SCAN UPDATE
SEGMENT 16128 ✓
ROW OCS-G28452

In Reply Refer To: GE 1035A

April 18, 2012

Mr. Gregory D. Roland
Petrobras America Inc.
10350 Richmond Ave., Suite 1400
Houston, Texas 77042

Dear Mr. Roland:

Reference is made to the following application that has been reviewed by the Bureau of Safety and Environmental Enforcement:

Application Type: Right-of-Way Modification
Application Date: November 10, 2009
Supplemental Data Dates: December 23, 2009 and March 26, 2010

Work Description: Establish a service, purpose, and MAOP for the following:

Assigned Pipeline Segment Number: 16128
Assigned Casing Segment Number: 17459
Assigned Umbilical Segment Number: 17722
Assigned Right-of-Way Number: OCS-G28452

The right-of-way is modified as follows:

A 200-foot wide right-of-way to operate and maintain a 6-inch x 14-inch Pipe-in-Pipe, 12.05 miles in length with associated power umbilical, to transport bulk oil from Subsea well No. 2 through a 6.625-inch jumper (CH01-J-WJ-01) to Subsea Manifold (CH01-G-AY-01) in Block 469, through 9.625-inch jumper (CH01-J-FJ-03) from Manifold (CH01-G-AY-01) in Block 469 to Pump Station DC1 in Block 425, through a 9.625-inch jumper (CH01-J-FJ-01) from Pump Station DC1 to PLET (CH01-F-PLT-01) in Block 425, through 14-inch x 9.625-inch Pipe-in-Pipe Pipeline (CH01-F-01) from PLET (CH01-F-PLT-01) in Block 425 through Blocks 381, 337, and 293 to PLET (CH01-F-PLT-02) in Block 249, through 9.625-inch jumper (CH01-J-RJ-01) from PLET (CH01-F-PLT-02) to Riser Base PLET (CH01-R-PLT-01) in Block 293, through 9.625-inch Free Standing Hybrid Riser vertical section (CH01-R-01) in Block 293, and through 13.44-inch Free Standing Hybrid Riser flexible jumper section (CH01-J-XJ-01) from Block 293 to Block 249, to the Floating Production Storage and Offloading facility (FPSO) in Block 249, all in the Walker Ridge Area. [Chinook West Pipeline Development.]

Pursuant to 30 CFR 250.1000(b), your application is hereby approved. Approval is subject to the following conditions:

1) The maximum allowable operating pressure (MAOP) shall be referenced at the boarding shut down valve (BSDV).

2) You must conduct a pressure buildup test within 30 days after the first date of continuous production to determine accurate system pressures and submit a report containing pressures referenced at the mud line and boarding shut down valve (BSDV).

3) You must submit quarterly reports, until further notified by this office, containing wellhead shut-in and flowing pressure data, production fluid properties and composition for each well during the reporting period. You must also include in the quarterly reports a detailed description and purpose of any operation involving the displacement of well production fluids in the risers or pipelines with any other fluid (liquid or gas).

4) You must maintain a fluid specific gravity in the pipeline and riser no less than that of diesel with a S.G. = 0.83 (reference Water = 1.0 at STP). You must notify the Regional Supervisor immediately if the specific gravity of the fluid in the pipeline and riser becomes less than 0.83 or if the pressure measured at the BSDV exceeds 10,000 psi. In this notification, you must report the reason for this occurrence and the steps that are being taken to return the system to normal operation and to prevent future occurrences. Please note that an occurrence such as this will require a re-evaluation by this office of the system design.

Segment No.	MAOP (psig)	MAOP Determination
16128	10,000	Receiving Riser Design, Valves, Flanges

Alternate compliance and departure requests:

1) Request to use alternate procedures from the requirements of 30 CFR 250.1002(a) to utilize the Lame' Equations and API RP 1111 for internal design pressure.

Pursuant to 30 CFR 250.141, your request to utilize the Lame' Equations and API RP 1111 for internal pressure design is hereby approved.

2) Request to use alternate procedures from the requirements of 30 CFR 250.1003(b)(1) to pre-test the flexible riser jumper on-shore and leak test upon installation.

Pursuant to 30 CFR 250.141, your request to pre-test the flexible riser jumper on-shore and leak test upon installation is hereby approved.

3) Request a departure from the requirements of 30 CFR 250.1002(c)(1) to determine the MAOP by allowing pressure credit at the top of the riser based

on the pressure head of a full column of diesel in the riser and pipeline, with a S.G.= 0.83 (reference Water = 1.0 at STP) to yield a maximum allowable surface pressure of less than 10,000 psi.

Your departure request to determine the MAOP by allowing pressure credit at the top of the riser based on the hydrostatic head of a full column of diesel in the riser and pipeline is hereby denied.

4) Request a departure from the requirements of 30 CFR 250.1002(d) to operate the pipeline at a pressure that exceeds the MAOP of 10,000 psi without the use of the redundant safety devices required in section A9 of API RP 14C. Use maximum anticipated surface pressure (MASP) of 11,281 psi, which is the SITP (12,684 psi) minus the pressure head (1,403 psi) of a full column of dry gas (S.G. = 0.65, reference Air = 1.0 at STP) measured between the boarding shut-down valve and the wellhead.

Pursuant to 30 CFR 250.142, your departure request to operate the pipeline at a pressure that exceeds the MAOP of 10,000 psi but no greater than the MASP of 11,410 psi as defined above in departure request number four is hereby approved for a period of 30 days starting on the first day the pipeline is placed in-service. Normal operating pressure range shall not exceed 10,000 psi measured at the BSDV. The PSH shall be set no higher than MAOP of 10,000 psi. Other conditions of approval stated above remain in effect.

5) Requests alternate compliance from the requirements of 30 CFR 250.1004(b)(9) to omit the PSV and FSV from the subsea pumps.

Pursuant to 30 CFR 250.141, your request to omit the PSV and FSV from the subsea pumps is hereby approved. All conditions in the deep water operations plan (DWOP) approval remain in effect.

Alternate compliance or departure requests, expressed or implied, not specifically addressed herein shall not be considered approved.

This office also acknowledges that Petrobras America Inc. has submitted a separate application dated March 23, 2012 to modify the right-of-way by decommissioning in place the portion of the pipeline from the *Riser Base PLET (CH01-R-PLT-01) in Block 293, through 9.625-inch Free Standing Hybrid Riser vertical section (CH01-R-01) in Block 293, and through 13.44-inch Free Standing Hybrid Riser flexible jumper section (CH01-J-XJ-01) from Block 293 to Block 249, to the Floating Production Storage and Offloading facility (FPSO) in Block 249, all in the Walker Ridge Area. The application is under separate review.*

Sincerely,

Nick Wetzel
Regional Supervisor
Regional Field Operations

bcc: 1502-01 Segment No. 16128, 17459 ROW OCS-G28452 (MS 5232)
1502-01 ROW OCS-G28452(Scanning)(MS 5033)
MS 5260 Amy Wilson

AAlvarado:bshrestha:April 10, 2012:Petrobras-

MICRO Amend 2 16128

PETROBRAS

26 March 2010

Mr. Lars Herbst
Regional Director
U.S. Department of the Interior
Minerals Management Service
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Attn. Mr. Alex Alvarado - MS 5232
Mr. Manny Gagliano

RE: Supplement to Modification Application for 14-Inch x 9-Inch Pipe-in-Pipe Bulk Oil Right-of-Way Pipeline (*West*), Segments 17459 and 16128 respectively, Installed In and/or Through Blocks 249, 293, 337, 381, 425 and 469, Walker Ridge Area, OCS Federal Waters, Gulf of Mexico, Offshore, Louisiana

Gentlemen:

In accordance with the requirements of the regulations contained in Title 30 CFR, Part 250, Subpart J, Petrobras America Inc. (PAI) filed original application for the referenced 14-inch x 9-inch pipe-in-pipe bulk oil right-of-way pipeline on 19 September 2008. Subsequently, PAI provided a required modification application to same in November 2009. Pursuant to the most recent e-mail and telephone discussions concerning the referenced applications, PAI respectfully provides this letter in duplicate, for clarification and conformance commitment in support of our request for your review and approval of our modification application to establish service, purpose and MAOP of the referenced pipeline.

PAI company policy is to maintain transparency, consistency and complete compliance with all regulations and approvals, within the different sections of the MMS as well as outside regulatory bodies like the USCG and EPA.

From the latest round of discussions with the MMS pipeline section centering on differences carried in our original application and subsequent modification application, as relates to the stipulations set forth in the Deep Water Operations Plan (DWOP), approved by the MMS, TAOS section on 18 August 2009, PAI respectfully provides the following:

- PAI has accepted the terms and conditions mandated by the approved DWOP. PAI will first and foremost comply with those approvals and stipulations and understands that in accordance with those conditions, elements with respect to guidance and approvals of the Pipeline section will be authorized and approved by the Pipeline section.
- PAI recognizes that possibly, certain elements whether requested departures or specific information or requests in the original pipeline

application and /or subsequent modification application may differ to the conditions set forth in the approved DWOP. PAI confirms that PAI will conform and comply with the requirements and conditions set forth by the TAOS section in the DWOP ***and*** any subsequent approvals of the Pipeline section.

- In an effort to reconcile any inadvertent differences in the referenced application(s) versus the approved DWOP, PAI respectfully requests MMS to allow PAI to withdraw from consideration, those specific requests and / or apparent discrepancies in the pipeline application or modification application that may be contrary to conditions and stipulations set forth in the approved DWOP.
- As with all sections of the MMS, PAI understands and agrees to fully adhere and conform to approvals received from the Pipeline section.

Considering the amount of information that is contained in both the pipeline applications and the DWOP, PAI agrees, pursuant to our most recent discussions with your office that this is the most logical and concise solution to reconcile any differences, however inadvertent, and should provide the highest level of comfort and understanding to the MMS that, PAI is committed to full and complete compliance with the regulations, conditions, stipulations and expectations of the MMS.

We trust this commitment will satisfy your request and we look forward to receiving approval of our modification application.

Should you require additional information please contact me directly at 713.808.2881 or by e-mail to groland@petrobras-usa.com at your convenience.

Sincerely,
Petrobras America Inc.

Gregory D. Roland
Regulatory Compliance Area Manager

PETROBRAS

26 March 2010

Mr. Lars Herbst
Regional Director
U.S. Department of the Interior
Minerals Management Service
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

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Should you require additional information please contact me directly at 713.808.2881 or by e-mail to groland@petrobras-usa.com at your convenience.

Sincerely,
Petrobras America Inc.

Gregory D. Roland
Regulatory Compliance Area Manager

PETROBRAS

10 November 2009

Mr. Lars Herbst
Regional Director
U.S. Department of the Interior
Minerals Management Service
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Attn. Mr. Alex Alvarado – MS 5232

RE: Modification Application for 14-Inch x 9-Inch Pipe-in-Pipe Bulk Oil Right-of-Way Pipeline (*West*), Segments 17459 and 16128 respectively, Installed In and/or Through Blocks 249, 293, 337, 381, 425 and 469, Walker Ridge Area, OCS Federal Waters, Gulf of Mexico, Offshore, Louisiana

Gentlemen:

Pursuant to the authority granted in Section 5 (e) of the Outer Continental Shelf Lands Act (43 U.S.C. 1331 et seq, P.L. 212, 67 Stat. 462), as amended (P.L. 95-372, 92 Stat. 629), and in compliance with the regulations contained in Title 30 CFR, Part 250, Subpart J, Petrobras America Inc. (PAI) filed original application for the referenced 14-inch x 9-inch pipe-in-pipe bulk oil right-of-way pipeline on 19 September 2008 with supplemental data submitted on 14 November 2008, 7 January, 6 March and 24 March 2009. Subsequently, conditional approval was granted by your office by letter date 27 March 2009. In accordance with the conditions set forth in your letter, PAI herewith submits for your review and approval a modification to the original application to establish service, purpose and MAOP of the referenced pipeline.

The *West* 14-inch x 9-inch pipe-in-pipe bulk oil pipeline was installed from the Chinook drill center pipeline end termination (PLET) in WR 425 to the PLET at the riser base in WR 293, during operations commencing on Sunday, 26 April 2009, completed and subsequently hydrotested on 12 June 2009, in accordance with terms of the approval. Installation of the remaining flowline pieces including the riser, riser base, subsea pumps and jumpers along with the associated power umbilical (Segment No. 17722) should follow within the next few months and be completed by January 2010. Completion reports on the various installation pieces are pending.

With respect to the conditions of approval PAI is fully committed to complying with all requirements as listed. Specifically, item number three, contains a number of items and requires the submittal of this modification application therefore; PAI will address these issues independently and specifically with this application.

MMS Approval Letter date 27 March 2009, Item 3)

"A service, purpose and MAOP will not be assigned to the pipeline and the pipeline shall not be placed in service until MMS has sufficient time to review the Deep Water Operations Plan (DWOP) and your proposed production safety system (SSS)".

Supplementary Information: MMS Technical Assessment and Operations Support Section (TAOS) approved the DWOP by letter dated 18 August 2009. The original SSS was submitted to MMS District office on 17 February 2009. The application documentation was thoroughly discussed with the District in the following months and during the visit of District personnel to the BW Pioneer during June 2009. Some recommendations were made by the District following the review and visit, and incorporated in Rev B, submitted on 19 October 2009. It is our understanding that this new revision meets fully with the requirements and recommendations made by the District.

Service and Purpose: Service and purpose of the referenced pipeline is to transport full well stream product from PAI's proposed Subsea Well No. 002, Walker Ridge Block 469, Lease OCS-G 16997, in a northeasterly direction 64,785.34 feet (12.27 miles) to PAI's proposed Floating Production, Storage and Offloading Facility (FPSO), to be located on PAI's Lease OCS-G 16969, Walker Ridge Block 249. Future wells will be brought into the pipeline only from the Walker Ridge Block 425 (Chinook) Unit (Unit Agreement Number 754306012) consists of the following leases:

Lease	Area / Block
OCS-G 16987	Walker Ridge Block 425
OCS-G 16988	Walker Ridge Block 426
OCS-G 16997	Walker Ridge Block 469
OCS-G 16998	Walker Ridge Block 470

The subject pipeline is independent but will twin pipe-in-pipe segment numbers 17460 and 16129 which will be installed parallel to the proposed line to add the

ability to circulate diesel (discussed further in this application), for pigging operations and redundant flow capabilities.

MAOP: PAI has rigorously evaluated the design pressures for the various shut-in scenarios and fluid cases, and believes safe operation of the Chinook pipeline system will be more than adequate for the proposed 10,000 psi MAOP. This has been consistently presented to MMS.

The Chinook field is located in water depths in excess of 8000-feet resulting in a significant column of fluid in the pipeline riser during production operations. This head of fluid must be considered and factored into the determination of the MAOP at the boarding shut down valve (BSDV), resulting in a MAOP at the BSDV that is lower than the Maximum Source Pressure (wellhead shut-in tubing pressure). These considerations were presented in the original application through a comprehensive flow assurance study carried out to evaluate the build-up of pressure in the lines after shut-in of the (BSDV). While the study included the cases of a column of dry gas, diesel and of well fluids, the actual well fluid properties are such that little if any free gas will break out in the risers rendering the theoretical case of a column of dry gas not applicable for the Chinook pipeline and riser. The study findings are included in PAI's technical report **I-RL-7040.02-1500-610-PTL-001** presented in the original application.

Live oil in the lines is replaced by diesel before FPSO disconnection, for the preservation of the system and protection from hydrate formation during periods of inactivity. Diesel is the only other fluid to be introduced in the flowlines and risers once production is established.

PAI has been requested to address in more detail the issue of shut-in time versus pressure build-up as it relates to MAOP. PAI utilized the flow assurance study results, combined with reservoir depletion model results to investigate the development of the BSDV shut-in pressure over time. A dry gas column case and a diesel column case (as described above) were studied for Cascade and Chinook. The results are described in the following paragraphs.

In Figure 1 below the "flowing pressure" curve (in green) represents the maximum source pressure as wells are opened to flow. Superimposed on that flowing pressure curve are curves for three BSDV shut-in scenarios. These are: shut-in after 30 days of production, after 60 days of production and after 180 days of production. A case representing a dry gas column (dotted lines) and a diesel column case (solid lines) were investigated for each of these shut-in scenarios. As expected, all diesel column curves easily fall below the MAOP of

10,000 psi proposed by PAI shortly after initiating production. For the theoretical case of a full column of dry gas, after one month of production, it takes about 30 days for the boarding valve shut-in pressure to reach 10,000 psi. After six months of production it takes 60 days.

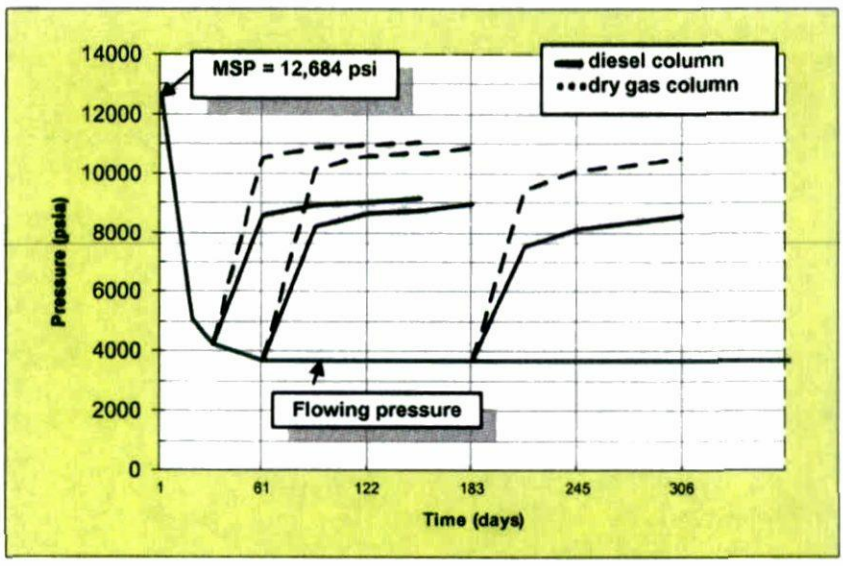

Figure 1: BSDV Pressure vs Time (Flowing and Shut-In)

These curves show that even in the theoretical case of dry gas the BSDV shut-in pressure will be below 10,000 psi for at least 30 days after shut-in. In addition this will require both of the following triggers to occur:

1. A large volume of dry gas to be entered into the production system (note that this gas cannot come from the well fluid because the well fluid bubble point is 1,200 psi)
2. Multiple failure of downhole and subsea tree isolation valves (failure of five valves in series)

Further mitigation can be provided in that PAI is willing to commit to advising MMS (district and region, pipeline section) if the BSDV is expected to be closed longer than 30 days. Typically, for storm avoidance purposes the BSDV would not be shut-in longer than 8 to 10 days.

An estimated calculation of the time it will take for the MSP to fall below the MAOP after startup has also been requested. The Maximum Source Pressure

(MSP) is defined as the wellhead shut-in tubing pressure (SITP) or 12,684 psi for Chinook. The MSP then, when open to flow, will decline as shown in Figure 1 after production commences. Based on calculations it is estimated that MSP (flowing) at seabed will drop below 10,000 psi in only a couple of days after a well is open. Additionally, it would take longer than 30 days, minimum in any case, to build up to or exceed the MAOP upon shut-in. It is expected that the scenario would be repeated each time a new well from Chinook is brought on line. PAI has requested a departure to address the initial operation with the MSP exceeding MAOP.

Departures

Departure requests were deferred, in item three of your approval letter "...until reviews of the DWOP and proposed production safety system are complete." In as much as the DWOP has been approved as referenced above and the near final version of the SSS is under review with the District Manager as required, PAI respectfully requests approval of the departures submitted in our original application of 19 September 2008 along with supplemental submittals 14 November 2008, 6 March and 24 March 09. Primarily, PAI has requested the following departures (not a complete listing):

- Departure from 30 CFR 250.1002(a) - to utilize Lame Equations to determine internal design pressure rather than certain formula contained in CFR and to allow the use of API RP 1111 in designing for the internal design pressure of flowlines, pipelines and risers
- Departure from 30 CFR 250.1002(b)(1) - to hydrotest the flexible jumper onshore to 15,000 psi for a minimum of twenty four hours and then leak test to 1.1 x MAOP (11,000 psi) for minimum of two hours after installation, and to allow hydrotesting of the pipe jumper kits onshore and leak testing after installation
- Departure from 30 CFR 250.1002(c)(1) - to determine the effective MAOP at the top of the riser with respect to the SITP at the seabed allowing pressure credit at the top of the riser based on the hydrostatic head of a full column of diesel in the riser and flowline, with a density of 51.8 lb/ft3 (specific gravity of 0.83 (water S.G. = 1.0)) at 60°F and 14.7 psia to yield an effective MAOP of 10,000 psi at the surface
- Departure from 30 CFR 250.1002(d) - for installing and maintaining redundant safety devices meeting the requirements of section A9 of API RP 14 C when the MSP exceeds the pipeline MAOP
- Departure from 30 CFR 250.1002(d)(2) - to allow operation of the system during a time that the maximum calculated pressure at the top of the riser

using the maximum SITP at the wellhead and a full column of dry gas is greater than the MAOP

- Departure from 30 CFR 250.1004(b)(9) - to omit safety devices (specifically a PSV and FSV) provided for subsea pipeline pumps and setting the PSHL's

For specific discussions provided for each of the departure requests please revert to the submittals and dates referenced above.

A Pay.Gov receipt in the amount of $3,865.00 in accordance with the service fee listed in 10 CFR 250.125(a)(22) is enclosed herewith. The project remains on schedule for production startup by May or June 2010.

We trust the enclosed information will satisfy the regulatory requirements in order for you to approve this modification application prior to first oil however; should you require additional information please contact our Regulatory Compliance Area Manager, Gregory D. Roland at 713.808.2881 or by e-mail to groland@petrobras-usa.com or you may contact me directly at 713.808.2883.

Sincerely,
Petrobras America Inc.

Cheryl Ann Saha
Attorney-In-Fact

SAS:gdr
Enclosures

Online Payment

Online Payment

Step 3: Confirm Payment 1 | 2 | 3

Thank you.
Your transaction has been successfully completed.

Pay.gov Tracking Information

Application Name: MMS Pipeline ROW Modification Application - BY/BZ/CM
Pay.gov Tracking ID: 24VVSCJC
Agency Tracking ID: 74088067693
Transaction Date and Time: 11/10/2009 15:50 EST

Payment Summary

Address Information

Account Holder Name: Petrobras America Inc.
Billing Address: 10777 Westheimer Road
Billing Address 2: Suite 1200
City: Houston
State / Province: TX
Zip / Postal Code: 77042
Country: USA

Account Information

Card Type: Master Card
Card Number: **********6098
Region: Gulf of Mexico
Contact: Jodi Knight 713-808-2884
Company Name/No: Petrobras America Inc., 01207
Pipeline Segment No.: 17459
Originating Area/Block: Walker Ridge WR, 469
Terminating Area/Block: Walker Ridge WR, 249

Payment Information

Payment Amount: $3,865.00
Transaction Date and Time: 11/10/2009 15:50 EST

MICRO

Amend 1

16128
17459

PETROBRAS

23 December 2009

Mr. Lars Herbst
Regional Director
U.S. Department of the Interior
Minerals Management Service
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Attn. Mr. Alex Alvarado - MS 5232
Mr. Manny Gagliano

RE: **Supplement to Modification Application for 14-Inch x 9-Inch Pipe-in-Pipe Bulk Oil Right-of-Way Pipeline (*West*), Segments 17459 and 16128 respectively, Installed In and/or Through Blocks 249, 293, 337, 381, 425 and 469, Walker Ridge Area, OCS Federal Waters, Gulf of Mexico, Offshore, Louisiana**

Gentlemen:

In accordance with e-mail request of 24 November 2009, PAI respectfully submits in duplicate, supplemental information for your review and approval of our modification to the original application to establish service, purpose and MAOP of the referenced pipeline.

Item number one of the 24 November 2009 e-mail

Item number one indicated your request for PAI to provide the settle out pressure and start times (days) for each of the six curves on Figure 1, Page 4 of 6. In response PAI respectfully offers the following:

The Boarding Shut-Down Valve (BSDV) shut-in pressure values were calculated using Well Bottom Hole Pressure (WBHP) values obtained in the reservoir flow simulations.

The flow simulation model was created in Eclipse-100 by integrating the geologic model with dynamic data such as fluid properties (PVT), rock physic properties (capillary pressures, relative perm abilities as to rock compressibility) and reservoir pressures (MDT survey data). This simulation model was used to investigate the WBHP build-up for a well shut-in after some production time. A total of 12 WBHP values were extracted from the results, representing the WBHP pressure at 30, 60, 90 and 120 days after shut-in of a well that had produced for 1, 2 and 6 months. These WBHP values were translated to the wellhead elevation (WHTSIP) by subtracting the weight of the fluid column inside the well

(6,316psi). The WBHP and WHTSIP values are shown in Tables 1, 2 and 3 below for the various shut-in times (days) after 1, 2 and 6 months production.

Table 1. SHUT-IN AFTER 1 MONTH PRODUCTION

DELTA (DAYS)	WBHP (PSIA)	WHTSIP (PSIA)	TIME AFTER SHUT-IN (DAYS)
29.980	10,541.65	4,225.65	0.000
59.959	18,252.43	11,936.43	29.979
90.938	18,588.12	12,272.12	60.958
120.917	18,718.88	12,402.88	90.938
151.896	18,793.45	12,477.45	121.917

Table 2. SHUT-IN AFTER 2 MONTHS PRODUCTION

DELTA (DAYS)	WBHP (PSIA)	WHTSIP (PSIA)	TIME AFTER SHUT-IN (DAYS)
60.958	10,000.00	3,684.00	0
90.938	17,872.33	11,556.33	29.980
120.917	18,308.15	11,992.15	59.959
151.896	18,509.11	12,193.11	90.938
181.875	18,612.72	12,296.72	120.917

Table 3. SHUT-IN AFTER 6 MONTHS OF PRODUCTION

DELTA (DAYS)	WBHP (PSIA)	WHTSIP (PSIA)	TIME AFTER SHUT-IN (DAYS)
182.875	10,000.00	3,684.00	0
212.355	17,165.45	10,849.45	29.480
243.833	17,791.13	11,475.13	60.958
271.814	18,042.20	11,726.2	88.939
302.793	18,219.90	11,903.9	119.918

The WHSITP values above were translated to the BSDV elevation by subtracting the weight of the diesel or gas column (3,342 psi or 1,403 psi, respectively). The following example illustrates this process:

What is the BSDV shut-in pressure for a well that has been in production for one month and is shut-in for 30 days?

From Table 1, the WHSITP 30 days after closing the well is 11,936.43 psi. The corresponding BSDV for the theoretical case of dry gas is 11,936 minus 1,403 =

10,533 psi. This value is noted in Table 4 below. A similar procedure was used to determine the other BSDV shut-in pressure values.

The resulting BSDV shut-in pressure values are given in Tables 4 and 5. These pressures were used to construct the curves shown in previous communication, and included again as Figure 1, following the tables below.

Table 4. DRY GAS CASE - BSDV shut-in pressure values

PRODUCTION TIME					
1 MONTH		2 MONTHS		6 MONTHS	
TIME AFTER SHUT-IN (days)	BSDV PRESSURE (psi)	TIME AFTER SHUT-IN (days)	BSDV PRESSURE (psi)	TIME AFTER SHUT-IN (days)	BSDV PRESSURE (psi)
0	2,822	0	2,281	0	2,281
30	10,533	30	10,153	30	9,446
60	10,869	60	10,589	60	10,072
90	10,999	90	10,790	90	10,323
120	11,074	120	10,893	120	10,500

Table 5. DIESEL CASE - BSDV shut-in pressure values

PRODUCTION TIME					
1 MONTH		2 MONTHS		6 MONTHS	
TIME AFTER SHUT-IN (days)	BSDV PRESSURE (psi)	TIME AFTER SHUT-IN (days)	BSDV PRESSURE (psi)	TIME AFTER SHUT-IN (days)	BSDV PRESSURE (psi)
0	883	0	342	0	342
30	8,594	30	8,214	30	7,507
60	8,930	60	8,650	60	8,133
90	9,060	90	8,851	90	8,384
120	9,135	120	8,954	120	8,561

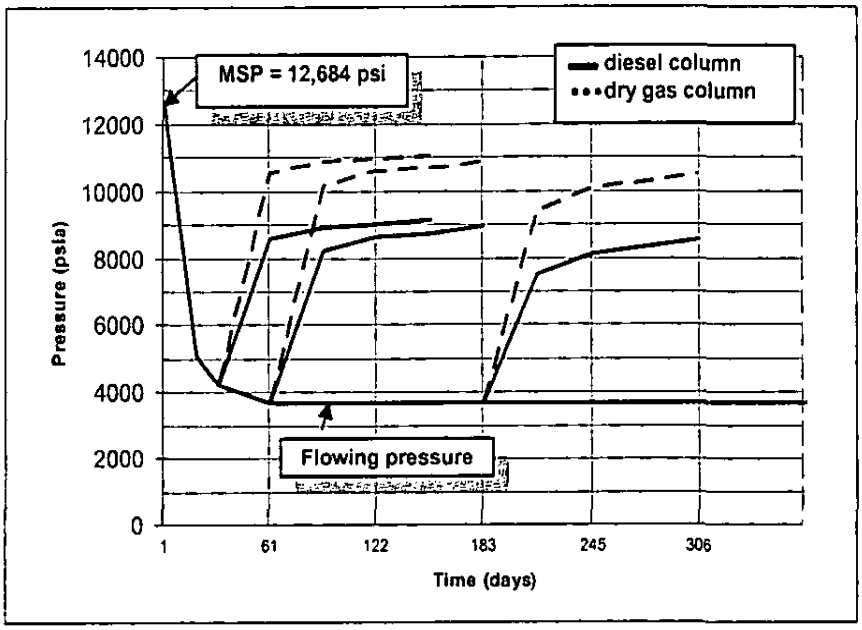

Figure 1: BSDV Pressure vs Time (Flowing and Shut-In)

Item number two of the 24 November 2009 e-mail

With respect to item two which called for PAI to "Submit a detailed description of the functionality of the final pump safety system including permissive signals, safety sensor quantity and type, safety sensor voting logic, system redundancy and spares" and "Include the final safety flow schematics for the pumps" the following enclosures provided in the DWOP are provided herewith:

- Cause and Effects Charts for the Subsea Boosting System – (PAI document no. I-ET-7040.02-1500-800-PTL-004 Rev. 0) *Highlighted* (Pages 1 thru 8 of 8);
- Subsea Pump Shut Down Philosophy - (PAI document no. I-ET-7040.02-1500-800-PTL-001 Rev. D) *Highlighted* (Pages 1 thru 32 of 32);
- ESD / PSD Subsea Shutdown Interface Block Diagram - (BWO drawing no. 4036-XL-00099416.001 Rev. 02)
- Piping and Instrumentation Diagram - Chinook Pump Station - (PAI drawing no. I-DE-7040.04-1243-944-TKU-001-F, Technip drawing no. 300948-EPS-DW-3726-0409)

We trust the enclosed information will satisfy your request and we look forward to receiving approval of our modification application.

Should you require additional information please contact me directly at 713.808.2881 or by e-mail to groland@petrobras-usa.com at your convenience.

Sincerely,
Petrobras America Inc.

Gregory D. Roland
Regulatory Compliance Area Manager

Enclosures

CASCADE · CHINOOK

CAUSE AND EFFECTS CHARTS
SUBSEA BOOSTING SYSTEM
Cascade & Chinook Development

PAI DOCUMENT NO.: I-ET-7040.02-1500-800-PTL-004

REV.	PREP. BY	REVISION DESCRIPTION	Prepared By Init/Date	Contractor		Company		CAUSE AND EFFECTS CHARTS SUBSEA BOOSTING SYSTEM
				Review Init/Date	Approval Init/Date	Review Init/Date	Approval Init/Date	
0	MN	ISSUED FOR INTERNAL REVIEW	MN 12/10/09	N/A	N/A	TC	KK	
								Cascade & Chinook Development
								Petrobras America, Inc.

PETROBRAS AMERICA INC.

CAUSE AND EFFECTS CHARTS - INDEX

OOSTING
PROJECT: Cascade & Chinook Development
DOCUMENT NO.: I-ET-7040.02-1500-800-PTL-004
CURRENT REV.: 0, DATE : 10-Dec-2009

CAUSE AND EFFECTS CHARTS - NOTES

Company: Petrobras America, Inc.
PROJECT: Cascade & Chinook Development
DOCUMENT NO.: I-ET-7040.02-1500-800-PTL-004
CURRENT REV.: 0, DATE : 10-Dec-2009

NOTES

1. PRODUCTION TREE, MANIFOLD AND SUBSEA PUMPING SYSTEMS INTERLOCKS GUARANTEE THE SAFE AND CORRECT OPERATION OF THE SUBSEA PRODUCTION SYSTEM. INTERLOCK WARNING POP-UP WINDOWS SHALL BE AVAILABLE ON THE MCS.

SYMBOLS

T1, T2, T3, and T11	:	CONFIGURABLE TIMERS (IN MINUTES) TO ELAPSE BEFORE RESPECTIVE ACTION (EFFECT) TAKES PLACE.
H	:	ELEMENT "HELD" IN ITS "AS IS" POSITION.
⊘	:	INTERLOCK CONDITION
•	:	ACTION REQUIRED.
□	:	TOPSIDES ACTION CONTROLLED BY PLATFORM SHUTDOWN SYSTEM OR INFORMATION SHOWN ON FPSO PCS.
X	:	ACTIVE SHUTDOWN INTERLOCKS.

ABBREVIATIONS

AAV	ANNULUS ACCESS VALVE
AMV	ANNULUS MASTER VALVE
ASD	ACOUSTIC SAND DETECTOR
AVV	ANNULUS VENT VALVE
AWV	ANNULUS WING VALVE
CIMV	TREE CHEMICAL INJECTION METERING VALVE
CIV	CHEMICAL INJECTION VALVE
CIU	CHEMICAL INJECTION UNIT (TOPSIDES)
CM	CORROSION MONITORING TRANSMITTER
CRT	CARTRIDGE
DHPT	DOWNHOLE PRESSURE TEMPERATURE TRANSMITTER
DV	DOWNHOLE VENTURI FLOWMETER
d/s	DOWN STREAM (OF..)
DSUO	DOWNHOLE SLEEVE UPPER OPEN
DSLO	DOWNHOLE SLEEVE LOWER OPEN
DSC	DOWNHOLE SLEEVE CLOSE
DSIV	DOWNHOLE SLEEVE ISOLATION VALVE
EMS	ESP MONITORING SYSTEM
EPPTT	EROSION, DUAL PRESSURE AND DUAL TEMPERATURE SENSOR
ESD	EMERGENCY SHUTDOWN
ESP	ELECTRICAL SUBMERSIBLE PUMP
MIU	METHANOL INJECTION UNIT (TOPSIDES)
MPFM	MULTI PHASE FLOW METER
F&G	FIRE AND GAS SYSTEM
FLIV	TREE FLOWLINE ISOLATION VALVE
HIV	PUMPING STATION FLOWLINE ISOLATION VALVE
HP	HIGH PRESSURE
HPU	HYDRAULIC POWER UNIT
LIM	LINE INSULATION MONITOR
LP	LOW PRESSURE
LS	LEVEL SWITCH
LVDT	CHOKE POSITION TRANSMITTER
LT	LEVEL TRANSMITTER
MCS	MASTER CONTROL STATION
MCC	FPSO MOTOR CONTROL CENTER
MPV	MANIFOLD FLOWLINE PIGGING VALVE
PCV	PRODUCTION/PUMP CHOKE VALVE
PCS	FPSO PROCESS CONTROL SYSTEM
PIV#-X	MANIFOLD BRANCH ISOLATION VALVE SLOT # HEADER X
PMV (USV 1)	PRODUCTION MASTER VALVE
PPIV	PUMPING STATION CARTRIDGE ISOLATION VALVE
PPV	PUMPING STATION FLOWLINE PIGGING VALVE
PSD	PROCESS SHUTDOWN
PSHL	BOARDING FLOW LINE PRESSURE SWITCH (HIGH-HIGH/LOW-LOW)
P	PRESSURE TRANSMITTER
PP	DUAL PRESSURE TRANSMITTER
PPTT	DUAL PRESSURE TEMPERATURE TRANSMITTER
PXOV	PUMPING STATION FLOWLINE CROSSOVER VALVE
PWV (USV 2)	PRODUCTION WING VALVE
SCM	SUBSEA CONTROL MODULE
SCSSV	SURFACE CONTROLLED SUBSURFACE SAFETY VALVE

ABBREVIATIONS

SDV	FPSO BOARDING VALVE
SM	ESP MOTOR
SPCU	SUBSEA POWER AND COMMUNICATIONS UNIT
T	TEMPERATURE TRANSMITTER
u/s	UP STREAM (OF..)
T	TEMPERATURE TRANSMITTER
UPS	UNINTERRUPTIBLE POWER SUPPLY
XOV	CROSSOVER VALVE
Vb	VIBRATION TRANSMITTER

TIMERS

T1	1 MIN
T2	2 MIN
T3	5 MIN
T4	10 MIN
T5	20 MIN
T6	60 MIN (RESETABLE)
T7	60 MIN
T8	85 MIN
T9	120 MIN
T10	180 MIN
T11	1440 MIN

ESD DEFINITIONS

ESD0 (AVS)	:	ABANDON VESSEL SHUTDOWN. HIGHEST LEVEL ESD.
ESD 2.3	:	FIRE IN FPSO HAZARDOUS AREAS AND PUSHBUTTONS IN SELECTED AREAS.
ESD 2	:	HIGH LEVEL LP/HP FLARE DRUM, HIGH LEVEL TURRET SWIVEL LEAK, GAS IN FPSO HAZARDOUS AREA, GAS IN COOLING MEDIUM SYSTEM.
PSD	:	FPSO PROCESS SHUTDOWN.
REMOTE WORKOVER ESD	:	REMOTE SHUTDOWN SIGNAL FROM WORKOVER RIG VIA RADIO LINK IN THE EVENT OF A WORKOVER SHUTDOWN CONDITION.
FLOWLINE PSHL:	:	PRODUCTION FLOWLINES PRESSURE HIGH-HIGH OR LOW-LOW SHUTDOWN.
SUBSEA ESD (SESD)	:	HIGH-HIGH OR LOW-LOW MANIFOLD, PRODUCTION FLOWLINES, AND BOOSTING STATION PRESSURE.
BOOSTING MOTOR (MTESD)	:	HIGH-HIGH BOOSTING SYSTEM MOTOR VIBRATION OR TEMPERATURE.
BOOSTING COMMS (BSESD)	:	BOOSTING SYSTEM SCM LOSS OF COMMS TO BOTH CHANNELS.

PETROBRAS AMERICA, INC.
CASCADE & CHINOOK DEVELOPMENT
CAUSE AND EFFECT CHART
SUBSEA BOOSTING SYSTEM
DOCUMENT NO. : I-ET-7040.02-1500-800-PTL-004

REV.	CURRENT REVISION	DATE	10-Dec-2009
0			

CAUSE (INPUT)

EFFECT (OUTPUT)

EQUIP	DESCRIPTION	TAG #	Notes	ESD LEVEL	NOTES No.	SSIV	MANIFOLD (CAE1/CH01-G-AY-01)	PRODUCTION TREE # (CAE1/CH01-O-AY-XX)	PUMPING SYSTEM # (CAW1/CH01-P-AY-01)	MISCELLANEOUS / TOPSIDE
						SSIV	CIV1 CLOSE; CIV2 CLOSE; CIV3 CLOSE; CIV4 CLOSE; MPV1 OPEN; PIV1_A CLOSE; PIV1_B CLOSE; PIV2_A CLOSE; PIV2_B CLOSE; PIV3_A CLOSE; PIV3_B CLOSE; PIV4_A CLOSE; PIV4_B CLOSE	SCSSV CLOSE; AAV CLOSE; AMV CLOSE; AVV CLOSE; AWV CLOSE; CIV1 CLOSE; CIV2 CLOSE; CIV3 CLOSE; CIV4 CLOSE; CIV5 CLOSE; CIV6 CLOSE; DSUO CLOSE; DSLO CLOSE; DSC CLOSE; DSIV CLOSE; FLIV CLOSE; PCV CLOSE; PMV CLOSE; PWV CLOSE; XOV CLOSE	PPIV1 CLOSE; PPIV3 CLOSE; PPV1 OPEN; CIV1 CLOSE; CIV3 CLOSE; CIV-5 CLOSE; CIV-7 CLOSE; CIV-9 OPEN; PCV1 CLOSE; PPIV2 CLOSE; PPIV4 OPEN; PPV2 CLOSE; CIV2 CLOSE; CIV4 CLOSE; CIV-6 CLOSE; CIV-8 CLOSE; CIV-10 CLOSE; PCV2 OPEN; PXOV2 CLOSE; CRT1(ESPs) STOP; CRT1(ESPs) STOP	HPU VENT; HPU VENT; HPU STOP; HPU STOP; HPU STOP; HPU START; HPU START; MIU STOP; CIU STOP; MCS ALARM; MCS ACK; MCS DPLY; MCS TIMER; EMS ALARM; EMS ACK; EMS DPLY; EMS TIMER; EMS; VFD; PCS ROL; PCS ALARM; PCS DPLY; SYSTORIAN; SPCU; HARDWIRED INPUT FROM FPSO PSD/ESD; HARDWIRED OUTPUT TO FPSO PSD/ESD; SDV VALVE
						SSIV	CIV1; CIV2; CIV3; CIV4; MPV1; PIV1_A; PIV1_B; PIV2_A; PIV2_B; PIV3_A; PIV3_B; PIV4_A; PIV4_B	SCSSV; AAV; AMV; AVV; AWV; CIV1; CIV2; CIV3; CIV4; CIV5; CIV6; DSUO; DSLO; DSC; DSIV; FLIV; PCV; PMV; PWV; XOV	PPIV1; PPIV3; PPV1; CIV1; CIV3; CIV-5; CIV-7; CIV-9; PCV1; PPIV2; PPIV4; PPV2; CIV2; CIV4; CIV-6; CIV-8; CIV-10; PCV2; PXOV2; CRT1(ESPs); CRT1(ESPs)	LP ESD; HP ESD; R/F PUMP; LP PUMPS; HP PUMPS; LP PUMPS; HP PUMPS; PUMPS; PUMPS; TO PCS; TO PCS; FROM MCC; MCS; OP CHANNEL; HARDWIRED INPUT FROM FPSO PSD/ESD; HARDWIRED OUTPUT TO FPSO PSD/ESD; SDV VALVE
FPSO										
ESD/F&G/PCS	1. FPSO ESD0 (AVS)	ESDO0	1, 2, 5, 6, 7, 11							
	Topsides		12, 16, 17, 18							T1
	Subsea		11, 14			●	● ● ● ● ● ● ● ● ● ● ● ● ● ●	● ● ● ● ● ● ● ● ● ● ● H H H ● ● ● ● ● ●	● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ●	
	2. FPSO *ESD 2.3*	ESD 2.3	2, 7, 11, 16, 19							
	Topsides									T7 T8 T1
	Subsea		12, 14			●	● ● ● ● ● ● ● ● ● ● ● ● ● ●	● ● ● ● ● ● ● ● ● ● ● H H H ● ● ● ● ● ●	● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ●	
	3. FPSO ESD 2	ESD 2	2, 7, 11, 16, 20							
	Topsides									T1
	Subsea		12, 14			●	● ● ● ● ● ● ● ● ● ● ● ● ● ●	● ● ● ● ● ● ● ● ● ● ● H H H ● ● ● ● ● ●	● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ●	
	4. FPSO PSD (Flowline Process Shutdown)	PSD 4.211, 4.212	2, 3, 14, 16, 21							
	Topsides	4.221, 4.222								
	Subsea		13, 14				● ● ● ●	● ● ● ● ● ● ● ● ● ● ● H H H H ● ● ● ● ● ●	● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ●	
	5. Flowline PSHL	PSHL CA1, CA2,	2, 7, 16, 23							
	Topsides	CH1, CH2								T11
	Subsea		13, 14				● ● ● ● ● ● ● ● ● ● ● ●	● ● ● ● ● ● ● ● ● ● ● H H H H ● ● ● ● ● ●	● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ●	T5
Pump System										
CAW1-P-AY-01	Pump Press u/s cartridge 1	PT1/PP1/PPTT1								
CH01-P-AY-01	Pump Press u/s cartridge 1 Hi/Lo	PT1/PT1/PP1/PPTT1 H/L								
	Pump Press u/s cartridge 1 Hi-Hi	PT1/PP1/PPTT1 HH	10,13,14,24,25,30				● ● ● ● ● ● ● ● ● ● ●	● ● ● ● ● ● ● ● ● ● ● H H H ● ● ● ● ● ●	● ● ● ● ● ● ● ●	
	Pump Press u/s cartridge 1 Lo-Lo	PT1/PP1/PPTT1 LL	10,13,14,24,25,30, 45				● ● ● ● ● ● ● ● ● ● ●	● ● ● ● ● ● ● ● ● ● ● H H H ● ● ● ● ● ●	● ● ● ● ● ● ● ●	
	Pump Temp u/s cartridge 1	PT1/PPTT1								
	Pump Temp u/s Cartridge 1 Hi/Lo	PT1/PPTT1 H/L								
	Pump Temp u/s cartridge 1 Hi-Hi	PT1/PPTT1 HH	10,13,14,24,25,30						● ● ● ● ● ● ● ●	
	Pump Press d/s cartridge 1	PT3/PP3/PPTT3								
	Pump Press d/s cartridge 1 Hi/Lo	PT3/PP3/PPTT3 H/L								
	Pump Press d/s cartridge 1 Hi-Hi	PT3/PP3/PPTT3 HH	10,13,14,24,25,30				● ● ● ● ● ● ● ● ● ● ●	● ● ● ● ● ● ● ● ● ● ● H H H ● ● ● ● ● ●	● ● ● ● ● ● ● ●	
	Pump Press d/s cartridge 1 Lo-Lo	PT3/PP3/PPTT3 LL	10,13,14,24,25,30, 45				● ● ● ● ● ● ● ● ● ● ●	● ● ● ● ● ● ● ● ● ● ● H H H ● ● ● ● ● ●	● ● ● ● ● ● ● ●	
	Pump Temp d/s cartridge 1	PT3/PPTT3								
	Pump Temp d/s cartridge 1 Hi/Lo	PT3/PPTT3 H/L								
	Pump Temp d/s cartridge 1 Hi-Hi	PT3/PPTT3 HH	10,13,14,24,25,30						● ● ● ● ● ● ● ●	
	Pump Differential Press cartridge 1	PPTT3 - PPTT1								
	Pump Differential Press cartridge 1 Hi/Lo	PPTT3 - PPTT1 H/L								
	Pump Differential Press cartridge 1 Hi-Hi	PPTT3 - PPTT1 HH	10,13,14,24,25,30				● ● ● ● ● ● ● ● ● ● ●	● ● ● ● ● ● ● ● ● ● ● H H H ● ● ● ● ● ●	● ● ● ● ● ● ● ●	
	Pump Differential Press cartridge 1 Lo-Lo	PPTT3 - PPTT1 LL	10,13,14,24,25,30, 45				● ● ● ● ● ● ● ● ● ● ●	● ● ● ● ● ● ● ● ● ● ● H H H ● ● ● ● ● ●	● ● ● ● ● ● ● ●	
	ESP 1 Motor Temperature (CRT1)	MTTESP1								
	ESP 1 Motor Temperature (CRT 1) Hi-Hi	MTTESP1HH/LL	10, 13, 14, 25						● ● ● ● ● ● ● ●	
	ESP 1 Vibration (CRT 1)	VBESP1								
	ESP 1 Vibration (CRT 1) Hi-Hi	VBESP1HH/LL	10, 13, 14, 25, 34						● ● ● ● ● ● ● ●	
	Pump Press cartridge 1 (u/s ESP 2)	PT2								
	Pump Press cartridge 1 (u/s ESP 2) Hi/Lo	PT2 H/L								
	Pump Press cartridge 1 (u/s ESP 2) Hi-Hi	PT2 HH	10,13,14,24,25,30				● ● ● ● ● ● ● ● ● ● ●	● ● ● ● ● ● ● ● ● ● ● H H H ● ● ● ● ● ●	● ● ● ● ● ● ● ●	
	Pump Press cartridge 1 (u/s ESP 2) Lo-Lo	PT2 LL	10,13,14,24,25,30, 45				● ● ● ● ● ● ● ● ● ● ●	● ● ● ● ● ● ● ● ● ● ● H H H ● ● ● ● ● ●	● ● ● ● ● ● ● ●	
	Pump Temp cartridge 1 (u/s ESP 2)	PT2								
	Pump Temp cartridge 1 (u/s ESP 2) Hi/Lo	PT2 H/L								
	Pump Temp cartridge 1 (u/s ESP 2) Hi-Hi	PT2 HH	10, 13, 14, 25, 34						● ● ● ● ● ● ● ●	
	ESP 2 Motor Temperature (CRT 1)	TTESP2								
	ESP 2 Motor Temperature (CRT 1) Hi-Hi	TTESP2HH/LL	10, 13, 14, 25, 34						● ● ● ● ● ● ● ●	
	ESP 2 Vibration (CRT 1)	VBESP2								
	ESP 2 Vibration (CRT 1) Hi-Hi	VBESP2HH/LL	10, 13, 14, 25, 34						● ● ● ● ● ● ● ●	
	Pump cartridge 1 recycle loop choke position	LVDT1								
	Total Flow Cartridge 1	FMAN1								
	Total Flow Cartridge 1 Lo-Lo	FMAN1LL	10, 13, 14, 25, 34, 45						● ● ● ● ● ● ● ●	
	Pump Press u/s cartridge 2	PT2/PP2/PPTT2								
	Pump Press u/s cartridge 2 Hi/Lo	PT2/PP2/PPTT2 H/L								
	Pump Press u/s cartridge 2 Hi-Hi	PT2/PP2/PPTT2 HH	10,13,14,24,25,30				● ● ● ● ● ● ● ● ● ● ●	● ● ● ● ● ● ● ● ● ● ● H H H ● ● ● ● ● ●	● ● ● ● ● ● ● ●	
	Pump Press u/s cartridge 2 Lo-Lo	PT2/PP2/PPTT2 LL	10,13,14,24,25,30, 45				● ● ● ● ● ● ● ● ● ● ●	● ● ● ● ● ● ● ● ● ● ● H H H ● ● ● ● ● ●	● ● ● ● ● ● ● ●	
	Pump Temp u/s cartridge 2	PT2/PPTT2								
	Pump Temp u/s cartridge 1 Hi/Lo	PT2/PPTT2 H/L								
	Pump Temp u/s cartridge 2 Hi-Hi	PT2/PPTT2 HH	10,13,14,24,25,30						● ● ● ● ● ● ● ●	
	Pump Press d/s cartridge 2	PT6/PP4/PPTT4								
	Pump Press d/s cartridge 2 Hi/Lo	PT6/PP4/PPTT4 H/L								
	Pump Press d/s cartridge 2 Hi-Hi	PT6/PP4/PPTT4 HH	10,13,14,24,25,30				● ● ● ● ● ● ● ● ● ● ●	● ● ● ● ● ● ● ● ● ● ● H H H ● ● ● ● ● ●	● ● ● ● ● ● ● ●	
	Pump Press d/s cartridge 2 Lo-Lo	PT6/PP4/PPTT4 LL	10,13,14,24,25,30, 45				● ● ● ● ● ● ● ● ● ● ●	● ● ● ● ● ● ● ● ● ● ● H H H ● ● ● ● ● ●	● ● ● ● ● ● ● ●	
	Pump Temp u/s cartridge 2	PT6/PPTT4								
	Pump Temp d/s cartridge 2 Hi/Lo	PT6/PPTT4 H/L								
	Pump Temp d/s cartridge 2 Hi-Hi	PT6/PPTT4 HH	10, 13, 14, 25, 34						● ● ● ● ● ● ● ●	
	Pump Differential Press cartridge 2	PPTT4 - PPTT2								
	Pump Differential Press cartridge 2 Hi/Lo	PPTT4 - PPTT2 H/L								
	Pump Differential Press cartridge 2 Hi-Hi	PPTT4 - PPTT2 HH	10,13,14,24,25,30				● ● ● ● ● ● ● ● ● ● ●	● ● ● ● ● ● ● ● ● ● ● H H H ● ● ● ● ● ●	● ● ● ● ● ● ● ●	
	Pump Differential Press cartridge 2 Lo-Lo	PPTT4 - PPTT2 LL	10,13,14,24,25,30, 45				● ● ● ● ● ● ● ● ● ● ●	● ● ● ● ● ● ● ● ● ● ● H H H ● ● ● ● ● ●	● ● ● ● ● ● ● ●	
	ESP 1 Motor Temperature (CRT 2)	MTTESP1								
	ESP 1 Motor Temperature (CRT 2) Hi-Hi	MTTESP1HH/LL	10, 13, 14, 25, 34						● ● ● ● ● ● ● ●	

Notes Description

1. Numbers shown in the matrix represent delayed activation in minutes to be performed by the FPSO topsides systems.
2. The MCS shall perform the subsea valve operation logic in response to hardwired inputs from the FPSO ESS. The AVS, ESD2.3, ESD 2, Flowline Shutdown (PSD), and PSHL shall be "voltage free" hardwired signals from the FPSO to both the MCS and EMS. The EMS shall stop the subsea pumps in response to hardwired inputs from the FPSO ESD/PSD. Acknowledge signals shall be sent back to the ESS via the Modbus communications link between the PCS and the MCS and EMS.
3. Only the wells contributing to the affected flowline shall be closed in the event of a process shutdown. The MCS shall receive signals from the FPSO PSD indicating the affected flowlines. The MCS shall close the well aligned to the affected flowlines only. The EMS shall stop the subsea pumps associated to the affected flowline only.
4. The purpose of the Remote Workover ESD System is to provide the workover operations vessel, the capability to shutdown any adjacent wells. In the event of an emergency, the workover vessel sends a shutdown command to the FPSO via a radio link. The FPSO rig ESD transmits the signal to the MCS, which closes the nearby producing wells and the EMS stops the subsea boosting pumps associated to the affected cluster. A hardwired signal shall be sent from the MCS to the FPSO ESD, indicating the affected cluster/flowlines. The FPSO ESD shall close the associated boarding valve.
5. For an AVS, closing the subsea wells shall be performed by commanded closure of the wells, manifolds, and boosting station valves by the MCS, and stop of the subsea boosting pumps by the EMS. Venting of the LP and HP hydraulic lines by the FPSO ESD shall be performed only after the timers has elapsed .
6. There shall be a resettable timer delay for closing the SCSSV after closing the PMV. This timer may be configurable by the operator. See closing sequences in sheet 4.
7. There shall be a delay between venting the LP and HP umbilical hydraulic lines to ensure that the tree valves will close before the SCSSV. This is vital to guarantee that no pressure differential is built across the SCSSV after closure, thus facilitating opening of the downhole valve.
8. Valve status on the MCS and EMS HMI screens can be OPEN, CLOSED or FAULT. Alarm on FAULT condition only.
9. Individual point alarms shall not be sent to the PCS. The PCS shall receive a common subsea alarms from the MCS and EMS and the operator shall verify the MCS and EMS for alarms detail.
10. Common subsea shutdown signals shall be sent from the MCS to the FPSO PSD in the event of subsea triggered shutdowns. The FPSO PSD shall close the boarding valves of the affected flowlines. A hardwired signal shall be sent from the MCS to the FPSO PSD, indicating the affected flowlines. The FPSO PSD shall close the associated FPSO boarding valves.
11. During AVS, ESD 2.3 and ESD2, priority shall be given to production well valve closure, stopping boosting pumps, and activation of timers prior to beginning shut-in of the manifold and pumping system valves.
12. ESD action applies to ALL subsea wells (Refer to valve sequence notes page 4).
13. ESD action applies to AFFECTED subsea wells only (Refer to valve sequence notes page 4).
14. Refer to notes page 4 for valves closing sequence.
15. A sudden decrease in output power or current to the pumps may be cause by gas slugs flowing through the pump or pump

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CAUSE (INPUT)

EQUIP	DESCRIPTION	TAG #	Notes
	ESP 1 Vibration (CRT 2)	VBESP1	
	ESP 1 Vibration (CRT 2) Hi-Hi	VBESP1HH/LL	10, 13, 14, 25, 34
	Pump Press CRT 2 (u/s ESP 2)	PT5	
	Pump Press CRT 2 (u/s ESP 2) Hi/Lo	PT5 H/L	
	Pump Press CRT 2 (u/s ESP 2) Hi-Hi	PT5 HH	10,13,14,24,25,30
	Pump Press CRT 2 (u/s ESP 2) Lo-Lo	PT5 LL	10,13,14,24,25,30, 45
	Pump Temp CRT 2 (u/s ESP 2)	PT5	
	Pump Temp CRT 2 (u/s ESP 2) Hi/Lo	PT5 H/L	
	Pump Temp CRT 2 (u/s ESP 2) Hi-Hi	PT5 HH	10, 13, 14, 25, 34
	ESP 2 Motor Temperature (CRT 2)	TTESP2	
	ESP 2 Motor Temperature (CRT 2) Hi-Hi	TTESP2HH/LL	10, 13, 14, 25, 34
	ESP 2 Vibration (CRT 2)	VBESP2	
	ESP 2 Vibration (CRT 2) Hi-Hi	VBESP2HH/LL	10, 13, 14, 25, 34
	Pump cartridge 2 recycle loop choke position	LVDT2	
	Total Flow Cartridge 2	FMAN1	
	Total Flow Cartridge 2 Lo-Lo	FMAN1LL	10, 13, 14, 25, 34, 45
	Pumping System valve status	Various Ptint	8
	Valve operation alarm		
	Common Pumping System alarm		9
	Common Pumping Cartridge alarm		9
	Pump Cartridge 1 Permissive		
	Pump Cartridge 2 Permissive		
SCM Pump			
	SCM Loss of Electrical Power		1,10,13,14,35,37
	SCM Loss of Comms	Watchdog	1,10,13,14,35,37
	SCM LP Supply	PTx	
	SCM LP Supply Press Lo	PTx	
	SCM LP Supply Press Lo-Lo	PTx	
	SCM HP Supply	PTx	
	SCM HP Supply Press Lo	PTx	
	SCM HP Supply Press Lo-Lo	PTx	
	SCM housekeeping data		
	SCM housekeeping alarms	Ptint	
	SCM Function Pressures	Ptint	
	Common SCM alarm		9

EFFECT (OUTPUT)

SSIV / MANIFOLD (CAE1/CH01-G-AY-01)

DESCRIPTION	SSIV	CIV1	CIV2	CIV3	CIV4	MPV1	PIV1 - A	PIV1 - B	PIV2 - A	PIV2 - B	PIV3 - A	PIV3 - B	PIV4 - A	PIV4 - B
ACTION	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	OPEN	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE
Pump Press CRT 2 (u/s ESP 2) Hi-Hi		●	●	●	●		●	●	●	●	●	●	●	●
Pump Press CRT 2 (u/s ESP 2) Lo-Lo		●	●	●	●		●	●	●	●	●	●	●	●

PRODUCTION TREE # (CAE1/CH01-G-AY-XX)

DESCRIPTION	SCSSV	AAV	AMV	AVV	AWV	CIV1	CIV2	CIV3	CIV4	CVI5	CIV6	DSUO	DSLO	DSC	DSIV	FLIV	PCV	PMV	PWV	XOV
ACTION	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE
Pump Press CRT 2 (u/s ESP 2) Hi-Hi	●	●	●	●	●	●	●	●	●	●	●	H	H	H	●	●	●	●	●	●
Pump Press CRT 2 (u/s ESP 2) Lo-Lo	●	●	●	●	●	●	●	●	●	●	●	H	H	H	●	●	●	●	●	●

PUMPING SYSTEM # (CAW1/CH01-P-AY-01)

DESCRIPTION	PPIV-1	PPIV-3	PPV1	CIV1	CIV3	CIV-5	CIV-7	CIV-9	PCV1	PPIV-2	PPIV-4	PPV2	CIV2	CIV4	CIV-6	CIV-8	CIV-10	PCV2	PXOV1	PXOV2	CRT1(ESPs)	CRT2(ESPS)
ACTION	CLOSE	CLOSE	OPEN	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	OPEN	CLOSE	CLOSE	OPEN	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	OPEN	CLOSE	CLOSE	STOP	STOP
ESP 1 Vibration (CRT 2) Hi-Hi										●	●	●	●	●	●	●	●	●				●
Pump Press CRT 2 (u/s ESP 2) Hi-Hi										●	●	●	●	●	●	●	●	●				●
Pump Press CRT 2 (u/s ESP 2) Lo-Lo										●	●	●	●	●	●	●	●	●				●
Pump Temp CRT 2 (u/s ESP 2) Hi-Hi										●	●	●	●	●	●	●	●	●				●
ESP 2 Motor Temperature (CRT 2) Hi-Hi										●	●	●	●	●	●	●	●	●				●
ESP 2 Vibration (CRT 2) Hi-Hi										●	●	●	●	●	●	●	●	●				●
Total Flow Cartridge 2 Lo-Lo										●	●	●	●	●	●	●	●	●				●
SCM Loss of Comms																					●	●

MISCELLANEOUS / TOPSIDE

DESCRIPTION	HPU	HPU	HPU	HPU	HPU	HPU	HPU	MIU	CIU	MCS	MCS	MCS	MCS	EMS	EMS	EMS	EMS	VFD	PCS	PCS	HYSTORIAN	SPCU			
ACTION	VENT	VENT	STOP	STOP	STOP	START	START	STOP	STOP	ALARM	ACK	D/PLY	TIMER	ALARM	ACK	D/PLY	TIMER	SOL	ALARM	D/PLY	STORE	S/DOWN			CLOSE
TAG NO	LP ESD	HP ESD	R/F PUMP	LP PUMPS	HP PUMPS	LP PUMPS	HP PUMPS	PUMPS	PUMPS		TO PCS				TO PCS			FROM MCC			MCS	O/P CHANNEL	HARDWIRED INPUT FROM FPSO PSD/ESD	HARDWIRED OUTPUT TO FPSO PSD/ESD	SDV VALVE
ESP 1 Vibration (CRT 2)												●				●					●				
ESP 1 Vibration (CRT 2) Hi-Hi													●	●			●								
Pump Press CRT 2 (u/s ESP 2)												●				●					●				
Pump Press CRT 2 (u/s ESP 2) Hi/Lo														●											
Pump Press CRT 2 (u/s ESP 2) Hi-Hi													●	●			●								□
Pump Press CRT 2 (u/s ESP 2) Lo-Lo													●	●			●								□
Pump Temp CRT 2 (u/s ESP 2)												●				●					●				
Pump Temp CRT 2 (u/s ESP 2) Hi/Lo														●											
Pump Temp CRT 2 (u/s ESP 2) Hi-Hi													●	●			●								
ESP 2 Motor Temperature (CRT 2)													●			●					●				
ESP 2 Motor Temperature (CRT 2) Hi-Hi													●	●			●								
ESP 2 Vibration (CRT 2)												●				●					●				
ESP 2 Vibration (CRT 2) Hi-Hi													●	●			●								
Pump cartridge 2 recycle loop choke position												●				●									
Total Flow Cartridge 2												●				●					●				
Total Flow Cartridge 2 Lo-Lo													●	●			●								
Pumping System valve status												●				●									
Valve operation alarm										●															
Common Pumping System alarm														●					□						
Common Pumping Cartridge alarm										●									□						
Pump Cartridge 1 Permissive												●				●									
Pump Cartridge 2 Permissive												●				●									
SCM Loss of Electrical Power										●									□						
SCM Loss of Comms										●									□					●	
SCM LP Supply												●									●				
SCM LP Supply Press Lo										●															
SCM LP Supply Press Lo-Lo										●															
SCM HP Supply												●									●				
SCM HP Supply Press Lo										●															
SCM HP Supply Press Lo-Lo										●															
SCM housekeeping data											●										●				
SCM housekeeping alarms										●															
SCM Function Pressures												●													
Common SCM alarm										●									□						

Notes Description

(discharge valve closed).

16. There shall be a "watchdog" signal between the FPSO system and both the MCS and EMS. The "watchdog" signal shall be sent via the PCS Modbus link.

17. The FPSO systems shall isolate power to the VFDs closing the MCC beakers after a 60 sec delay to allow time for the EMS to perform the safe stop of the subsea boosting pumps.

18. There shall be one (1) hardwired AVS shutdown signal from the FPSO ESD to both the EMS and MCS.

19. There shall be one (1) hardwired ESD2.3 shutdown signal from the FPSO ESD to both the EMS and MCS.

20. There shall be one (1) hardwired ESD2 shutdown signal from the FPSO ESD to both the EMS and MCS.

21. There shall be four (4) hardwired PSD shutdown signals from the FPSO PSD to both the EMS and MCS. Cascade flowline 1 and 2, and Chinook flowline 1 and 2.

22. There shall be two (2) hardwired Rig ESD shutdown signals from the MCS to the FPSO ESD . Cascade and Chinook clusters. The FPSO ESD shall close the respective FPSO boarding valves.

23. There shall be four (4) hardwired PSHL shutdown signals from the FPSO ESD to both the EMS and MCS. Cascade flowline 1 and 2, and Chinook flowline 1 and 2.

24. There shall be four (4) hardwired SESD shutdown signals from the MCS to the FPSO PSD . Cascade flowline 1 and 2, and Chinook flowline 1 and 2. The FPSO PSD shall close the respective FPSO boarding valves.

25. Subsea triggered shutdowns related to the subsea pumping system, i.e motor vibration, motor temperature, pump base and cartridge pressure HH shall be handled by the EMS. The EMS shall stop the affected pump cartridge and send a signal to the MCS, which in turn shall close the related tree, pumping station and manifold valves.

26. There shall be permissive signals for each subsea pumping system cartridge form the MCS to the EMS, to allow the pumps to be started up or run only when the correct valves are aligned on the subsea pumping station and production system.

27. VFD hall temperature High-High shall cause the subsea pumping system to stop. In the event of temperature High-High is detected by the VFD panel, the power to the VFD will be cut via the "VFD healthy" signal to the MCC (via ESD system).

28. ESD/PSD hardwired signals shall be sent directly to each VFD panel for the FPSO ESD/PSD systems.

29. VFD hall ventilation intake gas detection shall cause the pumping system to stop and power to be cut to the VFD from the FPSO MCC as a consequence of an ESD1 (isolation of all normal power to the VFD hall).

Fire/smoke detection in the VFD hall will alarm remotely, and cause the subsea pumps to stop. VFD hall CO2 deluge system will be operated manually and locally at hall location. Electrical isolation in case of fire initiates ESD2 and electrically isolates power to the VFD hall.

30. Subsea ESD (SESD) sequence from page 4 (Valve Closure Sequence).

31. Individual Well Shutdown (IWDS) sequence from page 4 (Valve Closure Sequence).

32. Tree Choke reverse differential pressure (CKRDP) sequence from page 4 (Valve Closure Sequence).

33. Tree annulus shutdown (ANSD) sequence from page 4 (Valve Closure Sequence).

34. Boosting system motor ESD (MTESD) sequence from page 4

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EFFECT (OUTPUT)

Group	Description	Tag No	Action
SSIV		SSIV	CLOSE
MANIFOLD (CAE1/CH01-G-AY-01)		CIV1	CLOSE
		CIV2	CLOSE
		CIV3	CLOSE
		CIV4	CLOSE
		MPV1	OPEN
		PIV1 - A	CLOSE
		PIV1 - B	CLOSE
		PIV2 - A	CLOSE
		PIV2 - B	CLOSE
		PIV3 - A	CLOSE
		PIV3 - B	CLOSE
		PIV4 - A	CLOSE
		PIV4 - B	CLOSE
PRODUCTION TREE # (CAE1/CH01-Q-AY-XX)		SCSSV	CLOSE
		AAV	CLOSE
		AMV	CLOSE
		AVV	CLOSE
		AWV	CLOSE
		CIV1	CLOSE
		CIV2	CLOSE
		CIV3	CLOSE
		CIV4	CLOSE
		CIV5	CLOSE
		CIV6	CLOSE
		DSUO	CLOSE
		DSLO	CLOSE
		DSC	CLOSE
		DSIV	CLOSE
		FLIV	CLOSE
		PCV	CLOSE
		PMV	CLOSE
		PWV	CLOSE
		XOV	CLOSE
PUMPING SYSTEM # (CAW1/CH01-P-AY-01)		PPIV-1	CLOSE
		PPIV-3	CLOSE
		PPV1	OPEN
		CIV1	CLOSE
		CIV3	CLOSE
		CIV-5	CLOSE
		CIV-7	CLOSE
		CIV-9	CLOSE
		PCV1	OPEN
		PPIV-2	CLOSE
		PPIV-4	CLOSE
		PPV2	OPEN
		CIV2	CLOSE
		CIV4	CLOSE
		CIV-6	CLOSE
		CIV-8	CLOSE
		CIV-10	CLOSE
		PCV2	OPEN
		PXOV1	CLOSE
		PXOV2	CLOSE
		CRT1(ESPs)	STOP
		CRT2(ESPS)	STOP
MISCELLANEOUS / TOPSIDE	HPU	LP ESD	VENT
	HPU	HP ESD	VENT
	HPU	R/F PUMP	STOP
	HPU	LP PUMPS	STOP
	HPU	HP PUMPS	STOP
	HPU	LP PUMPS	START
	HPU	HP PUMPS	START
	MIU	PUMPS	STOP
	CIU	PUMPS	STOP
	MCS		ALARM
	MCS	TO PCS	ACK
	MCS		D/PLY
	MCS		TIMER
	EMS		ALARM
	EMS	TO PCS	ACK
	EMS		D/PLY
	EMS		TIMER
	VFD	FROM MCC	SOL
	PCS		ALARM
	PCS		D/PLY
	HYSTORIAN	MCS	STORE
	SPCU	O/P CHANNEL	S/DOWN
		HARDWIRED INPUT FROM FPSO PSD/ESD	
		HARDWIRED OUTPUT TO FPSO PSD/ESD	
		SDV VALVE	CLOSE

ESD LEVEL

CAUSE (INPUT)

EQUIP	DESCRIPTION	TAG #	Notes	NOTES No.

Notes Description

(Valve Closure Sequence).

35. Boosting system comms ESD (BSESD) sequence from page 4 (Valve Closure Sequence). In the event of loss of power or comms to both channels of the boosting system SCM, the EMS shall immediately cut power to the boosting pumps from the VFD

36. Tree comms ESD (TMESD) sequence from page 4 (Valve Closure Sequence). In the event of loss of power or comms to both channels of a tree SCM, the EMS shall immediately shut down the boosting pumps from the VFD
If the comms is not reinstated, the FPSO ESD shall bleed the hydraulic supply to the affected cluster after the the timer has elapsed.

37. There shall be two hardwired loss of comms shutdown signals from the MCS to the FPSO ESS . Cascade system, and Chinook system, respectively. The FPSO ESS shall bleed the hydraulic supply to the affected cluster after a programmable timer times out.

38. Status and readings of the chemical injection units to be passed to the MCS via the Modbus communications link.

39. Status and readings of the hydraulic power unit to be passed to the MCS via the Modbus communications link.

40. In the event of a Gas Export Shutdown, the FPSO ESS shall close the gas export pipeline boarding valve and the MCS shall close the subsea SSIV. It is likely that this event will trigger process shutdown causing the subsea production system, or parts of it, to close.

41. In the event of a confirmed gas or fire detection in the VFD hall power shall be isolated to the low voltage distribution panels in the hall from the FPSO MCC, in addition to isolating power to the VFD.

42. There are two types of cluster shutdowns: 1)Shutdown affecting cluster only, i.e. does not affect boosting system (in this case the effects to the boosting system is not implemented). This shutdown is applicable to Cascade East, Cascade West, Chinook DC1, and Chinook DC2. 2) Shutdown affecting the cluster equipment and boosting station. This shutdown is applicable to Cascade West, and Chinook DC1.

43.Timers T2 and T5 shall start counting after timer T9 has elapsed.

44. For the subsea shutdown philosophy and details of the valve closure sequence for each shutdown event refer to document I-ET-7040.02-1500-800-PTL-001 (Subsea Production System Shutdown Philosophy).

45. Shutdown or signal by-pass shall be provided to enable the pump start-up sequence.

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CAUSE (INPUT) / EFFECT (OUTPUT)

Effect groups: ESD/PSD (ESD0, ESD 2,3, ESD 2, PSD, PSHL – action CLEAR); SSIV (SSIV – O/C); MANIFOLD (CAE1/CH01-G-AY-01) (CIV1, CIV2, CIV3, CIV4, MPV1, PIV1 - A, PIV1 - B, PIV2 - A, PIV2 - B, PIV3 - A, PIV3 - B, PIV4 - A, PIV4 - B – O/C); PRODUCTION TREE # (CAE1/CH01-Q-AY-XX) (SCSSV, AAV, AMV, AVV, AWV, CIV1, CIV2, CIV3, CIV4, CVI5, CIV6, DSUO, DSLO, DSC, DSIV, FLIV, PCV, PMV, PWV, XOV – O/C); PUMPING SYSTEM # (CAW1/CH01-P-AY-01) (PPIV-1, PPIV-3, PPV1, CIV1, CIV3, CIV5, CIV7, CIV9, PCV1, PPIV-2, PPIV-4, PPV2, CIV2, CIV4, CIV6, CIV8, CIV10, PCV2, PXOV1, PXOV2, CRT1(ESPs), CRT2(ESPS) – O/C); TOPSIDES (SDV A, SDV B, CI PUMPS, MeOH PUMP). ESD LEVEL; NOTES No.; Inhibit.

EQUIP	DESCRIPTION	TAG #	Note (Interlocks)	ESD0	ESD 2,3	ESD 2	PSD	PSHL
CAW1-P-AY-01	PUMPING SYSTEM							
CH01-P-AY-01								
	PPIV-1		6,7,8	x	x	x	x	x
	PPIV-A		9,					
	PPIV-3		2,3,4	x	x	x	x	x
	PPIV-C		5,					
	PPV1		13,14,15,26	x	x	x	x	x
	CIV1		1,23	x	x	x	x	x
	CIV3		1,23	x	x	x	x	x
	CIV5		1,23	x	x	x	x	x
	CIV7		1,23	x	x	x	x	x
	CIV9		1,23	x	x	x	x	x
	PCV1		11,12	x	x	x	x	x
	PPIV-2		6,7,8	x	x	x	x	x
	PPIV-B		9,					
	PPIV-4		2,3,4	x	x	x	x	x
	PPIV-D		5,					
	PPV2		13,14,15,26	x	x	x	x	x
	HIV-1		10,11,19,20,21					
	HIV-2		10,11,16,17,18					
	CIV2		1,23	x	x	x	x	x
	CIV4		1,23	x	x	x	x	x
	CIV6		1,23	x	x	x	x	x
	CIV8		1,23	x	x	x	x	x
	CIV10		1,23	x	x	x	x	x
	PCV2		12,22	x	x	x	x	x
	PXOV-1		19,20,21	x	x	x	x	x
	PXOV-2		16,17,18	x	x	x	x	x
	CRT1(ESPs)		24,25,27	x	x	x	x	x
	CRT2(ESPs)		24,25,27	x	x	x	x	x

Notes

1. Warning. "Tree or Manifold or boosting system MeOH injection valves in the same field shall not be open at the same time. "Common MeOH header (only one MeOH isolation valve on the common header shall be open at any given time).

2. Pump PPIV3/4 should not closed when related pump cartridge is running. "Prevent pump from running in "shut-off" mode, and cause overpressure and pump damage."

3. Related pump cartridge shall be turned off (disabled) if PPIV3/4 are closed. "Prevent pump from running in "shut-off" mode, and cause overpressure and pump damage."

4. Related pump cartridge shall be inhibited from running (disabled) if PPIV3/4 are closed. "Prevent pump from running in "shut-off" mode, and cause overpressure and pump damage."

5. Related pump cartridge shall be inhibited from running (disabled) if PPIVC/D are closed. "Prevent pump from running in "shut-off" mode, and cause overpressure and pump damage."

6. Pump PPIV1/2 should not closed when related pump cartridge is running."Prevent pump from running without flow, causing motor over temperature and excessive vibration."

7. Related pump cartridge shall be turned off (disabled) if PPIV1/2 are closed. "Prevent pump from running without flow, causing motor over temperature and excessive vibration."

8. Related pump cartridge shall be inhibited from running (disabled) if PPIV1/2 are closed. "Prevent pump from running without flow, causing motor over temperature and excessive vibration."

9. Related pump cartridge shall be inhibited from running (disabled) if PPIVA/B are closed. "Prevent pump from running without flow, causing motor over temperature and excessive vibration."

10. Pump cartridge #2 shall be inhibited from running (disabled) if HIV1 is closed. "Prevent pump from running without flow, causing motor over temperature and excessive vibration."

11. Pump cartridge #2 shall be inhibited from running (disabled) if HIV2 is closed. "Prevent pump from running in "shut-off" mode, and cause overpressure and pump damage."

12. Related pump cartridge shall be inhibited from starting (disabled) if PCV1/2 are closed (or not at the minimum recirculation setting). "Prevent pump from starting up at low flow, causing motor over temperature and excessive vibration (follow proper start-up procedure)."

13. Pump PPV1/2 should not open when related pump cartridge are running. "Prevent pump from running without flow, causing motor over temperature and excessive vibration."

14. Related pump cartridge shall be turned off (disabled) if PPV1/2 are open. "Prevent pump from running without flow, causing motor over temperature and excessive vibration."

15. Related pump cartridge shall be inhibited from running (disabled) if PPV1/2 are open. "Prevent pump from running without flow, causing motor over temperature and excessive vibration."

16. Pump PXOV2 should not open when either pump cartridges are running and HIV2 is open. "Prevent cross communication of pump cartridges discharge to both flowlines."

17. Both pump cartridges shall be turned off (disabled) if PXOV2 is open and HIV2 is open."Prevent cross communication of pump cartridges discharge to both flowlines."

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SUBSEA BOOSTING SYSTEM
DOCUMENT NO. : I-ET-7040.02-1500-800-PTL-004

REV.	CURRENT REVISION	DATE	10-Dec-2009
0			

CAUSE (INPUT)

EFFECT (OUTPUT)

EQUIP	DESCRIPTION	TAG #	Note (Interlocks)	ESD LEVEL	NOTES No.

ESD/PSD

DESCRIPTION	ADDRESS	ACTION	TAG NO
	CLEAR		ESD0
	CLEAR		ESD 2.3
	CLEAR		ESD 2
	CLEAR		PSD
	CLEAR		PSHL

Inhibit

SSIV

SSIV
O/C

MANIFOLD (CAE1/CH01-Q-AY-01)

CIV1	CIV2	CIV3	CIV4	MPV1	PIV1_A	PIV1_B	PIV2_A	PIV2_B	PIV3_A	PIV3_B	PIV4_A	PIV4_B
O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C

PRODUCTION TREE # (CAE1/CH01-Q-AY-XX)

SCSSV	AAV	AMV	AVV	AWV	CIV1	CIV2	CIV3	CIV4	CIV5	CIV6	DSUD	DSLO	DSC	DSIV	FLIV	PCV	PMV	PWV	XOV
O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C

PUMPING SYSTEM # (CAW1/CH01-P-AY-01)

PPIV-1	PPIV-3	PPV1	CIV1	CIV3	CIV5	CIV7	CIV9	PCV1	PPIV-2	PPIV-4	PPV2	CIV2	CIV4	CIV6	CIV8	CIV10	PCV2	PXOV1	PXOV2	CRT1(ESPs)	CRT2(ESPS)
O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C	O/C

TOPSIDES

SDV A	SDV B	CI PUMPS	MeOH PUMP

Notes

18. Both pump cartridges shall be inhibited from running (disabled) if PXOV2 and HIV2 are open. "Prevent cross communication of pump cartridges discharge to both flowlines."

19. Pump PXOV1 should not open when either pump cartridges are running and HIV1 is open. "Prevent cross communication of pump cartridges suction from both flowlines."

20. Both pump cartridges shall be turned off (disabled) if PXOV1 is open and HIV1 is open."Prevent cross communication of pump cartridges suction from both flowlines."

21. Both pump cartridges shall be inhibited from running (disabled) if PXOV1 and HIV1 are open. "Prevent cross communication of pump cartridges suction from both flowlines."

22. Pump cartridge shall be inhibited from running if all related tree FLIV are closed and PCV below minimum recirculation setting. "Prevent pump from running without flow, causing motor over temperature and excessive vibration."

23. Pump MeOH CIV should not be opened if any other pump methanol injection valve is open. "Common MeOH header (only one pump MeOH isolation valve shall be opened in the common header)."

24. Stop (disable) respective subsea boosting cartridge if respective FPSO boarding valve is closed. "Prevent pump from running in shut-off mode, and cause overpressure and pump damage."

25. Related pump cartridge shall be inhibited from running (disabled) if FPSO SDV is closed. "Prevent pump from running in "shut-off" mode, and cause overpressure and pump damage."

26. Pump PPV1/2 shall not be opened if difference in flowline pressure absolute value (PT1 - PT2)) is greater than 1000 psi. "Opening pump pigging valve with high differential pressure across the valve may damage gate valves (equalize pressure)."

27. The pump cartridges shall not be allowed to start, i.e. no permissive if the flow path from a well is not open to the pump suction (tree and manifold valve configuration aligned open to the pump suction). Pump shall prevent from running "dry". motor over temperature and excessive vibration."

PETROBRAS	TECHNICAL SPECIFICATION	I-ET-7040.02-1500-800-PTL-001
	CLIENT: PETROBRAS AMERICA, INC.	SHEET: 1 of 32
	PROGRAM: CASCADE & CHINOOK PROJECT	-
	AREA: WALKER RIDGE AREA	SCALE: -
PAI	TITLE: SUBSEA PRODUCTION SYSTEM SHUTDOWN PHILOSOPHY	

CASCADE · CHINOOK

INDEX OF REVISIONS

REV.	DESCRIPTION AND/OR AFFECTED SHEETS
0	ORIGINAL ISSUE
A	Included shutdown sequences & updated trigger events
B	Included subsea valve timing sequence defined to MMS, interface requirements, and shutdown timers
C	Revised FPSO PSHL valve timing sequence
D	General Revision and Description of MeOH Shutdown Philosophy

Subsea Pump Shutdown Highlight

	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE	01-24-08	05-10-08	02-12-2009	03-04-2009	06-01-2009				
DESIGN	WR/SS	WR/SS	WR/SS	WR/SS	WR/SS				
EXECUTION	MN	MN	MN	MN	MN				
VERIFICATION	KK	KK	KK	KK	KK				
APPROVAL	TMC	TMC	TCC	TCC	TCC				

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INTRODUCTION

Petrobras America Inc. (PAI) is currently developing Cascade and Chinook fields both located respectively in 8,100 ft and 8,800 ft water depth in the Walker Ridge (WR) area in the Gulf of Mexico (GOM). Wells for the Cascade field will be located in two (2) separate Drill Centers (DCs). DC East (located in GOM WR Block 206) and DC West (located in GOM WR Block 249). The Chinook wells will be located in two (s) Drill Centers located in GOM WR Block 425 and 469.

The Walker Ridge development plan assumes a phased development that is comprised of an initial phase (Phase I) of about one year, followed by a second phase (Phase II) of additional four (4) years and finally a Full Field phase (Phase III) of at least twenty (20) additional years.

In Phase I and Phase II, wells will be tied back to a floating production, storage and offloading (FPSO) facility which will be permanently moored and located in GOM WR block 249.

Purpose

This document defines the shutdown philosophy for the design of the subsea production system.

This document is a philosophy document and further development of the shutdown details shall be developed during detailed engineering.

Abbreviations

AVS	Abandon Vessel Shutdown
CCR	Central Control Room
DCV	Direct Control Valve
EMS	ESP Management System (Electric Submersible Pump)
EPU	Electrical Power Unit
ESD	Emergency Shutdown
ESP	Electric Submersible Pump
FPSO	Floating production Storage and Offloading
HP	High Pressure
HPU	Hydraulic Power Unit
LP	Low Pressure

MCS	Master Control Station
MMS	Minerals Management Service
SCM	Subsea Control Module
SCS	Subsea Control System
SPS	Subsea Pumping System
SCSSV	Surface Controlled Sub-Surface Safety Valve

References

Phase I & II – Overall Field Layout	I-DE-7040.02-1500-942-TKU-001
Phase I – Base Case Process Flow Schematic	I-DE-7040.02-1500-944-TKU-001 Sht1
Phase II – Base Case Process Flow Schematic	I-DE-7040.02-1500-944-TKU-002 Sht. 2
Subsea P&Ids – Typical Subsea Tree	I-DE-7040.02-1500-944-TKU-003
Subsea P&Ids – Cascade East Drill Center	I-DE-7040.03-1500-944-TKU-004
Subsea P&Ids – Cascade West Drill Center	I-DE-7040.03-1500-944-TKU-005
Subsea P&Ids – Cascade West Pipeline & Riser	I-DE-7040.03-1500-944-TKU-006
Subsea P&Ids – Cascade West Pump Station	I-DE-7040.02-1500-944-TKU-002
Subsea P&Ids – Chinook Drill Center 1	I-DE-7040.04-1500-944-TKU-003
Subsea P&Ids – Chinook Drill Center 2	I-DE-7040.04-1500-944-TKU-004
Subsea P&Ids – Chinook Pipeline & Riser	I-DE-7040.03-1500-944-TKU-005
Subsea P&Ids – Chinook Pump Station	I-DE-7040.04-1500-944-TKU-001
Subsea P&Ids – Gas Export Pipeline	I-DE-7040.02-6500-944-TKU-001
Subsea Production Controls System Overview	I-DE-7040.02-1510-830-TKU-002
Subsea Production Controls Topsides Block Diagram	I-DE-7040.02-1510-830-TKU-004
Subsea Production Control System Specification	I-ET-7040.02-1510-941-TKU-005
Production Shutdown PSD Philosophy - BW Offshore	4036-FD-00107452
Emergency Shutdown (ESD) Philosophy - BW Offshore	4036-FD-00068846
Emergency Shutdown Logic Block Diagram - BW Offshore	3036-XL-00068847.001
ESD/PSD Subsea Shutdown Interface Block Diagram - BW Offshore	4036-XL-00099416.001
Production Shutdown Hierarchy - BW Offshore	0713-M7-I-XL-0310 to 0316

Automation, Instrumentation & Control System Philosophy	4026-FD-00068853
FMC – Surface Controls Block Diagram Topsides Equipment	DA-100047031

SHUTDOWNS

The subsea control system shall be designed to have various responses to planned and unplanned inputs and conditions to the subsea production system. The three basic categories of events are listed below.

Emergency and process shutdown

The Subsea Control System MCS and the Subsea Pumping System EMS shall respond to inputs from the FPSO, the drilling rig / workover vessel, feedback from the subsea production system or operator action via programmed control sequences to the following conditions:

- FPSO ESD 0 (AVS)
- FPSO ESD level 1
- FPSO ESD level 2
- FPSO ESD level 2.3
- FPSO PSD level 3
- FPSO low-low flowline boarding pressure
- FPSO high-high flowline boarding pressure
- Drilling rig/workover vessel ESD
- Low-low well bore pressure
- High-high well bore pressure
- Well choke reverse differential pressure
- High-high well annulus pressure
- Low-low well annulus pressure
- Low-low subsea flowline pressure
- High-high subsea flowline pressure
- Low-low chemical injection pressure
- Low-low chemical injection flow
- Low-low subsea pumping system flow
- High-high subsea pumping system temperature
- High-high subsea pumping system vibration
- High-high subsea pumping system pressure
- Low-low subsea pumping system pressure

- High-High subsea pumping system differential pressure
- MeOH Pressure Modes – Flushing and Bullheading

The programmed shutdown control sequences shall check for proper execution for each commanded operation where applicable and when feedback is available. Failure of selected operations may require additional shutdown operations as a backup.

Means shall be provided (such as operator override) to control or limit the execution of shutdown operations during production start-up.

Loss of Communications, Low FPSO UPS Power and Low production HPU Hydraulic Supplies

Loss of communications to both channels of a production tree SCM shall raise an alarm and allow a suitable time delay prior to initiating shutdown events, by venting the hydraulic supplies to the affected field, i.e. either Cascade or Chinook fields. The production from the affected well will be shut in by:

a. Initiating bleed of the LP hydraulic system of the affected field within 120 minutes of loss of communication;
b. When the LP hydraulic supply is bled within 120 minutes of the loss of communications to shut in production from the wells, bleeding of the HP hydraulic system of the affected field shall be initiated within 180 minutes of loss of communication.
c. Shut-in down the subsea pumps of the affected field via the topsides VFD immediately.

Whenever loss of communication to a production tree is detected and an ESD signal is concurrently activated, production from the wells will be shut in by:

d. Initiating bleed of the LP hydraulic system of the affected field immediately;
e. Initiating bleed of the HP hydraulic system of the affected field within 25 minutes of loss of communication;
f. Shut-in down the subsea pumps of the affected field via the topsides VFD immediately.

Loss of communications to both channels the subsea manifolds SCM shall raise an alarm but will not cause the subsea system to shut-in. The manifold valves will stay in the last commanded position (fail as-is) and production will resume normally. Whenever loss of communication to a production manifold is detected and an ESD signal is concurrently activated, the configured shutdown sequences shall be initiated.

Loss of communications to both channels of a subsea boosting system SCM shall raise an alarm and cause the immediate shut-down of the affected pumps via hardwired commands from the topsides PSD System, on response from a hardwired signal from the MCS, to the Variable Frequency Drivers (VFD). The related subsea system will not be shut-in and production will resume at lower rates without the boosting system. Whenever loss of communication to a subsea boosting system is detected and an ESD signal is concurrently activated, the configured shutdown sequences shall be initiated.

The SCS and EMS are powered by the FPSO UPS. By the time the SCS equipment is powered by the FPSO UPS battery bank, due to the loss of the FPSO generation systems, the subsea production system should have already been shutdown by consequence of an overall production shutdown. Therefore, the SCS shall not react specifically to low-low FPSO UPS battery power.

There are independent hydraulic supply outputs to cascade and Chinook production systems from the FPSO production HPU. Loss of or Low-Low LP or HP topsides hydraulic power supplies to either or both subsea production systems shall raise an alarm and initiate an FPSO process shutdown which will initiate the shutdown event of the affected subsea production system.

Alarm Conditions

The SCS shall be designed to continually monitor subsea conditions and selected inputs from the FPSO systems. Various conditions shall cause an alarm to be raised at the MCS:

- Loss of all or some subsea communications
- Loss of all or some subsea electrical power
- Loss of hydraulic supply from the HPU
- Loss of communications to the FPSO systems
- Any subsea and selected topsides variables out of predetermined set points

GENERAL SHUTDOWN PHILOSOPHY

The facilities on the FPSO will have four main levels of emergency shutdown depending on the severity of hazard sensed. The system will operate in a hierarchical arrangement where Abandon Vessel Shutdown (AVS) is the highest level above Emergency Shutdown 1 (ESD 1). In general, a shutdown initiated at a higher level will initiate all lower levels.

The following descriptions of events and responses are indicative of the required system operation. Detailed information regarding the actions to be taken at each level of shutdown can be found in the subsea production system cause and effects chart document.

FPSO ESD 0 – ABANDON VESSEL SHUTDOWN (AVS)

The ESD 0 shutdown is a total facility shutdown and will be initiated manually from the CCR or from manual stations strategically located around the installation at positions such as the helideck, muster areas, and lifeboat stations.

An AVS ESD shall cause the following subsea related events, when initiating all lower levels such as ESD1, ESD2 and ESD 2.3:

1. Through the MCS, independently of the FPSO actions
   - Close all subsea tree valves and SCSSVs in a preset order to allow for the correct pressure equalization
   - Close all tree chemical injection valves
   - Close all manifold branch valves
   - Close all subsea pumping system valves
   - Close gas export pipeline SSIV
2. Through the subsea pumping system EMS and FPSO PSD system
   - Shutdown all subsea pumping systems

3. Through the FPSO PSD/ESD systems
    - Close risers boarding valves
    - Isolate medium voltage power to VFD container
    - Shutdown topsides chemical injection units
    - Bleed the topsides HPU LP and HP output hydraulic supplies

FPSO ESD 1

ESD 1 shutdown actions will be caused by the following events:

- Manual push-button at FPSO selected areas
- Confirmed gas detection any non hazardous areas
- Confirmed gas detection in heat medium system
- Confirmed gas detection in ventilation air intakes in non hazardous area

An FPSO ESD 1 shall cause the following subsea related events, when initiating lower levels such as ESD2:

1. Through the MCS, independently of the FPSO actions
    - Close all subsea tree valves in a preset order to allow for the correct pressure equalization
    - Close all tree chemical injection valves
    - Close all manifold valves
    - Close all subsea pumping system valves
    - Close gas export pipeline SSIV
2. Through the subsea pumping system EMS and FPSO PSD system
    - Shutdown all subsea pumping systems
3. Through the FPSO PSD/ESD systems
    - Close risers boarding valves
    - Isolate medium voltage power to VFD container
    - Shutdown topsides chemical injection units

ESD1 will immediately cause the loss of electrical power to the Variable Frequency Drivers (VFD) for both Cascade & Chinook Systems.

FPSO ESD 2

ESD 2 shutdown actions will be caused by the following events:

- High level in HP flare drum
- High level in LP flare drum

- Confirmed gas in hazardous areas
- Gas in cooling medium system

An ESD 2 shall cause the following subsea related events:

1. Through the MCS, independently of the FPSO actions
   - Close all subsea tree valves in a preset order to allow for the correct pressure equalization
   - Close all tree chemical injection valves
   - Close all manifold valves
   - Close all subsea pumping system valves
   - Close gas export pipeline SSIV
2. Through the subsea pumping system EMS and FPSO PSD system
   - Shutdown all subsea pumping systems
3. Through the FPSO PSD/ESD systems
   - Close riser boarding valves
   - Isolate medium voltage power to VFD container
   - Shutdown topsides chemical injection units

FPSO ESD 2.3

ESD 2.3 shutdown actions will be caused by the following events:

- Confirmed fire in hazardous area
- Push buttons in process areas, along escape routes and main exits to living quarters.

An ESD 2.3 shall cause the following subsea related events:

1. Through the MCS, independently of the FPSO actions
   - Close all subsea tree valves and SCSSVs in a preset order to allow for the correct pressure equalization
   - Close all tree chemical injection valves
   - Close all manifold branch valves
   - Close all subsea pumping system valves
   - Close gas export pipeline SSIV
2. Through the subsea pumping system EMS and FPSO PSD system
   - Shutdown all subsea pumping systems
3. Through the FPSO PSD/ESD systems
   - Isolate medium voltage power to VFD container
   - Shutdown topsides chemical injection units

- Bleed the topsides HPU LP and HP output hydraulic supplies

FPSO PSD (PROCESS SHUTDOWN)

A PSD shutdown is initiated by any process exhibiting conditions outside the designated ranges, which would result in an unsafe condition. The PSD System operates in a hierarchical arrangement where PSD 3.0 (Total Production shutdown) is the highest level in the PSD System.
There are certain process shutdown conditions that may affect either Cascade or Chinook production systems or both. Therefore, dedicated shutdown signals shall be implemented to each production system. The SCS shall react to dedicated process shutdown to a specific field by closing or isolating the subsea production facilities of the affected field only.

An FPSO PSD shutdown shall cause the following subsea related events:

1. Through the MCS, independently of the FPSO actions
   - Close subsea tree at the subsea wells flowing to the affected riser(s)
   - Close chemical injection valves at the subsea wells flowing to the affected riser(s)
   - Close appropriate subsea pumping system valves at pump station associated with the affected riser(s)
2. Through the subsea pumping system EMS and FPSO PSD system
   - Shutdown the subsea pumping systems associated with the affected drill riser(s)
3. Through the FPSO PSD system
   - Close riser boarding valve associated with the affected riser(s)

DRILLING RIG / WORKOVER VESSEL ESD SIGNAL

Any drilling rig or workover vessel involved in work on adjacent Cascade and Chinook equipment or wells shall be equipped with ESD equipment as described in specification 303948-EPS-SP-3726-0005. The system shall allow a shutdown of the subsea facilities to be initiated in one of two ways.

Operator Initiated ESD

The operator on the drilling rig or workover vessel can initiate a shutdown by pressing the ESD button located at strategic locations of the vessel. The ESD REQUEST signal is subsequently transmitted to the FPSO receiving system and subsequently relayed to the MCS and to the FPSO ESD System.

Cascade and Chinook production systems will have, at some point, more than one Drill Centers (DC) interconnected by a pair of production flowlines. In the event of a drilling rig/workover vessel ESD cause by a dropped object from the rig, it is not possible to determine if the flowlines interconnecting the DC are affected or not. Therefore, such an ESD, with the rig located on any DC of a production system, shall cause the whole production system, i.e. either Cascade or Chinook, to be closed.

On receipt of the signal the FPSO receiving system shall automatically initiate an ESD of the affected production system:

1. Through the MCS, independently of the FPSO actions
   - Close all subsea tree valves and SCSSVs associated with the affected production system
   - Close all tree chemical injection valves associated with the affected production system
   - Close all manifold branch valves associated with the affected production system
   - Close all subsea pumping system valves associated with the affected production system
2. Through the subsea pumping system EMS and FPSO PSD system
   - Shutdown the subsea pumping systems associated with the affected production system
3 Through the FPSO PSD/ESD systems
   - Close riser boarding valves associated with the affected production system
   - Bleed down HPU LP and HP hydraulic supplies associated with the affected production system

Radio Link Fail ESD

Should both Comms Path links between the workover vessel and the FPSO based equipment fail the MCS shall receive a COMMS PATH FAIL signal. The operator shall be given the opportunity to abort the shutdown within a given time period. If this is not done the drilling rig/workover ESD sequence will be performed. If the operator chooses to abort the alarm, the shutdown sequence will not be performed.

HIGH-HIGH FLOWLINE BOARDING PRESSURE

Detection of a high-high FPSO flowline boarding pressure reading shall cause the following automatic sequenced commands to be performed:

1. Through the MCS, independently of the FPSO actions
   - Close subsea tree at the subsea wells flowing to the affected flowline(s)
   - Close chemical injection valves at the subsea wells flowing to the affected flowline(s)
   - Close appropriate subsea pumping system valves associated with the affected flowline(s)
2. Through the subsea pumping system EMS and FPSO PSD system
   - Shutdown the subsea pumping systems associated with the affected flowline(s)
3. Through the FPSO PSD/ESD systems
   - Delayed close riser downstream boarding valve associated with the affected flowline(s)
   - Bleed down HPU LP and HP hydraulic supplies associated with the affected production system

LOW-LOW FLOWLINE BOARDING PRESSURE

Detection of a low-low FPSO flowline boarding pressure reading shall cause the following automatic sequenced commands to be performed:

4. Through the MCS, independently of the FPSO actions
   - Close subsea tree at the subsea wells flowing to the affected flowline(s)
   - Close chemical injection valves at the subsea wells flowing to the affected flowline(s)
   - Close appropriate subsea pumping system valves associated with the affected flowline(s)
5. Through the subsea pumping system EMS and FPSO PSD system
   - Shutdown the subsea pumping systems associated with the affected flowline(s)
6. Through the FPSO PSD system
   - Close riser downstream boarding valve associated with the affected flowline(s)
   - Close riser upstream boarding valve associated with the affected flowline(s)
   - Bleed down HPU LP and HP hydraulic supplies associated with the affected production system

LOW-LOW WELL BORE PRESSURE

Detection of a low-low well bore pressure reading shall cause the MCS to initiate an automatic sequence to function the following commands, independently of the FPSO actions:

- Close the tree Flowline Isolation Valve (FLIV)
- Close the tree wing valve
- Close the tree master valves and annulus valves and choke valve
- Close chemical injection valves
- Close the associated manifold branch valves

HIGH-HIGH WELL BORE PRESSURE

Detection of a high-high well bore pressure reading shall cause the MCS to initiate an automatic sequence to function the following commands, independently of the FPSO actions:

- Close the tree Flowline Isolation Valve (FLIV)
- Close the tree wing valve
- Close the tree master valves and annulus valves and choke valve
- Close chemical injection valves
- Close the associated manifold branch valves

WELL CHOKE REVERSE DIFFERENTIAL PRESSURE

Detection of a well choke reverse differential pressure reading shall cause the MCS to initiate an automatic sequence to function the following commands, independently of the FPSO actions:

- Close the tree Flowline Isolation Valve (FLIV)
- Close the tree wing valve
- Close the tree master valves and annulus valves and choke valve
- Close chemical injection valves
- Close the associated manifold branch valves

HIGH-HIGH WELL ANNULUS PRESSURE

Detection of a high-high well annulus pressure reading shall cause the MCS to initiate an automatic sequence to function the following commands, independently of the FPSO actions:

- Close the tree annulus valves;

LOW-LOW OR HIGH-HIGH SUBSEA FLOWLINE PRESSURE

Detection of a low-low or high-high subsea flowline pressure reading shall cause the following automatic sequenced commands to be performed:

1. Through the MCS, independently of the FPSO actions
   - Close the flowline isolation valve at the subsea wells flowing to the affected flowline(s)
   - Close the wing valve at the subsea trees flowing to the affected flowline(s)
   - Close the master, annulus and choke valves at the subsea trees flowing to the affected flowline(s)
   - Close chemical injection valves at the subsea trees flowing to the affected flowline(s)
   - Close appropriate manifold branch valves of the subsea trees flowing to the affected flowline(s)
   - Close appropriate subsea pumping system valves associated with the affected flowline(s)
2. Through the subsea pumping system EMS and FPSO PSD system
   - Shutdown the subsea pumping systems associated with the affected flowline(s)
3. Through the FPSO PSD system
   - Close riser boarding valve associated with the affected flowline(s)

Subsea flowline pressure can be monitored and detected by pressure transmitters located at the manifold headers, subsea pump cartridge, and riser base.

LOW-LOW CHEMICAL INJECTION PRESSURE

Detection of a topsides low-low chemical injection unit pressure reading shall cause the MCS to initiate an automatic sequence to function the following commands, independently of the FPSO actions:

- Close flowline isolation valve of all trees associated with the affected drill center (DC)

- Close the wing valve of all trees associated with the affected drill center (DC)
- Close the master valves and annulus valves and choke valve of all trees associated with the affected drill center (DC)
- Close chemical injection valves of all trees associated with the affected drill center (DC)

Detection of a subea tree chemical metering valve low-low pressure reading shall cause the MCS to initiate an automatic sequence to function the following commands, independently of the FPSO actions:

- Close flowline isolation valve of the affected well
- Close the wing valve of the affected well
- Close the master valves and annulus valves and choke valve of all of the affected well
- Close chemical injection valves of the affected well

LOW-LOW CHEMICAL INJECTION FLOW

Detection of a topsides low-low chemical injection unit flow reading shall cause the MCS to initiate an automatic sequence to function the following commands, independently of the FPSO actions:

- Close flowline isolation valve of all trees associated with the affected drill center (DC)
- Close the wing valve of all trees associated with the affected drill center (DC)
- Close the master valves, annulus valves and choke valve of all trees associated with the affected drill center (DC)
- Close chemical injection valves of all trees associated with the affected drill center (DC)

Detection of a subea tree chemical metering valve low-low flow reading shall cause the MCS to initiate an automatic sequence to function the following commands, independently of the FPSO actions:

- Close flowline isolation valve of the affected well
- Close the wing valve of the affected well
- Close the master valves and annulus valves and choke valve of all of the affected well
- Close chemical injection valves of the affected well

LOW-LOW SUBSEA PUMPING SYSTEM FLOW

The subsea boosting system ESP pumps shall be protected against overheating due to low flow. Therefore, upon detection of a low-low subsea pumping system flow reading, by the FlowManager and System, the EMS System shall cause the following automatic sequenced commands to be performed:

1. Through the subsea pumping system EMS
   - Shutdown the affected subsea pumping system ESP

2. Through the MCS
   - Open the affected subsea pumping system cartridge recycle loop choke

HIGH-HIGH SUBSEA PUMPING SYSTEM TEMPERATURE

The subsea boosting system ESP pumps shall be protected against overheating due to low flow. Therefore, upon detection of a high-high subsea pumping system temperature reading, the EMS System shall cause the following automatic sequenced commands to be performed:

1. Through the subsea pumping system EMS
   - Shutdown the affected subsea pumping system ESP
2. Through the MCS
   - Open the affected subsea pumping system cartridge recycle loop choke

HIGH-HIGH SUBSEA PUMPING SYSTEM VIBRATION

The subsea boosting system ESP pumps shall be protected against excessive vibration that could potentially lead to pump failure. Therefore, upon detection of a high-high subsea pumping system vibration reading, the EMS System, shall cause the following automatic sequenced commands to be performed:

1. Through the subsea pumping system EMS
   - Shutdown the affected subsea pumping system ESP
2. Through the MCS
   - Open the affected subsea pumping system cartridge recycle loop choke

HIGH-HIGH SUBSEA PUMPING SYSTEM PRESSURE

The subsea boosting shall be protected against overpressure, which can be caused primarily by allowing the pumps to run in a shut-off condition. Therefore, upon detection of a high-high subsea pumping system discharge or differential pressure readings shall cause the following automatic sequenced commands to be performed:

1. Through the MCS, independently of the FPSO actions
   - Close subsea tree at the subsea wells flowing to the affected pump(s)
   - Close the flowline isolation valve at the subsea trees flowing to the affected pump(s)
   - Close the wing valve at the subsea trees flowing to the affected pump(s)
   - Close the master, annulus and choke valves at the subsea trees flowing to the affected pump(s)
   - Close chemical injection valves at the subsea trees flowing to the affected pump(s)
   - Close appropriate manifold branch valves at manifolds flowing to the affected pump(s)

- Open appropriate subsea pumping system valves at pump bases associated with the affected pump(s)
- Open subsea pumping system recycle loop choke valve at pump cartridge associated with the affected pump(s)

2. Through the subsea pumping system EMS and FPSO PSD system
   - Shutdown the affected subsea pumping system ESP
3. Through the MCS
   - Open the affected subsea pumping system cartridge recycle loop choke
   - Open the affected subsea pumping system cartridge bypass valve.

The subsea boosting system pressure monitoring shall be done via the redundant pressure sensors located at the pump suction and discharge in the pump cartridge. In this case, the ESP Monitoring System (EMS) detects the high-high pressure condition, which shall be sent to the MCS.

HIGH-HIGH SUBSEA PUMPING SYSTEM DIFFERENTIAL PRESSURE

The subsea boosting delta pressure shall be controlled not to exceed the maximum specified limit and cause overpressure of on the pump discharge. High delta pressure can be caused primarily by allowing the pumps to run in a shut-off condition. Therefore, upon detection of a high-high subsea pumping system differential pressure, or pump head, readings shall cause the following automatic sequenced commands to be performed:

1. Through the MCS, independently of the FPSO actions
   - Close subsea tree at the subsea wells flowing to the affected pump(s)
   - Close the flowline isolation valve at the subsea trees flowing to the affected pump(s)
   - Close the wing valve at the subsea trees flowing to the affected pump(s)
   - Close the master, annulus and choke valves at the subsea trees flowing to the affected pump(s)
   - Close chemical injection valves at the subsea trees flowing to the affected pump(s)
   - Close appropriate manifold branch valves at manifolds flowing to the affected pump(s)
   - Open appropriate subsea pumping system valves at pump bases associated with the affected pump(s)
   - Open subsea pumping system recycle loop choke valve at pump cartridge associated with the affected pump(s)
2. Through the subsea pumping system EMS and FPSO PSD system
   - Shutdown the affected subsea pumping system ESP
3. Through the MCS
   - Open the affected subsea pumping system cartridge recycle loop choke
   - Open the affected subsea pumping system cartridge bypass valve.

The subsea boosting system differential pressure monitoring shall be done via the differential reading between the redundant pressure sensors located at the pump suction and discharge in the pump cartridge. In this case, the ESP Monitoring System (EMS) detects the high-high differential pressure condition, which shall be sent to the MCS.

LOW-LOW SUBSEA PUMPING SYSTEM PRESSURE

The subsea boosting shall be protected against low suction pressure. Therefore, upon detection of a low-low subsea pumping system suction pressure reading shall cause the following automatic sequenced commands to be performed:

1. Through the subsea pumping system EMS
   - Shutdown the affected subsea pumping system ESP
2. Through the MCS
   - Open the affected subsea pumping system cartridge recycle loop choke

The subsea boosting system pressure monitoring shall be done via the redundant pressure sensors located at the pump suction and discharge in the pump cartridge. In this case, the ESP Monitoring System (EMS) detects the low-low pressure condition, which shall be sent to the MCS.

MEOH OPERATING MODES – FLUSHING AND BULLHEADING

Flow assurance requires that injection of MeOH occurs both at the tree and downhole. Pressures required for downhole injection of MeOH can exceed the MAOP of the rest of the Subsea equipment. Downhole injection is called "Bullheading-Mode" in the control system. Flushing-Mode is used when injecting to service Subsea equipment downstream of the tree.

The tree is rated to 15,000 psia. The lowest pressure rating that defines the MAWP for all other Subsea equipment is 12,916 psia and 13,129 for Cascade and Chinook, respectively (subsea pressure reading at shallowest "mud-line" point in the fields). Because injection is required at both high and low pressures, the subsea control system is used as part of the protection scheme.

Bullheading-Mode and Flushing-Mode setpoints are programmed to work with Subsea valve interlocks to ensure tree valves are properly aligned for both high pressure and low pressure service. This results in adequate protection for both high pressure and low pressure operations to the appropriate location in the subsea system.

Harwired "Cascade Bullheading" and "Chinook Bullheading" signal will be provided from the MCS to the FPSO PSD system. The MCS will detect the MeOH injection mode based on the position of the various subsea valves. The system defaults to "flushing mode" when the hardwired signal level is de-energized.

The hardwired signal is used to define the MeOH injection mode, i.e the topsides chemical injection skid PSH setting.

A shutdown valve is located topsides on the flow control / meter run that delivers MeOH to the subsea equipment. Shutdown is initiated by a PSH at the end of each of these runs. This PSH works with the Process Shutdown System (PSD). Shutdown set-points are placed in the shutdown system that will actuate the shutdown valve if the PSH senses pressures outside these set-points.

GAS EXPORT FLOWLINE SYSTEM (Discovery) ESD Signal

The gas export system may be shutdown by Operator on ESD request via normal communication channels from Discovery system operations. There is no automatic ESD signal from host gas receiving facility to the FPSO. These events will initiate a total production shutdown (PSD 3.0).

LOSS OF COMMUNICATIONS TO THE FPSO SYSTEM

Loss of communications with the FPSO systems shall raise an alarm at the MCS.

ANY SUBSEA CONDITIONS OUTWITH THOSE PREDETERMINED LEVELS

Various parameters of the subsea system shall be continually or periodically monitored by the production subsea control system and EMS, these shall include but not be limited to the following:

- Choke flow and position characteristics
- Actuator positions
- Electrical power and communication status
- SCM housekeeping data
- Annulus pressure
- Tree production sensors
- Manifold production sensors
- Subsea pumping system production sensors

The control system shall be pre set with high and low set points to all parameters that require monitoring. The system shall then be designed to provide the operator with a warning or alarm at the MCS and the subsea pumping system EMS should any of the parameters not fall within those pre set limits.

TESTING

Factory Acceptance Testing

The factory acceptance testing of the Master Control Station, ESP Management System and Subsea Control Modules (SCM) shall ensure that all shutdown procedures are tested prior to equipment undergoing integration testing.

Subsea System Integration Testing

The system integration testing shall ensure that ALL ESD, shutdown, disconnection and alarm conditions are extensively tested. To ensure that all external ESD signals to the MCS and EMS are functioning correctly, FPSO and work over vessel equipment or simulators will be required.

Regular Maintenance Testing

The shutdown sequences shall require regular testing to ensure their operation should an ESD situation occur. The MCS and EMS shall be provided with suitable test sequences to allow easy operation of such testing. The frequency and extent of regular testing is to be determined and shall meet the requirements defined by MMS.

CAUSE AND EFFECTS CHARTS

The Subsea Production System Cause & Effects Chart I-ET-7040.02-1500-800-PTL-002 provides the detailed shutdown sequences described in this document and the valve interlocks to be configured in the Subsea Control System MCS and Subsea Pumping System EMS.

INTERFACES BETWEEN MCS, EMS AND FPSO PSD AND ESD SYSTEMS

The following main interface signals are required to implement the shutdown logic described in this document. This list is not intended to be all inclusive, and other signals may be included as the detailed design progresses.

Table 1. Interface signals

Signal	Description	From	To	Type	Remarks
1	ESD 0 (AVS) initiated	ESD	MCS	Hardwired	Duplicated
2	ESD 2 initiated	ESD	MCS	Hardwired	Duplicated
3	ESD 2.3 initiated	ESD	MCS	Hardwired	Duplicated
4	ESD 0 (AVS) initiated	ESD	EMS	Hardwired	
5	ESD 2 initiated	ESD	EMS	Hardwired	
6	ESD 2.3 initiated	ESD	EMS	Hardwired	
7	PSHL Cascade Riser 1	ESD	MCS	Hardwired	
8	PSHL Cascade Riser 2	ESD	MCS	Hardwired	
9	PSHL Chinook Riser 1	ESD	MCS	Hardwired	
10	PSHL Chinook Riser 2	ESD	MCS	Hardwired	
11	PSHL Cascade Riser 1	ESD	EMS	Hardwired	
12	PSHL Cascade Riser 2	ESD	EMS	Hardwired	
13	PSHL Chinook Riser 1	ESD	EMS	Hardwired	
14	PSHL Chinook Riser 2	ESD	EMS	Hardwired	
15	Isolate VFD Cascade Pump 1	ESD	MCC	Hardwired	
16	Isolate VFD Cascade Pump 2	ESD	MCC	Hardwired	
17	Isolate VFD Chinook Pump 1	ESD	MCC	Hardwired	
18	Isolate VFD Chinook Pump 2	ESD	MCC	Hardwired	
19	PSD Cascade Riser 1	PSD	MCS	Hardwired	
20	PSD Cascade Riser 2	PSD	MCS	Hardwired	
21	PSD Chinook Riser 1	PSD	MCS	Hardwired	
22	PSD Chinook Riser 2	PSD	MCS	Hardwired	
23	PSD Cascade Riser 1	PSD	EMS	Hardwired	

24	PSD Cascade Riser 2	PSD	EMS	Hardwired	
25	PSD Chinook Riser 1	PSD	EMS	Hardwired	
26	PSD Chinook Riser 2	PSD	EMS	Hardwired	
27	Trip VFD Cascade Pump 1	ESD	VFD	Hardwired	
28	Trip VFD Cascade Pump 2	ESD	VFD	Hardwired	
29	Trip VFD Chinook Pump 1	ESD	VFD	Hardwired	
30	Trip VFD Cascade Pump 2	ESD	VFD	Hardwired	
31	Trip VFD Cascade Pump 1	PSD	VFD	Hardwired	
32	Trip VFD Cascade Pump 2	PSD	VFD	Hardwired	
32	Trip VFD Chinook Pump 1	PSD	VFD	Hardwired	
33	Trip VFD Cascade Pump 2	PSD	VFD	Hardwired	
34	Loss of comms Cascade	MCS	ESD	Hardwired	
35	Loss of comms Chinook	MCS	ESD	Hardwired	
36	Loss of comms Cascade Pump	MCS	PSD	Hardwired	
37	Loss of comms Chinook Pump	MCS	PSD	Hardwired	
38	SESD Cascade Flowline 1	MCS	PSD	Hardwired	
39	SESD Cascade Flowline 2	MCS	PSD	Hardwired	
40	SESD Chinook Flowline 1	MCS	PSD	Hardwired	
41	SESD Cascade Flowline 2	MCS	PSD	Hardwired	
42	Depressurize HP/LP Headers (Rig ESD) Cascade	MCS	ESD	Hardwired	
43	Depressurize HP/LP Headers (Rig ESD) Chinook	MCS	ESD	Hardwired	
44	EMS System Failure	MCS	PSD	Hardwired	
45	MCS System Failure	MCS	ESD	Hardwired	
46	Asphaltene Inj.Pressure LOLO	PCS	MCS	Modbus/OPC	
47	Asphaltene Inj. Flow LOLO	PCS	MCS	Modbus/OPC	
48	Scale Inj. Pressure LOLO	PCS	MCS	Modbus/OPC	
49	Scale Inj. Flow LOLO	PCS	MCS	Modbus/OPC	
50	Corrosion Inj. Pressure LOLO	PCS	MCS	Modbus/OPC	
51	Corrosion Inj. Flow LOLO	PCS	MCS	Modbus/OPC	
52	LDHI Inj. Pressure LOLO	PCS	MCS	Modbus/OPC	
53	LDHI Inj. Flow LOLO	PCS	MCS	Modbus/OPC	

54	Cascade MEOH Pressure LOLO	PCS	MCS	Modbus/OPC	
55	Cascade MEOH Flow LOLO	PCS	MCS	Modbus/OPC	
56	Chinook MEOH Pressure LOLO	PCS	MCS	Modbus/OPC	
57	Chinook MEOH Flow LOLO	PCS	MCS	Modbus/OPC	
58	Cascade MeOH "bullheading"	MCS	PCS	Hardwired	
59	Chinook MeOH "bulhheading"	MCS	PCS	Hardwired	

SHUTDOWN SEQUENCES

Reference is made to table 3 (MMS valve closure table), which contains the regulatory valve closure and hydraulic lines bleeding timings, for the main shutdown events. The information provide in the table is mandatory.

The valve closure sequence for each type of defined topsides and subsea triggered shutdowns are described below. T1, T2, T3. T4, T5, T6, T7, T8, T9, T10, and T11 are configurable timers, which values can be adjusted from the subsea production system MCS and FPSO shutdown system at a supervisor level.

Usually, these timers will be set at the following values:

Table 2: Shutdown Timers

Timer	Value (min/sec)	Comments
T1	1 /60	FPSO ESD
T2	2 /120	MCS
T3	5/300	MCS
T4	10/600	MCS and FPSO ESD
T5	20/1200	MCS
T6	60/3600	MCS - 60 min re-settable timer up to 24 hours
T7	60/3600	FPSO ESD
T8	85 min/5100	FPSO ESD
T9	120 min/7200	MCS and FPSO ESD
T10	180 min/10800	FPSO ESD
T11	1440/86400	FPSO ESD - 24 hour timer

The interpretation of the valve closure sequence to be implemented shall be (for instance, considering the ESS 2.3 shutdown sequence):

1. Step 1: close appropriate tree valves of ALL trees sequentially (tree, 1, tree 2, etc..)
2. Close appropriate pump valves and stop pumps
3. Close appropriate manifold valves

4. Close appropriate SSIV valves
5. Repeat sequence above for the remaining valves/actions until the end of the valve closure sequence.

Topsides triggered shutdowns

1. AVS (*Close/stop wells/boosting system, SCSSV, and manifold valves on all clusters)*

Start timers T2, T3, and T4

- Production tree (first)
  - Close CIV1, CIV2, CIV3, CIV4, CIV5, CIV6, and XOV
  - Close PCV
  - Close FLIV, after T2 times out
  - Close AVV
  - Close PWV, after T3 times out
  - Close PMV, AWV, AAV, AMV
  - Close SCSSV after T4 times out
- Boosting system (second)
  - Stop pump cartridges #1 and #2
  - Close CIV1, CIV2, CIV3, CIV4, CIV5, CIV6, CIV7, CIV8, CIV9, and CIV10
  - Open PCV1 and PCV 2
  - Close PPIV1, PPIV2, PPIV4, and PPIV4 after T4 times out
  - Close PPV1, and PPV2
  - Close PXOV1 and PXOV2
- Production manifold (third)
  - Close CIV1, CVI2, CIV3, and CIV4
  - Close PIV1-A, PIV1-B, PIV2-A, PIV2-B, PIV3-A, PIV3-B, PIV4-A, and PIV4-B, after T4 times out
  - Close PPV1 and PPV2
- Gas export line (fourth)
  - Close SSIV
- Production HPU
  - Bleed Cascade & Chinook LP output immediately
  - Bleed Cascade & Chinook HP output immediately
- FPSO Switchboard
  - Isolate medium voltage power to VDF container (VFD)

2. ESD2.3 (*Close/stop wells/boosting system, SCSSV, and manifold valves on all clusters)*

Start timers T1, T2, T3, T4, T7 and T8

- Production tree (first)
  - Close CIV1, CIV2, CIV3, CIV4, CIV5, CIV6, and XOV
  - Close PCV
  - Close FLIV, after T2 times out
  - Close AVV
  - Close PWV, after T3 times out
  - Close PMV, AWV, AAV, AMV

- Close SCSSV after T4 times out
- Boosting system (second)
  - Stop pump cartridges #1 and #2
  - Close CIV1, CIV2, CIV3, CIV4, CIV5, CIV6, CIV7, CIV8, CIV9, and CIV10
  - Open PCV1 and PCV 2
  - Close PPIV1, PPIV2, PPIV4, and PPIV4 after T4 times out
  - Close PPV1, and PPV2
  - Close PXOV1 and PXOV2
- Production manifold (third)
  - Close CIV1, CVI2, CIV3, and CIV4
  - Close PIV1-A, PIV1-B, PIV2-A, PIV2-B, PIV3-A, PIV3-B, PIV4-A, and PIV4-B, after T4 times out
  - Close PPV1 and PPV2
- Gas export line manifold (fourth)
  - Close SSIV
- Production HPU
  - Bleed Cascade & Chinook LP output after T7 times out
  - Bleed Cascade & Chinook HP output after T8 times out
- FPSO Switchboard
  - Isolate medium voltage power to VDF container (VFD) after T1 times out

3. ESD 2 (*Close/stop wells/boosting system on all clusters)*

Start timers T1, T2, T3 and T4

- Production tree (first)
  - Close CIV1, CIV2, CIV3, CIV4, CIV5, CIV6, and XOV
  - Close PCV
  - Close FLIV, after T2 times out
  - Close AVV
  - Close PWV, after T3 times out
  - Close PMV, AWV, AAV, AMV
- Boosting system (second)
  - Stop pump cartridges #1 and #2
  - Close CIV1, CIV2, CIV3, CIV4, CIV5, CIV6, CIV7, CIV8, CIV9, and CIV10
  - Open PCV1 and PCV 2
  - Close PPIV1, PPIV2, PPIV4, and PPIV4 after T4 times out
  - Close PPV1, and PPV2
  - Close PXOV1 and PXOV2
- Production manifold (third)
  - Close CIV1, CVI2, CIV3, and CIV4
  - Close PIV1-A, PIV1-B, PIV2-A, PIV2-B, PIV3-A, PIV3-B, PIV4-A, and PIV4-B, after T4 times out
  - Close PPV1 and PPV2
- Gas export line (fourth)
  - Close SSIV
- FPSO Switchboard

- Isolate medium voltage power to VDF container (VFD) after T1 times out

4. FPSO PSD (*Close/stop wells/boosting system aligned to affected flowline(s) only)*

Start timers T2 and T5

- Production tree (first)
  - Close CIV1, CIV2, CIV3, CIV4, CIV5, CIV6, and XOV
  - Close PCV
  - Close FLIV, after T2 times out
  - Close AVV
  - Close PWV, after T5 times out
  - Close PMV, AWV, AAV, AMV
- Boosting system (second)
  - Stop pump cartridges #1 and #2
  - Close CIV1, CIV2, CIV3, CIV4, CIV5, CIV6, CIV7, CIV8, CIV9, and CIV10
  - Open PCV1 and PCV 2
  - Close PPIV1, PPIV2, PPIV4, and PPIV4 after T5 times out
- Production manifold (third)
  - Close CIV1, CVI2, CIV3, and CIV4
- Gas export line manifold (fourth)
  - Close SSIV

5. Flowline PSH (*Close/stop wells/boosting system. manifold valves aligned to affected flowline(s) only)*

Start timer T5, T6, and T11

- Production tree (first)
  - Close CIV1, CIV2, CIV3, CIV4, CIV5, CIV6, and XOV
  - Close PCV
  - Close FLIV
  - Close AVV
  - Close PWV
  - Close PMV, AWV, AAV, AMV
  - Close SCSSV after T6 times out
- Boosting system (second)
  - Stop pump cartridges #1 and #2
  - Close CIV1, CIV2, CIV3, CIV4, CIV5, CIV6, CIV7, CIV8, CIV9, and CIV10
  - Open PCV1 and PCV 2
  - Close PPIV1, PPIV2, PPIV4, and PPIV4
  - Open PPV1, and PPV2
  - Close PXOV1 and PXOV2
- Production manifold (third)
  - Close CIV1, CVI2, CIV3, and CIV4
  - Close PIV1-A, PIV1-B, PIV2-A, PIV2-B, PIV3-A, PIV3-B, PIV4-A, and PIV4-B
  - Close PPV1 and PPV2
- FPSO Boarding valve
  - Close FPSO boarding valve after T5 times out

- Production HPU
  - Bleed Cascade & Chinook HP output after T11 times out

6. Flowline PSL (*Close/stop wells/boosting system. manifold valves aligned to affected flowline(s) only)*

Start timers T5, T6, and T11

- Production tree (first)
  - Close CIV1, CIV2, CIV3, CIV4, CIV5, CIV6, and XOV
  - Close PCV
  - Close FLIV
  - Close AVV
  - Close PWV
  - Close PMV, AWV, AAV, AMV
  - Close SCSSV after T6 times out
- Boosting system (second)
  - Stop pump cartridges #1 and #2
  - Close CIV1, CIV2, CIV3, CIV4, CIV5, CIV6, CIV7, CIV8, CIV9, and CIV10
  - Open PCV1 and PCV 2
  - Close PPIV1, PPIV2, PPIV4, and PPIV4
  - Open PPV1, and PPV2
  - Close PXOV1 and PXOV2
- Production manifold (third)
  - Close CIV1, CVI2, CIV3, and CIV4
  - Close PIV1-A, PIV1-B, PIV2-A, PIV2-B, PIV3-A, PIV3-B, PIV4-A, and PIV4-B,
  - Close PPV1 and PPV2
- FPSO Boarding valve
  - Close FPSO boarding valve
- Production HPU
  - Bleed Cascade & Chinook HP output after T11 times out

7. Remote workover ESD (*Close/stop wells/boosting system. manifold valves related to the affected production system only)*

Start timers T2, and T4

- Production tree (first)
  - Close CIV1, CIV2, CIV3, CIV4, CIV5, CIV6, and XOV
  - Close PCV
  - Close FLIV
  - Close AVV
  - Close PWV
  - Close PMV, AWV, AAV, AMV
  - Close SCSSV after T2 times out
- Boosting system (second)
  - Stop pump cartridges #1 and #2
  - Close CIV1, CIV2, CIV3, CIV4, CIV5, CIV6, CIV7, CIV8, CIV9, and CIV10
  - Open PCV1 and PCV 2

- Close PPIV1, PPIV2, PPIV4
- Open PPV1, and PPV2
- Close PXOV1 and PXOV2

- Production manifold (third)
  - Close CIV1, CVI2, CIV3, and CIV4
  - Close PIV1-A, PIV1-B, PIV2-A, PIV2-B, PIV3-A, PIV3-B, PIV4-A, and PIV4-B
  - Close PPV1 and PPV2
- Production HPU
  - Bleed Cascade & Chinook LP
  - Bleed Cascade & Chinook HP output after T4 times out

8. Well MCS Planned Shutdown (*Well selected from the MCS)*

Start timers T2 and T5

- Production tree (first)
  - Close CIV1, CIV2, CIV3, CIV4, CIV5, CIV6, and XOV
  - Close PCV
  - Close FLIV, after T2 times out
  - Close AVV
  - Close PWV, after T5 times out
  - Close PMV, AWV, AAV, AMV
- Production manifold (third)
  - Close PIV1-A, PIV1-B, or PIV2-A, PIV2-B, or PI32-A, PIV3-B, or PIV4-A, PIV4-B, after T5 times out

9. Cluster MCS Planned Shutdown (*Close/stop wells/boosting system. manifold valves related to the affected cluster(s) only)*

Start timers T2 and T5

- Production tree (first)
  - Close CIV1, CIV2, CIV3, CIV4, CIV5, CIV6, and XOV
  - Close PCV
  - Close FLIV, after T2 times out
  - Close AVV
  - Close PWV, after T5 times out
  - Close PMV, AWV, AAV, AMV
- Boosting system (second)
  - Stop pump cartridges #1 and #2
  - Close CIV1, CIV2, CIV3, CIV4, CIV5, CIV6, CIV7, CIV8, CIV9, and CIV10
  - Open PCV1 and PCV 2
  - Close PPIV1, PPIV2, PPIV4, and PPIV4 after T5 times out
- Production manifold (third)
  - Close CIV1, CVI2, CIV3, and CIV4
  - Close PIV1-A, PIV1-B, PIV2-A, PIV2-B, PI32-A, PIV3-B, PIV4-A, and PIV4-B, after T5 times out

Subsea triggered shutdowns

1. SESD (subsea ESD) HH/LL manifold and/or boosting station pressure (*Close/stop wells/boosting system. manifold valves aligned to affected flowline(s) only)*

Start timers T2, and T5

- Production tree (first)
  - Close CIV1, CIV2, CIV3, CIV4, CIV5, CIV6, and XOV
  - Close PCV
  - Close FLIV, after T2 times out
  - Close AVV
  - Close PWV, after T5 times out
  - Close PMV, AWV, AAV, AMV
- Boosting system (second)
  - Stop pump cartridges #1 and #2
  - Close CIV1, CIV2, CIV3, CIV4, CIV5, CIV6, CIV7, CIV8, CIV9
  - Open PCV1 and PCV 2
  - Close PPIV1, PPIV2, PPIV4, and PPIV4 after T5 times out
  - Open PPV1, and PPV2
  - Close PXOV1 and PXOV2
- Production manifold (third)
  - Close CIV1, CVI2, CIV3, and CIV4
  - Close PIV1-A, PIV1-B, or PIV2-A, PIV2-B, or PIV3-A, PIV3-B, or PIV4-A, PIV4-B, after T5 times out
  - Close PPV1 and PPV2
- FPSO Boarding valve
  - Close FPSO boarding valve after T5 times out

2. WESD Tree HH/LL pressure upstream/downstream choke, and sand/erosion HH (*Close affected well and manifold associated valves only*)

Start timers T2 and T5

- Production tree (first)
  - Close CIV1, CIV2, CIV3, CIV4, CIV5, CIV6, and XOV
  - Close PCV
  - Close FLIV, after T2 times out
  - Close AVV
  - Close PWV, after T5 times out
  - Close PMV, AWV, AAV, AMV
- Production manifold (second)
  - Close PIV1-A, PIV1-B, or PIV2-A, PIV2-B, or PI32-A, PIV3-B, or PIV4-A, PIV4-B, after T5 times out

3. Subsea choke reverse differential pressure (*Close affected well only)*

Start timers T2 and T5

- Production tree (first)
  - Close CIV1, CIV2, CIV3, CIV4, CIV5, CIV6, and XOV
  - Close PCV

- Close FLIV, after T2 times out
- Close AVV
- Close PWV, after T5 times out
- Close PMV, AWV, AAV, AMV

- Production manifold (second)
  - Close PIV1-A, PIV1-B, or PIV2-A, PIV2-B, or PI32-A, PIV3-B, or PIV4-A, PIV4-B, after T5 times out

4. Tree annulus shutdown (*Close affected well only)*

Start timers T2 and T5

- Production tree (first)
  - Close CIV1, CIV2, CIV3, CIV4, CIV5, CIV6, and XOV
  - Close PCV
  - Close FLIV, after T2 times out
  - Close AVV
  - Close PWV, after T5 times out
  - Close PMV, AWV, AAV, AMV
- Production manifold (second)
  - Close PIV1-A, PIV1-B, or PIV2-A, PIV2-B, or PI32-A, PIV3-B, or PIV4-A, PIV4-B, after T5 times out

5. Boosting system ESD motor and pump temperature, motor vibration HH or pump flow rate LL (*Stop and isolate affected boosting system(s) only)*

Start timer T4

- Boosting system
  - Stop pump cartridges #1 and #2
  - Close CIV1, CIV2, CIV3, CIV4, CIV5, CIV6, CIV7, CIV8, CIV9
  - Open PCV1 and PCV 2
  - Close PPIV1, PPIV2, PPIV4, and PPIV4 after T4 times out
  - Open PPV1 or PPV2

6. Loss of both communications channels of boosting system SCM (*Stop affected boosting system(s) only)*

- Boosting system
  - Stop pump cartridges #1 and #2

7. Loss of both comms channels of any tree (*Bleed down hydraulic supply to affected umbilical system(s) only)*

Start timers T9, and T10

- Production tree (first)
  - Start T2 and T5 after T9 times out
  - Close CIV1, CIV2, CIV3, CIV4, CIV5, CIV6, and XOV
  - Close PCV
  - Close FLIV, after T2 times out

- Close AVV
- Close PWV, after T5 times out
- Close PMV, AWV, AAV, AMV

- Boosting system (second)
  - Stop pump cartridges #1 and #2
  - Open PPV1 or PPV2
  - Close PPIV1, PPIV2, PPIV4, and PPIV4
- Production manifold (third)
  - Close CIV1, CVI2, CIV3, and CIV4 after T9 times out
- Production HPU
  - Bleed Cascade & Chinook LP output after T9 times out
  - Bleed Cascade & Chinook HP output after T10 times out

See loss of communications section on page 6 for shutdown philosophy of loss of communications to a production tree and concurrent activation of an ESD signal.

Table 3 – MMS valve Closure Timing

Conditions[10]	Flow line BSDV	USV1[1]	USV2[1]	Alternate Isolation Valve[2]	SCSSV	Subsea Pumps	Pump Isolation Valve	LP Hydraulics	HP Hydraulics.	Comments
Process Upset	Close within 45 seconds of sensor activation[3]	Automatic closure in 20 min.	Automatic closure in 20 min.	Automatic closure in 2 min.	No closure	Stop immediately (30 seconds)	Automatic closure in 20 min.	No Bleed	No Bleed	Alternate Isolation Valve will close after tree choke closes to a certain trim to avoid "hydraulic hammer" on the USV valves. .
Flow line PSH[8]	Close within 20 minutes of sensor activation	Initiate valve closure immediately			60-minute resettable timer; valves must close within 24 hours of sensor activation[5]	Stop immediately (30 seconds)	Initiate valve closures immediately	No Bleed	Bleed within 24 hours of sensor activation	
Flow line PSL[8]	Close within 45 seconds of sensor activation	Initiate valve closure immediately			60-minute resettable timer; valves must close within 24 hours of sensor activation[5]	Stop immediately (30 seconds)	Initiate valve closures immediately	No Bleed	Bleed within 24 hours of sensor activation	
Platform ESD/TSE[9] (Host)	Close within 45 seconds of ESD or sensor activation	5-minute resettable timer; valve must close within 20 minutes of ESD or sensor activation[6]	Valves must close within 60 minutes of ESD or sensor activation.		5-minute resettable timer; valve must close within 60 minutes of ESD or sensor activation[5].	Stop immediately (30 seconds	Close within 20 minutes of sensor activation	Bleed within 60 minutes of ESD or sensor activation.	Bleed within 60 minutes of ESD or sensor activation.	

Conditions[10]	Flow line BSDV	USV1[1]	USV2[1]	Alternate Isolation Valve[2]	SCSSV	Subsea Pumps	Pump Isolation Valve	LP Hydraulics	HP Hydraulics.	Comments
[11]Subsea ESD (Host) or [12]BSDV TSE	Close within 45 seconds of ESD	Valve must close within 5 minutes of BSVD closure			Valve must close within 10 min of BSDV closure	Stop immediately (30 seconds)	Valve must close within 10 minutes of BSVD closure	Bleed within 60 minutes of ESD or sensor activation.	Bleed within 60 minutes of ESD or sensor activation.	
Subsea ESD[7] (MODU)	No automatic closure	Initiate valve closure immediately			Initiate closure 2 min after sensor activation	Stop immediately (30 seconds)	Initiate valve closures immediately	Bleed immediately	Bleed within 10 min of ESD or sensor activation	
Subsea Pump PSHL (downstream/ upstream pump)	Close within 20 minutes of sensor activation	One or more valves must close within 2 minutes after sensor activation. Designated USV must close within 20 minutes of sensor activation.			No closure	Stop immediately (30 seconds)	Close within 20 minutes of sensor activation.	No bleed	No bleed	Open pump recycle valve
Subsea Pump Differential Pressure High	No automatic closure	One or more valves must close within 2 minutes after sensor activation. Designated USV must close within 20 minutes of sensor activation.			No closure	Stop immediately (30 seconds)	Close within 20 minutes of sensor activation.	No bleed	No bleed	Open pump recycle valve
Subsea Pump Temperature High [13]	No automatic closure	No closure			No closure	Stop immediately (30 seconds)	Close within 20 minutes of sensor activation.	No bleed	No bleed	Open pump by-pass valve
Subsa Pump Vibration High [13]	No automatic closure	No closure			No closure	Stop immediately (30 seconds)	Close within 20 minutes of sensor activation.	No bleed	No bleed	Open pump by-pass valve
Subsa Pump Flow Low [13]	No automatic closure	No closure			No closure	Stop immediately (30 seconds)	Close within 20 minutes of sensor activation.	No bleed	No bleed	Open pump by-pass valve

Notes:

[1] In order to designate a valve as the USV, it must be located upstream of the choke valve.

[2] When applicable, the alternate isolation valve must be of same code and construction as designated USV to be recognized as an isolation valve.

[3] BSDV can be reopened to blow down the flow line to prevent hydrates provided the well has been secured and adequate protection has been provided.

[4] PSL must be located upstream of the BSDV.

[5] Prior to resetting the timer on the HP hydraulic system, the integrity of the subsea system must be verified.

[6] The designated USV must close within 5 minutes of an ESD unless an operator actives the timer. After 20 minutes, the USV must close.

[7] Pertains to dropped objects from rig or intervention vessel; Operator must notify the District Manager before resuming production

[8] All wells and flow lines associated with a dual or multi flow line system must be closed according to the PSHL closure schedule. The operators must seek approval of the Minerals Management Service (MMS) District Manager prior to resuming production in the unaffected flow line(s) of a dual or multi flow line system. Should it be determined that the PSHL alarm was a false alarm, then the wells may be returned to production without contacting the MMS District Manager.

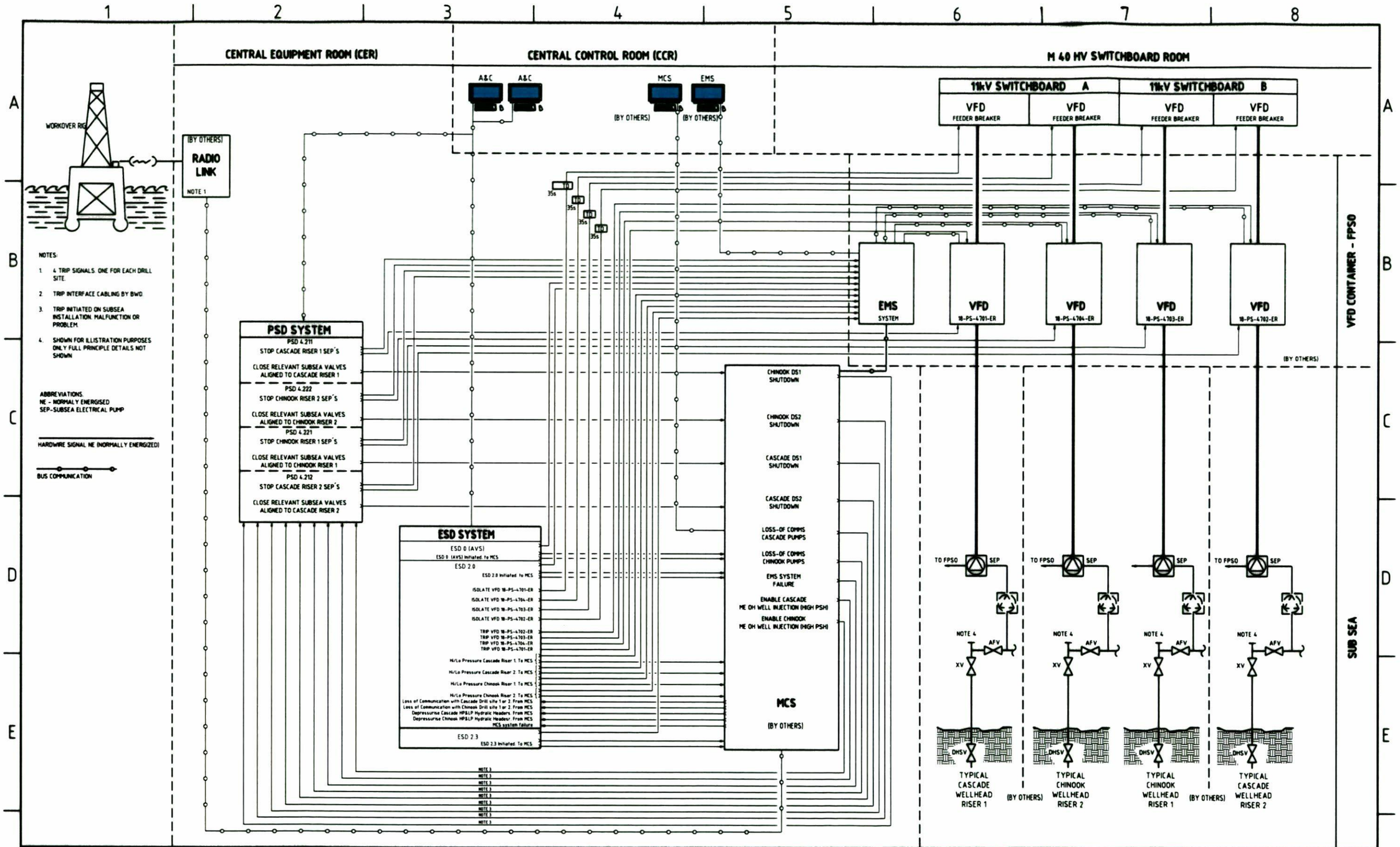
[9] This closure table applies to an ESD/TSE at the host. A 5-minute manual reset timers must be used on the program logic controller for the USV and the SCSSV as described in NTL No. 2000-G13.

[10] The subsea control system must be designed to meet the valve closure times required by the MMS in this table. On installation, the valve closure times must be verified.

[11] Pertains to a Subsea ESD activated from the host facility.

[12] Resettable timers are not allowed to delay valve closure when the BSDV TSE is activated. A TSE must be located within 5 feet of the BSDV. The BSDV valve must be fire rated for 30 minutes per API Spec 6A.

[13] These pump shutdowns, i.e. high pump temperature and vibration are not safety related since the pump is totally enclosed in a casing and there are no leakages to the environment in the event of pup component (motor, seal and impeller) failure. They are implemented prevent damage to the pump.



REV	REASON FOR ISSUE	DATE	ISS.BY	CHECKED	APPR.BY
02	Re-issued for Construction		RB	KVA	JAH
01	Re-issued for Construction	16.02.2009	RB	KVA	JAH
00	ISSUED FOR CONSTRUCTION	20.01.2009	RB	KVA	JAH
A	ISSUED FOR IDC	23.06.2008	RB	KVA	JAH

REV	REASON FOR ISSUE	DATE	ISS.BY	CHECKED	APPR.BY

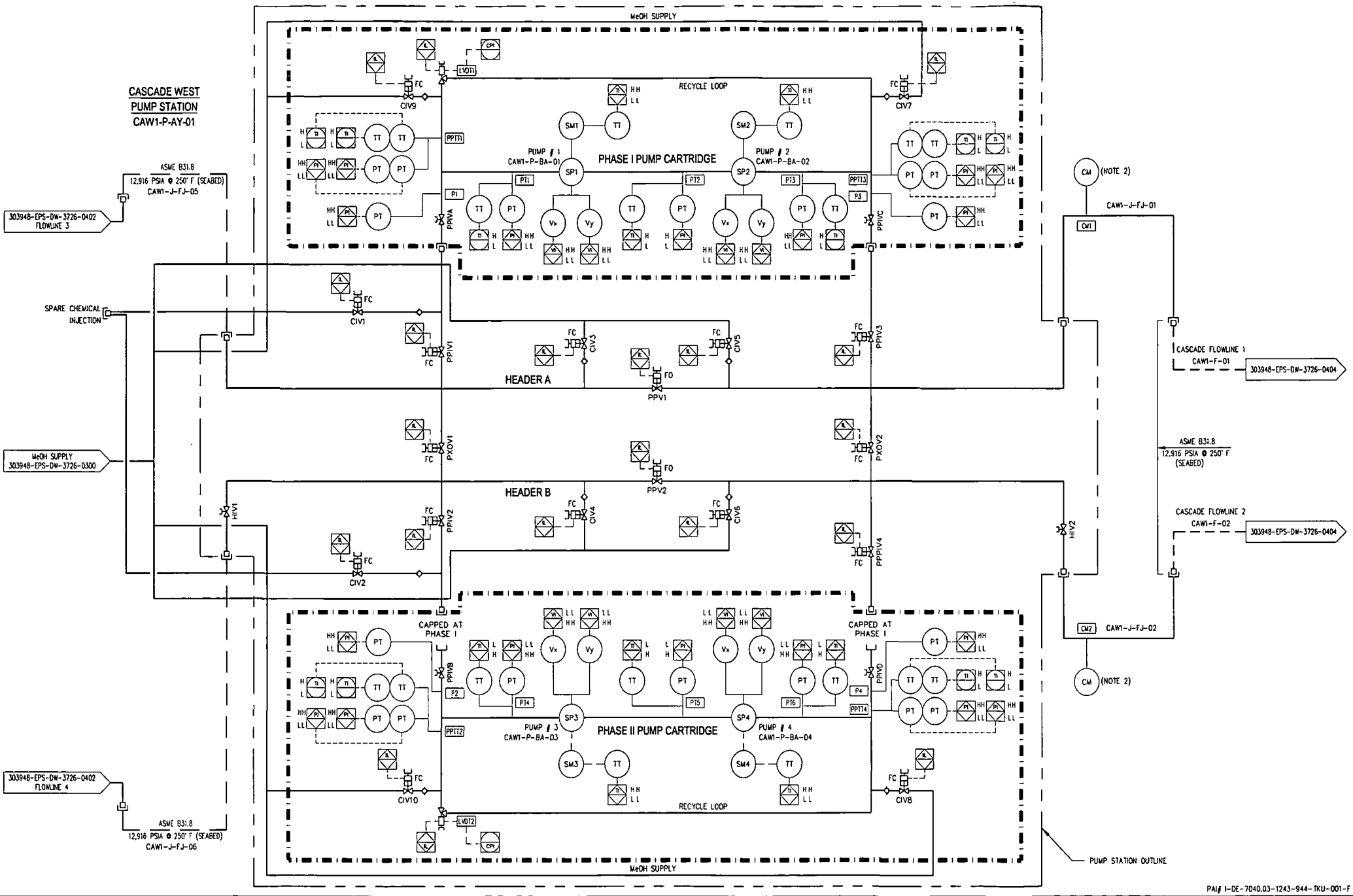
Designed by:	Date:	Discipline:	Area/Module:	Project no:	System no:	Scale:	Format/Size:
BSJ	20.06.2008	EIT	MULTI	4036	79	NTS	A3

Client: PETROBRAS AMERICA INC.

Unit/Field: BW PIONEER

Subject: ESD / PSD SUBSEA SHUTDOWN INTERFACE BLOCK DIAGRAM

BWO dwg. no: 4036-XL-00099416.001	Rev.	Sheet
Client dwg. no:	02	1
Ref. doc. no:		



NOTES:

1. 2x1/2" FUTURE CHEMICAL (TBD), FUTURE TIE-IN TO SPARE UMBILICAL LINE AT HDM.
2. CORROSION MONITOR INSTALLED ON JUMPER BUT SENSOR ELECTRICAL CONNECTION WILL BE MADE ON A FUTURE PROJECT PHASE TO A NEARLY SUBSEA EQUIPMENT SCM.

REV	DATE	BY	DESCRIPTION	CHKD	ENG	APRVD
0	5-AUG-2009	BT	APPROVED	TR	TC	JC

Technip

PETROBRAS CASCADE & CHINOOK
GULF OF MEXICO

DRAWN	CHECKED	ENGINEER	SCALE
R. GAINEY	T. RODGERS	T. COURTES	NONE
DATE	DATE	DATE	SHEET
02/15/08	5-AUG-2009	5-AUG-2009	1 of 1

PETROBRAS AMERICA INC.

PIPING & INSTRUMENTATION DIAGRAM CASCADE WEST PUMP STATION

CLIENT APPROVAL

DRAWING NUMBER: 303948-EPS-DW-3726-0408

REV: (

MICRO

16128
17459

PETROBRAS

10 November 2009

Mr. Lars Herbst
Regional Director
U.S. Department of the Interior
Minerals Management Service
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Attn. Mr. Alex Alvarado - MS 5232

RE: Modification Application for 14-Inch x 9-Inch Pipe-in-Pipe Bulk Oil Right-of-Way Pipeline (*East*), Segments 17460 and 16129 respectively, Installed In and/or Through Blocks 249, 293, 337, 381, 425 and 469, Walker Ridge Area, OCS Federal Waters, Gulf of Mexico, Offshore, Louisiana

Gentlemen:

Pursuant to the authority granted in Section 5 (e) of the Outer Continental Shelf Lands Act (43 U.S.C. 1331 et seq, P.L. 212, 67 Stat. 462), as amended (P.L. 95-372, 92 Stat. 629), and in compliance with the regulations contained in Title 30 CFR, Part 250, Subpart J, Petrobras America Inc. (PAI) filed original application for the referenced 14-inch x 9-inch pipe-in-pipe bulk oil right-of-way pipeline on 19 September 2008 with supplemental data submitted on 14 November 2008, 7 January, 6 March and 24 March 2009. Subsequently, conditional approval was granted by your office by letter date 27 March 2009. In accordance with the conditions set forth in your letter, PAI herewith submits for your review and approval a modification to the original application to establish service, purpose and MAOP of the referenced pipeline.

The *East* 14-inch x 9-inch pipe-in-pipe bulk oil pipeline was installed from the Chinook drill center pipeline end termination (PLET) in WR 425 to the PLET at the riser base in WR 293, during operations commencing on Sunday, 26 April 2009, completed and subsequently hydrotested on 09 July 2009, in accordance with terms of the approval. Installation of the remaining flowline pieces including the riser, riser base, subsea pumps and jumpers along with the associated control umbilical (Segment No. 17723) should follow within the next few months and be completed by January 2010. Completion reports on the various installation pieces are pending.

Petrobras America Inc. • 10350 Richmond Ave. • Suite 1400 • Houston, Texas 77042 • Tel (713) 808-2000 • (713) 808-2007

With respect to the conditions of approval PAI is fully committed to complying with all requirements as listed. Specifically, item number three, contains a number of items and requires the submittal of this modification application therefore; PAI will address these issues independently and specifically with this application.

MMS Approval Letter date 27 March 2009, Item 3)

"A service, purpose and MAOP will not be assigned to the pipeline and the pipeline shall not be placed in service until MMS has sufficient time to review the Deep Water Operations Plan (DWOP) and your proposed production safety system (SSS)".

Supplementary Information: MMS Technical Assessment and Operations Support Section (TAOS) approved the DWOP by letter dated 18 August 2009. The original SSS was submitted to MMS District office on 17 February 2009. The application documentation was thoroughly discussed with the District in the following months and during the visit of District personnel to the BW Pioneer during June 2009. Some recommendations were made by the District following the review and visit, and incorporated in Rev B, submitted on 19 October 2009. It is our understanding that this new revision meets fully with the requirements and recommendations made by the District.

Service and Purpose: Service and purpose of the referenced pipeline is to transport full well stream product from PAI's proposed Subsea Well No. 002, Walker Ridge Block 469, Lease OCS-G 16997, in a northeasterly direction 64,785.34 feet (12.27 miles) to PAI's proposed Floating Production, Storage and Offloading Facility (FPSO), to be located on PAI's Lease OCS-G 16969, Walker Ridge Block 249. Future wells will be brought into the pipeline only from the Walker Ridge Block 425 (Chinook) Unit (Unit Agreement Number 754306012) consists of the following leases:

Lease	Area / Block
OCS-G 16987	Walker Ridge Block 425
OCS-G 16988	Walker Ridge Block 426
OCS-G 16997	Walker Ridge Block 469
OCS-G 16998	Walker Ridge Block 470

The subject pipeline is independent but will twin pipe-in-pipe segment numbers 17459 and 16128 which will be installed parallel to the proposed line to add the

ability to circulate diesel (discussed further in this application), for pigging operations and redundant flow capabilities.

MAOP: PAI has rigorously evaluated the design pressures for the various shut-in scenarios and fluid cases, and believes safe operation of the Chinook pipeline system will be more than adequate for the proposed 10,000 psi MAOP. This has been consistently presented to MMS.

The Chinook field is located in water depths in excess of 8000-feet resulting in a significant column of fluid in the pipeline riser during production operations. This head of fluid must be considered and factored into the determination of the MAOP at the boarding shut down valve (BSDV), resulting in a MAOP at the BSDV that is lower than the Maximum Source Pressure (wellhead shut-in tubing pressure). These considerations were presented in the original application through a comprehensive flow assurance study carried out to evaluate the build-up of pressure in the lines after shut-in of the (BSDV). While the study included the cases of a column of dry gas, diesel and of well fluids, the actual well fluid properties are such that little if any free gas will break out in the risers rendering the theoretical case of a column of dry gas not applicable for the Chinook pipeline and riser. The study findings are included in PAI's technical report **I-RL-7040.02-1500-610-PTL-001** presented in the original application.

Live oil in the lines is replaced by diesel before FPSO disconnection, for the preservation of the system and protection from hydrate formation during periods of inactivity. Diesel is the only other fluid to be introduced in the flowlines and risers once production is established.

PAI has been requested to address in more detail the issue of shut-in time versus pressure build-up as it relates to MAOP. PAI utilized the flow assurance study results, combined with reservoir depletion model results to investigate the development of the BSDV shut-in pressure over time. A dry gas column case and a diesel column case (as described above) were studied for Cascade and Chinook. The results are described in the following paragraphs.

In Figure 1 below the "flowing pressure" curve (in green) represents the maximum source pressure as wells are opened to flow. Superimposed on that flowing pressure curve are curves for three BSDV shut-in scenarios. These are: shut-in after 30 days of production, after 60 days of production and after 180 days of production. A case representing a dry gas column (dotted lines) and a diesel column case (solid lines) were investigated for each of these shut-in scenarios. As expected, all diesel column curves easily fall below the MAOP of

10,000 psi proposed by PAI shortly after initiating production. For the theoretical case of a full column of dry gas, after one month of production, it takes about 30 days for the boarding valve shut-in pressure to reach 10,000 psi. After six months of production it takes 60 days.

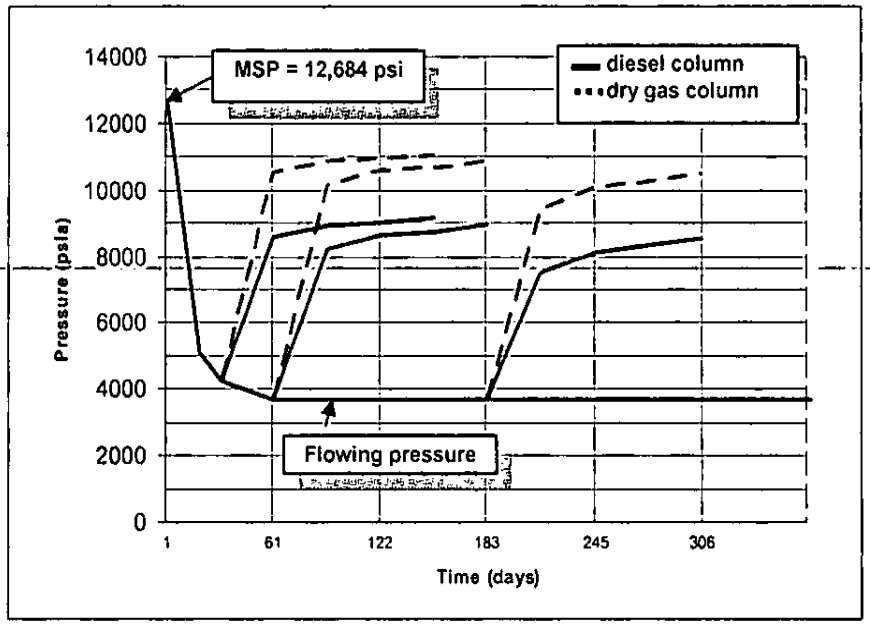


Figure 1: BSDV Pressure vs Time (Flowing and Shut-In)

These curves show that even in the theoretical case of dry gas the BSDV shut-in pressure will be below 10,000 psi for at least 30 days after shut-in. In addition this will require both of the following triggers to occur:

1. A large volume of dry gas to be entered into the production system (note that this gas cannot come from the well fluid because the well fluid bubble point is 1,200 psi)
2. Multiple failure of downhole and subsea tree isolation valves (failure of five valves in series)

Further mitigation can be provided in that PAI is willing to commit to advising MMS (district and region, pipeline section) if the BSDV is expected to be closed longer than 30 days. Typically, for storm avoidance purposes the BSDV would not be shut-in longer than 8 to 10 days.

An estimated calculation of the time it will take for the MSP to fall below the MAOP after startup has also been requested. The Maximum Source Pressure

(MSP) is defined as the wellhead shut-in tubing pressure (SITP) or 12,684 psi for Chinook. The MSP then, when open to flow, will decline as shown in Figure 1 after production commences. Based on calculations it is estimated that MSP (flowing) at seabed will drop below 10,000 psi in only a couple of days after a well is open. Additionally, it would take longer than 30 days, minimum in any case, to build up to or exceed the MAOP upon shut-in. It is expected that the scenario would be repeated each time a new well from Chinook is brought on line. PAI has requested a departure to address the initial operation with the MSP exceeding MAOP.

Departures

Departure requests were deferred, in item three of your approval letter "...until reviews of the DWOP and proposed production safety system are complete." In as much as the DWOP has been approved as referenced above and the near final version of the SSS is under review with the District Manager as required, PAI respectfully requests approval of the departures submitted in our original application of 19 September 2008 along with supplemental submittals 14 November 2008, 6 March and 24 March 09. Primarily, PAI has requested the following departures (not a complete listing):

- Departure from 30 CFR 250.1002(a) - to utilize Lame Equations to determine internal design pressure rather than certain formula contained in CFR and to allow the use of API RP 1111 in designing for the internal design pressure of flowlines, pipelines and risers
- Departure from 30 CFR 250.1002(b)(1) - to hydrotest the flexible jumper onshore to 15,000 psi for a minimum of twenty four hours and then leak test to 1.1 x MAOP (11,000 psi) for minimum of two hours after installation, and to allow hydrotesting of the pipe jumper kits onshore and leak testing after installation
- Departure from 30 CFR 250.1002(c)(1) - to determine the effective MAOP at the top of the riser with respect to the SITP at the seabed allowing pressure credit at the top of the riser based on the hydrostatic head of a full column of diesel in the riser and flowline, with a density of 51.8 lb/ft3 (specific gravity of 0.83 (water S.G. = 1.0)) at 60°F and 14.7 psia to yield an effective MAOP of 10,000 psi at the surface
- Departure from 30 CFR 250.1002(d) - for installing and maintaining redundant safety devices meeting the requirements of section A9 of API RP 14 C when the MSP exceeds the pipeline MAOP
- Departure from 30 CFR 250.1002(d)(2) - to allow operation of the system during a time that the maximum calculated pressure at the top of the riser

using the maximum SITP at the wellhead and a full column of dry gas is greater than the MAOP

- Departure from 30 CFR 250.1004(b)(9) - to omit safety devices (specifically a PSV and FSV) provided for subsea pipeline pumps and setting the PSHL's

For specific discussions provided for each of the departure requests please revert to the submittals and dates referenced above.

A Pay.Gov receipt in the amount of $3,865.00 in accordance with the service fee listed in 10 CFR 250.125(a)(22) is enclosed herewith. The project remains on schedule for production startup by May or June 2010.

We trust the enclosed information will satisfy the regulatory requirements in order for you to approve this modification application prior to first oil however; should you require additional information please contact our Regulatory Compliance Area Manager, Gregory D. Roland at 713.808.2881 or by e-mail to groland@petrobras-usa.com or you may contact me directly at 713.808.2883.

Sincerely,
Petrobras America Inc.

Cheryl Ann Saha

Cheryl Ann Saha
Attorney-In-Fact

SAS:gdr
Enclosures

Online Payment

Online Payment

Step 3: Confirm Payment 1 | 2 | 3

Thank you.
Your transaction has been successfully completed.

Pay.gov Tracking Information

Application Name: MMS Pipeline ROW Modification Application - BY/BZ/CM
Pay.gov Tracking ID: 24VVSCDL
Agency Tracking ID: 74088067510
Transaction Date and Time: 11/10/2009 15:48 EST

Payment Summary

Address Information		Account Information		Payment Information	
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		Card Number:	**********6098	Transaction Date and Time:	11/10/2009 15:48 EST
Billing Address:	10777 Westheimer Road	Region:	Gulf of Mexico		
Billing Address 2:	Suite 1200	Contact:	Jodi Knight 713-808-2884		
City:	Houston	Company Name/No:	Petrobras America Inc., 01207		
State / Province:	TX	Pipeline Segment No.:	17460		
Zip / Postal Code:	77042	Originating Area/Block:	Walker Ridge WR, 469		
Country:	USA	Terminating Area/Block:	Walker Ridge WR, 249		