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2009 Worldwide Survey of Subsea Processing: Separation, Compression, and Pumping Systems

STATUS OF THE TECHNOLOGY

MARCH 2009

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Information Accuracy: We have attempted to use correct and current, as of press time, information for the subsea processing systems and equipment described herein. No installed, sanctioned, nor pending application was intentionally excluded. We have summarized the capability and operating experience by acting as a neutral party and integrator of information. Information has been collected from public sources, company brochures, personal interviews, phone interviews, press releases, industry magazines, vendor-supplied information, and web sites. No guarantee is made that information is accurate or all-inclusive. Neither **INTECSEA** nor **Offshore Magazine** assumes any responsibility or liability for any party's use of the information presented. If any information is found to be incorrect, not current, or has been omitted, please send comments to ssp@intecsea.com.

POSTER 77
2009 Update

LOCATIONS FOR CONCEPTUAL, QUALIFIED, AND INSTALLED SYSTEMS

TABLE 3 – DRIVERS / REASONS FOR SUBSEA COMPRESSION, BOOSTING, WI, AND SEPARATION

1.0 SUBSEA COMPRESSION
1.1 Increase subsea tieback distance
1.2 Improve flow assurance issues
1.3 Eliminate offshore platform(s)
1.4 Enabler – Without the technology the field could not be economically and/or technically developed (i.e. - Gas subsea tieback under the ice in Arctic regions)

2.0 SUBSEA BOOSTING
2.1 RESERVOIR ADVANTAGES
2.1.1 Increase ultimate recovery by lowering abandonment pressure
2.1.2 Enable oil recovery from low pressure reservoirs
2.1.3 Enable oil recovery for low quality fluids
2.2 PRODUCTION ADVANTAGES
2.2.1 Increase production rate by reducing the flowing wellhead pressure
2.2.2 Reduce OPEX by reducing recovery time (shorten life of field)
2.2.3 Offset high friction pressure losses in flowline due to fluid viscosity
2.2.4 Offset elevation head pressure loss
2.3 FACILITIES ADVANTAGES
2.3.1 Longer subsea tiebacks

3.0 SUBSEA WATER INJECTION
3.1 Eliminate topsides water injection handling equipment
3.2 Eliminate water injection flowlines

4.0 SUBSEA SEPARATION
4.1 Minimize topsides water handling
4.2 Remove liquids from gas stream
4.3 Increase hydrocarbon production volume
4.4 Decrease total boost system power requirements
4.5 Accelerate and/or increase recovery
4.6 Improve flow management and flow assurance
4.7 Reduce CAPEX on topsides processing equipment and pipelines
4.8 Improve economics of field with low GOR, high viscosity and low permeability.

4.0 SUBSEA SEPARATION (continued)
4.3 Increase hydrocarbon production volume
4.4 Decrease total boost system power requirements
4.5 Accelerate and/or increase recovery
4.6 Improve flow management and flow assurance
4.7 Reduce CAPEX on topsides processing equipment and pipelines
4.8 Improve economics of field with low GOR, high viscosity and low permeability.

COURTESY OF INTECSEA & BHP BILLITON

TABLE 4 – INDUSTRY ACRONYMS & ABBREVIATIONS

BPD	Barrels per Day	GLR	Gas Liquid Ratio
BOPD	Barrels of Oil per Day	Hp	Horsepower
CAPEX	Capital Expenditures	ICS	Integrated Compressor System
COSSP	Configurable Subsea Separation & Pumping	IOR	Improved (Increased) Oil Recovery
CSSP	Centrifugal Subsea Submersible Pump	kW	Kilowatt
CTCU	Cable Traction Control Unit	LSDM	Long Distance Delivery Management
DMBS	Deepwater Multiphase Boosting System	LDDS	Long Distance Delivery System
ESP	Electrical Submersible Pump	MPP	Multiphase Pump
FFD	Full Field Development	MW	Mega Watts
FPS	Floating Production System	OPEX	Operating Expenditures
FPSO	Floating, Production, Storage, & Offloading Vessel	PCM	Power Control Module
GOWSP	Gas-Oil-Water Separation Platform	PCDM	Power and Communication Distribution Module
GVF	Gas Volume Fraction	PLIM	Pipeline Inline Manifold
		ROV	Remote Operated Vehicle
		RPM	Revolutions Per Minute
		RWI	Raw Water Injection
		SCM	Subsea Control Module
		SOSRS	Subsea Increased Oil Recovery System
		SMUBS	Shell Multiphase Underwater Boost Station
		SPEED	Subsea Power Electrical Equipment Distribution
		SS	Subsea
		SSBI	Subsea Separation Boosting Injection
		SUSSIS	Subsea Separation and Injection System
		SWIT	Subsea Water Injection and Treatment System
		SPCX	Subsea Processing Control Module
		VASPS	Vertical Annular Separation and Pumping System
		VSD	Variable Speed Drive
		WD	Water Depth
		WGC	Wet Gas Compressor
		WI	Water Injection
		WIP	Water Injection Pump

ADDITIONAL RESOURCE
For those who want to understand 'Subsea Processing Terminology' view Poseidon Group AS's document from the following web path:
http://posceansar.vestforsk.no/intra/Portals/0/reports/processing.pdf

SUBSEA SEPARATION TYPES
2-Phase (Gas/Liquid)
2-Phase (Oil/Water)
3-Phase (Gas/Oil/Water)
4-Phase (3-Phase with solids removal & disposal)

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CHART 1 – SUBSEA SUPPLIER MATRIX

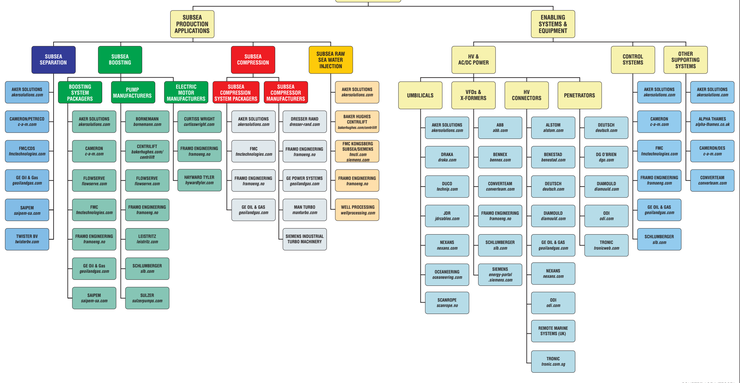


TABLE 2 – METHODS/CONFIGURATIONS

	METHOD/CONFIGURATION	TECHNOLOGY STATUS: CONCEPTUAL	QUALIFIED	INSTALLED OR QUALIFIED/TESTING	SAMPLE PROJECTS Where systems have progressed the furthest
SUBSEA COMPRESSION METHODS/CONFIGURATIONS					
1	Centrifugal (AKS, Siemens/FMC)		Q		Ormen Lange, Asgard
2	Contra-Rotating Axial (Framo WGC)		Q		
3	Twin-Screw Multiphase Pump	C			
WELL PRODUCTION FLOW BOOSTING METHODS/CONFIGURATIONS					
1	MPP Per Well			I	Ceiba C3 & C4, King
2	MPP at SS Manifold			I	Ceiba
3	MPPs Incorporated within SS Manifold			I	Brenda, Exeter + Multiexer
4	MPP at Flowline Inlet			I	Ceiba, Shiehallion, Vincent, Azurite
5	MPP at Riser Base		Q		
6	ESP Downhole in SS Well			I	Otter, Gannet, Lihua
7	ESP Downhole + MPP			I	Multiexer/Exeter
8	ESP Downhole + Caisson ESP			I	Jubarte
9	ESP Downhole + ESP Horiz. Boost Station		Q		
10	ESP Vertical Boost Station (Caisson ESP)		Q		Guiltinho
11	ESP Horizontal Seafloor Boost Station		Q		Cascade/Chinook
12	ESP in Flowline Riser			I	Navajo
13	ESP in Flowline Jumper (Note 1)	C			
SUBSEA WATER INJECTION METHODS/CONFIGURATIONS					
1	Produced WI System (with SS Separation)			I	Troll C Pilot
2	Raw Sea Water SS Injection System			I	Columba E
SUBSEA SEPARATION METHODS/CONFIGURATIONS					
1	In-line Supersonic - Twister Technology		Q		Canapu Field
2	ESP Downhole Oil/Water Separation		Q		
3	ESP Downhole Gas/Liquid Separation		Q		
4	ESP Caisson Separation			I	Marimba (VASPS)
5	2-Phase - Gas/Liquid		Q		Pazflor
6	2-Phase - Water/Oil with Water Reinjection			I	Troll C Pilot
7	3-Phase - Gas, then Oil/Water			I	Tordis

NOTE 1. Brownfield application using existing infrastructure.

COURTESY OF INTECSEA & BHP BILLITON

TABLE 1 – WORLDWIDE SURVEY OF SUBSEA GAS COMPRESSION, BOOSTING, WATER INJECTION, AND SEPARATION (1)

PROCESSING DISCIPLINE	COUNT	FIELD OR PROJECT (Ordered by Start Date)	STATUS	COMMENTS	OWNER/ FIELD OPERATOR	REGION	WATER DEPTH		TIEBACK DISTANCE		SYSTEM TOTAL FLOW RATE (VALVE CONDITIONS)		DIFF. PRESSURE		POWER (Fwd)	GAS VOLUME FRACTION (GVF)	SYSTEM PACKAGER	NO. OF PUMPS OR COMPRESSORS	PUMP TYPE or COMPR. TYPE	COMPRESSOR/PUMP MANUFACTURER	IN-SERVICE/OPERATING INFORMATION			OPERATING EXPERIENCE
					COMPANY		Meters	Feet	Km	Miles	MSCfm	MBOPD MBWPD	BAR (3)	PSI (3)	MW (2)	% OF VOL.	COMPANY	QUANTITY	TYPE	COMPANY	START (11) (Month-Year)	END or PRESENT	MOS.	1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 PRESENT
SUBSEA GAS COMPRESSION	1	**DEMO 2000**	Q	Statoil K-Lab Test	StatoilHydro	Norway									3.60	n/a	Framo Engineering		Counter Axial	Framo Engineering	2001			
	2	**Ormen Lange (4)**	Q	Wet Gas Compression	StatoilHydro	Norway	860	2,789	120	193.1	520	78.5	60.0	870	60.00	n/a	Aker Solutions	4	Centrifugal	GE Compr/Aker Pump	2012			
	3	**Asgard - Midgard & Mikkel Fields**	Q	Wet Gas Compression	StatoilHydro	Norway	300	984	53.0	85.3	TBD	TBD	TBD	TBD	16.00	n/a	FMC/Aker Solutions		Centrifugal	Man Turbo/Siemens	2012			
	4	**Troll**	C		StatoilHydro	Norway	340	1,116	4.0	6.4						n/a	TBA		Undecided	TBA	2016			
	5	**Shtokman**	C		Gazprom	Barents Sea	350	1,148	565.0	909.3					240.00	n/a	TBA		Centrifugal	TBA	2020			
	6	**Snohvit**	C		StatoilHydro	Barents Sea	345	1,132	143.0	230.1					60.00	n/a	TBA		Centrifugal	TBA	2020			
FULL WELLSTREAM SUBSEA BOOSTING (NOTE 1, SEABED & RISER ONLY. NOTE 2. EXCLUDES DOWNHOLE ESPs)	1	★ **Prezioso (20)**	I	MPP at Base of Platform	AGIP	Italy	50	164	0.0	0	65	9.8	40.0	580	0.15	30-90%	Nuovo Pignone (8)	1	Twin-Screw	GE Oil & Gas	1994			
	2	**Gela Field**	I		AGIP																1994			
	3	**Draugen Field**	I	SMUBS Project, 1MPP	A/S Norske Shell	Norway	270	886	6.0	3.7	193	29.2	53.3	773	0.75	42%	Framo Engineering	1	Helico-Axial	Framo	Nov-95	15-Nov-96	12.2	
	4	★ **Lufeng 22/1 Field (9)(19)**	I	Tieback to FPSO	StatoilHydro	South China Sea	330	1,083	1.0	0.6	1,600	241.7	35.0	508	0.40	3%	Framo/FMC	5+2 Spare	Centrifugal (VF)	Framo	Jan-98	Present	133.1	
	5	**Machar Field (ETAP Project)**	C	Hydraulic Turbine Drive	BP Amoco	North Sea	85	277	35.2	21.9	1,100	166.2	22.0	319	0.65	64%	Framo Engineering	2+1 Spare	Helico-Axial	Framo	1999	Never Installed		
	6	**Topacio Field**	Q	1 Dual MPP System	ExxonMobil	Equatorial Guinea	500	1,641	9.0	5.6	940	142.5	35.0	508	0.86	75%	Framo Engineering	2+1 Spare	Helico-Axial	Framo	Aug-00	Present	101.8	
	7	**Ceiba C3 and C4**	Q	Phase 1 SS MPP Project	Amerada Hess	Equatorial Guinea	750	2,461	7.5	4.7	600	90.6	45.0	653	0.84	75%	Framo Engineering	2+1 Spare	Helico-Axial	Framo	Oct-02	Present	75.9	
	8	**Ceiba Field (FFD)**	Q	Full Field Development (FFD)	Amerada Hess	Equatorial Guinea	700	2,297	7.5	4.7	2,500	337.6	45.0	580	1.10	75%	Framo Engineering	5	Helico-Axial	Framo	Dec-03	Present	61.9	
	9	**Multiexer/Exeter**	Q	Santos	W. Australia	145	476	7.0	4.3	1,200	181.3	30.0	435	1.10	0-40%	Framo Engineering	7 ESPs, 2+1 Spare	Helico-Axial	Framo	Mar-05	Present	47.0	
	10	**Lyell**	Q	SS Tieback to Ninian South	CNR	North Sea	146	479	15.0	9.3	1,100	166.2	18.0	261	1.10	40-70%	Aker Solutions	1	Twin-Screw	Bornemann	Jan-06	Present	37.0	
	11	★ **Schiehallion**	I	2 x Dual MPP Systems	BP	West of Shetlands	400	1,312	3.0	1.9	2 x 1,200	2 x 204	26.0	377	1.80	74%	VetcoGray/Framo	4	Helico-Axial	Framo	Mid 2012	Delayed Start Up		
	12	★ **Navajo Field (17)**	Q	ESP in Flowline Riser	Anadarko	GOM	1,110	3,642	7.2	4.5	24	3.6	40.2	583	0.75	57%	BH Centrilift	1	ESP	BH Centrilift	Feb-07	Present	24.0	
	13	Uses BCSS **(14)**	Q	Uses BCSS (14)	Petrobras	Espirito Santo Basin	1,350	4,429	4.0	2.5	120	18.1	138.0	2,002	0.90	10-40%	FMC Technologies	1	ESP	Schlumberger (REDA)	2007			
	14	**Brenda & Nicol Fields**	Q	MultiManifold with 1 MPP	OILEXCO N.S.	North Sea	145	476	8.5	5.3	800	120.8	19.0	276	1.10	75%	Framo Engineering	1+1 Spare	Helico-Axial	Framo	Apr-07	Present	22.0	
	15	★ **King (7)**	Q	SS Tieback to Marlin TLP	BP	GOM, MC Blks	1,700	5,578	29.0	18.0	497	75.0	50.0	725	1.30	0-95%	Aker Solutions	2+1 Spare	Twin-Screw	Bornemann TS/Loher	Nov-07	Present	15.0	
	16	★ **Vincent**	I	Dual MPP System	Woodside	W. Australia	470	1,542	3.0	1.9	2,700	407.9	28.0	406	1.80	25-80%	Framo Engineering	2+2 Spare	Helico-Axial	Framo	May-08	Present	9.0	
	17	**Marlim**	Q	MultiManifold with 1 MPP	OILEXCO N.S.	North Sea	145	450	8.5	5.3	800	120.8	19.0	276	1.10	75%	(13)	1	Helico-Axial	Framo	3Q, 2009		0.0	
	18	**Pfarmigan**	Q	MultiManifold with 1 MPP	OILEXCO N.S.	North Sea					800	120.8	19.0	276	1.10	75%	Framo Engineering	1	Helico-Axial	Framo	Mid 2010		0.0	
	19	**Cascade**	Q	Horizontal ESP on Skid	Petrobras	GOM	2,484	8,150	8.0	5.0	135	20.4	220.0	3,191	1.10	20%	FMC Technologies	2+2	ESPs	BH Centrilift	2011		0.0	
	20	**Chinook**	Q	Horizontal ESP on Skid	Petrobras	GOM	2,682	8,800	19.3	12.0	135	20.4	220.0	3,191	1.10	0%	FMC Technologies	2+2	ESPs	BH Centrilift	2012		0.0	
	21	**Espadarte**	Q	Horizontal ESP on Skid	Petrobras	Espirito Santo Basin	1,350	4,429			125	18.9	100.0	1,450	0.90	10-40%	FMC Technologies	2	ESPs	BH Centrilift	2010		0.0	
	22	**Jubarte Field**	Q	Phase 2 will use BCSS **(14)**	Petrobras	Espirito Santo Basin	1,193	3,914			1,325	200.2				30-40%	Aker Solutions	8	ESPs	BH Centrilift	2010		0.0	
	23	**Jubarte EWT**	I	Riser lift to Seillean drillship	Petrobras	Espirito Santo Basin	1,400	4,593	1.4	0.9	145.0	21.9	140.0	2,000	0.70	32%	FMC Technologies	1	ESP	Schlumberger (REDA)	Dec-02	1-Dec-06	47.9	
	24	**CLOV (12)**	C	Subsea Boosting	Total	Angola, Blk 17	1,200	3,940	12.0	6.2	330.0	49.8	50.0	725	2.30	55%	N/A				2016			
SUBSEA WATER INJECTION	1	**Troll C Pilot (15, 21)**	Q	SUBSIS (SS Sep & WI Sys.)	NorskHydro AS	Norway	340	1,116	4.0	2.5	250	37.8	115.0	2,190	1.60	0%	VetcoGray/Framo	1+1 Spare	Centrifugal	Framo	Sep-99	Present	112.8	
	2	★ **Columba E.**	Q	Dual SPP System	CNR	North Sea	145	476	7.0	4.3	331	50.0	320.0	4,641	2.30	0%	Framo Engineering	2	Centrifugal	Framo	May-07	Present	21.0	
	3	**Tordis**	Q	**(12)**, Separation, Boosting, WI	StatoilHydro	North Sea	200	656	11.0	6.8	700	105.7	77.0	1,117	2.30	0%	FMC Technologies	1+1 Spare	Centrifugal	Framo	Nov-07	15-May-08	6.0	
	4	**Albacora Leste Field**	Q	Raw Water Injection	Petrobras	Brazil	400	1,312	4 to 9	2.5-5.6	1,125	169.9	85.0	1,233	1.2	0%	FMC Technologies	3+1 Spare	Centrifugal	Framo	3Q, 2009		0.0	
	5	**Tyrihans**	I	SS Raw Sea WI System	StatoilHydro	Norway	300	984	31.0	19.3	710	107.3	195.0	2,828	2.70	0%	FMC / Aker	2+1 Spare	Centrifugal	Aker Solutions	Jan-10		0.0	
SUBSEA SEPARATION	1	**SPS Project**	Q		Exxon	GOM	610	2,001			80	12.1									1968			
	2	**Zakum**	I		BP	Abu Dhabi	22	72	0.0	0.0											1970			
	3	**Argyll**	I		BOET (6)	North Sea	75	246													1989			
	4	**Marimba Field**	Q	VASPS Field Test	Petrobras	Campos Basin	395	1,296	1.1	0.7	60	9.1	52.0	754	0.3		Cameron	1	ESPs	Schlumberger (REDA)	May-00	15-Nov-08	101.8	
	5	★ **Tordis**	Q	**(12)**, Separation, Boosting, WI	StatoilHydro	North Sea	200	656	11.0	6.8	1,500	226.6	27.0	392	2.30	10-68%	FMC Technologies	1+1 Spare	Helico-Axial	Framo	Nov-07	15-Nov-08	6.0	
	6	**Perdido**	Q	Gas Separation and Boosting	Shell	GOM	2,438	7,999	0.0	0.0	132-264	20-40	158.8	2,303	1.00	15%	FMC Technologies	5	ESPs	BH Centrilift	2010			
	7	**Cascade/Chinook (BC 10)**	Q	Caisson / Artificial Lift Manifold	Shell	Brazil	2,150	7,054	40.0	25.0	185	27.9	152.0	2,205	1.10	5%	FMC Technologies	4	ESPs	BH Centrilift	2010			
	8	**Pazflor (5)**	I	3 Gas/Liq. Vert. Separation Sys.	Total	Angola, Blk 17	800	2,625	4.0	2.5	1,800	271.9	90.0	1,305	2.30	0-20%	FMC Technologies	6+2 Spare	Hybrid	Framo	3-4Q, 2011			
	9	**Canapu Field**	Q	Twister Separation Technology	Petrobras	Espirito Santo Basin	1,700	5,578	21.0	13.1							TwisterBV	none						

HISTORICAL — PRESENT — FUTURE

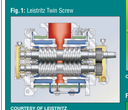
LEGEND ("Stop Light")
C Conceptual Project
Q Qualified/Testing
I Installed
I Installed & Currently Operating
★ Indicates a World Record

NOTES:
1. See information accuracy statement below title block.
2. Power for gas compression is for the entire compression station. Pump power listed is for individual pump motors.
3. Differential Pressure values are for individual pumps.
4. Ormen Lange is pumping low volumes of condensate.
5. Total required that the Pazflor development will utilize seabed gas / liquid separation next to the production well.
6. British Offshore Engineering Technology.
7. King utilizes the world's first umbilical combining HV cables with the service umbilical.
8. Nuovo Pignone is now part of GE Oil & Gas.
9. Low wellhead pressure of 100 psig at seabed dictated that artificial lift was required.
10. VASPS - Vertical Annular Separation and Pumping System.
11. Year indicates first year of operation for the SS processing system.
12. Tordis Field 1+1 Spare Multiphase Boosting Pumps, and 1+1 Spare Water Injection Pumps; Tieback to Gullfaks C platform. Statoil hopes to increase oil recovery from 49% to 55%, an additional 36 MMBO, due to the world's first commercial subsea separation, boosting, injection and solids disposal system.
13. Manufacturers are: Framo Engineering and Schlumberger REDA. There are 2 ESPs per well feeding Framo MPP on seafloor.
14. BCSS - Centrifugal Subsea Submersible Pumps. Pumps are placed in protective holes in the seabed, 200m from the producing wells.
15. Troll SUBSIS - The world's longest operating subsea separation system and first subsea water injection pump system.
16. Manufacturers are: Framo Engineering and Centrilift. There are 2 ESPs per well feeding Framo MPP on seafloor.
17. Navajo field is a 55 fathom in Mississippi Canyon.
18. BH Centrilift = Baker Hughes Centrilift.
19. World Record - 7 Years of operation without intervention.
20. World's first deployment of an electrically driven twin screw MPP operating on a live well. Testing occurred in 1994 and 1995 for a total of 7,850 hours of operation at base of platform on seafloor.
21. Troll C Pilot - Separation began on Aug. 25, 2001. However, SS boosting began in late 2006 after natural flow period ended.
22. Total reports that the CLOV development will utilize seabed multiphase pumps to boost Dropsika and Violeta Miocene two years after "first oil".

COURTESY OF INTECSEA AND BHP BILLITON

SUBSEA PUMP TYPES

Fig. 1: Leistritz Twin Screw

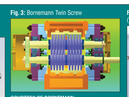


COURTESY OF LEISTRITZ

Fig. 2: Leistritz Twin Screw Pump & Motor

COURTESY OF LEISTRITZ

Fig. 3: Bornemann Twin Screw

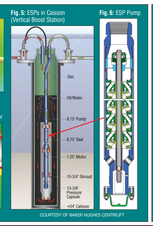


COURTESY OF BORNEMANN

Fig. 4: Bornemann Twin Screw Pump & Motor

COURTESY OF BORNEMANN

Fig. 5: ESPs in Caisson (Vertical Boost Station)



COURTESY OF BAKER HUGHES CENTRILIFT

Fig. 6: ESP Pump

COURTESY OF BAKER HUGHES CENTRILIFT

SUBSEA MULTIPHASE PUMPING SYSTEMS

Fig. 1A: Aker Solutions – MultiBooster™ System

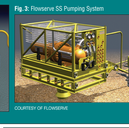
COURTESY OF AKER SOLUTIONS

Fig. 1B

Fig. 2: CAMFORCE™ Boosting System

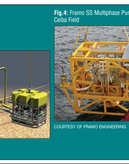
COURTESY OF CAMERON

Fig. 3: Flowserve SS Pumping System



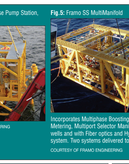
COURTESY OF FLOWSERVE

Fig. 4: Framo SS Multiphase Pump Station, Ceiba Field



COURTESY OF FRAMO ENGINEERING

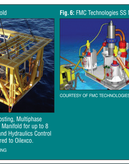
Fig. 5: Framo SS MultiManifold



Incorporates Multiphase Boosting, Multiphase Metering, Multiport Selector Manifold for up to 8 wells and with Fiber optics and Hydraulics Control system. Two systems delivered to Oleoco.

COURTESY OF FRAMO ENGINEERING

Fig. 6: FMC Technologies SS Multiphase Pump



COURTESY OF FMC TECHNOLOGIES

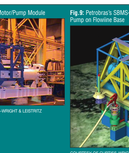
Fig. 7: SSMS-500 System in Transit from Petrobras Qualification Test Site

COURTESY OF CURTISS-WRIGHT & LEISTRITZ

Fig. 8: SSMS-500 Motor/Pump Module

COURTESY OF CURTISS-WRIGHT & LEISTRITZ

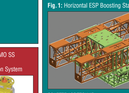
Fig. 9: Petrobras's SSMS-500 Subsea Multiphase Pump on Flowline Base



COURTESY OF CURTISS-WRIGHT & LEISTRITZ

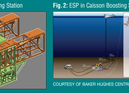
SUBSEA BOOSTING METHODS USING ESPs

Fig. 1: Horizontal ESP Boosting Station



COURTESY OF TECHNIP

Fig. 2: ESP in Caisson Boosting System

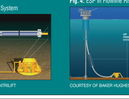


COURTESY OF BAKER HUGHES CENTRILIFT

Fig. 3: ESP Jumper Boosting System

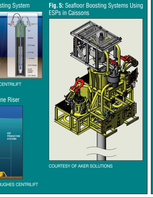
COURTESY OF BAKER HUGHES CENTRILIFT

Fig. 4: ESP in Flowline Riser



COURTESY OF BAKER HUGHES CENTRILIFT

Fig. 5: Seafloor Boosting Systems Using ESPs in Caissons



COURTESY OF AKER SOLUTIONS

SUBSEA PROCESSING ENABLER – MARS™ (Multiple Application Re-injection System)

Fig. 1: MARS™ Subsea Tree Interface diagram.

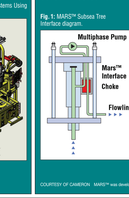


Fig. 2: Cameron's MARS™ System on SS Tree

Fig. 3: MARS™ First Application: BF King Project (2007)

COURTESY OF CAMERON. MARS™ was developed by DES Operations Ltd., now a Cameron Company

SUBSEA GAS COMPRESSION SYSTEMS & PRODUCTS

Fig. 1: Aker Solutions – Proposed Ormen Lange SS Gas Compression Package