(19) Europäisches Patentamt
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(11) **EP 2 474 704 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
11.07.2012 Bulletin 2012/28

(51) Int Cl.:
E21B 33/035 *(2006.01)*

(21) Application number: **11150315.7**

(22) Date of filing: **06.01.2011**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

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(54) Monitoring the operation of a subsea hydrocarbon production control system

(57) A method of monitoring the operation of a subsea hydrocarbon production control system comprises monitoring at least one subsea device of the system and, if the device fails to a fail-safe condition, sending an indication of that by wireless.

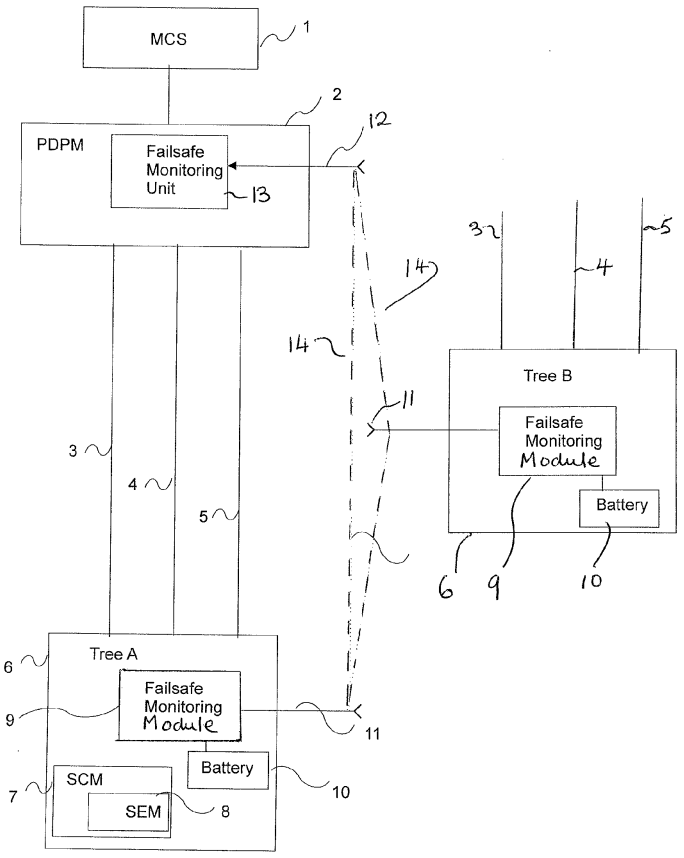

Fig.1

EP 2 474 704 A1

Description

Field of the Invention

[0001] The present invention relates to monitoring the operation of a subsea hydrocarbon production control system.

Background of the Invention

[0002] A shutdown philosophy is employed in the design of production control systems for subsea oil and gas wells, to ensure the protection of personnel, environment and equipment from the consequences that may occur as a result of abnormal operational conditions, accidental release of hydrocarbons or other accidents. This usually entails the inclusion of production shutdown and emergency shutdown mechanisms being built into the system, so that the system fails to a safe condition.

[0003] In this respect it is important that the status of all subsea valves and their actuators, which form part of the production control system, are known at all times but, more essentially, after a fail-safe shutdown has occurred. However, situations can arise where this information is not available and where this knowledge is critical for eliminating the problem (such as oil spilling out of a well or pipeline). Recent events in the Gulf of Mexico have demonstrated this need.

[0004] Examples of fail-safe shutdowns resulting from subsea failures, where relevant status information cannot be obtained using the existing system functionality, are those which occur between a well Christmas tree and the power distribution and protection module (PDPM) which is installed subsea and is the main subsea interface with Christmas trees providing electrical power, hydraulic power and communications to each Christmas tree. Such failures include:

- failure in communications between a Christmas tree and the PDPM;
- failure of the power line between a Christmas tree and PDPM;
- failure in the hydraulic line between a Christmas tree and the PDPM; and
- a combination of the above three failures.

[0005] Other situations are possible. A failure in any of these links will result in no information being available topside on valve status.

[0006] In all these situations, flow control valves and protective valves go into a fail-safe condition, but there is no means of verifying the actual status of the valves because communication is not possible between the Christmas tree concerned and the PDPM. A means of overcoming this would significantly improve the functional safety of hydrocarbon production control systems.

[0007] As prior art, there may be mentioned WO 2009/122168; the Internet article "To the last drop", pages 63-66, XP002532134 (www.abb.com/abbreview); WO 2005/078233; US 2006/0159524 A1; US 2003/0098799 A1; US 2004/0124994 A1; US-A-6 798 338; GB-A-2 377 131; WO 2006/134331; GB-A-2 163 029; and Ram Somaraju, et al, "Frequency, Temperature and Salinity Variation of the Permittivity of Seawater", Vol. 54, No. 11, November 2006, IEEE Transactions on Antennas and Propagation, IEEEE Service Center, Piscataway, NJ, US, pages 3441-3448, XP011150333 ISSN: 0018-926X.

Summary of the Invention

[0008] According to the present invention from one aspect, there is provided a method of monitoring the operation of a subsea hydrocarbon production control system, the method comprising monitoring at least one subsea device of the system and, if the device fails to a fail-safe condition, sending an indication of that by wireless.

[0009] According to the present invention from another aspect, there is provided a subsea hydrocarbon production control system, comprising means for monitoring at least one subsea device of the system and means for, if the device fails to a fail-safe condition, sending an indication of that by wireless.

[0010] Typically, said indication is sent to a fail-safe monitoring unit, which could be a subsea unit.

[0011] Typically, such a subsea unit is in a subsea power distribution and protection module.

[0012] Typically, the at least one device comprises at least one of a valve and an actuating mechanism for a valve.

[0013] The indication could be sent from fail-safe monitoring means at a tree of the system with which the device is associated. Typically, the system has at least one further such tree from which, if a device associated with it, fails to a fail-safe condition, an indication to that effect is sent by wireless from fail-safe monitoring means of the further tree.

[0014] An embodiment of the invention to be described below entails including a separate, independent, dedicated, health monitoring module on a Christmas tree, for monitoring the status of all actuators and valves installed on the Christmas tree and wellhead. The system has its own dedicated subsea wireless communication link capable of communicating information to a wireless receiving system on the PDPM and on other Christmas trees. Thus, in the event of failure of the normal communication links, the wireless channel is available. The module is provided with its own battery back-up to provide power in the event of power supply failure. The module sits alongside the normal process and control equipment in the Christmas tree mounted subsea control module (SCM) and can also be used to enhance the fail-safe decision making process in the SCM, by providing additional confirmation of the state of actuators and valves. If a shutdown should occur, but an indication that a device has gone to a fail-safe condition is not received, then this

is an indication of a problem.

[0015] The module can also form part of the normal decision making process by adding some intelligence to process the critical data which is related to a fail-safe condition.

[0016] Addition of the module also adds redundancy to the system.

Brief Description of the Drawings

[0017]

Fig. 1 is a schematic diagram of an embodiment of the invention; and

Fig. 2 is a block diagram of a modification which can be made to Fig. 1.

Description of Embodiments of the Invention.

[0018] Fig. 1 illustrates an implementation of the invention. In a conventional production control system, a master control station (MCS) 1, installed topside, provides the operator interface with subsea equipment and displays the current state of the various equipments and sensor information, enabling the operator to control the system. The MCS 1 collates data such as the operational state of all subsea valves and data relating to the state of production fluids across an entire oilfield. The MCS 1 interfaces with the subsea installed power distribution and protection module (PDPM) 2 which feeds electric power on lines 3, hydraulic power on lines 4, and communication on a line 5 to a plurality of Christmas trees 6, only two (A and B) being shown.

[0019] Each Christmas tree 6 includes a subsea control module (SCM) 7 which controls all the Christmas tree processes by providing hydraulic power to actuate valves mounted on the Christmas tree and at the wellhead. It also receives process instrumentation signals from sensors mounted on the Christmas tree and at the wellhead. These are received and processed in a subsea electronics module (SEM) 8 housed within the SCM 7 and communicated via the system communication link to the PDPM 2, and then topside. Failure of the communications link between a Christmas tree 6 and the PDPM 2 will result in no valve and other status data being available from that tree.

[0020] In accordance with the embodiment of the invention, a dedicated fail-safe monitoring module 9 is at each tree 6, which module provides data on the health of the valves, as well as their actuating mechanisms. The module 9 includes its own interfacing, signal conditioning and processing and have its own dedicated sensors. A back-up battery 10 is built-in so that the module can still operate in the event of electrical power failure. Health monitoring of the module 9 would form part of the normal equipment condition monitoring checks and the battery would be kept charged from the normal power supplies.

[0021] The production control system is provided with its own subsea wireless communication arrangement to communicate with the PDPM 2, so that in the event of a normal communication channel failure (copper wire, communications-on-power or fibre-optic) it has an alternative independent communication link. More particularly, at each tree 6, there is an RF antenna 11 for sending data to an RF antenna 12 at the PDPM 2 and thence to a fail-safe monitoring unit 13 in the PDPM 2. Thus, each Christmas tree 6 in the overall production well complex has its own SCM 7 and failsafe monitoring module 9 with a subsea wireless link 14. This enables individual Christmas trees to communicate with the PDPM and each other, providing alternative routes for valve and other status information to reach topside.

[0022] Fig. 2 illustrates an example of a configuration in which the fail-safe monitoring module 9 with its fail-safe monitoring (FSM) dedicated sensor package 15 is used in conjunction with the SEM 8 and its sensor package 16. When the sensor signals feeding the SEM 8 result in it triggering the fail-safe mechanism, a check can be made against the output from the fail-safe monitoring module 9 to see if this has also triggered a fail-safe mechanism as a result of the data from its dedicated sensor package. A fail-safe mechanism gets executed if either or both the SEM and the fail-safe monitoring system takes the decision to trigger a fail-safe mechanism. This also adds redundancy to the system.

Advantages of using the Invention

[0023] The invention can utilise a wireless communication system between topside and subsurface equipment that forms part of the latest hydrocarbon production control system.

[0024] There is no need to rely on hardwired communication systems using communications-on-power techniques or separate wired communication cables. The availability of subsea status information can provide immediate confirmation of a fail-safe situation and enable a rapid response to be achieved to a developing situation.

[0025] A rapid response to dangerous situations can save lives, significantly reduce environmental pollution and thereby reduce the cost of rectifying situations which arise.

Claims

1. A method of monitoring the operation of a subsea hydrocarbon production control system, the method comprising monitoring at least one subsea device of the system and, if the device fails to a fail-safe condition, sending an indication of that by wireless.

2. A method according to claim 1, wherein said indication is sent to a fail-safe monitoring unit.

3. A method according to claim 2, wherein said unit is

a subsea unit.

4. A method according to claim 3, wherein said subsea unit is in a subsea power distribution and protection module.

5. A method according to any preceding claim, wherein the at least one device comprises at least one of a valve and an actuating mechanism for a valve.

6. A method according to any preceding claim, wherein the indication is sent from fail-safe monitoring means at a tree of the system with which the device is associated.

7. A method according to claim 6, wherein the system has at least one further such tree from which, if a device associated with it, fails to a fail-safe condition, an indication to that effect is sent by wireless from fail-safe monitoring means of the further tree.

8. A subsea hydrocarbon production control system, comprising means for monitoring at least one subsea device of the system and means for, if the device fails to a fail-safe condition, sending an indication of that by wireless.

9. A system according to claim 8, wherein, in use of the system, said indication is sent to a fail-safe monitoring unit of the system.

10. A system according to claim 9, wherein said unit is a subsea unit.

11. A system according to claim 10, wherein said subsea unit is in a subsea power distribution and protection module.

12. A system according to any of claims 8 to 11, wherein the at least one device comprises at least one of a valve or an actuating mechanism for a valve.

13. A system according to any of claims 9 to 12, wherein, in use of the system, the indication is sent from fail-safe monitoring means at a tree of the system with which the device is associated.

14. A system according to claim 13, wherein the system has at least one further such tree from which, if a device associated with it, fails to a fail-safe condition, an indication to that effect is sent by wireless from fail-safe monitoring means of the further tree.

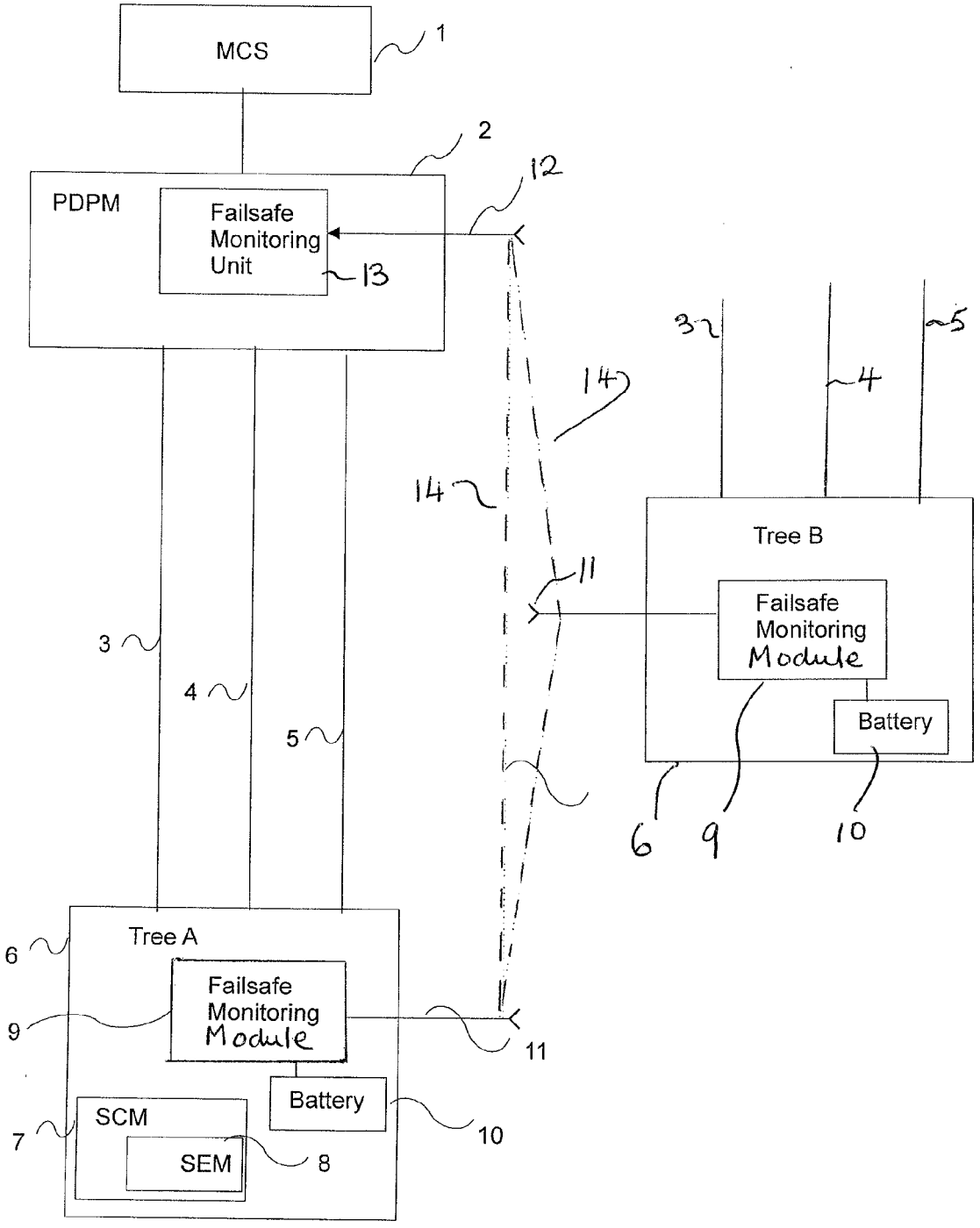
MCS
1
2
PDPM
Failsafe Monitoring Unit
13
12
14
14
3
4
5
3
4
5
Tree B
Failsafe Monitoring Module
Battery
11
6
9
10
Tree A
Failsafe Monitoring Module
Battery
SCM
SEM
6
9
7
8
10
11

Fig.1

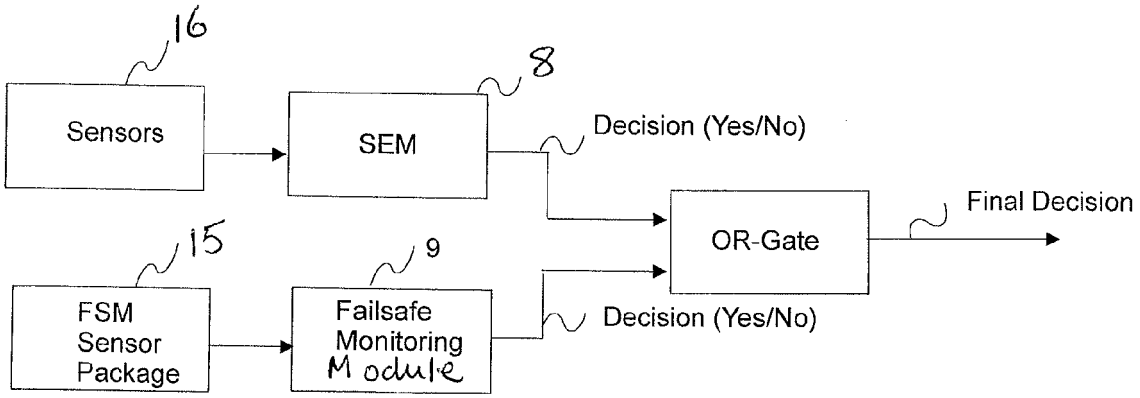
16
Sensors
8
SEM
Decision (Yes/No)
OR-Gate
Final Decision
15
FSM
Sensor
Package
9
Failsafe
Monitoring
Module
Decision (Yes/No)

Fig.2

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EUROPEAN SEARCH REPORT

Application Number
EP 11 15 0315

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 3 416 566 A (ANDERSON CLIFFORD E) 17 December 1968 (1968-12-17) * column 1, line 71 - column 2, line 2 * * columns 232-52; claim 1 *	1-14	INV. E21B33/035
Y	US 2009/212969 A1 (VOSS ROBERT K [GB]) 27 August 2009 (2009-08-27) * paragraphs [0006], [0008], [0021]; figure 1 *	1-14	
A,D	WO 2009/122168 A1 (VETCO GRAY CONTROLS LTD [GB]; SIMPSON STEVEN LEWIS CHARLES [GB]; DAVEY) 8 October 2009 (2009-10-08) * the whole document *	1-14	
			TECHNICAL FIELDS SEARCHED (IPC)
			E21B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	19 May 2011	Bellingacci, F

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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19-05-2011

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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- GB 2163029 A **[0007]**

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- *To the last drop,* 63-66, www.abb.com/abbreview **[0007]**
- **RAM SOMARAJU et al.** *Frequency, Temperature and Salinity Variation of the Permittivity of Seawater,* November 2006, vol. 54 (11), ISSN 0018-926X, 3441-3448 **[0007]**