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Produced Water Discharge Monitoring: What are the standards and how to meet them?

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Confused by the legislation regarding discharge of produced water?

With tightening environmental processes and an ever-increasing industry drive towards an eco-friendlier future, we are often wading through endless paperwork and regulations to understand to what we are required to conform.

Produced water is an unavoidable fact of life for oil and gas production which can offer opportunities and challenges for operational and environmental compliance. Created during oil and gas or condensate production operations, produced water is a complex combination of formation water, hydrocarbons, chemicals, solids and salt.

Water can dissolve and carry many impurities within it. Accurate measurement of these impurities, suspended solids, and oil content is a critical element to oil and gas operators. Over the years our industry has addressed the by-product in a form of hierarchy to Minimise, Re-use, Re-Cycle and then Dispose.

From international regulations through to a consumer's perception of a company, the importance of protecting our environment has never been greater. This has put 'big data' and 'environmental monitoring' at the top of many company's agendas. Therefore, while there is a financial argument for monitoring produced water the liability of environmental discharges is every bit as strong.

In this paper, we will discuss the environmental issues and more pertinently the regulations for discharging produced water.

Produced Water Discharge

There are a number of regulators and bodies ensuring minimal oil discharge to protect our environment. These include the OSPAR (Oslo/Paris) Convention, International Maritime Organization (IMO), classification societies, flag state authorities and national/regional laws.

To further clarify the legislation, first we must draw the distinction between produced water and contaminated seawater (slops discharge). These are two different applications with different regulatory regimes.

As denoted in the Annex I of MARPOL 73/78, there are five categories of discharges that may be associated with the operation of fixed or floating platforms which are covered in this regulation:

1. Machinery Space drainage;
2. Offshore processing drainage;

3. Production water discharge;
4. Displacement water discharge; and
5. Contaminated seawater from operational purposes such as produced oil tank cleaning water, produced oil tank hydrostatic testing water.

Only the discharge of machinery space drainage and contaminated ballast should be subject to MARPOL 73/78. See Figure 1.

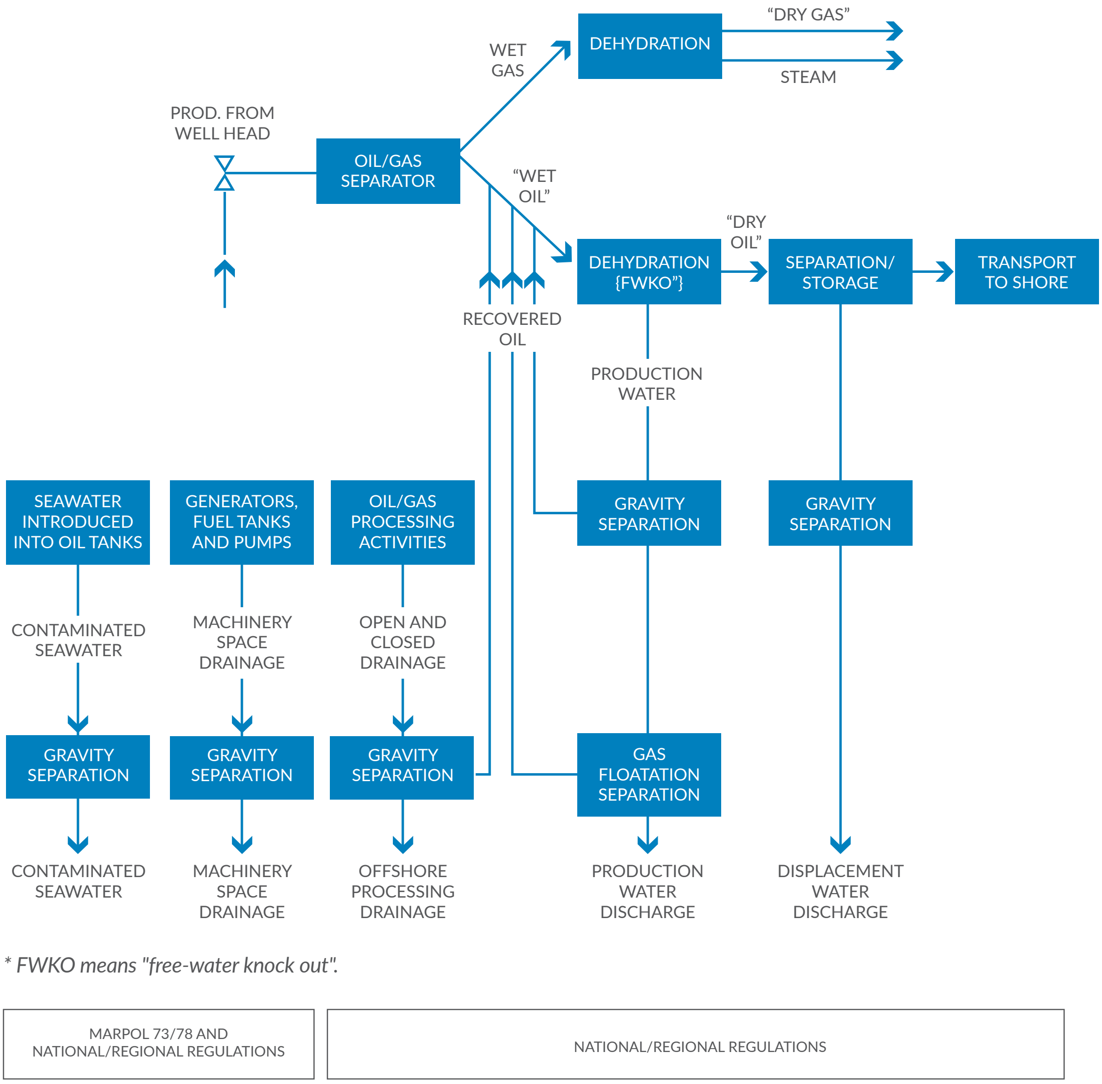

Figure 1: MARPOL 73/78 Annex 1 Reg. 39 Appendix 5 - Discharges from fixed or floating platforms (IMO MARPOL 73/38 Annex I- Regulations for the Prevention of Pollution by Oil, 1978)

Only when discharge from a machinery space is mixed with production water discharge does it then become subject to MARPOL; and the overboard effluent shall be of maximum 15ppm. (MEPC.139(53) , 2005)

Therefore, the MEPC.139(53) covers the deviations / non-compliance of the MEPC.108(49) for FPSOs and FSUs. Produced water discharges are governed by National regulations such as the Department for Business Energy and Industrial Strategy (BEIS), formerly Department of Energy and Climate Change (DECC), and the Norwegian state Pollution Control Authority for the North Sea. These generally follow the provisions outlined in the OSPAR Convention, stating the current oil concentration allowed for discharge is 30mg of dispersed oil per litre of produced water. Upon application for a field licence/permit, the limits for discharge will be agreed with the operator and regulatory authority. Nations who act as a Coastal State in other regions will have a variation of OSPAR integrated into their own legislation.

Region	Latitude	Legal Base	Standard Daily Max.	Ave.
Europe				
North Sea	High	OSPAR Convention	-	30mg/L
Baltic Sea	High	HELCOM Convention	15 mg/L	-
Mediterranean	Low	Barcelona Convention	100 mg/L	40 mg/L
Asia				
Red Sea	Low	Kuwait Convention	100 mg/L	40 mg/L
China	Moderate	GB 4914-85	70 mgL	30-50 mg/L
Indonesia	Low	MD KEP 3/91; 42/97	100 mg/L	75 mg/L
Thailand	Low	NEQA 1992: Gov. Reg. 20.90	100 mg/L	40 mg/L
Vietnam	Low	Decision no. 333/QB 1990	-	40 mg/L
North America				
United States (Alaska)	High	40 CFR 435	42 mg/L	29 mg/L
Canada (North Atlantic)	High	Act RSC 1987	60 mg/L	30 mg/L
South America (Brazil)	Moderate	-	20 mg/L	-
Oceania				
Australia	Moderate	-	50 mg/L	30 mg/L

Table 5 (J.Zheng, 2016)

Regulations and discharge standards of oil and grease concentration for offshore produced water discharge worldwide

Monitoring and Analysis of Discharges

Continuous online monitoring can provide direct measurements of produced water at various stages of the separation process providing more detailed information on the size distribution and concentration of oil and solids in water. The fact that the monitoring is able to take place in real-time also provides a highly effective early warning system in terms of any production threats enabling optimisation of the separation process to take place.

Normally, Produced Water is discharged overboard separately from both the Slop and Engine Room Bilge, which are also individually discharged overboard as it is not permitted under IMO MARPOL to mix oily water discharges from Engine Room and Cargo Area.

Many operators would like to use an ODME (Oil Discharge Monitoring Equipment) to monitor the produced water as they already have this equipment for MEPC.108(49). However, the monitoring requirements are assessed on a case by case basis as noted in (DECC, 2014) Figure 3.

8.4.3 Environmental monitoring requirements will be assessed on a case-by-case basis. Where monitoring is considered to be appropriate, the requirements will be discussed and agreed with the Permit Holder and detailed in the Permit.

Figure 3: Extract from OPPC Guidance Notes regarding monitoring requirements for FPSO Produced water discharges (DECC, 2014)

Can a MEPC.108(49) Oil Discharge Monitoring Equipment accurately read the oil content of the produced water?

This is an important question, and the short answer is NO. An ODME is designed to provide means of monitoring, recording and controlling the ballast discharge for crude oil, product and chemical tankers in accordance with the IMO rules MEPC 108 (49) MEPC 240(65) and MEPC Circ1, 761.

These rules state that the discharge will be automatically stopped when the limit of 30 litres of oil per nautical mile or of 1/30,000 of the previous cargo is reached. If the ODME PPM exceeds 1000ppm or a fault occurs, the discharge will also be stopped.

6.12 Alarm conditions resulting in the stopping of discharge

Audio-visual alarms should be activated for any of the following conditions and the monitoring system should be so arranged that the discharge of effluent into the sea is stopped:

.1 whenever the instantaneous rate of discharge of oil exceeds 30 litres per nautical mile;

.2 when the total quantity of oil discharged reaches 1/30,000* of the previous cargo;

.3 in the event of failure of the system's operation, such as:

.3.1 power failure;

.3.2 loss of sample;

.3.3 significant failure of the measuring or recording system; or

.3.4 when the input of any sensor exceeds the effective capacity of the system.

Figure 4: Extract of the alarm conditions set by the IMO for ODME equipment (MEPC.108(49), 2003)

The rules also give specific oils and solids that the ODME has to be able to detect and reject for it to comply with the Rule Figure 5

Category of Oil	Categories Represented	Parameters Tolerance
1	Density – low Viscosity – low Pour Point – very low General description – mixed base	Density*: 790.0-800.0 Kinematic viscosity**: 2.65 ± 5% Cloud point***: -2 ± 3oC
2	Density – medium Viscosity – medium Pour Point – low General description – mixed base	Density: 852.0-862.0 Kinematic viscosity: 10.19 ± 5% Cloud point: -5 ± 3oC
3	Density – high Viscosity – medium Pour Point – low General description – naphthenic	Density: 884.0-894.0 Kinematic viscosity: 12.9 ± 5% Cloud point: 5 ± 3oC
4	Density – very high Viscosity – very high Pour Point – low General description – asphaltic	Density: 947.0-957.0 Kinematic viscosity: 1246 ± 5% Cloud point: 29 ± 3oC
5	Density – medium Viscosity –high Pour Point – very high General description – asphaltic	Density: 839.0-849.0 Kinematic viscosity: 3.96 ± 5% Cloud point: 39 ± 3oC
6	Marine residual fuel oil – RMG 35	RMG Parameters as per ISO 8217:1996 (table 2)

Figure 5: Extract of the oils and solids specified for ODME Equipment as set by the IMO (MEPC.108(49), 2003)

On a stationary FPSO, a MEPC.108(49) monitor would not allow any discharge as the vessel is not ‘en route’ as per MEPC.108(49) regulations.

ODME systems use scattered light technology which is notoriously bad at solid discrimination and therefore, even with a software change to the alarm limits, to allow discharge in a stationary position, this would not be the correct equipment to ensure compliant environmental monitoring of produced water.

Consequently, a typical arrangement for an FPSO would be equipped with an ODME certified to MEPC.108(49) and a unit to accurately measure the PPM of the produced water serving the National/Regional regulations.

Produced Water monitors are specifically developed for this application to enable them to accurately and reliably detect the oil content and tolerate other substances such as dispersed oil, inorganic and organic compounds, treatment chemicals, solids and salt.

Class association, DNV-GL, have confirmed that produced water monitors, do not require certification to MEPC.108(49) - “Certifications requirements to such equipment is not part of MARPOL and dependent on the National / Regional requirements” (Konstantinov, 2018)

Rivertrace Solutions

Rivertrace has developed a number of solutions for the application of monitoring produced water discharge and have installed our monitors on a range of FPSOs in Europe, Africa and Asia. Rivertrace offers customers a complete environmental monitoring compliance system. This incorporates the SMART ODME for MEPC.108(49) discharges and an OCD Xtra or a SMART PFM for the monitoring of produced water discharge, with an interface module to control the valves.

OCD Xtra

The OCD Xtra combines multiple light wavelengths with multiple sensor technology, to measure oil accurately in the range of 0-200ppm, even in the blackest of produced water.

Rivertrace’s OCD Xtra is factory calibrated for six different oil types and six different suspended solids. This allows the OCD Xtra to accurately measure a broad spectrum of oil types without the need for oil specific calibration, as found with the vast majority of oil-in-water analysers. Multiple oil types and suspended solids are automatically compensated for by sophisticated algorithms.

A multi-parameter display shows the samples oil content, turbidity, pressure and a graphical average of the last four hours oil readings. The last seven days readings are stored on a ROM, easily accessed via the console.

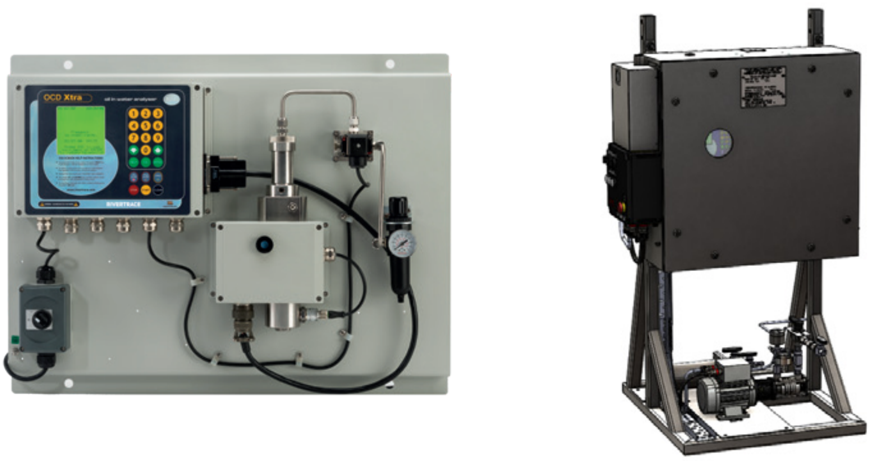

Figure 6 Rivertrace OCD Xtra & OCD Xtra Purged System

The OCD Xtra has an “Oil Factors” function that allows the calibration curve to be pulled in line with laboratory results taken from grab samples. With this function, we can fine tune the calibration to give great accuracy on any oil type.

As with all optical equipment, keeping the optical path clean is crucial for accuracy and reliability. The OCD Xtra is no different, and with such harsh, soiled samples passing through the measuring cell the need for a robust and effective cleaning device is elevated. The OCD Xtra uses an automatic pneumatic cleaning system that we have found to outperform both ultrasonic and water jet technology to ensure the optical path stays clear.

SMART PFM

Rivertrace’s alternative option the SMART PFM monitor, uses microscopy technology to measure particulates in the sample stream by passing the process fluid through a proprietary photo optical measuring cell. Unlike conventional monitors such as light scatter or UV fluorescence, which are solely based on light intensity, the Rivertrace monitor deploys optical recognition algorithms and light intensity to differentiate between oil particles, gas/air bubbles and solid particulates ranging from 1-500 microns in size. The system is designed to auto adjust its light source according to the sample‘s turbidity.

Over recent years UV fluorescence monitors have been widely adopted and used in offshore, but this technology has performance and accuracy issues that are well known in the industry. UV fluorescence monitors are calibrated on one type of hydrocarbon which limits its detection range yielding false positives or non-detection of hydrocarbon that is out the range of calibration oil. The SMART PFM was designed to overcome all of the short-comings of a UV florescence monitor.

On a UV fluorescence monitor, signal intensity is very dependent on the oil chemistry, oil droplet size, cleanliness of the cell and requires regular calibrations. In comparison the SMART PFM works on shape recognition, so it is independent of the chemistry of the oil. It is also independent of oil size or conditioning / temperature/ pressure. The SMART PFM does not fall out of calibration and does not require constant calibration as it is not intensity based but shaped based technique. The SMART PFM requires no re-calibration if the oil being analysed varies from the standard calibration fluid and it is this feature that makes it particularly suitable for applications in the offshore oil industry.

Oil concentration, pressure, temperature and oil alarm status are displayed on an LCD touch-screen display and any oil concentrations, alarms or faults are logged and stored on the system in compliance with reporting requirements. These reports can be accessed remotely or downloaded to a PC via LAN or USB stick, if necessary. When the monitor is connected to the Internet, remote diagnostics can be undertaken by the manufacturer. Optional dedicated software on any Windows PC allows the display to be duplicated remotely by the user giving full functionality without the need for a physical visit to the analyser.

The Smart PFM incorporates several ways in which automatic cleaning can be achieved including air-driven solenoid, or electronic actuator. The cleaning process is automatically triggered whenever the system senses contamination of the optical windows.

Figure 7 Rivertrace SMART PFM & SMART PFM Exd Version

Company	Yinson Production Limited
Project	The FPSO John Agyekum Kufuor is part of the Cape Offshore Three Points development project (OCTP) in Ghana
Application	Produced Water Discharge and Slop Water Discharge to meet MEPC 108 (49)
Requirement	SMART ODME and OCD Xtra
What we provided	The key functions of the system are as follows; • The ODME system will integrate with the customers ICSS for controlling the Overboard and Re-Circulation Valves. • The ODME system will monitor the PPM Level when the vessel is underway and will change the relay state on the ODME Computer Module from open to closed. • The OCD Xtra system will monitor the PPM Level when the vessel is stationary on field. • The ODME/OCD Xtra Interface Module, and a Volt Free Relay will be wired to the ships ICSS which will be used by the customers to control the Overboard/ Re-Circulation Valves to either open or close them. • The Overboard Discharge Valve and the Re-Circulation Valve are generally set that if one opens the other closes. • The ODME Computer Module will also monitor the position of the Overboard Discharge Valve. • The ships ICSS should be connected to the Valves Position Limit Switches, which monitor the position of the Valve.

Figure 8 Concept design for the FPSO for the OCTP Project

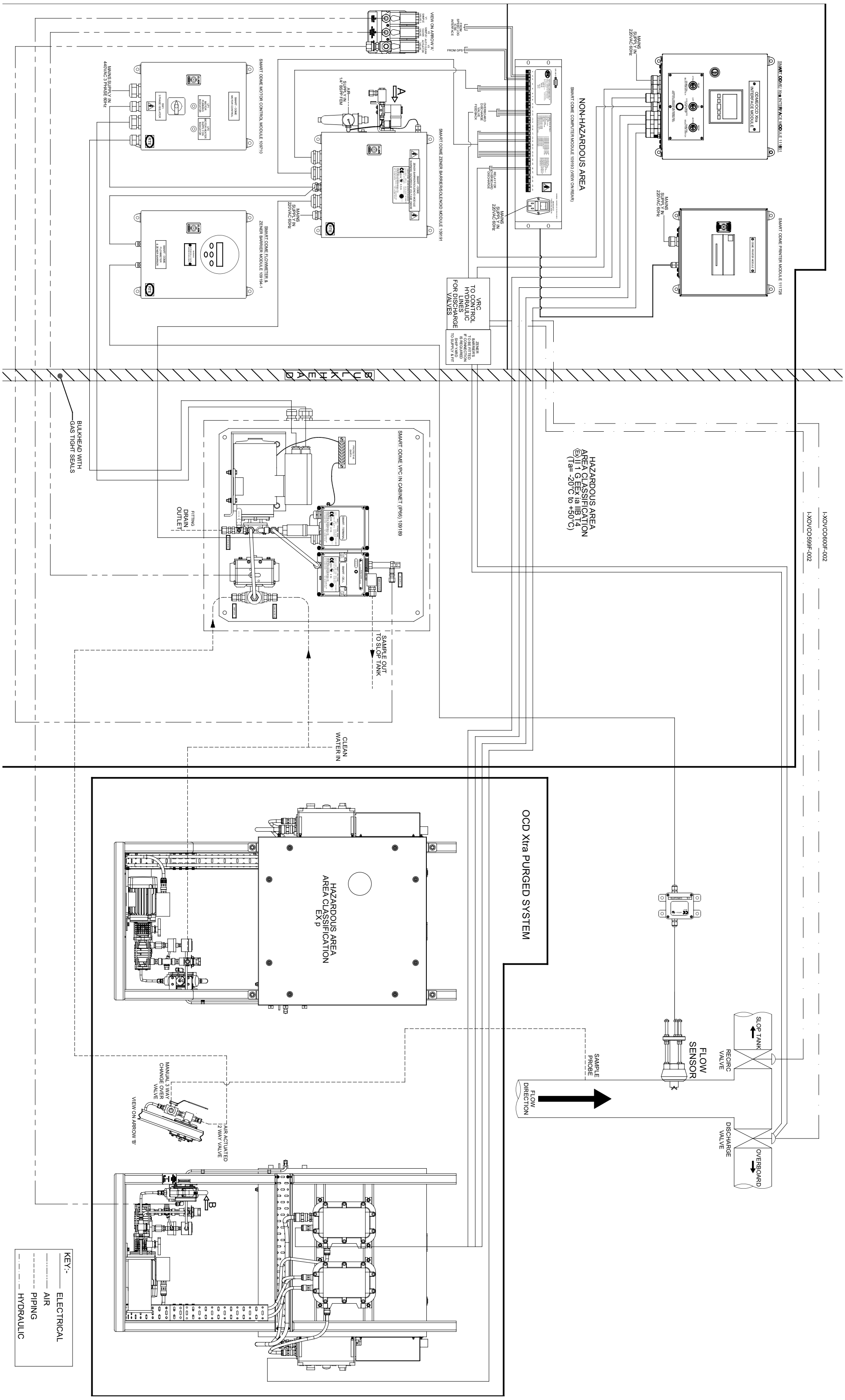

Figure 9 SMART ODME system with integrated OCD Xtra system overview schematic

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