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Document title:

DESIGN BASIS

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CSONOR Project No.: 31132

COFLEXIP STENA OFFSHORE NORGE AS

BP AMOCO NORGE AS
Contract No. C01009

VALHALL FLANK DEVELOPMENT PROJECT
SUBSEA FLOWLINE

VFD

REVISION RECORD

Rev. No.		Date	Section(s)	Page(s)	Reason
CLIENT	CSONOR				
0		27.09.01	All		General update
1		15.11.01	All		BP comments 19.10.01
2		22.01.02	All		General update and BP comments. ABB comment dated 15.01.02.

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1 INTRODUCTION

1.1 General

CSONOR has been award the EPCI contract for the production flowlines and cables installation for the BP Valhall Flank Development. Un-manned Wellhead Platforms (WHP) at Valhall North and Valhall South will be tied back to the Valhall field centre by 10" production flowlines and power and fibre optical cables. The length of each flowline and cable is approximately 7 km.

The production flowline will be tied in to the WHP's via rigid expansion spools to pre-fit risers on the WHP's. CSONOR will install a 36" riser caisson with 2 off 10" production risers at Valhall PCP for tie-in of the flowlines via rigid expansion spools. The diverless tie-in system to be used is FLEXCONNECT. The cable will be pulled into J-tubes on the new Valhall IP and the new WHP's. The flowlines and the cables will be trenched.

2/8 Valhall Flank North, 2/11 Valhall Flank South and 2/8 Valhall PCP/IP are situated in the Norwegian sector of the Central North Sea in about 73 meters waterdepth. The location of the Valhall PCP is 6 237 182 N and 524 549 E.

The subsea system is consisting of:

- 2 off 10" Production Flowline (each appr. 7 km long)
- 4 off tie-in spools (each end of the two pipelines) tied in with FLEXCONNECT
- 1 off 36" riser caisson with 2 off 10" risers at Valhall PCP
- 2 off Electrical Cables (each appr. 7 km long)

1.2 Scope of document

This document summarises all basic flowline system data for the BP Valhall Flank Development.

Basic data is defined as all information used as input to the engineering activities including design, installation and interfaces.

All 13% Cr line pipe and bends is CPI. All material for the main riser caisson pipe are not CPI.

The field layout is presented in Ref. /57/ through /60/.

The flowline design and installation engineering is based on performing the pipelay with the reelship CSO Apache.

1.3 Abbreviations

Client	:	BPA
CPI	:	Company Provided Item
CSONOR	:	Coflexip Stena Offshore Norge a.s.
DNV	:	Det Norske Veritas a.s.
EL	:	Elevation
FBE	:	Fusion Bonded Epoxy
FJ	:	Field Joint
FJC	:	Field Joint Coating
FOC	:	Fibre Optic Cable
ID	:	Internal Diameter
LAT	:	Lowest Astronomical Tide
MSL	:	Mean Sea Level
MTO	:	Material Take Off
NDT	:	Non Destructive Testing
NIU	:	Not In Use
OD	:	Outer Diameter
PCP	:	Production Compression Platform
PIP	:	Pipe in Pipe
PP	:	Polypropylene
SG	:	Specific Gravity
SOW	:	Scope of Work
TBC	:	To be confirmed
UPBK	:	Upheaval Buckling
WHP	:	Wellhead Platform
WHP-N	:	2/8 Valhall Flank North
WHP-S	:	2/11 Valhall Flank South
WP	:	Valhall Complex Wellhead Platform
WT	:	Wall Thickness

2 SYSTEM DEFINITION AND INTERFACE DESCRIPTION

2.1 Design Requirements

2.1.1 Company requirements

The following principal governing documents within BP Amoco are to be considered. Ref. /8/, /20/, /43/, /45/ through /53/,/55/,/56/ and /62/.

2.1.2 Regulatory Requirements

Regulatory requirements are collected in NPD's "Acts, Regulations and Provisions for Petroleum Activity", Volumes 1 and 2. Relevant NPD regulations for the project are Ref. /40/ through /42/ and /63/.

2.1.3 Norwegian and International Standards

The latest revisions of relevant NORSOK standards apply to the project. Ref. /21/ through /39/ and /54/.

In addition the following applies:

- DNV standards and guidelines apply for the project. Ref. /10/ through /13/
- ISO standards Ref. /14/ through /16/
- API standards Ref. / 2/ through /5/
- ASME standard Ref. /6/
- ASTM Ref. /7/

2.1.4 Other documents

Other documents to be considered are Ref. /1/, /17/ through /19/ and /44/. Note that the references /17/ and /44/ is premises for the work and not requirements.

2.1.5 Priority

The following list of priorities shall apply in case of conflict between requirements:

- Regulatory requirements
- Company requirements
- Norwegian and international standards
- Other

2.2 System Definition PCP to WHP-S and WHP-N

A system definition is listed in Table 2.2.1

Item	Description	Approx. length	Nom. OD (mm)
Production Pipelines	10" production pipeline from PCP to WHP-N. Material 13%Cr steel.	6.0 km [1)]	273.1
	10" production pipeline from PCP to WHP-S. Material 13%Cr steel	7.1 km [1)]	273.1
Riser Caisson	36" Riser Caisson containing 2 off 10" risers at PCP	77 m [2)]	914.4
Electrical Cables	Electrical Cable from PCP to WHP-N.	6.3 km [3)]	66.0
	Electrical Cable from PCP to WHP-S.	6.6 km [3)]	66.0

Table 2.2.1 System Definition.

Notes:
1) The pipeline lengths are approximate lengths from the Field layout drawing Ref./57/.
2) The caisson is 83 m long inclusive risers in each end.
3) The cable lengths are approximate lengths from the Field layout drawing Ref./57/.

2.3 Battery Limits

PCP

The following battery limits apply on the Valhall PCP:

Items	Battery limit description
Production Flowline & Spool	Tie in to riser caisson 1.5 m above seabed
Riser Caisson	Seabed to EL. + 10 m

WHP-S

The following battery limits apply on the WHP-S:

Items	Battery limit description
Production Flowline & Spool	Riser end termination 0.8 (±0.1m) m above seabed. TBC
Electrical Cable	J-tube bellmouth TBA m above seabed cable hang-off at EL. TBA

WHP-N

The following battery limits apply on the WHP-N:

Items	Battery limit description
Production Flowline & Spool	Riser end termination 0.8 (±0.1m) m above seabed. TBC
Electrical Cable	J-tube bellmouth TBA m above seabed cable hang-off at EL. TBA

IP

The following battery limits apply on the Valhall IP:

Items	Battery limit description
Electrical Cable (2 off)	J-tube bellmouth 1 m above seabed (TBC) cable hang-off at EL.TBA

2.4 Safety Zones

Safety zones of 500 m radius around (ref. platform center):

- PCP
- WHP-S
- WHP-N

2.5 Flowline Route

The 10" production pipelines and cable routes are based on the platform and tie-in coordinates (UTM) in Ref. /57/ through /60/.

2.6 Crossings

The flowline routing between PCP and WHP-S will cross the line and cable listed below. There will be only one (1) crossing of these since the line and cable crosses each other at the same point as the flowline crosses the line and cable:

- Existing 4" Gas Lift line
- Fibre Optic Cable (FOC).

These are assumed to be trenched and backfilled.

2.7 Tie-in System

The flowline tie-ins at the platforms will be by use of rigid spool and diverless mechanical connectors.

The tie-in of the electrical cable will be performed by pull-in to J-tubes on the WHP's.

2.8 Riser Caisson at Valhall PCP

A caisson including riser for flowlines will be installed at Valhall PCP.

2.8.1 Battery Limits

The bottom of the riser caisson will be at elevation ~7m above seabed. This is to be determined by detail design and installation engineering and taking into account requirements for the tie-in system for the rigid spool.

The risers protruding through the bottom of the Caisson have tie-in porches attached to the ends with centre line ~1.5m above seabed.

3 REFERENCES

Ref.:	Document number:	Document title:
/1/	ABB Global Engineering b.v.	Riser Design Brief, No. W-PP-R-100
/2/	API 17D	Specification for Subsea Wellhead and Christmas Tree Equipment
/3/	API 5L	Specification for Line Pipe.
/4/	API 6D	Specification for Pipelines Valves (Gate, Plug, Ball and Check Valves).
/5/	API 6H	Specification for Pipeline Connectors and End Closures
/6/	ASME sect. IX	Welding and Brazing Qualifications
/7/	ASTM A388	Recommended Practice for Ultrasonic Testing and Inspection of Heavy Forgings.
/8/	BP VFD-BR-U-136	Pipeline and Tie-in Functional Requirements
/9/	CSONOR Doc.no. 30930-ST-10100	Ula Tambar Design Basis
/10/	DNV Guideline 14	Free Spanning Pipelines
/11/	DNV OS-F101	Submarine Pipeline Systems, 2000
/12/	DNV RP B 401	Cathodic Protection Design
/13/	DNV RP E 305	On-bottom Stability Design of Submarine Pipelines
/14/	ISO 13628-1	Subsea Colour and Marking
/15/	ISO 9000	Quality Management and Quality Assurance Standards
/16/	ISO 9001	Quality Management Systems – Requirements
/17/	KW Ltd. Consultants	Fax no. 01224 744038, 01.06.01
/18/	NAS 1638	Hydraulic Fluid Cleanliness
/19/	NMD	Norwegian Maritime Directorate: Regulations for Mobile Offshore Units.
/20/	BP / NORSOK	Standards with BP additional requirements. Refer to Invitation to Tender, volume 2, book 3 section 10.
/21/	NORSOK G-CR-001	Marine soil investigations, Rev.1, May 1996
/22/	NORSOK J-003	Marine Operations. Rev. 2 Aug. 1997
/23/	NORSOK M-001	Material Selection Rev. 2, Nov 1997
/24/	NORSOK M-101	Structural steel fabrication, Rev. 4 Dec. 2000
/25/	NORSOK M-120	Material Datasheets for structural steel. Rev. 3, Dec. 2000
/26/	NORSOK M-501	Surface Preparation and Protective Coating, Rev. 4 Dec. 1999.
/27/	NORSOK M-503	Cathodic Protection. Rev. 2, Sept 1997
/28/	NORSOK N-001	Structural Design. Rev. 3 August 2000
/29/	NORSOK N-004	Design of steel structure. Rev. 1, Dec. 1998
/30/	NORSOK R-003	Lifting Operations. Rev. 1, Oct. 1997
/31/	NORSOK R-100	Mechanical equipment selection. Rev. 2, Nov. 1997
/32/	NORSOK S-CR-002	HSE during construction. Rev. 1, Jan 1996
/33/	NORSOK U-001	Subsea production system. Rev. 2, June 1998
/34/	NORSOK U-002	Subsea structures and piping system. Rev. 2, June 1998

/35/	NORSOK U-007	Subsea intervention. Rev. 2, June 1998
/36/	NORSOK Y-001	Subsea pipelines. Rev. 1, Sept.1997
/37/	NORSOK Z-007	Mechanical completion and commissioning. Rev. 2, Dec. 1999
/38/	NORSOK Z-013	Risk and emergency preparedness analysis. Rev. 1, March 1998
/39/	NORSOK Z-015	Temporary equipment. Rev. 1, July 1998
/40/	NPD	Guidelines for Design, Fabrication and Installation of Submarine Pipelines and Risers
/41/	NPD 1990	Regulations relating to pipeline systems in the petroleum activities.
/42/	NPD Regulations	Acts, regulations and Provisions for the Petroleum Activities, (Oljedirektoratet YA-001 A YA-001 B)
/43/	BP	Invitation to tender Volume 3 Geophysical Survey
/44/	CSO OED	Memo dated 16.05.01 Ref. 31132-N-01-0001
/45/	BP VFD-BR-U-130	Linepipe specification
/46/	BP	Invitation to tender. Volume 4 Geotechnical Survey
/47/	BP/CSO	Clarification no Q51
/48/	BP VFD-BR-U-129	Y-piece specification
/49/	BP VFD-BR-U-131	Induction bends specification
/50/	BP VFD-BR-U-132	Valve specification (ROV operated)
/51/	BP VFD-BR-U-133	Valve specification (hydraulic operated)
/52/	BP VFD-BR-U-134	Tie in system Specification
/53/	BP VFD-BR-U-135	Pipeline coating specification
/54/	NORSOK N003	Action and action effects.
/55/	BP/CSO	Clarification Q45
/56/	BP/CSO	Clarification Q13
/57/	NK 31132-0008	Field Layout Valhall
/58/	NK 31132-0009	Field Layout over all view at Valhall
/59/	NK 31132-0010	Field Layout at WHP North Approach
/60/	NK 31132-0011	Field Layout at WHP South Approach
/61/	CSONOR Doc.no. 31132-SR-10101	Pipeline Wall thickness design and MTO
/62/	BP VFD-BR-Z-120	Environmental Specification
/63/	NPD Regulations	Regulations related to lifting appliances and lifting gear in the petroleum activities, 7th Feb. 1992. Last amended 25 March 1999.
/64/	BP / Sumitomo TSL-1494R2	Manufacturing, testing and inspection procedure, seamless 13% Cr line pipe. Valhall Flank.
/65/	BP mail dated 26.10.01.	Response to technical query, Water depth at Valhall PCP. Ref. VFDPIP-E-012-OS-107.3
/66/	BP mail dated 03.12.01	Wave Criteria Final, Fugro Geos ref.no. C50139/2318/F0 rev. 0
/67/	BP mail dated 29.11.01	VFD Production line temperature profiles Ref. VFDPIP-E-051-DM-107.3
/68/	BP fax dated 30.11.01	Potential for a reduced minimum SMYS VFDPIP-F-0054-DM-107.5

/69/	BP mail dated 18.12.01	Temperature profiles for the flowline Ref. VFDPIP-E-078-DM-107.3
/70/	BP mail dated 19.12.01	Temperature profiles for the flowline Ref. VFDPIP-E-083-DM-107.3

4 ENVIRONMENTAL DATA

4.1 Geotechnical Data

The seabed soil conditions for the proposed pipeline route between PCP and the WHP-S and the WHP-N consist of fine to medium slightly silty sand Ref. /43/. There is possibility of clay layers in the sand along the WHP-N to PCP. The seabed soil within the area is described as essentially flat.

For detailed soil data along the route, reference is made to Ref. /46/. The soil conditions at the Valhall location are described in Ref./46/.

Assumed backfill soil properties (ref. /44/ and /9/):

• Thermal conductivity; backfill	2.0 W/mK	Ref. /9/
• Backfill Soil density (submerged unit weight):	7.0 kN/m^3	Ref. /44/
• Backfill Internal angle of friction: ⇒ to be concluded during pre-installation upheaval buckling analysis/modelling	31° - 34°	
• Thermal conductivity rock dump:	2.5 W/mK	
• Rock dump density (submerged unit weight):	9.5 kN/m^3	Ref. /44/
• Rock dump internal friction angle: ⇒ to be concluded during pre-installation upheaval buckling analysis/modelling	TBA	

4.2 Seabed Friction Factors

The following lateral and axial friction factors shall be used for on-bottom stability and expansion of the flowline.

• Lateral friction coefficient (on bottom stability):	0.4	Ref. /44/
• Lateral friction coefficient (pipelay):	0.4	
• Axial friction coefficient (expansion analysis) :	0.4	

4.3 Wave Data

The installation condition (empty) shall be checked using 1-year monthly data.

Installation is planned in August. The Ref. /13/ requires use of September data from Table 4.3.1:

Hs = 6.7 m

Tp = 10.7 s

Operation, hence values from Table 4.3.3:

Hs(100 year) = 12.9 m

Tp = 14.7 s

The monthly wave period and wave heights for the significant and maximum wave height is given in Table 4.3.1. Ref. /9/ and /66/.

Monthly extreme waves	Wave height Hs (m)	Wave height Hmax (m)	Period Tz (s)	Period Tp (s)
January	8.8	16.7	9.3	12.6
February	7.8	14.8	8.6	11.7
March	6.5	12.4	7.8	10.5
April	5.9	11.2	7.4	10.0
May	4.0	7.6	6.1	8.3
June	4.0	7.6	6.1	8.3
July	4.0	7.6	6.1	8.3
August	4.8	9.1	6.6	9.0
September	**6.7**	12.7	7.9	**10.7**
October	7.7	14.6	8.6	11.6
November	7.3	13.9	8.3	11.3
December	8.8	16.7	9.3	12.6

Table 4.3.1 Valhall Monthly Extreme Wave – 1 year return period (Ref. /66/)

Monthly extreme waves	Wave height Hs (m)	Wave height Hmax (m)	Period Tz (s)	Period Tp (s)
January	11.2	21.3	10.9	14.8
February	9.8	18.6	11.0	13.5
March	7.8	14.8	8.6	11.7
April	7.7	14.6	8.6	11.6
May	5.0	9.5	6.8	9.2
June	5.1	9.7	6.8	9.3
July	5.1	9.7	6.8	9.3
August	6.4	12.2	7.7	10.4
September	8.8	16.7	9.3	12.6
October	10.2	19.4	10.2	13.9
November	9.2	17.5	9.6	13.0
December	11.2	21.3	10.9	14.8

Table 4.3.2 Valhall Monthly Extreme Wave – 10 year return period (Ref. /66/)

Data including the wave period and wave heights for the significant wave height is given in Table 4.3.3.

Return period (year)	Wave height Hs (m)	Period Tp (s)
100	**12.9**	**14.7**

Table 4.3.3 Valhall Significant Wave Height and Periods (Ref. /66/)

The maximum wave height with an average recurrence period of 100 years is defined as in the Table 4.3.4. The direction given is the direction from which the wave approaches. Ref. /62/.

Wave direction True north direction	Wave height H_{max} (m)	Wave Period (s)
North	24.5	14.7
North East	16.0	12.1
East	18.6	12.9
South East	17.7	12.7
South	18.2	13.3
South West	20.5	13.5
West	21.2	13.8
North West	23.2	14.3

Table 4.3.4 100 years extreme maximum wave height (H_{max}).

For design. the period variation as given in Ref. /54/ shall be taken into account.

4.3.1 Wave Forces

For 10000-years and 100-year return period the Stream function 6 or the Stoke 5th theory can be used for the wave force calculation. For the other return periods the Stoke 5th theory shall be used.

4.3.2 Fatigue

The lifetime for the platform shall be 30 years. Table 4.3.5 shows wave periods likely to be associated with given wave heights for use in fatigue analysis.

Individual wave heights (meters)	Wave period (sec)
1	4
2	6
4	8
6	9
8	10
10	11
12	12
14	13
16	13
18	14
20	15

Table 4.3.5 Wave height and associated period to be used for fatigue analysis.

The long term distribution of the wave heights can be calcuated from the following formula using sector values H1 and N1 from Table 4.3.6.

$$N = H_1 \times \left[1 - \frac{\log N}{\log N_1}\right]$$

Where:
H= Wave height (m)
N= No. of waves with specific height
Subscript 1 denotes the annual extreme values

From the above. the number of waves of a specific height is given by:

$$N = 10^{\left[\log N_1 - \left[1 - \frac{H}{H_1}\right]\right]}$$

Direction from	Wave height H1	Number of waves N1
North	15.8	0.95×10^6
North East	10.5	0.47×10^6
East	12.1	0.56×10^6
South East	11.3	0.73×10^6
South	11.7	0.85×10^6
South West	13.2	1.13×10^6
West	13.8	1.02×10^6
North West	15.1	0.82×10^6

Table 4.3.6 Directional distribution of individual wave heights

4.4 Current Data

Current profiles by direction for an average reoccurrence of 10 years are given in Table 4.4.1(Ref. /8/).

Depth (m)	N (cm/s)	NE (cm/s)	E (cm/s)	SE (cm/s)	S (cm/s)	SW (cm/s)	W (cm/s)	NW (cm/s)
Surface	79	65	59	54	58	57	58	77
60	79	65	59	54	58	57	58	77
55	79	57	50	46	51	50	58	77
50	67	53	46	42	46	46	47	64
40	63	50	41	38	42	41	43	60
30	61	48	39	36	40	39	41	58
20	61	48	39	36	40	39	41	58
10	58	46	37	35	38	37	39	56
1	46	36	30	28	30	30	31	43
Seabottom	43	34	28	25	28	28	30	41

Table 4.4.1 10 year current profiles by direction.

Current profiles by direction for average reoccurrence of 100 year are given in Table 4.4.2.

Depth (m)	N (cm/s)	NE (cm/s)	E (cm/s)	SE (cm/s)	S (cm/s)	SW (cm/s)	W (cm/s)	NW (cm/s)
Surface	88	72	64	60	65	64	65	86
60	88	72	64	60	65	64	65	86
55	88	64	56	51	57	56	65	86
50	78	62	53	49	54	53	55	75
40	75	59	49	45	50	49	51	71
30	73	57	47	43	48	47	49	69
20	73	57	47	43	48	47	49	69
10	70	55	45	42	46	45	47	67
1	55	43	36	33	36	36	34	52
Seabottom	51	40	33	30	34	33	35	49

Table 4.4.2 100 years current profiles by direction.

4.5 Splash Zone

The splash zone shall be taken Ref. /62/:

- 4 m below the lowest sea level
- 5 m above the highest sea level

The splash zone is related to the platform. It is therefor necessary to consider the water depth uncertainty and the subsidence in the determination of the design splash zone.

4.6 Temperature

The absolute range of the sea bottom temperature is from 3°C to 8.5°C. Ref. /62/.

4.7 Seawater Properties

The seawater density in the North Sea is 1030 kg/m^3.

4.8 Marine Growth Data

The design thickness of the marine growth layer is Ref. /62/:

The marine growth profile for extreme analysis shall be taken according to Table 4.8.1. while the marine growth profile for fatigue analysis shall be taken according to Table 4.8.2. The weight of the marine growth may be taken according to Ref. /54/.

The effect of the marine growth on the flowline on the seabed is assumed negligible.

Depth Range (m)	Thickness on radius (mm)	Coverage %	Effective thickness (mm)
Above +2.35m	0	0	0
+2.35m to –20m	80	100	80
-20m to –40m	100	50	50
-40m to ML	60	40	25

Table 4.8.1 Marine growth profile for extreme analysis

Depth Range (m)	Thickness on radius (mm)	Coverage %	Effective thickness (mm)
Above +2.35m	0	0	0
+2.35m to –20m	80	100	50
-20m to –40m	100	50	50
-40m to ML	60	40	25

Table 4.8.2 Marine growth profile for fatigue analysis

4.9 Water Depths

PCP	:	73.0 m MSL	(Ref. /8/)
WHP-N	:	69.4 m MSL	(Ref. /8/)
WHP-S	:	66.6 m MSL	(Ref. /8/)

Note that the design should be based on the waterdepth 72.5 m (LAT) Ref. /65/. 73.1 m (MSL).

The effect of tidal amplitude. storm surge. height of wave crest etc. is neglected as this is assumed to have a negligible effect on the pipeline system design.

4.10 Tidal data

The following total tide above LAT is to be used in combination with the 100-year storm wave to calculate wave forces. Ref. /62/.

Elevation of mean sea level above LAT	:	0.6 m
Tide elevation above MSL	:	0.4 m
Storm surge associated with 100-year wave	:	0.4 m
Total tide	:	**1.4 m**

5 DESIGN DATA

5.1 Design Life

The design life of the pipeline system and caisson shall be 30 years (Ref. /8/).

5.2 Design Operational Data

The design conditions and operation conditions for the 10" Production line is listed in (Ref./8/ and /47/):

Pressure / temperatures		References
Design pressure	310 barg @ Valhall topside El.+20m)	Ref./8/ and /56/.
Maximum Design Temperature	80 °C (max)	Ref./8/
Minimum Design Temperature	-7 °C (min)	
Maximum Temperature @ WHP-S	70 °C	Ref. /67/, /69/ Note 1.
Maximum Temperature @ WHP-N	70 °C	Ref. /67/, /69/ Note 2.
Maximum Temperature @ PCP (WHP-S)	54 °C	Ref. /67/, /70/ Note 2.
Maximum Temperature @ PCP (WHP-N)	58 °C	Ref. /67/, /70/ Note 2.

Table 5.2.1 Pressure and Temperatures

Notes:
1. The max. temperature refers to top of riser at maximum flow.
2. The max. design temperature allows for 1°C higher temperature at the end of the pipeline compared to top of riser.

CSONOR will review dynamic effects onto the pipeline from production processes as defined by Client.

The minimum design density of the pipeline content in operation is 50 kg/m^3 Ref. /55/
The maximum design density of the pipeline content in operation is 800 kg/m^3 Ref. /55/

5.3 Flowline Design Data

5.3.1 Flowline Size and Material

From PCP to WHP-S and WHP-N (Ref./8/):

Material: 13%Cr steel (Ref./45/)
Outer Diameter Zone 1 & 2: 273.1 mm

Linepipe material is assumed to comply with the additional requirements of DNV OS-F101 2000 Ref. /11/.

The material selection for the production flowlines is based on NIL content of H_2S.

5.3.2 Manufacturing Tolerances

Dimensional tolerances shall be in accordance to API 5L (Ref. /3/) with the supplementary requirement as given in Table 5.3.1 (Ref. /64/):

Manufacturing Tolerances	
Wall Thickness Tolerance	± 12.5 %
Tolerances on Lengths TBC	Pipe lengths shall generally be within range 10.7 – 11.5 m Minimum average of 11.0 m (Max 5% minimum of 9.0 m)
Tolerance for Diameter: Pipe Body (OD): Pipe Ends (ID): Pipe Ends (ID for root face):	 ± 0.75% ± 2.4 mm ± 1.6 mm for 80% ± 2.0 mm for 100%
Out of Roundness: Pipe body	 $OD_{m.max} - OD_{m.min} \leqslant 2.73$ mm
Weight Single pipe:	 +10.0%. -3.5%

Table 5.3.1 Pipeline Manufacturing Tolerances for 13% Cr Steel

5.3.3 Other Relevant Flowline Data

The following data are assumed:

Steel density:	7790	kg/m³	
Poisson's ratio:	0.27	[-]	
Young's Modulus (25 °C):	2.01×10^5	MPa	
Young's Modulus (80 °C):	2.01×10^5	MPa	
Coefficient of Thermal Expansion:	11.0×10^{-6}	°C⁻¹	
Minimum Yield Strength @ 20 °C:	535	MPa	(Ref. /68/)
Minimum Yield Strength @ 80 °C:	535	MPa	(Ref. /68/)
Minimum Tensile Strength @ 20 °C:	750	MPa	(Ref. /45/)
Minimum Tensile Strength @ 80 °C:	750	MPa	(Ref. /45/)

5.3.4 Design Criteria

The general design criteria and wall thickness sizing shall be based on DNV OS-F101 "Submarine Pipeline Systems" 2000 (Ref. /11/) and NPD requirements Ref. /40/ through /42/.

5.3.5 Internal Corrosion

There is no corrosion allowance for the production (13%Cr steel material). (Ref. /8/).

5.3.6 External Corrosion

The pipelines shall be protected against external corrosion by a combination of corrosion protection coating and sacrificial half shell anodes.

The external anticorrosion coating shall be of the 3-layer Polypropylene type and the fieldjoints shall be coated with a compatible field joint coating system. Ref. /53/.

The external coating system applied shall be compatible with the reel lay method.

5.3.7 Insulation Requirement

The pipeline will be ploughed resulting in a soil cover of 0.7m. However the100m sections at each end of the pipelines will be exposed. The overall heat transfer coefficient (U-value) requirement for buried and exposed pipeline is defined as U = 5.0 W/m²K (related to OD).

5.3.8 Allowable Freespan Definition

Calculation methodology for Vortex induced vibrations is not fully covered in the DNV 2000 alone (Ref. /11/). The DNV Guideline No. 14 “Free Spanning Pipelines”. (Ref. /10/). supports and complies with DNV 2000 and will be used for the allowable freespan calculations.

5.4 Electrical Cable Design Data

5.4.1 Electrical Cable Design and properties

From PCP to WHP-N and to WHP-S:

Outer Diameter:	66 mm
Weight of electrical cable (air)	8.9 kg/m
Weight of electrical cable (submerged):	5.6 kg/m
Minimum bending radius (MBR):	1000 mm
Allowable tension:	5 Te

6 MECHANICAL PROTECTION

The requirements to mechanical protection of the pipelines in the vicinity of the platforms shall be determined based on a risk assessment for the various locations. The cable shall be protected by Uraduct over 100 m in the vicinity of the platforms

The pipeline ploughing and backfilling/rockdumping and the pipeline and cable trenching and rock dumping (where relevant) shall provide protection against upheaval buckling and fishing and shipping activities in the area. In addition the cover on the pipeline shall provide necessary pipeline insulation.

The pipeline will be trenched backfilled using plough. The cable will be trenched using jetting.

7 LANGUAGE AND UNITS

System International (SI) units shall be used and the language shall be English.