Claims

1. A marine riser component having an integrated fatigue damage sensor, wherein the sensor is adapted to be damaged by stresses and strains applied to the marine riser component, and wherein the sensor is adapted to record said damage on the sensor.

2. A marine riser component as claimed in claim 1, wherein the fatigue damage sensor is mounted in a recess.

3. A marine riser component as claimed in claim 2, wherein the recess is formed on an outer surface of the component.

4. A marine riser component as claimed in claim 2 or claim 3, wherein the recess is closed.

5. A marine riser component as claimed in any one of claims 2-4, wherein the recess is sealed.

6. A marine riser component as claimed in any one of claims 2-5, incorporating a cover for the recess, wherein the cover is removable from the component to expose the recess.

7. A marine riser component as claimed in claim 6, wherein the outer surface of the cover is flush with the outer surface of the component.

8. A marine riser component as claimed in any one of claims 6-7, wherein the cover comprises a plate secured in place over the recess by removable fasteners connecting the plate to the outer surface of the component.

9. A marine riser component as claimed in any one of claims 6-8, incorporating a groove retaining a seal, which is adapted to be compressed between at least a portion of the cover and the component, wherein the seal surrounds the recess, and wherein the cover is adapted to be held in position over the recess by a plurality of fasteners extending through the plate and engaging the component,

and wherein the fasteners are distributed around the periphery of the plate to engage the component and retain the plate in place over the recess at a number of peripherally-spaced locations around the plate, and wherein the fasteners are adapted to engage portions of the component located outside the area surrounded by the groove.

10. A marine riser component as claimed in any one of claims 2-9, wherein the recess extends radially into the outer surface of the component, perpendicular to a long axis of the component.

11. A marine riser component as claimed in any one of claims 2-10, wherein the recess extends axially along the component, parallel to the long axis of the component.

12. A marine riser component as claimed in any one of claims 2-11, wherein the recess extends circumferentially around the component.

13. A marine riser component as claimed in any one of claims 2-12, wherein the recess is formed on an area of the component having an expanded outer diameter.

14. A marine riser component as claimed in any one of claims 2-12, wherein the recess is formed on an end terminal of a marine riser pipe having an expanded outer diameter larger than a central section of the marine riser pipe.

15. A marine riser component as claimed in any one of claims 2-14 wherein the fatigue damage sensor is fixed to an inner surface of the recess.

16. A marine riser component as claimed in claim 15, wherein the fatigue damage sensor is fixed to the surface of the recess at locations on the fatigue damage sensor that are spaced apart in an axial direction on the sensor.

17. A marine riser component as claimed in claim 15 or 16, wherein the recess has a floor extending parallel to the axis of the component, and the fatigue damage sensor is fixed to the floor of the recess.

18. A marine riser component as claimed in any one of claims 1-17, wherein the fatigue damage sensor comprises a gauge having an initiated crack and being adapted to monitor the growth of the crack as the gauge is subjected to fatigue loads.

19. A marine riser component as claimed in any one of claims 1-18, wherein the sensor is integrated into the component in a location that experiences a fraction of the fatigue loads of the marine riser pipe.

20. A marine riser component as claimed in any one of claims 1-19, wherein the sensor is integrated into the component in a location on the component that transmits fatigue loads to the sensor at a known stress concentration factor.

21. A marine riser component as claimed in claim 20, wherein the location is chosen based on the known stress concentration factor required to apply sufficient fatigue loads to the sensor to damage the sensor during a known period of normal operation of the marine riser, and wherein the fatigue loads applied to the sensor during normal operation are limited in accordance with the stress concentration factor to loads that cause damage to the sensor over the known period of normal operation without destruction of the sensor as a result of the fatigue loads during the normal period of operation.

22. A marine riser component as claimed in any one of claims 1-21, wherein the sensor is passive.

23. A marine riser component as claimed in any one of claims 1-22, wherein the sensor has no electrical connections extending outside the component.

24. A marine riser component as claimed in any one of claims 1-23, wherein the sensor is unpowered.

25. A marine riser component as claimed in any one of claims 1-24, wherein data is read from the sensor only when the sensor is recovered to surface.

26. A marine riser component as claimed in any one of claims 1-25, wherein the fatigue damage sensor is subjected to a preload before being integrated into the component, and wherein the preload is maintained in the sensor when integrated into the component.

27. A marine riser component as claimed in any one of claims 1-26, incorporating a communication port extending from the outer surface of the component, and incorporating an interface allowing connection of conduits outside the outer surface of the component to the fatigue damage sensor.

28. A marine riser component as claimed in claim 27, wherein the fatigue damage sensor is connected via at least one signal or power conduit to the port, and wherein an outer surface of the port exposed to the outer surface of the component can be accessed to allow data recovery from the fatigue damage sensor.

29. A marine riser component as claimed in claim 27, wherein the port is sealed to prevent fluid ingress through the port.

30. A marine riser component as claimed in any one of claims 1-29, wherein the component incorporates at least one of a storage device and an electrical connector.

31. A marine riser component as claimed in any one of claims 1-30, wherein each component has more than one sensor, and wherein each sensor is integrated into the component in a respective recess on the component.

32. A marine riser component as claimed in claim 31, having a plurality of sensors at the same axial position on the component, but spaced apart from one another circumferentially around the outer surface of the body of the component.

33. A marine riser component as claimed in claim 32, wherein the plurality of sensors are spaced at regular intervals around the outer surface of an end of the component.

34. A marine riser component as claimed in any one of claims 1-33, wherein the component comprises at least one of one of a coupling pin, a coupling box, a riser pipe, a clamp and an auxiliary line.

35. A method of assessing fatigue damage in a marine riser component, the method comprising integrating a fatigue damage sensor into a body of the marine riser component, and collecting fatigue damage data from the sensor, including damaging the sensor by stresses and strains applied to the marine riser component, and including recording said damage on the sensor.

36. A method as claimed in claim 35, including mounting the fatigue damage sensor in a recess on the body.

37. A method as claimed in claim 36, including sealing the recess.

38. A method as claimed in claim 34 or 35, wherein the recess is on the outer surface of the body.

39. A method as claimed in any one of claims 36 to 38, including covering the recess.

40. A method as claimed in any one of claims 36-39, including extending the recess radially into the outer surface of the component, perpendicular to a long axis of the component.

41. A method as claimed in any one of claims 36-40, including extending the recess axially along the component, parallel to the long axis of the component.

42. A method as claimed in any one of claims 36-41, including extending the recess circumferentially around the component.

43. A method as claimed in any one of claims 36-42, including forming the recess on an area of the component having an expanded outer diameter.

44. A method as claimed in any one of claims 36-43, including forming the recess on an end terminal of the component.

45. A method as claimed in any one of claims 36-44, including fixing the fatigue damage sensor to an inner surface of the recess.

46. A method as claimed in any one of claims 36-45, wherein the recess has a floor extending parallel to the axis of the component, and including connecting the fatigue damage sensor to the floor of the recess.

47. A method as claimed in any one of claims 35-46, including fixing the fatigue damage sensor to the component at locations on the fatigue damage sensor that are spaced apart in an axial direction on one of the sensor and the riser.

48. A method as claimed in any one of claims 35-47, wherein the fatigue damage sensor comprises a gauge having an initiated crack and wherein the gauge is adapted to monitor the growth of the crack as the gauge is subjected to stress.

49. A method as claimed in any one of claims 35-48, including securing the sensor to the component in a location that in normal use experiences less stress as another region of the component wherein fatigue damage is to be monitored.

50. A method as claimed in any one of claims 35-49, including integrating the sensor on the component in a location on the component that transmits fatigue loads to the sensor at a known stress concentration factor.

51. A method as claimed in claim 50, wherein the location is chosen based on the known stress concentration factor required to apply sufficient fatigue loads to the sensor to damage the sensor during a known period of normal operation of the marine riser, and wherein the fatigue loads applied to the sensor during normal operation are limited in accordance with the stress concentration factor to loads that cause damage to the sensor over the known period of normal operation without destruction of the sensor as a result of the fatigue loads during the normal period of operation.

52. A method as claimed in any one of claims 35-51, wherein the sensor is passive.

53. A method as claimed in any one of claims 35-52, including subjecting the fatigue damage sensor to a preload before being integrated into the component, and maintaining the preload in the sensor when the sensor is integrated into the component.

54. A method as claimed in any one of claims 35-53, including transmitting data to or from the sensor from the outer surface of the component, via a communication port extending through the outer surface of the component.

55. A method as claimed in claim 54, including connecting the fatigue damage sensor via at least one signal conduit to the port, and accessing an outer surface of the port to recover data from the fatigue damage sensor.

56. A method as claimed in any one of claims 35-55, including storing fatigue damage data within the component.

57. A method as claimed in any one of claims 35-56, including tracking the progress of a crack on the sensor visually by inspection.

58. A method as claimed in any one of claims 35-57, including tracking the progress of a crack in the sensor by taking electronic resistance measurements across the crack, and comparing changes in the resistance measurements over time to establish trends in crack growth and hence fatigue performance.