between a high pressure side and a low pressure side of the subsea unit 116 to drive fluid flow. The high pressure side of the fluid flow stream may be used to bring the sampling fluid into the sampling system 201. The lower pressure side of the flow stream may be used to allow fluid discharge from the sampling system back into the wellbore via outtake flowline 226b. The flowlines 226a,b may be interchangeable to permit fluid to pass in either direction therethrough. The discharged fluid may be replaced with the same volume of sampled fluid. Thus, the differential pressure at the interface ~~123~~ 224 may be used to draw fluid into the sampling system 201.

The sampling system 201 may be usable at a wellsite with or without a differential pressure at the port 123. A pumping unit 247 may be used to draw fluid through the interface ~~123~~ 224 and into the sampling system 201. The pumping unit 247 may include one or more pumping chambers 234a,b. The pumping unit 247 may be used to manipulate fluid flow therethrough to control pressure, to control fluid temperature, and/or to separate the fluid as is passes through the sampling system 201. Fluid may be collected in the pumping unit 247 and stabilized to allow it to separate into phases within the pumping chambers 234a,b. Separated fluid may be collected in pumping chamber 234a,b or diverted to a sample chamber 234c inside or outside of the pumping unit 247.

One or more sample or pumping chambers 234a-c may be used in the separation circuit 225 to collect samples of separated fluid. The sample chambers ~~234a-c~~ 234c used herein may be conventional sample chambers used for collecting fluid samples. The sample chambers 234c may have a cylinder 266 with a piston 268 slidably positionable therein to define a sample cavity 270 for receiving the downhole fluid and a buffer cavity 272 having a buffer fluid therein. Optionally, the sample chambers 234c may have additional features, such as a charging chamber 273 with a second buffer fluid (e.g., Nitrogen). The sample chambers 234c may be provided

123. Fluid may be passed into the sampling system 301, separated into phases for sampling, and collected for retrieval.

The port 123 may have various devices for fluidly connecting the sampling unit 301 to fluid in the subsea unit 116 (see Fig. 1). The port 123 as shown has a flushing fluid 382, a tree control 384 and production fluid access flowlines 386a,b in fluid communication with the subsea unit 116, but may vary with the wellsite features. Interface 324 may have various devices for operatively interacting with the port 123 to facilitate flow of the fluid between the subsea unit 116 and the sampling system 301. The separation circuit 325 is fluidly, electrically and/or hydraulically connected to the port 123 via the interface 324. The interface 324 as shown has various flowlines 226a,b and valves 335a-h for fluid interaction with the port 123 and the separation circuit 325. The interface 324, port 123, and separation circuit ~~324~~ 325 also have links 393 for electrical and/or hydraulic coupling therebetween (and with the ROV 122 and the surface unit 112 if present).

Intake flowline 226a and outtake flowline 226b of interface 324 are fluidly connected to the production fluid access flowlines 386a,b in port 123, and to circuit flowlines 326a,b in the separation circuit 325 for fluid communication therebetween. Connectors 388a,b fluidly connect the circuit flowlines 326a,b of the separation circuit 325 to the intake flowline 226a and outtake flowline 226b, and electrically and/or hydraulically connect the interface 324 with the separation circuit 325 for electrical and/or hydraulic interaction therebetween and with port 123. Valves 355a,b are connected to production flowlines 386a,b and valves 335a-h are positioned in intake/outtake flowlines 226a,b of the interface 324 for selectively diverting flow therethrough. A connector 388b electrically and/or hydraulically connects the interface 324 with the separation circuit 325 for electrical and/or hydraulic interaction therebetween, and with port 123.

Separation circuit 325 may include a pumping unit 347, a flushing unit 349, sample chambers 334(a-g) and valves 352(a-l). Separation circuit 325 has sample chambers 334a-d fluidly connected to circuit flowline~~s~~ 326a ~~326b~~ and sample chambers 334e-g fluidly connected to circuit flowline 326b ~~326a~~. The sample chambers 334a-g may be the same as sample chamber 234 ~~224~~ of Figure 2, or may vary as desired. Sample chambers 334a-d may be used to collect samples of the downhole fluid drawn into the separation circuit 325.

Sample chamber 334e as depicted is the flushing unit 349 fluidly connected to flowline 326b for selectively flushing fluid from the separation circuit 325. The flushing unit 349 may include one or more sample chambers 334e fluidly connected about the separation circuit 325. The flushing unit 349 may also be fluidly connected to the sample chambers 334a-d by circuit flowline 374e1. Valves 352g-j may selectively permit passage of fluid between the sample chambers 334a-d and flushing unit 349. Flushing unit 349 may be used to flush fluid from the sample chambers 334a-d and the flowline.

Sample chambers 334f,g as depicted are pumping chambers 334f,g used as the pump 347 for selectively pumping fluid through the separation circuit 325. The pumping unit 347 includes two pumping chambers 343f,g for selectively manipulating fluid flow through the sampling unit 301, but one or more such chambers or other pumping devices may be used. The pumping chambers 343f,g are fluidly connected to circuit flowlines 326a,b. Sample chambers 334f,g have sample cavities 370f,g with sample flowlines 374f1-g1 fluidly connected to circuit flowline 326a for receiving or discharging fluid therefrom.

Buffer cavities 372f,g of pumping chambers 334f,g are fluidly connected together by a buffer flowline 376g. A pump 374 may be provided between the buffer cavities 372f,g for manipulating flow into the pump 347, for example, to draw fluid through the separation circuit

During operation, commands may be sent, for example, from the surface unit 112 and/or ROV 122 to the separation circuit 325, interface 324 and/or port 123 to activate various flow control devices, such as sample chambers 334a-g, pump 347, valves 352a-o or other devices therein. Each of the Figures 3A-3G sequentially depict steps of a sampling operation. In the initial step of Figure 3A, the valves 352a-j,m,o are closed and valves 352k,l,n are open.

In the hot stab step of Figure 3B, a connection is established between separation circuit 325 and interface 324 via connector 388a,b for hydraulic and/or electrical interaction between separation circuit 325 and interface 324. As also shown in Figure 3B, valves 352a,f,k,l,n,o are opened for performing a pressure test. The pressure test may be used to verify that the hot stab connection between the port 123, interface 324 and/or sampling circuit 325 is working satisfactorily. The pressure test may be performed, for example, by using pumping unit 347 to draw fluid into the sampling circuit from flushing unit 349. Sensors 380 (and/or other sensors) may be used to monitor pressure and relay data to the ROV 122 and/or surface unit 112 as necessary.

In step 3 of Figure 3C, a pressure test may be performed by opening port valves 355a,b to the tree flushing fluid 382, and opening interface valves 335b,c,f,g. As shown in Figure 3C (and after performing the hot stab test of Figure 3B), the fluid of the pumping unit 347 and flushing unit 349 may be used to perform the pressure test on valves 335a-b of interface 324. In some cases, flushing fluid ~~from charging tank~~ 382 may be used to perform the pressure test on valves 335a-b.

Interface valves, such as 335a,b,e,f and/or others, may be opened by link 392c as shown in Figure 3D. The interface valves 335a,e may to fluidly link hydraulic unit 392c with the flushing fluid ~~charging tank~~ 382. Sensors may be provided about port 123 to measure pressure. Data gathered

by these sensors may be captured by the computer unit 390c and passed to the ROV 122 and/or surface unit 112, for example, when a connection is provided in 388b.

In a back flushing step of Figure 3E, fluid is pumped from flushing unit 349 by pumping fluid in pumping unit 347 from buffer cavity 372f to buffer cavity 372g. This pumping action causes fluid to flow from sample cavity 370g out through flowline 326b and through production flowline ~~port~~ 386b. This step may also be performed by flushing the fluid out through flowline 326a and through production flowline ~~port~~ 386b by closing valve 352f and opening valve 352a. Fluid may also be flushed through sample cavities 370e,f,g and discharged through flowline 226b of interface 324, out through the production flowline ~~port outlet~~ 386a and back to the subsea unit 116.

In an intake step of Figure 3F, fluid is pumped by pump 347 from buffer cavity 372g into buffer cavity 372f. Valves 352b-e,g-j,m is closed and valves 352a,f,k,l,n,o are open. Valves 352k, l are redirected to fluidly connect sample cavities 370f,g to flowline 226b for drawing fluid into sample cavities 370f,g.

In another intake step of Figure 3G, fluid is pumped by pump 347 from buffer cavity 372f into buffer cavity 372g. Valves 352b-e,g-j,m is closed and valves 352a,f,k,l,n,o are open. Valves 352j,k,l are redirected to fluidly connect sample cavities 370f,g to flowline 226b for drawing fluid into sample cavities 370f,g, and discharging fluid from fluid cavity 370g to flowline 226a.

In Figure 3H, pumping is completed, pump 347 is turned off. As fluid flows into the sample chambers 334f,g, the pistons 368f,g fall to receive sampling fluid into sample cavities 370f,g. While sample chambers 334f,g are depicted as having equal volumes of selected phases, any amounts may selectively be collected in any of the chambers.

In a sampling step of Figure 3I, valves 352a-d,g-i,o are closed, valves 352e,f,j-n are open, and valves 352j,k are redirected to allow fluid to flow from flowline ~~226b~~ 226a and into fluid cavity 370g. Buffer fluid from buffer cavity 372g passes into buffer cavity 372f. Fluid from fluid cavity 370f is passed into fluid cavity 370d. Buffer fluid from buffer cavity 372d is passed into fluid cavity 370e.

In another sampling step of Figure 3J, valves 352a-c,e,f,g,h,j,m are closed, and valves 352d,i,k,l,n,o are opened. Buffer fluid from buffer cavity 372f passes into buffer cavity 372g. Fluid from fluid cavity 370g is passed into fluid cavity 370e. Buffer fluid from buffer cavity 372d is passed into sample chamber 334e. Valve 352l is diverted to allow fluid to flow from intake flowline 226b into sample chamber 334g. In a final flushing step of Figure 3K, valves 352a,f,i,k,l,n are open, and valves 352b-e,g-h,j,m,o are closed. Valve 352 k is redirected to fluidly connect sample cavities 370e,f to flowlines 226b. The steps may be repeated as desired to sample from one or more sample chambers 334. Additional steps may be performed to selectively divert fluid as desired and/or optionally to reverse flow.

Figures 4A-4C are schematic views of a separation circuit 425a1-a3, respectively, each having a single pumping/sample chamber 434. The separations circuits 425a1-a3 may act as pumping units 447. Flow into the pumping/sample chamber 434 may be achieved by using differential pressure pumping as previously described with respect to Figure 2. The pumping chambers have cylinders 466 with pistons 468 therein defining a fluid cavity 470 and a buffer cavity 472. Fluid from the wellbore (e.g., 120 of Figure 1) may be drawn into intake flowline 426a and collected in the fluid cavity 470.

In the differential pressure configuration of Figure 4A, the separation circuit 425 may be provided with a flow controller, such as orifice ~~476~~ 477, used in combination with valves 452 (or

chamber 434b has two sample flowlines 474b1, b2. The sample flowlines 474a1, b1,b2 are fluidly connected to the intake flowline 226a for passage of fluid into the sample cavity 470a for sampling. The sample flowline 474a2 is fluidly connected to the outtake flowline 226b for passage of fluid from the sample cavity 470a for discharge.

Each of the pumping/sample chambers 434a,b have a shared buffer flowline 476. The buffer flowline 476 fluidly connects the buffer cavity 472a,b of each of the sample chambers 434a,b to allow buffer fluid to pass therebetween. The buffer cavities 472a,b may be charged with, for example, about 50% buffer fluid. As fluid is drawn into one of the sample cavities 470a,b of one of the pumping/sample chambers 434a,b, buffer fluid may be passed between the buffer cavities 472a,b of each of the sample chambers 434a,b to adjust pressure therebetween. The buffer fluid may also be manipulated between the buffer cavities 472a,b to draw fluid into the sample cavities 470a,b.

Similar to the technique described with respect to Figure 4A, flow into the pumping/sample chambers 434a,b may be achieved by using differential pressure pumping as shown in Figure 4A. In the pressure differential configuration of Figure 5A, differential pressure may be used as the motive force to drive the pistons 468a,b back and forth by selectively switching the inlet valves 552a-b (and optionally 552c-d) and creating a pumping action. The upstream pressure from intake flowline 226a may be used to push the piston 468a down while collecting the well fluid in sample cavity 470a and transferring the hydraulic fluid between buffer cavities 472a,b. This will then lift the piston ~~470b~~ 468b in sample chamber 434b to discharge the well fluid out of sample cavity 470b.

The fluid drawn into the sample cavities 470a,b may be permitted to gravitationally separate. As fluid separates, fluid may be selectively passed from the sample cavities 470a,b and