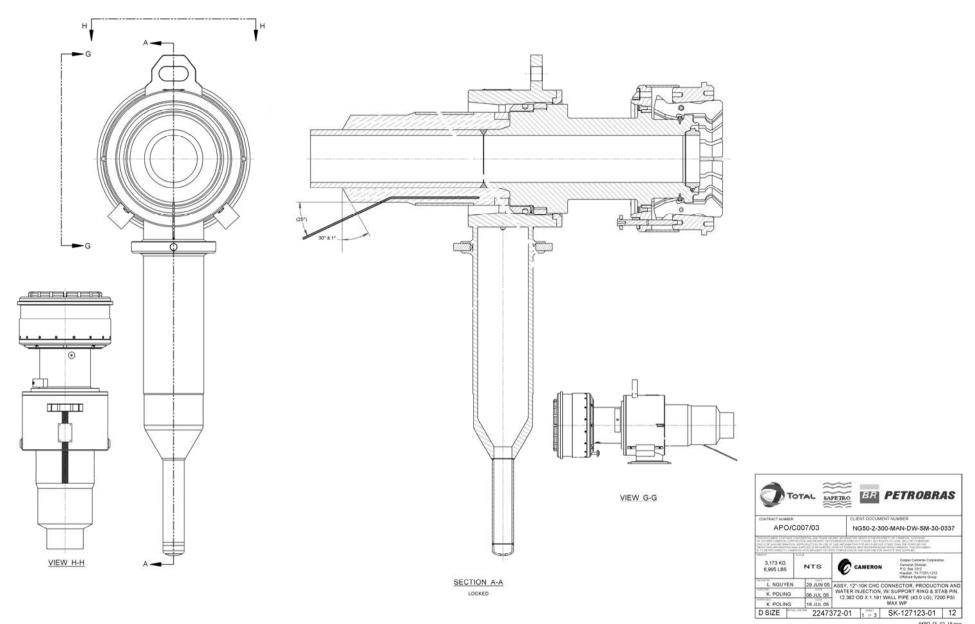


The following drawing illustrates a 12in – 10k CHC connector (Production and Water Injection) with support ring and stab pin.

Refer to:

• NG50-2-300-MAN-DW-SM-30-0337

2.17 Subsea Production System – 10in 10k CHC Connector



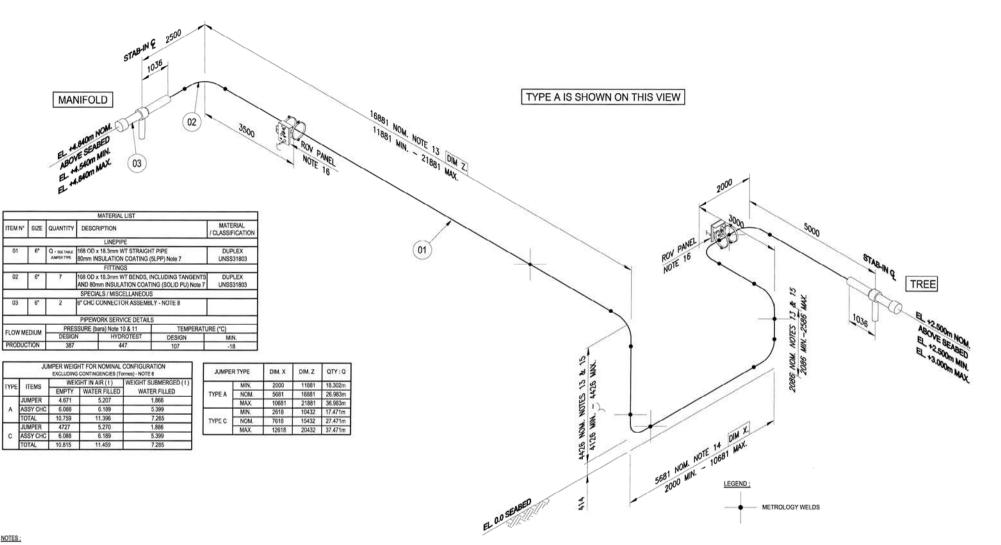
AKPO_SS_02_18.png

Well jumpers connect the tree to the manifold (upstream end connects to the tree). The jumper consists of a 6in OD rigid spool designed to be installed with remote collect-type connectors on either end to allow make-up to the tree and manifold.

There are no valves or instruments in these lines, which are insulated to minimise heat loss and to meet the cool down criteria from 56°C to 23°C in 9hrs. Separately installed dog houses are used to insulate the connectors.

The following drawing illustrates a Production Jumper configuration Type A&C.

2.18 Subsea Production System – 12in 10k CHC Connector (Production and WI)





1 - ALL DIMENSIONS ARE IN MILLIMETERS, U.N.O.

6 - WEIGHT IS BASED ON 5LPP COATING FOR STRAIGHTS AND SOLID PU COATING FOR BENDS.

7 - INSULATING COATING SHALL BE IN ACCORDANCE WITH SPECIFICATIONS LINE PIPE : NG50-3-200-ENG-SP-AB-30-2609. INDUCTION BENDS : NG50-3-200-ENG-SP-AB-30-2898. FIELD JOINT :NG50-3-200-ENG-SP-AB-30-2898.

10 - DESIGN PRESSURE IS AT MEAN SEA LEVEL (EL 0.00).

11 - HYDROTEST PRESSURE IS AT MEAN SEA LEVEL (EL 0.00).

16 - ROV PANEL INSTALLATION SHALL BE IN ACCORDANCE WITH DRAWING : NG50-3-200-ENG-DW-AB-00-2301 Sheet 2/5

17 - THE FOLLOWING JUMPER MARKINGS ARE REQUIRED AS PER SPECIFICATION : NG50-3-200-ENG-SP-AB-00-2959 - MARKINGS OF JUMPER OD PREFERABLY LOCATED IN THE MIDDLE OF JUMPER (ON TOP & SIDES). - ONE MARKING NEAR EACH CONNECTOR, ON TOP OF JUMPER, INDICATING MANIFOLD SIDE OR TREE SIDE RESPECTIVELY.

AKPO SS 02 19.png ment as privited may not be the latest version. Please refer to the electronic file in the MDR tool TOTAL UPSTREAM NIGERIA LIMITED 0 Salpern s.a. NIGERIA - OML 130 TOTAL **AKPO Field Development Project** UMBILICALS, FLOWLINES AND RISERS (UFR) RESERVED TO PRODUCTION JUMPER - TYPE A & C AKPO LOGO LONG CONFIGURATION - G.A. AND ISOMETRIC Revision Status Class Scale Folo COMPANY Doc. ref. NG50-3-200-ENG-DW-AB-30-2363 3 IFC 2 NTS 2/2 Electronic file name : NG50-3-200-ENG-DW-AB-30-2383-002 3

The various production, WI and GI drill centre spools connect to the appropriate flowlines through Inline Tee Assemblies (ITA) and Flow Line End Terminations (FLET)

The flowline ITA contain forged T blocks and FLETs welded directly into the flowline and laid with it. The number of potential spurs that can be taken from each string varies. The forged T blocks have the capability of serving one or two spurs and the end terminations can feed three spurs.

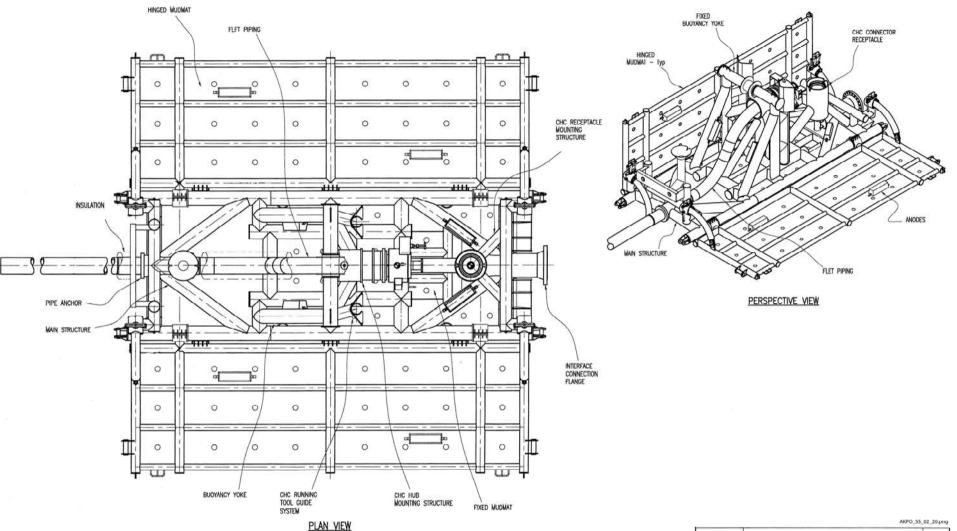
Each water injection well is tied in to the injection string via separate tie-in hubs and rigid jumper spools. There are four water injection flowlines and each has up to five tee assemblies. Each tie-in branch includes a manual ROV operable Water Inlet Valve (WIV) for commissioning purposes. Unused tie-in hubs will be provided with a pressure cap.

The FLET assemblies on each injection string are a tie-in hub suitable for connection of a future flowline, a pig receiver or potentially an additional well (as utilised by Water Injection Flowlines WI10 and WI50).

A manual ROV operable Water Hub Valve (WHV) is included in the flowspool, and the hub will be provided with a pressure cap.

The following drawings shows the general arrangement of the various production FLET and injection ITA in subsea operation.

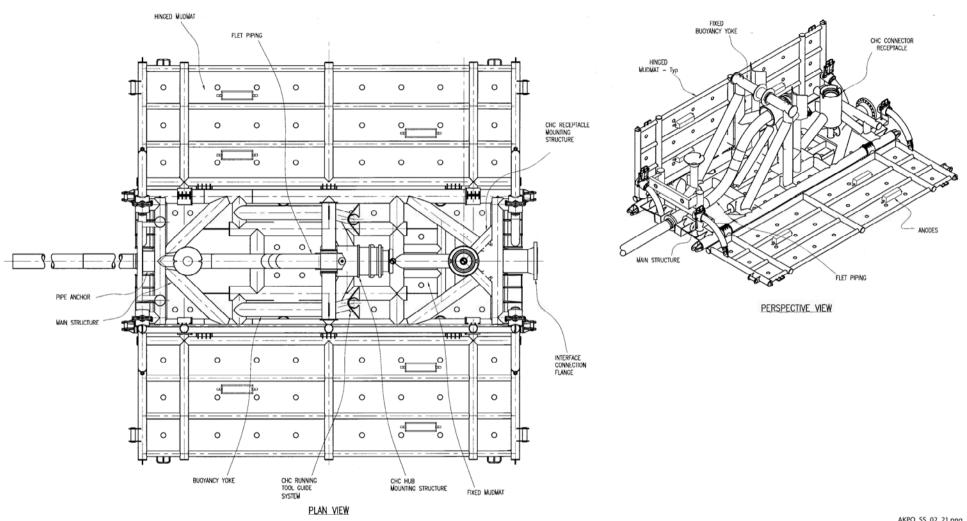
2.19 Subsea Production System Production Jumper – Type A & C Long Configuration – GA and Isometric



 Seipen s.a
 TOTAL UPSTRCAM NIGCRIA LIMITCD NIGERIA - OML 130
 Image: Constraint of the seigence of the

The following drawing shows the general arrangement of a water injection Flow Line End Termination (FLET) Type-FW1.

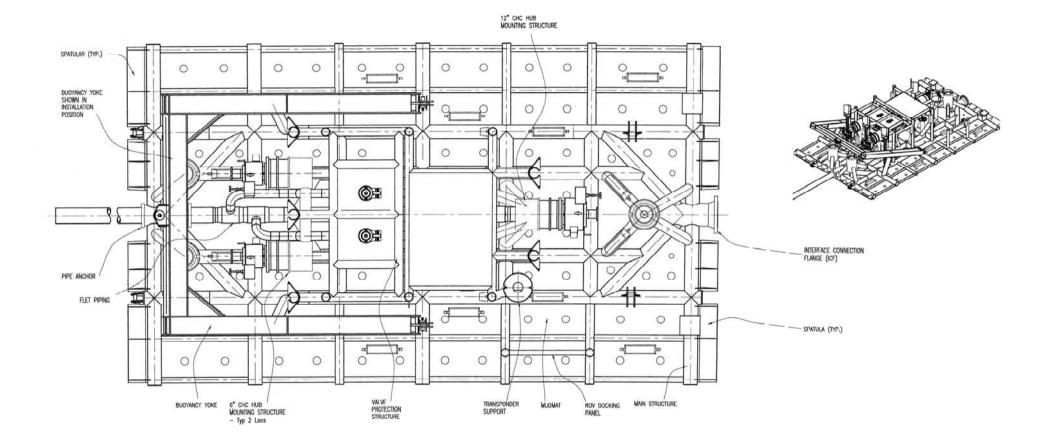
2.20 Subsea Production System – Production FLET Type FP1 General Arrangement



| | | | | AKE | O_SS_0 | 2_21.png | | | |
|--------------------------|--|---|----------------|------------------|----------------|----------|--|--|--|
| WARNING: Th | is document as printed may not be the latest v | ersion. Please | reler to the e | éctronic file in | the MDR tools' | | | | |
| | TOTAL UPSTRE | TOTAL UPSTREAM NIGERIA LIMITED | | | | | | | |
| Saipem s.a. | NIGERIA - OML 130 | | | | | | | | |
| | AKPO Field Development Project | | | | | | | | |
| RESERVED TO AKPO LOGO | | UMBILICALS, FLOWLINES AND RISERS (UFR) WATER INJECTION FLET TYPE FW1 | | | | | | | |
| | General Arrar | General Arrangement - sheet 1 of 2 | | | | | | | |
| | | Revision | Status | Class | Scale | Folio | | | |
| COMPANY Doc. ref. | NG50-3-200-ENG-DW-AB-56-2441 | 2 | IFC | 2 | 1/50 | 1/2 | | | |
| | | Electronic file name : NG50-3-200-ENG-DW-AB-66-2441-01 | | | | | | | |

The following drawing shows the general arrangement of a water injection Flow Line End Termination (FLET) Type-FW2.

2.21 Subsea Production System – Water Injection FLET Type FW1 General Arrangement



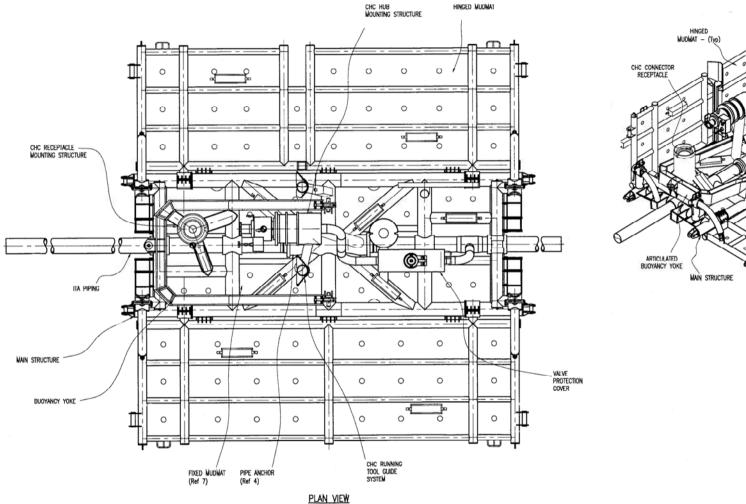
PLAN VIEW

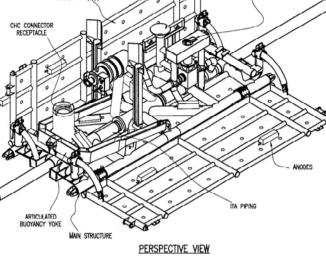


AKPO_SS_02_22.png

The following drawing shows the general arrangement of a water injection inline Tee Assembly (ITA) Type-TW1.

2.22 Subsea Production System – Water Injection FLET Type FW2 General Arrangement



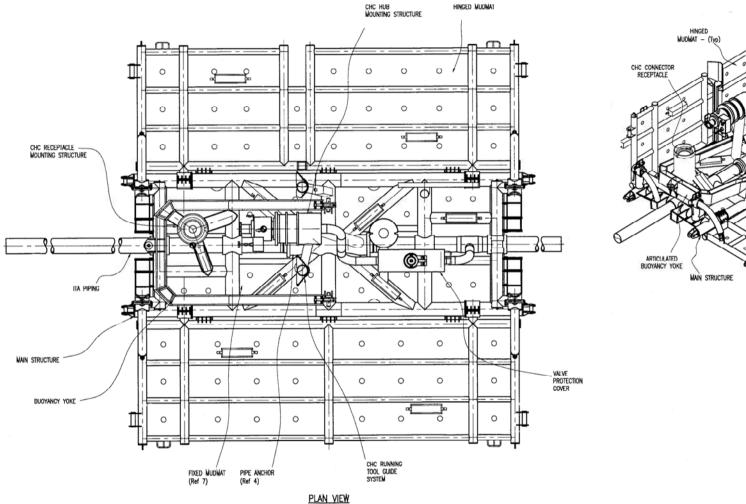


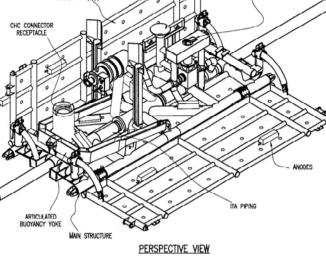
VALVE PROTECTION STRUCTURE

| Salpern s.a. | TOTAL UPSTREAM NIGERIA LIMITED NIGERIA - OML 130 AKPO Field Development Project | | | | | | | |
|--------------------------|--|---|--------|-------|-------|--------------|--|--|
| RESERVED TO AKPO LOGO | UMBILICALS, FLOWLINES AND RISERS (UFR) WATER INJECTION ITA TYPE TW1 General Arrangement - Sheet 1 of 2 | | | | | | | |
| | | Revision | Status | Class | Scale | Folio | | |
| COMPANY Doc. ref . | NG50-3-200-ENG-DW-AB-76-2471 | 2 | IFC | 2 | 1/50 | 1/2 | | |
| | | Electronic file name : NG50-3-200-ENG-DW- | | | | 2471-01_2.PI | | |

The following drawing shows the general arrangement of a water injection loop inline Tee Assembly (ITA) Type-TW2.

2.23 Subsea Production System Water Injection ITA Type TW1 General Arrangement



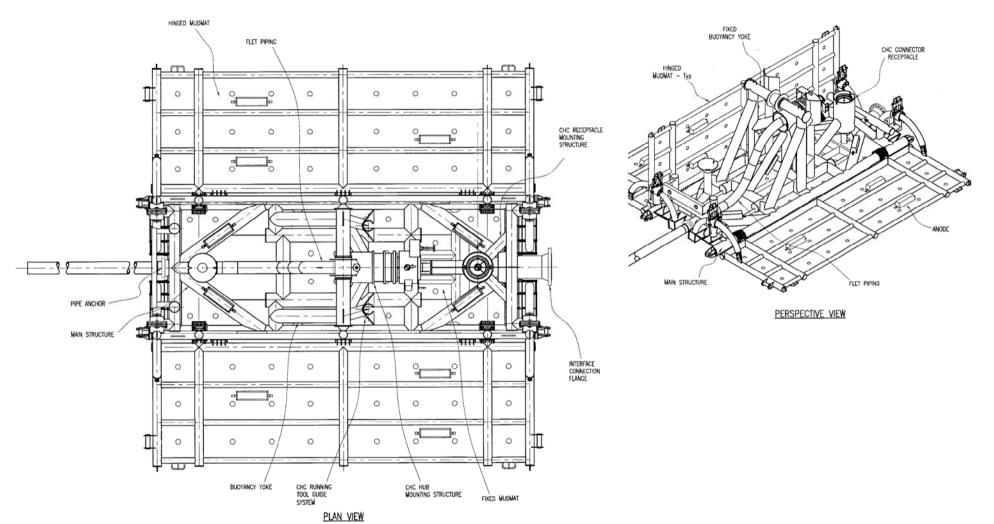


VALVE PROTECTION STRUCTURE

| Salpern s.a. | TOTAL UPSTREAM NIGERIA LIMITED NIGERIA - OML 130 AKPO Field Development Project | | | | | | | |
|--------------------------|--|---|--------|-------|-------|--------------|--|--|
| RESERVED TO AKPO LOGO | UMBILICALS, FLOWLINES AND RISERS (UFR) WATER INJECTION ITA TYPE TW1 General Arrangement - Sheet 1 of 2 | | | | | | | |
| | | Revision | Status | Class | Scale | Folio | | |
| COMPANY Doc. ref . | NG50-3-200-ENG-DW-AB-76-2471 | 2 | IFC | 2 | 1/50 | 1/2 | | |
| | | Electronic file name : NG50-3-200-ENG-DW- | | | | 2471-01_2.PI | | |

The following drawing shows the general arrangement of a gas injection Flow Line End Termination (FLET) Type-FG1.

2.24 Subsea Production System – Water Injection ITA Type TW2 General Arrangement



AKPO_SS_02_25.png

| Saipem s.a. | TOTAL UPSTREAM NIGERIA LIMITED NIGERIA - OML 130 | | | | | | | |
|--------------------------|---|------------|-------------|--------------|-------------|---------------|--|--|
| | AKPO Field Development Project | | | | | | | |
| RESERVED TO AKPO LOGO | UMBILICALS, FLOWLINES AND RISERS (UFR) GAS INJECTION FLET TYPE FG1 General Arrangement - sheet 1 of 2 | | | | | | | |
| | | Revision | Status | Class | Scale | Folio | | |
| COMPANY Doc. ref . N | G50-3-200-ENG-DW-AB-30-2491 | 2 | IFC | 2 | 1/50 | 1/2 | | |
| | | Electronic | file name : | NG50-3-200-E | NG-DW-AB-30 | -2491-01_2.PD | | |

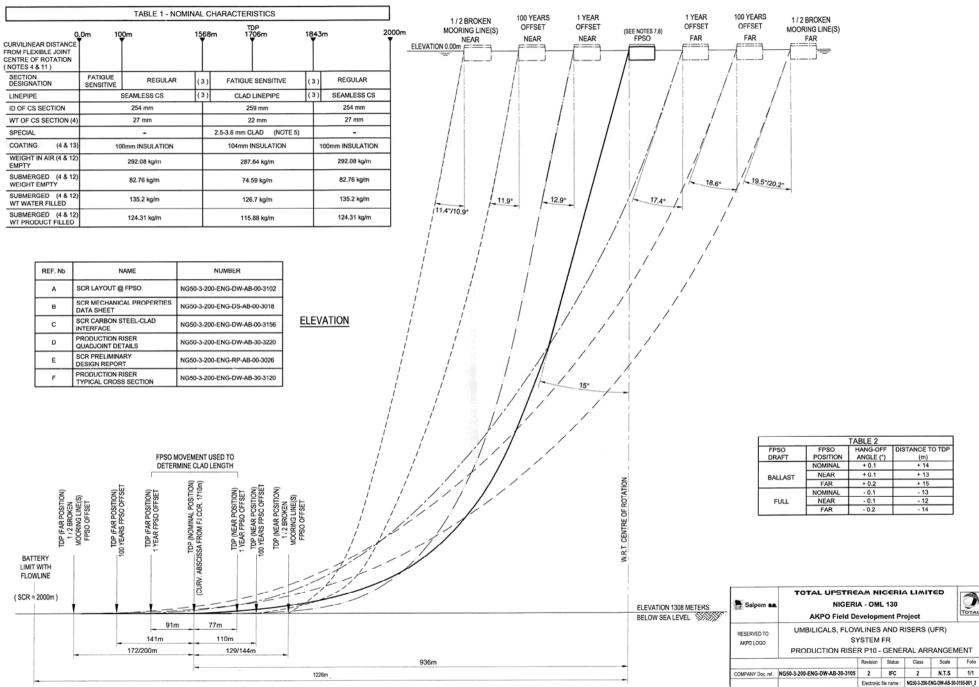
2.25 Subsea Production System – Gas Injection FLET Type FG1 General Arrangement

Drawing Supplementary Information

Flowlines are mainly up sloping from the far end manifold to the riser touch down point to avoid large slugs from pockets of liquid. At the riser base, the flowline connects to a steel riser, which extends between the FPSO and Steel Catenary Riser (SCR) base touch down point fixed on the sea bed.

The SCR is provided with a high pressure core protected by a wire braid armoured cover and finally a protective sheath to prevent damage by scuffing. As the riser approaches the FPSO vertically, a flexible joint is provided to allow FPSO movement without inducing inducing high stress and fatigue on the riser. The riser terminates at the riser base where it connects the carbon steel flowline to the associated drill centre via a riser base touch down point fixed on the sea bed.

The following drawing shows the general arrangement of a typical Production Riser (P10).



AKPO_SS_02_26.png

2.26 Subsea Production System – System FR Production Riser P10 – General Arrangement

Drawing Supplementary Information

FlexJoints are designed for Catenary Risers used to transport high pressure gas or multi-phase fluids where large internal pressure fluctuations are expected. The FlexJoint bellows shields the elastomeric flex element from the gaseous environment and prevents explosive decompression damage to the flex element's rubber surface.

The bellows is a self-equilibrating pressure-balanced system in which the bellows extends or compresses to compensate for changes in the internal pressure and cocking angle. The cavity between the body/flex element and the bellows is sealed and filled with Compenol a water-propylene glycol based corrosion inhibiting fluid.

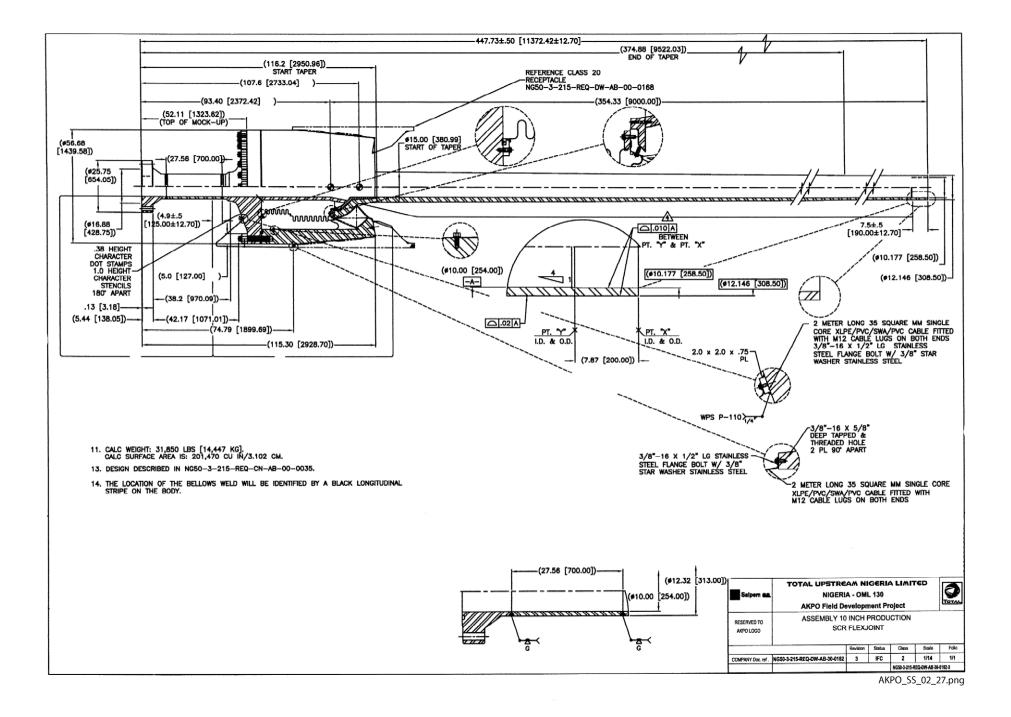
The assembly drawing illustrates a typical 10in Production SCR FlexJoint in cross section.

10in Production FlexJoints are:

- 30-LE-P11
- 30-LE-P12
- 30-LE-P21
- 30-LE-P22
- 30-LE-P31
- 30-LE-P32
- 30-LE-P41
- 30-LE-P42

Refer to:

 NG50-3-200-ENG-PR-AB-00-9308 – Production, Water and Gas Injection Risers Recovery and Standard Pipelaying Procedure



2.27 Subsea Production System – SCR 10in Production FlexJoint Cross Section

Drawing Supplementary Information

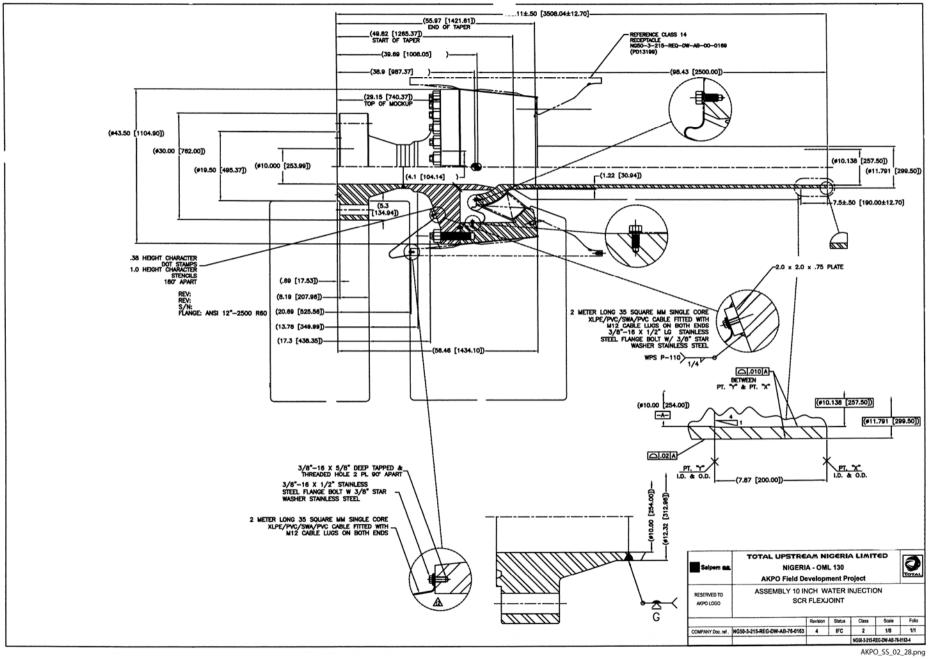
The assembly drawing illustrates a typical 10in Water Injection SCR FlexJoint in cross section.

10in WI FlexJoints are:

- 76-LE-W11
- 76-LE-W21
- 76-LE-W31
- 76-LE-W51

Refer to:

 NG50-3-200-ENG-PR-AB-00-9308 – Production, Water and Gas Injection Risers Recovery and Standard Pipelaying Procedure



2.28 Subsea Production System – SCR 10in Water Injection FlexJoint Cross Section

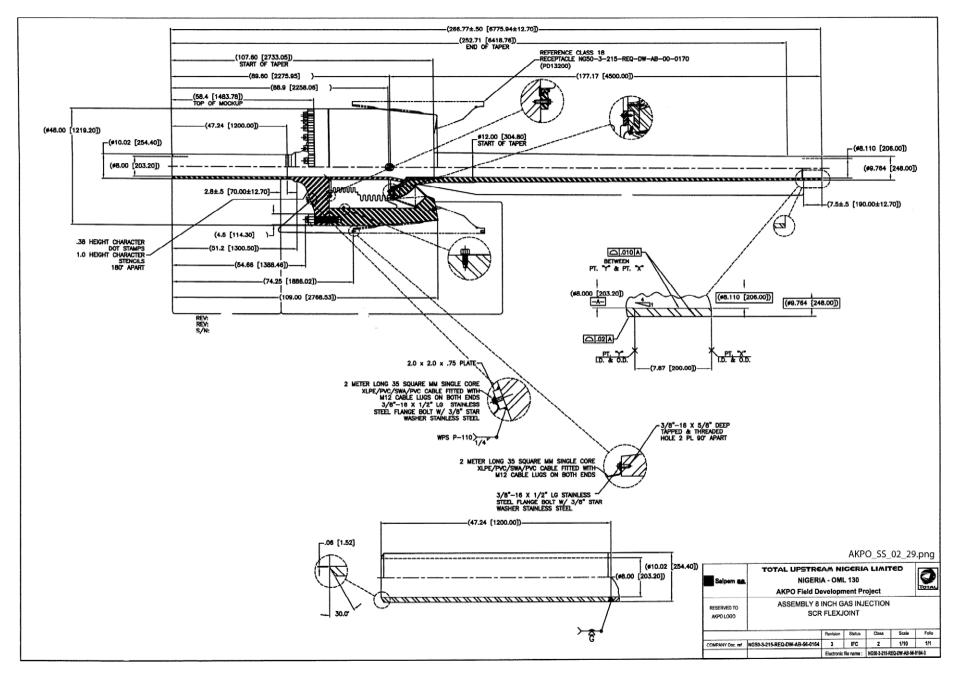
Drawing Supplementary Information

The assembly drawing illustrates a typical 8in Gas Injection SCR FlexJoint in cross section.

- 8in GI FlexJoint
- 56-LE-G41

Refer to:

 NG50-3-200-ENG-PR-AB-00-9308 – Production, Water and Gas Injection Risers Recovery and Standard Pipelaying Procedure



[4] A. R. Karakara, "A strain of the stra

2.29 Subsea Production System – SCR 8in Gas Injection FlexJoint Cross Section

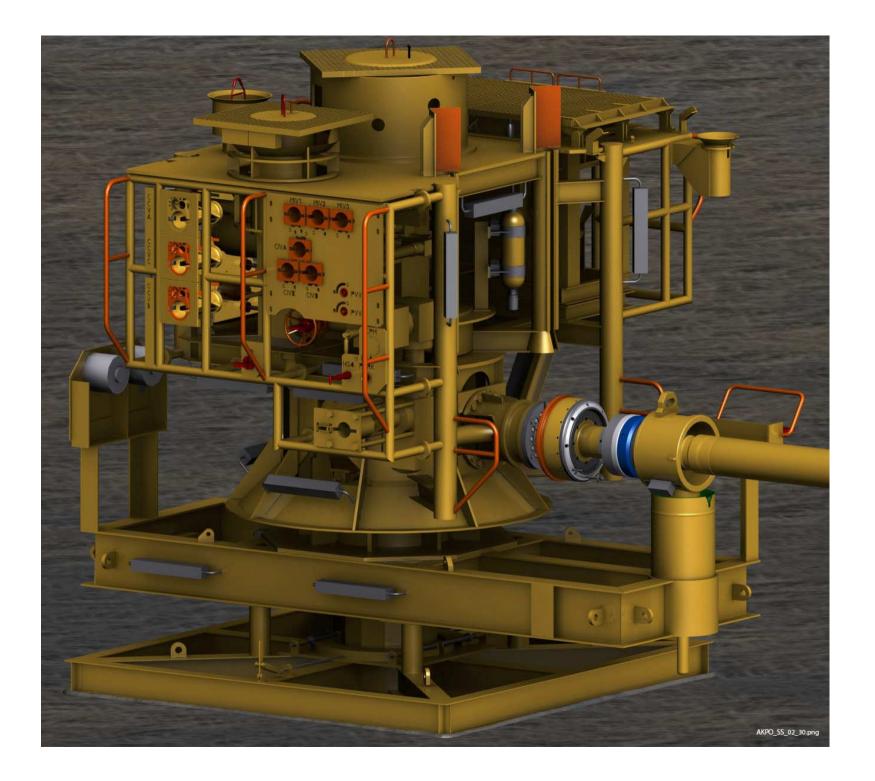
Drawing Supplementary Information

The following illustrations in 3D view, show three main components of the Subsea Production System.

- Typical Production Tree (XT)
- Typical Production Manifold
- Typical Subsea Umbilical Termination (SUT)

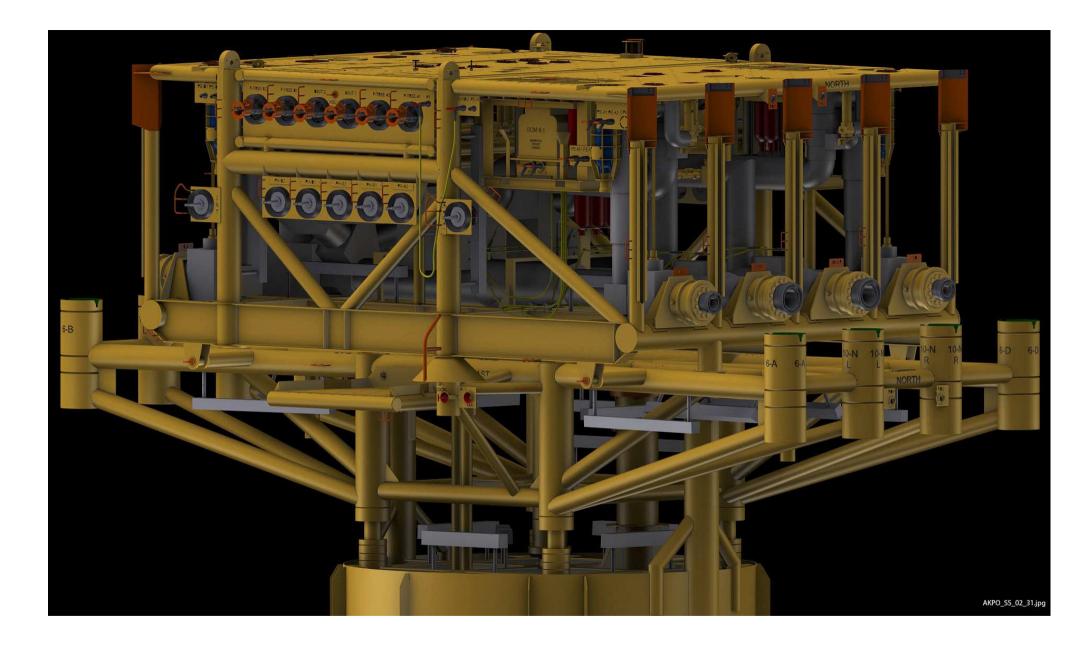
The following 3D drawing is of a typical Production Tree (XT).

The XT is shown located on the TGB. The CHC connection is shown without the Insulation Doghouse



The following 3D drawing is of a typical Production Manifold.

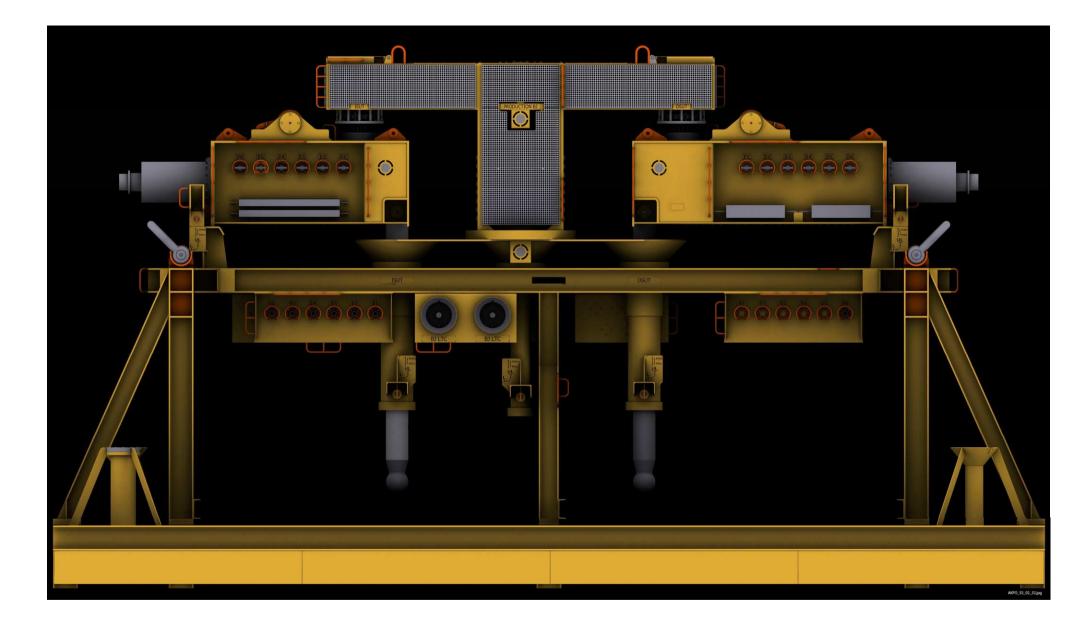
2.30 Subsea Production System – 3D View of Production Tree (XT)



The following 3D drawing is of a typical Subsea Umbilical Termination (SUT) with the ISUT the DSUT and Bridge Jumper in situ.

The HFL parking places can also be clearly seen on the foundation base.

2.31 Subsea Production System – 3D View of Production Manifold



2.32 Subsea Production System – 3D View of SUT (DSUT, ISUT) and Bridge Jumper

AKPO Subsea Reference Manual Section 3 Production Control/ Distribution System

CONTENTS

- 3.1 Production Control/Distribution System Scope of Supply
- 3.2 Production Control/Distribution System Subsea Control System – Schematic
- 3.3 Production Control/Distribution System Hydraulic Power Unit (HPU) – Tables
- 3.4 Production Control/Distribution System Single Line Diagram: Topside Subsea Control Unit
- 3.5 Production Control/Distribution System Subsea Power and Communications Unit (SPCU) SEM/SOM Correspondence – Tables
- 3.6 Production Control/Distribution System Assembly Drawing: Subsea Control Module (SCM) Production Tree
- 3.7 Production Control/Distribution System Assembly Drawing: Subsea Control Module (SCM) Water Injection Tree
- 3.8 Production Control/Distribution System Assembly Drawing: Subsea Control Module (SCM) Gas Injection Tree
- 3.9 Production Control/Distribution System Assembly Drawing: Subsea Control Module (SCM) Production Manifold
- 3.10 Production Control/Distribution System Assembly Drawing: Subsea Accumulator Module (SAM)
- 3.11 Production Control/Distribution System Production/Gas Injection Tree Choke Insert
- 3.12 Production Control/Distribution System Water Injection Tree Choke Insert
- 3.13 Production Control/Distribution System Multi Phase Flow Meter (MPFM)

CONTENTS (cont'd)

- 3.14 Production Control/Distribution System Chemical Injection Throttle Valves
- 3.15 Production Control/Distribution System Assembly Drawing: Sand Detector
- 3.16 Production Control/Distribution System Hydraulic Distribution Unit (HDU)
- 3.17 Production Control/Distribution System Valve List for HDU
- 3.18 Production Control/Distribution System Hydraulic Flying Leads (HFL)
- 3.19 Production Control/Distribution System Electrical Flying Leads (EFL)
- 3.20 Production Control/Distribution System Distribution Subsea Umbilical Terminations (DSUT)
- 3.21 Production Control/Distribution System Intermediate Subsea Umbilical Terminations (ISUT)
- 3.22 Production Control/Distribution System Relay Subsea Umbilical Terminations (RSUT)
- 3.23 Production Control/Distribution System Short Umbilicals (WI)
- 3.24 Production Control/Distribution System Assembly Drawing: Bridge Jumper Production
- 3.25 Production Control/Distribution System Flow Diagram: Topside Umbilical Termination (TUT) Production
- 3.26 Production Control/Distribution System Flow Diagram: Topside Umbilical Termination (TUT) Water Injection

CONTENTS (cont'd)

- 3.27 Production Control/Distribution System Flow Diagram: Topside Umbilical Termination (TUT) Gas Injection
- 3.28 Production Control/Distribution System Subsea Electrical Distribution System – Line Drawings
- 3.29 Production Control/Distribution System Table of Hydraulic Actuators – Volumes

The Subsea Control System is currently designed and configured to handle all 44 subsea wells (22 oil producers, 20 water injectors and 2 gas injectors) and 9 manifolds (for First Oil, Phase 1 and Phase 2 of this project) and is expandable in the future to handle additional wells. The subsea control facility consists of the following:

- Subsea Hydraulic Power Unit (HPU)
- Topsides Umbilical Termination (TUT) Unit
- Subsea Control Unit (SCU)
- Subsea Power and Communications Unit (SPCU)
- Subsea Control Modules (SCM)

The Akpo Subsea Control System can be split into two main groups of equipment – surface equipment and subsea equipment.

The Scope of Supply document provides illustrations of the equipment associated with the subsea control facilities.

Refer to:

 NG50-2-300-SCS-DW-SC-64-0480 – Scope of Supply – Subsea Production Control System Refer to: NG50-2-300-SCS-DW-SC-64-0480 Scope of Supply – Subsea Production Control System

The Subsea Control Unit (SCU) is capable of providing substantial diagnostics of the Subsea Control System in addition to its basic control and monitoring features. A dual redundant link is provided between the SCU and the ICSS. The FPSO Emergency Shutdown System (ESD) directly interfaces with the SCU to provide an ESD capability for the Subsea Control System. Dedicated operator workstations are provided to facilitate local control.

The SCU performs the following functions:

- Gather and validate sensor readings every 2s maximum, convert to engineering units, monitor for alarm limits and display and trend process variables
- Validate and execute operator commands from ICSS
- Control and execute sequences as requested by the ICSS
- Monitor MPFMs and allow transparent configuration access from an Engineering Workstation
- Monitor and validate housekeeping data from Subsea Control Modules and topside plc units to ensure a proper performance and to warn of failure
- Store subsea housekeeping data for a minimum of 6 months at a rate driven by events occurring in the system
- Perform sequenced shutdowns of the SCS, initiated by triggers from the ESD System or by data processed from the ICSS using sequences dictated by the project Shutdown Logic Diagrams
- Include maintenance tools for the SCS

The System Schematic document provides the operating control links for the subsea control facilities. Refer to:

 NG50-2-300-SCS-DW-SC-64-0048 – System Schematic – Subsea Production Control System

3.1 Production Control/Distribution System – Scope of Supply Refer to: NG50-2-300-SCS-DW-SC-64-0048 System Schematic – Subsea Production Control System

3.2 Production Control/Distribution System – Subsea Control System – Schematic

Drawing Supplementary Information

The Subsea Hydraulic Power Unit (HPU) provides a stable and clean supply of pressurised hydraulic control fluid to the hydraulic distribution headers. The hydraulic control fluid for the Subsea Control System is Castrol Transaqua HT, which is a glycol/water-based, fluorescent yellow coloured, low-viscosity liquid.

Main equipment of the Subsea HPU consists of:

- Supply Reservoir 2-TA-64101
- Return Reservoir 2-TA-64102
- Circulation Hydraulic Pump 2-GA-64101
- HP1 Hydraulic Pump GA-64103 and associated HP Accumulators 2-DA-64101/3
- HP2 Hydraulic Pump GA-64104 and associated HP Accumulators 2-DA-64102/4
- LP1 Hydraulic Pump GA-64105 and associated LP Accumulators 2-DA-64105/7/9
- LP2 Hydraulic Pump GA-64106 and associated LP Accumulators 2-DA-64106/8

Refer to:

- NG50-2-300-SCS-PI-SC-30-0649 HPU Subsea Control System
- NG50-2-300-SCS-SP-ST-64-0076 FDS, HPU Total Akpo
- NG50-2-300-SCS-TR-SC-64-0058 Subsea Hysraulic Response Analysis
- NG50-4-400-MEC-PO-GA-00-0001 (Vendor Doc) Hydraulic Pumps and HPU PKG

The following table provides the operating parameters for the HPU system.

| System | Nominal Working Pressure (WP) | Design Pressure (=PSV Set Pressure) | Test Pressure |
|---------------|----------------------------------|--|---------------|
| LP Hydraulics | 310barg | 345barg | 517barg |
| HP Hydraulics | 627barg | 690barg | 1035barg |

| TA 64101 Supply Reservoir | | |
|------------------------------|------------------------|---------------------------|
| Capacity | 4700 litres | |
| TA 64102 Return Reservoir | | |
| Capacity | 4700 litres | |
| 2-GA-64101 Circulation Tra | nsfer Pump | |
| Flowrate | 80 L/Min | |
| Inlet Filter | 150 micron | |
| FL 64101 Discharge Filter | 3 micron | |
| Discharge Pressure | Duty 570 to 627barg | Standby 560 to 627barg |
| 2-GA-64103/4 HP Pumps | | |
| Flowrate | 4.5 L/Min | |
| Inlet Filter | 150 micron | |
| Discharge Pressure | Duty 570 to 627barg | Standby 560 to 627barg |
| PRV 64121/2 Set Point | 690barg | |
| 2-GA-64105/6 LP Pumps | | |
| Flowrate | 16 L/Min | |
| Inlet Filter | 150 micron | |
| Discharge Pressure | Duty 280 to 310barg | Standby 270 to 310barg |
| PRV 64131/2 Set Point | 345barg | |

| HP Accumulators | | |
|-------------------------------------|-------------------------------------|---------|
| DA 64101/3 (HP1) Capacity | 37 litres each (74 litres Total) | 690barg |
| DA 64102/4 (HP2) Capacity | 37 litres each (74 litres Total) | 690barg |
| TSV 64121/3 Set Point (HP1) | 690barg | 690barg |
| TSV 64122/4 20 litres each (HP2) | 690barg | |
| FL 64103/4 | 3 micron | |
| LP Accumulators | | |
| DA 64105/A/B (LP1) Capacity | 50 litres each | 345barg |
| DA 64107/A/B (LP1) Capacity | 50 litres each | 345barg |
| DA 64109/A/B (LP1) Capacity | 50 litres each | 345barg |
| | (450 litres Total) | |
| DA 64106/A/B (LP2) Capacity | 50 litres each | 345barg |
| DA 64108/A/B (LP2) Capacity | 50 litres each | 345barg |
| | (300 litres Total) | |
| TSV 64132/4 Set Point (LP2) | 345barg | |
| TSV 64131/3/5 Set Point (LP1) | 345barg | |
| FL 64105/6 | 3 micron | |
| LP Distribution Headers (LP1 and | i LP2) | |
| PRV 64181-196 Set Point | 345barg | |
| Subsea Accumulator Module (SA | M) | |
| 6 Accumulators on each SAM | 20 litres each | |
| Subsea Control Module (SCM) | | |
| 3 LP Accumulators on each SCM | 20 litres each | |
| 1 HP Accumulator on each SCM | 2.5 litres each | |

3.3 Production Control/Distribution System – Hydraulic Power Unit (HPU) – Tables

Drawing Supplementary Information

The topside Subsea Control Unit (SCU) utilizes communications on power to monitor, control, and shutdown the production wells and manifolds via the multiplexed electro-hydraulic SCMs.

The main components of the topside SCU are segregated into three main sections as follows:

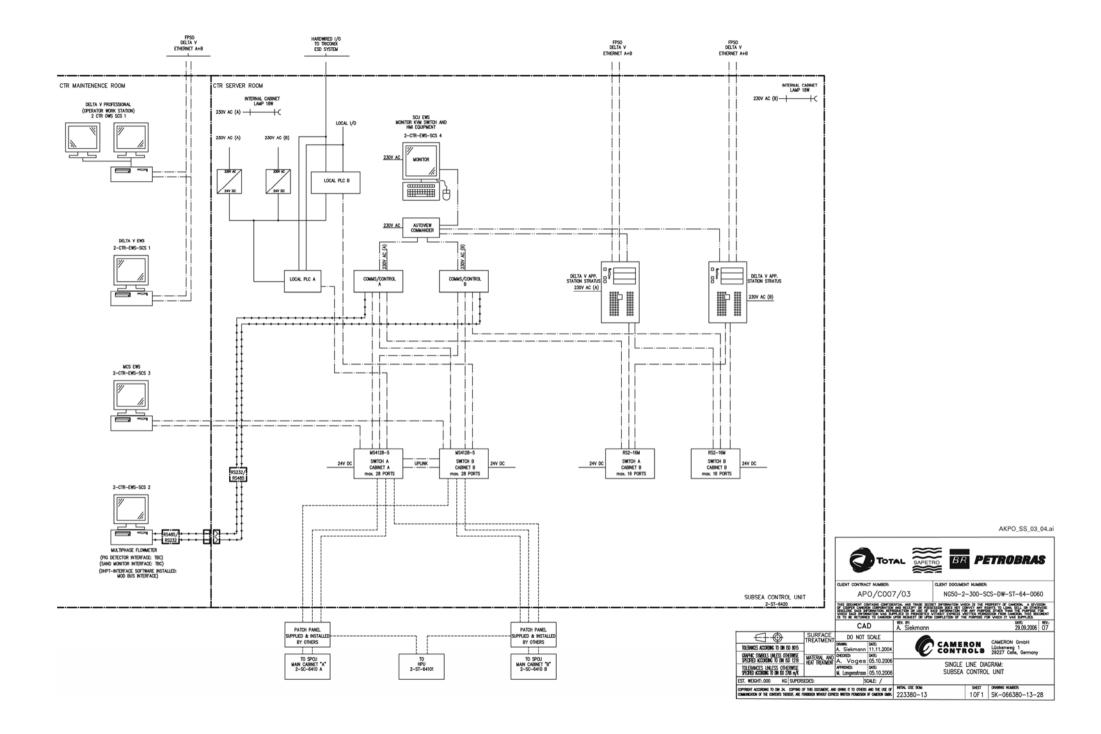
MCS Communications Layer: The Master Control Station (MCS) Communications layer consists of a pair of servers, each capable of containing and updating all of the data items used within the system, and each capable of monitoring and maintaining the data in the database of the other. Each MCS server is connected to topside modems housed in the SPCU.

Delta V Stratus Layer: The Delta V Stratus Layer consists of a pair of servers, each capable of containing and updating only those data items used by the operator to execute process control functions. The Delta V Stratus Layer is integrated into the topsides ICSS and is the normal medium for controlling subsea.

Configuration and Operation Stations: Remote Delta V Stratus Layer Engineering Workstation (EWS) located in the Central Technical Room. Remote Delta V Stratus Layer Operator Workstation (OWS) located in the Central Control Room. Administration of Delta V Application Station can be performed from existing HMI cabinet via KVM switch. A remote MPFM Engineering Workstation is located in the Central Technical Room. An MCS EWS is located in the CTR.

Electrical supplies are derived from regulated dual platform supplies via the Uninterruptible Power Supply (UPS). Wherever practical, components are designed to be modular to facilitate replacement on site.

A single line diagram of the topside control system is shown opposite.



3.4 Production Control/Distribution System – Single Line Diagram: Topside Subsea Control Unit

Drawing Supplementary Information

The Subsea Power and Communications Unit (SPCU) supplies electrical power and signals to the subsea equipment. The SPCU has two Channels, 'A' and 'B'. Each channel comprises six subsea cabinets and one main cabinet. Each subsea cabinet contains seven Subsea Output Modules (SOMs), seven modems, seven diplexers and one Master PLC to communicate with the Main Cabinet PLC. The Main Cabinets contain all devices for subsea cabinet power supply and communication to the PLC for communication between SPCU and SCU.

The SPCU also houses the Subsea Output Module (SOM), sized to power a minimum of three SCMs from a single channel, with an adjustable output voltage. The transformer is coupled via the composite service umbilical to power the isolating transformers installed within the subsea electronics modules.

The SPCU contains the following main components:

- **Main Cabinet:** Contains all devices for subsea cabinet power supply and communication to the PLC for communication between SPCU and SCU. Currently, each Main Cabinet (A and B)is coupled to 6 Subsea Cabinets
- **Subsea Cabinet:** Contains seven Subsea Output Modules (SOMs), seven modems, seven diplexers and one Master PLC to communicate with the Main Cabinet PLC
- Subsea Output Module (SOM): Each Subsea Output Module is sized to power a minimum of three SCMs from a single channel, with an adjustable output voltage. Each SOM transforms the UPS 230VAC power supply to 650-690VAC to pass through the umbilical. At the SCM (in the SEMs), the voltage is transformed to 24VDC. Each SOM is connected to a surface diplexer, which is connected to a Surface modem to allow communication over the power line (Comms on Power)

The following table: Subsea Output Modules identifies the SEM/SOM correspondence for the Production Loops P10, P20, P30 and P40.

Refer to:

• NG50-2-300-SCS-PR-SC-64-0879 - EFL Deployment Procedure

| | | | | | 30 |)-DS-P | 11 | | | 30 |)-DS-P | 13 | - | | | | | |
|------------------------|--------------------|------------|-----|------------|------------|------------|------------|----------|------------|------------|------------|------------|----------|---|--|---|--|--|
| | duction op P 10 | | | 30-X-P11-A | 30-X-P11-B | 30-X-P11-C | 30-X-P11-D | 30-M-P11 | 30-X-P12-A | 30-X-P12-B | 30-X-P12-C | 30-X-P12-D | 30-M-P12 | | | | | |
| 2 SC 6420 A SOM 3011 A | ND-30101 | | Q1 | | | | | | | Α | | Α | | | | | | |
| 2 SC 6420 B SOM 3011 B | ND-30101 | | QI | В | | | В | | | | | | | | | | | |
| 2 SC 6430 A SOM 3012 A | ND-30102 | | Q2 | | | | Α | | | | | | | | | | | |
| 2 SC 6430 B SOM 3012 B | ND-30102 | | QZ | | В | В | | | | | | | | | | | | |
| 2 SC 6440 A SOM 3013 A | ND-30103 | | Q3 | Α | | Α | | | | | | | | | | | | |
| 2 SC 6440 B SOM 3013 B | ND-30103 | 30-UD-P11 | 00 | | | | | | | В | | | В | | | | | |
| 2 SC 6450 A SOM 3014 A | ND-30104 | 30-0D-F 11 | Q4 | | | | | | | | | | Α | | | | | |
| 2 SC 6450 B SOM 3014 B | ND-30104 | | 04 | | | | | | | | В | | | | | | | |
| 2 SC 6460 A SOM 3015 A | ND-30105 | | 5 (| 5 | | | | Q5 | | | | | | Α | | Α | | |
| 2 SC 6460 B SOM 3015 B | ND-30103 | | | | | 00 | | | | | В | | | | | | | |
| 2 SC 6470 A SOM 3016 A | ND-30106 | | Q6 | | Α | | | Α | | | | | | | | | | |
| 2 SC 6470 B SOM 3016 B | ND-30100 | | QO | | | | | | В | | | В | | | | | | |

| | | | | | 30 |)-DS-P | 21 | | | 30 |)-DS-P | 23 | | | | | |
|------------------------|-------------------|-----------|-----|------------|------------|------------|------------|----------|-----------|------------|------------|------------|----------|--|--|--|--|
| | luction p P 20 | | | 30-X-P21-/ | 30-X-P21-E | 30-X-P21-0 | 30-X-P21-E | 30-M-P21 | 30-X-P22- | 30-X-P22-E | 30-X-P22-0 | 30-X-P22-I | 30-M-P22 | | | | |
| 2 SC 6420 A SOM 3021 A | ND-30201 | | Q1 | | | | | | | Α | | Α | | | | | |
| 2 SC 6420 B SOM 3021 B | ND-30201 | | Q I | В | | | В | | | | | | | | | | |
| 2 SC 6430 A SOM 3022 A | ND-30202 | | Q2 | | | | Α | | | | | | | | | | |
| 2 SC 6430 B SOM 3022 B | ND-30202 | | QZ | | В | В | | | | | | | | | | | |
| 2 SC 6440 A SOM 3023 A | ND-30203 | | Q3 | Α | | Α | | | | | | | | | | | |
| 2 SC 6440 B SOM 3023 B | ND-30203 | 30-UD-P21 | QS | | | | | | | В | | | В | | | | |
| 2 SC 6450 A SOM 3024 A | ND-30204 | 30-0D-P21 | Q4 | | | | | | | | | | Α | | | | |
| 2 SC 6450 B SOM 3024 B | ND-30204 | | Q4 | | | | | | | | В | | | | | | |
| 2 SC 6460 A SOM 3025 A | ND-30205 | | Q5 | | | | | | Α | | Α | | | | | | |
| 2 SC 6460 B SOM 3025 B | ND-30205 | i | j l | i | | (| QD | | | | | В | | | | | |
| 2 SC 6470 A SOM 3026 A | ND-30206 | | Q6 | | Α | | | Α | | | | | | | | | |
| 2 SC 6470 B SOM 3026 B | ND-30200 | | 20 | | | | | | В | | | В | | | | | |

| | | | | | | 30 |)-DS-P | 31 | | | 30 |)-DS-P | | |
|-------------|------------|-------------------|-----------|-----|------------|------------|------------|------------|----------|------------|------------|------------|------------|----------|
| | | luction p P 30 | | | 30-X-P31-/ | 30-X-P31-E | 30-X-P31-0 | 30-X-P31-E | 30-M-P31 | 30-X-P32-/ | 30-X-P32-E | 30-X-P32-0 | 30-X-P32-E | 30-M-P32 |
| 2 SC 6420 A | SOM 3031 A | ND-30301 | | Q1 | | | | | | | Α | | Α | |
| 2 SC 6420 B | SOM 3031 B | ND-30301 | | QI | В | | | В | | | | | | |
| 2 SC 6430 A | SOM 3032 A | ND-30302 | | Q2 | | | | A | | | | | | |
| 2 SC 6430 B | SOM 3032 B | ND-30302 | | QZ | | В | В | | | | | | | |
| 2 SC 6440 A | SOM 3033 A | ND-30303 | | Q3 | Α | | A | | | | | | | |
| 2 SC 6440 B | SOM 3033 B | ND-30303 | 30-UD-P31 | 0,5 | | | | | | | В | | | В |
| 2 SC 6450 A | SOM 3034 A | ND-30304 | 30-0D-P31 | Q4 | | | | | | | | | | A |
| 2 SC 6450 B | SOM 3034 B | ND-30304 | | Q4 | | | | | | | | В | | |
| 2 SC 6460 A | SOM 3035 A | ND-30305 | | Q5 | | | | | | Α | | Α | | |
| 2 SC 6460 B | SOM 3035 B | ND-30303 | | 00 | | | | | В | | | | | |
| 2 SC 6470 A | SOM 3036 A | ND-30306 | | Q6 | | Α | | | Α | | | | | |
| 2 SC 6470 B | SOM 3036 B | ND-30300 | | 20 | | | | | | В | | | В | |

| | | | | | | 30 |)-DS-P | 41 | | | 30 |)-DS-P | 43 | | | 30 |)-DS-P | 45 | |
|-------------|-------------------------|-----------|-----------|-----|------------|------------|------------|------------|----------|------------|------------|------------|------------|----------|------------|------------|------------|------------|----------|
| | Production Loop P 40 | | | | 30-X-P41-/ | 30-X-P41-E | 30-X-P41-0 | 30-X-P41-E | 30-M-P41 | 30-X-P42-/ | 30-X-P42-E | 30-X-P42-0 | 30-X-P42-E | 30-M-P42 | 30-X-P43-/ | 30-X-P43-E | 30-X-P43-0 | 30-X-P43-E | 30-M-P43 |
| 2 SC 6420 A | SOM 3041 A | ND-30401 | | Q1 | | | | | | | | | | | | Α | | | A |
| 2 SC 6420 B | SOM 3041 B | ND-30401 | | Q I | | В | | В | | В | | | | | | | | | |
| 2 SC 6430 A | SOM 3042 A | ND-30402 | | Q2 | | A | Α | | | | | | Α | | | | | | |
| 2 SC 6430 B | SOM 3042 B | ND-30402 | | QZ | | | | | | | | | | | В | В | | | |
| 2 SC 6440 A | SOM 3043 A | NID 00400 | | 00 | Α | | | | | Α | | | | | Α | | | | |
| 2 SC 6440 B | SOM 3043 B | ND-30403 | 30-UD-P41 | Q3 | | | В | | В | | | | | | | | | | |
| 2 SC 6450 A | SOM 3044 A | ND-30404 | 30-0D-F41 | Q4 | | | | | Α | | Α | | | | | | | | |
| 2 SC 6450 B | SOM 3044 B | ND-30404 | | Q4 | | | | | | | | В | В | | | | | В | |
| 2 SC 6460 A | SOM 3045 A | ND-30405 | | Q5 | | | | A | | | | | | | | | Α | Α | |
| 2 SC 6460 B | SOM 3045 B | ND-30405 | | QS | В | | | | | | В | | | В | | | | | |
| 2 SC 6470 A | SOM 3046 A | ND-30406 | | Q6 | | | | | | | | Α | | Α | | | | | |
| 2 SC 6470 B | SOM 3046 B | ND-30406 | | 20 | | | | | | | | | | | | | В | | В |

The following table: Subsea Output Modules identifies the SEM/SOM correspondence for the Water Injection Strings WI10, WI20, WI30 and WI50 and Gas Injection String GI40.

Refer to:

• NG50-2-300-SCS-PR-SC-64-0879 – EFL Deployment Procedure

3.5 Production Control/Distribution System – Subsea Power and Communications Unit (SPCU) SEM/SOM Correspondence – Tables (Page 1 of 2)

| | | | | | | 76-DS | | | 76-RS-W12 from 76-DS-W11 | | | | | 76-DS | S-W13 | | 76-DS | S-W15 | | | | | | | |
|-------------|---------------------------------|-----------|--------------|-----|------------|------------|------------|-------------------------------------|-----------------------------|-------------|------------|------------|------------|------------|-----------------------------------|-------------------------------------|------------|------------|--|---|--|--|--|---|--|
| | Water Injection String WI 10/50 | | | | 76-X-W51-A | 76-X-W51-B | 76-X-W51-C | To 76-RS-W12 via short umbilical | AKPO West 1 | AKPO West 2 | 76-X-W11-A | 76-X-W11-B | 76-X-W12-A | 76-X-W12-B | 76-X-W13-A via short umbilical | To 76-RS-W14 via short umbilical | 76-X-W14-A | 76-X-W14-B | | | | | | | |
| 2 SC 6420 A | SOM 7611 A | ND-76101 | | Q1 | | | A | S1 | A | | | | | | | | | A | | | | | | | |
| 2 SC 6420 B | SOM 7611 B | ND-76101 | | QI | В | | | 51 | | В | | | | | | | | | | | | | | | |
| 2 SC 6430 A | SOM 7612 A | ND-76102 | | Q2 | | Α | | S2 | | Α | | | | | | | | | | | | | | | |
| 2 SC 6430 B | SOM 7612 B | ND-70102 | | QZ | | | | 52 | В | | | | | | В | | В | | | | | | | | |
| 2 SC 6440 A | SOM 7613 A | ND-76103 | 70 110 14/44 | Q3 | | | | | | | | Α | | Α | Α | S2 | | | | | | | | | |
| 2 SC 6440 B | SOM 7613 B | ND-70103 | 76-UD-W11 | 60 | | | В | | | | В | | | | | 52 | | | | | | | | | |
| 2 SC 6450 A | SOM 7614 A | ND-76104 | | Q4 | Α | | | | | | Α | | | | | S1 | | | | | | | | | |
| 2 SC 6450 B | SOM 7614 B | 110-70104 | | 45 | | В | | | | | | В | В | | | 31 | | | | | | | | | |
| 2 SC 6460 A | SOM 7615 A | ND 76105 | D-76105 | | 05 | 0 | Q5 | 05 | 05 | 05 | 05 | | | | | | | | | Α | | | | Α | |
| 2 SC 6460 B | SOM 7615 B | ND-70103 | | 0,5 | | | | | | | | | | В | | | | В | | | | | | | |

| | | | | | 76 | i-DS-W | 21 | 76-RS-W24 from 76-DS-W23 | | | 76-D | S-W23 | | | 8-RS-W n 76-DS-1 | | 76 | -DS-W | 25 | | | | | | |
|-------------|-----------------|--------------|-----------|----------|-----------------------------------|------------|------------|-----------------------------|------------|------------|------------|-------------------------------------|-------------------------------------|------------|---------------------|------------|------------|------------|------------|---|---|---|---|--|--|
| | Water Injection | String WI 20 | /10 | | 76-X-W21-A via short umbilical | 76-X-W22-A | 76-X-W22-B | 76-X-W23-A | 76-X-W23-B | 76-X-W24-A | 76-X-W24-B | To 76-RS-W24 via short umbilical | To 76-RS-W25 via short umbilical | 76-X-W25-A | 76-X-W25-B | 76-X-W25-C | 76-X-W15-A | 76-X-W15-B | 76-X-W15-C | | | | | | |
| 2 SC 6470 A | SOM 7621 A | ND 76201 | | Q1 | | | | A | | | | S1 | 1.6 | | | | | | 7 | | | | | | |
| 2 SC 6470 B | SOM 7621 B | ND-76201 | ND-76201 | | Q1 | | | | | В | В | В | 51 | | | | | | | | | | | | |
| 2 SC 6420 A | SOM 7622 A | ND 70000 | ND 76202 | ND-76202 | ND-76202 | ND-76202 | ND-76202 | | Q2 | | | | | Α | | | S2 | S4 | | | Α | Α | | | |
| 2 SC 6420 B | SOM 7622 B | ND-76202 | | | | | | QZ | | | | В | | | | 52 | 54 | В | | | | В | | | |
| 2 SC 6430 A | SOM 7623 A | ND 76202 | 76-UD-W21 | 03 | | | | | | | Α | | S5 | | Α | | | Α | | | | | | | |
| 2 SC 6430 B | SOM 7623 B | ND-76203 | ND-76203 | ND-76203 | ND-76203 | ND-76203 | 10-00-021 | 43 | В | | В | | | | | | - 35 | | | В | | | | | |
| 2 SC 6440 A | SOM 7624 A | ND 76204 | ND 76204 | ND 76204 | | Q4 | Α | A | | | | | | | | | | | | | | | | | |
| 2 SC 6440 B | SOM 7624 B | ND-76204 | ND-76204 | ND-76204 | ND-76204 | ND-76204 | ND-76204 | ND-76204 | | Q4 | | | | | | | | | | | | | В | | |
| 2 SC 6450 A | SOM 7625 A | ND-76205 | | Q5 | | | Α | | | Α | | | S3 | Α | | | | | | | | | | | |
| 2 SC 6450 B | SOM 7625 B | | ND-76205 | ND-76205 | ND-76205 | ND-76205 | ND-76205 | | 45 | | В | | | | | | | 33 | | В | | | | | |

| | | | | | 76-DS | S-W31 | 76-DS | S-W33 | 76 | 5-DS-W | 35 | | 6-RS-W n 76-DS-1 | | | | | |
|---------------------|--------|---------------|-----------|----|------------|------------|------------|------------|------------|------------|-------------------------------------|------------|---------------------|------------|--|--|--|--|
| Water In | jectio | n String WI 3 | 0 | | 76-X-W31-A | 76-X-W31-B | 76-X-W32-A | 76-X-W32-B | 76-X-W33-A | 76-X-W33-B | To 76-RS-W36 via short umbilical | 76-X-W34-A | 76-X-W34-B | 76-X-W34-C | | | | |
| 2 SC 6460 A SOM 763 | 1 A | ND-76301 | | Q1 | | | | | | Α | S1 | Α | | | | | | |
| 2 SC 6460 B SOM 763 | 1 B | ND-70301 | | Q | | | | В | | | 51 | | В | | | | | |
| 2 SC 6470 A SOM 763 | 2 A | ND-76302 | | Q2 | Α | | | | | | S2 | | A | | | | | |
| 2 SC 6470 B SOM 763 | | ND-70302 | | QZ | | | | | В | | 52 | | | В | | | | |
| 2 SC 6420 A SOM 763 | 3 A | ND-76303 | 76-UD-W31 | Q3 | | | | | | | S3 | | | Α | | | | |
| 2 SC 6420 B SOM 763 | 3 B | ND-70000 | 10-00-001 | QU | | | В | | | | 00 | В | | | | | | |
| 2 SC 6430 A SOM 763 | | ND-76304 | 4 | 4 | 4 | 1 | 1 | Q4 | | Α | | | Α | | | | | |
| 2 SC 6430 B SOM 763 | 4 B | | | | | | | 42 | | | | | | В | | | | |
| 2 SC 6440 A SOM 763 | | ND-76305 | 5 | 0 | Q5 | | | Α | Α | | | | | | | | | |
| 2 SC 6440 B SOM 763 | 5 B | 112 / 0000 | | 20 | В | В | | | | | | | | | | | | |

| | | | | | | | 56-DS | S-G41 | | |
|-------------|---------------|------------|------------|------------|------------|-------------|---------------|-------|---|---|
| | Gas Injection | 56-X-G41-A | 56-X-G41-B | 56-X-G41-C | 56-X-G41-D | Contingency | Contingency 2 | | | |
| 2 SC 6450 A | SOM 5641 A | ND-56101 | | Q1 | Ă | | | | | Ă |
| 2 SC 6450 B | SOM 5641 B | ND-56101 | | QI | | В | | В | | |
| 2 SC 6460 A | SOM 5642 A | ND-56102 | 30-UD-G41 | Q2 | | Α | Α | | | |
| 2 SC 6460 B | SOM 5642 B | ND-30102 | 30-0D-041 | QZ | | | | | В | В |
| 2 SC 6470 A | SOM 5643 A | ND-56103 | | Q3 | | | | Α | Α | |
| 2 SC 6470 B | SOM 5643 B | ND-30103 | | 00 | В | | В | | | |

3.5 Production Control/Distribution System – Subsea Power and Communications Unit (SPCU) SEM/SOM Correspondence – Tables (Page 2 of 2)

Drawing Supplementary Information

The Subsea Control Module (SCM) directs hydraulic fluid to operate subsea valves upon receiving commands from the SCU. The SCM also gathers information from subsea located sensors and relays the values to the SCU. The SCM is fitted with dual Subsea Electronics Modules (SEMs), which are capable of fully controlling the SCM.

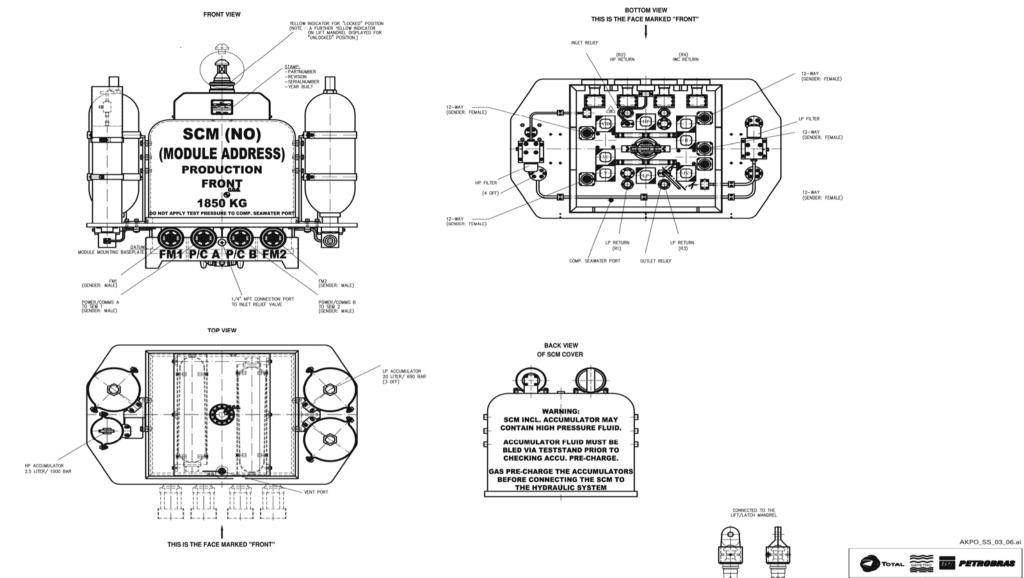
The primary interface with an SCM is through the Subsea Control Module Mounting Base (SCMMB), which is a structure that allows the SCMs many hydraulic function lines and electrical connections to be quickly made or broken, thus allowing the SCM to be replaced.

The hydraulic internals of the SCM contain 316L stainless steel manifold blocks, valves, pressure transducers, flowmeters, accumulators, and other components all bolted together to give the required functionality. The SCM Hydraulic System provides both the LP and HP services (water injection only has LP system).

| Parameter | Operating |
|--------------------------------------|-----------|
| LP Maximum Operating Pressure | 310bara |
| LP Minimum System Operating Pressure | 250bara |
| LP Minimum Operating Pressure | 207bara |
| LP Proof Test Pressure | 518bara |
| Pilot Maximum Operating Pressure | 310bara |
| Pilot Minimum Operating Pressure | 207bara |
| Pilot Proof Test Pressure | 518bara |
| HP Maximum Operating Pressure | 627bara |
| HP Minimum Operating pressure | 380bara |

Assembly diagram illustrates a Production Tree SCM. For flow diagram refer to:

- NG50-2-300-SCS-PF-SC-64-0017 SCM Production Tree
- NG50-2-300-SCS-PI-SC-30-0649 HPU Subsea Control System



| | | 9 | Тот | | RO | P 1 | TROB | RAS |
|--|-----------------------|-------------|---|-------------------------------------|-----|---------------|--|----------|
| | QUENT CONTRACT MUMBER | | | CLEDIT DOCUMENT NUMBER: | | | | |
| | APO/C007/03 | | | NG50-2-300-SCS-DW-SC-64-0020 | | | | |
| | | | | 3447 | | | an in | |
| | CAD | | C. Mindermann | | | 14.09.2006 11 | | |
| | SURFACE | DO NOT | SCALE | | | | CAMERON OF | nbH |
| TALENNES ACCOUNTS TO BE SO ADIS | | R. Scholz | 22.04.2004 | 62 | MER | • N | CAMERON Gr Libohammag 1 202277 Culture | Common w |
| CHARTE STATUS (MESS CHERRE) | WATERNAL AND | oton | 14.09.2006 | - | | | | |
| STERNICS UNLESS CONFINES SPERA COMMENTS IN BUT AN | HOAT TRADED | J. Levodoux | and the second se | ASSEMBLY DRAW SUBSEA CONTROL MOD | | | ULE (SCM) | |
| EST. WEIGHE 1650.000 KD SUPERSEDES: SCALE 1.5 | | | | PRODUCTION TREE | | | | |
| COMMENT ACCOUNTS TO ME X, COMMENT OF THE INCLUDER, AND GAMES IT TO CHEEK AND THE UNE OF COMMENTATION OF THE COMMENT THEORY, AND THEORY WHICH THEORY PERSON OF CHEEKS AND ACCOUNTS AND ACCOU | | | | 223052-48 | | 10F5 | SK-066052 | -48 |

3.6 Production Control/Distribution System – Assembly Drawing: Subsea Control Module (SCM) Production Tree

Drawing Supplementary Information

 3×20 litre LP accumulators, pre-charged to 690bar, are positioned on the outside of the cover such that they may be pre-charged or vented without the need to remove the cover.

The SCM is designed uniquely to work either on a production tree, water injection tree, gas injection tree or a production manifold, and are not interchangeable

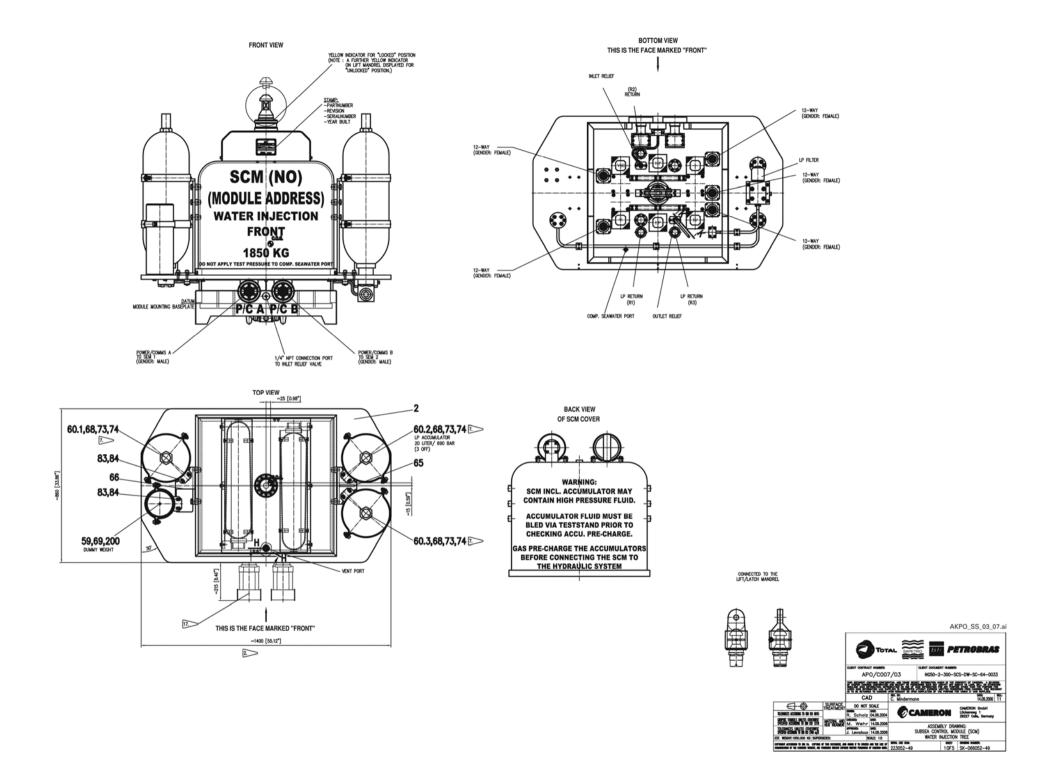
Gas injection and Production SCMs have 1×2.5 litre HP accumulator, pre-charged to 1000bar, located on the other side of the LP module.

.The inside of the SCM is filled with a dielectric oil to prevent water ingress and a pressure and temperature compensation system is provided. Should the inside become flooded with seawater, a water ingress alarm will be raised and anodes are provided for temporary cathodic protection.

Each SCM is equipped with two Subsea Electronic Modules (SEMs), used for communicating with SPCU Channel 'A' and Channel 'B'. The SCM receives the 'A' and 'B' signals through two EFL connectors. The SEM contains the processor, memory and other interface cards required to control and monitor the SCM. The SCM is capable of being operated with only one SEM. The external sensor connections are made through the bottom of the SCM via the SCMMB.

Assembly diagram illustrates a Water Injection Tree SCM. For a flow diagram refer to:

NG50-2-300-SCS-PF-SC-64-0035 – SCM Water Injection Tree

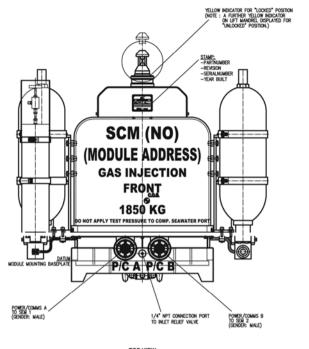


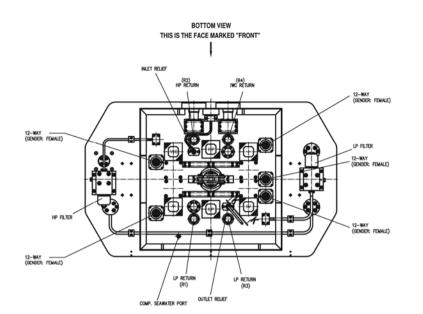
Gas injection and Production SCMs have 1 x 2.5 litre HP accumulator, pre-charged to 1000bar, located on the other side of the LP module.

Assembly diagram illustrates a Gas Injection Tree SCM. For a flow diagram refer to:

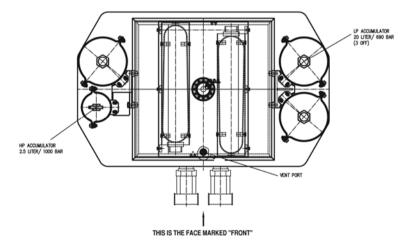
• NG50-2-300-SCS-PF-SC-64-0023 – SCM Gas Injection Tree

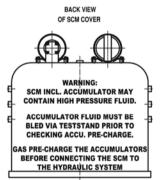
3.7 Production Control/Distribution System – Assembly Drawing: Subsea Control Module (SCM) Water Injection Tree

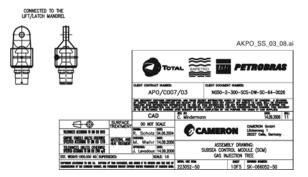




TOP VIEW







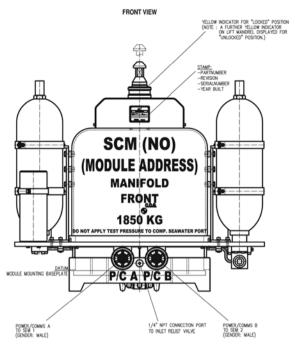
Gas injection and Production SCMs have 1 x 2.5 litre HP accumulator, pre-charged to 1000bar, located on the other side of the LP module.

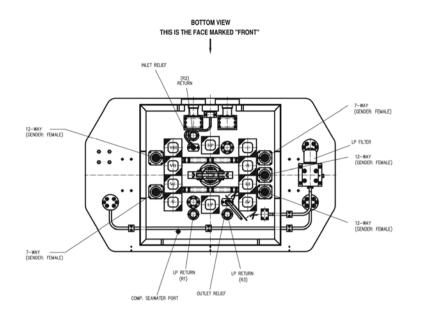
Assembly diagram illustrates a Production Manifold SCM. For a flow diagram refer to:

• NG50-2-300-SCS-PF-SC-64-(HOLD) – SCM Production Manifold

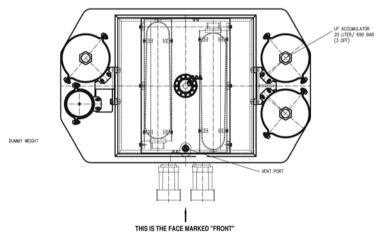
3.8 Production Control/Distribution System -Gas Injection Tree

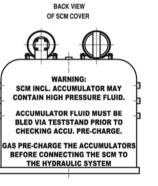
Assembly Drawing: Subsea Control Module (SCM)

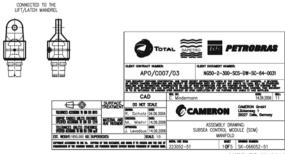




TOP VIEW







AKPO_SS_03_09.ai

3.9 Production Control/Distribution System – Assembly Drawing: Subsea Control Module (SCM) Production Manifold

Drawing Supplementary Information

The manifold is provided with a Subsea Accumulator Module (SAM) to provide sufficient stored volume to the drill centre to minimize pressure drops during valve operations, so allowing sequenced operations and preventing spurious closure of other open actuators during valve movement.

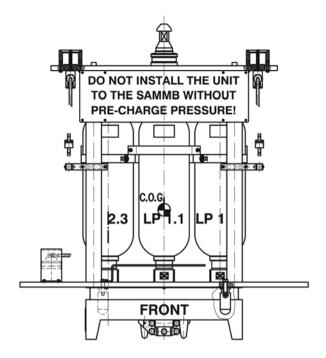
Each SAM comprises two banks of three accumulators, two each connected to LP1, LP2 and LP3 hydraulic circuits respectively. Each accumulator has a capacity of 20 litres with a subsea pre-charge pressure of 341bar.

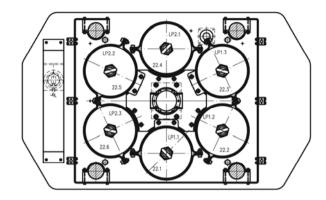
An interlock facility is incorporated that allows the accumulators to maintain the system pressure above the system dropout pressure.

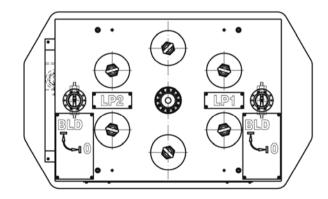
- Production xmas trees and Gas injection xmas trees require HP and LP accumulation
- Production manifolds and Water injection xmas trees require only LP accumulation

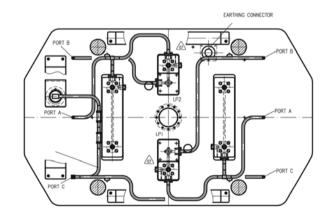
Assembly diagram illustrates a Subsea Accumulator Module (SAM). For a flow diagram refer to:

• NG50-2-300-SCS-PF-SC-64-0039 (SAM)











AKPO_SS_03_10.ai

The retrievable insert choke is a subsea flow control device. The insert is stabbed vertically into the choke body and can be retrieved independently of the body by means of a remotely operated hydraulic running tool.

The choke insert consists primarily of four systems: the trim for controlling flow, the actuator for adjusting trim position, the manual/ROV override for manually adjusting trim position, and the crown connector for locking the choke insert into the body.

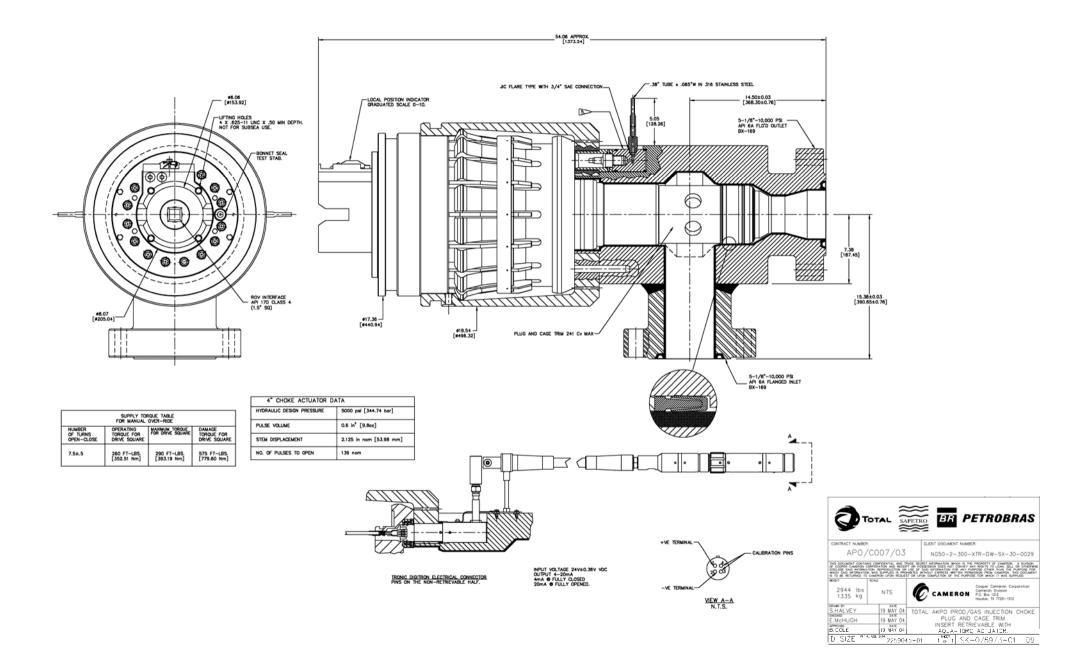
Manual/ROV override operation is accommodated by an external drive located in an API 17D rotary intervention fixture on top of the choke. Clockwise/counter-clockwise rotation causes closing/opening of the choke, respectively.

For details of Choke insert assemblies and Running Tools (CIRT), refer to:

• Akpo Installation, Operation and Maintenance (IOM) Manual (REV 01)

For Cameron Crown Chokes and Accessories

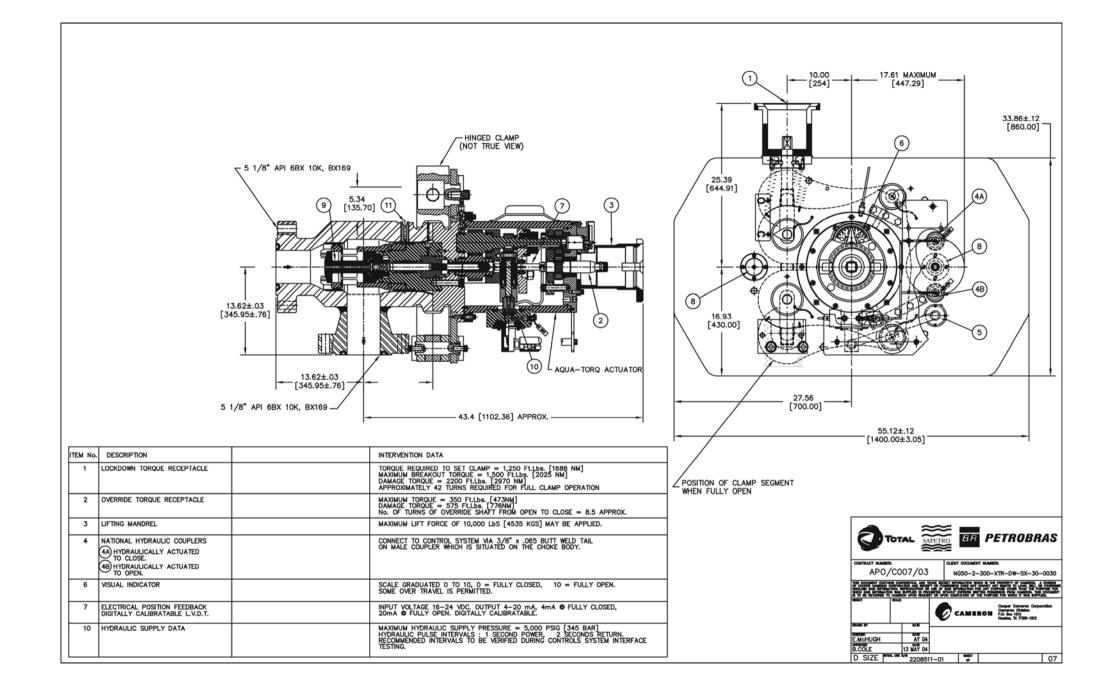
3.10 Production Control/Distribution System – Assembly Drawing: Subsea Accumulator Module (SAM)



The drawing illustrates in cross section a Water Injection Tree Choke Insert For details of Choke insert assemblies and Running Tools (CIRT), refer to:

• Akpo Installation, Operation and Maintenance (IOM) Manual (REV 01) For Cameron Crown Chokes and Accessories

3.11 Production Control/Distribution System – Production/Gas Injection Tree Choke Insert



Multi-Phase Flow Meters (MPFM), measure and record individual well flows (non fiscal). Production flow rates are controlled to limit water or gas and optimise production.

The flowmeter is comprised of a venturi through which the fluids flow for conventional mass flow measurement using a differential pressure sensor. A pressure and temperature sensor is provided on the meter to convert this measurement to standard conditions.

In addition to the venturi there is a radioactive chemical source at a window at the throat of the venturi and a spectral gamma ray detector in a window diametrically opposite.

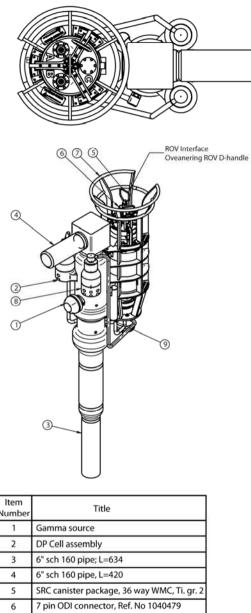
The attenuation of the gamma rays by the fluids between the windows at two energy levels are used to determine the oil, water and gas fractions for the fluids by comparing the results with those for pure representative oil, water and gas samples.

From the mass flow and fluid fractions, the individual phase flow are calculated in the data acquisition flow computer at the meter and the signals are transmitted to the associated TCM.

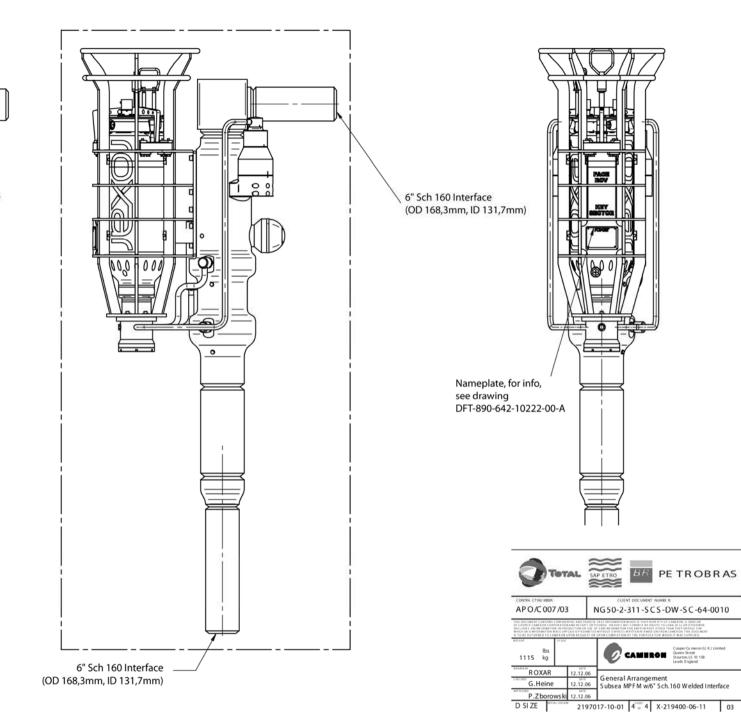
Power for the operation of the flow meter is provided from the TCM and converted to the required voltage levels within the flow meter package.

The general arrangement drawing illustrates a MPFM canister and frame.

3.12 Production Control/Distribution System – Water Injection Tree Choke Insert



| Number | Itte | |
|--------|--|--|
| 1 | Gamma source | |
| 2 | DP Cell assembly | |
| 3 | 6" sch 160 pipe; L=634 | |
| 4 | 6" sch 160 pipe, L=420 | |
| 5 | SRC canister package, 36 way WMC, Ti. gr. 2 | |
| 6 | 7 pin ODI connector, Ref. No 1040479 (RXR-032-01-7) | |
| 7 | SRC Funnel Welded | |
| 8 | DP cell assembly, right | |
| 9 | PT transmitter, Weps-3 | |



3.13 Production Control/Distribution System – Multi Phase Flow Meter (MPFM)

Drawing Supplementary Information

The Subsea Chemical Injection System stores, filters and delivers different chemicals by batch or continuous injection to each of the loop umbilicals. An Injection Rate Control Device (IRCD) incorporating a Flow Control Valve and Flow Indicator is provided for each chemical umbilical distribution to each loop via a Production Topside Umbilical Termination (TUT).

Final adjustment of each chemical injection rate is made at the subsea xmas tree via the following valves:

- Asphaltine Chemical Control Valve (CCV) and Chemical Injection Valve (CIV) upstream of the SCSSV
- Wax Inhibitor CIV upstream of PWV
- Corrosion/Scale Inhibitor CCV and CIV upstream of the PWV
- Spare Chemical Umbilical CCV and CIV upstream of the PWV

The subsea injection of demulsifier will only be used when the injection of topside demulsifier is found to insufficient.

Refer to:

• NG50-2-300-SCS-TR-SC-64-0102 - Chemical System Analysis

The following drawing illustrates a Chemical Injection Throttle Valve (HOLD)

HOLD (Drawing Not Available)

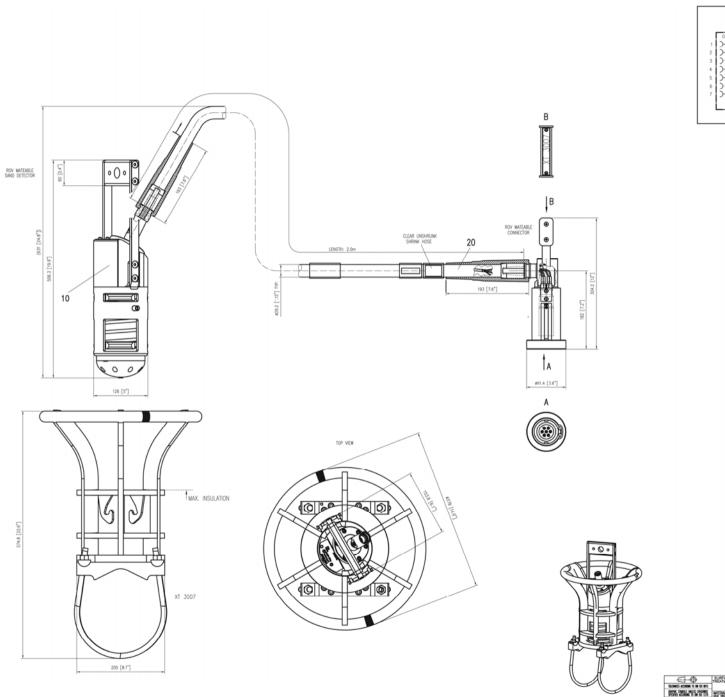
A non-intrusive sand detector is provided on each production tree in order to monitor sand production as well as detecting any major failure of the down-hole sand control equipment. Sand detectors provide warning of sand production by the comparison of the noise received at the detector with a known background noise level for any given velocity.

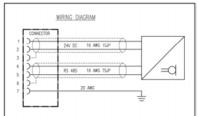
The sand detectors are provided with the average of the gas and liquid velocities from the MPFM associated with the well. The instrument determines the background noise level at that velocity from calibration data within the instrument and compares the value with the current noise level.

Calculation of the produced sand rate from that noise level shall be based on calibration data within the instrument and correlated data fed to the ICSS as grams per second.

The assembly diagram illustrates a typical Sand Detector.

3.14 Production Control/Distribution System – Chemical Injection Throttle Valves







3.15 Production Control/Distribution System – Assembly Drawing: Sand Detector

Drawing Supplementary Information

A Hydraulic Distribution Unit (HDU) is located on each manifold, which is fed from the production umbilical and includes the following lines:

- 2 x ¹/₂in LP hydraulic Lines
- 2 x ¹/₂in HP Hydraulic Lines
- 1 x ¹/₂in Spare Chemical Line
- 1 x ¹/₂in Spare Line
- 3 x ¾in Methanol Lines
- 1 x ¹/₂in Wax Inhibitor Line
- 1 x ¹/₂in Corrosion/Scale Inhibitor Line
- 1 x ¹/₂in Anti-Asphaltine Line

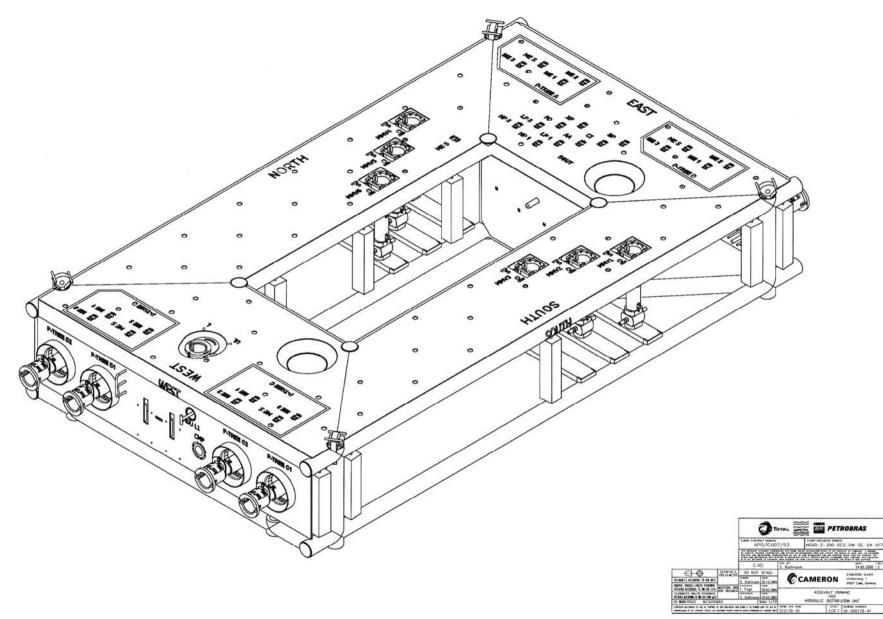
With the exception of methanol, all the headers on the HDU are equipped with a Remote Operated Vehicle (ROV) operable Isolation Valve (IV). The methanol lines are equipped with two actuated Manifold Methanol Valves (MMVs), one to isolate flow to the individual distribution header and one to isolate the supply from the 1in service line.

The HDU receives all umbilical hydraulic lines from the production Distribution SUT (DSUT) from two separate HFLs. An Electrical Flying Lead (EFL) is installed between the HDU and the corresponding manifold SCM in order to communicate with the HDU pressure sensors.

The assembly diagram illustrates the Hydraulic Distribution Unit (HDU).

Refer to:

• NG50-2-300-SCS-DW-SC-64-0178 – Assembly Drawing HDU

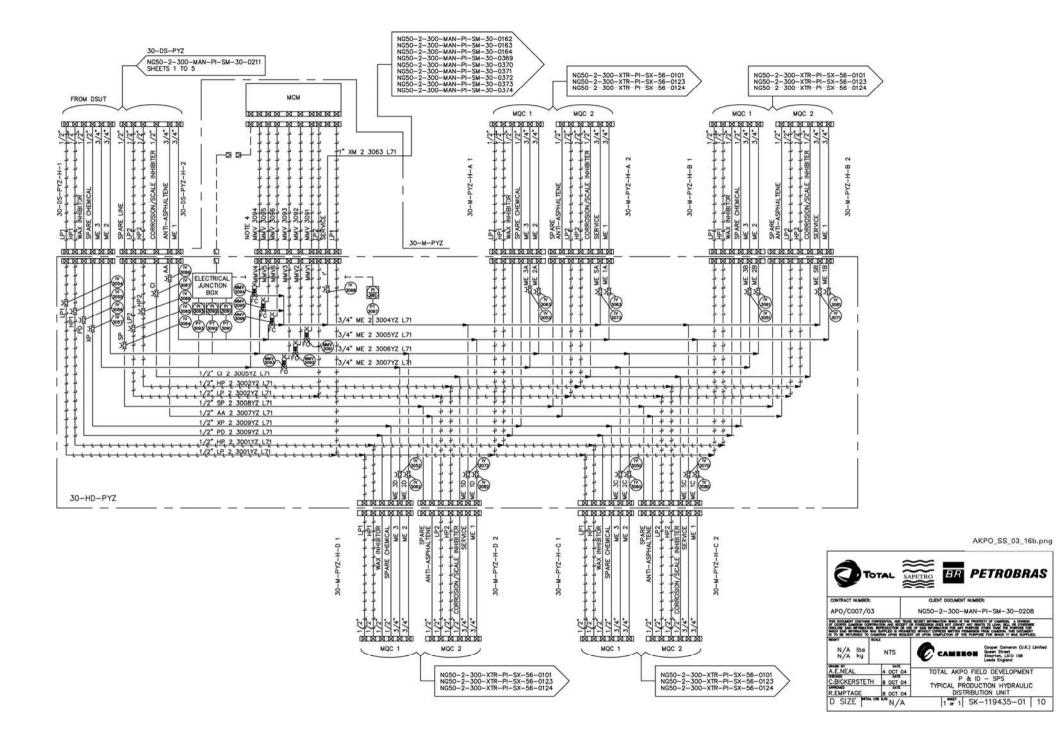


AKPO_SS_03_16a.ai

The following drawing is of a typical Hydraulic Distribution Unit (HDU). Refer to:

• NG50-2-300-MAN-PI-SM-30-0208 – Typical Production Hydraulic Unit

3.16 Production Control/Distribution System – Assembly Drawing: Hydraulic Distribution Unit (HDU) (Page 1 of 2)



The following valve list is for a typical Hydraulic Distribution Unit (HDU).

3.16 Production Control/Distribution System – P&ID: Hydraulic Distribution Unit (HDU) (Page 2 of 2)

Hydraulic Distribution Unit

| Valve | Manifold Markings | Description | | |
|---------|-------------------|--|--|--|
| IV3081 | ME 1B | Methanol 1B (¾in) – Ball valve ROV operated | | |
| IV3071 | ME SB | Methanol Service B (¾in) – Ball valve ROV operated | | |
| IV3061 | ME 2B | Methanol 2B (¾in) – Ball valve ROV operated | | |
| IV3051 | ME 3B | Methanol 3B (¾in) – Ball valve ROV operated | | |
| IV3080 | ME 1C | Methanol 1C (¾in) – Ball valve ROV operated | | |
| IV3070 | ME SC | Methanol Service C (¾in) – Ball valve ROV operated | | |
| IV3060 | ME 2C | Methanol 2C (¾in) – Ball valve ROV operated | | |
| IV3050 | ME 3C | Methanol 3C (¾in) – Ball valve ROV operated | | |
| IV3083 | ME 1A | Methanol 1A (¾in) – Ball valve ROV operated | | |
| IV3073 | ME SA | Methanol Service A (¾in) – Ball valve ROV operated | | |
| IV3063 | ME 2A | Methanol 2A (¾in) – Ball valve ROV operated | | |
| IV3053 | ME 3A | Methanol 3A (¾in) – Ball valve ROV operated | | |
| IV3072 | ME SD | Methanol Service D (¾in) – Ball valve ROV operated | | |
| IV3082 | ME 1D | Methanol 1D (¾in) – Ball valve ROV operated | | |
| IV3062 | ME 2D | Methanol 2D (¾in) – Ball valve ROV operated | | |
| IV3052 | ME 3D | Methanol 3D (¾in) – Ball valve ROV operated | | |
| IV3098 | ME | SM Service (1in) – Ball valve ROV operated | | |
| MMV3091 | MMV1 | Methanol 1 (¾in) | | |
| MMV3092 | MMV2 | Methanol 2 (¾in) | | |
| MMV3093 | MMV3 | Methanol 3 (¾in) | | |
| MMV3094 | MMV4 | Methanol 1 (¾in) | | |
| MMV3095 | MMV5 | Methanol 2 (¾in) | | |
| MMV3096 | MMV6 | Methanol 3 (¾in) | | |
| IV3068 | AA | Anti-asphaltene, AA (¾in) | | |
| IV3067 | CI | Corrosion/Scale Inhibitor, CI (½in) | | |
| IV3066 | HP2 | HP2 (½in) | | |
| IV3065 | LP2 | LP2 (½in) | | |
| IV3064 | SP | Spare line, SP (½in) | | |
| IV3054 | LP1 | LP1 (½in) | | |
| IV3055 | HP1 | HP1 (½in) | | |
| IV3056 | PD | Wax inhibitor (½in) | | |
| IV3057 | XP | Spare chemical (½in) | | |

A, B, C & D refer to the 4 Well locations linked to the manifold

3.17 Production Control/Distribution System – Valve List for HDU

Drawing Supplementary Information

Hydraulic Flying Leads (HFL), distribute hydraulic, chemical and methanol lines to the HDU, production manifolds and production/injection xmas trees.

The following hydraulic and chemical flying leads are supplied:

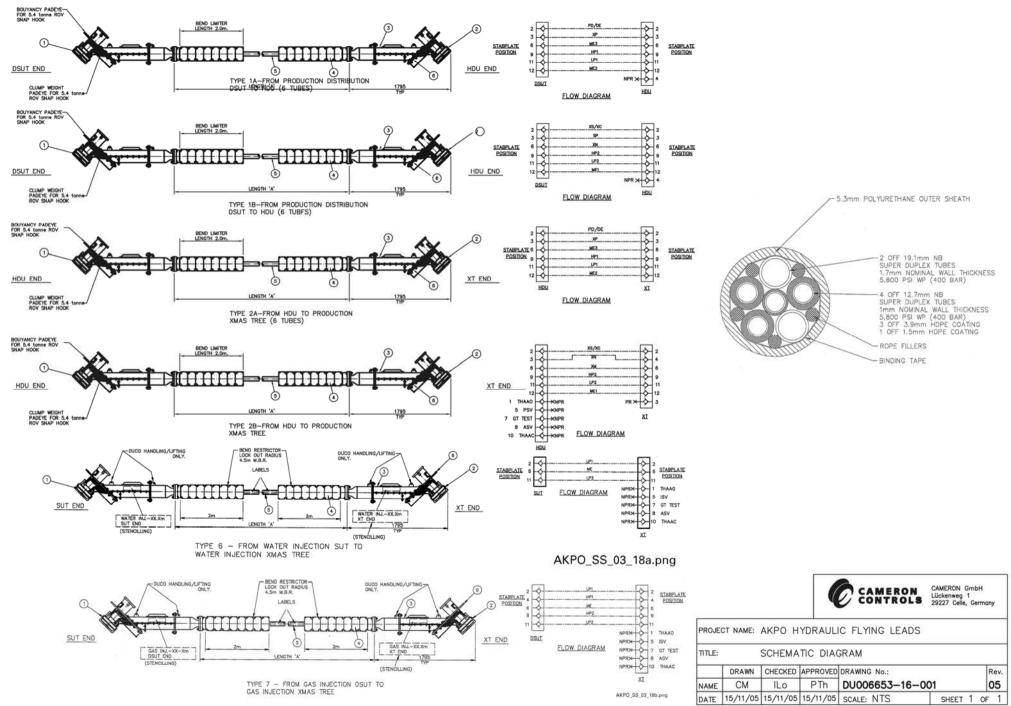
- SUT to HDU chemical and hydraulic supplies
- HDU to Production tree hydraulic and chemical supplies
- SUT to Gas Injection tree hydraulic and chemical supplies
- SUT to Water Injection tree hydraulic supplies

HFL are constructed as a sheathed steel tube bundle containing the requisite hydraulic and chemical hoses distributing:

- Methanol
- Scale inhibitor
- Corrosion inhibitor
- Asphaltene Inhibitor
- Biocide
- Wax Inhibitor
- Demulsifier
- Service connection
- HP and LP Hydraulic utilities

The following diagrams illustrate the HFL types in service.

- HFL Type 1A
- HFL Type 1B
- HFL Type 2A
- HFL Type 2B
- HFL Water Injection (WI) SUT to WI Tree
- HFL Gas Injection (GI) SUT to GI Tree



AKPO_SS_03_18.ai

3.18 Production Control/Distribution System – Hydraulic Flying Leads (HFL)

Drawing Supplementary Information

Oil-filled Electrical Flying Leads (EFL), distribute power and signal within subsea facilities. These have the following applications within the system:

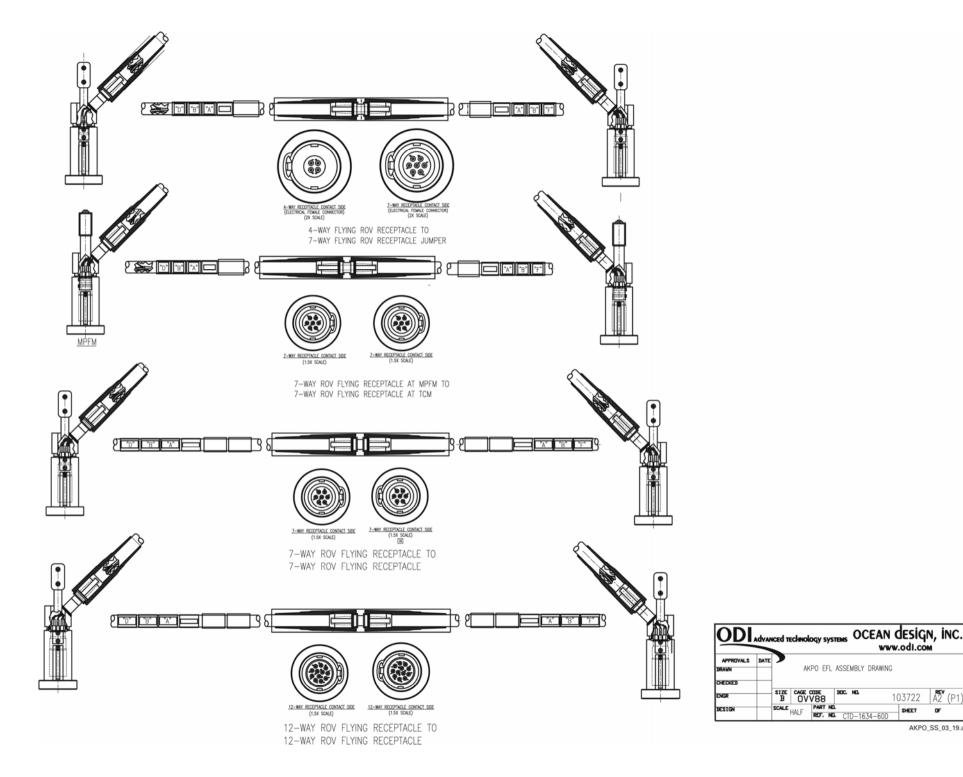
- Electrical flying leads from the Distribution SUT to Subsea Control Modules
- Electrical flying leads from SCM to MPFM
- Electrical flying leads from manifold SCM to HDU
- Electrical flying leads between Distribution SUT an Intermediate SUT

Electrical connectors are colour coded to designate 4, 7 and 12 way connectors and labelled to indicate the destination and function of that connector. There are 13 Types of EFL available:

| 12-way/12-way | 5m | PN 2197087-78-04 |
|-----------------------------------|------|------------------|
| 7-way/7-way | 61m | PN 219088-09-49 |
| 7-way/7-way | 52m | PN 2197088-08-64 |
| 4-way/7-way | 135m | PN 2197087-80-52 |
| 4-way/7-way | 147m | PN 2197087-80-55 |
| 4-way/7-way | 115m | PN 2197087-80-47 |
| 4-way/7-way | 82m | PN 2197087-80-38 |
| 4-way/7-way | 76m | PN 2197087-80-36 |
| 4-way/7-way | 151m | PN 2197087-80-56 |
| 4-way/7-way | 119m | PN 2197087-80-48 |
| 4-way/7-way | 67m | PN 2197087-80-33 |
| 4-way/7-way | 143m | PN 2197087-80-54 |
| 7-way/7-way | 22m | PN 2197087-79-15 |

The following 4 diagrams illustrate each class of EFL.

- 4-WAY FLYING ROV RECEPTACLE to 7-WAY FLYING ROV RECEPTACLE JUMPER
- 7-WAY ROV FLYING RECEPTACLE at MPFM to 7-WAY ROV FLYING RECEPTACLE at TCM
- 7-WAY FLYING RECEPTACLE to 7-WAY FLYING ROV FLYING RECEPTACLE
- 12-WAY FLYING RECEPTACLE to 12-WAY ROV FLYING FLYING RECEPTACLE



DF AKPO_SS_03_19.ai

3.19 Production Control/Distribution System – Electrical Flying Leads (EFL)

Drawing Supplementary Information

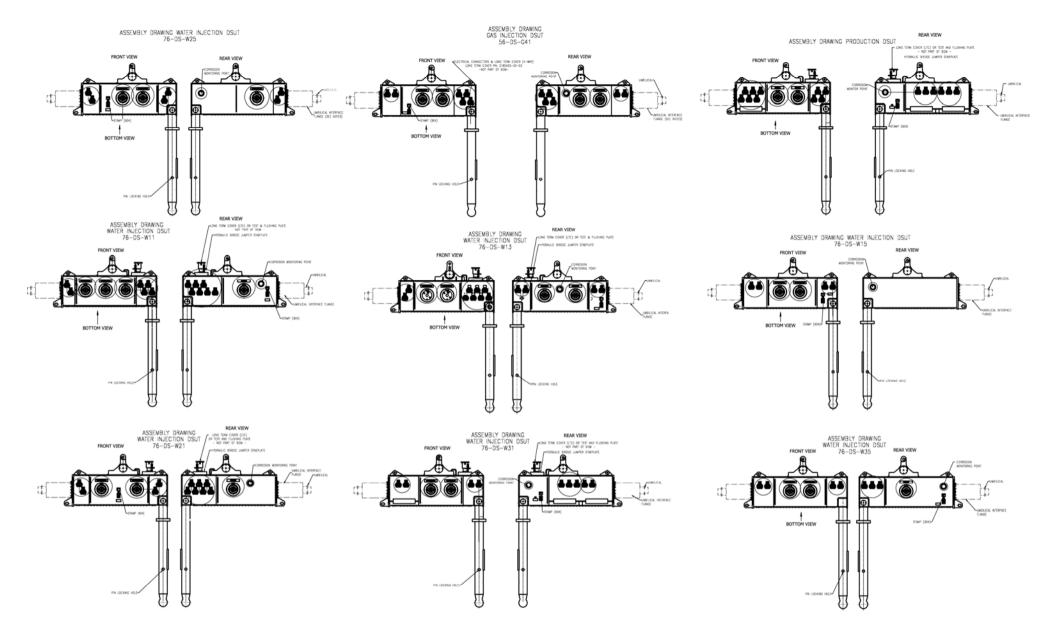
Distribution Subsea Umbilical Terminations (DSUT) terminate the subsea end of the dynamic umbilical, providing a connection plate for the umbilical flange. Nine DSUT types are provided:

- Production DSUT P11 P13 P21 P23 P31 P33 P41 P43
- Production DSUT P45
- Water Injection DSUT W15
- Water Injection DSUT W13/W21
- Water Injection DSUT W31/W33
- Water Injection DSUT W35
- Water Injection DSUT W11
- Water Injection DSUT W23
- Gas Injection DSUT G41

Each SUT type shall include the following features:

- Permanent termination of the umbilical tubing, electrical cables
- Electrical connection by ROV bulkhead connector to the production manifold and associated xmas trees. All electrical connections achieved with individual flying leads for wells located in the vicinity of the DSUT
- DSUT for production loops allow pressurised mating/demating of the hydraulic flying leads for the distribution to the HDU
- DSUT for injection strings allow pressurised mating/demating of the hydraulic flying leads for the injection xmas trees, or in some cases for connection of the Short Umbilical Termination Head for RSUT connection
- The Gas injection SUT distribute 4 wells and have contingency electrical connections for 2 SCMs
- Parking facilities for all flying leads including hydraulic and electrical bridging jumpers are provided on the SUT foundation frame
- Connections for a hydraulic bridge jumper for the associated Intermediate
 SUT
- Connections for electrical flying leads for the associated Intermediate SUT

The assembly diagram illustrates the DSUT available.



AKPO_SS_03_20.ai

3.20 Production Control/Distribution System – Distribution Subsea Umbilical Terminations (DSUT)

Drawing Supplementary Information

Intermediate Subsea Umbilical Terminations (ISUT) terminate the upstream end of infield umbilicals (the end closest to the FPSO), providing a connection plate for the umbilical flange. The ISUT is designed to allow the umbilical to be lifted from its position on the sea bed, using the ISUT to connect the lift wire to the umbilical.

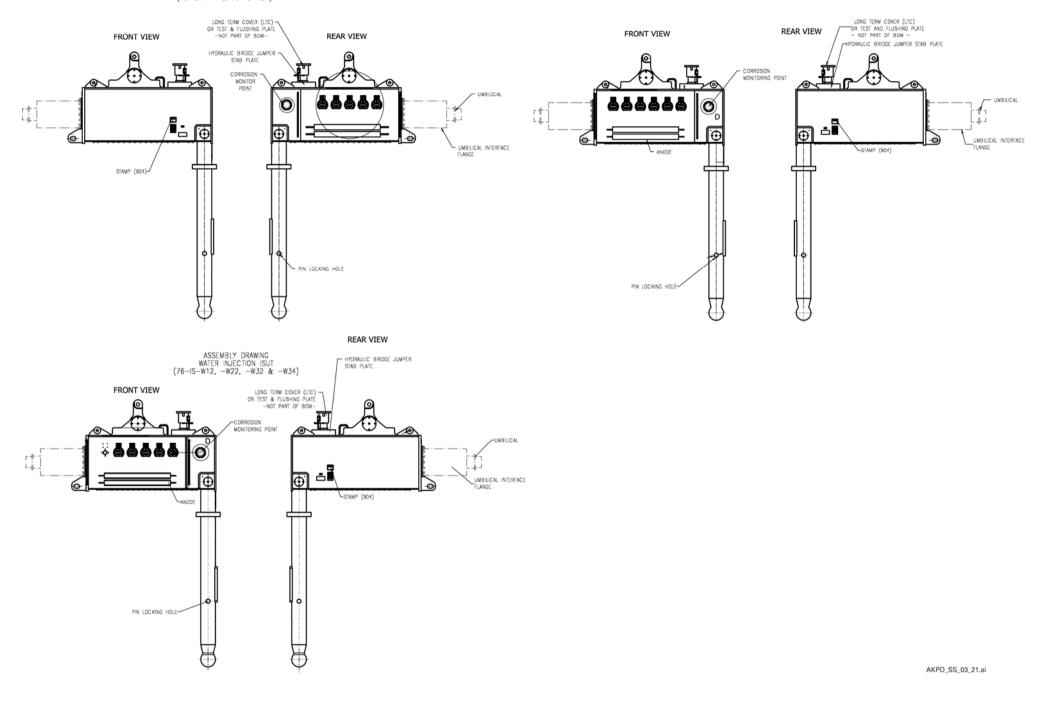
Two ISUT types are provided:

- Production DSUT P11 P13 P21 P23 P31 P33 P41 P43 P45
- Water Injection DSUT W11 W13 W15 W21 W23 W31 W33 W35

Assembly diagrams illustrate the ISUT available.

ASSEMBLY DRAWING PRODUCTION ISUT (30-IS-P12, -P22, -P32, -P42, -P44)

ASSEMBLY DRAWING WATER INJECTION ISUT (76-IS-W14 & 76-IS-W24)



3.21 Production Control/Distribution System – Intermediate Subsea Umbilical Terminations (ISUT)

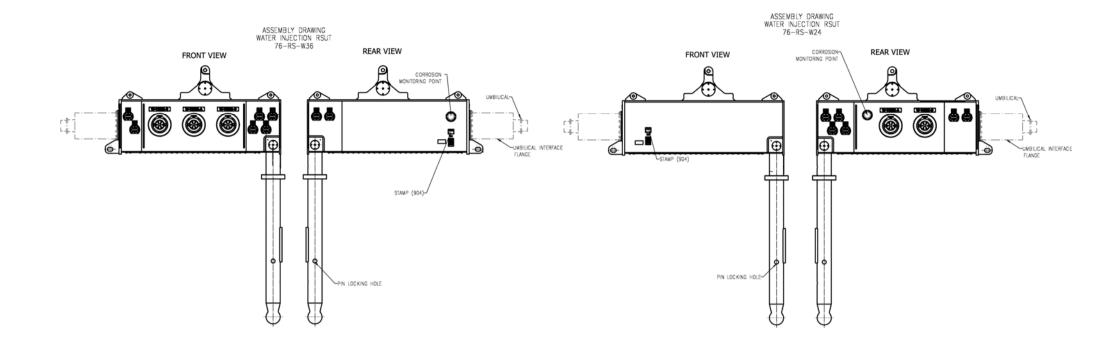
Drawing Supplementary Information

Relay Subsea Umbilical Terminations (RSUT) terminate the downstream end of short umbilicals (the end furthest from the FPSO), providing a connection plate for the umbilical flange. The RSUT is designed to allow the umbilical to be lifted from its position on the sea bed, using the RSUT to connect the lift wire to the umbilical.

Two RSUT types are provided:

- Water Injection R-SUT W21a/W23a/W23b
- Relay SUT W15a/W35b

Assembly diagrams illustrate the RSUT available



AKPO_SS_03_22.ai

3.22 Production Control/Distribution System – Relay Subsea Umbilical Terminations (RSUT)

Drawing Supplementary Information

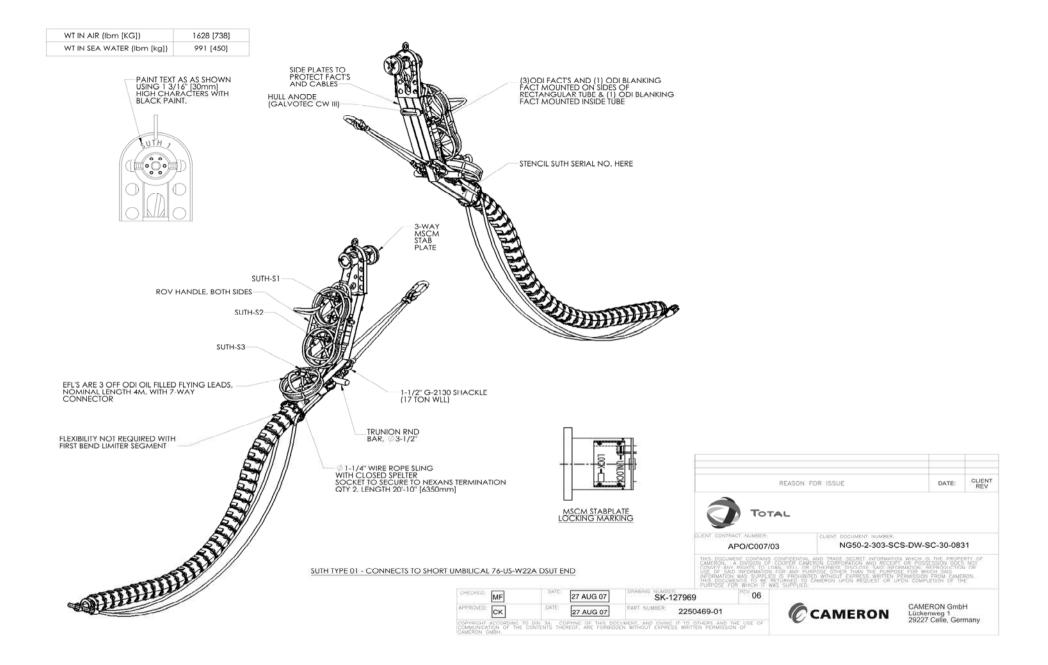
Short umbilicals supply hydraulic control fluid, service line, electrical power and communication to water injection wells located remotely from Distribution SUT.

They are terminated by the Relay SUT at the end furthest from the FPSO or by the termination heads at the DSUT.

Short umbilicals may additionally be used to connect single trees to the DSUT, in which case a Short Umbilical Termination Head (SUTH) may be used at both ends of the umbilical.

The connection of the short umbilical termination head to the Distribution SUT or remote xmas tree is performed by a single MQC plate for the hydraulic lines and independent electrical cables with ROV electrical connectors to be connected direct to the SCM or SUT:

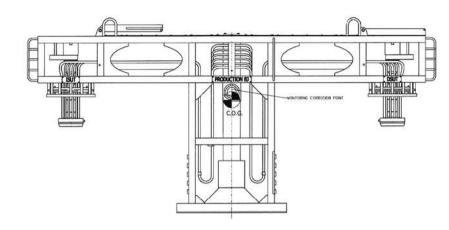
- 5 off for short umbilical supplying more than one WI xmas trees via a relay SUT
- 3 off on both end of short umbilical supplying a single WI xmas tree

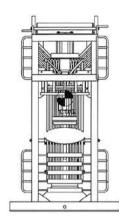


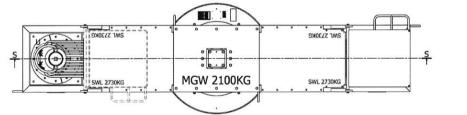
After the DSUT and ISUT are landed on the foundation base, a bridging jumper is used to connect the hydraulic and chemical supplies from the DSUT to the ISUT and on to the next drill centre

Assembly diagram illustrates a DSUT/ISUT bridging jumper. Highlighted are the debris covers

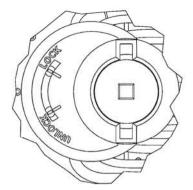
3.23 Production Control/Distribution System – Short Umbilicals (WI)

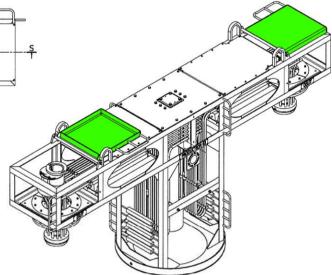












AKPO_SS_03_24.png

| C SONTA | OLS | CANCRON Distort Globerang 1 20227 Cala, Geimeny |
|---------------------|--------|---|
| ASSEM BIRDGE JUA | PER PR | KINC DOUCTION |
| 223206-91 | I OF 4 | 5K-05620691 |

Topsides Umbilical Termination (TUT) units are the transition point between surface equipment and subsea equipment. The TUT are located in dedicated umbilical cabinets located near the umbilical hang-off point, which provide a connection and diagnosis point for the hydraulic and chemical services. All services are bundled into the dedicated umbilicals.

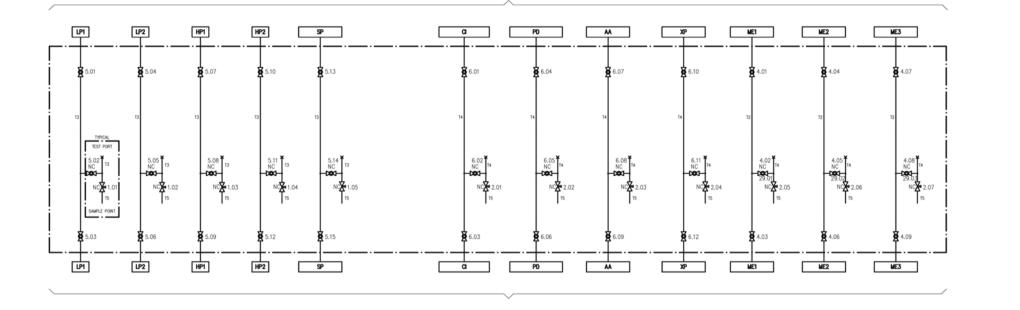
There are three types of TUT provided for the termination of production, water injection and gas injection umbilicals.

Each hydraulic and chemical supply line contains block valves to isolate the umbilical from topsides, as well as bleed/sample points and test port monitoring for each line in the umbilical.

There are 4 Production TUT - 2 ST 30 10/20/30/40.

The following diagram show all isolation valves and connections for a typical production TUT.

3.24 Production Control/Distribution System – Assembly Drawing: Bridge Jumper Production



HYDRAULIC & CHEMICAL SUPPLIES FROM FPSO (INLET)

| | ···· /···/ | | | | | | | | |
|-------------|---------------------|----------|--------------|------------------------------------|---------------------------------|------|--------------------------------------|--------------------------------------|------------------------------|
| T2 | 48.60 x 7.3 mm | 34.00 mm | 316 SST | | | | | | |
| T3 | 19.05 x 2.97 mm | 13.11 mm | 316 SST | | | | | | |
| T4 | 25.40 x 3.97 mm | 17.48 mm | 316 SST | | | | | | |
| T5 | 6,35 x 1,78 mm | 2,77 mm | 316 SST | | | | | | |
| line No. | DESCRIPTION | | ABBREVIATION | OPERATION PRESSURE BAR (PSI) | design Pressure Bar (PSI) | REF. | INLET CONNECTION | OUTLET CONNECTION | TEST PORT CONNECTION |
| 1 | LOW PRESSURE SUPP | LY 1 | LP1 | 310 (4500) | 690 (10000) | T3 | 3/4" OD AE MP (SF750CX) | 3/4" OD AE MP (SF750CX) | 3/4" OD AE MP (PLUG CPX 120) |
| 2 | LOW PRESSURE SUPP | LY 2 | LP2 | 310 (4500) | 690 (10000) | T3 | 3/4" OD AE MP (SF750CX) | 3/4" OD AE MP (SF750CX) | 3/4" OD AE MP (PLUG CPX 120) |
| 3 | HIGH PRESSURE SUPP | PLY 1 | HP1 | 627 (9090) | 690 (10000) | T3 | 3/4" OD AE MP (SF750CX) | 3/4" OD AE MP (SF750CX) | 3/4" OD AE MP (PLUG CPX 120) |
| 4 | HIGH PRESSURE SUPP | PLY 2 | HP2 | 627 (9090) | 690 (10000) | T3 | 3/4" OD AE MP (SF750CX) | 3/4" OD AE MP (SF750CX) | 3/4" OD AE MP (PLUG CPX 120) |
| 5 | SPARE | | SP | 627 (9090) | 690 (10000) | T3 | 3/4" OD AE MP (SF750CX) | 3/4" OD AE MP (SF750CX) | 3/4" OD AE MP (PLUG CPX 120) |
| 6 | CORROSION INHIBITOR | 1 | CI | 365 (5290) | 402 (5830) | T4 | 1" OD AE MP (SF1000CX) | 1" OD AE MP (SF1000CX) | 1" OD AE MP (PLUG CPX 160) |
| 7 | WAX INHIBITOR | | PD | 365 (5290) | 402 (5830) | T4 | 1" OD AE MP (SF1000CX) | 1" OD AE MP (SF1000CX) | 1" OD AE MP (PLUG CPX 160) |
| 8 | ANTI ASPHALTENE | | AA | 365 (5290) | 402 (5830) | T4 | 1" OD AE MP (SF1000CX) | 1" OD AE MP (SF1000CX) | 1" OD AE MP (PLUG CPX 160) |
| 9 | SPARE CHEMICAL | | XP | 365 (5290) | 402 (5830) | T4 | 1" OD AE MP (SF1000CX) | 1" OD AE MP (SF1000CX) | 1" OD AE MP (PLUG CPX 160) |
| 10 | METHANOL 1 | | ME1 | 365 (5290) | 402 (5830) | T2 | SAE - FLANGE (DFx-405 STM 160-Havit) | SAE - FLANGE (DFx-405 STM 160-Havit) | 1" OD AE MP (PLUG CPX 160) |
| 11 | METHANOL 2 | | ME2 | 365 (5290) | 402 (5830) | T2 | SAE - FLANGE (DFx-405 STM 160-Havit) | SAE - FLANGE (DFx-405 STM 160-Havit) | 1" OD AE MP (PLUG CPX 160) |
| 12 | METHANOL 3 | | ME3 | 365 (5290) | 402 (5830) | T2 | SAE - FLANGE (DFx-405 STM 160-Havit) | SAE - FLANGE (DFx-405 STM 160-Havit) | 1" OD AE MP (PLUG CPX 160) |
| | | | | | | | | | |

REF. OD x WT (MM)

ID (MM) MATERIAL

| | | | AKPO_SS_03_25. |
|---|------|----------------------|----------------------|
| | | | ETROBRAS |
| CLIENT CONTRACT NUMBER: | | CUENT DOCUMENT NUMBE | R: |
| APO/COC | 7/03 | NG50-2-300- | SCS-PF-ST-64-0167 |
| The section contains contra proceeding contains contra vector and protection of the vector and protection via t is to at attraction to contain CAD | | | |
| DO NOT SCALE | Co | | CAMERON GmbH |
| J.J. Santos 08.03.200 | | AMERON | 29227 Celle, Germony |
| J.J. Santos 08.03.200 ONEXED: DATE: J. Vagts 22.01.200 APPROAD: DATE: | | FLOW DIAGE | AM: |
| J.J. Santos 08.03.200 OKENER: DOTE J. Vagts 22.01.200 | | | AM: TERMINATION |

3.25 Production Control/Distribution System – Flow Diagram: Topside Umbilical Termination (TUT) Production

Drawing Supplementary Information

Topsides Umbilical Termination (TUT) units are the transition point between surface equipment and subsea equipment. The TUT are located in dedicated umbilical cabinets located near the umbilical hang-off point, which provide a connection and diagnosis point for the hydraulic and chemical services. All services are bundled into the dedicated umbilicals.

There are three types of TUT provided for the termination of production, water injection and gas injection umbilicals.

Each hydraulic and chemical supply line contains block valves to isolate the umbilical from topsides, as well as bleed/sample points and test port monitoring for each line in the umbilical.

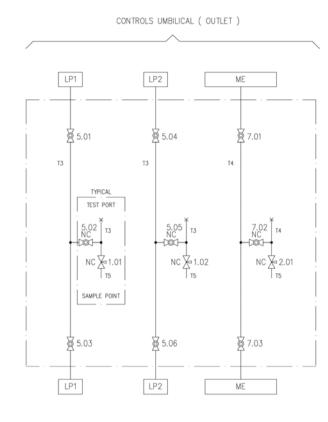
There are 3 Water Injection TUT - 2 ST 7610/20/30.

The following diagram show all isolation valves and connections for a typical Water Injection TUT.

| REF. | OD x WT (MM) | ID (MM) | MATERIAL | | | | | | |
|-------------|-----------------|----------|--------------|------------------------------------|---------------------------------|------|----------------------------|----------------------------|---------------------------------|
| T3 | 19.05 x 2.97 mm | 13.11 mm | 316 SST | | | | | | |
| T4 | 25.40 x 3.97 mm | 17.48 mm | 316 SST | | | | | | |
| T5 | 6,35 x 1,78 mm | 2,17 mm | 316 SST | | | | | | |
| LINE NO. | DESCRIPTION | | ABBREVIATION | OPERATION PRESSURE BAR (PSI) | DESIGN PRESSURE BAR (PSI) | REF. | INLET CONNECTION | OUTLET CONNECTION | TEST PORT CONNECTION |
| 1 | LOW PRESSURE SU | IPPLY 1 | LP1 | 310 (4500) | 690 (10000) | T3 | 3/4" OD AE MP (SF750CX) | 3/4" OD AE MP (SF750CX) | 3/4" OD AE MP (PLUG CPX 120) |
| 1 | LOW PRESSURE SU | IPPLY 2 | LP2 | 310 (4500) | 690 (10000) | T3 | 3/4" OD AE MP (SF750CX) | 3/4" OD AE MP (SF750CX) | 3/4" OD AE MP (PLUG CPX 120) |
| 3 | SERVICE | | ME | 365 (5290) | 402 (5830) | T4 | 1" OD AE MP (SF1000CX) | 1" OD AE MP (SF1000CX) | 1" OD AE MP (PLUG CPX 160) |

| Ø | Тот | AL SAPET | RO BR | PE | TROBRA | S |
|--|---|---|--|--|---|--------------------------------|
| CLIENT CONTRA | CT NUMBER: | | CLIENT DOCUME | NT NUMBER: | | |
| AP | 0/000 | 7/03 | NG50-2 | -300-S | CS-PF-ST-64-017 | 3 |
| THIS DOCUMENT CO DF CODPER CAMER DISCLOSE SAID IN WHICH SAID INFOR IS TO BE RETURN | INTAINS CONFIDE DN CORPORATION FORMATION REPR MATION WAS SU ID TO CAMERON | NTIAL AND TRADE SECR AND RECEIPT DR PDSSE IODUCTION OR USE OF S PPLIED IS PROHIBITED V UPON REQUEST DR UPON | ET INFORMATION WH ESSION DOES NOT CO AID INFORMATION FO VITHOUT EXPRESS W COMPLETION OF TH | ICH IS THE PF INVEY ANY RI R ANY PURPOS RITTEN PERMIS E PURPOSE FO | ROPERTY OF CAMERON, A DIVI GHTS TO LOAN, SELL OR DTHEF SE OTHER THAN THE PURPOSE I SSION FROM CAMERON. THIS DOC IR WHICH IT WAS SUPPLIED. | SION RVISE FOR CUMENT |
| CA | D | C. Schulze | | | DATE: 14.03.2007 | ^{REV.:} |
| DO NOT | SCALE | | | | CAMERON GmbH | |
| DRAWN: J.J. Santos CHECKED: | DATE: 08.03.2005 DATE: | Ø⊂/ | AMER | DN | Lückenweg 1 29227 Celle, Germany | |
| J. Vagts | 14.03.2007 | | FLOV | V DIAGRA | M· | |
| APPROVED: L. Ohlendorf | DATE: 14.03.2007 | · · | TOPSIDE UME | BILICAL T | ERMINATION | |
| S | CALE: / | | (TUT) W/ | ATER INJE | ECTION | |
| | | INITIAL USE BOM: 223398-62 | | SHEET 1 OF 1 | DRAWING NUMBER: SK-066398-62-0 |)1 |

Г



HYDRAULIC & CHEMICAL SUPPLIES FROM FPSO (INLET)

AKPO_SS_03_26.ai

3.26 Production Control/Distribution System – Flow Diagram: Topside Umbilical Termination (TUT) Water Injection

Drawing Supplementary Information

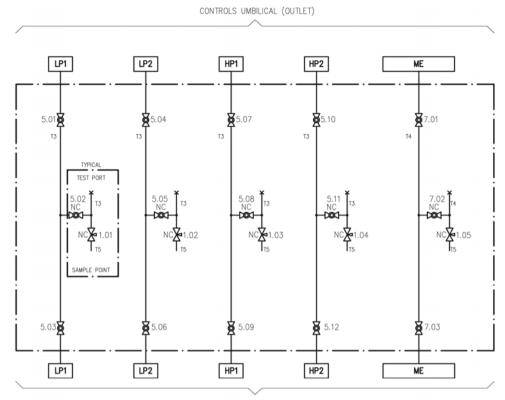
Topsides Umbilical Termination (TUT) units are the transition point between surface equipment and subsea equipment. The TUT are located in dedicated umbilical cabinets located near the umbilical hang-off point, which provide a connection and diagnosis point for the hydraulic and chemical services. All services are bundled into the dedicated umbilicals.

There are three types of TUT provided for the termination of production, water injection and gas injection umbilicals.

Each hydraulic and chemical supply line contains block valves to isolate the umbilical from topsides, as well as bleed/sample points and test port monitoring for each line in the umbilical.

There is 1 Gas Injection TUT - 2 ST 56 10.

The following diagram show all isolation valves and connections for a typical Gas Injection TUT.



| REF. | OD x WT (MM) | ID (MM) | MATERIAL | | | HYDF | RAULIC & CHEMIC | AL SUPPLIES FROM | FPSO (INLET) |
|-------------|------------------|----------|--------------|------------------------------------|---------------------------------|------|----------------------------|----------------------------|---------------------------------|
| T3 | 19.05 x 2.97 mm | 13.11 mm | 316 SST | | | | | | |
| T4 | 25.40 x 3.97 mm | 17.48 mm | 316 SST | | | | | | |
| T5 | 6,35 x 1,78 mm | 2,17 mm | 316 SST | | | | | | |
| line No. | DESCRIPTION | | ABBREVIATION | operation pressure bar (psi) | DESIGN PRESSURE BAR (PSI) | REF. | INLET CONNECTION | OUTLET CONNECTION | TEST PORT CONNECTION |
| 1 | LOW PRESSURE SU | IPPLY 1 | LP1 | 310 (4500) | 690 (10000) | T3 | 3/4" OD AE MP (SF750CX) | 3/4" OD AE MP (SF750CX) | 3/4" OD AE MP (PLUG CPX 120) |
| 2 | LOW PRESSURE SU | IPPLY 2 | LP2 | 310 (4500) | 690 (10000) | Т3 | 3/4" OD AE MP (SF750CX) | 3/4" OD AE MP (SF750CX) | 3/4" OD AE MP (PLUG CPX 120) |
| 3 | HIGH PRESSURE SI | UPPLY 1 | HP1 | 627 (9090) | 690 (10000) | Т3 | 3/4" OD AE MP (SF750CX) | 3/4" OD AE MP (SF750CX) | 3/4" OD AE MP (PLUG CPX 120) |
| 4 | HIGH PRESSURE SI | UPPLY 2 | HP2 | 627 (9090) | 690 (10000) | T3 | 3/4" OD AE MP (SF750CX) | 3/4" OD AE MP (SF750CX) | 3/4" OD AE MP (PLUG CPX 120) |
| 5 | SERVICE | | ME | 425 (6160) | 468 (6800) | T4 | 1" OD AE MP (SF1000CX) | 1" OD AE MP (SF1000CX) | 1" OD AE MP (PLUG CPX 160) |

a CLIENT CONTRACT NUMBER: CLIENT DOCUMENT NUMBER: APO/C007/03 NG50-2-300-SCS-PF-ST-64-0163 C. Schulze DATE: REV.: 07.12.2006 04 CAD DO NOT SCALE CAMERON GmbH DRAWN: DATE: J.J. Santos 08.03.2005 DRAWN: **CAMERON** Lückenweg 1 29227 Celle, Germany
 CHECKED:
 DATE:

 J. Vagts
 22.01.2007

 APPROVED:
 DATE:

 L. Ohlendorf
 22.01.2007
 FLOW DIAGRAM: TOPSIDE UMBILICAL TERMINATION (TUT) GAS INJECTION SCALE: / INITIAL USE BOM: SHEET DRAWING NUMBER: 223398-61 10F1 SK-066398-61-01

AKPO_SS_03_27.ai

Subsea Distribution Systems distribute electrical, hydraulic and various chemical supplies from the surface to the subsea equipment, making use of both surface and subsea equipment.

The Electrical Distribution System on Akpo is comprised of an electrohydraulic control system wherein electrical signals are transmitted to the SCM and are used to open or close electrically controlled hydraulic control valves.

To reduce the number of conductors in an umbilical, Akpo uses a common system whereby the electrical signals are modulated (using diplexers) on the same conductors as those used for supplying electrical power to subsea. This system is known as Signal on Power (SOP), or is sometimes referred to as the Communication on Power System.

The electrical power from an Uninterruptible Power Supply (UPS) is fed through a power conditioning unit to provide clean and reliable power to each SPCU.

For electrical line drawings of the Electrical Distribution System refer to:

• NG50-2-300-SCS-DW-SC-64-0062

3.27 Production Control/Distribution System – Flow Diagram: Topside Umbilical Termination (TUT) Gas Injection Refer to: NG50-2-300-SCS-DW-SC-64-0062 HOLD

3.28 Production Control/Distribution System – Subsea Electrical Distribution System Line Drawings

Drawing Supplementary Information

Table of Actuators hydraulic volume data.

For additional data of Hydraulic Actuators refer to:

- NG50-2-300-SCS-PI-SC-30-0649 HPU Subsea Control System
- NG50-2-300-SCS-SP-ST-64-0076 FDS, HPU Total Akpo
- NG50-2-300-SCS-TR-SC-64-0058 Subsea Hydraulic Response Analysis
- NG50-4-400-MEC-PO-GA-00-0001 (Vendor Doc) Hydraulic Pumps and HPU PKG

The table shows the required volume for a Typical Production Tree. The volume should be at least 125% of the total swept volume.

| Description | Qty | Volume | Total Volume |
|----------------------|--------|--------------|---------------|
| SCSSV | 1/well | TBD | TBD |
| 5in Tree Valve | 2/well | 2.98 litres | 5.96 litres |
| 2in FC Tree Valves | 4/well | 0.473 litres | 1.892 litres |
| 2in FO Tree Valves | 1/well | 0.473 litres | 0.473 litres |
| 3/4in FC Tree Valves | 4/well | 0.071 litres | 0.284 litres |
| 3/4in FO Tree Valves | 3/well | 0.071 litres | 0.213 litres |
| Choke | 1/well | TBD | TBD |
| IWC | 1/well | TBD | TBD |
| | | Total | 8.822 litres |
| 125% | | Req Vol | 11.030 litres |

The table below shows the required volume for a Typical Production Manifold. The volume should be at least 125% of the total swept volume.

| Description | Qty | Volume | Total Volume |
|--------------------------|------------|--------------|---------------|
| 5in Manifold Valve | 8 Manifold | 1.34 litres | 5.36 litres |
| 10in FO Manifold Valves | 2 Manifold | 6.654 litres | 19.962 litres |
| 2in FC Manifold Valves | 1 Manifold | 0.473 litres | 0.473 litres |
| 3/4in FC Manifold Valves | 5 Manifold | 0.071 litres | 0.355 litres |
| 3/4in FC HDU Valves | 3 HDU | 0.071 litres | 0.213 litres |
| 3/4in FO HDU Valves | 3 HDU | 0.071 litres | 0.213 litres |
| | | Total | 21.216 litres |
| 125% | | Req Vol | 26.52 litres |

3.29 Production Control/Distribution System – Table of Hydraulic Actuators – Volumes

AKPO Subsea Reference Manual Section 4 Umbilical Data/Volumes

CONTENTS

- 4.1 Umbilical Data/Volumes Dynamic/Static Production Umbilical Cross Section
- 4.2 Umbilical Data/Volumes Dynamic/Static Water Injection Umbilical 76-UD-W11, Cross Section
- 4.3 Umbilical Data/Volumes Static Water Injection Infield Umbilical 76-US-W11, Cross Section
- 4.4 Umbilical Data/Volumes Dynamic/Static Gas Injection Umbilical 56-UD-G41, Cross Section
- 4.5 Umbilical Data/Volumes Dynamic/Static Production Umbilical Spare Umbilical, Cross Section
- 4.6 Umbilical Data/Volumes Umbilicals Data Tables

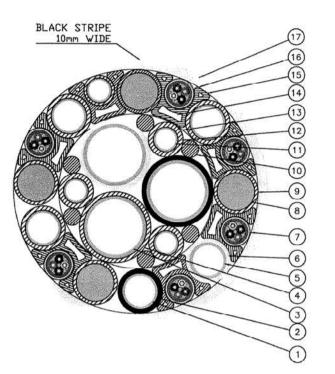
There are four main Production Umbilicals that convey hydraulic, chemical, methanol supplies, electrical communication and power services from the Topsides Umbilical Termination (TUT) unit to the various subsea locations. Each main umbilical consists of a static section that is laid on the seabed and a dynamic section that is hung-off the FPSO. Additional short static sections are used to distribute the main umbilical services to each of the relevant subsea locations.

Each Production Umbilical contains cores for the following:

- 2 x HP and 2 x LP Hydraulic lines (12.7mm ID each)
- 3 x Methanol lines (34mm ID each)
- 1 x Wax Inhibitor line (19mm ID)
- 1 x Corrosion and Scale Inhibitor line (19mm ID)
- 1 x Anti-asphaltine line (19mm ID)
- 1 x Spare chemical line (19mm ID)
- 1 x General spare line (19mm ID)
- 6 x Electrical Power/Signal Quads

The following diagram shows a Production Umbilical in cross section. Refer to:

 NG50-2300-SCS-TR-SC-64-0477 – Total Akpo Project Umbilical Verification Report



| PRELIMINARY MECHANICAL DATA | METRIC |
|---|------------|
| Weight in Air (tubes filled) | 39,22 kg/m |
| Submerged Weight Umbilical flooded & tubes filled | 20,11 kg/m |
| Submerged Weight to Diameter Ratio | 124 kg/m2 |
| Minimum Breaking Load at 150 Bar (no bending) | 1360 kN |
| Axial Stiffness | 446 MN |
| Bend Stiffness | 40 kNm2 |
| Torsional Stiffness | 40 kNm2 |
| Maximum clamping force (per track) | 250 kN/m |
| Maximum strain on delivery reel (dia 4.5m) during storage, 150 bar | 0,88 % |
| MBR (150 Bar, Elastic, No Tension) | 6,20 m |
| MHT (150 Bar, 100% Utilization) | 759 kN |

| - | | - | | | | provident little | And and a state of the state of | |
|------|----------|------------|---|---------------------------------------|--------|----------------------|--|------------------|
| COMP | ANY Doc. | uf. NO | 350-3-212-REQ-DW-AB-19-1501 | 02 | IFC | 117 | A2, 1/1 | 1/1 |
| | 1271 - C | - | | Revision | Status | Class | Scale | Folio |
| | ERVED TO | | UMBILICALS, FLOW DYNAMIC/STATIC CROS | | JCTIO | | | N |
| | Saibo | s | NIGERI AKPO Field De | A - OM | L 130 | | | TOTAL |
| | | 0: 11 m a | TOTAL UPSTRE | and the second designed | | electronic file is i | the MOR Look | 1 |
| 10 N | | ALD FOR R | | , i=uli | | AND Intelator | Reviewed | UN Accorcived |
| | | | A CONSTRUCTION DISTRUCTION | | | NOTE GALEN | Aminut | ENVIORTIZ |
| + | - | - | | | | 1/10 | 124 | 120 |
| + | - | | | | | 100 | | |
| + | -+- | | | | | + | - | 1 |
| POS | ety | | DESCRIPTION | | | NDM. THECKNESS m | 20 | NON. |
| 1 | 4 | SD S | TEEL TUBE, ID-19.0mm 39184 | 8 | _ | 1,5 | | 22,0 |
| 2 | | SHEAT | TH, HOPE | | | 2,55 | | |
| 3 | 3 | 50 ST | TEEL TUBE, ID=34mm 420BAR | 0 | | 2,3 | 38,5 | |
| 4 | | SHEAT | TH, HOPE | | | 2,5 | | |
| 5 | 1 | SD ST | TEEL TUBE, ID=19.0mm 690B | R | | 2,05 | 23,1 | |
| 6 | | | TH, HOPE | | | 2,0 | | |
| 7 | 6 | 1041104110 | RICAL QUAD, 6mm* (ARAMIDE) | i i i i i i i i i i i i i i i i i i i | | | + | 18,5 |
| 8 | 4 | | ROPE | | - | | | 22.3 |
| | - | 11.00.007 | NI. HOPE | | - | 2.4 | | 1010 |
| 10 | 8 | | R ELEMENT (HOPE) | | | 10,5 | - | 15,3 |
| 11 | 4 | | TEEL TUBE, ID-12,7mm 6908 | P | | 1.3 | | 15,3 |
| 12 | 2 | | HAD THE NTLON POLTESTER | - Harris | - | 3,1 | - | li e i e c |
| 13 | 2 | - | PING TAPE, NYLON/POLYESTER | | - | 0,17 | | |
| 15 | 2 | _ | PING TAPE, NYLON/POLYESTER LED FILLER ELEMENT (HOPE) | | | 0,17 | - | |
| 16 | 1 | | PING TAPE, POLYESTER | | | 0,13 | _ | |
| 17 | | | R SHEATH, HOPE | | | 5,5 | 162 | +/-3 |
| _ | | | | | | | | |

AKPO_SS_04_01.png

4.1 Umbilical Data/Volumes – Dynamic/Static Production Umbilical Cross Section

Drawing Supplementary Information

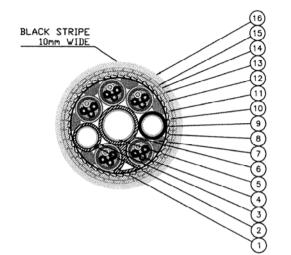
There are three main Water Injection Umbilicals that convey hydraulic and methanol supplies as well as electrical communication and power services from the Topsides Umbilical Termination (TUT) unit to the various subsea locations. Umbilical UMB10 controls Water Injection String WI-10 (partial) and Water Injection String WI-50. Umbilical UMB20 controls Water Injection String WI-20 and the last FLET of Water Injection String WI-10. Umbilical UMB30 controls Water Injection String WI-30 only. Each main umbilical consists of a static section that is laid on the seabed and a dynamic section that is hung-off the FPSO. Additional short static sections are used to distribute the main umbilical services to each of the relevant subsea locations.

Each Water Injection Umbilical contains cores for the following:

- 2 x LP Hydraulic lines (12.7mm ID each)
- 1 x Methanol line (19mm ID)
- 5 x Electrical Power/Signal Quads

The umbilical bases are located at the point of minimal back-tension, to ensure lateral loads on the umbilical are kept within acceptable limits.

A cross-sectional drawing of a Water Injection umbilical is shown

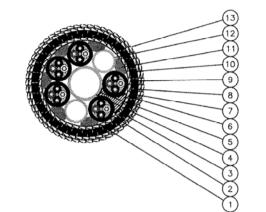


| PRELIMINARY MECHANICAL DATA | METRIC |
|---|------------|
| Weight in Air (tubes filled) | 13,21 kg/m |
| Submerged Weight Umbilical flooded & tubes filled | 8,66 kg/m |
| Submerged Weight to Diameter Ratio | 103 kg/m2 |
| Minimum Breaking Load at 150 Bar (no bending) | 418 kN |
| Axial Stiffness | 186 MN |
| Bend Stiffness | 2,3 kNm2 |
| Torsional Stiffness | 9,6 kNm2 |
| Maximum clamping force (per track) | 250 kN/m |
| Maximum strain on delivery reel (dia 4.5m) during storage, 150 bar | 0,51 % |
| MBR (150 Bar, Elastic, No Tension) | 3,38 m |
| MHT (150 Bar, 100% Utilization) | 310 kN |

| _ | | | | | | | |
|-----|---------------------|--|-----------------------------|-----------------|----------------------------|--------------------|----------------------|
| 16 | | outer sheath, hdpe | | | 3,5 | 84 | +/-3 |
| 15 | 1 | WRAPPING TAPE, POLYESTER | | | 0,13 | | |
| 14 | 1 | WRAPPING TAPE, NYLON/POLYESTER | | | 0,17 | | |
| 13 | 2 | WRAPPING TAPE, MELINEX | | | 0,05 | | |
| 12 | 36 | GALVANIZED FLAT ARMOUR WIRES, G | RADE 65 | 2 | 0 X 6,0 | | |
| 11 | 1 | WRAPPING TAPE, FPP | | | 0,15 | | |
| 10 | 34 | GALVANIZED FLAT ARMOUR WIRES, G | RADE 65 | 2 | ,0 X 6,0 | | |
| 9 | 51 | PP YARN (ARMOUR BEDDING) | | | | | |
| 8 | 2 | WRAPPING TAPE, NYLON/POLYESTER | | | 0,17 | | |
| 7 | 6 | FILLER ELEMENT (PP) | | | 8,0 | | |
| 6 | | Sheath, Hope | | | 2,0 | | |
| 5 | 1 | SD STEEL TUBE, ID=19.0mm 391B | NR . | | 1,5 | | 22,0 |
| 4 | 1 | PROFILED FILLER ELEMENT (HOPE) | | | | | |
| 3 | | sheath, hdpe | | | 1,6 | | |
| 2 | 2 | SD STEEL TUBE, ID=12,7mm 6908 | WR. | | 1,3 | _ | 15,3 |
| 1 | 5 | ELECTRICAL QUAD, 6mmª (ARAMIDE) | | | | | 18,5 |
| POR | OTY | DESCRIPTION | | | NDK. | | NDK. |
| | | | | | 1/w | and the | MBe International |
| | 10205 (555) | SUED FOR CONSTRUCTION TO FOR CONSTRUCTION | | | AND AND | 441 | 0.000 |
| | 1105 650 | DFOR REVEW DESIGNATION | | | AHO | Just Generation | ER. |
| - | WARNING | This document as privited they not be the lease to | erson Please | neller is the c | kochronie fike in d | to MDR isola" | |
| | Saibo | | A - OMI | L 130 | | εD | ToTA |
| | | AKPO Field De | evelopn | nent Pr | oject | | Louisvesse |
| | | | | | | IFR) | |
| | ERVED TO | UMBILICALS, FLOV | VLINES | AND R | ISERS (I | | N |
| | ERVED TO PO LOGO | UMBILICALS, FLOW | VLINES | AND R | ISERS (I | | N |
| | | UMBILICALS, FLOW DYNAMIC/STATIC W | VLINES | AND R | ISERS (I | | N |
| AЮ | | UMBILICALS, FLOV DYNAMIC/STATIC W/ 76-UD-W11 | VLINES ATER IN , CROS | AND R | ISERS (I ON UMB TION | ILICAL | N |

AKPO_SS_04_02.png

4.2 Umbilical Data/Volumes – Dynamic/Static Water Injection Umbilical 76-UD-W11, Cross Section



| POS | e Ty | DESCRIPTION | NOL THICKNESS M | NDA BLAN AN |
|-----|-------------|--|--------------------|----------------|
| 1 | 2 | WRAPPING TAPE, NYLON/POLYESTER | 0.17 | |
| 2 | 5 | ELECTRICAL QUAD, 6mm* | | 16.3 |
| 3 | 1 | PROFILED FILLER ELEMENT (HDPE) | | |
| 4 | 1 | SD STEEL TUBE, ID-19.0mm 391bar | 1.5 | 22.0 |
| 5 | 1 | WRAPPING TAPE | | |
| 6 | 49 | PP YARN (ARMOUR BEDDING) | | |
| 7 | 29 | GALVANIZED FLAT ARMOUR WIRES, GREDE 65 | 2.0 X 6.0 | |
| 8 | 1 | WRAPPING TAPE, FPP | 0.15 | |
| 9 | 31 | GALVANIZED FLAT ARMOUR WIRES, GRADE 65 | 2.0 X 6.0 | |
| 10 | 2 | WRAPPING TAPE, MELINEX | 0.05 | |
| 11 | 6 | FILLER ELEMENT (PP) | 7.0 | |
| 12 | 2 | SD STEEL TUBE, iD=12.7mm 690bar | 1.3 | 15.3 |
| 13 | 55/57 | PP YARN (OUTER COVER) | | 77 +/-3 |

| | | | | Electronic file neme : NG50-3-212-REQ-OW-AB-1 | | | | 534_mv03 |
|-----------------------|---------|------------|---|---|----------------|------------------------------------|-----------------------------|----------|
| CO | MPANY C | koc. nat . | NG50-3-212-REQ-DW-AB-19-1534 | 03 | IFC | 12 | A2, 1/1 | 1/1 |
| | | | | Revision | Sist/a | Class | Scale | Falio |
| Saibos RESERVED TO | | | UMBILICALS, FLOV STATIC WATER INJE 76-US-W12 | ECTION | INFIE | D UMBIL | | N•*** |
| | | | NIGERI | TOTAL UPSTREAM NIGERIA LIMITED NIGERIA - OML 130 AKPO Field Development Project | | | | |
| Rev. | Oete | RNING, 17 | DESIGNATION de document es printed may not be the talent y | watoo, Piesaw | e refer la Ste | Inditator electronic file in th | Raviewed by a MOR social | Approved |
| | 220805 | INSUED IN | DEBIONATION | | | ANO . | | |
| 01 | 100108 | RE-ISALE | D FOR REVIEW | | | AND | Aut i | U |
| 8 | 20000 | | D FOR CONSTRUCTION | | NOTING OLALEBO | Candel | COWA INCIDE | |
| | | | | | | Ha | alt | Co. |
| | - | | | _ | | 100 | | - |
| | | - | | | - | | - | - |

AKPO_SS_04_02.png

| PRELIMINARY MECHANICAL DATA | METRIC |
|---|------------|
| Weight in Air (tubes filled) | 11,17 kg/m |
| Submerged Weight Umbilical flooded & tubes filled | 7,69 kg/m |
| Submerged Weight to Diameter Ratio | 100 kg/m2 |
| Minimum Breaking Load at 150 Bar (no bending) | 372 kN |
| Axial Stiffness | 162 MN |
| Bend Stiffness | 2,2 kNm2 |
| Torsional Stiffness | 7,0 kNm2 |
| Maximum clamping force (per track) | 250 kN/m |
| Maximum strain on delivery reel (dia 4.5m) during storage, 150 bar | 0,51 % |
| MBR (150 Bar, Elastic, No Tension) | 3,38 m |
| MHT (150 Bar, 100% Utilization) | 276 kN |

4.3 Umbilical Data/Volumes – Static Water Injection Infield Umbilical 76-US-W11, Cross Section

Drawing Supplementary Information

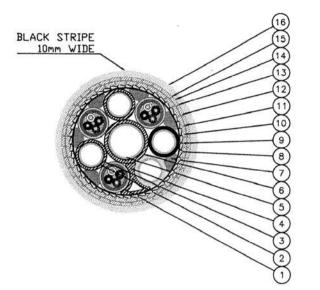
There is one main Gas Injection Umbilical that conveys hydraulic and methanol supplies as well as electrical communication and power services from the Topsides Umbilical Termination (TUT) unit to the various subsea locations. The main umbilical consists of a static section that is laid on the seabed and a dynamic section that is hung-off the FPSO. Additional short static sections are used to distribute the main umbilical services to each of the relevant subsea locations.

The Gas Injection Umbilical contains cores for the following:

- 2 x LP Hydraulic lines (12.7mm ID each)
- 2 x HP Hydraulic lines (12.7mm ID each)
- 1 x Methanol line (19mm ID)
- 3 x Electrical Power/Signal Quads

The umbilical bases are located at the point of minimal back-tension, to ensure lateral loads on the umbilical are kept within acceptable limits.

A cross-sectional drawing of a Gas Injection umbilical is shown.



| PRELIMINARY MECHANICAL DATA | METRIC |
|---|------------|
| Weight in Air (tubes filled) | 14,00 kg/m |
| Submerged Weight Umbilical flooded & tubes filled | 8,88 kg/m |
| Submerged Weight to Diameter Ratio | 105 kg/m2 |
| Minimum Breaking Load at 150 Bar (no bending) | 432 kN |
| Axial Stiffness | 205 MN |
| Bend Stiffness | 2,9 kNm2 |
| Torsional Stiffness | 9,8 kNm2 |
| Maximum clamping force (per track) | 250 kN/m |
| Maximum strain on delivery reel (dia 4.5m) during storage, 150 bar | 0,51 % |
| MBR (150 Bar, Elastic, No Tension) | 3,37 m |
| MHT (150 Bar, 100% Utilization) | 341 kN |

| POS | QTY | DESCRIPTION | NOK THICKNESS H |
|-----|-----|--|--------------------|
| 1 | 3 | ELECTRICAL QUAD, 6mm" (ARAMIDE) | |
| 2 | 4 | SD STEEL TUBE, ID=12,7mm 690BAR | 1,3 |
| 3 | | SHEATH, HDPE | 1,6 |
| 4 | 1 | PROFILED FILLER ELENENT (HDPE) | The second second |
| 5 | 1 | SD STEEL TUBE, ID=19.0mm 442BAR | 1,5 |
| 8 | | SHEATH, HDPE | 2,0 |
| 7 | 6 | FILLER ELEMENT (PP) | 8,0 |
| 8 | 2 | WRAPPING TAPE, NYLON/POLYESTER | 0,17 |
| 9 | 51 | PP YARN (ARMOUR BEDDING) | |
| 10 | 34 | GALVANIZED FLAT ARMOUR WIRES, GRADE 65 | 2,0 X 6,0 |
| 11 | 1 | WRAPPING TAPE, FPP | 0,15 |
| 12 | 36 | GALVANIZED FLAT ARMOUR WIRES, GRADE 85 | 2,0 X 6,0 |
| 13 | 2 | WRAPPING TAPE, WELINEX | 0,05 |
| 14 | 1 | WRAPPING TAPE, NYLON/POLYESTER | 0,17 |
| 15 | 1 | WRAPPING TAPE, POLYESTER | 0,13 |
| 15 | | OUTER SHEATH, HOPE | 3,5 |

AKPO_SS_04_04.png

| _ | | | | | | | | |
|--------------------------|--------|-------------|---|----------------|-------------|--|--|--|
| | - | | | a | 1/200 | | | |
| - | 010402 | REASING | DR CONSPLICTION | ANCENS CLAUBSE | JOHINAL | | | |
| | 170206 | | CONSTRUCTION | NIC | 1000 | | | |
| 01 | 25468 | RE-ISSUED F | | ANQ | Jarii . | | | |
| 1 | 72068 | ISSUED FOR | | ANO . | And | | | |
| | 163615 | ISSUED FOR | 0xC | 810 | KRIT. | | | |
| Rev. | Diate | | DESIGNATION | NORE BY N | Revenued In | | | |
| Saibos | | ibos | NIGERIA - OML 130 AKPO Field Development Project | | | | | |
| RESERVED TO AKPO LOGO | | | UMBILICALS, FLOWLINES AND | | | | | |

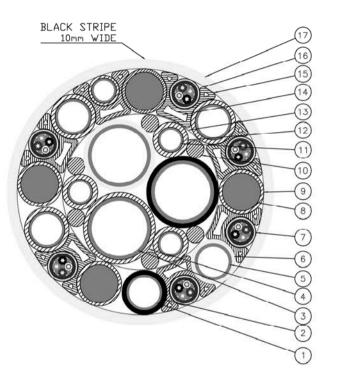
 Revealed
 Status
 Class
 Scale

 COMPANY Doc. ml
 NG50-3-212-REQ-DW-AB-19-1560
 03
 IFC
 // 2
 A2, 1/1

 Electronic file name
 NG50-3-212-REQ-DW-AB-19-1560
 NG50-3-212-REQ-DW-AB-19-1560

Spare Dynamic/Static Production Umbilical.

4.4 Umbilical Data/Volumes – Dynamic/Static Gas Injection Umbilical 56-UD-G41, Cross Section



| PRELIMINARY MECHANICAL DATA | METRIC |
|---|------------|
| Weight in Air (tubes filled) | 39,22 kg/m |
| Submerged Weight Umbilical flooded & tubes filled | 20,11 kg/m |
| Submerged Weight to Diameter Ratio | 124 kg/m2 |
| Minimum Breaking Load at 150 Bar (no bending) | 1470 kN |
| Axial Stiffness | 453 MN |
| Bend Stiffness | 42 kNm2 |
| Torsional Stiffness | 35 kNm2 |
| Maximum clamping force (per track) | 250 kN/m |
| Maximum strain on delivery reel (dia 4.5m) during storage, 150 bar | 0.88 % |
| MBR (150 Bar, Elastic, No Tension) | 6.43 m |
| MHT (150 Bar, 100% Utilization) | 756 kN |

| 16 | | OUTER SHEATH, HDPE | | 5,5 162 | | | | |
|-------------------------------|--|---|---|--|---------------------------|--|----------------------|--|
| 10 | 1 | WRAPPING TAPE, POLYESTER | | | 0,13 | | | |
| 15 | 2 | WRAPPING TAPE, NYLON/POLYESTE | R | | 0,17 | | | |
| 14 | 7 | PROFILED FILLER ELEMENT (HDPE) |) | | | | | |
| 13 | 2 | WRAPPING TAPE, NYLON/POLYESTE | R | 0,17 | | | | |
| 12 | | SHEATH, HDPE | | | | | | |
| 11 | 4 | SD STEEL TUBE, ID=12,7mm 690 | BAR | | 1,3 | i. | 15,3 | |
| 10 | 6 | FILLER ELEMENT (HDPE) | | | 10,5 | | 15,3 | |
| 9 | | SHEATH, HDPE | | | 2,0 | | | |
| 8 | 4 | STEEL ROPE | | | | | 23,1 | |
| 7 | 6 | ELECTRICAL QUAD, 6mm ² (ARAMID | E) | | | | 18,5 | |
| 6 | | SHEATH, HDPE | | | 2,0 | | | |
| 5 | 1 | SD STEEL TUBE, ID=19.0mm 690 | BAR | | 2,05 | | 23,1 | |
| 4 | | SHEATH, HDPE | | | 2,5 | | | |
| 3 | 3 | SD STEEL TUBE, ID=34mm 420B4 | NR . | | 2,3 | | 38,6 | |
| 2 | | SHEATH, HDPE | | 2,55 | | | | |
| | 25.7 | | 0.0822 | 1,5 | | | 1000042100 | |
| 1 | 4 | SD STEEL TUBE, ID=19.0mm 391 | BAR | | 1,5 | | 22,0 | |
| - | 4 0TY | SD STEEL TUBE, ID=19.0mm 391 | BAR | 1 | 1,5 NON HEICHIESS m | n | 22,0 NDM ML nn | |
| PDS | 0TY | and the second se | BAR | Air is the | NON | Jarri Jarri Jarri Jarri Victoria | NDK | |
| PDS | 0TY | | EAM NIC | GERIA 130 | | arti Arti Arti Arti Cinde | NDK NNL nn | |
| POS 01 11 02 21 RESI | | VIET DIA CONTINUETON ALCO DIA REVIEW TOTAL UPSTR OS NIGEF AKPO Field I UMBILICALS, FLO | Citate: Four S EAM NIC RIA - OML Developmi WULINES A C PRODUC | ant Providence Provide | A LIMIT | am am e⊃ | | |
| POS 01 11 02 21 RESI | anv team t | ABLING CONSTRUCTION LED FOR CONSTRUCTION LED FOR EXMAN C THE DECISION OF THE DECISION OF THE C THE DECISION OF THE DECISION OF THE DECISION OF THE C THE DECISION OF THE DECISION OF THE DECISION OF THE C THE DECISION OF THE DECIS | CALL FOR AND EAM NIC RIA - OML Developme WULINES A C PRODUC LICAL, CR | ant Providence Provide | A LIMIT | am am e⊃ | | |

AKPO_SS_04_05.png

4.5 Umbilical Data/Volumes – Dynamic/Static Production Umbilical Spare Umbilical, Cross Section

Drawing Supplementary Information

Table of the umbilical lengths and volumes for:

Production umbilicals

- UMB-1 (P10)
- UMB-2 (P20)
- UMB-3 (P30)
- UMB-4 (P40)

Water injection umbilicals

- UMB-5 (WI10+WI50)
- UMB-6 (WI20)
- UMB-7 (WI30)

Gas injection umbilical

• UMB-8 (WI40)

AKPO UMBILICALS DATA

| | | | | | | | | | | - | | | |
|---------------------------------------|------------------------------|-------------|-------------|-------------|------|--------------|--------|--------|-------|---------|--------------|-----------|----------|
| Production umbilicals | Line | LP1 | LP2 | HP1 | HP2 | meth 1 | meth 2 | meth 3 | Spare | Corr/SI | Wax inhib | Anti Asph | Spare ch |
| | ID | 1/2 | 1/2 | 1/2 | 1/2 | 34 | 34 | 34 | 19 | 19 | 19 | 19 | 19 |
| | Pservice (bar) | 310 | 310 | 527 | 527 | 348 | 348 | 348 | 527 | 350 | 350 | 350 | 350 |
| UMB-1 (P10) | Dynamic length(m) | 3180 | 3180 | 3180 | 3180 | 3180 | 3180 | 3180 | 3180 | 3180 | 3180 | 3180 | 3180 |
| | Static length (m) | 3220 | 3220 | 3220 | 3220 | 3220 | 3220 | 3220 | 3220 | 3220 | 3220 | 3220 | 3220 |
| | Line volume (I) | 811 | 811 | 811 | 811 | 5811 | 5811 | 5811 | 1815 | 1815 | 1815 | 1815 | 1815 |
| | Line volume (m3) | 0.81 | 0.81 | 0.81 | 0.81 | 5.81 | 5.81 | 5.81 | 1.81 | 1.81 | 1.81 | 1.81 | 1.81 |
| | | 0.01 | 0.01 | 0.01 | 0.01 | 3.01 | 5.01 | 5.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| UMB-2 (P20) | Dynamic length(m) | 5315 | 5315 | 5315 | 5315 | 5315 | 5315 | 5315 | 5315 | 5315 | 5315 | 5315 | 5315 |
| | Static length (m) | 1960 | 1960 | 1960 | 1960 | 1960 | 1960 | 1960 | 1960 | 1960 | 1960 | 1960 | 1960 |
| | Line volume (I) | 922 | 922 | 922 | 922 | 6605 | 6605 | 6605 | 2063 | 2063 | 2063 | 2063 | 2063 |
| | Line volume (m3) | 0.92 | 0.92 | 0.92 | 0.92 | 6.61 | 6.61 | 6.61 | 2.06 | 2.06 | 2.06 | 2.06 | 2.06 |
| | | _ | _ | | _ | _ | _ | _ | _ | - | | | |
| UMB-3 (P30) | Dynamic length(m) | 3710 | 3710 | 3710 | 3710 | 3710 | 3710 | 3710 | 3710 | 3710 | 3710 | 3710 | 3710 |
| | Static length (m) | 1970 | 1970 | 1970 | 1970 | 1970 | 1970 | 1970 | 1970 | 1970 | 1970 | 1970 | 1970 |
| | Line volume (I) | 720 | 720 | 720 | 720 | 5157 | 5157 | 5157 | 1610 | 1610 | 1610 | 1610 | 1610 |
| | Line volume (m3) | 0.72 | 0.72 | 0.72 | 0.72 | 5.16 | 5.16 | 5.16 | 1.61 | 1.61 | 1.61 | 1.61 | 1.61 |
| | Discourse in the seath (sea) | 0115 | 0115 | 0115 | 0115 | 0115 | 0115 | 0115 | 0115 | 2115 | 0115 | 2115 | 0115 |
| UMB-4 (P40) | Dynamic length(m) | 3115 | 3115 | 3115 | 3115 | 3115 | 3115 | 3115 | 3115 | 3115 | 3115 | 3115 | 3115 |
| | Static length (m) | 3925 | 3925 | 3925 | 3925 | 3925 | 3925 | 3925 | 3925 | 3925 | 3925 | 3925 | 3925 |
| | Line volume (I) | 892 0.89 | 892 0.89 | 892 0.89 | 892 | 6392 6.39 | 6392 | 6392 | 1996 | 1996 | 1996 2.00 | 1996 | 1996 |
| | Line volume (m3) | 0.89 | 0.89 | 0.89 | 0.89 | 0.39 | 6.39 | 6.39 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| Water inj umbilicals | Line | LP1 | LP2 | Sce line | 1 | | | | | | | | |
| Water ing ambilicato | ID | 1/2 | 1/2 | 19 | | | | | | | | | |
| | Pservice (bar) | 310 | 310 | 348 | | | | | | | | | |
| | | | | | | | | | | | | | |
| UMB-5 (WI10+WI50) | Dynamic length(m) | 2980 | 2980 | 2980 | | | | | | | | | |
| | Static length (m) | 7145 | 7145 | 7145 | | | | | | | | | |
| | Line volume (I) | 1283 | 1283 | 2871 | | | | | | | | | |
| | Line volume (m3) | 1.28 | 1.28 | 2.87 | | | | | | | | | |
| | | | | | | | | | | | | | |
| UMB-6 (WI20) | Dynamic length(m) | 5395 | 5395 | 5395 | | | | | | | | | |
| | Static length (m) | 5835 | 5835 | 5835 | | | | | | | | | |
| | Short umb length(m) | 3415 | 3415 | 3415 | | | | | | | | | |
| | Line volume (I) | 1855 | 1855 | 4152 | | | | | | | | | |
| | Line volume (m3) | 1.86 | 1.86 | 4.15 | 1 | | | | | | | | |
| UMB-7 (WI30) | Dynamic length(m) | 2910 | 2910 | 2910 | 1 | | | | | | | | |
| | Static length (m) | 3915 | 3915 | 3915 | | | | | | | | | |
| | Short umb length(m) | 2355 | 2355 | 2355 | | | | | | | | | |
| | Line volume (I) | 1163 | 1163 | 2603 | | | | | | | | | |
| | Line volume (m3) | 1.16 | 1.16 | 2.60 | | | | | | | | | |
| | | | | 2.00 | | | | | | | | | |
| Gas injection umbilical | Line | LP1 | LP2 | HP1 | HP2 | Sce line | 1 | | | | | | |
| UMB-8 (WI40) | ID | 1/2 | 1/2 | 1/2 | 1/2 | 19 | | | | | | | |
| · · · · · · · · · · · · · · · · · · · | Pservice (bar) | 310 | 310 | 627 | 627 | 348 |] | | | | | | |
| | Dynamic length(m) | 5665 | 5665 | 5665 | 5665 | 5665 | 1 | | | | | | |
| | Line volume (I) | 718 | 718 | 718 | 718 | 1606 | | | | | | | |
| | Line volume (m3) | 0.72 | 0.72 | 0.72 | 0.72 | 1.61 | J | | | | | | |
| | | | | | | | - | | | | | | |

4.6 Umbilical Data/Volumes – Umbilicals Data – Tables

AKPO Subsea Reference Manual Section 5 ROV Intervention Tooling

CONTENTS

- 5.1 ROV Intervention Tooling Scope of Supply Total AKPO Field Development
- 5.2 ROV Intervention Tooling Assembly Drawing, Multipurpose Running Tool
- 5.3 ROV Intervention Tooling Assembly Drawing, Multipurpose Running Tool Shipping Skid
- 5.4 ROV Intervention Tooling Choke Insert Running Tool (CIRT)
- 5.5 ROV Intervention Tooling CIRT Shipping and Test Skid
- 5.6 ROV Intervention Tooling General Assembly Doghouse Running Tool
- 5.7 ROV Intervention Tooling ImpROViser Torque Tool (Class 4)
- 5.8 ROV Intervention Tooling ImpROViser Torque Tool (Class 4) Control System
- 5.9 ROV Intervention Tooling ImpROViser Torque Tool (Class 4) Torque Analyser
- 5.10 ROV Intervention Tooling Flying Lead Orientation Tool (FLOT)
- 5.11 ROV Intervention Tooling Linear Valve Override Tool 2in and 5in (LVOT)
- 5.12 ROV Intervention Tooling Linear Valve Override Tool Test Fixture
- 5.13 ROV Intervention Tooling 5in Lock Out Tool
- 5.14 ROV Intervention Tooling 2in Lock Out Tool
- 5.15 ROV Intervention Tooling Torque Limited Fork Tool

CONTENTS (cont'd)

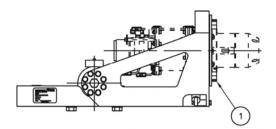
- 5.16 ROV Intervention Tooling General Assembly Doghouse Running Tool Shipping Skid
- 5.17 ROV Intervention Tooling Valve Torque Tables

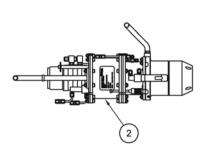
Subsea connection and repair operations require assistance from the Remote Operated Vehicle (ROV). The ROV may use manipulators to do simple tasks, or perform advanced intervention operations by use of tailor made ROV tools.

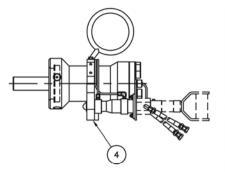
Intervention tooling available to ROV operations is illustrated in the Scope of Supply drawings

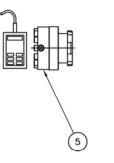
Refer to:

• NG502-324-INT-DW-SR-30-0036 – Scope of Supply









GA DRAWING REF :0350-0200 CAMERON REF :SK-119829-02 AKPO PROJECT REF :NG50-2-324-INT-DW-SR-30-0002

GA DRAWING REF :0350-0201 CAMERON REF :SK-119829-03 AKPO PROJECT REF :NG50-2-324-INT-DW-SR-30-0007

 GA DRAWING
 REF
 :0.350-0202

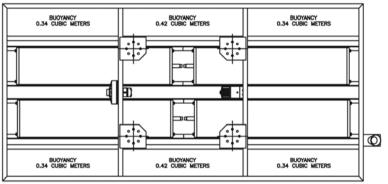
 CAMERON
 REF
 :SK-119829-0005

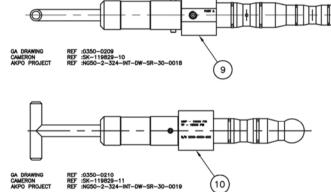
 AKPO PROJECT
 REF
 :NG50-2-324-INT-DW-SR-30-0010

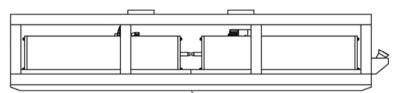
 GA DRAWING
 REF
 :0350-0205

 CAMERON
 REF
 :SK-119829-06

 AKPO
 PROJECT
 REF
 :NG50-2-324-INT-DW-SR-30-0013

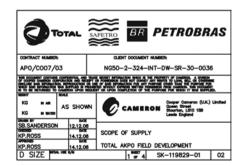




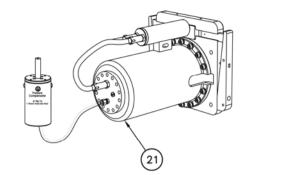


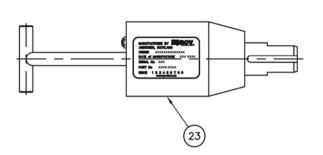
(8)

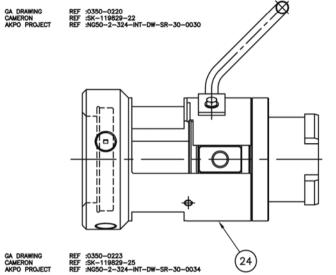
GA DRAWING REF :0350-0208 CAMERON REF :SK-119829-09 AKPO PROJECT REF :NG50-2-324-INT-DW-SR-30-0017



5.1 ROV Intervention Tooling – Scope of Supply – Total AKPO Field Development (Page 1 of 5)







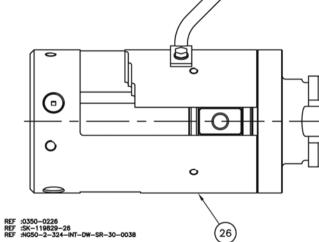
GA DRAWING CAMERON AKPO PROJECT

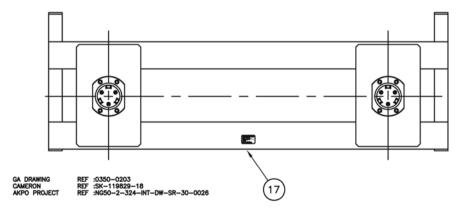


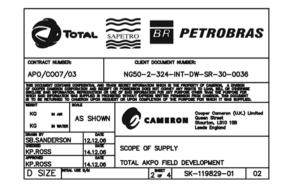


GA DRAWING CAMERON AKPO PROJECT

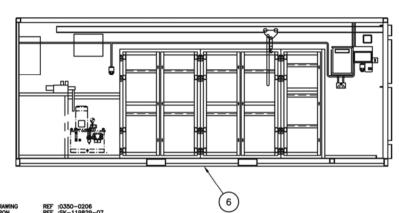
GA DRAWING CAMERON AKPO PROJECT REF :0350-0222 REF :SK-119829-24 REF :NG50-2-324-INT-DW-SR-30-0033

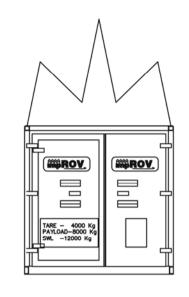


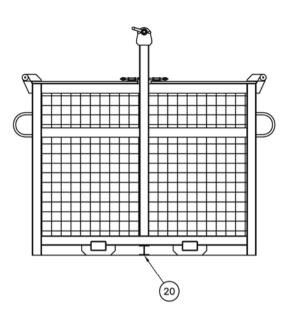




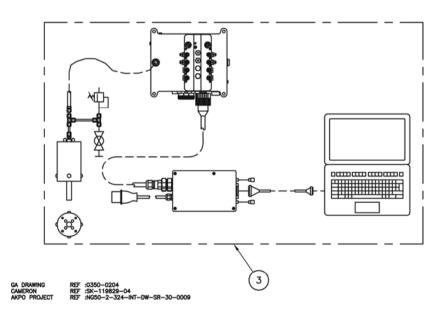
5.1 ROV Intervention Tooling – Scope of Supply – Total AKPO Field Development (Page 2 of 5)

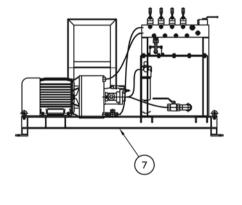






GA DRAWING REF :0350-0206 CAMERON REF :SK-119829-07 AKPO PROJECT REF :NG50-2-324-INT-DW-SR-30-0015





 GA
 DRAWING
 REF
 :0350-0219

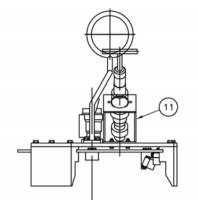
 CAMERON
 REF
 :SK-119829-21

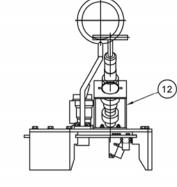
 AKPO
 PROJECT
 REF
 :NG50-2-324-INT-DW-SR-30-0029

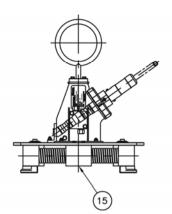
| CAMERON REI | : :0350-0207 : :SK-119829-08 : :NG50-2-324-INT-DW-SR-30-0016 |
|-------------|--|
|-------------|--|

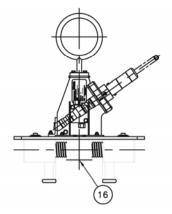
| | SAPETRO |
|--|--|
| CONTRACT NUMBER: | CLIENT DOCUMENT NUMBER: |
| AP0/C007/03 | NG50-2-324-INT-DW-SR-30-0036 |
| KG H WITH | A Province status of control and status of the Additional and the Addi |
| BANNE BY BANE SB.SANDERSON 12.12.06 GEDBBS BANE KP.ROSS 14.12.06 APPROVED BANE | SCOPE OF SUPPLY TOTAL AKPO FIELD DEVELOPMENT |
| KP.ROSS 14.12.06 | 3 ⁴ 4 SK-119829-01 02 |

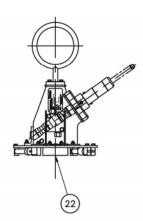
5.1 ROV Intervention Tooling – Scope of Supply – Total AKPO Field Development (Page 3 of 5)











GA DRAWING REF :0350-0211 CAMERON REF :SK-119829-12 AKPO PROJECT REF :NG50-2-324-INT-DW-SR-30-0020

> > (19)

GA DRAWING REF :0350-0212 CAMERON REF :SK-119829-13 AKPO PROJECT REF :NG50-2-324-INT-DW-SR-30-0021

 GA
 DRAWING
 REF
 :0350-0215

 CAMERON
 REF
 :SK-119829-16

 AKPO
 PROJECT
 REF
 :NG50-2-324-INT-DW-SR-30-0024

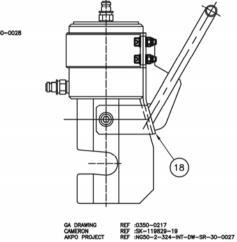
 GA
 DRAWING
 REF
 :0350-02160

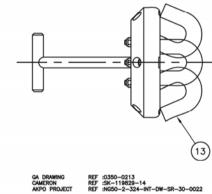
 CAMERON
 REF
 :SK-119829-17

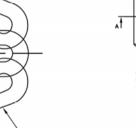
 AKPO
 PROJECT
 REF
 :NG50-2-324-INT-DW-SR-30-0025

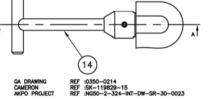
REF :0350-0221 REF :SK-119829-23 REF :NG50-2-324-INT-DW-SR-30-0032











GA DRAWING CAMERON AKPO PROJECT

| TOTAL | SAPETRO BR PETROBRAS |
|--|--|
| CONTRACT NUMBER: | CLIENT DOCUMENT NUMBER: |
| AP0/C007/03 | NG50-2-324-INT-DW-SR-30-0036 |
| KG H AR AS SHOW | N CAMERON CONTINUES IN A Second Content (U.C.) Limited |
| SB.SANDERSON 12.12.00 Second Second KP.ROSS 14.12.00 Second KP.ROSS 14.12.00 Second KP.ROSS 14.12.00 | SCOPE OF SUPPLY |
| | A SK-119829-01 02 |

5.1 ROV Intervention Tooling – Scope of Supply – Total AKPO Field Development (Page 4 of 5)

| ITEM DESCRIPTION | QTY | UNIT |
|------------------|-----|------|
|------------------|-----|------|

| 1 | Flying Lead Orientation Tool (F.L.O.T.) | 5 | |
|-----|---|-----|--|
| 2 | impROViser Torque Tool (Class 4) | 5 | |
| 3 | Control System | 5 | |
| 4 | Linear Valve Override Tool 2" & 5" (L.V.O.T.) | 4 | |
| 5 | Linear Valve Override Tool Test Fixture | 4 | |
| 6 | Support Container | 2 | |
| 7 | Hydraulic Power Supply | 3 | |
| 8 | Methanol Skid | 3 | |
| 9 | Dual Port Hot Stab, Type A | 6 | |
| 10 | Single Port Hot Stab, Type A | 3 | |
| 11 | Gasket Cleaning Tool, 18-3/4" | 4 | |
| 12 | Gasket Cleaning Tool, 13-5/8" | 4 | |
| 13 | Gasket Cleaning Tool, 5" | 4 | |
| 14 | Gasket Cleaning Tool, 2" | 4 | |
| 15 | Gasket Changeout Tool, 18-3/4" | 3 | |
| 16 | Gasket Changeout Tool, 13-5/8" | 3 | |
| 17 | Telemetry Docking Frame | 4 | |
| 18 | Rope/Pipe Cutter | 3 | |
| 19 | Water Blast Unit | 2 | |
| 20 | Subsea Storage Basket | 6 | |
| 21 | Subsea Class 4 Torque Analyser | 4 | |
| 22 | 5" x 2" Gasket Changeout Tool | 3 | |
| 23 | Torque Limited Fork Handle | 8 | |
| 24 | 2" Lock Out Tool | 3 | |
| 25 | ROV Interfacing Equipment | 5 | |
| 26 | 5" Lock Out Tool | 3 | |
| | | | |
| | | | |
| | | | |
| 900 | Manufacturing Data Record | Ref | |
| 901 | Operating & Maintenance Manual | Ref | |

5.1 ROV Intervention Tooling – Scope of Supply – Total AKPO Field Development (Page 5 of 5)

Drawing Supplementary Information

Multi-purpose Running Tool (MPRT)

The MPRT system is designed to provide a means of remote installation and removal of the Subsea Control Modules (SCM), Subsea Accumulator Modules (SAM), Long Term Covers (LTC) for Subsea Control Module Mounting Base (SCMMB) and choke inserts of the AKPO water injection tree.

The SCM lifting interface is used to lock and unlock it to and from its SCMMB. The MPRT is fitted with an SCM lifting and lock-down mechanism, suspended from beneath the MPRT lifting Beam.

Specifications and dimensions of the MPRT in are as follows:

| • | |
|---------------------------------|--------------------|
| Overall Height (when suspended) | 3090mm/121.65in |
| Overall Width | 1990mm/78.35in |
| Overall Depth | 1505mm/59.25in |
| Weight in Air | 3000kg/6172.94 lb |
| Weight in Water | 2540kg/5434.39 lb |
| Maximum Design Depth | 3000 metres/9845ft |
| Maximum Payload | 2000kg/4409.24 lb |

Refer to:

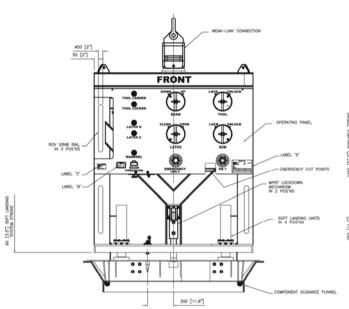
 NG50-2-300-SCS-MA-SR-64-0347 – Operation and Maintenance Manual (MPRT)

NOTE:

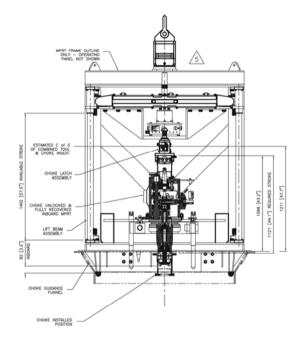
| 1 MAX. PAYLOAD | 2000KG (4400 LBS) |
|---|--|
| MODULE LOCKDOWN FORCES SETTING 1 SETTING 2 SETTING 3 MODULE RETREIVAL FORCES SETTING 1 SETTING 2 SETTING 3 | - 7000KG (15400 LBS) - 3000KG (6600 LBS) - 2000KG (4400 LBS) |
| ESTIMATED WEIGHT OF TOOL IN AIR IN WATER | :- - 3000KG (6614 LBS) - 2540KG (5600 LBS) |

5 WEAK LINK ASSEMBLY IN 'SAFE' CONDITION - SWL 6 TONNES

IN WEAK' CONDITION - WILL SHEAR AT 5-6 TONNES FORCE REQUIRED TO ARM/DISARM APPROXIMATELY 200N



Ŧ MPRT FRAME ONLY - OI PANEL NOT $\overline{5}$ -LATCH ASSEMBLY/SCM MANDREL INTERFACE LATCH ASSEMBLY TROKE 54.77 ESTIMATED C of G OF COMBINED TOOL ۳æ: [56.97] SCM UNLOCKED & FULLY RECOVERED INBOARD MPRT 447 LIFT BEAM ASSEMBLY SCM GUIDANCE FUNNEL K = 1 ᅄᇣ _ SCM FULLY INSTALLED & LOCKED



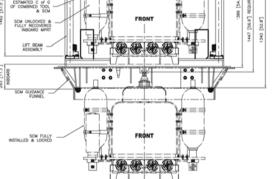
FRONT VIEW OF TOOL SHOWING CHOKE RECOVERY/DEPLOYMENT POSITIONS

AKPO_SS_05_02.png



SCHE 1:1 10F5 SK-066403-08 -----223403-08





FRONT VIEW OF TOOL PRIOR TO FULLY LANDING

FRONT VIEW OF TOOL SHOWING SCM RECOVERY/DEPLOYMENT POSITIONS

5.2 ROV Intervention Tooling – Assembly Drawing, Multipurpose Running Tool

Drawing Supplementary Information

The MPRT Shipping Skid consists of a carbon steel framework, which provides a stable base and protection for the running tool during offshore transportation and lifting. The skid is designed and certified in accordance with BS EN 12079/DNV 2.7-1. The skid is coated with a 'topside' epoxy paint scheme, the top coat colour being white to RAL9016.

The skid does not allow for the transportation of any of the component payloads.

Specifications and dimensions of the MPRT Shipping Skid are as follows:

| Overall Height | 2995mm/177.9in |
|------------------------------------|-------------------|
| Overall Width | 2610mm/102.8in |
| Overall Depth | 2000mm/78.74in |
| Tare Mass | 1900kg/4188.78 lb |
| Payload | 3000kg/6172.94 lb |

Refer to:

 NG50-2-300-SCS-MA-SR-64-0347 – Operation and Maintenance Manual (MPRT)



TOTAL

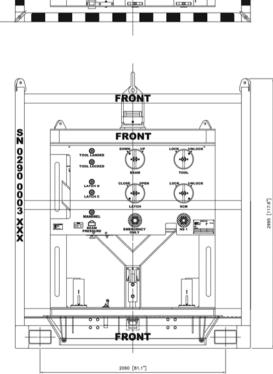
OLENT CONTRACT NUMBER

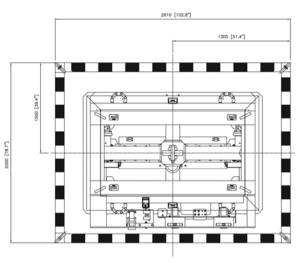
SAPETRO

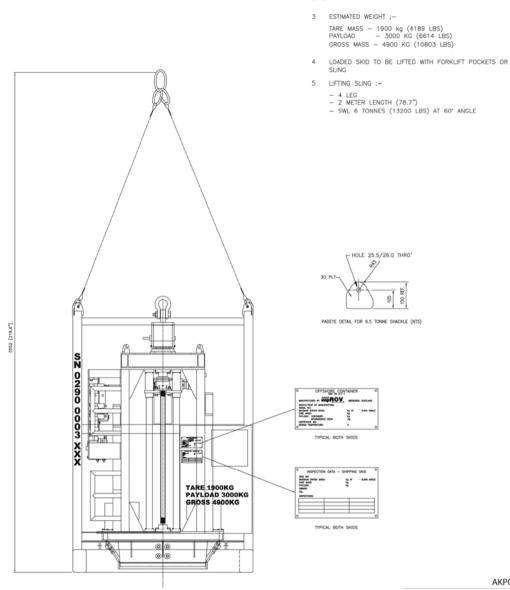
AKPO_SS_05_03.ai

III PETROBRAS

MPRT SHIPPING SKID







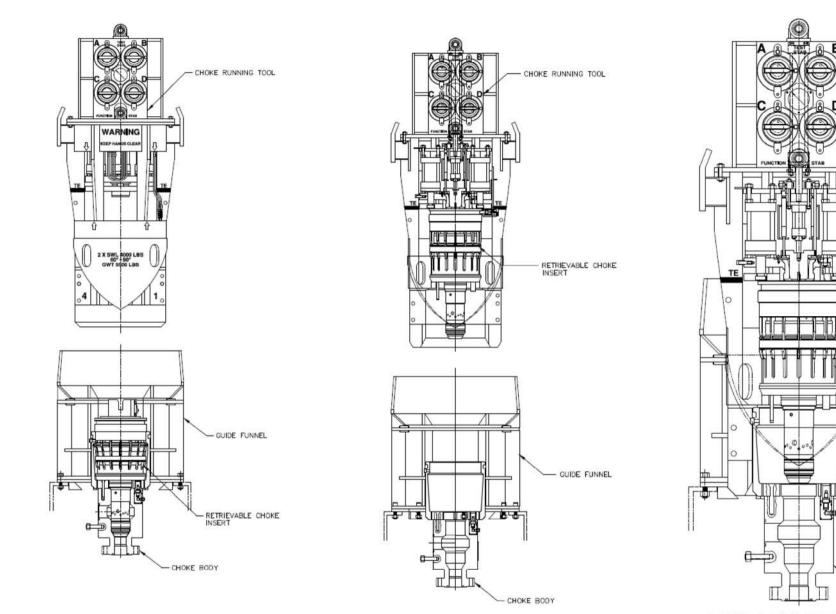
The Choke Insert Running Tool (CIRT) is a hydraulically controlled device used to run and retrieve the Choke Insert (CI) to and from the Choke Body (CB). The CIRT is lowered from the workboat or rig to the subsea tree by a heave compensated line or on drill pipe.

The CIRT provides nine hydraulic functions to interface the CIRT and CB, CIRT and CI, operate the crown connector, and test the metal to metal choke bonnet seal. Hydraulic control of the CIRT is supplied by the ROV via the ROV hotstab port on the CIRT or via a 2 line umbilical.

Refer to:

• AKPO-Installation, Operation and Maintenance (IOM) Manual (REV 01) for Cameron Crown Chokes and Accessories

5.3 ROV Intervention Tooling – Assembly Drawing, Multipurpose Running Tool Shipping Skid



LANDING THE RUNNING TOOL ONTO THE SUBSEA TREE

AKPO_SS_05_04.ai

- CHOKE BODY

- GUIDE FUNNEL

- RETRIEVABLE CHOKE

- CHOKE RUNNING TOOL

TE

0

LOWER RUNNING TOOL OVER CHOKE BODY

RAISING RUNNING TOOL AND CHOKE INSERT FROM CHOKE BODY

The Test Stand (TS) is designed for testing the CI either after retrieval from subsea or prior to running subsea, as well as shipment and minor maintenance of an insert.

The TS simulates the CB which allows testing of the CI hydraulic and electrical circuits.

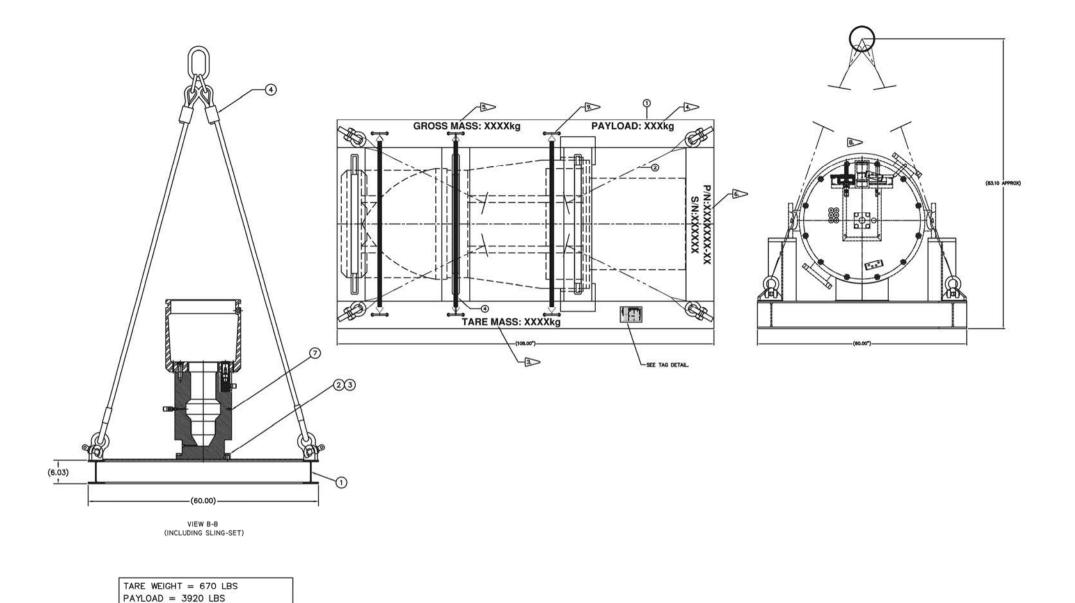
The minor maintenance on an insert would normally consist of replacing the trim and associated seals. The TS is not intended for use in the disassembly of an insert.

The running tool shipping skid is utilized for shipping and storing the running tool.

Refer to:

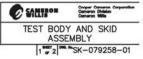
• AKPO-Installation, Operation and Maintenance (IOM) Manual (REV 01) for Cameron Crown Chokes and Accessories

5.4 ROV Intervention Tooling – Choke Insert Running Tool (CIRT)



GROSS WEIGHT = 4590 LBS

AKPO_SS_05_05.ai



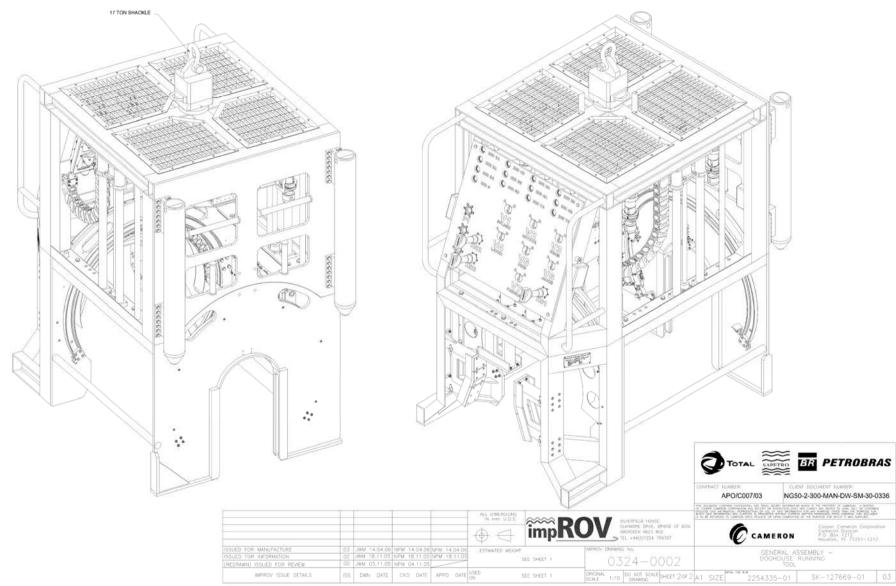
The Insulation Doghouse Running Tool (IDRT)

ROV Interface Requirement:

• 207barg (3000psig) @ 20 l/min ISO 22/32 Mineral Oil

ROV Valve interface Type A Hot Stab Dual Port

5.5 ROV Intervention Tooling – CIRT Shipping and Test Skid



AKP0_SS_05_06.png

5.6 ROV Intervention Tooling – General Assembly – Doghouse Running Tool

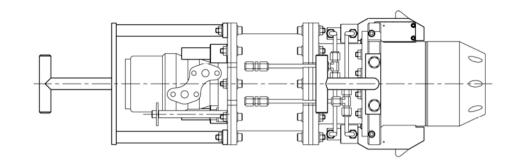
Drawing Supplementary Information

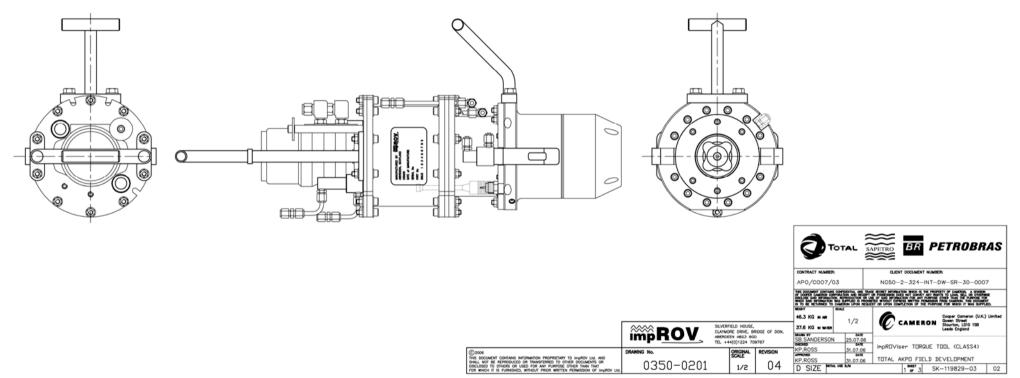
The torque tool, class range 1 to 4 is designed to interface with an API 17D/ISO13628-8 Rotary Class 1 to 4, docking interface, supplied with a self adjusting subsea drive socket, capable of interfacing with a $1\frac{1}{2}$ in, $1\frac{1}{2}$ in and $1^{1}/16$ in square drive. The AKPO Project Tools are supplied with a single Class 4 Socket. It consists of:

The torque tool body is oil filled and requires pressure compensation during subsea operations. The tool must never be run without oil filling as the compensation oil also acts as a lubricant for the moving parts and bearing surfaces inside the tool. The tool as supplied with the Danfoss 250 motor is capable of the following theoretical output torques:

- Multiplier Disengaged (CLASS 1 & 2) Max continuous output – 350Nm (260ft/lbs) @ 100bar (1450psi)
- Multiplier Engaged (CLASS 3 & 4) Max continuous output – 2700Nm (2000ft/lbs) @ 175bar (2538psi)

Refer to:





AKPO_SS_05_07.ai

Control Unit for Torque Tool (Class 4)

The control system is a proprietary model named Jupiter Lite. It consists of an oil filled enclosure containing the necessary valves, drive cards and software to facilitate operation of the following functions;

- FLOT Pitch UP/DOWN
- FLOT Roll CW/CCW
- Latch Open/Closed
- High/Low Torque
- Torque Tool CW/CCW (Pressure and Flow Control Valves)

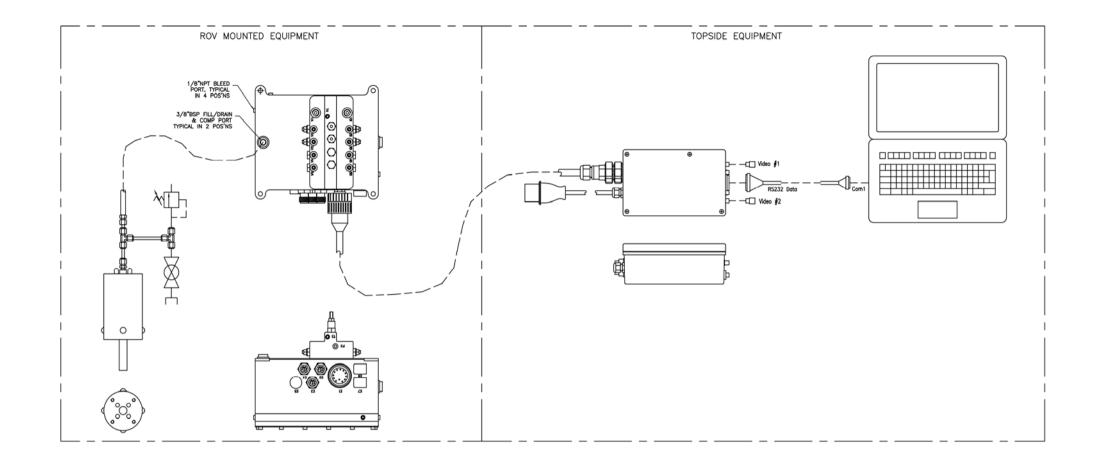
The subsea enclosure is mounted within the ROV chassis and is the main operating interface to the ROV itself, receiving a mineral oil supply from the ROV as well as a power and data connection. The system is operated at surface via a laptop in the ROV shack. Downstream interface is to the ROV mounted class 1 to 4 torque tool system with all interfaces controlled by impROV.

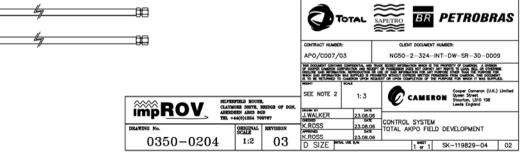
The control system is designed and tested for operation in water depths to 3000 metres.

Refer to:

 NG50-2-324-INT-MA-SR-30-0005 – ROV Tooling – Operation and Maintenance Manual

5.7 ROV Intervention Tooling – ImpROViser Torque Tool (Class 4)





AKPO_SS_05_08.ai

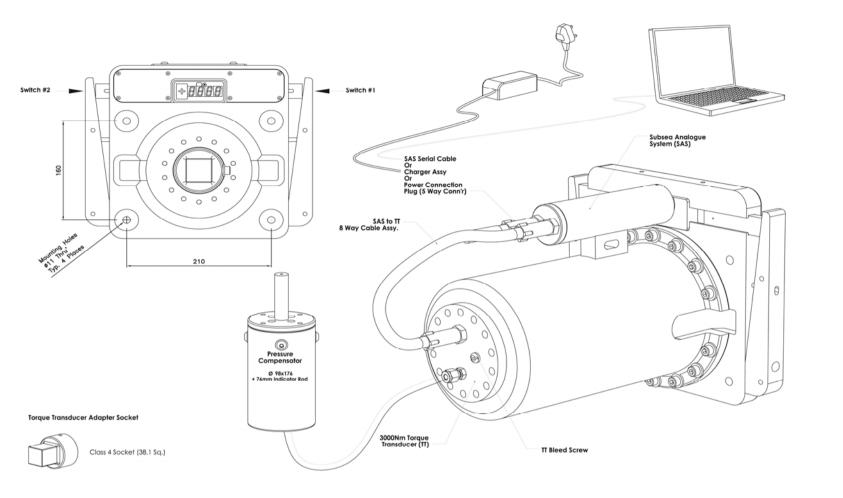
5.8 ROV Intervention Tooling – ImpROViser Torque Tool (Class 4) Control System

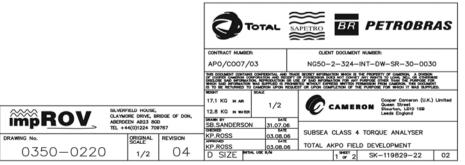
Drawing Supplementary Information

The Subsea Class 4 Torque Analyser provides a means of testing the output from the Class 4 torque tool. It can be used on the vessel deck prior to use and then deployed subsea, to prove the accuracy of the torque tools, real time torque measurement system. It consists of a Class 4 interface bucket, fitted with a calibrated torque cell. These are all sealed and depth rated to 3000msw. The torque tool is inserted into the bucket and latched in place. When the torque tool is operated, the resulting torque is displayed on a hand held meter. The unit is battery powered and self contained.

Specifications:

| Depth Rating: | 3,000m (10,000ft) sea water |
|--|--|
| Environment: | 0 to 50°C Operational 0 to 65°C Storage |
| Compensation Oil: | Shell Diala B (or equivalent) |
| Battery: | 1 x D Cell Type |
| Battery Life: | 5 Days Average Display on Continuously 5 Months Standby |
| Weight: | |
| • In Air | 17.10kg |
| In water | 12.80kg |
| General Dimensions: | |
| Length | 451mm |
| Width | 330mm |
| Height | 282mm |
| Refer to: | |
| NG50-2-324-INT-MA Maintenance Manual | -SR-30-0005 – ROV Tooling – Operation and |
| | |
| | |





AKPO_SS_05_09.ai

5.9 ROV Intervention Tooling – ImpROViser Torque Tool (Class 4) Torque Analyser

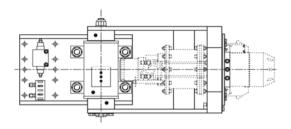
Drawing Supplementary Information

Flying Lead Orientation Tool (FLOT)

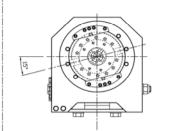
The FLOT provides a means of securely mounting the torque tool to the ROV, and providing the operator a means of orienting the tool and payload with respect to the ROV. It consists of an anodised aluminium base frame, a rotary actuator providing +/- 90° tilt up and down and a cylinder providing +/- 15° roll CW and CCW.

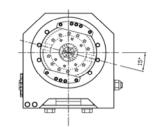
The FLOT is capable of carrying an additional payload of 200kg on top of the weight of the torque tool. The FLOT movements are hydraulically locked in position unless a command to move them is in operation.

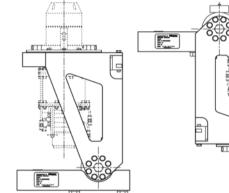
Refer to:

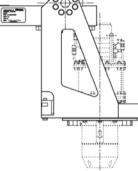


8

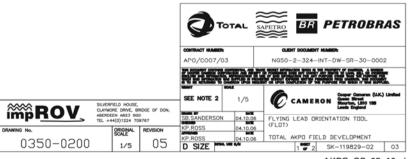




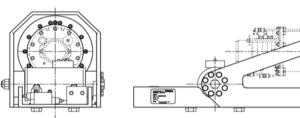


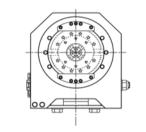


TOOL MOVEMENT RANGE



AKPO_SS_05_10.ai





5.10 ROV Intervention Tooling – Flying Lead Orientation Tool (FLOT)

Drawing Supplementary Information

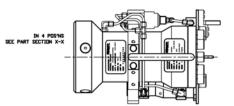
Linear Valve Override Tool (LVOT) 2in and 5in

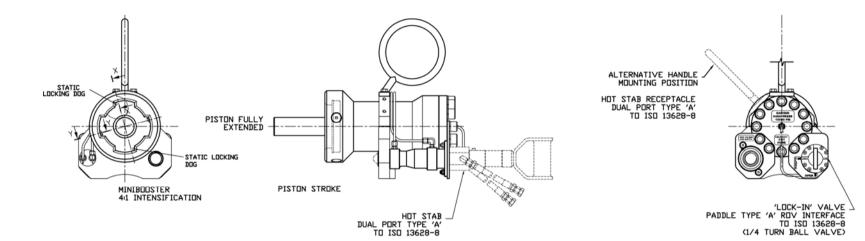
The tool is basically a high pressure hydraulic cylinder. It consists primarily of the main housing, the piston, the end cap, a dual port hot stab, manually operated secondary isolation valve (if fitted) and a pressure intensifier. The standard tool has a maximum stroke of 7.874in (200mm), and generates a Maximum Linear force of (745kN) 169,506 lbf from a maximum WP of 2500psi (172bar)

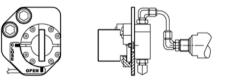
A 'Minibooster' pressure intensifier with a 4:1 pressure ratio is fitted to all tools. This multiplies the 2500psi input pressure to 10,000psi. The intensifier includes a check valve which locks the 10,000psi into the tool. Reversing the pressure and return inputs to the intensifier releases the check valve and allows the tool to be stroked back.

Technical Specifications:

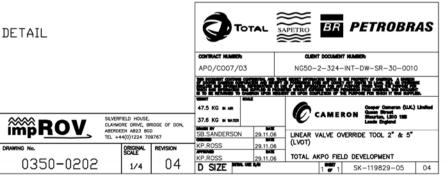
| Max. Hydraulic Pressure (Supply): | 172bar/2500psi |
|-----------------------------------|--------------------------|
| Recommended Max Flow: | 2-8 litres/min |
| Primary Hydraulic Fluid spec: | ISO 32/22 Hydraulic Oil |
| Fluid Cleanliness: | 10 micron |
| Hydraulic Connections via: | ISO type A Dual Hot Stab |
| Refer to: | |







LOCK-IN VALVE ASSEMBLY DETAIL



AKPO_SS_05_11.ai

5.11 ROV Intervention Tooling – Linear Valve Override Tool 2in and 5in (LVOT)

Drawing Supplementary Information

LVOT Test Fixture

The test jig consists of two main components, the main (ISO 13628-8) Linear push bayonet interface type (A) suitable for loads at the specified maximum load of 745kN. The proprietary load cell unit rated to 100 tonne (981kN):

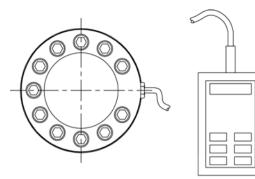
Note: No attempt should be made to operate the test jig above the maximum load stated above.

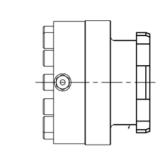
Operators should be aware that using the test fixture, with other LVOT designs requires particular caution, as any input pressure advised only relates to improve specific tooling, all operating figures used should be verified against the specific equipments operating procedures and instructions as changes in piston bore diameter increases the output loading significantly.

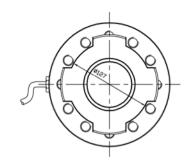
Technical Specifications (Test Fixture)

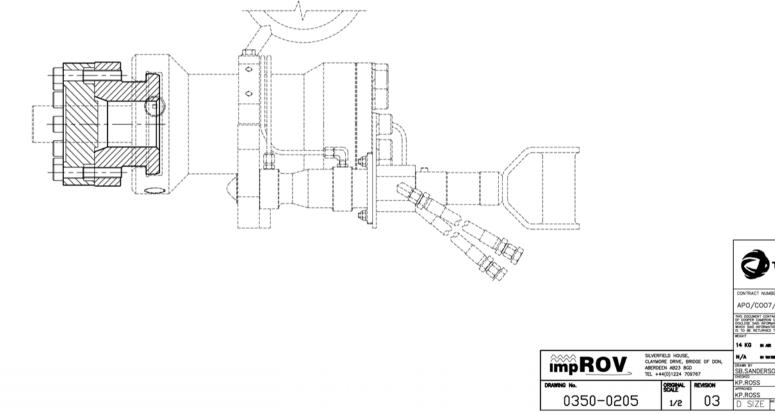
| Interface (Class) | (ISO 13628-8) Linear push interface |
|---------------------------------------|--|
| Max. Operational Load | 745kN/76886kg (169,000 lbf) |
| Length | 164mm/(6.5in) |
| Width (Diameter) | 187mm/(7.4in) |
| Weight | 22kg/(48.5 lb) |
| Supply Voltage | (220/240VAC) Charging Input (9VDC Rechargeable Battery) |

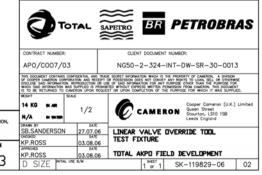
Refer to:











AKPO_SS_05_12.ai

5.12 ROV Intervention Tooling – Linear Valve Override Tool Test Fixture

Drawing Supplementary Information

LVOT Lock Out Tool (5in)

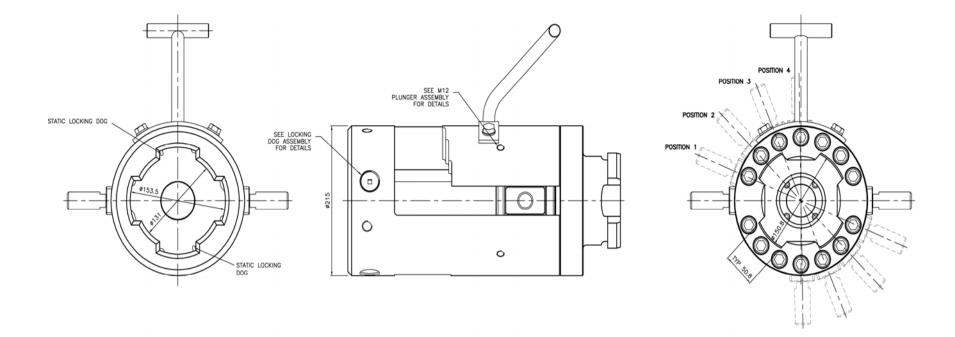
The 2in LLOT and 5in LLOT are designed to be used on valves fitted with an ISO 13628-8 Linear Push Interface Type 'A'. The 2in LLT and 5in LLT are designed to be operated by the AKPO LVOT (0350-0204)

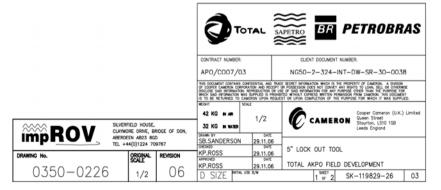
The 5in LLT has a maximum stroke of 170.mm (6.72in), and will operate at the maximum valve force of 534kN (120,000 lbf) onto a valve stem, when used in conjunction with the AKPO LVOT. On the 5in LLOT, the piston may be locked out at 4-off distinct linear positions, each step representing a further 5mm extension of the piston. The nominal required stroke for the LLOT is at the 3rd step up from the fully retracted position. The remaining steps allow for manufacturing tolerance variations across different valves.

5in LVOT Summary Technical Specification:

| Valve interface | ISO 13628-8 Type A |
|-------------------------------------|---|
| Overall dimensions | 439mm (17.3in) x 356mm (14.0in) x 361mm (14.2in) |
| Overall weights | 46kg (101 lbs) in-air 36kg (79 lbs) in-water |
| Max stroke | 170mm (6.69in) ~ 4-off distinct stops |
| Max valve reaction force | 534kN (120,000 lbs) |
| Defector | |

Refer to:





AKPO_SS_05_13.ai

5.13 ROV Intervention Tooling – 5in Lock Out Tool

Drawing Supplementary Information

LVOT Lock Out Tool (2in)

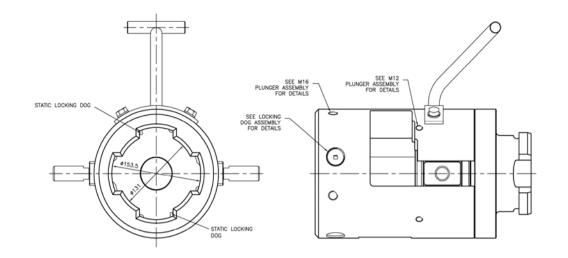
The 2in LLOT and 5in LLOT are designed to be used on valves fitted with an ISO 13628-8 Linear Push Interface Type 'A'. The 2in LLT and 5in LLT are designed to be operated by the AKPO LVOT (0350-0204)

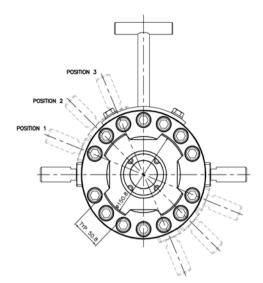
The 2in LLOT has a maximum stroke of 88.5mm (3.5in), and will operate at the maximum valve force of 149kN (33,500 lbf) onto a valve stem, when used in conjunction with the AKPO LVOT. On the 2in LLOT, the piston may be locked out at 3-off distinct linear positions, each step representing a further 4.5mm extension of the piston. The nominal required stroke for the LLT is at the 2nd step up from the fully retracted position. The remaining steps allow for manufacturing tolerance variations across different valves.

2in LVOT Summary Technical Specification:

| Valve interface | ISO 13628-8 Type A |
|--------------------------|--|
| Overall dimensions | 372.5mm (14.66in) x 356mm (14.0in) x 361mm (14.2in) |
| Overall weights | 42kg (92.4 lbs) in-air 33kg (72.6 lbs) in-water |
| Max stroke | 88.5mm (3.5in) ~ 3-off distinct stops |
| Max valve reaction force | 149kN (33,000 lbs) |
| | |

Refer to:







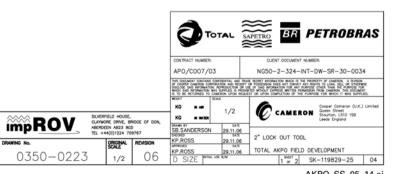
STATIC LOCKING DOG ASSEMBLY TYPICAL IN 2 POS'NS

LOCKING DOG ASSEMBLY TYPICAL IN 2 POS'NS



M16 PLUNGER ASSEMBLY TYPICAL IN 4 POS'NS

M12 PLUNGER ASSEMBLY TYPICAL IN 4 POS'NS





5.14 ROV Intervention Tooling – 2in Lock Out Tool

Drawing Supplementary Information

Limited Torque Fork Tool

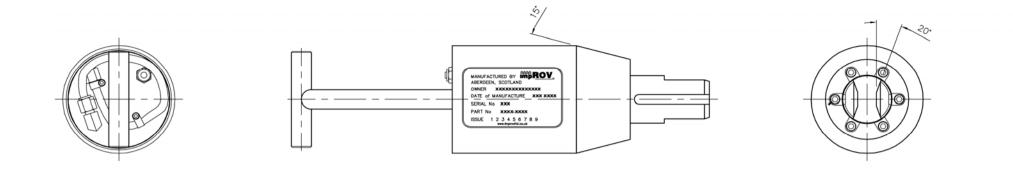
The Torque Limiting Fork Handle Tool is an ROV manipulator deployed/operated tool, designed to enable the ROV to interface with a Subsea valve, paddle type interface; ISO 13628-8, Figure 13, Type A.

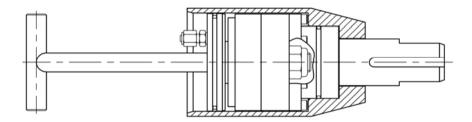
The tool has four main components. Basically, it consists of a fork shaped front piece, which is designed to interface with the Subsea paddle valve handle. This is fitted to a T-bar handle which the ROV uses to hold and operate it by.

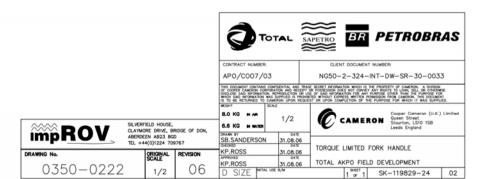
To prevent over torqueing of the Subsea valves, the T-bar handle is connected to the fork front interface via a slipping clutch arrangement. If excessive torque is applied through the tool, the torque limiting assembly will disengage and rotate freely, preventing the applied torque from increasing beyond the pre-set limit. Once the applied torque reduces, the assembly will re-engage allowing the tool to continue operating up to its set torque limit.

The ROV must be equipped with suitable manipulators to be able to deploy the tool and operate the subsea valves. The manipulator wrist function should be capable of producing 50Nm/11.24ft/lb of torque minimum and 150Nm/33.72ft/lb maximum to the Tool. The Maximum Torque for the Subsea valves has been stated as 130Nm, the tool is set up to ensure that this value is not exceeded

Refer to:





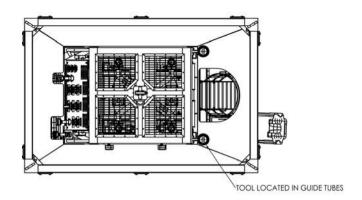


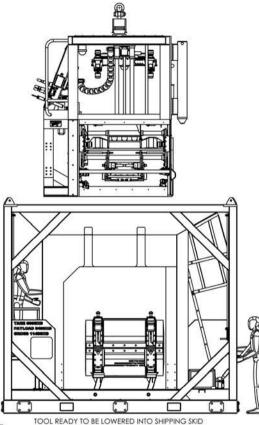
IDRT Load Out Skid

Estimated Weight:

- Tare Mass 6000kg
- Payload 5480kg
- Gross Mass 11,480kg

5.15 ROV Intervention Tooling – Torque Limited Fork Tool





ALL DIMENSIONS IN mm U.O.S.

 $\oplus \ominus$

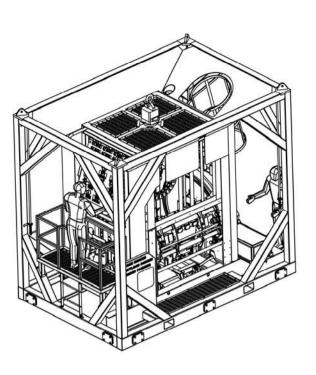
ESTIMATED WEIGHT

USED ON

4

0003-0001

IMPROV DRAWING No.





COURSE

NONCE THE TOOL HAS COLLECTED THE DOGHOUSE THE SUPPORTS CAN BE LOWERED TO PROVIDE THE REQUIRED SPACE TO ROTATE THE DOGHOUSE LOWER SHELL

DOGHOUSE LOADED INTO TOOL AND READY TO BE SETUP FOR FOR DEPLOYMENT

AKPO_SS_05_16.ai

The following tables show the intervention tools required for all ROV intervention tasks.

Refer to:

• NG50-2-300-SPS-LT-AA-30-0334 - ROV Task List

5.16 ROV Intervention Tooling – General Assembly – Doghouse Running Tool Shipping Skid

| FUNCTION | IDENTIFICATION | VALVE TYPE | INTERFACE | ROV OPERATION | LINEAR FORCE | ROTA | RY TORQUE LB.FT | .(Nm) | No. OF | | Book 62-03 & 06 | ROV TOOLING NG50-2-324-INT-SP-SR-30-0003 | ROV ACCESSIBILITY NG50-2-300-SPS-RP-SC-30-0363 |
|--|----------------|---------------------------|---|---|--|-----------------|--------------------|-------------|----------|----------|--------------------|---|---|
| 1 She hold | DEITH IORION | VALUE I III E | ISO 13628.8 | NOV OF EIGHTON | LBF (N) | MAKE UP | MAX.OPERATING | DAMAGE | TURNS | Volume | Section | X-219400-09-10. PageNo. | X-285883-01. PageNo. |
| PRODUCTION MASTER VALVE - 5" | PMV | F/S CLOSE GATE VALVE | TYPE A | LINEAR | 120000 (53376) | | | | | 3&6 | 6.2&5.3.10 | 11,38 | 11,12,13,14,15 |
| PRODUCTION SWAB VALVE - 5" | PSV | F/S CLOSE GATE VALVE | TYPE A | LINEAR | 120000 (53376) | | | 1 | | 3&6 | 6.2&5.3.10 | 11,38 | 11,12,13,14,15 |
| PRODUCTION WING VALVE - 5" | PWV | F/S CLOSE GATE VALVE | TYPE A | LINEAR | 120000 (53376) | | | 1 | | 3&6 | 6.2&5.3.10 | 11,38 | 11,12,13,14,15 |
| ANNULUS MASTER VALVE - 2" | AMV | F/S CLOSE GATE VALVE | TYPE A | LINEAR | 33500 (149008) | | | 1 | | 3&6 | 6.2&5.3.10 | 11,38 | 11,12,13,14,15 |
| ANNULUS SWAB VALVE - 2" | ASV | F/S CLOSE GATE VALVE | TYPE A | LINEAR | 33500 (149008) | | | 1 | | 3&6 | 6.2&5.3.10 | 11,38 | 11,12,13,14,15 |
| ANNULUS WING VALVE - 2" | AWV | F/S CLOSE GATE VALVE | TYPE A | LINEAR | 33500 (149008) | | | 1 | | 3&6 | 6.2&5.3.10 | 11,38 | 11,12,13,14,15 |
| CROSS OVER VALVE - 2" | XOV | F/S CLOSE GATE VALVE | TYPE A | LINEAR | 33500 (149008) | | | | | 3&6 | 6.2&5.3.10 | 11.38 | 11,12,13,14,15 |
| METHANOL INJECTION VALVE B - 2" | MIVB | F/S CLOSE GATE VALVE | TYPE A | LINEAR | 33500 (149008) | | | | | 3&6 | 6.2&5.3.10 | 11,38 | 11,12,13,14,15 |
| | | THE GEODE ONTE THEFE | THEX. | Entern | 00000 (110000) | | | | | | | | |
| SPARE CHEMICAL INJECTION VALVE | CIVA | F/S CLOSE GATE VALVE | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 100 (136) | 250 (339) | 365(495) | 12 | 3&6 | 6.2&5.3.10 | 7 | |
| WAX INHIBITOR/DEMULSIFIER INJECTION VALVE | CIVB | F/S CLOSE GATE VALVE | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 100 (136) | 250 (339) | 365(495) | 12 | 3&6 | 6.285.3.10 | 7 | |
| ANTI-ASPHALTINE INJECTION VALVE | CIVC | F/S CLOSE GATE VALVE | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 100 (136) | 250 (339) | 365(495) | 12 | 3&6 | 6.2&5.3.10 | 7 | |
| CORROSION/SI INJECTION VALVE | CIVD | F/S CLOSE GATE VALVE | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 100 (136) | 250 (339) | 365(495) | 12 | 3&6 | 6.2&5.3.10 | 7 | |
| METHANOL ISOLATION VALVE A | MIVA | F/S CLOSE GATE VALVE | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 100 (136) | 250 (339) | 365(495) | 12 | 3&6 | 6.2&5.3.10 | 7 | |
| METHANOL ISOLATION VALVE A METHANOL ISOLATION VALVE 1 | MIVA MIV1 | F/S OPEN GATE VALVE | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | - | 100 (136) | 250 (339) | 365(495) | 12 | 3&6 | 6.2&5.3.10 | 7 | |
| | | | | | | | 250 (339) | | | | | 7 | |
| METHANOL ISOLATION VALVE 2 | MIV2 | F/S OPEN GATE VALVE | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 100 (136) | 250 (339) | 365(495) | 12 | 3&6 | 6.2&5.3.10 | 7 | |
| METHANOL ISOLATION VALVE 3 | MIV3 | F/S OPEN GATE VALVE | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 100 (136) | === (===) | 365(495) | 12 | | | 7 | |
| SERVICE LINE VALVE | SLV | F/S CLOSE GATE VALVE | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | ┥ | 100 (136) | 250 (339) | 365(495) | 12 | 3&6 | 6.2&5.3.10 | / | |
| TREE ISOLATION VALVE | TIV | F/S OPEN GATE VALVE | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | l | 260(353) | 690 (936) | 1035(1403) | 29 | 3&6 | 6.2&5.3.10 | 7 | |
| | | | | | | | | 1 | | ļ | | l | |
| GASKET TEST | GT | N.C. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | 1 | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2&5.3.10 | 37, MANIPULATOR | 16 |
| INTELLIGENT WELL COMPLETION 1 | IWC1 | N.O. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2&5.3.10 | 37,MANIPULATOR | 16 |
| INTELLIGENT WELL COMPLETION 2 | IWC2 | N.O. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2&5.3.10 | 37, MANIPULATOR | 16 |
| INTELLIGENT WELL COMPLETION RETURN | IWCR | N.O. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2&5.3.10 | 37, MANIPULATOR | 16 |
| PRODUCTION CHOKE VENT VALVE 1 | PVV1 | N.C. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2&5.3.10 | 37, MANIPULATOR | 16 |
| PRODUCTION CHOKE VENT VALVE 2 | PVV2 | N.C. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2&5.3.10 | 37, MANIPULATOR | 16 |
| SURFACE CONTROLLED SUSEA SAFETY VALVE | SCSSV | N.O. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2&5.3.10 | 37, MANIPULATOR | 16 |
| TREE CAP TEST | TCT | N.C. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2&5.3.10 | 37, MANIPULATOR | 16 |
| TREE CAP VENT | TCV | N.C. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | 1 | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2&5.3.10 | 37, MANIPULATOR | 16 |
| TUBING HANGER ANNULUS ACCESS CLOSE | THAAC | N.C. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2&5.3.10 | 37,MANIPULATOR | 16 |
| TUBING HANGER ANNULUS ACCESS OPEN | THAAO | N.C. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2&5.3.10 | 37,MANIPULATOR | 16 |
| | THAA | N.O. MANDAE GATE VAEVE | LOW TORGOE TABBEL | MANIFOLATOR | | 24(00) | 200 (000) | 400(042) | 1/4 | 040 | 0.200.0.10 | or, in the obtroit | 10 |
| INSTALL/REMOVE TREE CAP | | | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 600 (813) | 900 (1220) | 1500 (2033) | 10.88 | 3&6 | 6.2&5.3.10 | 7 | 42,43,44 |
| INSTALL/REMOVE TREE CAP | | | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 600 (813) | 900 (1220) | 1500 (2033) | 10.88 | 300 | 0.200.3.10 | · · · · | 42,43,44 |
| PRODUCTION CHOKE OVERBIDE | | CHOKE OPEN/CLOSE | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 260 (353) | 290 (393) | 575 (780) | 75.45 | 3 | | 7 | 35,36 |
| | | | CIRT | TORQUE TOOL | | 260 (353) | 290 (393) | 575 (780) | 7.5 +/5 | 3 | 6.2 | ' | 36,37 |
| CHOKE INSERT REMOVAL | | INSERT REMOVAL | CIRI | | | | | | | | | | 38,37 |
| | 0.014 | | | | | (5.(0.0)) | | | | 0 | 0.0 | | 17,18,19,20 |
| CHEMICAL CONTROL VALVE A | CCVA | THROTTLE VALVE ADJUSTMENT | LOW TORQUE PADDLE | MANIPULATOR | | 15 (20) | 37 (50) | 41 (55) | 30 | 3 | 6.2 | | |
| CHEMICAL CONTROL VALVE C | CCVC | THROTTLE VALVE ADJUSTMENT | LOW TORQUE PADDLE | MANIPULATOR | | 15 (20) | 37 (50) | 41 (55) | 30 | 3 | 6.2 | | 17,18,19,20 |
| CHEMICAL CONTROL VALVE D | CCVD | THROTTLE VALVE ADJUSTMENT | LOW TORQUE PADDLE | MANIPULATOR | | 15 (20) | 37 (50) | 41 (55) | 30 | 3 | 6.2 | 5,7, MANIPULATOR ARM | 17,18,19,20 |
| CHEMICAL CONTROL VALVE A | CCVA | THROTTLE VALVE CHANGE OUT | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 74 (100) | 148 (200) | 295 (400) | 4.5 | 3 | 6.2 | l · · · | 17,18,19,20 |
| CHEMICAL CONTROL VALVE C | CCVC | THROTTLE VALVE CHANGE OUT | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 74 (100) | 148 (200) | 295 (400) | 4.5 | 3 | 6.2 | | 17,18,19,20 |
| CHEMICAL CONTROL VALVE D | CCVD | THROTTLE VALVE CHANGE OUT | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 74 (100) | 148 (200) | 295 (400) | 4.5 | 3 | 6.2 | | 17,18,19,20 |
| | | | | | | | | | | | | | |
| COVER GRATING LOCKING MECHANISM | | | LOW TORQUE | | | 20 (27) | 200 (271) | 400 (542) | 176 DEG. | 6 | 5.3.14 | MANIPULATOR ARM | 24,25,26 |
| | | | PADDLE/MANIPULATOR | | | 20 (21) | 200 (271) | 100 (012) | ROTATION | , v | 0.0.11 | | 21,20,20 |
| HFL STABPLATES | | | | | | | | | | | | | |
| MATE | | | CLASS 4 SQ. DRIVE BUCKET | FLOT, TORQUE TOOL | | 960 (1300) | | | | | | | |
| DEMATE | MQC1 | | CLASS 4 SQ. DRIVE BUCKET | FLOT, TORQUE TOOL | | 480 (650) | | | 0.75 | 0 | 5.3.10 | 5,7 | 52,53 |
| EMERGENCY DISCONNECT | MQC2 | | CLASS 4 SQ. DRIVE BUCKET | FLOT, TORQUE TOOL | | 480 (650) -1106 | (1500) IN PREDETER | MINED STEPS | 9.75 | 0 | 5.3.10 | 5,7 | 52,53 |
| TO ACTIVATE SHEAR PIN | | | CLASS 4 SQ. DRIVE BUCKET | | | 1365 (1850) | | | 1 | | | | |
| EEL CONNECTORS | FM1,FM2, | | | | MATE : 27 (120) | | | 1 | | <u>^</u> | E 0 40 | | 53 |
| EFL CONNECTORS | P/C A, P/C B | | | MANIPULATOR | DE-MATE: 25 (111) | | | | | 6 | 5.3.10 | MANIPULATOR ARM | 55 |
| SWIMS ARM EFL | | | | MANIPULATOR | MATE : 27 (120) | | | | | 6 | 5.3.2 | MANIPULATOR ARM | 112 |
| | | | | | DE-MATE: 25 (111) | | | | l | o | 5.3.2 | MANIFULATOR ARM | 112 |
| TREE CONTROL MODULE | | | | MANIPULATOR | MATE : 27 (120) | | | | | | | | 32,33,34 |
| | | | | + HOT STAB | DE-MATE: 25 (111) | l | | l | | L | | | 02,00,01 |
| | | | | | | | | 1 | | _ | | | |
| | | | | | | | | | | | | | |
| INSTALL/REMOVE RE-ENTRY HUB COVER | | | ROV HOOK + WIRELINE | MANIPULATOR | | | | | | 6 | 5.3.14 | MANIPULATOR ARM | 27,28,29 |
| INSTALL/REMOVE CHOKE COVER | | | ROV HOOK + WIRELINE | MANIPULATOR | | | | | | 6 | 5.3.14 | MANIPULATOR ARM | 30,31 |
| INSTALL/REMOVE CHC FLUID RETAINING CAP | | | | MANIPULATOR | 25 (110) | | | | | 6 | 5.3.16 | MANIPULATOR ARM | 45,46.47 |
| CHC DEBRIS COVER | | | | MANIPULATOR | | | | | | 6 | 5.3.17 | MANIPULATOR ARM | |
| SAND DETECTOR REPLACEMENT | | | | MANIPULATOR | | | | | | | | MANIPULATOR ARM | 21,22,23 |
| | | 1 | | MANIPULATOR / | | | | 1 | | | | | |
| CHC PRESSURE CAP REMOVAL | | | CLASS 4 SQ. DRIVE BUCKET / | TORQUE TOOL / | MATE : 35 (156) | 50/80 (67/108) | | 1 | | 6 | 5.3.15 | 7,24, MANIPULATOR ARM | 48,49,50,51 |
| | | | SINGLE PORT HOT STAB | HOT STAB | DE-MATE: 35-55(156-245) | (11.100) | | 1 | | | | , , | |
| | | | | | | | | | | | | I | |
| HOT STAB FUNCTIONS | | | | | | | | | | | | | |
| TREE CAP VENT / TEST | HS1 | TCV/TCT | SINGLE PORT HOT STAB | MANIPULATOR | 1 | r – | | r | 1 | r | 1 | г | |
| | | | | | MATE - 05 (450) | <u> </u> | | ł | | | | | |
| | HS2 | GRV | SINGLE PORT HOT STAB | MANIPULATOR | MATE : 35 (156) DE-MATE: 35-55(156-245) | L | | 1 | ļ | L | ļ | 5,7, MANIPULATOR ARM | 55 |
| GASKET RELEASE VALVE | | | | | | | | | | | | | |
| T.H. ANNULUS ACCESS CLOSE/OPEN | HS3 | THAAC/THAAO | DUAL PORT HOT STAB | MANIPULATOR | DE-WATE. 33-33(130-243) | | | - | | | | | |
| | HS3 HS4 | THAAC/THAAO PCV | DUAL PORT HOT STAB SINGLE PORT HOT STAB MANIPULATOR | MANIPULATOR MANIPULATOR MANIPULATOR | DE-MATE: 33-33(130-243) | | | | | | 537 | | 65 66 67 |

5.17 ROV Intervention Tooling – Production Trees (Page 1 of 7)

| FUNCTION | IDENTIFICATION | VALVE TYPE | INTERFACE | ROV OPERATION | LINEAR FORCE | ROT | ARY TORQUE LB.F | .(Nm) | No. OF | | J Book 262-03&06 | ROV TOOLING NG50-2-324-INT-SP-SR-30-0003 | ROV ACCESSIBILITY NG50-2-300-SPS-RP-SC-30-0363 |
|--|----------------|------------------------|--|--|--|----------------|--------------------|-------------|----------------------|--------|---------------------|---|---|
| | | | ISO 13628.8 | | LBF (N) | MAKE UP | MAX.OPERATING | DAMAGE | TURNS | Volume | Section | X-219400-09-10. PageNo. | X-285883-01. PageNo. |
| INJECTION MASTER VALVE - 5" | IMV | F/S CLOSE GATE VALVE | TYPE A | LINEAR | 120000 (53376) | | | | | 3&6 | 6.2 & 5.3.10 |) 11,38 | 11,12,13,14,15 |
| INJECTION SWAB VALVE - 5" | ISV | F/S CLOSE GATE VALVE | TYPE A | LINEAR | 120000 (53376) | | | | | 3&6 | 6.2 & 5.3.10 | 11,38 | 11,12,13,14,15 |
| INJECTION WING VALVE - 5" | IWV | F/S CLOSE GATE VALVE | TYPE A | LINEAR | 120000 (53376) | | | | | 3&6 | 6.2 & 5.3.10 | 11,38 | 11,12,13,14,15 |
| ANNULUS MASTER VALVE - 2" | AMV | F/S CLOSE GATE VALVE | TYPE A | LINEAR | 33500 (149008) | | | | | 3&6 | 6.2 & 5.3.10 |) 11,38 | 11,12,13,14,15 |
| ANNULUS SWAB VALVE - 2" | ASV | F/S CLOSE GATE VALVE | TYPE A | LINEAR | 33500 (149008) | | | | | 3&6 | 6.2 & 5.3.10 |) 11,38 | 11,12,13,14,15 |
| ANNULUS WING VALVE - 2" | AWV | F/S CLOSE GATE VALVE | TYPE A | LINEAR | 33500 (149008) | | | | | 3&6 | 6.2 & 5.3.10 |) 11,38 | 11,12,13,14,15 |
| CROSS OVER VALVE - 2" | XOV | F/S CLOSE GATE VALVE | TYPE A | LINEAR | 33500 (149008) | | | | | 3&6 | 6.2 & 5.3.10 | 11,38 | 11,12,13,14,15 |
| CHEMICAL INJECTION VALVE | CIV | F/S CLOSE GATE VALVE | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 100 (136) | 250 (339) | 365(495) | 12 | 3&6 | 6.2 & 5.3.10 | 0 7 | |
| SERVICE LINE VALVE | SLV | F/S CLOSE GATE VALVE | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 100 (136) | 250 (339) | 365(495) | 12 | 3&6 | 6.2 & 5.3.10 |) 7 | |
| TREE ISOLATION VALVE | TIV | F/S OPEN GATE VALVE | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 260(353) | 690 (936) | 1035(1403) | 29 | 3&6 | 6.2 & 5.3.10 | 7 | |
| GASKET TEST | GT | N.C. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2 & 5.3.10 |) 37,MANIPULATOR | 16 |
| INTELLIGENT WELL COMPLETION 1 | IWC1 | N.O. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2 & 5.3.10 | 37, MANIPULATOR | 16 |
| INTELLIGENT WELL COMPLETION 2 | IWC2 | N.O. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2 & 5.3.10 | 37, MANIPULATOR | 16 |
| INTELLIGENT WELL COMPLETION RETURN | IWCR | N.O. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2 & 5.3.10 | 37,MANIPULATOR | 16 |
| INJECTION CHOKE VENT VALVE 1 | IVV1 | N.C. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2 & 5.3.10 | 37,MANIPULATOR | 16 |
| INJECTION CHOKE VENT VALVE 2 | IVV2 | N.C. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | 1 | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2 & 5.3.10 | 37,MANIPULATOR | 16 |
| SURFACE CONTROLLED SUSEA SAFETY VALVE | SCSSV | N.O. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | 1 | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2 & 5.3.10 | 37,MANIPULATOR | 16 |
| TREE CAP TEST | TCT | N.C. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2 & 5.3.10 | 37,MANIPULATOR | 16 |
| TREE CAP VENT | TCV | N.C. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2 & 5.3.10 | 37.MANIPULATOR | 16 |
| TUBING HANGER ANNULUS ACCESS CLOSE | THAAC | N.C. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2 & 5.3.10 | 37,MANIPULATOR | 16 |
| TUBING HANGER ANNULUS ACCESS CEOSE | THAAO | N.C. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2 & 5.3.10 | 37,MANIPULATOR | 16 |
| | 11000 | | | | | | | | | | | | |
| INSTALL/REMOVE TREE CAP | | | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 600 (813) | 900 (1220) | 1500 (2033) | 10.88 | 3&6 | 6.2 & 5.3.10 | 0 7 | 42,43,44 |
| G.I. CHOKE OVERRIDE | | CHOKE OPEN/CLOSE | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 260 (353) | 290 (393) | 575 (780) | 7.5 +/5 | 3 | 6.2 | 7 | 35,36,37 |
| CHOKE INSERT REMOVAL | | INSERT REMOVAL | CIRT | | | | · · · | | | | | | 36,37 |
| | | | | | | | | | 1 | | | | |
| COVER GRATING LOCKING MECHANISM | | | LOW TORQUE PADDLE/MANIPULATOR | | | 20 (27) | 200 (271) | 400 (542) | 176 DEG. ROTATION | 6 | 5.3.14 | MANIPULATOR ARM | 24,25,26 |
| HFL STABPLATES | | | | | | | | | | | | | |
| MATE | | | CLASS 4 SQ. DRIVE BUCKET | FLOT, TORQUE TOOL | | 960 (1300) | | | | | | | |
| DEMATE | | | CLASS 4 SQ. DRIVE BUCKET | FLOT, TORQUE TOOL | | 480 (650) | | | | | | | |
| EMERGENCY DISCONNECT | MQC1 | | CLASS 4 SQ. DRIVE BUCKET | FLOT.TORQUE TOOL | | | (1500) IN PREDETER | AINED STEPS | 9.75 | 6 | 5.3.10 | 5,7 | 52,53 |
| TO ACTIVATE SHEAR PIN | | | CLASS 4 SQ. DRIVE BUCKET | FLOT.TORQUE TOOL | | 1365 (1850) | (, | | - | | | | |
| EFL CONNECTORS | FM1,FM2, | | CENCO 4 GQ. DRIVE DOORET | MANIPULATOR | MATE : 27 (120) | 1303 (1030) | | | | 6 | 5.3.10 | MANIPULATOR ARM | 53 |
| | P/C A, P/C B | | | | DE-MATE: 25 (111) MATE : 27 (120) | | | | | | | | |
| SWIMS ARM EFL | | | | MANIPULATOR | DE-MATE: 25 (111) | | | | | 6 | 5.3.2 | MANIPULATOR ARM | 112 |
| TREE CONTROL MODULE | | | SINGLE PORT HOT STAB | MANIPULATOR + HOT STAB | MATE : 35 (156) DE-MATE: 35-55(156-245) | | | | | | | | 32,33,34 |
| | | | | | | | | | | | | | |
| INSTALL/REMOVE RE-ENTRY HUB COVER | | | ROV HOOK + WIRELINE | MANIPULATOR | | | | | | 6 | 5.3.14 | MANIPULATOR ARM | 27,28,29 |
| INSTALL/REMOVE CHOKE COVER | | | ROV HOOK + WIRELINE | MANIPULATOR | | | | | | 6 | 5.3.14 | MANIPULATOR ARM | 30,31 |
| INSTALL/REMOVE CHC FLUID RETAINING CAP | | | | MANIPULATOR | 25 (110) | | | | | 6 | 5.3.16 | MANIPULATOR ARM | 45,46.47 |
| CHC DEBRIS COVER | | | | MANIPULATOR | | | | | | 6 | 5.3.17 | MANIPULATOR ARM | |
| CHC PRESSURE CAP REMOVAL | | | CLASS 4 SQ. DRIVE BUCKET / SINGLE PORT HOT STAB | MANIPULATOR / TORQUE TOOL / HOT STAB | MATE : 35 (156) DE-MATE: 35-55(156-245) | 50/80 (67/108) | | | | 6 | 5.3.15 | 7,24, MANIPULATOR ARM | 48,49,50,51 |
| HOT STAB FUNCTIONS | | | - | • | <u>.</u> | | | | • | • | | | |
| TREE CAP VENT / TEST | HS1 | TCV/TCT | SINGLE PORT HOT STAB | MANIPULATOR | | | | | | | | | |
| GASKET RELEASE VALVE | HS2 | GRV | SINGLE PORT HOT STAB | MANIPULATOR | MATE : 35 (156) | | | | | | | | FF |
| T.H. ANNULUS ACCESS CLOSE/OPEN | HS3 | THAAC/THAAO | DUAL PORT HOT STAB | MANIPULATOR | DE-MATE: 35-55(156-245) | | | | | | | 5,7, MANIPULATOR ARM | 55 |
| PRODUCTION CHOKE VALVES | HS4 | PCV | SINGLE PORT HOT STAB | MANIPULATOR | 7 | | | | | | |] | |
| THEOCT | | | MANIPULATOR | MANIPULATOR | | 1 | | | 1 | 6 | 5.3.7 | 1 | 65.66.67 |

5.17 ROV Intervention Tooling – Gas Injection Tree (Page 2 of 7)

| FUNCTION | IDENTIFICATION | VALVE TYPE | INTERFACE | ROV OPERATOR | LINEAR FORCE | ROTA | ARY TORQUE LB.FT | .(Nm) | No. OF | • | Book Ref. 3262-03 & 06 | ROV TOOLING NG5-2-324-INT-SP-SR-30-0003 | ROV ACCESSIBILITY NG5-2-324-INT-SP-SR-30-0003 |
|---|----------------|------------------------|--|--|--|-------------------|----------------------|-------------|----------|------|---------------------------|--|--|
| | DENTION | | ISO 13628.8 | | LBF (N) | MAKE UP | MAX.OPERATING | DAMAGE | TURNS | Vol. | Section | X-219400-09-10. PageNo. | X-285883-01. PageNo. |
| INJECTION MASTER VALVE - 5" | IMV | F/S CLOSE GATE VALVE | TYPE A | LINEAR | 120000 (53376) | | | | | 3&6 | 6.2 & 5.3.10 | 11,38 | 11,12,13,14,15 |
| INJECTION SWAB VALVE - 5" | ISV | F/S CLOSE GATE VALVE | TYPE A | LINEAR | 120000 (53376) | | | | | 3&6 | 6.2 & 5.3.10 | 11,38 | 11,12,13,14,15 |
| INJECTION WING VALVE - 5" | IWV | F/S CLOSE GATE VALVE | TYPE A | LINEAR | 120000 (53376) | | | | | 3&6 | 6.2 & 5.3.10 | 11,38 | 11,12,13,14,15 |
| ANNULUS MASTER VALVE - 2" | AMV | F/S CLOSE GATE VALVE | TYPE A | LINEAR | 33500 (149008) | | | | | 3&6 | 6.2 & 5.3.10 | 11,38 | 11,12,13,14,15 |
| ANNULUS SWAB VALVE - 2" | ASV | F/S CLOSE GATE VALVE | TYPE A | LINEAR | 33500 (149008) | | | | | 3&6 | 6.2 & 5.3.10 | 11,38 | 11,12,13,14,15 |
| ANNULUS WING VALVE - 2" | AWV | F/S CLOSE GATE VALVE | TYPE A | LINEAR | 33500 (149008) | | | | | 3&6 | 6.2 & 5.3.10 | 11,38 | 11,12,13,14,15 |
| CROSS OVER VALVE - 2" | XOV | F/S CLOSE GATE VALVE | TYPE A | LINEAR | 33500 (149008) | | | | | 3&6 | 6.2 & 5.3.10 | 11,38 | 11,12,13,14,15 |
| CHEMICAL INJECTION VALVE | CIV | F/S CLOSE GATE VALVE | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 100 (136) | 250 (339) | 365(495) | 12 | 3&6 | 6.2 & 5.3.10 | 7 | |
| SERVICE LINE VALVE | SLV | F/S CLOSE GATE VALVE | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 100 (136) | 250 (339) | 365(495) | 12 | 3&6 | 6.2 & 5.3.10 | 7 | |
| TREE ISOLATION VALVE | TIV | F/S OPEN GATE VALVE | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 260(353) | 690 (936) | 1035(1403) | 29 | 3&6 | 6.2 & 5.3.10 | 7 | |
| GASKET TEST | GT | N.C. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2 & 5.3.10 | 37,MANIPULATOR | 16 |
| INJECTION CHOKE SEALS TEST VALVE | ITV | N.C. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2 & 5.3.10 | 37, MANIPULATOR | 16 |
| INJECTION CHOKE VENT VALVE 1 | IVV1 | N.C. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2 & 5.3.10 | 37, MANIPULATOR | 16 |
| INJECTION CHOKE VENT VALVE 2 | IVV2 | N.C. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2 & 5.3.10 | 37, MANIPULATOR | 16 |
| TREE CAP TEST | TCT | N.C. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2 & 5.3.10 | 37, MANIPULATOR | 16 |
| TREE CAP VENT | TCV | N.C. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2 & 5.3.10 | 37, MANIPULATOR | 16 |
| TUBING HANGER ANNULUS ACCESS CLOSE | THAAC | N.C. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2 & 5.3.10 | 37, MANIPULATOR | 16 |
| TUBING HANGER ANNULUS ACCESS OPEN | THAAO | N.C. MANUAL GATE VALVE | LOW TORQUE PADDLE | MANIPULATOR | | 24(33) | 250 (339) | 400(542) | 1/4 | 3&6 | 6.2 & 5.3.10 | 37, MANIPULATOR | 16 |
| INSTALL/REMOVE TREE CAP | | | CLASS 4 SQ.DRIVE BUCKET | TORQUE TOOL | | 600 (813) | 900 (1220) | 1500 (2033) | 10.88 | 3&6 | 6.2 & 5.3.10 | 7 | 42,43,44 |
| | | | | | | 050 (475) | 050 (475) | F7F (700) | 0.5 | • | | - | 00.00 |
| WATER INJ. CHOKE OVERRIDE | | CHOKE OPEN/CLOSE | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 350 (475) | 350 (475) | 575 (780) | 8.5 | 3 | 6.2 | 7 | 38,39 |
| WATER INJ. CHOKE LOCKDOWN CLAMP | | CHOKE RELEASE CLAMP | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 1250 (1695) | 1500 (2034) | 2200 (2983) | 42 | 3 | 6.2 | 1 | 38,39 |
| CHOKE INSERT REMOVAL | | INSERT REMOVAL | MPRT | | | | | | | | | | 40,41 |
| HFL STABPLATES | | | | | | | | | | | | | |
| MATE | | | CLASS 4 SQ. DRIVE BUCKET | FLOT, TORQUE TOOL | | 960 (1300) | | | | | | | |
| DEMATE | 1 1 | | CLASS 4 SQ. DRIVE BUCKET | FLOT, TORQUE TOOL | | 480 (650) | | | | | | | |
| | MQC1 | | CLASS 4 SQ. DRIVE BUCKET | FLOT, TORQUE TOOL | | · · / | 1106 (1500) IN PREDE | TERMINED | 9.75 | 6 | 5.3.10 | 5,7 | 52,53 |
| EMERGENCY DISCONNECT TO ACTIVATE SHEAR PIN | - | | CLASS 4 SQ. DRIVE BUCKET | FLOT, TORQUE TOOL | | 1365 (1850) | STEPS | | | | | | |
| TO AOTIVATE OREALT IN | FM1,FM2, | | OLAGO 4 GQ. DITIVE DOORET | TEOT, TORQUE TOUL | MATE : 27 (120) | 1000 (1000) | | | | | | | |
| EFL CONNECTORS | P/C A, P/C B | | | MANIPULATOR | DE-MATE: 25 (111) | | | | | 6 | 5.3.10 | MANIPULATOR ARM | 53 |
| TREE CONTROL MODULE | | | | MANIPULATOR + HOT STAB | MATE : 35 (156) DE-MATE: 35-55(156-245) | | | | | | | | 32,33,34 |
| SWIMS ARM EFL | | | | MANIPULATOR | MATE : 27 (120) DE-MATE: 25 (111) | | | | | 6 | 5.3.2 | MANIPULATOR ARM | 112 |
| | | | LOW TORQUE | | | 00 (07) | 000 (77) | 100 / 7 10 | 176 DEG. | | | | 04 07 00 |
| COVER GRATING LOCKING MECHANISMS | | | PADDLE/MANIPULATOR | | | 20 (27) | 200 (271) | 400 (542) | ROTATION | 6 | 5.3.14 | | 24,25,26 |
| STAB PLATE 1 | MQC1 | FLOT TOOL INC. | CLASS 4 SQ. DRIVE BUCKET | FLOT, TORQUE TOO | - | 960 (1300) | 1365 (1850) | 1585 (2150) | 9.75 | 6 | 5.3.10 | 5,7 | 52,53 |
| | | | | | | | | | | | | | |
| INSTALL/REMOVE RE-ENTRY HUB INSULATION COVER | | | ROV HOOK + WIRELINE | MANIPULATOR | | | | | | 6 | 5.3.14 | MANIPULATOR ARM | 27,28,29 |
| INSTALL/REMOVE CHC FLUID RETAINING CAP | ļ | | | MANIPULATOR | | l | | | | 6 | 5.3.16 | MANIPULATOR ARM | 45,46.47 |
| CHC DEBRIS COVER | | | | MANIPULATOR | | | | | | 6 | 5.3.17 | MANIPULATOR ARM | |
| CHC PRESSURE CAP REMOVAL | | | CLASS 4 SQ. DRIVE BUCKET / SINGLE PORT HOT STAB | MANIPULATOR / TORQUE TOOL / HOT STAB | MATE : 35 (156) DE-MATE: 35-55(156-245) | 50/80 (67/108) | | | | 6 | 5.3.15 | 7,24, MANIPULATOR ARM | 48,49,50,51 |
| HOT STAB FUNCTIONS | | | | | | | | | | | | | |
| TREE CAP VENT / TEST | HS1 | TCV/TCT | SINGLE PORT HOT STAB | MANIPULATOR | | | | | | | | | |
| GASKET RELEASE VALVE | HS2 | GRV | SINGLE PORT HOT STAB | MANIPULATOR | MATE : 35 (156) | | | | | | | | |
| T.H. ANNULUS ACCESS CLOSE/OPEN | HS3 | THAAC/THAAO | DUAL PORT HOT STAB | MANIPULATOR | DE-MATE: 35-55(156-245) | | | | | 3,6 | | 5,7, MANIPULATOR ARM | 55 |
| PRODUCTION CHOKE VALVES | HS4 | PCV | SINGLE PORT HOT STAB | MANIPULATOR | | | | | | | | 1 | |
| THEOCT | 1104 | FUV | MANIPULATOR | MANIPULATOR | | | | | | 6 | 5.3.7 | | 65,66,67 |
| INEUGI | 1 | | MANIPULATUR | WANIPULATUR | 1 | I | | | | O | 0.3.7 | 1 | 00,00,07 |

5.17 ROV Intervention Tooling – Water Injection Trees (Page 3 of 7)

| FUNCTION | IDENTIFICATION | VALVE TYPE | | LINEAR FORCE | ROTAF | RY TORQUE LB.FT.(Ni | m) | No. OF | Rig Boo NG50-2-300-XTR | | ROV TOOLING NG50-2-324-INT-SP-SR-30-0003 | ROV ACCESSIBILITY NG50-2-300-SPS-RP-SC-30-0363 | |
|---|------------------|------------|----------------------------|----------------------------|--------------------------------------|---------------------|----------------------|-----------|---------------------------|--------------|---|---|-----------------------|
| i chonor | ID LINII IOANION | | | | (LBF) (N) | MAKE UP | MAX.OPERATING | DAMAGE | TURNS | SD-018262-01 | Section | X-219400-09-10. Page No. | X-285883-01. Page No. |
| CORROSION CAP INSTALLATION/REMOVAL | | | GRAB HANDLE & WIRELINE | MANIPULATOR | | | | | | | 8.10 | Manipulator, hot Stab | 58,59 |
| CORROSION CAP CORROSION INHIBITOR | | | SINGLE PORT HOT STAB | MANIPULATOR | | | | | | | 8.10 | MANIPULATOR, 24 | 60,61 |
| HFL STABPLATES | | | | | | | | | | | | | |
| MATE | | | | | | 960 (1300) | | | | | | | |
| DEMATE | | | CLASS 4 SQ. DRIVE BUCKET | | | 480 (650) | | | | | 8.11 | 5.7 | 62 |
| EMERGENCY DISCONNECT | | | GLASS 4 SQ. DRIVE DUCKET | IURQUE IUUL/FLUI | | 480 (650) -1106 (| 1500) IN PREDETERMIN | IED STEPS | | | 0.11 | 3,7 | 02 |
| TO ACTIVATE SHEAR PIN | | | | | | 1365 (1850) | | | | | | | |
| EFL PARKING/TRANSFER | | | MANIPULATOR | MANIPULATOR | MATE : 27 (120) DE-MATE: 25 (111) | | | | | | 8.11 | | 63,64 |
| WELLHEAD GASKET CLEANING/ REPLACEMENT | | | MANIPULATOR | MANIPULATOR | | | | | | | | 25 | 68,69 |
| GUIDEBASE ALIGNMENT | | | ISO 13628.8 DOCKING PORT | TELEMETRY DOCKING FRAME | | 20 (27) | 20 (27) | 120 (163) | 0.25 | | | 31 | |
| HFL COVER PLATE REMOVAL | | | GRAB HANDLE | | 44 (196) - 110 (490) | | | | | | | | |
| 18.3/4" HOUSING RUNNING TOOL BALL VALVE | | | PADDLE | MANIPULATOR | | 20 (27) | 20 (27) | 120 (163) | 0.25 | | 8.11 | | |
| TREE SPECIAL TOOLING | | | | | | | | | | | | | |
| GASKET CLEANING TOOL - 18.3/4"/13.5/8" | | | RING TYPE ROV HANDLE | MANIPULATOR | | | | | | | | | |
| GASKET CLEANING TOOL - 5.1/8" | | | ROV HANDLE-ISO13628-8 | MANIPULATOR | | | | | | | | | |
| GASKET CLEANING TOOL - 2.1/16" | | | RING TYPE ROV HANDLE | MANIPULATOR | | | | | | | | | |
| GASKET CHANGEOUT TOOL - 18.3/4"/13.5/8" | | | TYPE 'A' DUAL PORT HOTSTAB | MANIPULATOR | | | | | | | | | |
| GASKET CHANGEOUT TOOL - 5.1/8"/2.1/16" | | | TYPE 'A' DUAL PORT HOTSTAB | MANIPULATOR | | | | | | | | | |
| GASKET LOCKOUT TOOL -18.3/4" | | | SINGLE PORT HOTSTAB | MANIPULATOR | | | | | | | | | |
| METHANOL SKID | | | SINGLE PORT HOTSTAB | MANIPULATOR | | | | | | | | | |

5.17 ROV Intervention Tooling – Tree Guide Base (TGB) (Page 4 of 7)

| FUNCTION | DENTIFICATIO | VALVE TYPE | INTERFACE | ROV OPERATOR | LINEAR FORCE | | RY TORQUE LB.FT.(N | | No. OF TURNS | | ook Ref. | ROV TOOLING NG5-2-324-INT-SP-SR-30-0003 | ROV ACCESSIBILITY NG50-2-300-SPS-RP-SC-30-0395 | ROV ACCESSIBILITY NG50-2-300-MAN-TR-SM-30-0429 |
|--|--|----------------------------------|---|-----------------------------|--------------------------------------|-------------------|--------------------------|-------------|-----------------|---------|----------|--|---|---|
| | | | | | (LBF) | MAKE UP | MAX.OPERATING | DAMAGE | TURNS | Fig.No. | Page No. | X-219400-09-10. PageNo. | X-261884-01. PageNo. (PROD.) | X-296104-01. PageNo.(G.I.) |
| MANUAL VALVES (ROV) | | WHERE USED | | | | | | | | | | | | |
| 2-1/16" 10K FLS GATE VALVES | MGV/GBV | PROD./GL/GI MANIFOLD | CLASS 4 SQ.DRIVE BUCKET | TORQUE TOOL | | 35 (47) | 85 (115) | 200 (271) | 12.3 | | | 7 | 38-48 incl. | 41,42,43,44,45,46,47 |
| 5-1/8" 10K FLS GATE VALVE | PIV/GIV | PROD./GI MANIFOLD | CLASS 4 SQ.DRIVE BUCKET | TORQUE TOOL | | 260 (353) | 690 (936) | 1035 (1404) | 29 | | | 7 | 38-48 incl. | 41,42,43,44,45,46,47 |
| 8" 10K FLS-R GATE VALVE | GHV | GI MANIFOLD | CLASS 4 SQ.DRIVE BUCKET | TORQUE TOOL | | 380 (515) | 700 (950) | 1050 (1424) | 20 | | | 7 | 38-48 incl. | 41,42,43,44,45,46,47 |
| 10" 6.5K FLS GATE VALVE | WHV | FLET | CLASS 4 SQ.DRIVE BUCKET | TORQUE TOOL | | 100 (136) | 200 (271) | 400 (543) | 66 | | | 7 | | |
| 5-1/8" 5K FLS GATE VALVE | WIV | ITA | CLASS 4 SQ.DRIVE BUCKET | TORQUE TOOL | | 75 (102) | 350 (475) | 1035 (1404) | 29 | | | 7 | 38-48 incl. | |
| | | | | | | | | | | | | | | |
| ACTUATED VALVES W/ROV OVERRIDE | | | | | | | | | | | | | | |
| 1" 10K GATE VALVE | HVV | PRO. MANIFOLDS | CLASS 4 SQ.DRIVE BUCKET | TORQUE TOOL | | 90 (122) | 250 (339) | 350 (475) | 10.5 | | | 7 | 38-48 incl. | |
| 2-1/16" 10K FLS GATE VALVES | MGV | PROD./GL MANIFOLD | CLASS 4 SQ.DRIVE BUCKET | TORQUE TOOL | | 150 (203) | 230 (312) | 350 (475) | 12.3 | | | 7 | 38-48 incl. | |
| 5-1/8" 10K FLS-R GATE VALVE | MPV | PROD. MANIFOLD | CLASS 4 SQ.DRIVE BUCKET | TORQUE TOOL | | 150 (203) | 400 (543) | 600 (814) | 24 | | | 7 | 38-48 incl. | |
| 10" 7.2K FLS GATE VALVE | MHV | PROD. MANIFOLD | CLASS 4 SQ.DRIVE BUCKET | TORQUE TOOL | | 1000 (1356) | 1500 (2030) | 2250 (3050) | 55 | | | 7 | 38-48 incl. | |
| | | | | | | | | r | | | | | | |
| HDU VALVES | | | | | | | | | | | | | | |
| 3/4" GATE VALVE | MMV1 TO 6 | PRO. MANIFOLDS | CLASS 4 SQ.DRIVE BUCKET | TORQUE TOOL | | 90 (122) | 250 (339) | 365 (495) | 10.5 | | | 24,37 | 38-48 incl. | |
| 3/4" METHANOL BALL VALVE | ME-1A TO ME-3D | PROD./GL MANIFOLD | LOW TORQUE PADDLE | MANIPULATOR | | 25 (34) | 50 (68) | 200 (271) | | | | 24,37 | 38-48 incl. | 48,49,50 |
| HOT STAB | | | SINGLE PORT HOT STAB | | | | | | | | | | | 48,49,50 |
| HDU & HDU TO MANIFOLD CONNECTORS | | | | | | | | | | | | | | |
| MATING | PTREE | PRODUCTION MANIFOLDS | CLASS 4 SQ.DRIVE BUCKET | TORQUE TOOL | | 960 (1300) | | | | | | 7 | | 72,73,74,75 |
| DEMATING | A1,A2,B1,B2 | PRODUCTION MANIFOLDS | CLASS 4 SQ.DRIVE BUCKET | TORQUE TOOL | | 480 (650) | | | | | | 7 | 70 70 74 75 | 72,73,74,75 |
| EMERGENCY DISCONNECT | PTREE C1,C2,D1,D2 | PRODUCTION MANIFOLDS | CLASS 4 SQ.DRIVE BUCKET | TORQUE TOOL | | | (1500) IN PREDETERMIN | NED STEPS | | | | 7 | 72,73,74,75 | |
| TO ACTIVATE SHEAR PIN | DSUT1,2 | PRODUCTION MANIFOLDS | CLASS 4 SQ.DRIVE BUCKET | TORQUE TOOL | | 1365 (1850) | | | 1 | 1 | 1 | 7 | 1 | |
| HDU GUIDEPOST INSERTION/REMOVAL | 1 | PROD/G.I. MANIFOLDS | ROV GRAB HANDLE | MANIPULATOR | | () | | 1 | 1 | | 1 | | 80,81,82 | 60-71 INCL. |
| | | | | | | | | 1 | 1 | | l | | | |
| HDU & HDU TO MANIFOLD LTC'S | | | | | | | | | | | | | | |
| MATING | | PRODUCTION MANIFOLDS | CLASS 4 SQ.DRIVE BUCKET | TORQUE TOOL | | 960 (1300) | | | 9.75 | | | 7 | | 72,73,74,75 |
| DEMATING | | PRODUCTION MANIFOLDS | CLASS 4 SQ.DRIVE BUCKET | TORQUE TOOL | | 480 (650) | | | 9.75 | | | 7 | | 72,73,74,75 |
| EMERGENCY DISCONNECT | | PRODUCTION MANIFOLDS | CLASS 4 SQ.DRIVE BUCKET | TORQUE TOOL | | 480 (650) -1106 | (1500) IN PREDETERMIN | NED STEPS | 9.75 | | | 7 | 72,73,74,75 | |
| TO ACTIVATE SHEAR PIN | | PRODUCTION MANIFOLDS | CLASS 4 SQ.DRIVE BUCKET | TORQUE TOOL | | 1365 (1850) | | | 9.75 | | | 7 | | |
| HDU LOCKING PIN | HDU L1/L2 | | ROV 'T' GRAB HANDLE | MANIPULATOR | | | | | | | | | | |
| | | | HOT T ON DAMABLE | MANIPULATOR | MATE : 27 (120) DE-MATE: 25 (111) | | | | | | | | | |
| HDU/MANIFOLD EFL | PT | | | | DE-MATE: 25 (111) | | | | | | | | | |
| | | | | | | | | | | | | | | |
| FOUNDATION SUPPORT STRUCTURE | | | | | | 500 (678) | | | | | | 7 | 22,23,24 | 19,20,21,22,23 |
| BASEFRAME JACKING SCREWS | | PROD./GI BASEFRAME | CLASS 4 SQ.DRIVE BUCKET | TORQUE TOOL | | 100 (136) | 2000 (2712) 125 (170) | | 5 | | | ' | 22,23,24 | 13,20,21,22,23 |
| | | | | | | 106 (130) | 133 (180) | | 10 | | | 7 | 14,15 | 13,16 |
| BUTTERFLY VALVE | | PROD./GI | CLASS 4 SQ.DRIVE BUCKET | TORQUE TOOL | | 100(144) | 135 (100) | | 10 | | | ' | 20,21 | 24,25,26 |
| GUIDE POST LOCKING PINS | | | ROV GRAB HANDLE | MANIPULATOR | | | | | | | | 31 | 10,11,12,13 | 10,11,12,13,29,30 |
| BASEFRAME TELEMETRY | | | ISO 13628.8 DOCKING PORT | DOCKING FRAME | 108 (00) | | | | | | | 31 | | |
| CONTINGENCY CAP (BUTTERFLY VALVE) | | | ROV GRAB HANDLE | MANIPULATOR | 198 (90) | 400 (400) | | | | | | | 16,17 30,31,32,33,34 | 14,15 32,33,34,35,36 |
| BASEFRAME LOCKDOWN PINS | | PRO. MANIFOLDS | ROV GRAB HANDLE | MANIPULATOR | | 100 (136) | | | | | | | | |
| SUCTION INLET | | PRO. MANIFOLDS | | | | | | | | | | | 18 26 | 17 |
| MANIFOLD RELEASE/RECOVERY SHACKLES | | | | MANIPULATOR | | | | | | | | | 20 | |
| | - | | | | | | | | <u> </u> | | | | | |
| CHC PRESSURE CAPS | | | CLASS 4 SQ.DRIVE BUCKET | TORQUE TOOL | | | | | | | | | | |
| 6" | 1 | PROD./GI MANIFOLD | /HOTSTAB (TYPE A ONLY) | /MANIPULATOR | | 50/80 (67/108) | | | 33/34 | | | 7,24 | 35,36,37 | 37,38,39,40 |
| 10" | | GI MANIFOLD | CLASS 4 SQ.DRIVE BUCKET /HOTSTAB (TYPE A ONLY) | TORQUE TOOL /MANIPULATOR | | 100/150 (136/204) | | | 9 to 10 | | | 7,24 | 35,36,37 | 37,38,39,40 |
| 10" | | | CLASS 4 SQ.DRIVE BUCKET | TORQUE TOOL | | 100/150 (136/204) | | 1 | 9 to 10 | | l | 7,24 | 35,36,37 | |
| 12 | 1 | PROD. MANIFOLD | /HOTSTAB (TYPE A ONLY) | /MANIPULATOR | | , | | - | | | | | | |
| | 1 | | | | | 1 | | - | | | | | | |
| CHC FLOODING CAPS | | | CLASS 4 SQ.DRIVE BUCKET | TORQUE TOOL | | | | | | | | | | |
| 10" | | GI MANIFOLD | /HOTSTAB (TYPE A ONLY) | /MANIPULATOR TORQUE TOOL | | 100/150 (136/204) | | | 10 to 11 | | | 7,24 | 35,36,37 | 37,38,39,40 |
| 12" | | PROD. MANIFOLD | CLASS 4 SQ.DRIVE BUCKET /HOTSTAB (TYPE A ONLY) | /MANIPULATOR | | 100/150 (136/204) | | | 10 to 11 | | | 7,24 | 35,36,37 | |
| | | | | | | | | | | | | | | |
| MCM REMOVAL/INSTALLATION | | PRO. MANIFOLDS | MPRT | MANIPULATOR | | | | | | | | | 52,53 | 60-71 INCL. |
| SCM EFL | P/C A P/C B | PRO. MANIFOLDS | | MANIPULATOR | MATE : 27 (120) DE-MATE: 25 (111) | | | | | | | | 54,55 | 60-71 INCL. |
| MPFM EFL | PE-A1,PE-A2 PE-B1,PE-B2 PE-C1,PE-C2 PE-D1,PE-D2 | PRO. MANIFOLDS | | MANIPULATOR | MATE : 27 (120) DE-MATE: 25 (111) | | | | | | | | 60-68 INCL. | 60-71 INCL. |
| | | | | MANIPULATOR | | | | | | | | | 69,70,71 | 60-71 INCL. |
| MPFM CANISTER REMOVAL | | PRO. MANIFOLDS | ROV GRAB HANDLE | | | | | | | | | | | |
| MPFM CANISTER REMOVAL | | PRO. MANIFOLDS PRO. MANIFOLDS | | | | | | | | | | | 50,51,52 | 60-71 INCL. |
| | | PRO. MANIFOLDS | ROV GRAB HANDLE | MANIPULATOR | | | | | | | | | 50,51,52 56,57,58 | 60-71 INCL. 60-71 INCL. |
| MPFM CANISTER REMOVAL MCM DEBRIS COVERS | | | | | | | | | | | | | | |

5.17 ROV Intervention Tooling – Manifolds (Page 5 of 7)

| FUNCTION | | | INTERFACE | | LINEAR FORCE | RO | TARY TORQUE LB.FT.(| Nm) | No. OF | | g Book | ROV TOOLING NG50-2-324-INT-SP-SR-30-0003 | ROV ACCESSIBILITY |
|------------------------------------|----------------|------------|--|---------------|--------------|--------------|---------------------|--------------|--------|---|----------------|---|-------------------|
| FUNCTION | IDENTIFICATION | VALVE TYPE | ISO 13628.8 | ROV OPERATION | LBF (N) | MAKE UP | MAX.OPERATING | DAMAGE | TURNS | | TBA Section | X-219400-09-10. PageNo. | X-TBA. PageNo. |
| JUMPER INSTALLATION / INTERVENTION | | | • | • | | • | | | | | | | - |
| | | | | | | | | | | | | | |
| CHC RUNNING TOOL | | | | | | | | | | | | | |
| VALVE, 3 WAY BALL | AL,AU | | LOW TORQUE PADDLE | MANIPULATOR | | | 36 (49) | | 1/4 | | | | |
| VALVE, DOUBLE 2 WAY TRUNNION | AC,CC,PC,PX,TL | | LOW TORQUE PADDLE | MANIPULATOR | | | | | | | | | |
| HOT STAB | HS | | | MANIPULATOR | | | | | | | | | |
| CLASS 4 SQ.DRIVE BUCKET | CCM | | | TORQUE TOOL | | | | 2000 (2722) | 68 | | | | |
| | | | | | | | | | 1 | | | | |
| CHC SEAL RETRIEVAL TOOL | | | | | | | | | | | | | |
| | | | ROV 'T' GRAB HANDLE | | | | | | | | | | |
| 12" | | | DUAL PORT HOTSTAB ROV 'T' GRAB HANDLE | MANIPULATOR | | | | | | | | | |
| 10" | | | DUAL PORT HOTSTAB | MANIPULATOR | | | | | | | | | |
| 6" | | | ROV 'T' GRAB HANDLE DUAL PORT HOTSTAB | MANIPULATOR | | | | | | | | | |
| | | | | | | | | | | | | | |
| CHC HUB CLEANING TOOL | | | | | | | | | | | | | |
| 12" | | | DUAL PORT HOT STAB | MANIPULATOR | | | | | | | | | |
| SCREW JACK | | | T' BAR HANDLE | TORQUE TOOL | | | | | | | | | |
| 10" | | | DUAL PORT HOT STAB | MANIPULATOR | | | | | | | | | |
| SCREW JACK | | | T' BAR HANDLE | TORQUE TOOL | | | | | | | | | |
| 6" | | | DUAL PORT HOT STAB | MANIPULATOR | | | | | | | | | |
| SCREW JACK | | | T' BAR HANDLE | TORQUE TOOL | | | | | | | | | |
| | | | T DARTHANDLE | TORQUE TOUL | | 1 | | | | | 1 | | |
| CHC SEAL REPLACEMENT TOOL | | | | | | | | | | | | | |
| | | | ROV 'T' GRAB HANDLE | | | | | | | | | | |
| 12" | | | DUAL PORT HOTSTAB ROV 'T' GRAB HANDLE | MANIPULATOR | | | | | - | | | | |
| 10" | | | DUAL PORT HOTSTAB | MANIPULATOR | | | | | | | | | |
| 6" | | | ROV 'T' GRAB HANDLE DUAL PORT HOTSTAB | MANIPULATOR | | | | | | | | | |
| | | | | | | | | | | | | | |
| CHC TRANSPORTATION CAP | | | | | | | | | | | | | |
| 12" | | | ROV GRAB HANDLE | MANIPULATOR | | 8-15 (11-20) | | | 5 | | | | |
| 10" | | | ROV GRAB HANDLE | MANIPULATOR | | 8-15 (11-20) | | | 5 | | | | |
| 6" | | | ROV GRAB HANDLE | MANIPULATOR | | 8-15 (11-20) | | | 5 | | | | |
| | | | · | | | | · · | | • | | | | |
| IDRT | | | | | | | | | | | | | |
| VALVES, | V1 THRU V8 | | LOW TORQUE PADDLE | MANIPULATOR | | 24 (33) | 36 (49) | | 1/4 | 1 | 1 | | |
| DUAL PORT HOT STAB | | | HOT STAB | MANIPULATOR | | | 1 | | | 1 | | | |
| WEAK LINK | | | | MANIPULATOR | | | 1 1 | | | | | | |
| CAMERA & LIGHTS | | | DIGITRON CONNECTION | | | | 1 1 | | | 1 | 1 | | |
| DOGHOUSE TORQUE ADAPTER | | | HIGH TORQUE TOOL | TORQUE TOOL | | | 1 1 | 1455 (2000) | | 1 | 1 | | |
| | | | | | | | <u> </u> | TO SHEAR PIN | + | | - | | |
| MPRT | | | | | | | | | | | | | |
| VALVES, | + + | | LOW TORQUE PADDLE | MANIPULATOR | | 24 (33) | 36 (49) | | 1/4 | 1 | | | |
| HOT STAB | | | HOT STAB | MANIPULATOR | | 24 (00) | 00 (40) | | 1/4 | + | + | | |
| WEAK LINK | | | TIOT STAD | MANIPULATOR | | | <u> </u> | | + | + | + | | |
| PIGGING LOOP ROV PANEL | + + | | + | WANT OLATOR | | | <u> </u> | | + | + | + | | |
| JUMPER ROV PANEL | | | | - | | | <u>├</u> | | + | - | | | |
| JUMPER NOV FANEL | | | | | | | | | | 1 | | | |

5.17 ROV Intervention Tooling – Special Tooling (Page 6 of 7)

| FUNCTION | IDENTIFICATION | VALVE TYPE | | ROV OPERATION | LINEAR FORCE | ROTA | RY TORQUE LB.FT.(N | m) | No. OF | Rig Book SD-TBA | ROV TOOLING NG50-2-324-INT-SP-SR-30-0003 | ROV ACCESSIBILITY NG50-2-300-SPS-RP-SC-30-0389 |
|--|--|------------|--------------------------|-------------------|--------------------------------------|-----------------|-----------------------|-------------|--------|--------------------|---|---|
| | | | ISO 13628.8 | | LBF (N) | MAKE UP | MAX.OPERATING | DAMAGE | TURNS | Volume Section | X-219400-09-10. PageNo. | X-261883-01. PageNo. |
| FOUNDATION BASE | | | | | | | | | | | | |
| HFL STABPLATES & LTC'S | | | | | | | | | | | | |
| MATE | | | | | | 960 (1300) | | | | | | |
| DEMATE | HDU1 | | CLASS 4 SQ. DRIVE BUCKET | | | 480 (650) | | | 9.75 | | 5,7 | 8,9,10 |
| EMERGENCY DISCONNECT | HDU2 | | CEASS 4 SQ. DRIVE BUCKET | | | 480 (650) -1106 | (1500) IN PREDETERMIN | NED STEPS | 5.15 | | 5,7 | 0,5,10 |
| TO ACTIVATE SHEAR PIN | | | | | | 1365 (1850) | | | | | | |
| EFL CONNECTORS | E1 THRU E6 | | | MANIPULATOR | MATE : 27 (120) DE-MATE: 25 (111) | | | | | | MANIPULATOR ARM | 11-18 INCL. |
| BRIDGE JUMPER | | | | | | | | | | | | |
| BRIDGE JUMPER DEBRIS COVER | | | GRAB HANDLE | MANIPULATOR | | | | | | | | 33,35 |
| BRIDGE JUMPER STAB PLATE | | | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 960 (1300) | 1365 (1850) | 1585 (2150) | 9.75 | | 7 | 36 |
| BRIDGE JUMPER GUIDEPOST LOCKDOWN PINS | | | GRAB HANDLE | MANIPULATOR | | | | | | | MANIPULATOR ARM | 46 |
| DSUT & ISUT | | | | | | | | | | | | |
| HFL STABPLATES (INCL.SUTH) | | | | | | | | | | | | |
| MATE | | | | | | 960 (1300) | | | | | | |
| DEMATE | HDU1 | | | | | 480 (650) | | | | | | |
| EMERGENCY DISCONNECT | HDU2 | | CLASS 4 SQ. DRIVE BUCKET | FLOT, TORQUE TOOL | | 480 (650) -1106 | (1500) IN PREDETERMIN | NED STEPS | 9.75 | | 5,7 | 30,31,32 |
| TO ACTIVATE SHEAR PIN | - | | | | | 1365 (1850) | | | | | | |
| EFL CONNECTORS | M1,M2,A1,A2,B1,B2, C1,C2,D1,D2, E1 THRU E6 | | | MANIPULATOR | MATE : 27 (120) DE-MATE: 25 (111) | | | | | | MANIPULATOR ARM | 11-18 INCL. |
| LTC STAB PLATE (INCL.BRIDGE JUMPER POSITION) | | | | | | | | | | | | |
| MATE | | | | | | 960 (1300) | | | | | | |
| DEMATE | HDU1 | | CLASS 4 SQ. DRIVE BUCKET | | | 480 (650) | | | 9.75 | | 7 | 8,9,10 |
| EMERGENCY DISCONNECT | HDU2 | | CLASS 4 SQ. DRIVE BUCKET | FLOT, TORQUE TOOL | | 480 (650) -1106 | (1500) IN PREDETERMIN | NED STEPS | 9.75 | | · · · · · · | 8,9,10 |
| TO ACTIVATE SHEAR PIN | | | | | | 1365 (1850) | | | | | | |
| DSUT/ISUT LOCKDOWN PINS | | | T' GRAB HANDLE | MANIPULATOR | | | | | | | MANIPULATOR ARM | 37,45 |
| GUIDEPOST LOCKDOWN PINS | | | T' GRAB HANDLE | MANIPULATOR | | | | | | | MANIPULATOR ARM | 46 |
| FLOWLINE END TERMINATION (FLET) | | | | | | | | | | | | |
| 10" 6500 'FLS' MANUAL GATE VALVE | | | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 100 (135.6) | 200 (271.1) | 400 (542.3) | 66 | | | |
| IN-LINE TEE ASSEMBLY (ITA) | | | | | | | | | | | | |
| 5.1/8" 5000 'FLS' MANUAL GATE VALVE | | | CLASS 4 SQ. DRIVE BUCKET | TORQUE TOOL | | 75 (101.7) | 350 (474.5) | 1035 (1403) | 29 | | | |
| ROV SKIDS | | | | | | | | | | | | |

5.17 ROV Intervention Tooling – SUT'S Bridge Jumper and Foundation Base (Page 7 of 7)

AKPO Subsea Reference Manual Section 6 Subsea CHC Connection System Tooling

CONTENTS

- 6.1 CHC Connection System Tooling CHC Running Tool (CHC RT)
- 6.2 CHC Connection System Tooling 6in Hub Cleaning Tool
- 6.3 CHC Connection System Tooling 10in Hub Cleaning Tool
- 6.4 CHC Connection System Tooling 12in Hub Cleaning Tool
- 6.5 CHC Connection System Tooling 6in Connector Cleaning Tool
- 6.6 CHC Connection System Tooling 10in Connector Cleaning Tool
- 6.7 CHC Connection System Tooling 12in Connector Cleaning Tool
- 6.8 CHC Connection System Tooling 6in Seal Replacement Tool
- 6.9 CHC Connection System Tooling 10in Seal Replacement Tool
- 6.10 CHC Connection System Tooling 12in Seal Replacement Tool
- 6.11 CHC Connection System Tooling 6in Seal Retrieval Tool
- 6.12 CHC Connection System Tooling 10in Seal Retrieval Tool
- 6.13 CHC Connection System Tooling 12in Seal Retrieval Tool
- 6.14 CHC Connection System Tooling 6in Pressure Cap (Manifolds)
- 6.15 CHC Connection System Tooling 10in Pressure Cap

CONTENTS (cont'd)

6.16 CHC Connection System Tooling – 12in Pressure Cap (Manifolds)

The jumper and spool Cameron Horizontal Connections (CHC) are made by the Cameron Horizontal Connection Running Tool (CHCRT) which is guided by the ROV.

A gasket between the two connecting faces ensures the sealing

The diagram illustrates a Cameron Horizontal Connection Running Tool (CHCRT) with the guidance balls positioned, for both pigging loop installation and FLET installation.

| Dry Weight | 21,000 lbs/(9546kg) |
|------------------|---------------------|
| Submerged Weight | 18,269 lbs/(8304kg) |

Refer to:

- NG50-2-300-MAN-DW-SM-30-0265 Assembly Details CHC Running Tool
- NG50-2-300-MAN-DW-SM-30-0107 Interface Drawing: CHC Running Tool
- NG50-2-300-MAN-DW-SM-30-0032 Interface Drawing: CHC Landing Porch
- NG50-2-300-MAN-PR-SM-30-0114 Installation Procedure CHC Running Tool

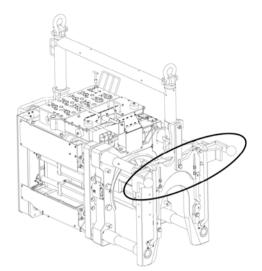


Figure 8 – CHCRT with the guidance balls in the 'top' position (circled)

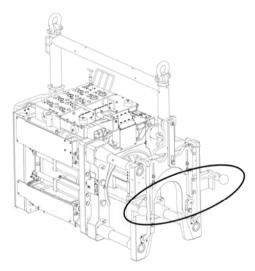
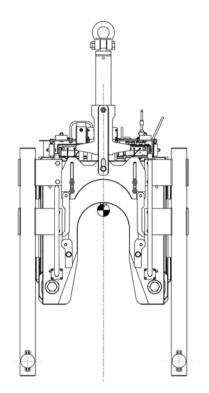
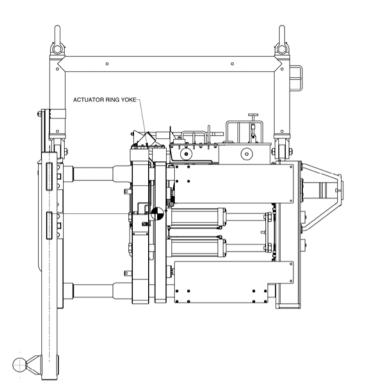


Figure 9 – CHCRT with the guidance balls in the 'bottom' position (circled)





AKPO_SS_06_01.ai SAPETRO ER PETROBRAS TOTAL CONTRACT NUMBER: CLIENT DOCUMENT NUMBER: APO/C007/03 NG50-2-300-MAN-DW-SM-30-0513 8 NTS C Cameron Division P.O. Box 1212 Houston, TX 77251-1212 L.RAMU DATE 17-OCT-07 DATE 19 OCT 07 DATE 18 OCT 07 ASSY, CHC RUNNING TOOL W/ FLET/ITA DEPLOYMENT CONFIGERATION L.RAMU P.SPELMAN 2090815-01 1 OF 1 SK-020529-01 01 D SIZE

Assembly diagram illustrates a 6in CHC Hub Cleaning Tool.

Designed to clean all seal areas of the CHC Flowline Connector. Capable of cleaning both inboard and outboard hub faces. The tool is ROV Deployed.

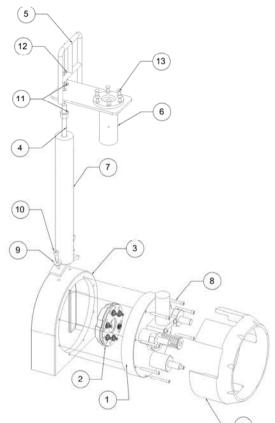
Hydraulic requirements:

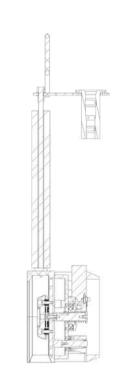
- Input pressure from ROV 2750psi (3000psi max)
- In/Out flow pressure ROV 4GPM (15.14L)/5.5GPM (20.8L)
- Hub Cleaner supplied with: 17-H-Dual Port Manifold 17-H-Dual Port Hotstab

Refer to:

 NG50-2-300-MAN-DW-SM-30-0440 – Assembly 6in Hub Cleaner (CHC) System

6.1 CHC Connection System Tooling – CHC Running Tool (CHC RT)





| ITEM NO. | PART NUMBER | DESCRIPTION | QTY |
|----------|--------------|---|-----|
| 1 | 0283494 | HUB CLEANER DRIVE ASSY | 1 |
| 2 | 0283493 | 6" CLEANING HEAD ASSY | 1 |
| 3 | 0283064 | 6" BODY | 1 |
| 4 | 0283441 | 6" HANDLE | 1 |
| 5 | 0283439 | TOP PLATE HANDLE | 1 |
| 6 | A10811 | API-17H DUAL PORT MANIFOLD FLANGE MOUNT | 1 |
| 7 | 0283529 | BUMPER | 1 |
| 8 | 0021385 | SCREW SHC 0.375-16UNC-2A X 3 316 SS | 8 |
| 9 | MF371-S19-01 | WASHER FLAT TYPE B 0.5 R | 2 |
| 10 | MF191-S19-15 | SCR CAP SCH 0.5-13UNC-2A X 1.25 | 2 |
| 11 | MF381-S25-01 | WASHER FLAT TYPE B 0.75 N 316 SS | 2 |
| 12 | MF311-S25-01 | NUT HEX NYLON LOCK 0.75-10UNC-2B 316 SS | 2 |
| 13 | 0015330 | SCREW FHSHC 82 DEG 0.375-16UNC X 0.875 316 SS | 6 |
| 14 | 0285175 | DRIVE BUMPER | 1 |





Assembly diagram illustrates a 10in CHC Hub Cleaning Tool.

Designed to clean all seal areas of the CHC Flowline Connector. Capable of cleaning both inboard and outboard hub faces. The tool is ROV Deployed.

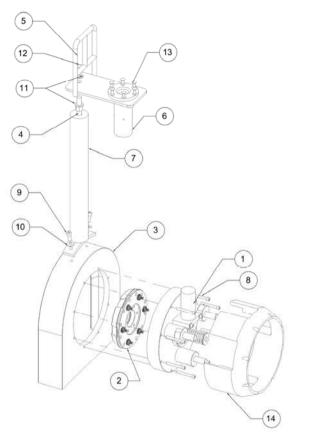
Hydraulic requirements:

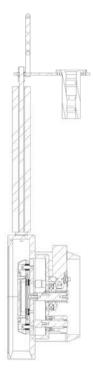
- Input pressure from ROV 2750psi (3000psi max)
- In/Out flow pressure ROV 4GPM (15.14L)/5.5GPM (20.8L)
- Hub Cleaner supplied with: 17-H-Dual Port Manifold 17-H-Dual Port Hotstab

Refer to:

 NG50-2-300-MAN-DW-SM-30-0441 – Assembly 10in Hub Cleaner (CHC) System

6.2 CHC Connection System Tooling – 6in Hub Cleaning Tool





| 0283 | | | | | | | | |
|---------|---|--|--|---------------|---|--|--|--|
| | 440 | 12"/10" H | ANDLE | | | 1 | | |
| 0283 | 439 | TOP PL/ | ATE HANDI | LE | | | | 1 |
| A108 | 811 | API-17H | DUAL POR | RT FLA | NGE MAN | IFOLD | | 1 |
| 0283 | 529 | BUMPER | 2 | | | | | 1 |
| 0021 | 385 | SCREW | SHC 0.375 | 5-16UN | C-2A X 2 3 | 16 SS | | 8 |
| MF191-5 | S19-15 | SCR CA | P SCH 0.5- | -13UNC | -2A X 1.25 | | | 2 |
| MF371-5 | S19-01 | WASHE | R FLAT TY | PEBO. | 5 R | | | 2 |
| MF381-5 | 525-01 | WASHE | R FLAT TY | PB0.7 | 5 N 316 SS | 5 | | 2 |
| MF311-5 | S25-01 | NUT HE | X NYLON L | LOCK 0 | .75-10UNC | -2B 316 S | s | 2 |
| 0015 | 330 | SCREW | FHSHC 82 | DEG | .375-16UN | VC X 0.87 | 5 316 SS | 6 |
| 0285 | 175 | DRIVE B | UMPER | | | | | 1 |
| | | | | OCEAN | EERING IN | TERNATI | ONAL INC | |
| | | | | UCEAN | | NEERING.COM | 22010/02/2010/02/2010 | 122 |
| | PROPRETAR THE INCOME INTERACTION PART FOR AP | ENT CONTAINS INFO IT TO OCEANEERING IN ATTOM CONTAINED IN ED, DUPLICATED, USED INF PURPOSE OTHER T AGENT WITHOUT WHIT IG INTERNATIONAL, IN | NTERNATIONAL INC. #EMBRID GHALL NOT D IN WHOLE OR IN THAN TO EVALUATE TEN COMMENT OF | TITLE | CAME | B CLEAN | 5736A | |
| | ORAWN P | w I | DATE 23 JUNE 06 | ⊕ -(| | GLE PROJECT | ION DO NO | OT SCALE |
| | ENGR: 5 | | | 507E | DAG NO | | | REV |
| | | | DATE 23 JUNE 06 | | | 283489 | | |
| | PR MGR: C | | DATE 23 JUNE 06 | B SCALE NT | | 1283489 124 LE | IS SHEET | A |
| | PR MGR: C | | DATE 23 JUNE 06 | в | s (wexcern | 124 LB | 142 | A 1 OF 1 |
| | PR MOR C | CULANS SEGNATURES O TO CONTRACT NUMB APO/C | DATE 23 JUNE 28 IN FILE | B SCALE NT | BR CLIENT DOCUM NG50-2-3 | PETI PETI IOO-MAN-D | R OBR W-SM-30-0 | A 1 OF 0.55.06.074 AS 0441 |
| | PR MOR. O | | DATE 23 JUNE 00 IN FILE | B SCALE NT | BR CLIENT DOCUM NG50-2-3 | PETI PETI RENT NUMBER: 100-MAN-D | R OBR W-SM-30-0 | A 1 OF 0.55.00.05. AS 0441 |
| | | | DATE 23 JUNE 00 IN FILE | | BR CLIENT DOCUM NG50-2-3 | PETI PETI RENT NUMBER: 1000-MAN-D THE BOCKMENT IN THE DOCKMENT | R OBR W-SM-30-0 | A 1 OF 0.35.00.000 AS AS 0441 0441 07.000 0.0000 0.0000 0.0000 0.000 0.0000 0.0000 0.0000 0.0000 0 |
| | PR MOR. 0 | | DATE 23 ANNE 26 IN FRE | | BR BR CLENT DOCUM NG50-2-3 | PETI PETI RENT NUMBER 1000-MAN-D Intel Rent N | AD ROBR W-SM-30-0 Solar Langer P.0. Bay 122 Denamor David P.0. Bay 122 Denamor David Denamor Dav | A 1 OF 0.35.00.004 AS 0.441 0.4441 0.4441 0.4441 0.4441 0.4441 0.4441 |
| | PR MOR. 0 | | DATE 23 JUNE 08 IN FILE | | BR GLIENT DOCUN NG50-2-3 CLIENT DOCUN NG50-2-3 CAMII | PETI PETI RENT NUMBER 1000-MAN-D IM RENT NUMBER ERON | AD ROBR W-SM-30-0 W-SM-30-0 Materiol, a dotted F 0 do Maler, lange F 0 do Maler, lange | A 1 OF 0.55.100,000 ASS 0.55.100,000 ASS 0.55.100,0000 0.55.100,000 0.55.100,0000 0.55.100,0000 0.55.100,000 0.55.100,000 0.55.100 |
| | PR MOR. 0 | | DATE 23 JUNE 08 NFRE | | BR GLIENT DOCUN NG50-2-3 CLIENT DOCUN NG50-2-3 CAMII | PETI PETI MENT NUMBER 100-MAN-D 100 MAN-D 100 | AD ROBR W-SM-30-0 W-SM-30-0 Materiol, a dotted F 0 do Maler, lange F 0 do Maler, lange | A 1 OF 1 0.55.06,050 AS 4441 00 0000000 0 00000000 0 00000000 0 00000000 |

DESCRIPTION HUB CLEANER DRIVE ASSY

10" CLEANING HEAD ASSY

12"/10" BODY

QTY.

ITEM NO.

PART NUMBER

Assembly diagram illustrates a 12in CHC Hub Cleaning Tool.

Designed to clean all seal areas of the CHC Flowline Connector. Capable of cleaning both inboard and outboard hub faces. The tool is ROV Deployed.

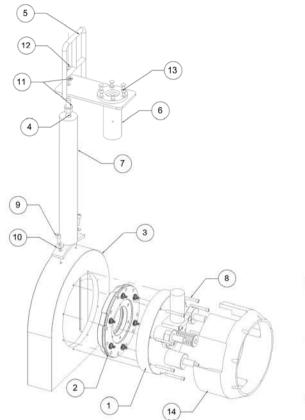
Hydraulic requirements:

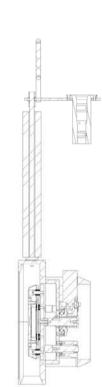
- Input pressure from ROV 2750psi (3000psi max)
- In/Out flow pressure ROV 4GPM (15.14L)/5.5GPM (20.8L)
- Hub Cleaner supplied with: 17-H-Dual Port Manifold 17-H-Dual Port Hotstab

Refer to:

NG50-2-300-MAN-DW-SM-30-0442 –
 Assembly 12in Hub Cleaner (CHC) System

6.3 CHC Connection System Tooling – 10in Hub Cleaning Tool





| | | | | 10,55,00,04 |
|----------|--|--|-----------------------------------|-------------|
| ITEM NO. | PART NUMBER | DES | SCRIPTION | QTY. |
| 1 | 0283494 | HUB CLEANER D | RIVE ASSY | 1 |
| 2 | 0283492 | 10" CLEANING H | EAD ASSY | 1 |
| 3 | 0283063 | 12*/10° BODY | | 1 |
| 4 | 0283440 | 12"/10" HANDLE | | 1 |
| 5 | 0283439 | TOP PLATE HAN | DLE | 1 |
| 6 | A10811 | API-17H DUAL PO | ORT FLANGE MANIFOLD | 1 |
| 7 | 0283529 | BUMPER | | 1 |
| 8 | 0021385 | SCREW SHC 0.3 | 75-16UNC-2A X 2 316 SS | 8 |
| 9 | MF191-S19-15 | SCR CAP SCH 0. | 5-13UNC-2A X 1.25 | 2 |
| 10 | MF371-S19-01 | WASHER FLAT T | YPE B 0.5 R | 2 |
| 11 | MF381-S25-01 | WASHER FLAT T | YP B 0.75 N 316 SS | 2 |
| 12 | MF311-S25-01 | NUT HEX NYLON | LOCK 0.75-10UNC-2B 316 SS | 2 |
| 13 | 0015330 | SCREW FHSHC | 82 DEG 0.375-16UNC X 0.875 316 SS | 6 |
| 14 | 0285175 | DRIVE BUMPER | | 1 |
| | PROPIDE TA THE INFORMED INFORMATION PARTICLE TABLE | MENT CONTAINS INFORMATION (MED) I IT 10 DOELANDERING BITTORATIONAL MO ANTON CONTAINED HERINE BITAL ING BITON CONTAINED HERINE BITAL ING BITTORATION (MED) HAN DI TONALIAT MERIT WITTERA COMBENT O IN DISTANTIONAL INC. | CAMERON AKPO | с. |
| | DRAWN, I | | | OT SCALE |
| | ENGR: . | IRWALKER DATE 23 JUNE (SOLJANI DATE 23 JUNE (| | REV |
| | | eSIGNATURES ON FILE | | 1 0F |

| 0 | Тот | AL | BR PETROBRAS |
|--|---|--|---|
| CONTRACT N | AJMBER. | | CLIENT DOCUMENT NUMBER |
| AP | 0/00 | 07/03 | NG50-2-300-MAN-DW-SM-30-0442 |
| AND REPUBLIC & H UNA REPUBLICAN WORK | NORACTICA C ROHBITED VI UPON COLIFI NORI | W USE OF SAC) INFORM THOUT EXPTNENT WRIT LETKIN OF THE PURPO | |
| J. ILLAKO | WICZ | 23 JUN 06 | |
| ROSS MABIE 23 JUN 06 | | | ASSY, 12" HUB CLEANER, HORIZONTAL CONNECTION SYSTEMS (CHC) |
| MARCUS LARA 23 JUN 06 | | 23 JUN 06 | 12" HUB CLEANER, |
| D SIZE | | | 1 a 3 SD-044033-03 03 |

Assembly diagram illustrates a 6in Connector Cleaning Tool.

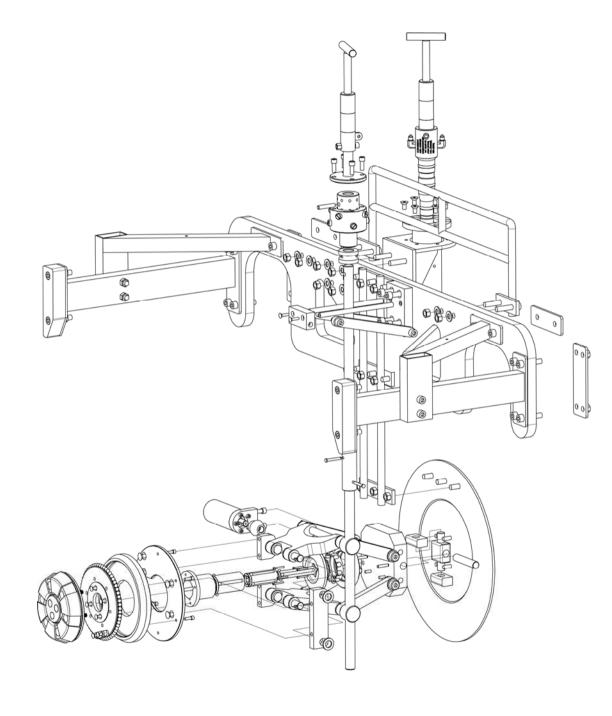
Approximate weight in air 170 lbs

Approximate weight in water 116 lbs

Refer to:

 NG50-2-300-MAN-DW-SM-30-0455 – Assembly 6in Connector Cleaner (CHC) System

6.4 CHC Connection System Tooling – 12in Hub Cleaning Tool



AKPO_SS_06_05.ai



Assembly diagram illustrates a 10in Connector Cleaning Tool.

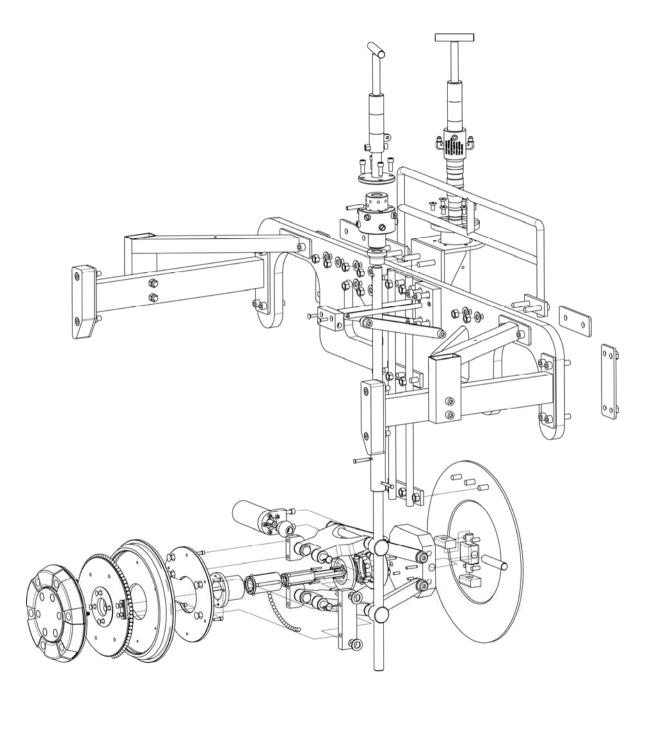
Approximate weight in air 175 lbs

Approximate weight in water 118 lbs

Refer to:

 NG50-2-300-MAN-DW-SM-30-0456 – Assembly 10in Connector Cleaner (CHC) System

6.5 CHC Connection System Tooling – 6in Connector Cleaning Tool



 CONTRACT NUMBER
 CUENT DOCUMENT NUMBER

 APO/COOT/OS
 CUENT DOCUMENT NUMBER

 MODIFICATION
 NOT

 MODIFICATION
 CUENT DOCUMENT NUMBER

 MODIFICATION
 NOT

 MODIFICATION
 NOT</

Assembly diagram illustrates a 12in CHC Connector Cleaning Tool.

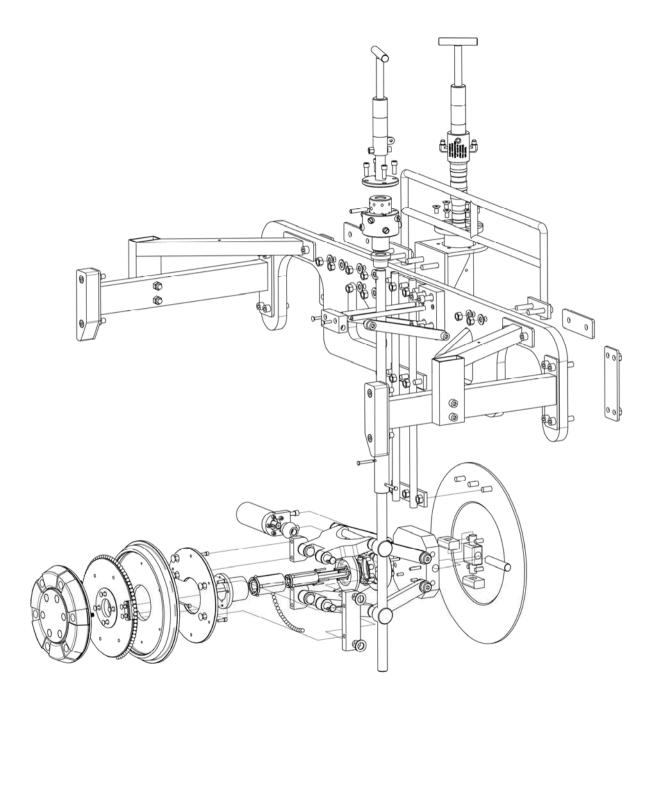
Approximate weight in air 186 lbs

Approximate weight in water 125 lbs

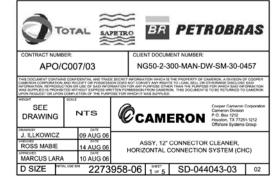
Refer to:

 NG50-2-300-MAN-DW-SM-30-0457 – Assembly 12in Connector Cleaner (CHC) System

6.6 CHC Connection System Tooling – 10in Connector Cleaning Tool







Assembly diagram illustrates a 6in Seal Replacement Tool. Refer to: HOLD no drawing available

6.7 CHC Connection System Tooling – 12in Connector Cleaning Tool

HOLD Drawing Not Available

Assembly diagram illustrates a 10in Seal Replacement Tool. Refer to: HOLD no drawing available

6.8 CHC Connection System Tooling – 6in Seal Replacement Tool HOLD Drawing Not Available

Assembly diagram illustrates a 12in Seal Replacement Tool. Refer to: HOLD no drawing available

6.9 CHC Connection System Tooling – 10in Seal Replacement Tool HOLD Drawing Not Available

Assembly diagram illustrates a 6in Seal Retrieval Tool. Refer to: HOLD no drawing available

6.10 CHC Connection System Tooling – 12in Seal Replacement Tool HOLD Drawing Not Available

Assembly diagram illustrates a 10in Seal Retrieval Tool. Refer to: HOLD no drawing available

6.11 CHC Connection System Tooling – 6in Seal Retrieval Tool HOLD Drawing Not Available

Assembly diagram illustrates a 12in Seal Retrieval Tool. Refer to: HOLD no drawing available

6.12 CHC Connection System Tooling – 10in Seal Retrieval Tool HOLD Drawing Not Available

6in CHC Pressure Cap for Manifolds

 NG50-2-300-MAN-DW-SM-30-0280 – Assembly 6in CHC 7.2K Pressure Cap

To lock and unlock pressure cap No of turns: 33 – 34

Torque:

Refer to:

Estimated weight in air

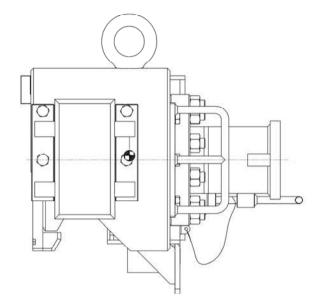
Estimated weight in water

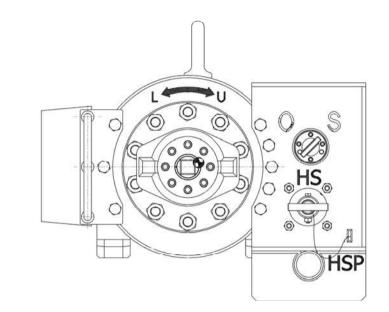
448kg/988 lbs

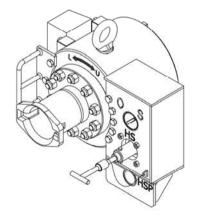
50 - 80ft/lbs (68 - 108Nm)

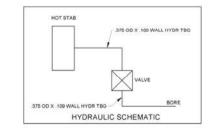
390kg/860 lbs

6.13 CHC Connection System Tooling – 12in Seal Retrieval Tool











100 – 150ft/lbs (136 – 203Nm)

838kg/1848 lbs

729kg/1608 lbs

10in CHC Pressure Cap

To lock and unlock pressure cap No of turns: 18 – 19

Torque:

140.

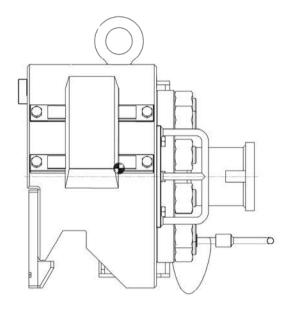
Estimated weight in air

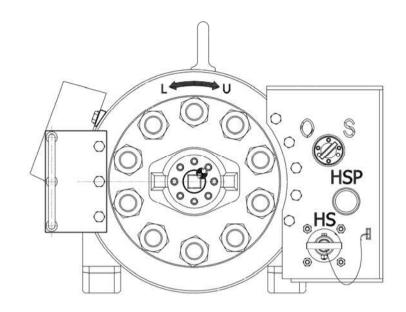
Estimated weight in water

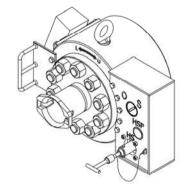
Refer to:

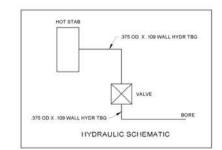
 NG50-2-300-MAN-DW-SM-30-0278 – Assembly 10in 10K CHC Pressure Cap

6.14 CHC Connection System Tooling – 6in Pressure Cap (Manifolds)











12in CHC Pressure Cap for Manifolds

To lock and unlock pressure cap No of turns: 9 – 10

Torque:

Estimated weight in air

833kg/1836 lbs

100 – 150ft/lbs (136 – 203Nm)

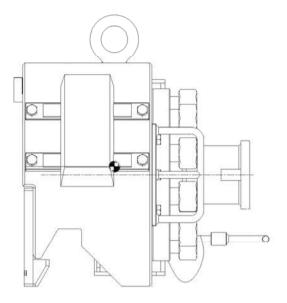
725kg/1597 lbs

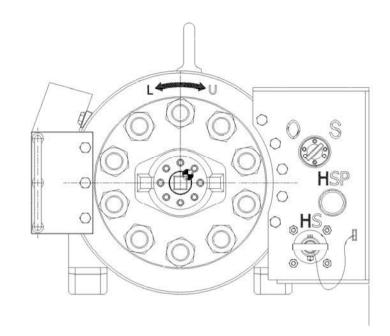
Estimated weight in water

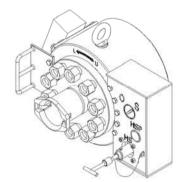
Refer to:

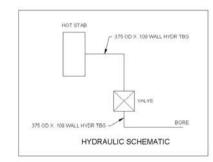
NG50-2-300-MAN-DW-SM-30-0279 –
 Assembly 12in 7.2K CHC Pressure Cap

6.15 CHC Connection System Tooling – 10in Pressure Cap











6.16 CHC Connection System Tooling – 12in Pressure Cap (Manifolds)

AKPO Subsea Reference Manual Section 7 Auxiliary Equipment/Tooling

CONTENTS

- 7.1 Auxiliary Equipment/Tooling General Assembly CHC Insulation Doghouse
- 7.2 Auxiliary Equipment/Tooling Assembly Drawing SCM/SAM Test and Flushing Stand
- 7.3 Auxiliary Equipment/Tooling General Assembly IDRT Doghouse Loading Platform
- 7.4 Auxiliary Equipment/Tooling Assembly, Debris Cap, 6in CHC Hub
- 7.5 Auxiliary Equipment/Tooling Assembly, Debris Cap, 12in CHC Hub
- 7.6 Auxiliary Equipment/Tooling S-AX Gaskets for CHC System
- 7.7 Auxiliary Equipment/Tooling Assembly, 6in (5.187 ID) Transportation Cap (Female)
- 7.8 Auxiliary Equipment/Tooling Assembly, 10in (8in ID) Transportation Cap (Female)
- 7.9 Auxiliary Equipment/Tooling Assembly, 12in (10in ID) Transportation Cap (Female)
- 7.10 Auxiliary Equipment/Tooling Assembly, 6in-10K Fabrication Stand, CHC Jumper
- 7.11 Auxiliary Equipment/Tooling– Hydraulic Distribution Unit Guide Posts
- 7.12 Auxiliary Equipment/Tooling Shipping Skid, CHC Running Tool
- 7.13 Auxiliary Equipment/Tooling SCM/SAM Setting Tool Assembly Drawing

CONTENTS (cont'd)

- 7.14 Auxiliary Equipment/Tooling HFL Deployment Frame General Arrangements and Details
- 7.15 Auxiliary Equipment/Tooling Assembly Drawing EFL Transport and Installation Basket
- 7.16 Auxiliary Equipment/Tooling Assembly, in CHC Flooding Caps
- 7.17 Auxiliary Equipment/Tooling Long Term Covers (LTC)
- 7.18 Auxiliary Equipment/Tooling Choke Insert Test Stand
- 7.19 Auxiliary Equipment/Tooling Installation Slings Manifold System
- 7.20 Auxiliary Equipment/Tooling Set Assembly for the Manifold Handling Sling

CHC Thermal Doghouse

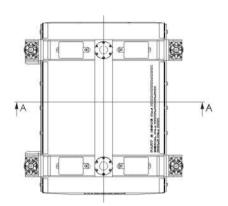
The connectors, once connected, are covered with a doghouse for heat preservation. The doghouse is installed by the Insulation Doghouse Running Tool (IDRT) and is ROV Deployed.

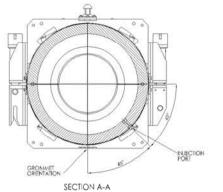
Doghouse Locking Jack figures:

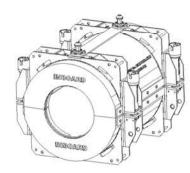
- Max Locking Torque (CW) 150Nm (111ft/lbs)
- Max Unlocking Torque (CCW) 200Nm (147ft/lbs)
- Override Shear Torque (CCW) 200Nm (147ft/lbs)

Refer to:

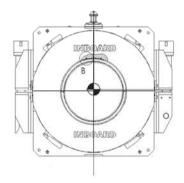
 NG50-2-300-MAN-DW-SM-30-0289 – General Assembly CHC Insulation Doghouse



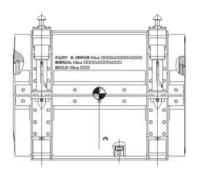


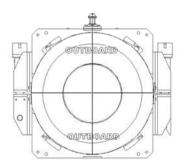


ISOMETRIC VIEW (NTS)



3. Some POCY IOLE TOOMID DEP SCREW BONDED INTO PLACE LISING ARAID TE DETAIL 8 SCALE 1: 2







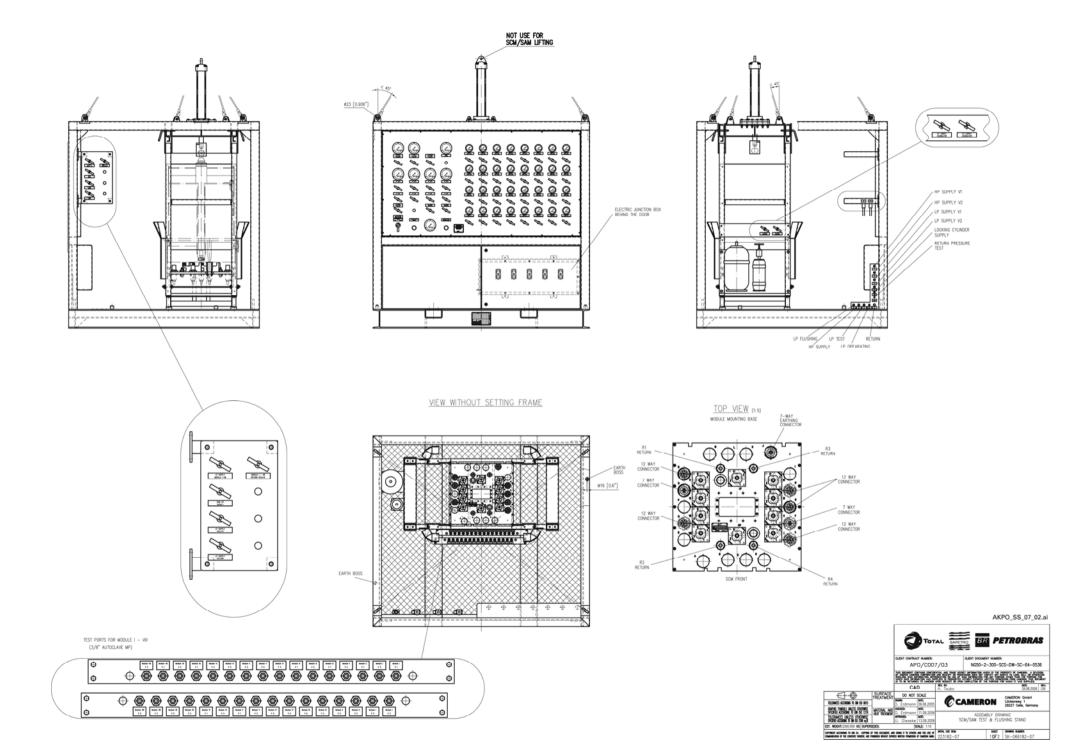
AKPO_SS_07_01.png

Assembly Diagram SCM/SAM Test and Flushing Stand

Refer to:

 NG50-2-300-SCS-DW-SC-64-0536 – Assembly Drawing SCM/SAM Test and Flushing Stand

7.1 Auxiliary Equipment/Tooling – General Assembly CHC Insulation Doghouse



7.2 Auxiliary Equipment/Tooling – Assembly Drawing SCM/SAM Test and Flushing Stand

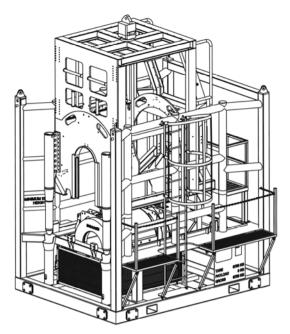
Drawing Supplementary Information

Doghouse Loading Skid Not for Shipping of Insulation Doghouse Shells or IDRT Estimated Weight:

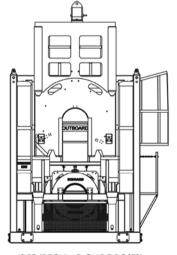
- Tare Mass 6750kg
- Payload 0kg
- Gross Mass 6750kg

Refer to:

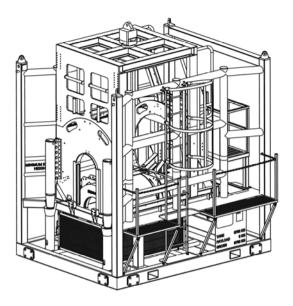
 NG50-2-300-MAN-DW-SM-30-0511 – General Assembly IDRT Doghouse Loading Platform



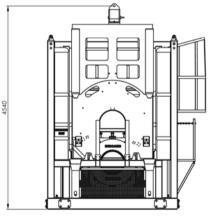
4. IDRT (FLET CONFIGURATION) BEING LOWERED INTO SKID AT MINIMUM LOADING HEIGHT



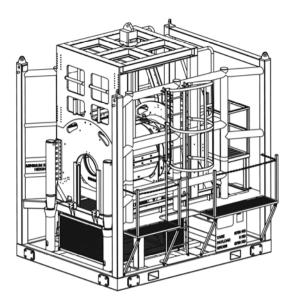
IDRT (REGULAR GUIDE POSTS) MINIMUM LOADING HEIGHT SCALE 1:30



5. IDRT LANDED IN SKID



MAXIMUM HEIGHT OF IDRT (REGULAR GUIDE POSTS) WHEN LANDED IN SKID SCALE 1:30



6. DOGHOUSE RAISED UP AND COLLECTED BY IDRT



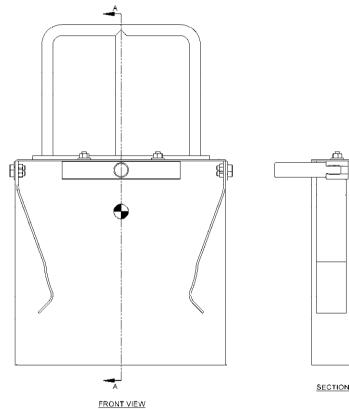
AKPO_SS_07_03.ai

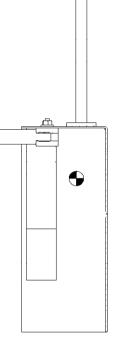
7.3 Auxiliary Equipment/Tooling – General Assembly – IDRT Doghouse Loading Platform

Drawing Supplementary Information Gin Debris Cap CHC Hub (Trees) Weight in air: 23.5 lbs (10.7kg) Weight in water: 20.5 lbs (9.3kg) Dimensions Inches 8.21/8.50 (208.53/215.90) for Tree Hub, B/M: 2254199-01 7.56/7.80 (192.02/198.12) for Tree Hub, B/M: 2254199-02

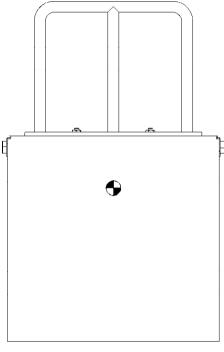
Refer to:

- NG50-2-300-MAN-DW-SM-30-0366 General Assembly 6in Debris Cap CHC Hub
- NG50-2-300-MAN-DW-SM-30-0338 Assembly Details 6in Debris Cap CHC Hub
- NG50-2-300-XTR-DW-SX-30-0227 Debris Cap interface detail
- NG50-2-300-MAN-PR-SM-30-0406 FAT procedure, 6in Debris Cap
- NG50-2-300-MAN-DW-SM-30-0032 Interface details CHC Landing Porch









BACK VIEW



10in/12in Debris Cap CHC Hub

Weight in air: 32 lbs (14.5kg)

Weight in water: 28 lbs (12.7kg)

Refer to:

- NG50-2-300-MAN-DW-SM-30-0504 General Assembly 10in/12in Debris Cap CHC Hub
- NG50-2-300-MAN-DW-SM-30-0032 Debris Cap interface detail
- NG50-2-300-MAN-PR-SM-30-0406 FAT procedure, CHC Debris Cap
- NG50-2-300-MAN-DW-SM-30-0268 Assembly Details 12in CHC Hub

7.4 Auxiliary Equipment/Tooling – Assembly, Debris Cap, 6in CHC Hub

INTERFACE DETAILS; CHC LANDING PORCH NG50-2-300-MAN-DW-SM-30-0032 (20.5 [519.7]) A (17.1 [435.5]) C.O.G. G (13) 345 0 -m Ó dþ ¢þ 00 dB. еþ 458 (2) (30.4 [771.5]) 2 • Ð 6 6 (9.9 [250.4]) C.O.G. _ (^{2.1} [53.5]) C.O.G. đ -FRONT VIEW SECTION A-A CONTRACT NUMBER: CUENT DOCUMENT NUMBER BACK VIEW APO/C007/03 NG50-2-300-MAN-DW-SM-30-0504



REFERENCE:

ASSEMBLY DETAILS; 12° CHC HUB NG50-2-300-MAN-DW-SM-30-0268 FAT PROCEDURE, CHC DEBRIS CAP NG50-2-300-MAN-PR-SM-30-0406

S-AX Gasket for CHC System

Refer to:

• HOLD No Drawing available

7.5 Auxiliary Equipment/Tooling – Assembly, Debris Cap, 12in CHC Hub HOLD No Data or Drawing provided

6in Female Transportation Cap

Reference drawing – NG50-2-300-MAN-DW-SM-30-0263

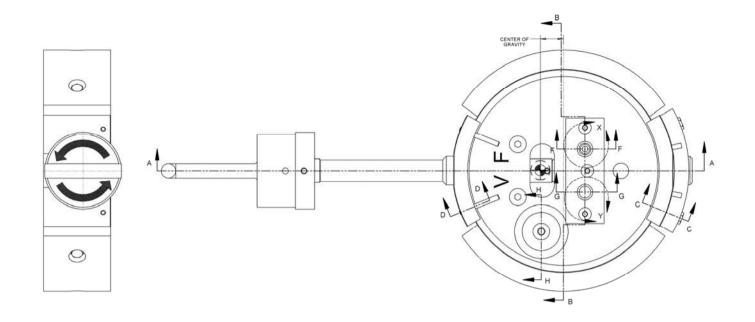
Weight in air: 68 lbs (31kg)

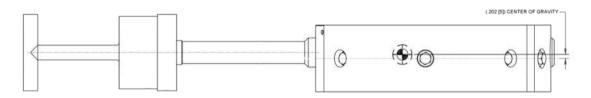
Weight in water: 57 lbs (26kg)

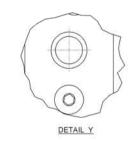
Refer to:

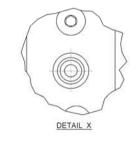
 NG50-2-300-MAN-DW-SM-30-0284 – Assembly 6in (5.187in ID) Transportation Cap

7.6 Auxiliary Equipment/Tooling – S-AX Gaskets for CHC System











7.7 Auxiliary Equipment/Tooling – Assembly, 6in (5.187 ID) Transportation Cap (Female)

Drawing Supplementary Information

10in Female Transportation Cap

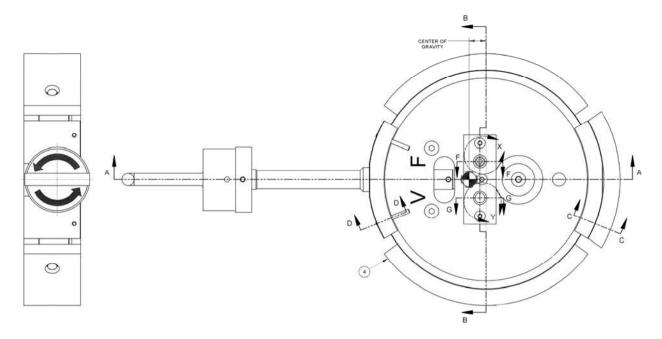
Reference drawing – NG50-2-300-MAN-DW-SM-30-0267

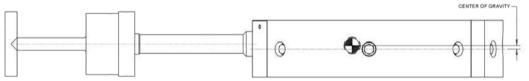
Weight in air: 107 lbs (49kg)

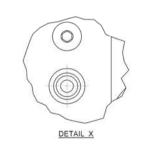
Weight in water: 92 lbs (42kg)

Refer to:

 NG50-2-300-MAN-DW-SM-30-0282 – Assembly 10in (8in ID) Transportation Cap











7.8 Auxiliary Equipment/Tooling – Assembly, 10in (8in ID) Transportation Cap (Female)

Drawing Supplementary Information

12in Female Transportation Cap

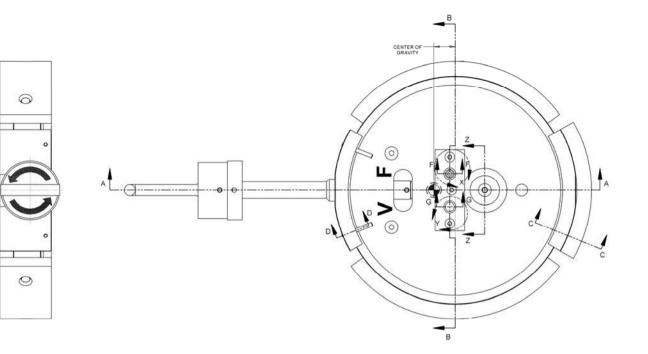
Reference drawing – NG50-2-300-MAN-DW-SM-30-0337

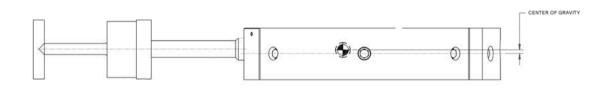
Weight in air: 126 lbs (57kg)

Weight in water: 105 lbs (48kg)

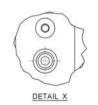
Refer to:

 NG50-2-300-MAN-DW-SM-30-0283 – Assembly 12in (10in ID) Transportation Cap









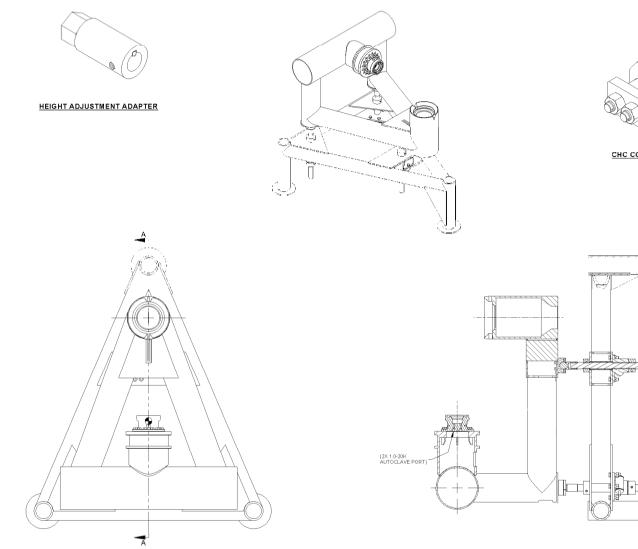


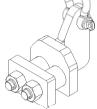
CHC Jumper Fabrication Stand

Refer to:

 NG-2-300-MAN-DW-SM-30-0262 – Assy 6in – 10k Fabrication Stand CHC Jumper

7.9 Auxiliary Equipment/Tooling – Assembly, 12in (10in ID) Transportation Cap (Female)





CHC CONNECTOR LIFT

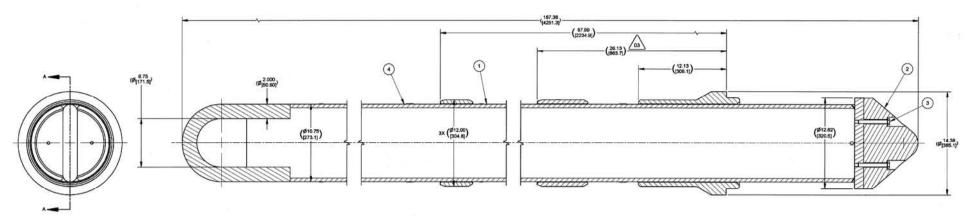


SECTION A-A

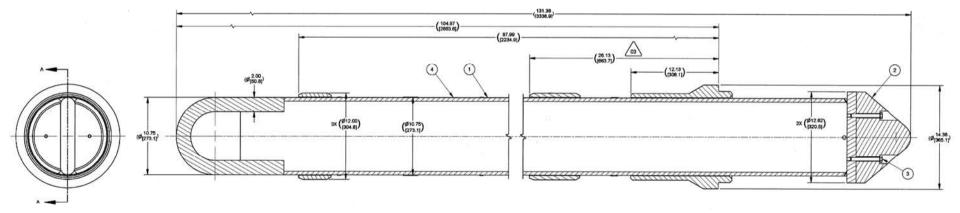
HDU Guide Posts

The following drawing shows a Long and Short HDU Gide Posts in cross section.

7.10 Auxiliary Equipment/Tooling – Assembly, 6in-10K Fabrication Stand, CHC Jumper



SECTION A-A



SECTION A-A

| BURANCE TREATMENT | DO NOT SCALE | | A | Cooper Cameron Corporation Cameron Division | |
|-----------------------|--------------|-----------|---|--|--|
| | A POWELL | 18 JUL 07 | CAMERON | P.O. Box 1212 Houston, TX 77251-1212 | |
| MATERIAL & HEAT TREAT | H. MOLDER | 18 JUL 07 | ASSEMBLY DETAIL LONG RETRIEVABLE GUIDEPOST | | |
| | J. WILHELMI | 19 JUL 07 | LONG RETRI | EVABLE GUIDEPOST | |
| APSR2002 | DATED INTO | 2254 | 037-01 1 01 | SK-127603-01 | |

CHCRT Shipping Skid

Reference drawing – NG50-2-300-MAN-DW-SM-30-0107

13,501 lbs (6137kg)

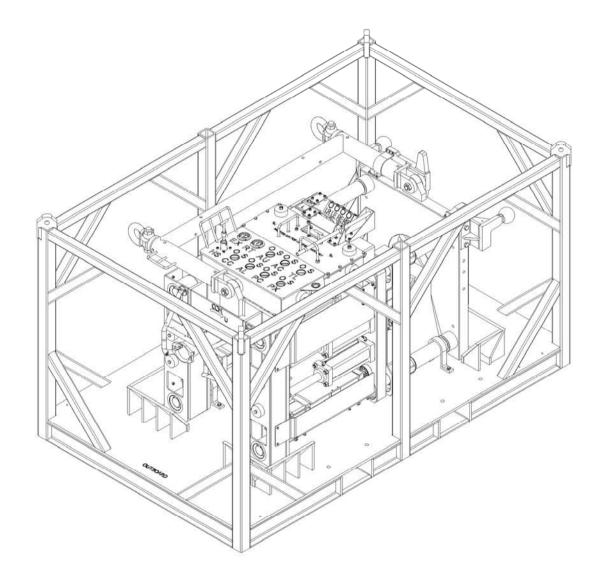
CHCRT Assembly plus Skid Weight: 32,800 lbs (14,910kg)

Refer to:

Skid Weight:

• NG50-2-300-MAN-DW-SM-30-0427 – Shipping Skid CHC Running Tool

7.11 Auxiliary Equipment/Tooling– Hydraulic Distribution Unit Guide Posts



AKPO_SS_07_12.png



SCM/SAM Setting Tool

Do not lift with SAM/SCM

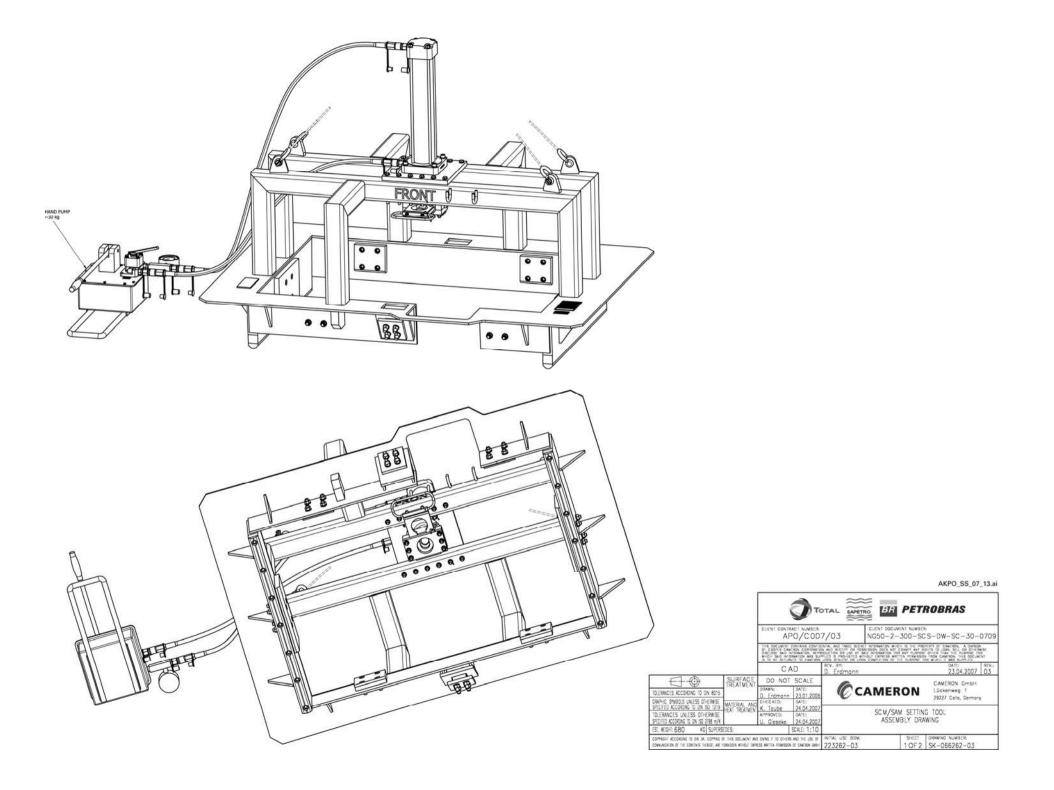
Max Operating Pressure: 200bar/2900psi

Hydraulic Hose Length 10 metres

Refer to:

• NG50-2-300-SCS-DW-SM-30-0709 – SCM/SAM Setting Tool Assembly

7.12 Auxiliary Equipment/Tooling – Shipping Skid, CHC Running Tool



HFL Deployment Frame

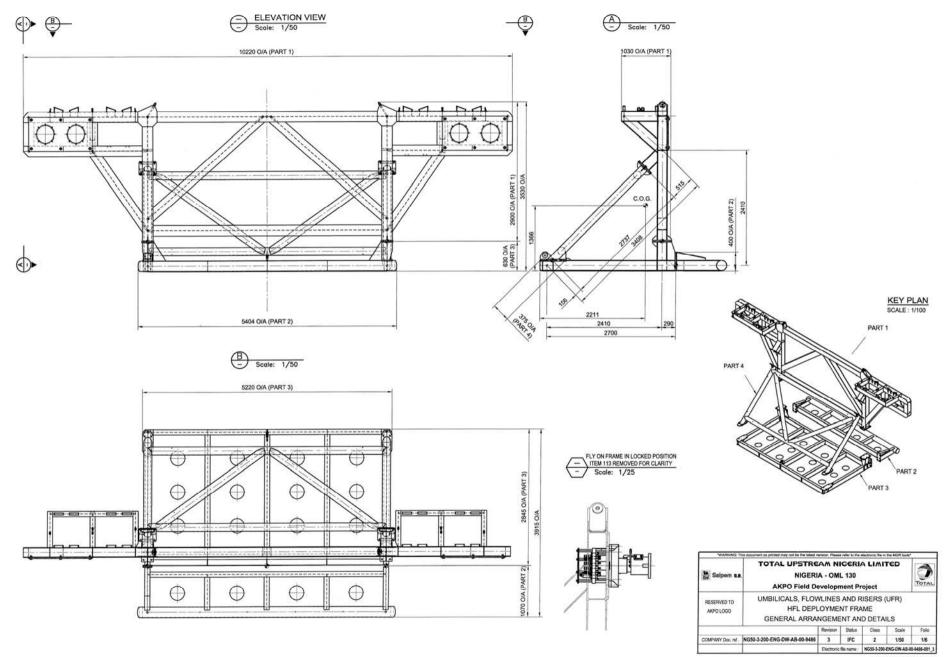
Rigging Arrangements: NG50-3-200-ENG-PR-AB-19-9485

Total Weight (4 parts) 4872kgs

Refer to:

 NG50-2-300-ENG-DW-AB-00-9486 – HFL Deployment Frame – General Arrangement and Details

7.13 Auxiliary Equipment/Tooling – SCM/SAM Setting Tool Assembly Drawing



AKPO_SS_07_14.png

7.14 Auxiliary Equipment/Tooling – HFL Deployment Frame General Arrangements and Details

Drawing Supplementary Information

EFL Installation Basket

EFL Installation Procedure for Deployment Frame:

• NG50-2-300-SCS-PR-SC-64-0879

Parking position with guide pin in:

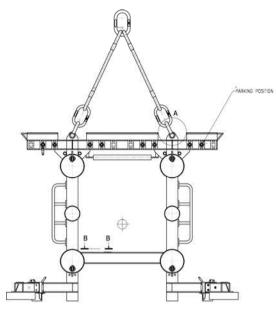
- 12 o'clock for 4-way connectors
- 6 o'clock for 7-way connectors
- EFL Basket Cargo Load 4 x 215kg = 860kg

EFL Length per Bar:

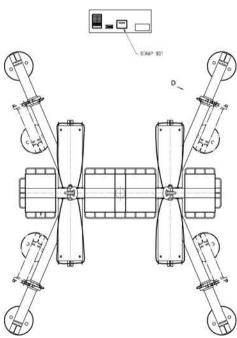
• One EFL = Max Length 200m (100%)

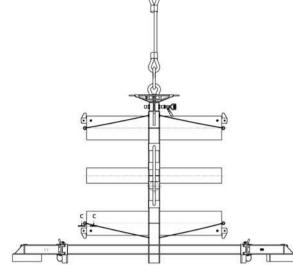
Refer to:

 NG50-2-300-SCS-DW-SE-30-0761 – EFL Transport and Installation Basket





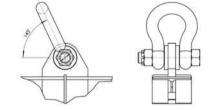


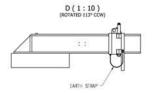






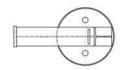
A(1:5)







MUDMAT FOOT (1:10)



-

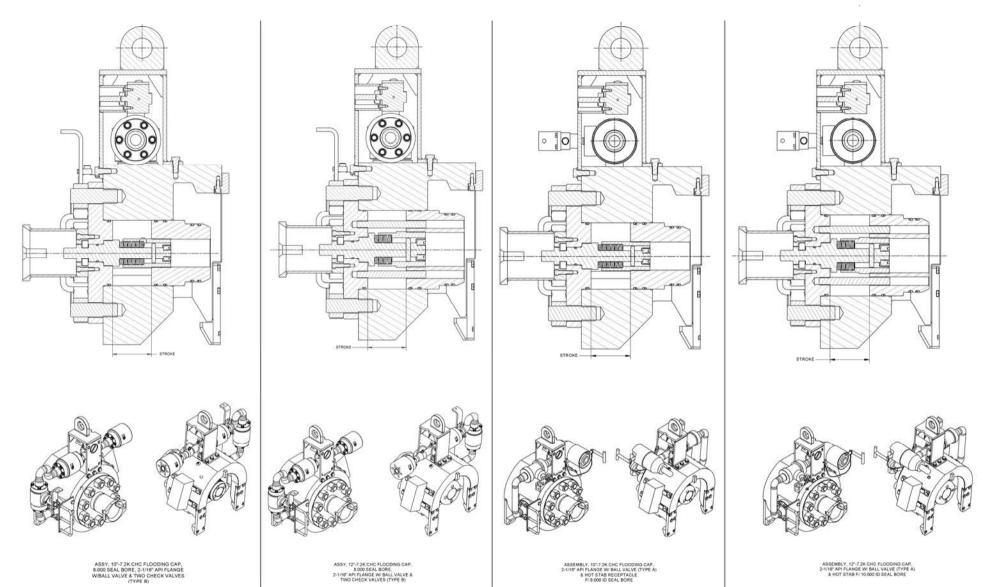


7.15 Auxiliary Equipment/Tooling – Assembly Drawing EFL Transport and Installation Basket

Drawing Supplementary Information

CHC Flooding Caps (Temporary Equipment Only) 12in CHC Flooding Caps Type A

- Estimated Weight in air: 2213 lbs/1004kg
- Estimated Weight in Water: 1923 lbs/872kg
 12in CHC Flooding Caps Type B
- Estimated Weight in air: 2035 lbs/923kg
- Estimated Weight in Water: 1768 lbs/802kg
 10in CHC Flooding Caps Type A
- Estimated Weight in air: 2177 lbs/9884kg
- Estimated Weight in Water: 1892 lbs/858kg
 10in CHC Flooding Caps Type B
- Estimated Weight in air: 2040 lbs/9254kg
- Estimated Weight in Water: 1773 lbs/804kg



AKPO_SS_07_16.png

E-LTCs are available as female types. The female type is available for different pin configurations (4-, 7-, 12-way) that are colour coded. The correct type need to be selected and the colour coding needs to be checked before installation. Refer also to 'Electric Schematic Subsea PCS' to identify 4-, 7-, 12-way requirements.

- 4- way: red PN 2185425-20-03
- 7-way: light green PN 2185425-04-10
- 12-way: black/white PN 2197088-01-34

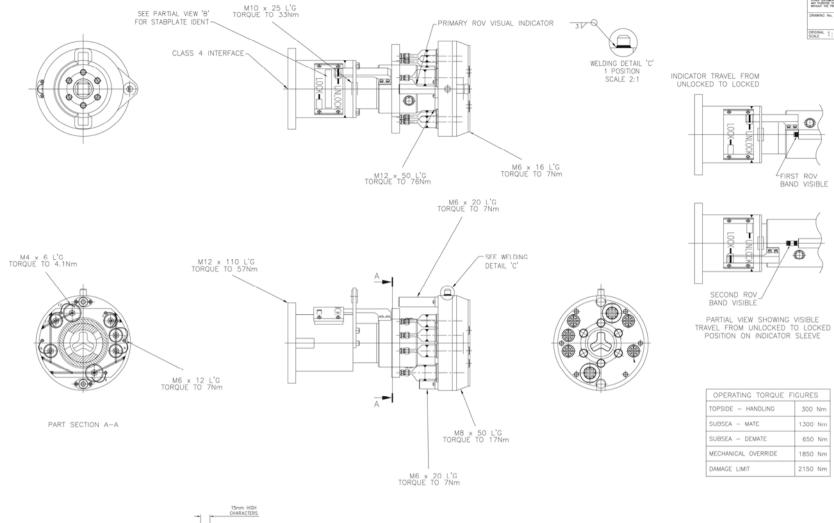
Typical LTC. several types are available, the drawing shows a 7-way HDU/Manifold mount.

For interface details: NG-2-300-SCS-DW-SC-30-0807

Weight in air: 73.5kg

Weight in Water: 64kg

7.16 Auxiliary Equipment/Tooling – Assembly, in CHC Flooding Caps



| © 2005 THE DOCUMENT CONTAINS INFORMATION PROPRIETARY TO MICH AND SHALL NOT BE REPRODUCED OF TRANSPORED TO | UNIT 8, FIRST AVE, GLOBE PARK, MARLOW | M.S.C.M. Louised | |
|---|---|--|--|
| ANY PURPOSE OTHER THAN THAT FOR WHICH IT IS FURNISHED WITHOUT THE PROF WRITTEN PERMISSION OF WISCH. | BUCKINGHAMSHIRE SL7 1YA | TEL : +44 (0)1628 488361 FAX : +44 (0)1628 478760 | |
| AS016252 | | G TERM COVER HDU/MAN' MTD | |
| SCALE 1:1 DO NOT SCALE SHEET 1 OF 1 | | - AKPO PROJECT | |

AKPO_SS_07_17.ai

۲

T

UNLOCK

٢

۲

٢

PARTIAL VIEW 'B' OF STABPLATE IDENT IDENT TO BE "DSUT# PR XL "

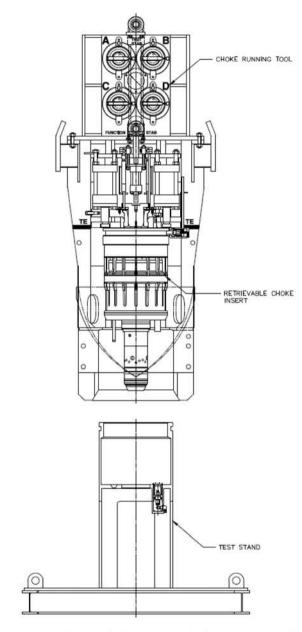
Choke Insert (CI) Test Stand is designed for testing the CI either after retrieval from subsea or prior to running subsea as well as shipment and minor maintenance of an insert. The TS simulates the CB which allows testing of the CI hydraulic and electrical circuits. Refer to the technical specifications for the choke inserts for pressure and electrical ratings of the individual test circuits.

The minor maintenance on an insert would normally consist of replacing the trim and associated seals. The TS is not intended for use in the disassembly of an insert.

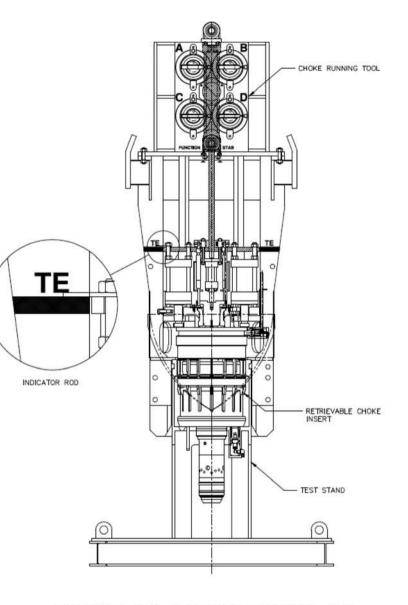
Refer to:

 Installation, Operation and Maintenance Manual (AKPO IOM) for Cameron Crown Chokes

7.17 Auxiliary Equipment/Tooling – Long Term Covers (LTC)



LOWERING RUNNING TOOL AND CHOKE INSERT ONTO TEST STAND



LOWERING THE ELEVATOR CYLINDER AND CHOKE INSERT ONTO THE TEST STAND (INSERT LOWER)

AKPO_SS_07_18.ai

The drawing shows the installation sling requirements for the following:

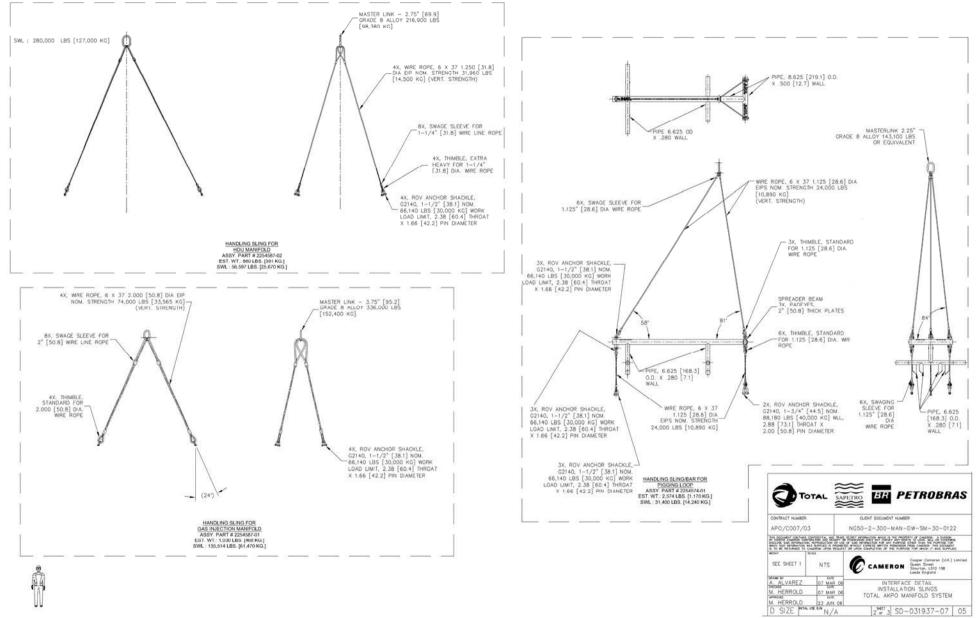
- HDU Manifold
- Gas Injection Manifold
- Pigging Loop

All dimensions are in inches (millimetres).

Refer to:

 NG50-2-300-MAN-DW-SM-30-0122 – Installation Slings Total Akpo Manifold System

7.18 Auxiliary Equipment/Tooling – Choke Insert Test Stand

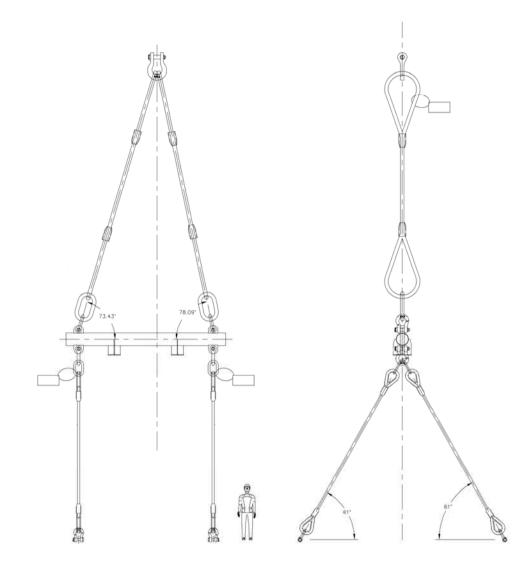


AKPO_SS_07_19.png

The drawing shows the installation sling requirements for the following:

- Sling Set Assembly for the production manifold Refer to:
- NG50-2-300-MAN-DW-SM-30-0094 Sling Set Assembly Production Manifold Handling Sling

7.19 Auxiliary Equipment/Tooling – Installation Slings Manifold System



AKPO_SS_07_20.png



7.20 Auxiliary Equipment/Tooling – Set Assembly for the Manifold Handling Sling

AKPO Subsea Reference Manual Section 8 MSV Trieste Data

CONTENTS

- 8.1 MSV Bourbon Trieste
- 8.2 MSV Bourbon Trieste (cont'd)
- 8.3 SONSUB Innovator 4K (ROV)

Main Characteristics

| Length Overall: | 85.25m |
|---|-------------------|
| Length waterline: | 81.70m |
| Beam moulded: | 18.00m |
| Depth moulded: | 7.40m |
| Draught: | 5.75m |
| Work deck area: (47.00 x 17.00m) | 800m ² |
| Mezzanine deck area: (18.00 x 14.40m) | 260m ² |
| Deck load capacity: (5.0t/m ² & 10t/m ²) | 1245t |
| Deadweight at max. draught: | 3210mt |
| Bollard pull: | 50t |

Propulsion – Machinery

| Main diesel generators: | 4 x 1700kVA (5440kW/7748HP) at 1800rpm, |
|-------------------------|---|
| | 480V/60Hz |
| Emergency generator: | 1 x 400kVA/320kW, 480V/60Hz |

Thrusters

| Main | propellers: | |
|------|-------------|--|
|------|-------------|--|

| hrusters (propeller |
|-----------------------|
| e) (rpm controlled by |
| |
| |
| |
| |

Special Equipment

- Moon pool: prestructured for 7.40m x 7.40m opening
- Fi-Fi I: 2 pumps 2400m³/h (total)
- 2 monitors $1200m^3/h$
- 1 water spray system with dedicated pump 1300m³/h
- ROV facilities: 2 x 500kW power supply on mezzanine deck for ROV
- Rescue facilities: For 150 survivors (in tropical area)
- Life boat: 1 Fast rescue boat with davit, life rafts with equipment
- Fresh water makers: 2 x 6,90t/24h



8.1 MSV Bourbon Trieste

Drawing Supplementary Information

Deck Equipment/Machinery

KNUCKLE BOOM OFFSHORE MAIN CRANE: (DNV rating)

- SWL: 110mt (double fall) 90mt (single fall) AHC
- Water depth: 1600m: 73mt SWL (DAF 1.6)
- Working radius, 7/30m: 31mt SWL (DAF 1.6), (single fall)
- Working radius, 7/13m: 90mt SWL (DAF 1.6), (single fall)
- Auxiliary winch: Active heave compensated winch, 10mt SWL at 2000m water depth, working radius 7/31m (100m/min)

KNUCKLE BOOM OFFSHORE AUXILIARY CRANE: (DNV rating).

- SWL: (DAF 1.6), 24mt at 10m (double fall)
- 12mt at 10m/6mt at 19m (single fall)
- 10mt at 2300m depth

Air compressor:

1500m³/h @ 8bars, with 6 outlets on deck.

Anti heeling:

Fast ballasting system, 2 x 1300m³/h.

Capstans:

2 x 5mt SWL with pull drum 5t @ 15m/min.

Single Wire Fall

| Type of Lift | Normal/ Subsea | | | |
|----------------------------|-------------------|----|-------|---|
| Dynamic Factor = | 1,6 | | | |
| Wire Type | 34L | | | |
| Wire Diameter | 62 | mm | | |
| Weight of Wire /m | 19,2 | Kg | | |
| Minimum Braking Load (MBL) | 3410 | kN | 347,6 | Т |
| Hook Weight | 1 | Т | | |
| Total Weight of Wire | 30,720 | Т | | |

| Limited due to wire safety factor | |
|--------------------------------------|---------------------------------|
| SF Wire (DNV) SF Wire (DNV) | Greatest of 3,7 3,68 3 |

| | | Deck Load | 1m Deep | 300m Deep | 600m Deep | 900m Deep | 1200m Deep | 1600m Deep |
|----|------------------------------------|-----------|---------|-----------|-----------|-----------|------------|------------|
| | | 0 | 1 | 300 | 600 | 900 | 1200 | 1600 |
| | Layer | 10 | 10 | 8 | | | | |
| 1 | Load, SWL (tonne, in air) | 90,0 | 90,0 | 90,0 | 90,0 | 85,0 | 85,0 | 85,0 |
| 2 | Hook (tonne) | 1,0 | 1,0 | 1,0 | 1,0 | 1,0 | 1,0 | 1,0 |
| 3 | Wire Weight (tonne) | 0,0 | 0,0 | 5,8 | 11,5 | 17,3 | 23,0 | 30,7 |
| 4 | Wire Parts | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 5 | Buoyancy Load+Hook (1025) | 0,0 | 11,9 | 11,9 | 11,9 | 11,2 | 10,6 | 9,7 |
| 6 | Buoyancy Wire (1025) | 0,0 | 0,0 | 0,8 | 1,5 | 2,3 | 3,0 | 4,0 |
| 7 | Total Crane Load, Boom tip (tonne) | 91,0 | 79,0 | 84,1 | 89,1 | 89,8 | 90,5 | 91,0 |
| 8 | | | | | | | | |
| 9 | Friction Wire Sheave % | 1,5 | 1,5 | 1,5 | 1,5 | 1,5 | 1,5 | 1,5 |
| 10 | Number of Wiresheaves | 3,0 | 3,0 | 3,0 | 3,0 | 3,0 | 3,0 | 3,0 |
| 11 | Friction Force in Sheave | 3,1 | 2,7 | 2,8 | 3,0 | 3,0 | 3,1 | 3,1 |
| 12 | Winch Load (tonne) | 94,1 | 81,7 | 87,0 | 92,1 | 92,8 | 93,5 | 94,1 |
| 13 | Winch Load Active Side 30% | 27,3 | 23,7 | 25,2 | 26,7 | 26,9 | 27,1 | 27,3 |
| 14 | Safety Fakt Wire | 3,7 | 4,2 | 4,0 | 3,8 | 3,7 | 3,7 | 3,7 |
| 15 | Min MBL (tonne) DNV | 346,2 | 301,0 | 320,0 | 339,1 | 341,6 | 344,1 | 346,4 |
| 16 | MBL Wire (tonne) | 347,6 | 347,6 | 347,6 | 347.6 | 347.6 | 347.6 | 347.6 |
| | Hook Load | 90,0 | 78,1 | 78,1 | 78,1 | 73,8 | 69,4 | 63,3 |

Note: Pos 1 SWL is solid load in air

8.2 MSV Bourbon Trieste (cont'd)

Drawing Supplementary Information

The Remote Operated Vehicle (ROV) is a 4000 meter rated heavy work class ROV. Power is delivered through seven 15in hydraulic thrusters from a dual shaft 200HP electric motor. The ROV provides a platform for all subsea intervention and support systems.

Depth Rating:

Depth 4000 metres

Thrust Performance:

- Forward: 1000kg
- Astern: 1000kg
- Vertical: 480kg
- Lateral: 1000kg
- Turning Rate: 40°per second minimum

| Vehicle Dimensions: | Height: 224cm, Width: 158cm, Length: 297cm |
|-------------------------|---|
| Vehicle weight in air: | 4500kg |
| Hydraulic Power System: | 1 x 200HP electric motor, Dual Shaft Motor |
| Propulsion System: | 4 x 380mm Horizontal Thrusters, 3 x 380mm Vertical Thrusters |
| Tether Capacity: | 1100 metres |

Tool Options:

- Cable cutter including intensifier
- Disc cutting wheel
- Impact wrench
- Low profile ratchet wrench
- Dredge unit (hydraulic)
- Soft line cutter
- AAD arm
- Various inspection package

Manipulator Options:

- Slingsby TA40 7 function
- Slingsby TA16 grabber
- Schilling Rigmaster grabber
- Schilling Titan 111



8.3 SONSUB Innovator 4K (ROV)

AKPO Subsea Reference Manual Section 9 Riser Monitoring Systems

CONTENTS

- 9.1 Riser Monitoring System (RMS) Insallation Overview
- 9.2 Riser Monitoring System (RMS) FPSO Topside Wiring Diagram

The FPSO is spread moored in 1,315 meters of water, operating up to 45 subsea wells arranged in clusters around subsea manifolds. The Subsea Manifolds will be connected to the FPSO through insulated flow lines and steel catenary risers.

As a part of the FPSO integrity management philosophy a data monitoring system is installed on the Steel Catenary Risers.

The objective of the SCR data monitoring system is:

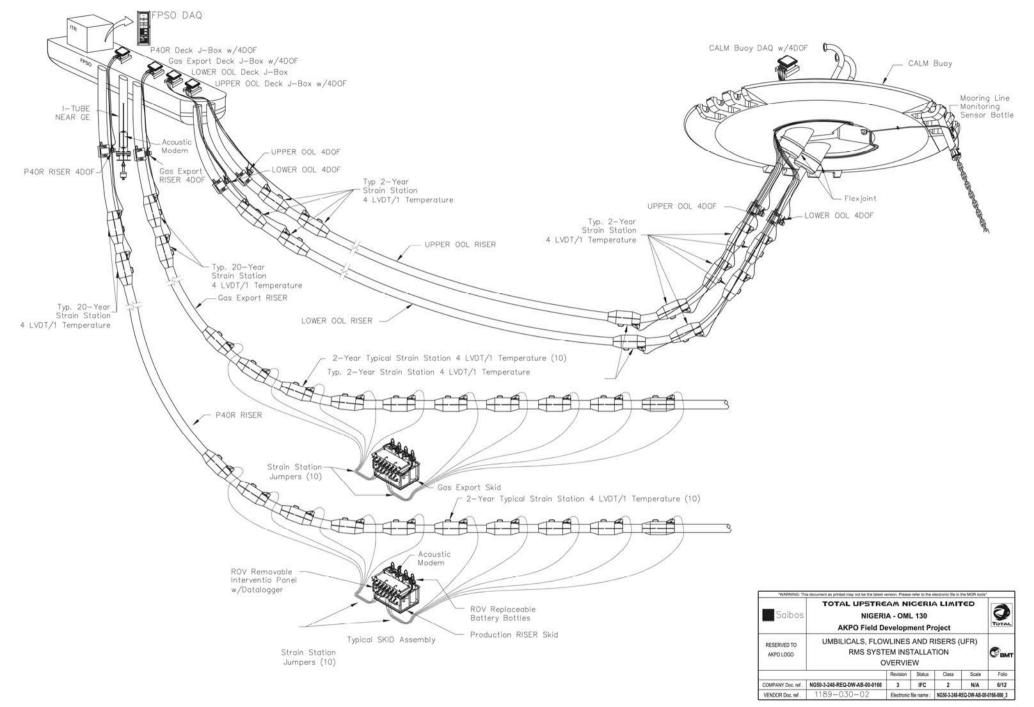
- To provide all the data required to calibrate the behaviour of the riser and the numerical models
- In the long term to allow the operators to ensure riser system integrity with respect to fatigue damage during operations and to provide adequate alarm (in case of abnormal loads)

The overview drawing illustrates the RMS installations for:

- A typical production riser
- Gas Export pipeline
- Oil Offloading Lines (OOL)

For detailed drawings and information of the Riser Monitoring System refer to:

- NG50-3-200-ENG-SP-AB-00-3500 Riser Monitoring System Specification (Rev 4)
- NG50-3-248-REQ-DW-AB-00-0016 Riser Monitoring System FPSO DAQ Drawings (Rev 2)
- NG50-3-248-REQ-DW-AB-00-0166 Riser Monitoring System Overview Drawings (Rev 4)



9.1 Riser Monitoring System – Installation Overview

Drawing Supplementary Information

The SCR Integrity Management system is basically sub divided into two systems.

- The Data Acquisition System (DAQ)
- The Interface Management System (IMS)

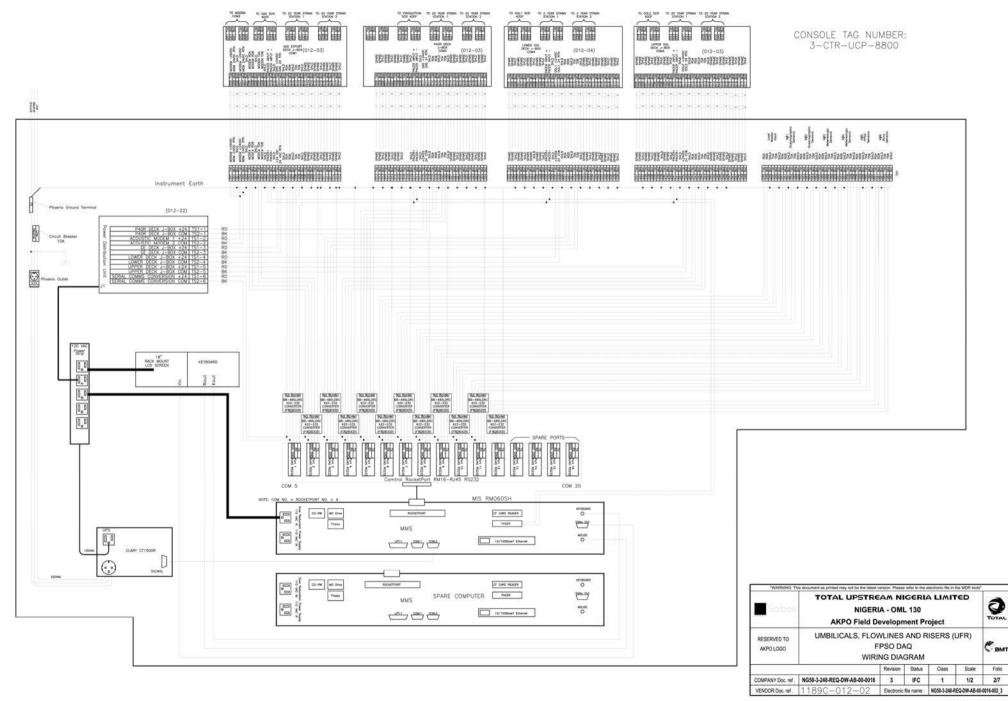
The DAQ is a grouping of sensors and the ancillary functional equipment. The DAQ is further divided into sub systems which are defined by the locations of the sensing elements along the riser. Sub systems are further divided by the types of instrument used and the measured parameters.

The IMS controls the DAQ, collects in real time and stores data; it also provides the interface with all other FPSO systems, and processes data and provides software protocol conversion.

The OOL monitoring system is a remote monitoring system feeding into the IMS.

The following drawing illustrates the Topsides DAQ equipment, for details refer to:

- NG50-3-200-ENG-SP-AB-00-3500 Riser Monitoring System Specification (Rev 4)
- NG50-3-248-REQ-DW-AB-00-0016 Riser Monitoring System FPSO DAQ Drawings (Rev 2)
- NG50-3-248-REQ-DW-AB-00-0166 Riser Monitoring System Overview Drawings (Rev 4)



AKPO_SS_10_02.ai

9.2 Riser Monitoring System – FPSO DAQ Topsides Wiring Diagram

AKPO Subsea Reference Manual Section 10 Subsea Intervention Work Packages Equipments Lists

CONTENTS

- 10.1 TCM and MCM Replacement, Equipment List
- 10.2 SAM Replacement, Equipment List
- 10.3 Water Injection Choke Replacement, Equipment List
- 10.4 HDU Replacement, Equipment List
- 10.5 Production and Gas injection Choke Replacement, Equipment List
- 10.6 MPFM Cannister Replacement, Equipment List
- 10.7 EFL Replacement, Equipment List
- 10.8 Chemical Valve Insert Replacement, Equipment List
- 10.9 HFL Replacement, Equipment List
- 10.10 Sand Detector Replacement, Equipment List
- 10.11 Bridge Jumper Replacement , Equipment List
- 10.12 Doghouse Replacement, Equipment List
- 10.13 Valves Operation, Equipment List

| Item | Equipment | Supplier | Part Number | Weight (Kg) | Qty |
|------|---|----------|--------------------------|----------------|-----|
| 1 | MPRT | CPY | P/N 223403-08 | 3100 | 1 |
| 2 | MPRT shipping skid | СРҮ | Part of P/N 223403-08 | 1900 | 1 |
| 3 | Component exchange skid | СРҮ | Part of P/N 223403-08 | 2000 | 1 |
| 4 | Weak link | СРҮ | Part of P/N 223403-08 | | 1 |
| 5 | Power charger | СРҮ | Part of P/N 223403-08 | | 1 |
| 6 | MPRT HPU | CPY | P/N 2297011-03 | 700 | 1 |
| 7 | SCM for Production Xmas Tree | СРҮ | P/N 223052-48 | | |
| 8 | SCM for Water Injection Xmas Tree | CPY | P/N 223052-49 | 1800 | 1 |
| 9 | SCM for Gas Injection Xmas Tree | CPY | P/N 223052-50 | | |
| 10 | SCM for Manifold | CPY | P/N 223052-51 | | |
| 11 | SCM Transportation skid | CPY | P/N 223210-57 | 800 | 1 |
| 12 | SCM lifting interface | CPY | P/N 223260-99 | | 1 |
| 13 | LTC | CPY | P/N 223415-90 | 420 | 1 |
| 14 | Workover SCM Test Stand | CPY | P/N 223182-07 | 2300 | 1 |
| 15 | Workover ETU | CPY | P/N 223182-28 | | 1 |
| 16 | Workover SCM Test Stand HPU | CPY | P/N 223380-16 | 700 | 1 |
| 17 | Dummy SCM | CPY | P/N 223261-93 | | 1 |
| 18 | Castrol Hypsin AWS32 or Tellus for MPRT hot stab operation | СРҮ | | | 1 |
| 19 | Transaqua IBC | CPY | | 1000 | 1 |
| 20 | N2 pump c/ precharge kit | CPY | P/N 223410-08 | | 1 |

10.1 TCM and MCM Replacement, Equipment List

| Item | Equipment | Supplier | Part Number | Weight (Kg) | Qty |
|------|---|----------|--------------------------|----------------|--------|
| 1 | MPRT | СРҮ | P/N 223403-08 | 3100 | 1 |
| 2 | MPRT shipping skid | CPY | Part of P/N 223403-08 | 1900 | 1 |
| 3 | Component exchange skid | СРҮ | Part of P/N 223403-08 | 2000 | 1 |
| 4 | Power charger | СРҮ | Part of P/N 223403-08 | | 1 |
| 5 | Weak link | СРҮ | Part of P/N 223403-08 | | 1 |
| 6 | SAM | CPY | P/N 223052-53 | 1800 | 1 |
| 7 | SAM Offshore shipping skid | CPY | P/N 223210-57 | 800 | 1 |
| 8 | SAM lifting interface | CPY | P/N 223260-99 | | 1 |
| 9 | LTC | CPY | P/N 223415-90 | 420 | 1 |
| 10 | Charging Adapter | СРҮ | P/N 619012-03- 06-96 | | 1 |
| 11 | Accumulator Precharge Kit with Air Compressor, 0-690 Bar | СРҮ | P/N 223410-08 | | 1 |
| 12 | Nitrogen bottles 50 liter / 200 bar / 2900psi | CPY | N/A | | 1 quad |
| 13 | MPRT HPU | CPY | P/N 2297011-03 | 700 | 1 |
| 14 | Workover SCM & SAM Test Stand | CPY | P/N 223182-07 | 2300 | 1 |
| 15 | Workover ETU | CPY | P/N 223182-28 | | 1 |
| 16 | Workover SCM & SAM Test Stand HPU | CPY | P/N 223380-16 | 700 | 1 |
| 17 | Dummy SCM | CPY | P/N 223261-93 | | 1 |
| 18 | Castrol Hypsin AWS32 or Tellus for MPRT hot stab operation | СРҮ | N/A | | 1 |
| 19 | Transaqua IBC | CPY | N/A | 1000 | 1 |
| 20 | Hot stab + spare seals | CPY | P/N 2731834-01 | | 2 |
| 21 | Pad eye for skids seafastening | | | | 8 |

10.2 SAM Replacement, Equipment List

| Item | Equipment | Supplier | P/N | Weight (Kg) | Qty |
|------|---|----------|--------------------------|----------------|-----|
| 1 | MPRT | CPY | P/N 223403-08 | 3100 | 1 |
| 2 | MPRT shipping skid | СРҮ | Part of P/N 223403-08 | 1900 | 1 |
| 3 | Component exchange skid | СРҮ | Part of P/N 223403-08 | 2000 | 1 |
| 4 | Weak link | СРҮ | Part of P/N 223403-08 | | 1 |
| 5 | Power charger | СРҮ | Part of P/N 223403-08 | | 1 |
| 6 | Dummy Choke bodies | СРҮ | Part of P/N 223403-08 | | 2 |
| 7 | WI Choke insert | CPY | P/N 2208620-01 | 1800 | 1 |
| 8 | WI Choke insert Transportation skid | CPY | P/N 2259048-01 | | 1 |
| 9 | WI Choke insert surface handling tool | CPY | N/A | | 1 |
| 10 | Choke Latch Assembly | СРҮ | Part of P/N 223403-08 | | 1 |
| 11 | MPRT HPU | CPY | P/N 2297011-03 | 700 | 1 |
| 12 | Castrol Hypsin AWS32 or Tellus for MPRT hot stab operation | СРҮ | | | 1 |
| 13 | Hot stab + spare seals | CPY | P/N 2731834-01 | | 2 |
| 14 | Pad eye for skids seafastening | | | | 8 |
| 15 | Class 4 Torque Tool | CPY | P/N 2731826-01 | | 1 |
| 16 | Class 4 torque tool calibration jig / analyser | СРҮ | P/N 2772040-01 | | 1 |

10.3 Water Injection Choke Replacement, Equipment List

| Item | Equipment | Supplier | Part Number | Weight | Qty |
|------|--|----------|-----------------------|---------|-----|
| 1 | HDU | CPY | P/N 223170-41 | 9 Te | 1 |
| 2 | Guide post / Long | CPY | P/N 2254037-01 | 438 Kg | 1 |
| 3 | Guide post / Short | CPY | P/N 2254037-02 | 361 Kg | 1 |
| 4 | HDU Connector Fixed stab plate LTC | СРҮ | P/N 2197010-05- 30 | 73.5 Kg | 1 |
| 5 | Pressure compensation system LTC (contingency) | СРҮ | P/N 2197010-05- 16 | 73.5 Kg | 2 |
| 6 | HFL stab plate LTC 6 way(contingency) | CPY | P/N 2197010-05- 14 | 73.5 Kg | 4 |
| 7 | HFL stab plate LTC 7 way(contingency) | СРҮ | P/N 2197010-05- 24 | 73.5 Kg | 4 |
| 8 | Nitrogen Quad | CPY | | | 1 |
| 9 | Transaqua IBC | CPY | | 1 Te | 1 |
| 10 | HPU | CPY | | 700Kg | 1 |
| 11 | Test and Flushing Plate | CPY | P/N 2197010-05 | | 1 |
| 12 | 12-way electrical protective cover | CPY | P/N 2197088-01- 34 | | 1 |
| 13 | FLOT | CPY | P/N 2731825-01 | 63 Kg | 1 |
| 14 | Torque Tool | CPY | P/N 2731826-01 | 39 Kg | 1 |
| 15 | Torque Tool calibration jib | CPY | P/N 2772040-01 | | 1 |
| 16 | Work Basket | CPY | P/N 2772096-01 | | 1 |
| 17 | FLDF or dummy FLDF (depending on availabilities) | СРҮ | | 4.8 Te | 1 |
| 18 | Wood Timbers 5000 x 300 x 300 | CPY | | | 6 |

10.4 HDU Replacement, Equipment List

| Item | Qty | Equipment | Supplier | Part Number | Dimension | Weig ht (Kg) |
|------|-----|--|----------|----------------|-------------------|--------------------|
| 1 | 1 | CIRT | CPY | P/N 2128019-01 | 2.6 x 0.8 | 1500 |
| 2 | 1 | Choke Insert | CPY | P/N 2259092-01 | 1.26 x 0.5 | 555 |
| 3 | 1 | CIRT shipping skid | CPY | P/N 2259046-01 | 2.7 x 1.52 x 1.25 | 1840 |
| 4 | 1 | Test Stand | CPY | P/N 2259047-01 | 1.5 x 1.5 x 1.2 | 304 |
| 5 | 1 | Work / Shipping Stand | CPY | P/N 2259048-01 | 1.5 x 1.5 x 1.4 | 600 |
| 6 | 1 | MPRT HPU (CIRT operation / working with mineral oil) | CPY | P/N 2297011-03 | 1.0 x 1.5 x 1.6 | 700 |
| 7 | 1 | CIRT HPU (Choke Insert Function Test HPU with transaqua) | CPY | P/N 2259052-01 | - | - |
| 8 | 1 | Transaqua <mark>I</mark> BC | CPY | - | 1.0 x 1.0 x 1.0 | 1000 |
| 9 | 1 | Mineral oil | CPY | - | - | - |
| 10 | 2 | Hot stab + spare seals | CPY | - | - | - |
| 11 | 8 | Pad eye for skids seafastening | - | - | - | - |
| 12 | 1 | Class 4 torque tool | CPY | P/N 2731826-01 | 0.6 x 0.3 | 46 |
| 13 | 1 | Class 4 torque tool calibration jig / analyser | СРҮ | P/N 2772040-01 | - | - |

10.5 Production and Gas injection Choke Replacement, Equipment List

| Item | Equipment | Supplier | Part Number | Weight (Kg) | Qty |
|------|--|----------|---------------|----------------|-----|
| 1 | New MPFM Canister | CPY | 2197017-10-02 | 140 | 1 |
| 2 | Work Basket (with lifting rigging) | CPY | | | 1 |
| 3 | Padeyes for Work basket seafastening | | | | 4 |
| 4 | Laptop for new Canister Communication test (contingency) ^(*) | СРҮ | 2197017-10-07 | | 1 |
| 5 | Set of power/com surface cables that connect the Canister to the laptop (contingency) ^(*) | СРҮ | | | 1 |

10.6 MPFM Cannister Replacement, Equipment List

| Item | Equipment | Supplier | Part Number | Dimension & Weight | Qty |
|------|---|----------|-------------------|-----------------------|-----|
| 1 | Work basket | CPY | P/N 2272096-01 | 3.7x3.3x3.5 3 Te | 1 |
| 2 | EFL Deployment Frame | CPY | P/N 223210-67 | 6.0x4.9x3.6 4.5 Te | 1 |
| 3 | Electrical Long Term Covers (7-way - green funnel) | CPY | P/N 2185425-04-10 | - | 2 |
| 4 | Electrical Long Term Covers (4-way - red funnel) | CPY | P/N 2185425-20-03 | - | 2 |
| 5 | Electrical Long Term Covers (12-way – black & white funnel) | СРҮ | P/N 2197088-01-34 | - | 2 |
| 6 | Test Connector | CPY | | | 2 |
| 7 | Multimeter | CPY | | | 1 |
| 8 | Mega | CPY | | | 1 |

10.7 EFL Replacement, Equipment List

| Item | Equipment | Supplier | Part Number | Weight (Kg) | Qty |
|------|---------------------------------|----------|-------------|----------------|-----|
| 1 | New RCVI | CPY | | 24 | 1 |
| 2 | Work Basket | CPY | | | 1 |
| 3 | Padeyes for Basket seafastening | | | | |

10.8 Chemical Valve Insert Replacement, Equipment List

| Item | Equipment | Supplier | Dimension | Weight | Qty |
|------|--|---------------------|------------------|------------------|-----|
| 1 | HFL cutting tool | Bourbon Offshore | Hold | Hold | 1 |
| 2 | FLDF (or Dummy FLDF) | CPY | 10.2 x 4.0 x 3.5 | 4.8 Te | 1 |
| 3 | LTC (type depend on HFL to be replaced) | CPY | Ø 0.6 x 0.6 | 73.5 Kg | 2 |
| 4 | Drum Drive System | CPY | Ø 2.4 | 1.4 Te | 1 |
| 5 | Straightner | CPY | 1.50 x 1.25 | 0.5 Te | 1 |
| 6 | Tensioner | CPY | 1.6 x 1.22 | 1.5 Te | 1 |
| 7 | Fore Overboarding Chute | CPY | 6.61 x 3.15 | 3.1 Te | 2 |
| 8 | Work Basket (P/N 2772096-01) | CPY | 3.6 x 3.6 x 3.6 | 3 Te | 1 |
| 9 | HFL Drum | СРҮ | Ø 3.5 | 1.6 to 1.9 Te | 1 |
| 10 | Pulling Padeye | CPY | | | 1 |
| 11 | FLOT (P/N 2731825-01) | CPY | | 63 Kg | 1 |
| 12 | Torque Tool (P/N 2731826-01) | CPY | | 39 Kg | 1 |
| 13 | Torque Tool calibration jib (P/N 2772040-01) | CPY | | | 1 |

10.9 HFL Replacement, Equipment List

| Item | Equipment | Supplier | Part Number | Weight (Kg) | Qty |
|------|--------------------------------------|----------|---------------|----------------|-----|
| 1 | New Sand Detector | CPY | 2197016-01-81 | 24 | 1 |
| 2 | Work Basket (with lifting rigging) | CPY | | | 1 |
| 3 | Padeyes for Work basket seafastening | CTR | | | 4 |

10.10 Sand Detector Replacement, Equipment List

| Item | Equipment | Supplier | Part Number | Weight | Qty |
|------|--------------------------------|----------|-------------------|--------|-----|
| 1 | Spare Bridge Jumper | CPY | P/N 223207-84 | 2.1 Te | 1 |
| 2 | Production DSUT 12 way LTC | CPY | P/N 2197010-05-26 | 78 Kg | 1 |
| 3 | Production ISUT 12 way LTC | CPY | P/N 2197010-05-28 | 78 Kg | 1 |
| 4 | Water Injection DSUT 3 way LTC | CPY | P/N 2197010-05-48 | 70 Kg | 1 |
| 5 | Water Injection ISUT 3 way LTC | CPY | P/N 2197010-05-50 | 70 Kg | 1 |
| 6 | Test and shipping frame | CPY | P/N 223210-63 | 1.5 Te | 1 |
| 7 | Test and flushing plate | CPY | P/N 2197010-05-51 | | 2 |
| 8 | Test and flushing frame | CPY | P/N 223210-36 | | 2 |
| 9 | FLOT | CPY | P/N 2731825-01 | 63 Kg | 1 |
| 10 | Torque Tool | CPY | P/N 2731826-01 | 39 Kg | 1 |
| 11 | Torque Tool calibration jib | CPY | P/N 2772040-01 | | 1 |
| 12 | Work Basket | CPY | P/N 2772096-01 | | 1 |
| 13 | Dummy FLDF or FLDF | CPY | | | 1 |

10.11 Bridge Jumper Replacement , Equipment List

| Item | Equipment | Supplier | Part Number | Weight (Kg) | Qty |
|------|--|----------|-------------|----------------|-----|
| 1 | New Doghouse | CPY | | 1016 | TBC |
| 2 | Protection Frame for Doghouse | CPY | | 675 | 2 |
| 3 | IDRT (*) | CPY | | 4589 | 2 |
| 4 | IDRT Guideposts for FLETs | CPY | | | 2 |
| 5 | IDRT Guideposts for Manifolds M21& M22 | СРҮ | | | 2 |
| 6 | IDRT Guideposts for all Xmas Trees and all other Manifolds | СРҮ | | | 2 |
| 7 | IDRT Shipping Skid | CPY | | 6000 | 1 |
| 8 | IDRT Loading Skid | CPY | | 5451 | 1 |
| 9 | ROV Valve handle tool | CPY | | 8.4 | 2 |
| 10 | HPU | CPY | | | 1 |
| 11 | Dual Hotstab with hoses | CPY | | | 2 |
| 12 | Dirty Work Pack | CPY | | | 2 |
| 13 | Weak Link | CPY | | | 2 |
| 14 | LED battery charger | CPY | | | 1 |
| 15 | Electrical subsea connector | CPY | | | 2 |
| 16 | Remote Control Unit | CPY | | | 2 |
| 17 | Torque Tool and Adaptor (contignency) | CPY | | | 1 |
| 18 | Torque Analyser | CPY | | | 1 |
| 19 | Extension Lead | CPY | | | 1 |
| 20 | Padeyes for skid seafastening | CPY | | | TBC |

10.12 Doghouse Replacement, Equipment List

| Item | Equipment | Supplier | Part Number | Weight (Kg) | Qty |
|--------------------------------|--|----------|-------------|----------------|-----|
| 1 | Remote Control Unit with all connecting parts and surface laptop | СРҮ | 2731827-01 | 24 | 3 |
| For Torque Tool | | | | | |
| 2 | Calibration Jig with valid certificate | CPY | 2731845-01 | | 3 |
| 3 | Torque Tool Class 4 including Turn Counter and spare parts | СРҮ | 2731826-01 | | 3 |
| 4 | Connecting parts to RCU | CPY | 2731826-01 | | |
| For Linear Valve Override Tool | | | | | |
| 5 | Digital Load Analyser | CPY | 2731830-01 | | 2 |
| 6 | LVOT and spare parts | CPY | 2731828-01 | | 4 |
| 7 | Detachable Lock Open Tool 5" | CPY | 2731849-01 | | 4 |
| 8 | Detachable Lock Open Tool 2" | CPY | 2731848-01 | | 4 |
| 9 | Dual Port Hotstab | CPY | 2731830-01 | | 4 |
| 10 | Dirty Oil Pack | CPY | 2731832-01 | | 3 |
| 11 | Connecting parts to Dirty Oil Pack | CPY | 2731830-01 | | |
| 12 | Connecting parts to RCU | CPY | | | |
| 13 | Work Basket (with lifting rigging) | CPY | | | 1 |
| 14 | Padeyes for Work basket seafastening | CTR | | | 4 |

10.13 Valves Operation, Equipment List