Bonn Agreement
Accord de Bonn

# PART 3:

# GUIDELINES FOR OIL POLLUTION DETECTION, INVESTIGATION AND POST FLIGHT ANALYSIS/ EVALUATION FOR VOLUME ESTIMATION

## *1 Introduction*

1.1 The primary task for marine pollution surveillance aircrew is to detect, observe, investigate, evaluate and report (oil) pollution. Assessing the volume of an oil slick is the result of a calculation using parameters recorded during the detection (remote sensing instruments) and observation (visual) of related circumstances and conditions. The result of the calculation is only an estimation; an indication of quantity. Based on the findings of the aircrew, the response authority will define appropriate counter pollution measures.

1.2 In flight, all detections should be treated in the same way regardless of whether they are considered legal or illegal, from whatever the source, known or unknown. All detections should be investigated and the fullest data set possible collected and recorded using the available remote sensing and photographic equipment together with visual observation. The data should be evaluated and a volume calculated. The estimated quantity of oil forms the basis for the decision to respond together with other essential information such as location and weather.

1.3 Post flight, an independent and detailed analysis / evaluation of the size and volume of the oil should be made using the recorded data set, visual observation and photographs. The 'post flight' assessment of size and volume should be used for any follow up legal action.

1.4 With regard to illicit discharges from vessels aircrews should be familiar with MARPOL 73 / 78 Regulations. The overall conclusion from trials simulating discharges in compliance with MARPOL Regulation was that the first trace of oil could be seen when the oil / water mixture release was only 50 ppm; this implies that when oil is seen in the wake of a vessel it is a violation of the regulations.

1.5 Aircrews should also be aware that certain discharges from offshore installations are permitted. The appearance of the oil and the interpretation of the appearance of discharges from oil rigs are not the same as for ship discharges or isolated slicks where the source is unknown. **However, all detections from or near offshore installations should still be investigated and the fullest data set possible collected and recorded using the available remote sensing and photographic equipment together with visual observation. The data should be evaluated and a volume calculated using the same procedures as for other types of oil detections.** Details of Discharges from Offshore Installations are at Annex C.

1.6 Although most marine pollutions detected/observed are the result of illicit mineral oil discharges by vessels (i.e. above discharge limits set in Annex I of MARPOL 73/78), aerial surveillance crews may also observe spills of other nature, resulting from a (legal or illegal) discharge of another harmful substance than mineral oil, such as a discharge of a noxious liquid substance carried in bulk (chemical) (MARPOL Annex II discharge) or of a solid cargo residue falling under the category of "garbage" (MARPOL Annex V discharge). Therefore an overview of the relevant discharge regulations under MARPOL Annexes II and V, together with operational procedures for aerial surveillance operators making an observation/detection of this kind, are added at Annex D and E respectively."

1.7 It is essential that all detections be reported as soon as possible to the relevant authorities so that any immediate response or follow up action can be initiated. Through international organisations of Port State Control, authorities may apply for assistance to inspect the suspect vessel on arrival at any harbour of a member state.

## *2 Detection*

2.1 The main detection equipment is radar. Most marine pollution aircraft have Side Looking Airborne Radar (SLAR).

2.2 After the initial detection where possible the aircrew should try to orientate the flight path so that all the oil passes down one side of the aircraft, parallel to the flight path, at a range of between 5 and 10 miles: this positioning optimises the radar performance and avoids the 'radar blind' area directly beneath the aircraft.

2.3 *If time permits a 'radar' box should be flown around the slick at a range of between 5 and 10 miles. This ensures that at some stage the oil and sea will present the best aspect for data collection to the radar. The best SLAR image will normally be available when the surface wind is at $90^0$ to the aircraft's flight path.*

## *3 Investigation - Data Collection*

3.1 Following the detection by SLAR, the slick should be thoroughly investigated using the vertical remote sensing instruments; IR, UV and Vertical Camera. The aircraft should be

flown directly over the oil to enable the 'plan' view (the most accurate view) of the slick to be recorded.

3.2 The UV sensor may enable an accurate 'oiled' area measurement. UV may also show the areas not covered with oil allowing the oiled area measurement to be 'adjusted'. The vertical camera may provide area and appearance data of the oil. The IR data may give a 'relative' thickness of the slick, which can be used to supplement the UV, and Vertical Camera information.

3.3 *It is suggested that the aircraft is flown 'up' the line of oil towards the 'polluter', ship or rig; this avoids the IR 'flaring out' because of the rapid increase in temperature associated with the vessel (engines) or installation (flare).*

3.4 *It is also suggested that the aircraft is flown at a height that allows as much of the slick as possible to fall within the field of view of the vertical sensors. It may be necessary to 'map' large slicks. On the other hand low clouds may hamper the sensors.*

## *4 Visual Observation*

4.1 Visual observation of the pollution and polluter provides essential information about the size, appearance and coverage of the slick that are used to calculate the initial estimate of volume.

4.2 The visual form of an oil slick may also suggest the probable cause of pollution:

- A long thin slick of oil sheen suggests a possibly illegal discharge of oil from a ship. The cause is obvious if the ship is still discharging, as the slick will be connected to the ship, but the slick may persist for some time after discharge has stopped; it will subsequently be broken up and dispersed by wind and waves.
- A triangular slick with one side aligned with the wind and another aligned with the prevailing current suggests a sub-sea release, such as that from a sub-sea oil pipeline or oil slowly escaping from a sunken wreck.
- Slicks seen some distance 'down current' of oil installations, particularly in calm weather, may be caused by re-surfacing of dispersed oil from permitted discharges of produced water.
- Large area's covered with a homogeneous oil layer are mostly the result of an accident e.g. a leaking storage tank of a tanker. In these cases detailed information would be easily obtained from the captain of the vessel. It is emphasized that also in accidental spill a similar method of collecting information (evidence) should be followed.

4.3 The observation can be influenced by several factors, cloud, sunlight, weather, sea, and angle of view, height, speed and local features as well as the type of oil. The observer should be aware of these factors and try to make adjustments for as many as possible.

4.4 *It is suggested that the ideal height to view the oil will vary from aircraft to aircraft. For example an Islander with its low speed allows observation at a lower level than a Merlin* *with its higher speed. For an aircraft with a speed of around 150 knots a height of around 700 to 1000 feet is suggested.*

4.5 *It is recommended that the slick should be viewed from all sides by flying a racetrack pattern around the oil. The best position to view the oil is considered to be with the sun behind the observer and the observer looking at the object / subject from an angle of $40^0$ to $45^0$ to the perpendicular.*

4.6 The oil appearances will generally follow a pattern. The thinner oils, sheen, rainbow and metallic, will normally be at the edges of the thicker oils, discontinuous true colour and true colour. It would be unusual to observe thick oil without the associated thinner oils; however, this can occur if the oil has aged and / or weathered or if the oil is very heavy. Heavy oil will tend to be mainly true colour and have very sharp defined edges.

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4.7 During the observation the aircrew should estimate the areas within the oiled area that have a specific oil appearance. The Bonn Agreement Oil Appearance Code (BAOAC) is detailed at Annex A.

## *5 Investigation - Photography*

5.1 Photographs of the oil slick and polluter are probably the most easily understood data for a non technical person. It is therefore essential to produce a complete set of pictures showing the required evidence.

5.2 The photographs can also confirm or amend the in flight visual observation during the post flight analysis. However, photographs should be used with caution when considering the oil appearance as the development of the film may affect the appearance / colour.

5.3 The ideal set of photographs will show an overall, long range, view of the pollution and the polluter and a series of detailed, close up, shots of the pollution and the polluter. Obviously a photograph showing the name of the vessel; the port of registration (the stern) and the IMO number are important details.

5.4 It is important, where possible; to show clear evidence of a connection between the polluter and the pollution, directly or indirectly, the camera data can provide this as can the IR and UV data.

5.5 The data should also show ‘clean’ water ahead of the vessel so that the ship’s crew cannot claim that the pollution was already there and they were ‘just’ sailing through it. A vessel passing through a slick will separate the oil and leave a clear wake.

5.6. In case the digital photo’s obtained from a polluter are processed using one of the available enhancement software programmes, the operator should clearly describe in his official report what manipulations he has applied.

## *6 Volume Estimation - Oiled Area Measurement*

6.1 Trials have shown that both oiled area and specific oil appearance area coverage measurement is the main source of error in volume estimation. Therefore observers should take particular care during this part of the volume estimation process.

6.2 Estimating or measuring the oiled area can be done either by:

- Visual estimation
- Measurement of sensor images

6.3 Estimations of oiled slick area based on visual observations are likely to be less accurate than estimates based on measurements made of remote sensing images.

6.4 If possible, the whole slick should be visible in one image for ease of area measurement. Area calculations using accurate measurements of SLAR images will be more appropriate for large oil slicks, while measurements of UV images will be more suitable for smaller slicks.

6.5 Most modern SLAR systems incorporate electronic measuring devices; areas can be measured by drawing a polygon around the detected slick. It is recommended that these devices be used where at all possible as they will provide the most accurate measurement within the confines of the aircraft during flight. Alternatively the overall length and width can be measured electronically and the oiled coverage estimated visually.

6.6 *It should be remembered that because of the resolution of the SLAR (generally 20 metres) small areas of less than 20 metres NOT covered with oil but within the overall area would not show on the SLAR. However, oil patches of less than 20 metres will show up as patches of 20 metres.*

6.7 The recommended procedure for visual observation is to estimate the length and width of the slick by making time and speed calculations. This forms an imaginary rectangle that encloses the slick. The coverage of the oil slick (expressed as a percentage or proportion) within this imaginary rectangle is then used to calculate the oiled area of the slick. Inevitable inaccuracies in dimension estimates and estimated coverage within these dimensions can give rise to high levels of error in area estimation.

6.8 When determining the oiled area coverage it is essential to remember that main body of an oil slick may have 'areas' of clear water, especially near the trailing edge of the slick. For compact slicks, there may be only a few ‘clear water’ areas but for more diffused oil slicks there could be several which would lower the overall coverage percentage significantly. More accurate assessments of oiled area can be made by a thorough analysis of the SLAR or UV images.

## *7 Volume Estimation - Specific Appearance Area Coverage Measurement*

7.1 The ‘oiled’ area should be sub-divided into areas that relate to a specific oil appearance. This can be achieved using the recorded data from the vertical sensors and the noted visual observations.

7.2 This part of the volume estimation is mainly subjective, so great care should be taken in the allocation of coverage to appearance, particularly the appearances that relate to higher thicknesses (discontinuous true colour and true colour).

7.3 The vertical camera data (if available in flight) and the visual observations should be compared with the IR data, which will give an indication of the thickest part of the slick.

7.4 Thermal IR images give an indication of the relative thickness of oil layers within a slick. Relatively thin oil layers appear to be cooler than the sea and relatively thick oil layers appear to be warmer than the sea in an IR image. There is no absolute correlation between oil layer thickness and IR image because of the variable heating and cooling effects caused by sun, clouds and air temperature.

7.5 The presence of any area within the slick shown as warm in an IR image indicates that relatively thick oil (Code 4 or 5 in the BAOAC) is present. Since these areas may only be small, but will contain a very high proportion of oil volume compared to the much thinner areas, their presence should be correlated with visual appearance in the BAOAC assessment.

7.6 The Volume Estimation Procedure is illustrated at Annex B.

7.7 It is generally considered that 90% of the oil will be contained within 10% of the overall slick (normally the leading edge (up wind side) of the slick), within a few hours after the release.

## *8 Post Flight Analysis*

8.1 The aim of post-flight analysis / evaluation is to provide a more accurate estimate of spilled oil volume than can be made within the confines of the aircraft during flight. It is based on measured oil slick areas and the estimated oil layer thickness in various parts of the oil slick. It involves integrating the information from several different sources in a systematic way.

8.2 Electronic methods or the use of grid overlays should be used to obtain accurate measurements of overall slick area from the recorded images. Where several images have been obtained during a period of time, the area should be calculated for each one.

8.3 The next stage in post-flight analysis is to calculate oil coverage within the overall area estimated from visual observation or measured from the remote sensing images.

8.4 The photographs and Standard Pollution Observation Log should be re-examined and the proportions of slick area of different BAOAC codes should be re-calculated. Any assessment of the appearance of different areas of oil within a slick will be somewhat subjective. Nevertheless, the BAOAC provides a standard classification system to allow at least semi-quantitative thickness (and subsequently, volume) estimation, particularly at lower oil thickness (Codes 1 to 3).

8.5 It is particularly important that areas of any thick oil (Codes 4 or 5 in the BAOAC) - if present - be confirmed as accurate or correlated with the thicker areas shown on the IR image, since these will have a very large influence on estimated volumes.

8.6 The final stage of post flight analysis is to calculate the estimated volume by totalling the volume contributions of the different areas of the slick.

8.7 Volume estimations made by analysis of different sensors and methods should be compared. Similarly, volume estimates made from data obtained at different times should be compared to ensure that it is consistent; spilled oil volume would not normally change over a short time, so very different estimates obtained only a few minutes apart will be a signal of problems.

## *9 Oil Volume Estimate Usage*

9.1 Using the BAOAC to estimate oil volume gives a maximum and minimum quantity. It is suggested that in general terms the maximum quantity should be used together with other essential information such as location to determine any required response action. It is suggested that the minimum volume estimate should be used for legal purposes. Reference is made to Bonn Agreement Contracting Parties Meeting Summary Record 2003 Page 5, Para. 2.4 (f) which states "When the BAOAC is used to estimate the quantity of oil released at sea, the lower limit of the range in the code for each coded appearance should be used for estimating the amount of oil present in the slick for enforcement purposes and for statistical reporting". However, it is emphasised that each national authority will determine how to use the BAOAC volume data within its own area.

9.2 It is emphasised that extra caution should be used when applying the BAOAC during major incidents involving large quantities of thick oil and / or heavy oils or when emulsion is present. Aircrews should use all the available information or intelligence; such as oil thickness measurements take by surface vessels, to estimate the volume.

## *10. Collecting evidence  - the chain of evidence*

### 10.1 Objective

One of the main objectives of aerial surveillance flights performed by most Bonn Agreement Contracting Parties and other Member States of the European Union is to identify the source of pollution. In the case of catching a vessel or offshore installation red-handed, thus whilst discharge, it is essential to gather data that can be used in the process of prosecution.

### 10.2 Evidence

National criminal law and other regulations describe what data or information is recognized contributing to "evidence". The bottom line is that at first the prosecutor will weigh the evidence and judge the admissibility. However, at the end of the procedure, it is the magistrate (judge) who gives the final verdict on the collected evidence. The procedure is there to prove whether the alleged violation of MARPOL or other Environmental Law really was an illicit discharge.

### 10.3 Parts of the evidence forming a chain

Identified pieces of information comprising the chain of evidence, without putting a value to the various parts are:

- first message (alert)
- a satellite SAR image, showing an indication of a possible pollution connected to a possible source
- AIS data of the possible source
- an aircraft SLAR detection, showing similar information as the satellite SAR
- a visual observation (BAOAC) and volume assessment
- sensor data supporting the SLAR, such as UV; IR or FLIR and or visual observation
- oblique and/or downward looking (still) photographs
- an oral statement by a person on board the source
- a sample of the pollution and the consequent analysis
- the report by the Port State Control authority
- an official statement or witness statement by any other authority or someone from the public.

Obviously, when the captain or platform manager gives a statement confessing that a discharge was made a strong case may result in a conviction. However, in most cases such a statement will not be obtained, and therefore the prosecutor has to make use of the evidence provided by aircrew and other authorities.

It is recognized that attached to all pieces of information, the reporting authority would preferably provide an explanation of the procedures followed in gathering the evidence and the capabilities of the sensors, as well as what information can be found in the various images.

Again, the necessity of gathering specific information depends on national law. For instance, the Dutch prosecutor (court) does not require samples taken at sea. The official statement prepared by the aircrew is considered to be sufficient. And in the attachment to the statement, reference is made to the report "Visibility limits of bilge oil discharges from ships" which concluded that whenever traces of oil are visible in the wake of a vessel the discharge contains more then 50 ppm.

### 10.4 Improvements

With regard to ways to improve the strength of the evidence three groups of information in the procedure are discriminated:

a. the sensor data;

b. visual observations;

c. reverse proof.

The sensor packages most Contracting Parties apply are state-of-the-art. From an expert opinion it is well understood what sensors will provide. At this moment there is no sensor available that will provide exactly what the substance is that has been discharged. The LFS is the only sensor providing an indication with a certain level of confidence. Through consultation with suppliers, R&D on the issue could be defined and physical or technical limits of feasibility could be explored.

Visual observations are tight to good visibility conditions (weather) and day light. In this respect the Bonn Agreement Oil Appearance Code provides a tool to recognize certain appearances in the discharged substances leading to an oil volume assessment in the case of a discharge of an oil/water mixture.

Combining photographs and InfraRed-UltraViolet imagery after landing could improve the quality of the volume assessment. Moreover the communication with the ship crew and verification of information with the authorities in the last port of call or the owners may clarify certain aspects. It is stressed that a thorough check of the collected data, after landing, is a viable option to improve the observation.

Reverse the burden of proof, making the ship crew prove that there was no violation of MARPOL regulations is an option to discuss. Again the possibility to apply the reverse burden of proof is depending on the national law.

An overall issue might be the ability to quickly respond to first alerts e.g. on receipt of a satellite detection indicating a possible illicit discharge, the time between receipt of the alerting message and the verification by an aircraft should be as short as possible.

It is strongly advised to reflect the entire working method for collecting evidence and a description of the sensors applied in the official statement, that in itself has to be in line with national criminal law. Also the handling and processing of the collected sensor data has to be elucidated.

## *11 The Bonn Agreement Oil Appearance Code*

### 11.1 The Theory of Oil Slick Appearances

1. The visible spectrum ranges from 400 to 750 nm (0.40 – 0.75 µm). Any visible colour is a mixture of wavelengths within the visible spectrum. White is a mixture of all wavelengths; black is absence of all light.

2. The colour of an oil film depends on the way the light waves of different lengths are reflected off the oil surface, transmitted through the oil (and reflected off the water surface below the oil) and absorbed by the oil. The observed colour is the result of a combination of these factors; it is also dependant on the type of oil spilled.

3. An important parameter is optical density: the ability to block light. Distillate fuels and lubricant oils consist of the lighter fractions of crude oil and will form very thin layers that are almost transparent. Crude oils vary in their optical density; black oils block all the wavelengths to the same degree but even then there are different 'kinds of black', residual fuels can block all light passing through, even in thin layers.

### 11.2 The Bonn Agreement Oil Appearance Code

4. Since the colour of the oil itself as well as the optic effects is influenced by meteorological conditions, altitude, angle of observation and colour of the sea water, an appearance cannot be characterised purely in terms of apparent colour and therefore an 'appearance' code, using terms independent of specific colour names, has been developed.

5. The Bonn Agreement Oil Appearance Code has been developed as follows:

- In accordance with scientific literature and previously published scientific papers,
- Its theoretical basis is supported by small scale laboratory experiments,
- It is supported by mesoscale outdoor experiments,
- It is supported by controlled sea trials

6. Due to slow changes in the continuum of light, overlaps in the different categories were found. However, for operational reasons, the code has been designed without these overlaps.

7. Using thickness intervals provides a biased estimation of oil volumes that can be used both for legal procedures and for response.

8. Again for operational reasons grey and silver have been combined into the generic term 'sheen'.

9. Five levels of oil appearances are distinguished in code detailed in the following table:

| Code | Description - Appearance | Layer Thickness Interval (µm) | Litres per km$^2$ |
|---|---|---|---|
| 1 | Sheen (silvery/grey) | 0.04 to 0.30 | 40 – 300 |
| 2 | Rainbow | 0.30 to 5.0 | 300 – 5000 |
| 3 | Metallic | 5.0 to 50 | 5000 – 50,000 |
| 4 | Discontinuous True Oil Colour | 50 to 200 | 50,000 – 200,000 |
| 5 | Continuous True Oil Colour | More than 200 | More than 200,000 |

10. The appearances described cannot be related to one thickness; they are optic effects (codes 1 - 3) or true colours (codes 4 - 5) that appear over a range of layer thickness. There is no sharp delineation between the different codes; one effect becomes more diffuse as the other strengthens. A certain degree of subjective interpretation is necessary when using the code *and any choice for a specific thickness within the layer interval MUST be explained on the Standard Reporting Log*.

### 11.3 Description of the Appearances

#### *10.3.1 Code 1 – Sheen (0.04 μm – 0.3 μm)*

11. The very thin films of oil reflect the incoming white light slightly more effectively than the surrounding water (Figure 1) and will therefore be observed as a silvery or grey sheen. The oil film is too thin for any actual colour to be observed. All oils will appear the same if they are present in these extremely thin layers.

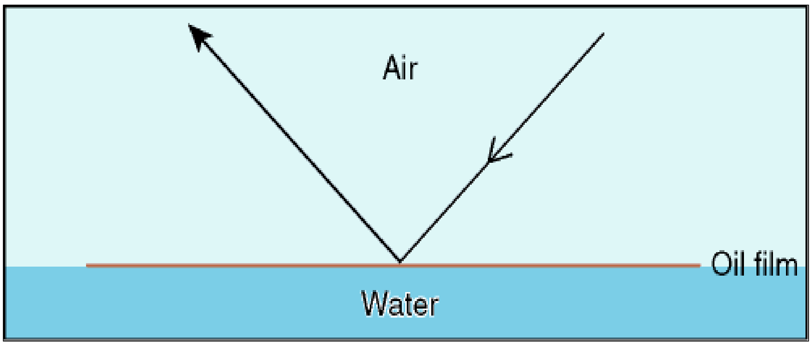



***Figure 1. Light Reflecting From Very Thin Oil Films***

12. Oil films below approximately 0.04-μm thickness are invisible. In poor viewing conditions even thicker films may not be observed.

13. Above a certain height or angle of view the observed film may disappear.

#### *11.3.2 Code 2 – Rainbow (0.3 μm – 5.0 μm)*

14. Rainbow oil appearance represents a range of colours: yellow, pink, purple, green, blue, red, copper and orange; this is caused by constructive and destructive interference between different wavelengths (colours) that make up white light. When white light illuminates a thin film of oil, it is reflected from both the surfaces of the oil and of the water (Figure 2).

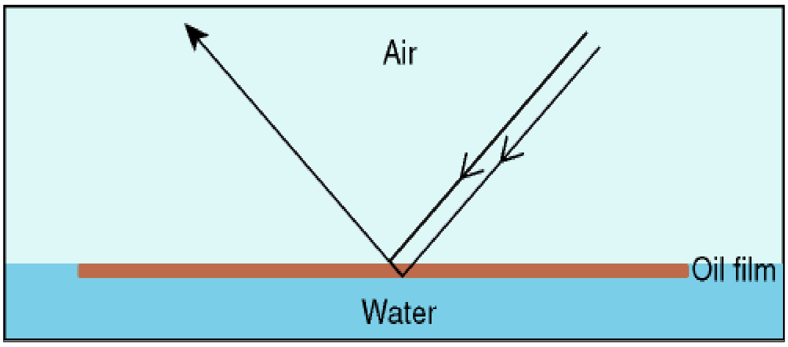



***Figure 2. The Rainbow Region***

15. Constructive interference occurs when the light that is reflected from the lower (oil / water surface combines with the light that is reflected from the upper (oil / air) surface. If the light waves reinforce each other the colours will be present and brighter (Figure 3).

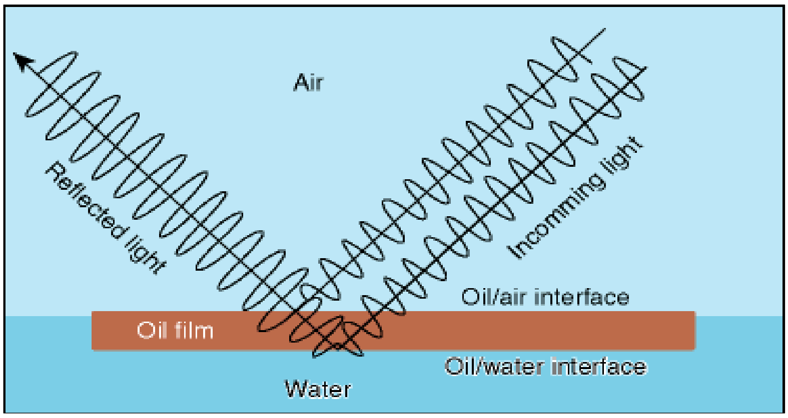



***Figure 3. Constructive Interference***

16. During destructive interference the light waves cancel each other out and the colour is reduced in the reflected light and appears darker (Figure 4).

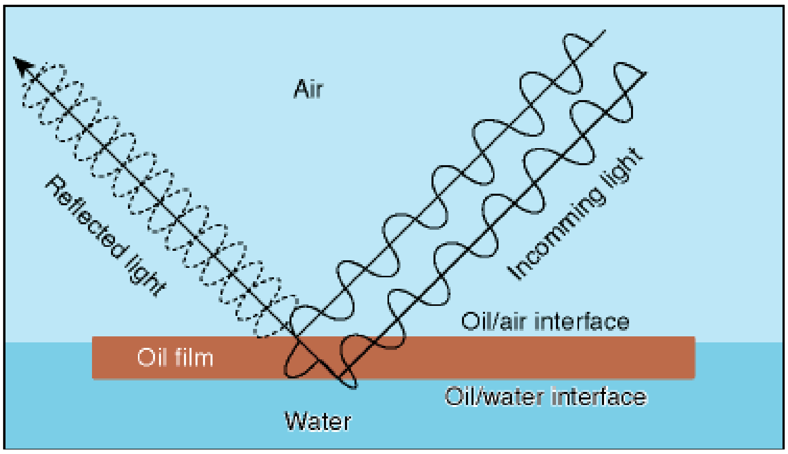



***Figure 4. Destructive Interference***

17. Oil films with thicknesses near the wavelength of different coloured light, 0.2 µm – 1.5 µm (blue, 400nm or 0.4 µm, through to red, 700nm or 0.7 µm) exhibit the most distinct rainbow effect. This effect will occur up to a layer thickness of 5.0 µm.

18. All oils in films of this thickness range will show a similar tendency to produce the 'rainbow' effect.

19. A level layer of oil in the rainbow region will show different colours through the slick because of the change in angle of view. Therefore if rainbow is present, a range of colours will be visible.

### *11.3.3 Code 3 – Metallic (5.0µm – 50 µm)*

20. The appearance of the oil in this region cannot be described as a general colour. The true colour of the oil will not be present because the oil does not have sufficient optical density to block out all the light. Some of the light will pass through the oil and be reflected off the water surface. The oil will therefore act as a filter to the light (Figure 5).

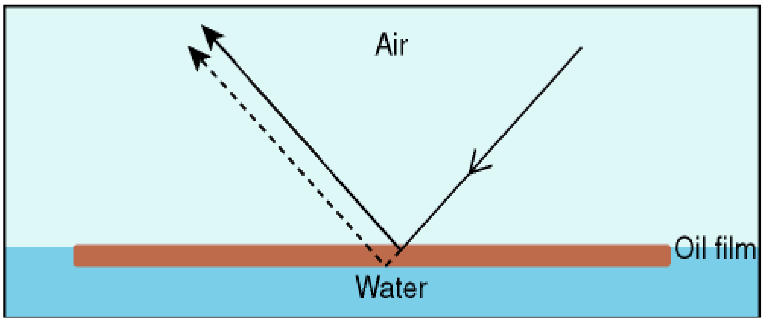
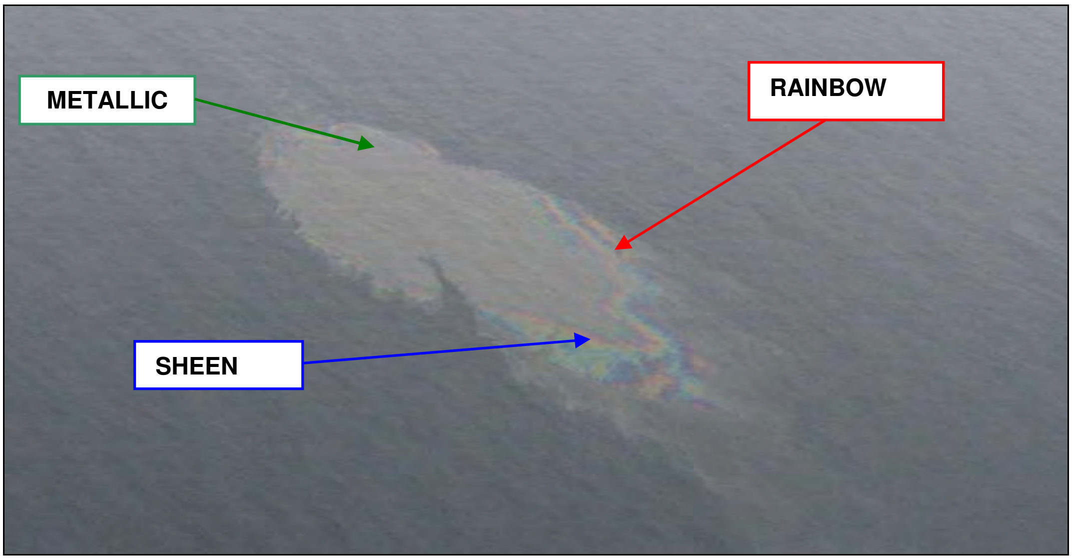



*Figure 5. The Metallic Region*

21. The extent of filtering will depend on the optical density of the oil and the thickness of the oil film.

22. The oil appearance in this region will depend on oil colour as well as optical density and oil film thickness. Where a range of colours can be observed within a rainbow area, metallic will appear as a quite homogeneous colour that can be blue, brown, purple or another colour. The 'metallic' appearance is the common factor and has been identified as a mirror effect, dependent on light and sky conditions. For example blue can be observed in blue-sky.




### *11.3.4 Code 4 – Discontinuous True Colours (50 µm – 200 µm)*

23. For oil films thicker than 50 µm the light is being reflected from the oil surface rather than the sea surface (Figure 6).

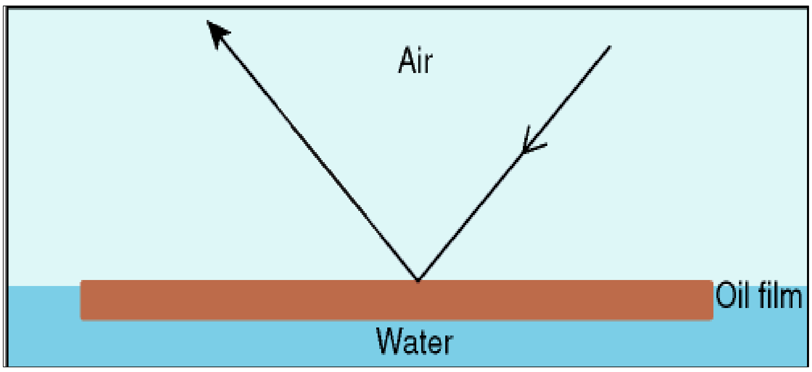



*Figure 6. Thick Oil Films*

24. The true colour of the oil will gradually dominate the colour that is observed. Brown oils will appear brown, black oils will appear black.

25. In this appearance category the broken nature of the colour, due to thinner areas within the slick, is described as discontinuous. This is caused by the spreading behaviour under the effects of wind and current.

26. 'Discontinuous' should not be mistaken for 'coverage'. Discontinuous implies colour variations and not non-polluted areas.

27. 'Discontinuous true colour' appeared to be a difficult appearance to describe and through imagery it may continue to get a more clear picture of what is meant. For now the best result of the elaborations is: "**true oil colour against a background of metallic**".

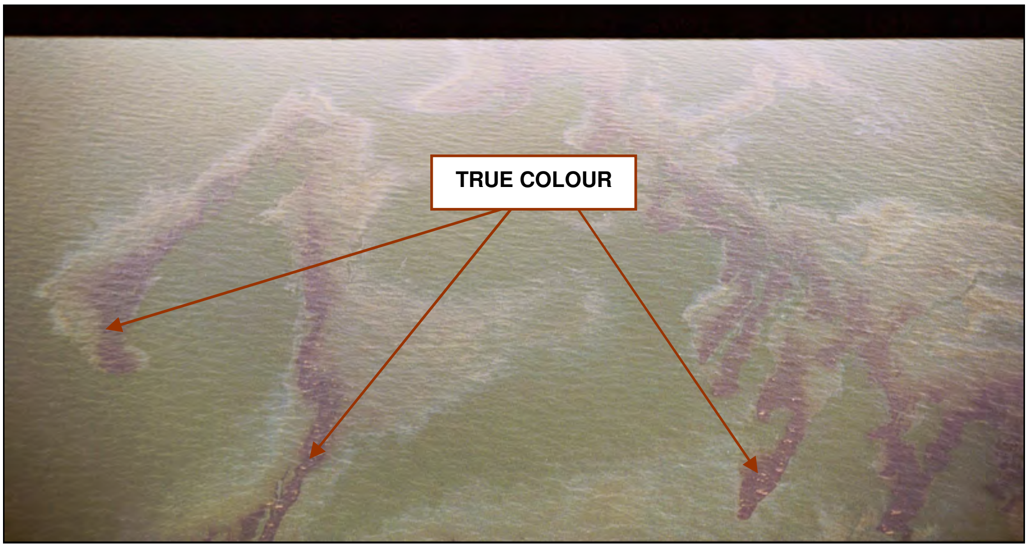
28. When oil is moved by waves, the oil layer obviously is thicker in the wave-trough then on the wave-top. This variation of the "oil appearance" may be understood by indicating "discontinuous".

### *11.3.5 Code 5 – True Colours (>200 µm)*

27. The true colour of the specific oil is the dominant effect in this category.

28. A more homogenous colour can be observed with no discontinuity as described in Code 4.

29. This category is strongly oil type dependent and colours may be more diffuse in overcast conditions.




Note: all documentation on the study can be downloaded from the Bonn Agreement web-site under publications, at: www.bonnagreement.org

ANNEX A

# THE VOLUME ESTIMATION PROCEDURE

**1. Oiled Area Measurement**

***SLAR Polygon***

Area from SLAR Data 12 $km^2$

***Length and Width (SLAR Image or Time and Distance)***

Length – 12 km x Width – 2 km (Imaginary Rectangle)

Area Covered with oil (Coverage) – 50%

Oiled Area 12 x 2 x 50% 12 $km^2$

**2. Appearance Coverage Allocation**

| | |
|---|---|
| Appearance Code 1 (Sheen) | 50% |
| Appearance 2 (Rainbow) | 30% |
| Appearance 3 (Metallic) | 15% |
| Appearance 5 (True Colour) | 5% |

**3. *Thickness Band for Allocated Appearance***

| | |
|---|---|
| Sheen | 0.04 µm – 0.3 µm |
| Rainbow | 0.3 µm – 5.0µm |
| Metallic | 5.0 µm – 50 µm |
| True Colour | More than 200 µm |

**4. *Minimum Volume Calculation***

Oiled Area x Area Covered with Specific Appearance x Minimum Thickness

Appearance 1 (Sheen)

12 $km^2$ x 50% x 0.04 µm = 0.24 $m^3$

Appearance 2 (Rainbow)

12 $km^2$ x 30% x 0.3 µm = 1.08 $m^3$

Appearance 3 (Metallic)

12 $km^2$ x 15% x 5.0 µm = 9 $m^3$

Appearance 5 (True Colour)

12 $km^2$ x 5% x 200 µm = 120.0 $m^3$

**Minimum Volume = 0.24 + 1.08 + 9 + 120 = 130.32 $m^3$**

## 6. *Maximum Volume Calculation*

Oiled Area x Area Covered with Specific Appearance x Maximum Thickness

Appearance 1 (Sheen)

12 $km^2$ x 50% x 0.3 µm = 1.8 $m^3$

Appearance 2 (Rainbow)

12 $km^2$ x 30% x 5 µm = 18 $m^3$

Appearance 3 (Metallic)

12 $km^2$ x 15% x 50 µm = 90.0 $m^3$

Appearance 5 (True Colour)

12 $km^2$ x 5% x (more than) > 200 µm = > 120.0 $m^3$

**Maximum Volume = 1.8 + 18+ 90.0 + > 120 = > 229.8 $m^3$**

**ANNEX B**

# DISCHARGES FROM OFFSHORE INSTALLATIONS

## Permitted Discharges

### *Produced Water*

1. The main discharge associated with an offshore installation is produced water. Produced water comes from the oil reservoir and contains a small amount of oil.

2. OSPAR Recommendation 2001/1 for the Management of Produced Water from Offshore Installations says that no individual offshore installation should exceed a performance standard of 40 mg of dispersed oil per litre (40 ppm) for produced water discharged into the sea. An improved performance standard of 30 mg per litre (30 ppm) is to apply by the end of 2006. These discharge limits are based on the total weight of oil discharged per month divided by the total volume of water discharged during the same period. A maximum oil concentration of 100 mg per litre (100 ppm) is generally applied.

3. Contracting Parties with installations exceeding these performance standards report to OIC on the reasons why the standards have not been met together with an evaluation of Best Available Technology (BAT) and Best Environmental Practice (BEP) for the installations concerned. In addition to these performance standards, the Recommendation sets a goal of reducing by 15% the total quantity of oil in produced water discharged into the sea in the year 2006 compared to the equivalent discharge in the year 2000. By 2020, Contracting Parties should achieve a reduction of oil in produced water discharged to the sea to a level that will adequately ensure that each of those discharges will present no harm to the marine environment.

### *Oil on Cuttings*

4. Cuttings produced during the drilling of wells are covered by the OSPAR Decision 2000/3 under which the discharge into the sea of cuttings contaminated with OBF (oil based fluids) at a concentration greater than 1% by weight on dry cutting is prohibited. Cuttings with less than 1% oil can be discharged. Until recently techniques able to reach the 1% target have not been available, and thus OBF contaminated cuttings have normally been transported to land for treatment and disposal or injected into deep layers. In the UK however a new technique has been trialed and approved which reduces the cuttings to a powder before discharge. Although such a discharge might cause some discolouration of the sea, oil sheen would not be expected.

### *Other permitted operational discharges of oil*

5. A number of other processes can give rise to minor discharges of oil. These are considered to be negligible in terms of volumes of oil discharged and hence have not been the subject of OSPAR decisions or recommendations. Contracting parties regulate these discharges in a manner that's fits with their own regulatory regime. These discharges include but are not limited to small quantities of produced sand that can be contaminated with oil, well clean-up fluids and releases during well abandonment and pipeline decommissioning.

### *Drains*

6. Drainage discharges from areas where oil may be present is covered by the PARCOM Recommendation of a 40 mg per litre Emission Standard for Platforms, 1986. The total volumes of oil discharged are considered negligible and are normally routed via the processing systems and released with the produced water discharge.

### *Flaring*

7. Flaring carried out with high efficiency burners should not result in a fall-out of oil into the sea. If oil from flaring is seen on the sea surface, flaring should cease.

### Non Permitted Releases

8. In addition to permitted operational discharges, spillages may occur where systems fail. The reported amounts released by spillages in 1999 for all the platforms in the OSPAR area was 293 tonnes.

### Appearance and Interpretation

9. When an offshore release enters the sea it will concentrate around the discharge point prior to dispersion by the tides, the sea state and the weather. For discharges that take place below the water surface, there may be a distance between the discharge point and the location where oil droplets emerge on the water surface. As the release is either constant or occurs over a period of time, there is a constant feed which can lead to the characteristic ‘snail trail’ that is often associated with an installation while the release is carried by the currents and dispersed in the water column.

10. There is a large difference between oil producing installations and gas and/or condensate producing installations: normally, the amount of produced water from oil installations is much larger then from gas/condensate installations (1000’s of $m^3$ per day vs. a couple of $m^3$ per day). Furthermore, as oil fields age, the amount of produced water increases substantially.

11. There is no proven correlation between observations of oil sheen from the air and the concentrations of oil in the discharge, which led to it. Work has been undertaken in relation to ship’s discharges but the results cannot be extrapolated to the offshore industry. The reason for this is the fundamental difference in the nature of the discharge whereby ships are in transit which prevents the discharge accumulating in the same manner that it does from an offshore installation which discharges continuously at the same point in space.

12. As a result of this difference, the rule of thumb used for shipping (which implies that if an oil sheen can be seen, the discharges must have contained more than 15 ppm and probably contained more than 100 ppm) cannot be applied to the offshore industry. Discharges have been observed from releases of produced water with concentrations as low as a few ppms’ simply because of the volumes of produced water being discharged and the conditions for dispersion at the time of the release i.e. calm seas. Again, volumes of produced water being discharged from oil installations can be as much as 70,000 $m^3$ per day (70,000 $m^3$ of produced water with 100 ppm of oil amounts to 7 $m^3$ of oil per day / at 40 ppm amounts to 2.8 $m^3$ of oil per day).

13. The OSPAR Recommendation for produced water (as well as those for other discharges described above) does not limit the volume of oil being discharged, only the concentration. While the colour codes can help in quantifying a volume of oil, they do not provide a basis for estimating the concentration of oil in the discharge of produced water. They cannot therefore be used to determine compliance with the OSPAR produced water recommendation or the other controlled releases cited above.

14. Determining compliance with OSPAR recommendations and decisions can only be achieved through investigations with the platform to determine the discharges that have been taking place at the time of the observation and the concentrations at which they occurred. However, information on the nature and appearance of any oil seen can be a useful indication for further investigation.

**ANNEX C**

# MARPOL 73/78 ANNEX I (POLLUTION BY OIL)

Regulations covering the various sources of ship generated pollution are contained in Annexes of the MARPOL 73/78 Convention. Annex I deals specifically with 'Pollution by Oil'. The regualtions detailed below are strickly related to operational discharges.

**AIRCREW SHOULD BE AWARE THAT UNDER MARPOL 73/78 THE NORTH SEA HAS BEEN DESIGNATED TO BE A 'SPECIAL' AREA.**

## *For OIL TANKERS OF ALL SIZES - Oil discharges from cargo tank areas, including the pump room*

**Within 'Special' Areas OR outside 'Special' Areas but within 50 nautical miles from the nearest land:**

**DISCHARGES PROHIBITED**, except clean or segregated ballast.

**Outside 'Special' Areas, but more than 50 nautical miles from the nearest land:**

**DISCHARGES PROHIBITED**, except clean or segregated ballast, or when:

- The tanker is proceeding en route
- The instantaneous rate of oil does not exceed 30 litres per nautical mile and:
- The total quantity of oil discharge does not exceed :

  For existing tankers 1/15.000

  For new tankers 1/30.000 of the cargo which was last carried, and
- The tanker has in operation an oil discharge monitoring and control system and slop tank arrangement, as per regulation 15.

## *For OIL TANKERS OF ALL SIZES AND OTHER SHIPS OF 400 GT AND ABOVE – Oil discharge from machinery spaces*

**Within 'Special' Areas**

**DISCHARGES PROHIBITED**, except when:

- The ship is proceeding *en route*
- Oil in the effluent is less than 15 ppm and
- The ship has in operation oil filtering equipment with an automatic 15 ppm stopping device and
- Bilge water is not mixed with any cargo residue or cargo pump room bilges (on oil tankers)

***For OIL TANKERS OF ALL SIZES AND OTHER SHIPS OF 400 GT AND ABOVE – Oil discharge from machinery spaces***

**Outside 'Special' Areas:**

**DISCHARGES PROHIBITED**, except when the ship is proceeding *en route* and:

- Oil in the effluent is less than 15 ppm and
- The ship has in operation an oil discharge and monitoring and control system, oily water separating or filtering equipment or other installation as required by Regulation 16, and
- Bilge water is not mixed with any cargo residue or cargo pump room bilges (on oil tankers)

***For SHIPS OF LESS THAN 400 GT OTHER THAN OIL TANKERS – Oil discharges from machinery spaces***

**Within 'Special' Areas:**

**DISCHARGES PROHIBITED,** except when oil in effluent without dilution does not exceed 15 ppm

**Outside 'Special' Areas:**

**DISCHARGES PROHIBITED**, except when at the judgement of the Flag State, all of the following conditions are satisfied as far as practicable and reasonable:

- The ship is proceeding en route and
- The oil in effluent is less than 15 ppm
- The ship has in operation appropriate equipment or installation, as required by Regulation 16.

**ANNEX D**

# MARPOL 73/78 ANNEX II (POLLUTION BY NOXIOUS LIQUID SUBSTANCES IN BULK)

Following a recent, thorough amendment of Annex II of the MARPOL 73/78 Convention (Annex II of MARPOL 73/78 on Regulation for the Control of Pollution by Noxious Liquid Substance in Bulk), and also the noticeable, continuous increase in volume of liquid chemicals transported in bulk, an overview is given below of the regulations under MARPOL Annex II related to operational discharges of these substances, as well as recommended operational procedures for aircrew that may observe/detect an Annex II discharge from a vessel during a pollution control flight.

## A. NEW HNS CATEGORISATION SYSTEM

Hazardous and noxious liquid substances (HNS; chemicals transported in bulk) are divided into **4 categories**, according to a new pollution categorization system:

1. ***Category X***: substances presenting the most severe hazard and therefore justify the prohibition of the discharge into the sea;
2. ***Category Y*:** substances which are deemed to present a hazard or cause harm and therefore justify a discharge limitation (includes <u>vegetable oils, biodiesels</u> (fatty acid methyl ethers – FAME), <u>paraffin waxes and animal fats</u>);
3. ***Category Z***: substances which are deemed to present a minor hazard and therefore justify less stringent discharge restrictions (includes <u>methanol</u> (a biofuel), <u>MTBE</u> (methyl-tert-buthyl-ether), <u>Ethylene Glucols, and UAN</u> (urea/ammonium nitrate solutions).
4. ***Other Substances (OS*)**: substances in the pollution category of chapter 18 of the IBC Code which have been evaluated and found to fall outside the above categories X/Y/Z, because they are considered to present no harm.

***For Substances that have not been categorized yet***: for those substances the governments involved in the over-seas transport have to establish and agree on a provisional assessment for the proposed operation (provisional tri-partite agreement between port State of loading, unloading port State and flag State).

***Ship type requirements*** are most stringent for substances of Categories X and Y: these can only be transported by chemical tankers with smaller maximum single tank volumes (e.g. Cat. Y: IMO ship type 2). Ship type requirements are less stringent for substances of Cat. Z or OS.

## B. HNS DISCHARGE REGULATIONS

**DISCHARGES** into the sea of residues of noxious liquid substances (HNS) assigned to Category X, Y or Z, or of those provisionally assessed as such, or ballast water, tank washings or other mixtures containing such substances are **PROHIBITED**, **UNLESS** such discharges are made in full compliance with the applicable operational requirements (*discharge standards*) in Annex II, as summarized below.

**DISCHARGED PROHIBITED**, <u>except when</u>:

***1. General discharge standards*:**

- **The ship is proceeding en route** at a speed of **at least 7 knots** in the case of self-propelled ships (or at least 4 knots in the case of ships which are not self-propelled);
- The discharge is made **below the waterline** through the underwater discharge outlet(s) not exceeding the maximum rate for which the underwater discharge outlet(s) is (are) designed; and
- The discharge is made **at a distance of not less than 12 nautical miles** from the nearest land, in a depth of water of **not less than 25 metres**.

### *2. Category-specific discharge standards*:

- For discharge of residues of **Category X**: Tanks, from which substances in Cat. X have been unloaded, have to be prewashed before the ship leaves port of unloading. The resulting residues have to be discharged to a reception facility. Any water subsequently introduced into the tank may be discharged into the sea in accordance with the above general discharge standards.
- For discharge of residues of **Category Y or Z**:
  · Discharge is allowed, IF the 3 abovementioned general standards are respected.
  · For *high-viscosity or solidifying substances* in Cat.Y, the residue/water mixture generated during the prewash should be discharged to a reception facility until the tank is empty.
  · *Operational requirements for ballasting and deballasting*: ballast introduced into a cargo tank which has been washed to such an extent that the ballast contains less than 1 ppm of the substance previously carried, may be discharged into the sea (a) without regard to the discharge rate, the speed of the vessel and discharge outlet location, but (b) provided that the ship is not less than 12 miles from the nearest land and in water that is not less than 25 metres deep.

- **For substances that are not categorized and provisionally assessed or evaluated**: the discharge of such substances is prohibited.

### *3. Other relevant discharge standards are:*

- **For ships constructed before January 2007** the discharge into the sea of residues of substances in *Category Z* or of those provisionally assessed as such or ballast water, tank washings or other mixtures containing such substances below the waterline (cf. 2nd general discharge standard above) is NOT mandatory.
- **Stripping requirements** before prewash: In general, before any prewash or discharge procedure is carried out the relevant tank *has to be emptied to the maximum extent* in accordance with the amended stripping limits (refers to maximum amounts that may be left in tanks after unloading).
- **If washing medium other than water**: If a washing medium other than water, such as mineral oil or chlorinated solvent, is used instead of water to wash a tank, its discharge shall be governed by the *provisions of either Annex I or Annex II*, which would apply to that medium.

## C. RECOMMENDED OPERATIONAL PROCEDURES FOR AIRCREW

In case of a suspected **MARPOL Annex II** violation (other harmful substance than oil), it is recommended that the aircrew follows to the best extent possible the general guidelines for investigation and documentation of oil pollutions detected/observed at sea, but moreover, and in particular:

- Check whether the discharge is made above the waterline or not
- Check the position of the discharging vessel, and its distance from the nearest land (in Territorial Sea or not?)
- Check the water depth at location (> 25 meters or not?)

- Identify the type of vessel (chemical tanker or not?)
- When establishing a radio contact with the suspected vessel, the following specific HNS-related questions can be asked (besides the standard radio-communication questions):
    a. What speed the vessel is sailing at;
    b. The name of the substance that is being discharged, and the IBC Code Category of that substance (X, Y,Z, OS, non-categorized?);
    c. If the vessel is performing a tank cleaning or deballasting operation;
    d. In case a Cat.X substance is reported, the vessel may be asked if the prewash residues of the discharged substance have been previously discharged in a port reception facility.
    e. In case a Cat.Y substance is reported: vessel may be asked if the discharged substance is a high-viscosity or solidifying substance or not;
    f. In case a Cat. Z substance is reported: vessel may be asked what the date of construction of the vessel is.

With those specific points and questions, the aircrew will have collected the most relevant information on the general and category-specific discharge standards as in MARPOL Annex II, which should be sufficient to initiate further legal or administrative follow-up action.

In a situation where a suspected vessel claims that it is performing a legal Annex II discharge, whereas the sheen observed in the wake of the vessel is not an equal (e.g. colourless or greyish) sheen but presents the typical characteristics of mineral oil appearances, it is recommended to document and investigate the discharge as in case of an illegal operational discharge of mineral oil, and to initiate a follow-up as in case of an alleged Annex I infringement.

**ANNEX E**

## MARPOL 73/78 ANNEX V (POLLUTION BY GARBAGE FROM SHIPS)

**AIRCREW SHOULD BE AWARE THAT THE NORTH SEA HAS BEEN DESIGNATED AS A SPECIAL AREA UNDER MARPOL ANNEX V**

### A. DISCHARGE OF CARGO RESIDUES AND OTHER PRODUCTS CATEGORIZED AS GARBAGE UNDER MARPOL ANNEX V

According to the definition of Annex V, garbage means: "all kind of victual, domestic and operational waste excluding fresh fish and parts thereof, generated during the normal operation of the ship and liable to be disposed of continuously or periodically except those substances which are defined or listed in other Annexes to" the MARPOL convention.

Following an amendment to Annex V (cf. Resolution MEPC.116(51)), cargo residues have been explicitly added to the list of products categorized as garbage. Cargo residues in the context of Annex V should be understood as remains of cargo after unloading as long the type of product is not belonging to a category covered by another Annex. This excludes hydrocarbons and liquid substances in bulk which are covered by Annex I and Annex II respectively. Therefore cargo residues in the meaning of Annex V mainly refer to solid substances.

The North Sea area is a "special area" for the purpose of MARPOL Annex V and is defined as follows:

"The *North Sea area* means the North Sea proper including seas therein with the boundary between:

(i) the North Sea southwards of latitude 62° N and eastwards of longitude 4° W;

(ii) the Skagerrak, the southern limit of which is determined east of the Skaw by latitude 57°44.8' N; and

(iii) the English Channel and its approaches eastwards of longitude 5° W and northwards of latitude 48°30'N."

This area corresponds more approximately to the geographical coverage of the Bonn Agreement. Only the western part of the Bonn Agreement area is not fully covered.

Within a special area, disposal into the sea of garbage, including cargo residues, is prohibited. However this prohibition does not apply for food wastes which have been passed through a comminuter or grinder provided that the discharge is carried out not lesser than 12 nautical miles from the nearest land. Other exceptions are discharges for the purpose of securing the safety of the ship and escape of garbage resulting from damage to the ship or accidental loss provided that all reasonable precautions have been taken to prevent such loss.

Past incidents have drawn the attention on the fact that aircrews can also observe potentially illicit behaviours of ships with respect to the provisions of Annex V.

Part B of this document aims at presenting operational guidelines intended for helping aerial surveillance crews to collect data about possible Annex V offences.

### B. RECOMMENDED OPERATIONAL PROCEDURES FOR AIRCREW

What to look for:

- All vessels sailing or at anchor with hatch covers open.
- All vessels sailing or at anchor which are surrounded by or connected to concentrations of drifting debris such as dunnage, packaging, …
- Any signs that something is thrown overboard by a ship.

How to collect data:

In case of a suspected **MARPOL Annex V** violation (discharge of cargo residues or other substance categorized as garbage), it is recommended that the aircrew follows to the best extent possible the general guidelines for investigation and documentation of oil pollutions detected/observed at sea.. In addition, special consideration should be given to the following:

- Take as far as practicable detailed pictures of the discharge operation and of the discharged product in order to be able to show the nature of the product and the circumstances of the discharge.
- When activities for cleaning holds are observed on board a vessel, it is important to find out whether the removed product is intended to be stored on board or discharged overboard.
- When establishing a radio contact with the suspected vessel it is important to collect the following data:

    a. Last cargo;
    b. Kind of cleaning activities currently carried out by the vessel;
    c. Intentions of the ship concerning the disposal of the recovered cargo residues / garbage;
    d. Awareness of ship's crew about the fact that the North Sea area is a special area for Annex V and that the discharge of garbage, including cargo residues, other than processed food wastes is therefore prohibited.