

SUBSEA JUMPER TERMINATION WITH ACCESS INTERFACE FOR SECOND JUMPER

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3 The present invention relates to apparatus, systems and methods for oil and gas
4 operations. In particular, the present invention relates to apparatus, systems and methods
5 for connecting subsea flowlines to a subsea manifold. Aspects of the invention also have
6 application to fluid and mechanical intervention in subsea oil and gas production and
7 injection infrastructure

8

9 Background to the invention

10

11 In the field of subsea engineering for the hydrocarbon production industry, it is known to
12 provide flow systems comprising a subsea manifold connected to several flowlines from or
13 to other flow infrastructure, for example from or to subsea wells. A typical subsea manifold
14 has a plurality of spatially distributed connectors for tie-in of the flowlines, which may be
15 jumper flowlines. During the development of subsea hydrocarbon fields, it is often the
16 case that new hydrocarbon discoveries are made and/or further tie-ins to the flow system

1 infrastructure are required. If an existing subsea manifold has no connectors available,
2 new subsea infrastructure may need to be installed to enable the new well to be tied-in
3 and to accommodate any further tie-ins which may be required in the future.

4
5 Summary of the invention

6
7 There is generally a need for a method and apparatus which addresses one or more of the
8 problems identified above.

9
10 It is amongst the aims and objects of the invention to provide a method and/or apparatus
11 for connecting subsea flowlines to a subsea manifold, which obviates or mitigates one or
12 more drawbacks or disadvantages of the prior art.

13
14 Other aims and objects will become apparent from the following description.

15
16 According to a first aspect of the invention, there is provided a method of connecting
17 subsea flowlines to a subsea manifold, the method comprising:
18 providing a first jumper flowline having a first jumper termination apparatus connected to a
19 first subsea manifold connector and comprising a first access interface;
20 providing a second jumper flowline having a second jumper termination apparatus; and
21 connecting the second jumper flowline to the subsea manifold via the access interface and
22 the first subsea manifold connector.

23
24 The method may comprise stacking the second jumper termination apparatus on the first
25 jumper termination apparatus. The method may comprise vertically stacking the second
26 jumper termination apparatus on the first jumper termination apparatus.

27
28 The second jumper termination apparatus may comprise a second access interface, and
29 the method may comprise:
30 providing a further jumper flowline having a further jumper termination apparatus; and
31 connecting the further jumper flowline to the subsea manifold via the second access
32 interface, the first jumper termination apparatus, and the first subsea manifold connector.

33
34 The further jumper termination apparatus may comprise a further access interface.

35

1 The method may also comprise connecting the first jumper termination apparatus to the
2 first subsea manifold connector, for example by an ROV-operated clamping action.

3
4 The method may comprise clamping the second jumper termination apparatus to the first
5 subsea manifold connector.

6
7 The second jumper termination apparatus may comprise a guide funnel. The method may
8 comprise orienting a cut-away or relief of the guide funnel to accommodate the first jumper
9 flowline.

10
11 The further jumper termination apparatus may comprise a guide funnel. The method may
12 comprise orienting a cut-away or relief of the guide funnel to accommodate the second
13 jumper flowline.

14
15 The method may comprise performing fluid intervention or mechanical intervention
16 operations on the flow system via the first access interface, and/or the second access
17 interface and/or the further access interface. Fluid intervention operations may be a fluid
18 intervention operation from the group comprising: fluid sampling, fluid pumping, fluid
19 diversion, fluid recovery, fluid injection, fluid circulation, fluid measurement fluid metering,
20 artificial/gas lift, and/or well scale squeeze operations. Mechanical intervention operations
21 may be cleaning and/or pigging operations.

22
23 According to a second aspect of the invention, there is provided a jumper termination
24 apparatus for a subsea jumper flowline, the jumper termination apparatus comprising:
25 a body;
26 a jumper coupling means configured to couple the body to a jumper flowline;
27 a connector coupling means configured to couple the body to a subsea manifold
28 connector;
29 and an access interface disposed on the body;
30 wherein the body defines a first flow path from a coupled jumper flowline to a coupled
31 subsea manifold connector, and a second flow path from the access interface to the first
32 flow path and/or the subsea manifold connector;
33 and wherein the access interface is configured to be connected to a second jumper
34 flowline.

1 The access interface may be vertically oriented, which may enable access from above.
2
3 The access interface may be oriented on an axis inclined to the main axis of the manifold
4 connector, for example in a radial plane.
5
6 Alternatively, the access interface may have an axis of orientation which may be
7 horizontal, or which may be inclined at an angle to the horizontal.
8
9 The second flow path may be inclined at an angle to the immediately adjacent portion of
10 the jumper flowline.
11
12 The jumper flowline may comprise a composite jumper flowline.
13
14 The jumper coupling means may comprise a studded connection.
15
16 The jumper coupling means may comprise a curved gooseneck section which may be
17 configured to be disposed between the body and the jumper flowline. The gooseneck
18 section may be connected to the body and the jumper flowline by flanged connections.
19
20 The access interface may be configured to provide access for a fluid intervention or
21 mechanical intervention operation on the flow system. Fluid intervention operations may
22 be a fluid intervention operation from the group comprising: fluid sampling, fluid pumping,
23 fluid diversion, fluid recovery, fluid injection, fluid circulation, fluid measurement fluid
24 metering, artificial/gas lift, and/or well scale squeeze operations. Mechanical intervention
25 operations may be cleaning and/or pigging operations.
26
27 In this context, connected means a physical interaction between two components. The
28 connection may be directly or via an intermediate component. The access interface may
29 be configured to be connected to a second jumper flowline directly. Alternatively, or in
30 addition, the access interface may be configured to be connected to a second jumper
31 flowline via a jumper termination apparatus of the second jumper flowline.
32
33 Embodiments of the second aspect of the invention may include one or more features of
34 the first aspect of the invention or its embodiments, or vice versa.
35

1 According to a third aspect of the invention, there is provided a jumper termination
2 apparatus for a subsea jumper flowline, the jumper termination apparatus comprising:
3 a body;
4 a jumper coupling means configured to couple the body to a jumper flowline;
5 an interface coupling means configured to couple the body to an access interface of a
6 jumper flowline termination head of a further jumper flowline.

7 The jumper termination apparatus may comprise a guide funnel, and/or may comprise a
8 cut-away or relief configured to accommodate the further jumper flowline. The cut-away or
9 relief may be in the guide funnel.

10

11 The jumper termination apparatus may comprise a further access interface, which may be
12 configured for connection of a jumper termination apparatus. The further access interface
13 may be configured to provide access for a fluid intervention or mechanical intervention
14 operation on the flow system.

15

16 Embodiments of the third aspect of the invention may include one or more features of the
17 first or second aspects of the invention or their embodiments, or vice versa.

18

19 According to a fourth aspect of the invention, there is provided a flow system for a subsea
20 hydrocarbon production or injection installation, the flow system comprising:
21 a subsea manifold;
22 a first jumper flowline having a first jumper termination apparatus connected to a first
23 subsea manifold connector and comprising a body and a first access interface;
24 wherein the body defines a first flow path from the first jumper flowline to the subsea
25 manifold connector, and a second flow path from the access interface to the first flow path
26 and/or the subsea manifold connector;
27 and wherein the first access interface is configured to be connected to a second jumper
28 flowline.

29

30 The subsea manifold may be a collection manifold.

31

32 The first subsea manifold connector may be a male connector.

33

1 The first jumper termination apparatus may comprise a connector coupling means for
2 connecting the first jumper termination apparatus to the first subsea manifold connector.

3 The connector coupling means may be a female connector.
4

5 The flow system may comprise a second jumper flowline having a second jumper
6 termination apparatus, wherein the second jumper flowline is connected to the subsea
7 manifold via the first access interface and the subsea manifold connector.
8

9 The first and second jumper termination apparatus may be stacked. The first and second
10 jumper termination apparatus may be vertically stacked.
11

12 The first and/or second jumper flowlines may comprise a composite jumper flowline.
13

14 The first and/or second jumper flowlines may be production jumper flowlines which may
15 facilitate production flow from respective subsea wells into the subsea manifold.
16

17 The subsea manifold, and the first and/or second jumper flowlines may comprise multiple
18 flow lines or flow bores. The first and/or second jumper termination apparatus may define
19 a further flow path or flow paths which correspond to the multiple flow lines or flow bores of
20 the subsea manifold and the first and/or second jumper flowlines.
21

22 Embodiments of the fourth aspect of the invention may include one or more features of the
23 first to third aspects of the invention or their embodiments, or vice versa.
24

25 According to a fifth aspect of the invention, there is provided a method of connecting
26 subsea flowlines to a subsea manifold, the method comprising:
27 providing a first jumper flowline having a first jumper termination apparatus configured to
28 be connected to a subsea manifold connector and comprising a first access interface;
29 providing a second jumper flowline having a second jumper termination apparatus
30 configured to be connected to an access interface;
31 connecting the second jumper termination apparatus of the second jumper flowline to the
32 first access interface of the first jumper termination apparatus; and
33 connecting the first jumper termination apparatus of the first jumper flowline to a subsea
34 manifold connector.
35

- 1 Embodiments of the fifth aspect of the invention may include one or more features of the
- 2 first to fourth aspects of the invention or their embodiments, or vice versa.
- 3
- 4

1 Brief description of the drawings

2

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

5

6 Figures 1A and 1B are perspective views of a prior art subsea production manifold tie-in
7 system, respectively before and after connection of a jumper flowline;

8

9 Figures 2A to 2C are perspective views of a subsea production manifold tie-in system
10 according to an embodiment of the invention, in various conditions;

11

12 Figure 3 is a side view of a jumper flowline termination according to an alternative
13 embodiment of the invention; and

14

15 Figure 4 is a side view of a jumper flowline termination according to a further alternative
16 embodiment of the invention.

17

18 Detailed description of preferred embodiments

19

20 Referring firstly to Figures 1A and 1B, there is shown, generally at 10 a subsea production
21 manifold tie-in system according to the prior art. The system comprises a subsea manifold
22 12, which in this example is a collection manifold comprising a plurality of proprietary
23 subsea connectors 16a for the connection of production jumper flowlines 14 from
24 respective subsea wells. The subsea connectors 16a are male connectors of a proprietary
25 vertical tie-in connection system, of which there are several types in the industry, and the
26 jumper flowlines 14 are terminated with a jumper termination head comprising a
27 corresponding female proprietary connector 16b. In this embodiment, the flowline being
28 tied-in is a vertically-deployed jumper flowline 14. Figure 1A shows the system prior to the
29 connection being made-up, and Figure 1B shows the connection made up such that
30 production flow from the jumper flowline can enter the manifold for onward processing,
31 production, or transportation.

32

33 The manifold 12 also comprises a number of other connectors 16a, each available to be
34 connected to connectors on additional jumper flowlines from other subsea wells. Subsea
35 manifolds of this type can therefore accommodate a number of jumper flowlines,

1 determined by the number of connectors on the manifold. However, during the
2 development of subsea hydrocarbon fields, it is often the case that new hydrocarbon
3 discoveries are made and/or further tie-ins to the production infrastructure are required. If
4 an existing subsea production manifold has no connectors available, new subsea
5 infrastructure must be installed to enable the new well to be tied-back and to
6 accommodate any further tie-ins which may be required in the future.

7
8 Referring now to Figures 2A, 2B and 2C, a subsea production manifold tie-in system
9 according to an embodiment of the invention is shown generally at 110. The manifold 110
10 is the same as the manifold 10 of Figures 1A and 1B, and comprises a number of
11 connectors 16a for connection of jumper flowlines. However, the connection system
12 between the jumper flowlines and the manifold is modified to provide additional flexibility of
13 operation and/or increased connection capability, as will be described below.

14
15 In this embodiment of the invention, the jumper flowline is terminated in a modified
16 connector assembly 115, comprising female connector 116b and access interface 122.
17 The female connector 116b is similar to the connector 16b, and enables the jumper
18 flowline 114 and the manifold to be fluidly coupled to a manifold connector 16a. The
19 access interface 122 comprises an additional access bore 117 which enables fluid and/or
20 mechanical access to the inlet bore of the connector 16a, even after make-up with the
21 jumper flowline 114. The access bore is at an angle to the immediately adjacent portion of
22 the jumper flowline, and in this embodiment is vertically oriented to enable access from
23 above.

24
25 Figure 2B shows the connection between the jumper flowline 114 and the manifold after it
26 is made up, by engagement of the connector 16a and the connector 116b. The system
27 110 also includes a second jumper flowline 124, terminated in a termination head 125
28 comprising a connector portion 126 configured for connection to the access bore 117 of
29 the access interface 122. The connector portion 126 comprises a guide funnel 127
30 comprising a cut out profile 128, such that the guide funnel can be placed over the access
31 interface 122 with the cut-out profile accommodating the installed jumper flowline 114.

32
33 Internal to the guide funnel is a bore connection which enables the jumper flowline to be
34 placed in fluid communication with the access bore 117. An external clamp mechanism
35 129, operable by an ROV, enables the connection to be made up as shown in Figure 2C.

1 The system 110 therefore comprises a dual jumper connection to a single manifold
2 connector 16a, with the jumper terminations connected to the manifold in a vertically
3 stacked arrangement. The system therefore increases the number of jumper flowlines that
4 may be connected to the manifold, and/or alternatively provides flexible connection
5 locations for jumper flowlines on the manifold. Such a configuration increases the
6 connection capacity of existing subsea flow systems, reducing the requirement for
7 additional subsea infrastructure.

8
9 The foregoing embodiment shows the vertically-stacked connection of a pair of vertically-
10 deployed conventional steel jumper flowlines onto a single proprietary connector on a
11 subsea manifold. However, it would be appreciated that alternative configurations of
12 jumper system may be used within the scope of the invention. For example, the access
13 interface may be oriented on an axis inclined to the main axis of the manifold connector,
14 for example in a radial plane. The principles of the invention may be applied to horizontal
15 manifold connectors or inclined manifold connectors, and/or the access interface may
16 have an axis of orientation which is vertical, horizontal, or inclined.

17
18 Alternative embodiments of the invention may use alternative materials for the jumper
19 system, and/or alternative geometries or configurations of the connection system in order
20 to facilitate the connection of two jumper flowlines to a single manifold connector.

21
22 Figure 3 is an example of a jumper connection systems, generally depicted at 300, having
23 a jumper termination head and jumper arrangement, where the jumper flowline 314 is a
24 composite jumper flowline provided with a studded inlet connection 315 to a body
25 supporting the access interface 322. As with previous embodiments, the access interface
26 322 is arranged above a female connector 316 with an external clamp 318, and is
27 designed to connect onto a corresponding proprietary connector of the manifold. By using
28 a composite material for the jumper flowline 314, the overall weight of the jumper flowline
29 and connector system may be reduced, compared to the weight of a conventional steel
30 jumper flowline. This reduces the static load on the connector and manifold. In addition,
31 the increased flexibility of the composite jumper flowline compared with the conventional
32 steel jumper flowline may reduce the dynamic load on the connector and manifold.

33
34 Figure 4 is a side view of a further alternative embodiment of the invention. In this
35 embodiment, the connector and jumper flowline system, generally shown at 400,

1 comprises a composite jumper flowline 414 connected to a block supporting an access
2 interface 422 above connector 416 with an external clamp 418. In this embodiment, the
3 composite jumper flowline forms a flanged connection 415 with a rigid, curved gooseneck
4 section 413 disposed between the block and the jumper flowline. The system 400 offers
5 the load reduction benefits of the system 300, and the gooseneck portion may provide an
6 improved position of the composite jumper flowline, and further reduce the static and/or
7 dynamic loads on the connector and manifold.

8
9 The load reduction benefits described above maybe significant in some applications of the
10 invention to mitigate the effect of increased loads due to additional connectors connecting
11 at a single point on the manifold. Alternatively, or in addition, the load reduction benefits
12 may enable landing and/or installation of additional equipment on the manifold before its
13 load bearing capacity is exceeded.

14
15 Although the foregoing embodiments show a pair of vertically stacked jumper connectors,
16 it will be appreciated that alternative embodiments of the invention, three or more jumper
17 flowlines may be connected onto a single manifold connector, for example by vertical
18 stacking of third and further jumper termination heads. In an embodiment, this can be
19 implemented by providing a second jumper termination head with a second access
20 interface, configured for the connection of a further jumper termination head. Third and
21 further jumper termination heads maybe similarly configured to enable continuing
22 connection (e.g. by stacking) of jumper flowlines on a single manifold connector. In such
23 implementations of the invention, reducing the static or dynamic loads by the use of
24 composite jumper flowlines and/or flowline geometries may be beneficial.

25
26 In further alternative embodiments of the invention, the access interface of a jumper
27 termination head may be used to provide access for a fluid intervention or mechanical
28 intervention operation. Such fluid intervention operations may be selected from (but are
29 not limited to) fluid sampling, fluid pumping, fluid diversion, fluid recovery, fluid injection,
30 fluid circulation, fluid measurement fluid metering, artificial/gas lift, and/or well scale
31 squeeze operations. Mechanical intervention operations include but are not restricted to
32 cleaning and/or pigging operations.

33
34 The jumper termination head may be a modified jumper termination head, modified to
35 include the access interface and a flow path connecting the access interface to the subsea

1 manifold connector or a flow path between the subsea manifold connector and the jumper
2 flowline coupling. Alternatively, the system may be provided with an adaptor hub which is
3 configured to be connected between the jumper flowline and the subsea manifold
4 connector (for example between the jumper termination head and the subsea manifold
5 connector, or between the jumper termination head), and which provides the access
6 interface. The invention may therefore extend to a jumper termination head assembly
7 comprising an adaptor hub and a conventional jumper termination head.

8
9 In a further alternative embodiment, the jumper termination head, or jumper termination
10 head assembly, may comprise multiple flow lines or flow bores extending therethrough, to
11 correspond to multiple flow lines or flow bores present in the flow system. For example, a
12 connector on the subsea manifold may incorporate production flow lines and injection or
13 artificial lift flow lines, and the jumper may be similarly configured. The jumper flowline
14 connection system may comprise a set of parallel flow lines configured for connection of
15 the respective lines between the subsea tree and the jumper, and at least one of the
16 parallel flow lines may be provided with an access interface for another flow stream
17 directed in or out of the flow system (e.g. production fluid being brought in from another
18 subsea tree), or as an access interface for fluid or mechanical intervention as described
19 above.

20
21 The invention provides a jumper termination apparatus for a subsea jumper flowline, a flow
22 system for a subsea hydrocarbon production or injection installation incorporating such a
23 jumper termination apparatus, and a method of use. The jumper termination apparatus
24 comprises a body, a jumper coupling means configured to couple the body to a jumper
25 flowline, and a connector coupling means configured to couple the body to a subsea
26 manifold connector. An access interface is disposed on the body. The body defines a first
27 flow path from a coupled jumper flowline to a coupled subsea manifold connector, and a
28 second flow path from the access interface to the first flow path or the subsea manifold
29 connector. The access interface is configured to be connected to a second jumper
30 flowline. A flow system comprises a subsea manifold and a first jumper flowline having a
31 first jumper termination apparatus connected to a first subsea manifold connector, and
32 may also comprise a second jumper flowline having a second jumper termination
33 apparatus, wherein the second jumper flowline is connected to the subsea manifold via the
34 first access interface and the subsea manifold connector. In another aspect, the invention
35 provides a jumper termination apparatus for a subsea jumper flowline comprising

1 a body, a jumper coupling means configured to couple the body to a jumper flowline;
2 and an interface coupling means configured to couple the body to an access interface of a
3 jumper flowline termination head of a further jumper flowline.

4

5 The invention facilitates connection of multiple flowlines, for example by daisy-chaining
6 flowlines, into flow systems with a limited number of connection locations, reducing the
7 requirement to add subsea flow infrastructure.

8

9 Various modifications to the above-described embodiments may be made within the scope
10 of the invention, and the invention extends to combinations of features other than those
11 expressly recited herein.

12