

1    APPARATUS, SYSTEMS AND METHODS FOR OIL AND GAS OPERATIONS

2

3    The present invention relates to apparatus, systems and methods for oil and gas  
4    operations, in particular to subsea manifolds, and apparatus, systems and methods for use  
5    with subsea manifolds.

6

7    Background to the invention

8

9    In the field of subsea engineering for the hydrocarbon production industry, it is known to  
10    provide flow systems comprising manifolds. A subsea manifold may be connected to one  
11    or more flowlines coming from or going to other flow infrastructure, for example from or to  
12    a subsea well or multiple subsea wells. As such, a typical subsea manifold has a plurality  
13    of connectors for the tie-in of the flowlines, which may be, for example, jumper flowlines  
14    carrying production fluids from the multiple wells. Fluids which enter a subsea manifold of  
15    this type from one or more flowlines are typically then sent onwards from the manifold to a  
16    different location. For example, the fluids delivered from several subsea wells may be  
17    commingled and sent topsides via one or more flowlines.

18

19    More generally, the term “subsea manifold” may be taken to include a number of different  
20    types of subsea infrastructure, including but not limited to a subsea Christmas tree, a  
21    subsea collection manifold system, a subsea well gathering manifold, a subsea distributed  
22    manifold system (such as an in-line tee (ILT)), a subsea Pipe Line End Manifold (PLEM), a  
23    subsea Pipe Line End Termination (PLET) and a subsea Flow Line End Termination  
24    (FLET).

25

26    During the development and life-span of subsea hydrocarbon fields, it is often the case  
27    that new hydrocarbon discoveries are made and/or further tie-ins to the flow system  
28    infrastructure are required. As such, typical subsea well gathering manifolds may be  
29    provided with surplus connectors, to accommodate future tie-in requirements. However,  
30    such manifolds tend to demand a large initial capital expenditure because they are fully  
31    equipped with all of the equipment, instrumentation and valving needed to facilitate the tie-  
32    in and production of the future wells.

33

34    Whatever the type of subsea manifold, if the internal equipment, instrumentation and/or  
35    valving within the manifold is to fail, in order to repair or replace these parts the entire

1 manifold must be recovered. This typically requires large vessels, is expensive, disruptive  
2 and potentially damaging to the surrounding subsea infrastructure, and disruptive to  
3 production operations.

4

5 Summary of the invention

6

7 It is amongst the aims and objects of the invention to provide a subsea manifold and  
8 method of use which mitigates drawbacks of prior art subsea manifolds and methods of  
9 use.

10

11 It is amongst the aims and objects of the invention to provide an apparatus, system and a  
12 method of use for providing fluid control, fluid measurement and/or intervention in a flow  
13 system of an oil and gas production installation, which is an alternative to the apparatus  
14 and methods described in the prior art.

15

16 It is amongst the aims and objects of the invention to provide an apparatus, system and a  
17 method of use for providing fluid control, fluid measurement and/or intervention in an oil  
18 and gas production installation, which addresses one or more drawbacks of the prior art.

19

20 An object of the invention is to provide a flexible apparatus, system and method of use  
21 suitable for use with and/or retrofitting to industry standard or proprietary oil and gas  
22 manifolds.

23

24 Further objects and aims of the invention will become apparent from the following  
25 description.

26

27 According to a first aspect of the invention, there is provided a subsea manifold configured  
28 for connection to a subsea production system, the subsea manifold comprising:  
29 at least one removable module;  
30 wherein the at least one removable module is configured to perform one or more functions  
31 selected from the group comprising: fluid control, fluid sampling, fluid diversion, fluid  
32 recovery, fluid injection, fluid circulation, fluid access, fluid measurement, flow  
33 measurement and/or fluid metering.

34

1 The subsea manifold may be a subsea manifold selected from the group comprising: a  
2 subsea Christmas tree; a subsea collection manifold system; a subsea distributed manifold  
3 system such as an in-line tee (ILT); a subsea Pipe Line End Manifold (PLEM); a subsea  
4 Pipe Line End Termination (PLET); and a subsea Flow Line End Termination (FLET).

5  
6 The manifold may comprise a plurality of removable modules.

7  
8 The at least one removable module may be pre-installed on the subsea manifold and left  
9 in situ at a subsea location for later performance of a subsea operation.

10  
11 The subsea manifold may be provided with alternative and/or additional removable  
12 modules. Such additional or alternative modules may be provided to the manifold at any  
13 time.

14  
15 Fluid measurement may comprise measurement of a temperature and/or a pressure of a  
16 fluid.

17 The at least one removable module may be retrievable. Preferably the removable module  
18 is retrievable to the surface. The removable module may be replaced with or swapped for  
19 an alternative removable module.

20  
21 The manifold may comprise one or more fluid access points which may be configured to  
22 connect to a removable module. The manifold may comprise flowlines and the one or  
23 more fluid access points may be in fluid communication with the flowlines.

24  
25 The one or more fluid access points may be provided with flow caps when not in use (i.e.  
26 when not currently being used to accommodate or receive a removable module).

27  
28 The one or more fluid access points may be single bore fluid access points. Alternatively,  
29 or in addition, the one or more fluid access points may be dual bore and/or a multi-bore  
30 fluid access points.

31  
32 The removable module may comprise a number of bores which corresponds to the  
33 number of bores of the fluid access point to which it is required to connect. Multiple  
34 removable modules may be provided with alternative bore configurations for multiple fluid  
35 access points of complimentary bore configurations.

1

2 The removable module may comprise a connector configured to be connected to the  
3 subsea production flow system. The connector may be configured to be connected to a  
4 flowline of the subsea production flow system (such as a jumper flowline).

5

6 According to a second aspect of the invention there is provided a subsea manifold for a  
7 subsea oil and gas production system, the subsea manifold comprising:

8 at least one connection location for a subsea well;

9 at least one outlet; and

10 at least one fluid access point between the connection location and the outlet;

11 wherein the manifold structure defines a first flow path between the connection location

12 and the at least one access point and a second flow path between the at least one access

13 point and the outlet; and

14 wherein the at least one access point is configured to receive a removable module.

15

16 The at least one fluid access point may be a single bore access point. Alternatively, or in

17 addition, the at least one access point may be a dual bore and/or a multi-bore access

18 point.

19

20 Embodiments of the second aspect of the invention may include one or more features of  
21 the first aspect of the invention or its embodiments, or vice versa.

22

23 According to a third aspect of the invention there is provided a removable module for a  
24 subsea manifold of a subsea production system, the removable module comprising:

25 at least one connector configured to connect the module to the subsea manifold;

26 wherein the removable module is configured to perform a function selected from the group  
27 comprising: fluid control, fluid sampling, fluid diversion, fluid recovery, fluid injection, fluid  
28 circulation, fluid access, fluid measurement, flow measurement and/or fluid metering.

29

30 The removable module may comprise an external connector configured to be connected to  
31 the subsea production flow system.

32

33 The external connector may be configured to be connected to a flowline of the subsea  
34 production flow system (such as a jumper flowline).

35

1 The external connector may be operable to route production flow from the manifold  
2 onwards, into the production flow system.

3  
4 Alternatively, or in addition, the removable module may comprise a plurality of connectors  
5 configured to connect the module to the subsea manifold, such that the module may be in  
6 fluid communication with one or more flow paths within the manifold and much that the  
7 module may receive flow from and/or direct flow back into the manifold.

8  
9 Embodiments of the third aspect of the invention may include one or more features of the  
10 first aspect or the second aspect of the invention or their embodiments, or vice versa.

11  
12 According to a fourth aspect of the invention there is provided a removable module for a  
13 subsea manifold of a subsea oil and gas production system, the removable module  
14 comprising:  
15 a body; and  
16 at least one connector configured to connect the removable module to the subsea  
17 manifold;  
18 wherein the body defines at least one flow path from the at least one connector configured  
19 to be in fluid communication with one or more flow paths of the subsea manifold.

20  
21 Embodiments of the fourth aspect of the invention may include one or more features of the  
22 first to third aspects of the invention or their embodiments, or vice versa.

23  
24 According to a fifth aspect of the invention, there is provided a subsea oil and gas  
25 production installation, the installation comprising:  
26 a subsea production system;  
27 a subsea manifold defining one or more flow paths and comprising at least one connection  
28 location for the subsea production system and at least one fluid access point; and  
29 a removable module;  
30 wherein the subsea manifold is fluidly connected to the subsea production system at the at  
31 least one connection location;  
32 wherein the removable module is connected to the at least one fluid access point of the  
33 subsea manifold; and  
34 wherein the at subsea production system and the removable module are each in fluid  
35 communication with a flow path of the one or more flow paths.

1  
2 Embodiments of the fifth aspect of the invention may include one or more features of the  
3 first to fourth aspects of the invention or their embodiments, or vice versa.

4  
5 According to a sixth aspect of the invention, there is provided a subsea oil and gas  
6 production installation, the installation comprising:  
7 at least one subsea well;  
8 a subsea manifold defining one or more flow paths and comprising at least one connection  
9 location for a subsea well and at least one fluid access point; and  
10 a removable module;  
11 wherein the at least one subsea well is fluidly connected to the subsea manifold at the at  
12 least one connection location;  
13 wherein the removable module is connected to the at least one fluid access point of the  
14 subsea manifold; and  
15 wherein the at least one subsea well and the removable module are each in fluid  
16 communication with a flow path of the one or more flow paths.

17  
18 Embodiments of the sixth aspect of the invention may include one or more features of the  
19 first to fifth aspects of the invention or their embodiments, or vice versa.

20  
21 According to a seventh embodiment of the invention, there is provided a method of  
22 installing a removable module to a pre-installed subsea manifold, the method comprising:  
23 providing a pre-installed subsea manifold comprising a connector connected to a pre-  
24 installed flow component, flow line, module or piece of equipment; and  
25 providing a removable module comprising at least one connector.  
26 removing the pre-installed flow component, flow line, module or piece of equipment from  
27 the connector of the subsea manifold; and  
28 coupling the at least one connector of the removable module to the connector of the  
29 subsea manifold.

30  
31 Embodiments of the seventh aspect of the invention may include one or more features of  
32 the first to sixth aspects of the invention or their embodiments, or vice versa.

33  
34 According to an eighth embodiment of the invention, there is provided a method of  
35 installing a removable module to a pre-installed subsea manifold, the method comprising:

1 providing a pre-installed subsea manifold comprising a connector connected to a pre-  
2 installed flowline; and  
3 providing a removable module comprising at least two connectors;  
4 removing the pre-installed flowline from the connector of the subsea manifold;  
5 coupling a first connector of the at least two connectors of the removable module to the  
6 connector of the subsea manifold; and  
7 coupling the pre-installed flowline to a second connector of the at least two connectors of  
8 the removable module.

9  
10 The pre-installed flowline may be a production flowline and may be an export flowline.  
11 More specifically, the pre-installed flowline may be a flexible or a rigid jumper flowline.

12  
13 The removable module may be configured to perform one or more functions selected from  
14 the group comprising: fluid control, fluid sampling, fluid diversion, fluid recovery, fluid  
15 injection, fluid circulation, fluid access, fluid measurement, flow measurement and/or fluid  
16 metering.

17  
18 The removable module may comprise a flow path between the at least two connectors.

19  
20 The removable module may be a fluid and/or a flow measurement removable module. The  
21 removable module may comprise transducers (or sensors) for measuring fluid properties  
22 such as pressure and/or temperature and/or for measuring properties such as flow rate.  
23 Such transducers (or sensors) may be in direct communication with the flow path of the  
24 retrievable module.

25  
26 Alternatively, or in addition, the removable module may not perform any of the above  
27 functions. Instead, the removable module may act as a spacer module which includes a  
28 flow path between its at least two connectors which may allow fluid to flow therethrough.

29  
30 The pre-installed flowline may be connected to an outlet connector of the subsea manifold.  
31 The method may comprise installing the removable module on the outlet connector of the  
32 subsea manifold.

33

1 The pre-installed flowline may be connected to an inlet connector of the subsea manifold.  
2 The method may comprise installing the removable module on the inlet connector of the  
3 subsea manifold.

4  
5 Embodiments of the eighth aspect of the invention may include one or more features of the  
6 first to seventh aspects of the invention or their embodiments, or vice versa.

7  
8 According to a ninth aspect of the invention there is provided a subsea manifold for a  
9 subsea oil and gas production flow system, the subsea manifold comprising:  
10 at first connector configured to be fluidly connected to a subsea well;  
11 a second connector configured to be fluidly connected to the subsea production flow  
12 system;  
13 a flowline header in fluid communication with the second connector; and  
14 a fluid access point located between the first connector and the flowline header and having  
15 first and second flow access openings;  
16 wherein the manifold structure defines a first flow path between the first connector and the  
17 first flow access opening of the fluid access point and a second flow path between the  
18 second flow access opening of the fluid access point and the flowline header;  
19 wherein the fluid access point is configured to be connected to a removable module  
20 comprising a flow path for connecting the first and second fluid access openings such that  
21 the subsea well and the subsea production flow system are fluidly connected by the  
22 removable module.

23  
24 The subsea manifold may be a subsea Christmas tree, a subsea collection manifold  
25 system, a subsea well gathering manifold, a subsea distributed manifold system (such as  
26 an in-line tee (ILT)), a subsea Pipe Line End Manifold (PLEM), a subsea Pipe Line End  
27 Termination (PLET) and a subsea Flow Line End Termination (FLET).

28  
29 The first connector may be configured to be connected to a flowline (such as a jumper  
30 flowline) to fluidly connect it to the subsea well. Various flow components (such as  
31 flowlines and connectors) may be positioned between the first connector and the subsea  
32 well.

33  
34 The first connector may be configured to receive production fluid from a subsea well. The  
35 first connector may be configured to route a fluid into the subsea well. The first connector

1 may be configured to deliver gas into the subsea well, for the execution of gas lift  
2 operations.

3

4 The manifold may comprise additional connectors configured to be fluidly connected to  
5 additional subsea wells.

6

7 The second connector may be configured to be fluidly connected to a flowline of the  
8 subsea production flow system (such as a jumper flowline). The second connector may be  
9 configured to be connected to an export production flowline of the flow system which may  
10 transport production fluid to the surface. The second connector may be configured to be  
11 connected to a gas delivery flowline.

12

13 The manifold may comprise additional connectors configured to be connected to the  
14 subsea production flow system.

15

16 The flowline header may be a production flowline header. Alternatively, the flowline header  
17 may be a gas lift flowline, also referred to throughout as a gas lift header or a gas lift  
18 flowline header. The manifold may comprise a plurality of flowline headers, and the  
19 plurality of flowline headers may comprise production headers, gas lift headers or a  
20 combination of production headers and gas lift headers.

21

22 The fluid access point comprising first and second flow access openings may be referred  
23 to as a dual bore fluid access point. The fluid access point may comprise more than two  
24 flow access openings and may be a multi-bore fluid access point.

25

26 The manifold may comprise additional fluid access points. The manifold may comprise  
27 fluid access points which may provide dual bore or multi-bore access to a flowline header.

28

29 The fluid access point or points may be provided with flow caps when not in use (i.e. when  
30 not currently being used to accommodate or be connected to a removable module). In this  
31 state, and when no removable modules are present, there cannot be flow between a  
32 subsea well and a flowline header of the manifold because no flow path exists between  
33 them. The flow path or paths that links these components is provided by the removable  
34 module(s).

35

1 The removable module may comprise additional flow paths. The flow path or paths of the  
2 removable module may comprise one or more valves. The removable module may  
3 selectively fluidly connect the subsea well and the subsea production flow system by  
4 operation of the one or more valves provided in the flow path or paths of the removable  
5 module.

6  
7 The removable module may comprise equipment or instrumentation which may be  
8 operable to monitor the properties of the fluid flowing therethrough (such as transducers  
9 and/or flow meters). The removable module may comprise one or more fluid access points  
10 in fluid communication with its flow path and/or one of its paths. The one or more fluid  
11 access points may provide a location for accessing the fluid in the manifold and hence the  
12 subsea well and/or production system to perform fluid intervention operations.

13  
14 The manifold may comprise a third connector configured to be fluidly connected to the  
15 subsea production flow system. The manifold may comprise a second flowline header in  
16 communication with the third connector. The fluid access point may comprise a third flow  
17 access opening. The manifold may define a third flow path between the third flow access  
18 opening of the fluid access point and the second flowline header. The fluid access point  
19 may be configured to be connected to a removable module comprising a first flow path for  
20 connecting the first and second fluid access openings such that the subsea well and the  
21 first flowline header are fluidly connected by the first flow path of the removable module  
22 and a second flow path for connecting the first and third fluid access openings such that  
23 the subsea well and the second flowline header are fluidly connected by the second flow  
24 path of the removable module. The first and second flow paths of the removable module  
25 may be fluidly connected.

26  
27 The manifold may comprise a third connector configured to be fluidly connected to the  
28 subsea well. The manifold may comprise a fourth connector configured to be fluidly  
29 connected to the subsea production flow system. The manifold may comprise a second  
30 flowline header in communication with the fourth connector. The fluid access point may  
31 comprise third and fourth flow access openings. The manifold may define a third flow path  
32 between the third connector and the third flow access opening of the fluid access point and  
33 a fourth flow path between the fourth flow access opening of the fluid access point and the  
34 second flowline header. The fluid access point may be configured to be connected to a  
35 removable module comprising a first flow path for connecting the first and second fluid

1 access openings such that the subsea well and the first flowline header are fluidly  
2 connected by the first flow path of the removable module and a second flow path for  
3 connecting the third and fourth fluid access openings such that the subsea well and the  
4 second flowline header are fluidly connected by the second flow path of the removable  
5 module. The first flowline header may be a production flowline header and the second  
6 flowline header may be a gas lift flowline header.

7

8 Embodiments of the ninth aspect of the invention may include one or more features of the  
9 first to eighth aspects of the invention or their embodiments, or vice versa.

10

11 According to a tenth aspect of the invention there is provided a removable module for  
12 fluidly connecting flow paths within a subsea manifold of a subsea oil and gas production  
13 system, the removable module comprising:

14 a body;

15 a first connector; and

16 a second connector;

17 wherein the first and second connectors are configured to be connected to first and  
18 second flow access openings of an access point of the subsea manifold, respectively; and  
19 wherein the body defines a flow path between the first connector and the second  
20 connector.

21

22 The removable module may comprise additional connectors. The removable module may  
23 comprise additional flow paths. The flow path or paths of the removable module may  
24 comprise one or more valves. The removable module may selectively fluidly connect a  
25 subsea well and a subsea production flow system by operation of the one or more valves  
26 provided in the flow path or paths of the removable module.

27

28 The removable module may comprise equipment or instrumentation which may be  
29 operable to monitor the properties of the fluid flowing therethrough (such as transducers  
30 and/or flow meters). The removable module may comprise one or more fluid access points  
31 in fluid communication with its flow path and/or one of its flow paths. The one or more fluid  
32 access points may provide a location for accessing the fluid in the manifold and hence  
33 may provide access to the subsea well and/or the subsea production system to perform  
34 fluid intervention operations.

35

1 Embodiments of the tenth aspect of the invention may include one or more features of the  
2 first to ninth aspects of the invention or their embodiments, or vice versa.

3

4 According to an eleventh aspect of the invention, there is provided a subsea oil and gas  
5 production installation, the installation comprising:

6 at least one subsea well and a subsea production flow system;

7 a subsea manifold according to the ninth aspect of the invention; and

8 a removable module;

9 wherein the first connector of the subsea manifold is fluidly connected to the subsea well  
10 and the second connector of the subsea manifold is fluidly connected to the subsea  
11 production flow system;

12 wherein the removable module comprises a first connector connected to the first flow  
13 access opening of the fluid access point of the manifold and a second connector  
14 connected to the second opening of the fluid access point of the manifold;

15 wherein the removable module defines a flow path between its first and second connectors  
16 such that the subsea well and the subsea production flow system are fluidly connected by  
17 the removable module.

18

19 Embodiments of the eleventh aspect of the invention may include one or more features of  
20 the first to tenth aspects of the invention or their embodiments, or vice versa.

21

22 According to a twelfth aspect of the invention, there is provided a method of controlling  
23 flow between a subsea well and a subsea production system, the method comprising:

24 providing a subsea oil and gas production installation according to the eleventh aspect of  
25 the invention, wherein the removable module comprises at least one valve in the flow path  
26 between its first and second connectors;

27 operating the at least one valve to selectively permit fluid to flow from the subsea well to  
28 the subsea production flow system and/or from the subsea production flow system to the  
29 subsea well.

30

31 The flowline header may be a production flowline header and the method may comprise  
32 operating the at least one valve to control flow of production fluid from the subsea well to  
33 the production flowline header and subsea production system.

34

1 Alternatively, or in addition, the flowline header may be a gas lift flowline header and the  
2 method may comprise operating the at least one valve to control flow of gas flow from the  
3 gas lift flowline header to the subsea well.

4

5 The manifold may comprise a third connector configured to be fluidly connected to the  
6 subsea production flow system and a second flowline header in communication with the  
7 third connector. The first and second flowline headers may be production flowline headers.  
8 The fluid access point may comprise a third flow access opening and the manifold may  
9 define a third flow path between the third flow access opening of the fluid access point and  
10 the second flowline header. The removable module may comprise a second flow path for  
11 connecting the first and third fluid access openings such that the subsea well and the  
12 second flowline header are fluidly connected by the second flow path of the removable  
13 module. The second flow path may comprise at least one valve. The method may  
14 comprise operating the at least one valve in the first flow path of the removable module  
15 and/or the at least one valve in the second flow path of the removable module to control  
16 whether fluid from the subsea well flows into the first and/or the second production flowline  
17 headers.

18

19 The manifold may comprise a third connector configured to be fluidly connected to the  
20 subsea well and a fourth connector configured to be fluidly connected to the subsea  
21 production flow system. The first flowline header may be a production flowline header and  
22 the manifold may comprise a second flowline header in communication with the fourth  
23 connector. The second flowline header may be a gas lift flowline header. The fluid access  
24 point may comprise third and fourth flow access openings and the manifold may define a  
25 third flow path between the third connector and the third flow access opening and a fourth  
26 flow path between the fourth flow access opening and the second flowline header. The  
27 removable module may comprise a second flow path for connecting the third and fourth  
28 fluid access openings such that the subsea well and the second flowline header are fluidly  
29 connected by the second flow path of the removable module. The method may comprise  
30 operating the at least one valve in the first flow path of the removable module to selectively  
31 permit production fluid to flow from the subsea well to the subsea production flow system  
32 via the production flowline header. The second flow path may comprise at least one valve,  
33 and the method may comprise operating the at least one valve in the second flow path of  
34 the removable module to selectively control the flow of gas flow from the gas lift flowline  
35 header to the subsea well.

1  
2 Embodiments of the twelfth aspect of the invention may include one or more features of  
3 the first to eleventh aspects of the invention or their embodiments, or vice versa.  
4  
5 According to a thirteenth aspect of the invention, there is provided a method of connecting  
6 a new subsea well to a subsea production system, the method comprising:  
7 providing a subsea well, a subsea production flow system and a subsea manifold  
8 according to the ninth aspect of the invention;  
9 wherein second connector of the subsea manifold is fluidly connected to the subsea  
10 production flow system; and  
11 wherein the fluid access point of the subsea manifold is provided with a flow cap;  
12 fluidly connecting the subsea well to the first connector of the subsea manifold;  
13 removing the flow cap from the fluid access point of the subsea manifold; and  
14 connecting a removable module according to the tenth aspect of the invention to the fluid  
15 access point of the module such that the subsea well and the subsea production flow  
16 system are fluidly connected by the removable module.

17  
18 Embodiments of the thirteenth aspect of the invention may include one or more features of  
19 the first to twelfth aspects of the invention or their embodiments, or vice versa.

20

21 Brief description of the drawings

22

23 There will now be described, by way of example only, various embodiments of the  
24 invention with reference to the drawings, of which:

25

26 Figure 1 is a schematic side view of a subsea production system according to a first  
27 embodiment of the invention;

28

29 Figures 2A and 2B are schematic plan views of a subsea manifold according to an  
30 alternative embodiment of the invention;

31

32 Figure 2C is a schematic view of a removable module according to an alternative  
33 embodiment of the invention;

34

35 Figures 3A is a schematic plan view of a subsea manifold according to an alternative  
36 embodiment of the invention;

1  
2 Figure 3B is a schematic view of a removable module according to an alternative  
3 embodiment of the invention;  
4  
5 Figures 4A is a schematic plan view of a subsea manifold according to an alternative  
6 embodiment of the invention;  
7  
8 Figure 4B is a schematic view of a removable module according to an alternative  
9 embodiment of the invention;  
10  
11 Figure 5 is a schematic side view of a subsea production system according to a first  
12 embodiment of the invention; and  
13  
14 Figures 6A to 6C are schematic side views of a subsea production system according to a  
15 first embodiment of the invention.  
16  
17 Detailed description of preferred embodiments  
18  
19 Referring firstly to Figure 1, there is shown, generally at 10, a subsea production manifold.  
20 The manifold 10 comprises a main manifold structure 12 and a removable module 14.  
21  
22 The main manifold structure 12 is a typical base manifold structure including one or more  
23 subsea well tie-in connection locations, a series of internal flowlines, and one or more  
24 outlets for production fluid to exit the manifold. The manifold 10 in question also includes  
25 an arrangement of valves.  
26  
27 One of the subsea well tie-in connection locations is shown at X1. Here, the manifold 10  
28 receives production fluid from a subsea Christmas tree 16 (not shown) of a subsea well. In  
29 addition, a single-bore flow outlet connector is shown at 18. However, it will be appreciated  
30 that numerous outlets and/or access points may be provided on the manifold which may  
31 also comprise dual-bore and/or multi-bore arrangements.  
32  
33 Typical subsea production manifolds contain instrumentation for monitoring the properties  
34 of the production fluid flowing therethrough (for example, pressure transducers for  
35 monitoring pressure, temperature transducers for monitoring temperature, and flow meters

1 for monitoring flow rate, amongst other things). However, such instrumentation has a  
2 tendency to fail and/or has a generally shorter life-span than that of the manifold, and in  
3 order to repair or replace the instrumentation, it would be necessary to recover the entire  
4 manifold in an operation which would cause substantial disruption to the surrounding  
5 subsea production system and infrastructure.

6  
7 Therefore, it is desirable to be able to provide this functionality in removeable modules  
8 which can be individually recovered for repair or replacement should a failure occur.

9  
10 Figure 1 shows, in dashed lines at 20, the location of pressure/temperature transducers  
11 within the manifold 10 which were used to take pressure and temperature measurements  
12 of the production fluid. However, in the present embodiment of the invention, the  
13 transducers 20 have failed and are unable to perform their function as intended. As such,  
14 this functionality has been added out with to the main manifold structure 12 and provided  
15 instead in removable module 14.

16  
17 Following an operation to lift the pre-existing rigid jumper flowline 26 from the outlet  
18 connector 18 of the manifold, the removable module 14 is installed. The removable  
19 module 14 has been landed on and connected to the manifold at the outlet connector 18,  
20 such that in use production fluid flows through the module 14 upon exiting the main  
21 manifold structure 12. The module 14 defines a single flow bore between upper and lower  
22 connectors 23, 24, respectively, and pressure/temperature transducers 22 in  
23 communication with the flow bore. Therefore, the module 14 provides the measurement  
24 functionality which would, in a typical working manifold, be provided within the main  
25 manifold structure. The upper connector 24 of the module 14 is substantially identical to  
26 the outlet connector 18 of the manifold 10 itself, such that an onward flowline - which is, in  
27 this case, a rigid jumper flowline 26 - can connect to the module 14 in the same manner as  
28 it would connect to the manifold 18. This avoids the requirement for modifications to be  
29 made to the production system flow infrastructure, thus saving time and expense.

30  
31 In the configuration shown in Figure 1, production flow is routed through the rigid jumper  
32 flowline 26 upon exiting the manifold 10, and in to a further manifold 10'. The further  
33 manifold 10' is a Pipe Line End Termination (PLET) and comprises a main manifold  
34 structure 12' and removable module 14'. The removable module 14' differs from the  
35 module 14 in that it provides only a single flow bore between its upper and lower

1 connectors, with no additional functionality. The purpose of the module 14 is simply to act  
2 as a spacer between the manifold 10' and the rigid flowline 26 and is required in this  
3 instance for flowline geometry reasons due to the addition of the transducer module 14.

4  
5 Referring now to Figure 2A there is shown, generally at 110, a subsea well gathering  
6 manifold comprising a main manifold structure 112 and a one or more removable modules.  
7 The main manifold structure 112 is a typical, passive base structure which includes only  
8 the necessary piping and flowline headers for the connection and tie-in of multiple subsea  
9 wells, and for onward transportation from the manifold of production fluid to the surface  
10 and/or to a storage or processing facility.

11  
12 The manifold 110 is a so-called "twin header" manifold, which comprises two main  
13 production flowline headers 130a and 130b. Production fluid from one or more subsea  
14 wells which are connected to the manifold 110 is operable to join and flow through either  
15 or both of the production flowline headers 130a, 130b. The production flowline headers  
16 130a, 130b of the manifold 110 may also be connected to and/or continuous with incoming  
17 production flowlines (not shown) which flow into the manifold 110 in the direction of arrows  
18 A. Flow from the wells and the production flowline headers 130a, 130b exits the manifold  
19 through the production flowline headers 130a, 130b in the direction of arrows A', into one  
20 or more export production flowlines (not shown) which transport the fluid to the surface  
21 and/or for onward storage or processing. The manifold also comprises a gas lift flowline  
22 header 132 into which gas can be delivered from the surface and/or from a storage or  
23 injection facility to the manifold 110 - and subsequently into one or more of the subsea  
24 wells which are connected to the manifold 110 - for gas lift operations to assist with the  
25 recovery of hydrocarbons.

26  
27 In the configuration shown, the manifold 110 has the capacity to be connected to up to four  
28 subsea wells. The four subsea well tie-in connection locations are shown generally at X1,  
29 X2, X3 and X4. Each connection location X1, X2, X3 and X4 comprises two flowline  
30 connectors: a connector 134 to receive production fluid from the subsea tree of a subsea  
31 well (either directly or via one or more flowlines and/or additional subsea infrastructure)  
32 and a connector 136 for the delivery of gas to a subsea well for gas lift operations. In  
33 Figure 2A, the connection locations X2, X3 and X4 are shown with flow caps installed  
34 thereon, as they are not connected to any wells. As such, there can be no flow from  
35 connection locations X2, X3 or X4 to any of the flowline headers, because no flow path

1 presently exists between them. The connector 136 of connection location X1 has also  
2 been provided with a flow cap. However, the connector 134 of connection location X1 is  
3 connected to a subsea Christmas tree of a first subsea well (not shown) such that the  
4 manifold 110 can receive production fluid flowing from the well. As the connector 136 has  
5 been capped, the subsea Christmas tree and well in question are not currently engaged  
6 for gas lift operations.

7  
8 In use, production fluid which flows into the manifold 10 from one or more subsea wells via  
9 the connectors 134 at connection locations X1, X2, X3 and X4 will be routed into either (or  
10 both) of the production flowline headers 130a, 130a by removable modules on the main  
11 manifold structure 112 (described in more detail below). This may also be assisted by an  
12 arrangement of valves provided in the removable modules. In the absence of the  
13 removable modules, no flow path exists between the subsea wells and the production  
14 headers.

15  
16 Likewise, gas which flows into the manifold 110 is directed from the gas lift flowline header  
17 132 and into one or more subsea wells via the connectors 136 by an arrangement of  
18 removable modules (not currently shown in this Figure) on the main manifold structure 112  
19 at access points 139 (currently provided with flow caps) and valves provided therein.  
20 Dashed lines 135' have been included to provide an indication of how and where such  
21 removable modules would attach to the manifold structure 112. Again, without the  
22 removable modules there is no flow path between the subsea wells and the header  
23 flowlines within the manifold.

24  
25 As mentioned above, the valves of the manifold 110 which are required for routing the  
26 production fluid from the wells and into the production flowline headers 130a, 130b are not  
27 provided within the main manifold structure 112. Instead, they are provided in removable  
28 modules which can be landed on and connected to the manifold structure 112 at discrete  
29 access points 137 (and 137'). Most of these access points are currently shown provided  
30 with flow caps at 137' and dashed lines 138' have been included to provide an indication of  
31 how and where some of these removable modules would attach to the manifold structure  
32 112.

33  
34 As a first well is connected to the connector 134 of connection location X1, routing of the  
35 production fluid from this well, through the manifold, will be described to provide an

1 example of how the manifold works in use. Production fluid from the well enters the  
2 manifold 110 at the connector 134 and a multi-bore removable module 138 containing the  
3 required valves is provided on access point 137. The valves within this module 138 are  
4 operable to route production flow to production flowline header 130a, production flowline  
5 header 130b, or both. In figure 2A, the access point 137 has three flow access bores /  
6 connectors and the removable module 138 is also provided with three flow access bores /  
7 connectors which correspond with the access point 137. However, in alternative  
8 arrangements of the invention, a removable module with a different number of access  
9 bores to an access point may be provided. For example, a removable module having two  
10 access bores corresponding to only two of the access bores of a three bore access point  
11 137 could be provided. In this case, the module might contain a flow cap or blank to shut  
12 off the third unused module. This sort of arrangement may be provided when production is  
13 only required through one of the production headers.

14

15 In some embodiments, the connection locations for the subsea wells may be provided  
16 directly on the removable modules, instead of on the manifold (or a combination of these  
17 two arrangements may be provided) and the removable modules may function to route  
18 said flow into or from the flowline headers as otherwise described throughout.

19

20 In this example, the valves of module 138 are configured to route production flow to  
21 production flowline header 130a. Flow from the well connected at connection location X1  
22 flows into the flowline header 130a in the manner described, by operation of the valves,  
23 and continues along the production header until it reaches arrives at a flow access point  
24 140 on the flowline header 130a. 140 is a dual-bore access point which facilitates the  
25 landing and connection of dual-bore removable module 142. This module contains  
26 instrumentation for measuring the temperature and the pressure of the production fluid  
27 flowing within flowline header 130a, as well as a number of valves.

28

29 Although only the provision of valves and instrumentation is described above, any  
30 additional flow intervention, measuring and control instrumentation and/or equipment  
31 required by the manifold may also be provided in this way (that is, not as part of the main  
32 manifold structure, but in removable modules).

33

34 Therefore, unlike typical subsea oil and gas manifolds, the manifold 110 does not include  
35 any valves, sensors, other instrumentation or equipment. Instead, these functional

1 elements are provided separately, integrated into one or more removable modules which  
2 can be landed on and connected to the manifold at various locations.

3

4 By providing valving, instrumentation and other equipment in removable modules, instead  
5 of being integral to the manifold, a number of advantages are realised. For example, this  
6 allows for the provision of a simple, standard manifold structure which can be modified  
7 depending on desired functions or requirements by selecting appropriate removable  
8 modules for connection to the manifold. In addition, the function of such a manifold can be  
9 altered at any time by changing the removable modules connected to it. This can be done  
10 without disturbing the manifold itself, and without disturbing the greater flow system to  
11 which it is connected.

12

13 In situations in which, initially, only one or a small number of wells are to be connected to  
14 the manifold, the manifold can be populated with removable modules containing the  
15 valving, instrumentation and equipment only required for this precise number of wells. In  
16 this way, initial capital expenditure can be reduced, yet the option to further populate the  
17 manifold and tie-in additional subsea wells in the future remains open.

18

19 With the functional elements of the manifold being provided in removable modules, repair  
20 and replacement is also made simpler, easier and cheaper. For example, specific modules  
21 can be retrieved, repaired and/or replaced where necessary without having to alter the  
22 entire manifold structure.

23

24 This also allows for a change in purpose or functionality and provides the flexibility to  
25 integrate emerging technologies into the flow system in the future, which could aid with  
26 reservoir management and increased recovery.

27

28 Referring now to Figure 2B, the same manifold 110 of Figure 2A is shown. However, two  
29 wells have now been connected to the manifold 110 at connection locations X1 and X2.  
30 The wells have been connected using both connectors 134 and 136 at each connection  
31 location, and the manifold structure 112 has been populated with removable modules at  
32 the X1 and X2 connection location access points 137, 139 containing the necessary  
33 valving and equipment required to send production fluid from the wells onward to the  
34 surface and/or for storage or processing and the necessary valving required to facilitate

1 the delivery of gas for a gas lift operation to either or both of the wells connected at X1  
2 and/or X2.

3  
4 Fluid is produced from the wells in the same manner that is described with reference to  
5 Figure 2A. In addition, gas flowing in the manifold can now be directed from the gas lift  
6 flowline header 132 and into the subsea wells connected at locations X1 and X2, via the  
7 connectors 136, by the arrangement of valves provided in removable modules 135.

8  
9 The gas lift flowline header comprises a dual bore flow access point 144, similar to the  
10 access point 140 and 140' on the production flowline headers 130a and 130b. Access  
11 point 144 facilitates the landing and connection of dual-bore removable module 146 to the  
12 manifold structure 112. Again, like the module 142, this module contains instrumentation  
13 for measuring the temperature and the pressure of the gas flowing into the gas lift flowline  
14 header 132 of the manifold, as well as two valves.

15  
16 In Figure 2B, the manifold has also been provided with an additional removable module  
17 upon a single bore access point 148, which is in fluid communication with production  
18 flowline header 130a. The additional module 150 is a chemical injection module  
19 comprising three main injection flowlines 151a, 151b and 151c through which chemicals  
20 can be introduced to the production flowline header 130a. Valves contained within the  
21 module 150 can control which (if any) injection flowlines are brought into fluid  
22 communication with the flowline header 130a in order to carry out chemical injection  
23 operations as and when required. The addition of such a module may only be temporary  
24 and may only occur as and when required.

25  
26 As the modules of the manifold 110 can be removed and replaced with relative ease, the  
27 functionality of the manifold 110 can be tailored and enhanced by simply adding, removing  
28 or swapping a module, as applicable. For example, Figure 2C shows an alternative  
29 module 152 which could be used in place of the multi-bore removable module 138 shown  
30 in Figures 2A and 2B, which is operable to route production fluid from one or more wells to  
31 either or both of the production headers. The module 152 differs from the module 138 in  
32 that it also comprises a multi-phase flow meter 154 to provide the manifold with the  
33 additional functionality of performing flow rate measurements for individual phases of the  
34 production fluid.

35

1 Manifolds can be provided with a wide range of further alternative modules. For example,  
2 a manifold may be provided with a module which has the sole purpose of taking fluid  
3 and/or flow measurements (such as temperature and pressure measurements and/or flow  
4 rate measurements), or a multi-purpose module which is able to fulfil a fluid and/or flow  
5 measurement functionality whilst also providing a flow access location for a further piece of  
6 process equipment to access the flow in the manifold.

7  
8 Referring now to Figure 3A, there is shown a manifold according to a further alternative  
9 embodiment of the invention, generally depicted at 210. The manifold 210 is similar to the  
10 manifold 110, and like components are indicated by like reference numerals incremented  
11 by 100. The manifold 210 differs from the manifold 110 in that it is a so-called "single  
12 header" manifold, which comprises only one main production flowline header 230. As  
13 such, the manifold requires only a dual-bore removable module 238, as production fluid is  
14 can only be routed to a single production flowline header 230.

15  
16 Figure 3B shows an alternative module 252 which could be used in place of the dual-bore  
17 removable module 238 shown in Figure 3A. The module 252 differs from the module 238  
18 in that it also comprises a multi-phase flow meter 354 to provide the manifold with the  
19 additional functionality of performing flow rate measurements for individual phases of the  
20 production fluid.

21  
22 Referring now to Figure 4A, there is shown a manifold according to a further alternative  
23 embodiment of the invention, generally depicted at 310. The manifold 310 is similar to the  
24 manifold 110, and like components are indicated by like reference numerals incremented  
25 by 200. The manifold 310 differs from the manifold 110 in that it is a so-called "lean single  
26 header" manifold, which comprises only one main production flowline header 330.

27  
28 A further difference between the manifolds 110 and 310, is that in the manifold 310  
29 production fluid flowing from a well and gas flowing from the gas lift flowline header are  
30 routed through a shared removable module 338 which is located on a quad-bore access  
31 point 337.

32  
33 Figure 3B shows an alternative module 352 which could be used in place of the quad-bore  
34 removable module 338 shown in Figure 3A. The module 352 differs from the module 338  
35 in that it also comprises a multi-phase flow meter 354 to provide the manifold with the

1 additional functionality of performing flow rate measurements for individual phases of the  
2 production fluid.

3

4 In accordance with embodiments described above, the invention extends to apparatus in  
5 which a removable module contains a sensor package, for example for measuring  
6 pressure and/or temperature using transducers in the module (for example, the removable  
7 module 14 of Figure 1). However, also as described above, modules with other functions  
8 or with multiple functions, including but not limited to the provision of a fluid intervention  
9 path, are also within the scope of the invention.

10

11 Figure 5 shows a manifold according to a further alternative embodiment of the invention.  
12 The manifold 410 is similar to the manifold 10 of Figure 1 and like components are  
13 indicated by like reference numerals incremented by 400. Like the manifold 10, the  
14 manifold 410 comprises a main manifold structure 412 and a removable module 414.  
15 However, the removable module 414 differs from that of Figure 1 in that it is a multi-  
16 purpose removable module.

17

18 Like the module 14 of Figure 1, the module 414 comprises pressure/temperature  
19 transducers 422. However, the module 414 also includes an access point 417 for hydraulic  
20 intervention operations. In the embodiment shown, the hydraulic intervention flow access  
21 point 417 is an ROV hot stab connector. However, it will be appreciated that alternative  
22 intervention means may be provided. Therefore, the module 414 can fulfil a fluid  
23 measurement functionality (by providing fluid temperature and/or pressure measurements  
24 of the fluid) as well as providing an additional flow access functionality for hydraulic  
25 intervention operations.

26

27 Another difference between the systems of Figures 1 and 5 is that the flowline 426 is a  
28 flexible jumper flowline. To install the removable module between the main manifold  
29 structure 412 and the jumper flowline 426, the jumper flowline is disconnected from the  
30 manifold structure and parked elsewhere. That is, it is temporarily moved to an alternative  
31 location (typically at or near the manifold; however, it could be moved further away from  
32 the manifold if required or replaced altogether). The module 414 is then installed on to the  
33 manifold 418 with the assistance of an ROV, which makes up the connection between an  
34 external connector of the manifold 418 (to which the jumper flowline 426 was previously  
35 connected) and a first connector 423 of the module 414. A second connector 424 of the

1 module 414 is a male x female jumper connector which allows the existing jumper flowline  
2 426 to be re-installed on the module 414.

3  
4 In use, production flow is routed through the jumper flowline 426 upon exiting the manifold  
5 410 comprising the main manifold structure 412 and removable module 414, and in to a  
6 further manifold 410'. The further manifold 410' is a Pipe Line End Termination (PLET)  
7 similar to that for Figure 1. Although the flowline 426 is a flexible flowline, the spacer  
8 module 414' may still be provided, whether or not it is required for flowline geometry  
9 reasons. However, it will be appreciated that the spacer removable module may be  
10 omitted or replaced with a removable module which is able to perform one or more  
11 functions.

12  
13 For example, Figures 6A to 6C show alternative configurations of the spacer module. In  
14 the configurations shown, an additional subsea well can be connected to the flow system  
15 via the spacer module. The spacer modules 514a, 514b, 514c are similar to the spacer  
16 module 414', and like components are indicated by like reference numerals incremented  
17 by 100.

18  
19 Figure 6A shows an additional subsea well being connected to the system via a flexible  
20 jumper flowline 560a. Figure 6B alternatively shows an additional well being connected via  
21 a rigid jumper flowline 560b. The modules can also be connected to composite flowlines or  
22 jumper flowlines, or a combination of flexible, rigid and composite jumper flowlines. In both  
23 of Figures 6A and 6B, the jumper flowlines are connected to the spacer modules  
24 horizontally.

25  
26 In the configuration of Figure 6C, the spacer module provides a dedicated vertical  
27 connector 561 for the jumper flowline 560c, to receive flow from the additional well.

28  
29 Although specific configurations and arrangements are described in the foregoing  
30 description, it will be appreciated that the spacer module can be installed between any  
31 manifold and flowline within a subsea system, such as between an external opening on the  
32 manifold (for example a flowline connector for a jumper flowline) and a jumper flowline. Not  
33 only can the spacer modules be installed on a variety of manifolds, they can also be  
34 connected at the riser base. Spacer modules can be connected to oil production, gas  
35 production, gas injection, gas lift, water injection and utilities and/or service lines, and can

1 be utilised for a multitude of purposes including sensor installation, flowline access, and  
2 new well tie-in and connection.

3

4 Although in the foregoing description the invention is described with reference to a well  
5 gathering manifold, it will be understood that application of the invention is also relevant to  
6 alternative manifold configurations and in particular to distributed manifolds, such as an in-  
7 line tee. In such an application, a simple and paired back manifold base structure is  
8 provided (i.e. an in-line tee structure with no, or minimal, valving, instrumentation and  
9 equipment), with all additional functional elements being provided in one or more manifold  
10 removable modules.

11

12 The invention provides a subsea manifold for a subsea production system comprising at  
13 least one removable module, and methods of installation and use. The at least one  
14 removable is configured to perform a function selected from the group comprising: fluid  
15 control, fluid sampling, fluid diversion, fluid recovery, fluid injection, fluid circulation, fluid  
16 measurement and/or fluid metering.

17

18 Various modifications to the above-described embodiments may be made within the scope  
19 of the invention, and the invention extends to combinations of features other than those  
20 expressly claimed herein.

21

## 1    Claims

- 2
- 3    1.    A method of connecting a new subsea well to a subsea production system, the
- 4            subsea production system comprising:
- 5                    a subsea well, a subsea production flow system and a subsea manifold,
- 6            wherein the subsea manifold comprises:
- 7                    a first connector;
- 8                    a second connector fluidly connected to the subsea production flow
- 9                    system;
- 10                  a flowline header in fluid communication with the second connector;
- 11                  a fluid access point located between the first connector and the
- 12                  flowline header and having first and second flow access openings;
- 13                  a first flow path between the first connector and the first flow access
- 14                  opening of the fluid access point and a second flow path between the
- 15                  second flow access opening of the fluid access point and the flowline
- 16                  header; and
- 17                  comprising a flow cap on the fluid access point;
- 18            wherein the method comprises:
- 19                    fluidly connecting the subsea well to the first connector of the subsea manifold;
- 20                    removing the flow cap from the fluid access point of the subsea manifold; and
- 21                    connecting a removable module to the fluid access point of the manifold, the
- 22                    removable module comprising a first flow path configured to connect the first and
- 23                    second flow access openings such that the subsea well and the subsea production
- 24                    flow system are fluidly connected by the removable module.
- 25
- 26    2.    The method according to claim 1, wherein the removable module comprises:
- 27            a body, a first connector and a second connector;
- 28            wherein the method comprises connecting the first and second connectors to the first
- 29            and second flow access openings of the access point of the subsea manifold,
- 30            respectively; and
- 31            wherein the first flow path is defined between the first connector and the second
- 32            connector fluidly connecting the subsea well and the flowline header.
- 33
- 34    3.    The method according to any preceding claim, wherein the removable module
- 35            further comprises equipment and/or instrumentation configured to perform one or
- 36            more functions selected from the group comprising: fluid control, fluid sampling, fluid

- 1 diversion, fluid recovery, fluid injection, fluid circulation, fluid access, fluid  
2 measurement, flow measurement and/or fluid metering.  
3
- 4 4. The method according to any of claims any preceding claim, wherein the subsea  
5 manifold is a subsea Christmas tree, a subsea collection manifold system, a subsea  
6 well gathering manifold, a subsea distributed manifold system (such as an in-line tee  
7 (ILT)), a subsea Pipe Line End Manifold (PLEM), a subsea Pipe Line End  
8 Termination (PLET) and/or a subsea Flow Line End Termination (FLET).  
9
- 10 5. The method according to any preceding claim, wherein the first connector of the  
11 subsea manifold is configured to receive production fluid from the subsea well and/or  
12 route a fluid into the subsea well.  
13
- 14 6. The method according to any preceding claim, wherein the second connector of the  
15 subsea manifold is connected to an export production flowline of the flow system  
16 and/or a gas delivery flowline.  
17
- 18 7. The method according to any preceding claim, wherein the removable module  
19 comprises at least one valve in the first flow path and wherein the method comprises  
20 controlling flow between the subsea well and the subsea production flow system by  
21 operating the at least one valve to selectively permit fluid to flow from the subsea  
22 well to the subsea production flow system and/or from the subsea production flow  
23 system to the subsea well.  
24
- 25 8. The method according to claim 7, wherein the flowline header is a production  
26 flowline header and wherein the method comprises operating the at least one valve  
27 to control flow of production fluid from the subsea well to the production flowline  
28 header and subsea production system.  
29
- 30 9. The method according to 7, wherein the flowline header is a gas lift flowline header  
31 and the method comprises operating the at least one valve to control flow of gas  
32 from the gas lift flowline header to the subsea well.  
33
- 34 10. The method according to any preceding claim, wherein the fluid access point of the  
35 subsea manifold further comprises a third flow access opening, and wherein the  
36 manifold further comprises:

1                   a third connector configured to be fluidly connected to the subsea  
 2           production flow system;  
 3                   a second flowline header in communication with the third connector; and  
 4                   a third flow path between the third flow access opening of the fluid access  
 5           point and the second flowline header;  
 6           and wherein the removable module further comprises a second flow path configured  
 7           to connect the first and third fluid access openings such that the subsea well and the  
 8           second flowline header are fluidly connected by the second flow path of the  
 9           removable module.

10

11   11.   The method according to claim 10, wherein the first flow path and/or the second flow  
 12           path of the removable module comprises at least one valve and the method  
 13           comprises operating the at least one valve in the first flow path and/or in the second  
 14           flow path to control whether fluid from the subsea well flows into the first and/or the  
 15           second production flowline headers.

16

17   12.   The method according to claim 10, wherein the first and second flow paths of the  
 18           removable module are fluidly connected.

19

20   13.   The method according to claim 1, wherein the fluid access point of the subsea  
 21           manifold further comprises third and fourth flow access openings, and wherein the  
 22           manifold further comprises:

23                   a third connector configured to be fluidly connected to the subsea well;

24                   a fourth connector configured to be fluidly connected to the subsea  
 25           production flow system;

26                   a second flowline header in communication with the fourth connector;

27                   a third flow path between the third connector and the third flow access  
 28           opening of the fluid access point; and

29                   a fourth flow path between the fourth flow access opening of the fluid  
 30           access point and the second flowline header;

31           and wherein the removable module further comprises a second flow path connecting  
 32           the third and fourth fluid access openings such that the subsea well and the second  
 33           flowline header are fluidly connected by the second flow path of the removable  
 34           module.

35

- 1    14.    The method according to claim 13, wherein the flowline header is a production  
2           flowline header and the second flowline header is a gas lift flowline header.  
3
- 4    15.    The method according to claim 14, wherein the first flow path and/or the second flow  
5           path of the removable module comprises at least one valve and wherein the method  
6           comprises operating the at least one valve in the first flow path to selectively permit  
7           production fluid to flow from the subsea well to the subsea production flow system  
8           via the production flowline header (330) and/or operating the at least one valve in the  
9           second flow path to selectively control the flow of gas flow from the gas lift flowline  
10          header (332) to the subsea well.