CLAIMS

1. An apparatus comprising:

an inlet, an outlet, and a flow path extending between the inlet and the outlet;

a flow meter configured to determine a flow rate of a fluid through the flow path;

a choke configured to vary the flow rate of the fluid through the flow path;

a frame having an alignment system configured to facilitate alignment of the apparatus with a separate subsea device to enable the apparatus to mate with the separate subsea device during a mating process;

one or more sensing elements;

a subsea monitoring module comprising a controller configured to receive and process data from the one or more sensing elements; and

wherein the flow path, the flow meter, the choke, the one or more sensing elements, and the subsea monitoring module are coupled with the frame to enable the apparatus to be deployed to or retrieved from a subsea location in a single operation, and wherein the subsea monitoring module is disposed within a removable housing to enable separate retrieval of the subsea monitoring module from the apparatus while the apparatus is mated with the separate subsea device.

2. The apparatus of claim 1, wherein the alignment system has a horizontal deployment configuration and is configured to facilitate alignment of the apparatus with the separate subsea device to enable the apparatus to horizontally mate with the separate subsea device during the mating process.

3. The apparatus of claim 1, wherein the flow meter comprises at least one of a wet gas flow meter or a multiphase flow meter configured to measure a flow rate of each of a plurality of phases of the fluid.

4. The apparatus of claim 1, wherein the apparatus comprises:

a communication port configured to receive a cable that electronically couples the subsea monitoring module to a separate subsea control module.

5. The apparatus of claim 1, wherein the one or more sensing elements comprises at least one of an acoustic sand detection sensor, a choke position indicator, a sand erosion/corrosion

monitor, or a pressure and temperature transducer.

6. The apparatus of claim 4, wherein the subsea monitoring module is configured to transmit processed data to the subsea control module for transmission to a surface communication device.

7. The apparatus of claim 4, wherein the subsea monitoring module is configured to receive data from one or more sensing elements and from the subsea control module, and wherein the subsea monitoring module comprises networking circuitry configured to transmit the received data to a surface communication device.

8. The apparatus of claim 1, wherein the subsea monitoring module comprises a plurality of controllers configured in a redundant manner.

9. The apparatus of claim 1, wherein the alignment system comprises at least one sliding member configured to permit movement of the apparatus when aligning the apparatus with the separate subsea device during the mating process, wherein the sliding member comprises an alignment member configured to engage a corresponding alignment slot on the separate subsea device.

10. The apparatus of claim 9, wherein the apparatus comprises a hydraulic cylinder with a first end coupled to the frame and second end having a retractable piston rod extending therefrom, the piston rod being coupled to the at least one sliding member, and wherein the retraction of the piston rod into the hydraulic cylinder facilitates movement of the apparatus toward the separate subsea device during the mating process.

11. The apparatus of claim 9, wherein the at least one sliding member is configured to slide along a first rod extending across the frame on a bottom face of the apparatus.

12. The apparatus of claim 9, wherein the at least one sliding member comprises:

a first sliding member configured to slide along a first rod extending across the frame on a first side face of the apparatus; and

a second sliding member configured to slide along a second rod extending across the frame on a second side face of the apparatus opposite the first side face.

13. The apparatus of claim 9, wherein the frame comprises a recess configured to receive a removable running tool.

14. The apparatus of claim 13, comprising the removable running tool, wherein the removable running tool comprises a hydraulic cylinder, a first flange configured to be received by a receiving block disposed in the recess, a piston rod extending from the first flange, and a second flange disposed at the distal end of the piston rod and being configured to be received by another receiving block located on the separate subsea device, and wherein the retraction of the piston rod into the hydraulic cylinder of the running tool facilitates movement of the apparatus towards the separate subsea device during the mating process.

15. The apparatus of claim 9, wherein the frame comprises a first set of alignment slots configured to receive a first set of guide pins extending from the separate subsea device.

16. The apparatus of claim 15, wherein the frame comprises a second set of alignment slots configured to receive a second set of guide pins extending from the separate subsea device, wherein the second set of alignment slots and the first set of alignment slots have different dimensions.

17. The apparatus of claim 1, wherein the separate subsea device comprises at least one of a production tree, a manifold, or a subsea processing station.

18. A system comprising:

a production tree configured to extract resources from a wellhead;

a flow module unit having a horizontal deployment configuration and being configured to horizontally mate with the production tree, wherein the flow module unit comprises a plurality of flow control and monitoring devices collocated within a frame and an alignment system configured to align the flow module unit with the production tree when horizontally mating the flow module unit and the production tree, wherein the frame is configured to enable the flow module unit to be retrieved via a single retrieval operation and the alignment system comprises:

a sliding member that includes an alignment feature configured to engage a mating alignment feature of the production tree; and

a hydraulic cylinder coupled between the sliding member and the frame;

wherein the sliding member and the hydraulic cylinder are configured such that, upon engagement of the alignment feature of the sliding member with the mating alignment feature of the production tree, the sliding member is retained in place with respect to the production tree through the engagement of the alignment feature with the mating alignment feature so that retraction of the hydraulic cylinder causes relative movement of the frame of the flow module unit with respect to the sliding member and the production tree to draw fluid conduits of the flow module unit and the production tree into mating engagement.

19. The system of claim 18, wherein the plurality of flow control and monitoring devices comprises a flow meter, a choke, a control unit, and at least one sensing element.

20. The system of claim 18, wherein the production tree comprises a platform configured to receive the flow module unit, the platform having the mating alignment feature of the production tree in the form of a first set of alignment slots to receive the alignment feature of the flow module unit.

21. A method for mating a retrievable flow module (RFM) unit to a subsea tree comprising:

lowering the RFM unit onto a platform of the subsea tree, wherein the RFM unit comprises an inlet, an outlet, and a plurality of flow control and monitoring devices collocated within a frame having an alignment system, the plurality of flow control and monitoring devices comprising a flow meter and a choke, wherein lowering the RFM unit onto the platform of the subsea tree includes inserting one or more teeth of the alignment system into one or more mating recesses of the subsea tree;

moving the RFM unit horizontally toward the subsea tree until a first set of guide pins extending from the subsea tree is substantially inserted into a first set of alignment slots on the RFM unit using the alignment system, wherein moving the RFM unit horizontally toward the subsea tree includes retaining the one or more teeth of the alignment system within the one or more mating recesses of the subsea tree and moving the inlet, the outlet, and the frame of the RFM unit with respect to the one or more teeth and the subsea tree; and

securing the inlet to a wing valve line of the subsea tree and securing the outlet to a flow line of the subsea tree.

22. The method of claim 21, wherein the RFM unit is lowered using at least one of a remotely operated vehicle, wireline deployment, or running tool deployment.

23. The method of claim 21, wherein using the alignment system to move the RFM unit toward the subsea tree comprises actuating a hydraulic cylinder coupled to the frame to cause a piston rod coupled to at least one sliding member having the one or more teeth to retract into the hydraulic cylinder.

24. The method of claim 21, wherein, in addition to using the alignment system, moving the RFM unit toward the subsea tree comprises:

actuating a running tool removably installed on the RFM unit to cause a piston rod having a flange engaged by a receiving block on the subsea tree to retract into a hydraulic cylinder of the running tool; and

removing the running tool after the RFM unit is mated to the subsea tree.

CLAIMS

1. An apparatus comprising:

an inlet, an outlet, and a flow path extending between the inlet and the outlet;

a flow meter configured to determine a flow rate of a fluid through the flow path;

a choke configured to vary the flow rate of the fluid through the flow path; and

a frame having an alignment system having a horizontal deployment configuration, wherein the alignment system is configured to facilitate alignment of the apparatus with a separate subsea device to enable the apparatus to horizontally mate with the separate subsea device during a mating process;

wherein the flow path, flow meter, and choke are generally disposed within a region enclosed by the frame, and wherein the frame enables the apparatus to be deployed to or retrieved from a subsea location in a single operation.

2. The apparatus of claim 1, wherein the flow meter is arranged upstream from the choke relative to the direction of fluid flow along the flow path.

3. The apparatus of claim 1, wherein the flow meter is arranged downstream from the choke relative to the direction of fluid flow along the flow path.

4. The apparatus of claim 1, wherein the flow meter comprises at least one of a wet gas flow meter or a multiphase flow meter configured to measure a flow rate of each of a plurality of phases of the fluid.

5. The apparatus of claim 1, wherein the apparatus comprises:

one or more sensing elements; and

a subsea monitoring module comprising a controller configured to receive and process data from the one or more sensing elements.

6. The apparatus of claim 5, wherein the one or more sensing elements comprises at least one of an acoustic sand detection sensor, a choke position indicator, a sand erosion/corrosion monitor, or a pressure and temperature transducer.

7. The apparatus of claim 5, wherein the apparatus comprises a communication port configured to receive a cable that electronically couples the subsea monitoring module to a separate subsea control module.

8. The apparatus of claim 7, wherein the subsea monitoring module is configured to transmit processed data to the subsea control module for transmission to a surface communication device.

9. The apparatus of claim 7, wherein the subsea monitoring module is configured to receive data from one or more sensing elements and from the subsea control module, and wherein the subsea monitoring module comprises networking circuitry configured to transmit the received data to a surface communication device.

10. The apparatus of claim 5, wherein the subsea monitoring module is at least partially disposed within a canister that is separately removable from the apparatus.

11. The apparatus of claim 5, wherein the subsea monitoring module comprises a plurality of controllers configured in a redundant manner.

12. The apparatus of claim 1, wherein the alignment system comprises at least one sliding member configured to permit movement of the apparatus when aligning the apparatus with the separate subsea device during the mating process, wherein the sliding member comprises an alignment member configured to engage a corresponding alignment slot on the separate subsea device.

13. The apparatus of claim 12, wherein the apparatus comprises a hydraulic cylinder with a first end coupled to the frame and second end having a retractable piston rod extending therefrom, the piston rod being coupled to the at least one sliding member,

and wherein the retraction of the piston rod into the hydraulic cylinder facilitates movement of the apparatus toward the separate subsea device during the mating process.

14. The apparatus of claim 12, wherein the at least one sliding member is configured to slide along a first rod extending across the frame on a bottom face of the apparatus.

15. The apparatus of claim 12, wherein the at least one sliding member comprises:

a first sliding member configured to slide along a first rod extending across the frame on a first side face of the apparatus; and

a second sliding member configured to slide along a second rod extending across the frame on a second side face of the apparatus opposite the first side face.

16. The apparatus of claim 12, wherein the frame comprises a recess configured to receive a removable running tool.

17. The apparatus of claim 16, comprising the removable running tool, wherein the removable running tool comprises a hydraulic cylinder, a first flange configured to be received by a receiving block disposed in the recess, a piston rod extending from the first flange, and a second flange disposed at the distal end of the piston rod and being configured to be received by another receiving block located on the separate subsea device, and wherein the retraction of the piston rod into the hydraulic cylinder of the running tool facilitates movement of the apparatus towards the separate subsea device during the mating process.

18. The apparatus of claim 12, wherein the frame comprises a first set of alignment slots configured to receive a first set of guide pins extending from the separate subsea device.

19. The apparatus of claim 18, wherein the frame comprises a second set of alignment slots configured to receive a second set of guide pins extending from the separate subsea device, wherein the second set of alignment slots and the first set of alignment slots have different dimensions.

20. The apparatus of claim 1, wherein the separate subsea device comprises at least one of a production tree, a manifold, or a subsea processing station.

21. The apparatus of claim 1, comprising a first locking device configured to secure the inlet to a first conduit of the separate subsea device and a second locking device configured to secure the outlet to a second conduit of the separate subsea device.

22. The apparatus of claim 21, wherein the first and second locking devices comprise torque clamps.

23. The apparatus of claim 1, wherein the inlet and the outlet are located on the same face of the apparatus.

24. A system comprising:

a production tree configured to extract resources from a wellhead;

a flow module unit having a horizontal deployment configuration and being configured to horizontally mate with the production tree, wherein the flow module unit comprises a plurality of flow control and monitoring devices collocated within a frame and an alignment system configured to align the flow module unit with the production tree when horizontally mating the flow module unit and the production tree, wherein the frame is configured to enable the flow module unit to be retrieved via a single retrieval operation.

25. The system of claim 24, wherein the plurality of flow control and monitoring devices comprises a flow meter, a choke, a control unit, and at least one sensing element.

26. The system of claim 25, wherein the plurality of flow control and monitoring devices comprises a chemical injection metering valve.

27. The system of claim 24, wherein the production tree comprises a platform having a first set of alignment slots, the platform being configured to receive the flow module unit.

28. The system of claim 27, wherein the alignment system comprises at least one sliding member having an alignment member extending therefrom, the alignment member being configured to engage one of the first set of alignment slots when the flow module unit is lowered onto the platform.

29 The system of claim 28, wherein the alignment member comprises a teeth-like structure or a pin.

30. The system of claim 28, wherein the alignment system comprises at least one hydraulic device configured to cause the flow module unit to move toward the production tree when interfacing the flow module unit and the production tree.

31. The system of claim 29, wherein interfacing the flow module unit and the production tree comprises fluidly coupling an inlet of the flow module unit with a wing valve line of the production tree and fluidly coupling an outlet of the flow module unit with a flow line of the production tree.

32. The system of claim 27, wherein the platform comprises a guide frame configured to receive the frame of the flow module unit as the flow module unit is lowered onto the platform.

33. The system of claim 27, wherein the alignment system comprises at least one threaded bar, wherein the rotation of the at least one threaded bar moves the flow module unit horizontally toward the production tree when horizontally mating the flow module unit and the production tree.

34. A method for mating a retrievable flow module (RFM) unit to a subsea tree comprising:

lowering the RFM unit onto a platform of the subsea tree, wherein the RFM unit comprises an inlet, an outlet, and a plurality of flow control and monitoring devices collocated within a frame having an alignment system, the plurality of flow control and monitoring devices comprising a flow meter and a choke;

moving the RFM unit horizontally toward the subsea tree until a first set of guide pins extending from the subsea tree is substantially inserted into a first set of alignment slots on the RFM unit using the alignment system; and

securing the inlet to a wing valve line of the subsea tree and securing the outlet to a flow line of the subsea tree.

35. The method of claim 34, wherein the RFM unit is lowered using at least one of a remotely operated vehicle, wireline deployment, or running tool deployment.

36. The method of claim 34, wherein the alignment system comprises at least one sliding member coupled to the frame and having an alignment tooth extending therefrom, and wherein lowering the RFM unit onto the platform comprises inserting the alignment tooth into an alignment slot located on the platform.

37. The method of claim 34, wherein using the alignment system to move the RFM unit toward the subsea tree comprises actuating a hydraulic cylinder coupled to the frame to cause a piston rod coupled to the at least one sliding member to retract into the hydraulic cylinder.

38. The method of claim 34, wherein, in addition to using the alignment system, moving the RFM unit toward the subsea tree comprises actuating a running tool removably installed on the RFM unit to cause a piston rod having a flange engaged by a receiving block on the subsea tree to retract into a hydraulic cylinder of the running tool.

39. The method of claim 38, comprising removing the running tool after the RFM unit is mated to the subsea tree.

40. The method of claim 34, wherein securing the inlet to the wing valve line comprises actuating a first torque clamp and securing the outlet to the flow line comprises actuating a second torque clamp.