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2015 WORLDWIDE SURVEY OF SUBSEA PROCESSING: SEPARATION, COMPRESSION, AND PUMPING SYSTEMS

STATUS OF THE TECHNOLOGY

MARCH 2015

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SUBSEA GAS COMPRESSION SYSTEMS

Fig. 1: Siemens Large Pipe Wet Gas Compression Module, Circuit Breaker Module, Compressor VSD Module, Pump VSD and Compressor Train Module — Courtesy of Aker Solutions

Fig. 2: OneSubsea Multiphase Compressor Delivery Units for Gullfaks Field — Courtesy of OneSubsea

Fig. 3: FMC Technologies Conceptual 2-Train Dry Gas Compression Station with Replaceable Modules — Courtesy of FMC Technologies

Fig. 4: MAN Diesel & Turbo SE Compressor Package for Aasgard Field — Courtesy of MAN Diesel & Turbo

Fig. 5: GE Conceptual Wet Gas Compression System with standardized modules — Courtesy of GE

Fig. 6: Transport of the OneSubsea Multiphase Compression Station for Gullfaks Field — Courtesy of OneSubsea

Fig. 7: GE BlueC Compressor Cross Section — Courtesy of GE

Fig. 8: Aker Solutions Aasgard Subsea Compression Train with 11.3 MW Compressor Module, Separator, Cooler and Pump Module — Courtesy of Aker Solutions

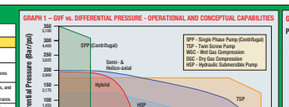
Fig. 9: Aasgard SS Compression Support Structure in Transit by Field for Installation — Courtesy of Aker Solutions

SUBSEA BOOSTING PUMP TYPES

TABLE 2 – PUMP TYPES & APPLICATIONS

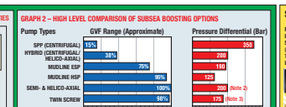
TYPE	CONFIG.	APPLICABILITY FOR SUBSEA BOOSTING
CENTRIFUGAL	HORIZONTAL OR VERTICAL	• Energy efficient pressure capability among pump types. • Handles less Gas Volume Fraction (GVF) < 10% at suction conditions.
HYBRID (CENTRIFUGAL & HELICO-AXIAL)	VERTICAL	• Combination of helico-axial and centrifugal impeller stages. • Primary application is for use downstream of separator or in low GOR applications where GVF is consistently < 30% at suction conditions.
MIXOLINE ESP	HORIZONTAL OR VERTICAL	• Widely deployed technology used for boosting in wells, caissons, flowline risers, and multiline horizontal boosting applications. • Applicable for conditions of GVF < 75% (continuous) and for improved flow assurance.
MIXOLINE HSP	HORIZONTAL OR VERTICAL	• Compact hydraulic drive boosting pump for wells, caissons & multiline applications. • Applicable for conditions of GVF < 75% (continuous) and for improved flow assurance.
SEMI- & HELICO-AXIAL	VERTICAL	• Applicable for higher GVF boosting applications - typical range of 35-100% GVF at suction conditions. • Moderate particulate tolerance.
TWIN SCREW	HORIZONTAL OR VERTICAL	• Good for handling high GVF - up to 90% GVF at suction conditions. • Preferred technology for high viscosity fluids.

GRAPH 1 – GVF vs. DIFFERENTIAL PRESSURE - OPERATIONAL AND CONCEPTUAL CAPABILITIES



Notes: SPP - Single Phase Pump (Centrifugal); TSP - Twin Screw Pump; WGC - Wet Gas Compression; DGC - Dry Gas Compression; HSP - Hydraulic Submersible Pump

GRAPH 2 – HIGH LEVEL COMPARISON OF SUBSEA BOOSTING OPTIONS



Notes:
1. Combination of parameter values shown above is not feasible.
2. There are a number of other parameters/factors that need to be considered for any pump application.
3. Data upon recent updates from Flowserve's new SS boosting pumping system test results. COURTESY OF INTECSEA WorleyParsons Group

CENTRIFUGAL PUMPS (For GVF < 10%)

Fig. 1: Vertically Configured Centrifugal Single-Phase Pump & Motor Diagram — Courtesy of OneSubsea

HYBRID PUMPS (For GVF < 38%)

Fig. 2: Vertically Configured Hybrid Pump & Motor Diagram — Courtesy of OneSubsea

Fig. 3: OneSubsea Hybrid Pump

HYBRID: OneSubsea's hybrid pump is a combination of the Twin Screw Pump surface separation and boosting project. It comprises a cassette series of lower helico-axial stages followed by upper centrifugal stages on the same shaft. This configuration "elevates" the helico-axial stages to generate high pressure lift and allow a wide operating envelope.

Fig. 2 & 3: Courtesy of OneSubsea

ESP PUMPS (For GVF < 75%)

Fig. 4: Diagram of Vertically Configured Cross Handling ESP in a Seabed Caisson — Courtesy of Schlumberger

ESPs can be configured as a downhole pump with the power pressure pump residing on a platform or on the seabed. The ESP can also be vertically configured in a sealed caisson for boosting and separation purposes.

HSP PUMPS (For GVF < 75%)

Fig. 5: Diagram of HSP Principle of Operation — Courtesy of Clyde Union Pumps (SPX)

HSPs can be configured as a downhole pump with the power pressure pump residing on a platform or on the seabed. The HSP can also be vertically configured in a sealed caisson for boosting and separation purposes.

HELICO-AXIAL PUMPS (For GVF < 90%)

Fig. 6: Vertically Configured Helico-Axial Pump & Motor Diagram — Courtesy of Leistritz

Fig. 7: OneSubsea Helico-Axial Pump

HELICO-AXIAL: OneSubsea's helico-axial pump design is a vertical configuration. Recent testing and successful qualification work, in the Hibernia JIP, Joint Industry Project, has greatly increased differential head capability (one Stage 2 for details), and GVF capability was applicable to GVF up to 100%.

Fig. 6 & 7: Courtesy of OneSubsea

TWIN SCREW PUMPS (For GVF < 90%)

Fig. 8: Vertically Configured SPP Twin Screw Pump & Motor — Courtesy of Leistritz

Fig. 9: TSP Twin Screw Pump Cross Section Diagram — Courtesy of Leistritz

Fig. 10: ITT Bornemann Twin Screw Cross Section Diagram — Courtesy of ITT Bornemann

Fig. 11: Vertically Configured SMPC Series 4 Twin Screw Pump & Motor — Courtesy of ITT Bornemann

Fig. 12: Flowserve Horizontally Configured Twin Screw Pump & Motor Concept — Courtesy of Flowserve

SUBSEA SEAWATER TREATMENT AND INJECTION

Fig. 1: Aker Solutions' LiquidBooster™ Subsea Raw Seawater Injection System (Photo: System for Statoil Systems Gullfaks Raw Water Injection Project) — Courtesy of Aker Solutions

Fig. 2: Conceptual Illustration of Installation of Subsea Subsea Raw Seawater Injection (SRSWI) System — Courtesy of Aker Solutions

Fig.3: OneSubsea Raw Seawater Injection System being installed for Columbia E Field — Courtesy of OneSubsea

Figs. 4 & 5: Total-Saipem VMS Westgarth Conceptual and Tested Prototype SS Sulphate Removal Unit capable of treating 60 kbwpd — Courtesy of Saipem

Fig. 6: Subsea Water Intake and Treatment (SWIT) Unit Capable of Treating 40 kbwpd — Courtesy of SEABOX AS

Fig. 7: GE Conceptual Subsea Seawater Sulphate Removal System — Courtesy of GE

Fig. 8: Integrated SS Raw Seawater Injection System Integrating SPP and Filtration — Courtesy of SEABOX AS

Fig. 9: FMC Technologies Vertical Access Caisson with ESP Boosting (Gas/Liquid Separation & Boosting System Diagram — Courtesy of FMC Technologies

SUBSEA SEPARATION SYSTEM TYPES: 1. GRAVITY SEPARATION SYSTEMS (Figs. 1–6)

Fig. 1A: FMC Technologies Conceptual Subsea Separation System for the Tordis Project — Courtesy of FMC Technologies

Fig. 1B: Tordis Separator

Fig. 2: FMC Technologies Conceptual SS Gas/Liquid Separation & Boosting System for Pazflor Project — Courtesy of FMC Technologies

Fig. 3: GE Subsea Separation and Produced Water Reinjection System for Troll C — Courtesy of GE

Fig. 4: Saipem CDSSP (Conceptual 2-Phase Gas/Liquid Separation & Boosting System — Courtesy of Saipem

Fig. 5: Aker Solutions's Conceptual DeepBooster™ with Separation System Flexsep™ — Courtesy of Aker Solutions

Fig. 6: Saipem SpeedSep (Conceptual 3-Phase Separation & Produced Water Reinjection System) — Courtesy of Saipem

HORIZONTAL SEPARATOR – This type is more efficient for oil/water separation. As example, is the concept patented by control engineer for the Tordis Project shown in Fig. 1A. Vertical separators are more efficient for gas/liquid separation. The liquid hold-up that is required on the pump and reduces pump cavitation. An example is the Pazflor vertical separator shown in Fig. 2.
LIMITATIONS – Both types of separators have limited applicability for >10kscf and <20 ft water depth due to material limits.

2. CAISSON SEPARATION SYSTEMS (Figs. 7–9) INTO SEABED

Fig. 7: BCSS Seabed Equipment — Courtesy of Aker Solutions

Fig. 8: Caisson Separation/ESP Boosting System — Courtesy of Baker Hughes

Fig. 9: FMC Technologies Vertical Access Caisson with ESP Boosting (Gas/ Liquid Separation & Boosting System Diagram — Courtesy of FMC Technologies

3. COMPACT/DYNAMIC SEPARATION SYSTEMS (Figs. 10-13)

Fig. 10: OneSubsea Conceptual Two-Phase Separation System — Courtesy of OneSubsea

Fig. 11: OneSubsea Conceptual Three-Phase Separation System — Courtesy of OneSubsea

Fig. 12: FMC Technologies 3-Phase Separation System with Produced Wt Using In-Line Separation Technology for the Marlim Project — Courtesy of FMC Technologies

Fig. 13: ExxonMobil's SS Compact Separation, Boosting and PWRI Using Proprietary/Vendor Technologies for Gas, O/W & Sand Separation — Courtesy of ExxonMobil

Figs. 4 and 6 Courtesy of Saipem

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TABLE 1 – 2015 WORLDWIDE SURVEY OF SUBSEA GAS COMPRESSION, BOOSTING, WATER INJECTION, AND SEPARATION (1/2) – As of Feb. 2015

PROCESS DISCIPLINE	COUNT	FIELD OR PROJECT (Ordered by Start Date)	CURRENT STATUS	COMMENTS	OWNER/ FIELD OPERATOR COMPANY	REGION/ BASINS	WATER DEPTH Meters	WATER DEPTH Feet	TIEBACK DISTANCE Kms	SYSTEM FLOW RATE (ALONE CONDITIONS) MBOPD	MMSCFD	M^3/Hr	DIFFERENTIAL PRESSURE PSI	BAR	INET POWER (1) MW	TOTAL POWER DELIVERED MW	GVF (2) GAS VOLUME FRACTION % OF TOTAL	SYSTEM PACKAGER COMPANY	NO. OF PUMPS/ UNITS PUMPS or COMPR.	PUMP TYPE/ COMPR. TYPE COMPANY	COMPRESSOR/PUMP MANUFACTURER TYPE	IN-SERVICE/OPERATING INFORMATION START (11) (Month-Year)	END or PRESENT	MTHS
SUBSEA GAS COMPRESSION	1	DEMO 2000	O	Statoil K-Lab Test	Statoil	Offshore Norway				3.60			n/a					OneSubsea		Counter Axial	OneSubsea	2001		
	2	Ormen Lange Gas Compression Pilot	S	Boeling 1 train @ Nyhamna, Norway	Shell	Offshore Norway	860	2,821	0.0	0.0	25,000	3776	60.0	870	12.50	58.00	n/a	Aker Solutions	1 + Spare	Centrifugal	GE Compr/Aker Pump	2011	1-Mar-15	
	3	Aasgard - Midgard & Mikkel Fields	M	Subsea Gas Compression	Statoil	Offshore Norway	300	984	40.0	25.0	40,000	6,042	60.0	870	11.50		75%	Aker Solutions	2+1 Spare +1	Centrifugal	MAN/Aker pumps	Q3/Q4, 2015		
	4	Gullfaks South Brent (20)	M	Subsea Wet Gas Compression	Statoil	Offshore Norway	135	443	15.0	8.7	8,000	1465	20.0	435	5.00	10.00	85%	OneSubsea	2+1 Spare	Counter Axial	OneSubsea	Q4, 2015		
	5	Ormen Lange Gas Compression	C	Subsea Gas Compression	Norske Shell	Offshore Norway	860	2,821	120.0	75.0	50,000	7553	60.0	870	12.50		n/a	TBA	2	Centrifugal	TBA	2021		
	6	Troll	C	Subsea Gas Compression	Statoil	Offshore Norway	340	1,116	4.0	2.0							n/a	TBA		Centrifugal	Undecided	TBA	2026	
	7	Pegasus	C	Subsea Gas Compression	Statoil	Offshore Norway	385	1,263	TBD	TBD							TBD	TBD						
	8	Snohvit	C	Subsea Gas Compression	Statoil	Barents Sea	345	1,132	143.0	88.4							TBD			Centrifugal	TBA	2020		
	9	Shtokman	C	Subsea Gas Compression	Gazprom	Barents Sea	350	1,148	585.0	353.1							TBD			Centrifugal	TBA	2022		
	10	Prestige (20)	P	MPP at Base of Platform	AGIP	Italy	32	164	5.0	5.0	65.0	10	40.0	580	0.15		30-90%	Nuovo Pignone (8)	1	Twin-Screw	GE	1994	1995	
	11	Dusseyn Field	P	SMJBS Project, 1 MPTUP	A/S Norske Shell	Offshore Norway	270	886	6.0	3.7	193.0	29	53.3	773	0.75		42%	OneSubsea	1+1 Spare	HSP	SPX Clydeunion	Nov-05	15-Nov-06	12.2
	12	Ludong 22/13 Field (8) (10)	P	Tieback to FPSO	Statoil	South China Sea	330	1,083	1.0	0.6	675.0	102	35.0	508	0.40		3%	OneSubsea/FMC Tech.	2+2 Spare	Centrifugal (GPP)	OneSubsea	Jan-08	31-Jul-09	13.0
	13	Machar Field (ETAP Project)	A	Hydraulic Drive MPP	BP Amoco	UK North Sea	85	277	35.2	21.9	1,100.0	166	22.0	319	0.65		64%	OneSubsea	2+1 Spare	Helico-Axial	OneSubsea			
	14	Tordis Field	O	1 x Dual MPP System	ExxonMobil	Equatorial Guinea	550	1,805	8.0	5.0	940.0	142	35.0	508	0.88		75%	OneSubsea	2+1 Spare	Helico-Axial	OneSubsea	Aug-00	1-Mar-15	174.1
	15	Pazflor (2) + C4	C	Subsea Gas Compression	Total	Angola	750	2,461	7.0	4.3	660.0	91	45.0	653	0.85		75%	OneSubsea	2+1 Spare	Helico-Axial	OneSubsea	Oct-02	1-Mar-15	146.2
	16	Jubarte EWT	C	Riser lift fo Seibsea drilship	Petrobras	Espirito Santo Basin	1,400	4,593	1.4	0.9	145.0	22	140.0	2,000	0.70		22%	FMC Technologies	1	Centrifugal	Schlumberger (REDA)	Dec-02	1-Dec-06	47.9
	17	Cnlta Field (PFD)	O	Full Field Development (FFD)	Hess	Equatorial Guinea	700	2,297	14.5	8.0	2,510.0	378	40.0	580	1.20		75%	OneSubsea	6+2 Spare	Helico-Axial	OneSubsea	Dec-03	1-Mar-15	134.2
	18	Multisenter	O	2 x Single MPP System	Santos	NW Shelf, Australia	45	148	7.8	4.3	1,260.0	181	30.0	435	1.10		0-40%	OneSubsea	2 MPP	Helico-Axial	OneSubsea (16)	Mar-05	1-Mar-15	119.3
	19	Lyell (Original Install)	O	SS Tieback to Nelson South	CNR	UK North Sea	146	479	15.0	8.3	1,100.0	166	18.0	261	1.60		40-70%	Aker Solutions	1	Twin Screw	ITT Bornemann SMPC-S	Jan-06	Dec-06	11.0
	20	Rosebank (17)	A	MPP in Flowline Riser	Anadarko	US GOM	1,110	3,642	7.2	4.5	24.0	4	40.2	633	0.25		27%	Baker Hughes	1	ESP	Baker Hughes	Feb-07	1-Aug-07	5.5
	21	Jubarte Field - Phase 1	O	Seabed ESP-MCSD, Uses BCSS (14)	Petrobras	Espirito Santo Basin	1,350	4,429	4.0	2.5	120.0	18	138.0	2,602	0.90		10-40%	FMC Technologies	1	ESP	Schlumberger (REDA)	Mar-07	Aug-07	5.0
	22	Brenda & Nicol Fields	O	Multibilliontbill with 1 MPP	Premier Oil	UK North Sea	145	476	8.5	5.3	800.0	121	10.0	276	1.10		75%	OneSubsea	1+1 Spare	Helico-Axial	OneSubsea	Apr-07	1-Mar-15	94.3
	23	Perdido	O	SS Tieback to Marlin TLP	Freeport McMoRan	US GOM	1,700	5,578	29.0	18.0	100.0	75	50.0	725	1.30		0-60%	Aker Solutions	Twin Screw	ITT Bornemann	Aker Solutions	Mar-09	15-Feb-09	15.0
	24	Vincent	O	Dual MPP System	Woodside	NW Shelf, Australia	475	1,558	3.0	1.9	2,430.0	363	42.0	609	1.60		25-70%	OneSubsea	2+2 Spare	Helico-Axial	OneSubsea	Aug-10	1-Mar-13	30.9
	25	Marlim	O	SBMS-500 SS Field Test	Petrobras	Campos Basin	1,800	6,234	3.1	1.9	500.0	75	80.0	870	1.20		0-100%	Cortlus-Wright/OneSubsea	1	Twin-Screw	Leistritz			
	26	Gunflint Field	O	2 x Single MPP Systems	Petrobras	Espirito Santo Basin	1,350	4,429	11.0	6.8	140.0	22	138.0	2,602	0.90		10-40%	Schlumberger (REDA) (35)	2	ESP	Baker Hughes (35)	Mar-07	Aug-07	5.0
	27	Jubarte Field - Phase 2 (23)	O	Subsea Gas Compression	Petrobras	Espirito Santo Basin	1,350	4,429	3.0	1.9	350.0	53	41.0	595	0.85		28%	OneSubsea	2+1 Spare	Helico-Axial	OneSubsea	Sep-10	1-Oct-13	36.5
	28	Jubarte Field - Phase 2 (23)	O	MOBO BCSS JESP Caissons (14)	Petrobras	Espirito Santo Basin	1,350	4,429	5.0	3.1	140.0	22	138.0	2,602	1.20		10-40%	Schlumberger (REDA) (35)	2	ESP	Baker Hughes	Mar-07	Aug-07	5.0
	29	Espadarte (Field Trial)	O	Horizontal ESP on Skid	Petrobras	Brazil	1,350	4,429	11.5	7.1	125.0	19	100.0	1,450	0.90		10-40%	FMC Technologies	2	ESP	Baker Hughes	Dec-11	Mar-13	14.5
	30	Canacade & Chinook (6)	O	Subsea Gas Compression	Petrobras	Campos Basin	2,150	7,054	9.0	5.6	185.0	28	152	2,205	1.10		40%	FMC Technologies	2	ESP	Baker Hughes	Jul-09	1-Mar-15	67.4
	31	Barracuda (12)	O	SS MP High Boost Pump System	Petrobras	Campos Basin	1,040	3,412	20.5	6.3	285.0	45	75.0	1,015	1.50		40%	FMC Technologies	2	ESP	Baker Hughes	Jul-12	1-Mar-15	7.0
	32	Montanazo & Lubina	O	Single MPP System	Repsol	Mediterranean	740	2,428	12.3	7.6	80.0	12	65.0	943	0.23		10-70%	OneSubsea	1+1 Spare	Centrifugal (GPP)	OneSubsea	2015+		
	33	Caisson & Pipeline	O	2 x Dual MPP Systems	BP	UK, West of Shetland	400	1,312	4.0	2.5	2,250.0	468	26.0	377	1.50		74%	OneSubsea	4+0 Spare	Helico-Axial	OneSubsea	2014	Delayed Start Up	
	34	CLOV (22)	O	Subsea MPP System	TOTAL	Angola, Blk 17	1,170	3,839	11.0	6.8	660.0	100	45.0	652	2.30		50%	OneSubsea	2+1 Spare	Helico-Axial	OneSubsea	Q4 2015		
	35	Jack & St. Malo	O	3 x Single SPP Systems (JSM)	Chevron	US GOM	2,134	7,000	13.0	21.0	1,191.0	180	241.3	3,500	3.00		10%	OneSubsea	3+2 Spare	Centrifugal (GPP)	OneSubsea	Mid-2015		
	36	Lyell Benefit	O	MPP Retrofit System - Tieback to Ninian	CNR	UK North Sea	146	479	7.0	4.3	700.0	106	21.0	305	1.60		67%	OneSubsea	1	Helico-Axial	OneSubsea	Q4 2014		
	37	Girilli (Girasol) (27)	M	Field Expansion Project	Total	Angola, Blk 17	1,350	4,429	16.0	11.2	600.0	91	130.0	1,885	2.50		20-50%	OneSubsea	4+2 Spare	Helico-Axial	OneSubsea	Q4 2015		
	38	Dusseyn Field	M	2 x Dual Hibernia MPP stations	A/S Norske Shell	Offshore Norway	268	879	4.0	2.5	1,710.0	253	47.5	689	2.30		10-31%	OneSubsea	2	Helico-Axial	OneSubsea	Mid-2015		
	39	Julia	M	SS Tieback with Dual MPP Systems	ExxonMobil	US GOM	2,067	7,560	27.2	17.0	337	53	175.0	2,550	3.00		0%	FMC Tech./Aker Solutions	2	Helico-Axial	OneSubsea	Mid-2016		
	40	Moho Phase 1bis	M	Brownfield Tieback to Alima FPU	Total	Congo, W. Africa	650	2,133	6.7	4.0	400	60	133.5	1,935	3.50		49%	OneSubsea	2	Helico-Axial	OneSubsea	Q4 2015		
	41	Atlanta Field	C	Caisson Application	CGGP (26)	Santos Basin, Blk BS-4	1,500	4,922												Centrifugal (GPP)	OneSubsea	Q2 2015		
	42	Stones	C	Single Phase HPHT Pump System	Shell	US GOM	2,627	8,600	5.0	3.1	TBD	TBD	TBD	TBD	TBD		<10%	TBD	2+1 Spare	TBD	TBD	2018		
	43	Cascade & Chinook	C	MPP in Future Phases	Shell	US GOM	2,222	7,290												Centrifugal (GPP)	TBD	2018		
	44	Parque Das Baleias	C	Horizontal ESP on Skid (14)	Petrobras	Espirito Santo Basin	1,500	4,922	10.0	6.2	125.0	19	100	1,450	1.20		10-25%	FMC Technologies	5+1 Spare	ESP	Schlumberger (REDA)	Q2 2015		
	45	Vigdis	C	Subsea Boosting of existing wells	Statoil	Offshore Norway	280	919	6.5	4.1			50.0	725	2.30	2.30	20-40%	TBA			TBA	2019+		
	46	Troll C Pilot (19) (21)	C	SUBSEA (SS. Sep. and MF Sys.)	Norsk(Hydro AS	Offshore Norway	340	1116	3.5	2.2	250.0	38	151.0	2,190	1.60		0%	GE/OneSubsea	1+1 Spare	Centrifugal (GPP)	OneSubsea	Aug-07	1-Mar-15	101.8
	47	Columba E.	C	Dual SPP System	CNR	North Sea	145	476	7.0	4.3	331.0	50	305.0	4,424	2.30		0%	OneSubsea	2+0 Spare	Centrifugal (GPP)	OneSubsea	May-07	1-Oct-13	76.4
	48	Tordis (IB)	O	Dual SPP & SS FMR Filtration System (12)	Statoil	Offshore Norway	210	689	11.0	6.8	760.0	106	77.0	1,117	2.30		0%	FMC Technologies	1+1 Spare	SPP&MPP	OneSubsea	Oct-07	1-Mar-15	88.3
	49	Tordis	O	SPP & SS FMR Filtration System	Statoil	Offshore Norway	210	689	31.0	19.3	583.0	92	77.0	1,117	2.30		0%	FMC Tech./Aker Solutions	1+1 Spare	Centrifugal (GPP)	Aker Solutions	Jun-08	1-Mar-15	81.8
	50	Albacora Leste/Este (23)	O	Raw Water Injection to 7 Wells	Petrobras	Campos Basin, Brazil	400	1,312	4 to 9	2.5 to 6.0	1125	179	65	1,233	1.2		0%	OneSubsea	3+1 Spare	Centrifugal (GPP)	OneSubsea	Q1 2013		0.0
SUBSEA WATER INJECTION	1	Zakum	O	Shallow Water Test Separation System	BP	Offshore Abu Dhabi	34	79														1969	1972	36
	2	Highlander Field (34)	O	Separator/Gas Catcher	Texaco	UK North Sea	400	1,276																
	3	Argyll	A	SS Sep. and Pumping Unit (SSPU)		Hamilton Bros	UK North Sea	80	262												BOET (36)	1989		
	4	Marimba Field (24)	O	MMPS Field Test	Petrobras	Campos Basin	395	1,296	1.7	1.1	60.0	9	52.0	754	0.3		0%	FMC Technologies	1	ESP	Schlumberger (REDA)	Jul-01	1-Jul-08	83.0
	5	Troll C Pilot (19) (21)	O	Horizontal SUBSEA (SS Sep. & MF Sys.)	Hydro (Statoil)	Offshore Norway	340	1,116	3.5	2.2	250.0	38	151.0	2,190	1.60		0%	GE/OneSubsea	1+1 Spare	n/a	OneSubsea	Aug-01	1-Mar-15	161.8
	6	Tordis	O	(12), Separation, Boosting, MF	Statoil	Offshore Norway	210	689	11.0	6.8	1,500.0	227	27.0	392	2.30		10-68%	FMC Technologies	1+1 Spare	Helico-Axial	OneSubsea	Oct-07	1-Mar-15	88.3
	7	Perdido	O	Separation Caisson/Artificial Lift Manifold	Shell	Campos Basin	2,100	7,054	25.0	15.8	150.0	23	152.0	2,205	1.10		15%	TBD	4	ESP	Baker Hughes Centrifr	Aug-09	1-Mar-15	66.4
	8	Perdido	O	Caisson Separation and Boosting	Shell	US GOM	2,438	7,999	0.0	0.0	132-264	20-40	155.8	2,303	1.20		15%	FMC Technologies	5	ESP	Baker Hughes Centrifr	Mar-10	1-Mar-15	58.9
	9	Pazflor	O	3 Gas/Liquid Vertical Separation System	Total	Angola, Blk 17	800	2,625	4.0	2.5	1,000.0	272	105.0	1,523	2.30		<16%	FMC Technologies	6+2 Spare	Hybrid H-A	OneSubsea	Aug-11	1-Mar-15	41.9
	10	Marlim SSAO - Pilot	O	In-Line Separation	Petrobras	Campos Basin	2,078	6,818	3.0	1.9	135.0	20	246	3,553	1.3		67%	FMC Technologies	2	Helico-Axial	OneSubsea	Mar-13	1-Mar-15	23.0
	12	Parque Das Conchas (BC 10) Phase 2 (23)	O	2 additional ESP systems	Shell	Campos Basin	2,150	7,054	25.0	15.6	185.0	28	152.0	2,205	1.10		15%	FMC Technologies	2	ESP	Baker Hughes Centrifr			
	13	Canapu	O	In-Line Separation by Twister BV	Petrobras	Espirito Santo Basin	1,750	5,741																
	14	Corvina (29)	O	WAPS w/Horizontal ESP	Petrobras	Campos Basin	280	919	8.0	5.0			0.0	135.0	20	21	30%	0.4	<10%	FMC Technologies	TBD	Baker Hughes Centrifr		

CURRENT STATUS CATEGORIES
- O Conceptual Project
- D Qualified/Testing
- A Awarded and in Manufacturing or Delivered
- S Installed & Currently Operating
- M Installed & Not Currently Operating or In-Active
- P Abandoned, Removed
- C Canceled Project

NOTES:
1. **Qualification Status** - See information accuracy statement below this block and note that the qualification status categorizations shown in this table, and throughout the poster, are based on the information that is publicly available or known to INTECSEA. These qualification status designations are not necessarily derived using technology readiness level (TRL) assessments per API RP 17G or DNV-RP-A203 (see TRL Cards). Generally speaking, "Testing" and "Qualified" are used interchangeably throughout this poster and in the industry.
2. **Unit Motor Power:** is the unit motor power for either a pump or comp