Australian Government

Australian Maritime Safety Authority

IDENTIFICATION OF OIL ON WATER

Aerial Observation and Identification Guide

Report all pollution to: 1800 641 792

January 2014

Contents

Purpose

To assist people involved in aerial observation and surveillance to more accurately report the presence of oil in the marine environment.

To help with locating, describing, documenting and reporting information about the oil pollution.

To assist observers to more effectively differentiate oil from other phenomena, however all sightings should be reported.

As accurate reporting of an oil spill is fundamental to successful response operations, this guide promotes standard reporting terms.

Observers should concentrate on:

Location, distribution, colour and appearance of the pollution.

Weather, wildlife and vessels seen in the area.

Other marine phenomena can appear similar to oil; clouds, algal blooms, river and drainage discharges, coral spawn, kelp and sea grass beds, and even fish schools.

Further information is available from AMSA.
Call +61 2 6279 5000 during business hours (EST).

Discharges from shipping in Australian waters

The International Convention for the Prevention of Pollution from Ships (known as MARPOL) sets the international standards for the discharge into the sea of all forms of ship-generated marine pollution. Commonwealth, State and Northern Territory legislation implement these standards.

MARPOL specifies prohibitions as well as permitted discharges under strict conditions. Current regulations cover oil/oily mixtures, chemicals, garbage, sewage, packaged harmful substances (e.g. containers) and air emissions. This includes fishing gear, cargo residues, deck and tank washings, etc.

All sightings of any pollutant type in the marine environment should be reported and, if possible, photographed.

Discharges of oil/oily mixtures from vessels at sea are only permitted at 15 parts of oil to one million parts of water (15ppm). Oil/oily mixtures at a concentration of 15ppm cannot be seen by people or remote sensing, and only become visible at around 60ppm. So, when traces of oil can be seen or detected by remote sensing equipment, the discharge needs to be reported for further investigation by the relevant authority.

Within 12 nautical miles from the nearest land or within the Great Barrier Reef Marine Park and Torres Strait, there should be no visible discolouration trailing any ship.

Bonn Agreement Oil Appearance Codes

Oil sightings tend to follow a pattern: it is unusual to see thick oil without its associated edges or patches of thinner oil (sheen, rainbow or metallic). However this can occur if the oil is weathered (mousse or emulsion).

Caution: Oil thickness/volume estimates can be uncertain due to variables (e.g. weather, visibility conditions, view angle, oil type, water conditions, waves, other surface material, etc.). It is important to treat these as rough estimates, using a range of thicknesses and derived volumes.

The majority of the oil within any slick will be in any darker true colour patches, and the actual thickness of these is impossible to determine with accuracy. Dark oil patches have >10,000 times more oil volume by area than sheens.

Note: A micron (µm) is one millionth of a metre.

Code	Description of Appearance	Approx Thickness (µm)	Approx volume (m^3/km^2)
1	Sheen	0.04 - 0.30	0.04 - 0.3
2	Rainbow	0.30 - 5.0	0.3 – 5.0
3	Metalic	5.0 - 50	5.0 - 50
4	Discontinuous true oil colour	50 - 200	50 - 200
5	Continuous true oil colour	>200	>200
Other	Mousse or emulsion		

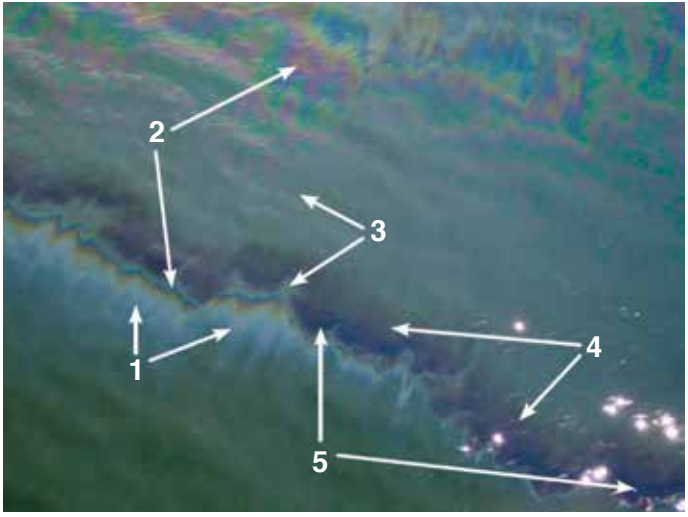
Description of the Appearance Codes

Code 1 – Sheen (< 0.3 µm)

Very thin films of oil reflect the incoming light slightly better than the surrounding water and can therefore be seen as a silvery or grey sheen due to this effect and not the oil colour itself. These thin layers can be seen due to this effect and not the oil colour itself. Oil films below approximately 0.04µm thickness are invisible. In poor viewing conditions even thicker films may not be seen. Above a certain height or angle of view the observed film may disappear.

Code 2 – Rainbow (0.3 µm – 5.0 µm)

Rainbow oil appearance presents as a range of colours, **yellow, pink, purple, green, blue, and red, copper, orange**; this is caused by an optical effect, independent of oil type. Depending on angle of view and layer thickness, the distinctive colours can be diffuse or very bright. Oil films with thickness near the wavelength of different coloured light (blue 0.4µm through to red 0.7µm) show the most distinct rainbow effect.



Code 3 – Metallic (5.0µm – 50 µm)

Depending on the oil type, light conditions and sky colour metallic oil colour can appear **blue, purple, brown, red or greenish**, but it will generally appear as all the one 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 seen in blue-sky conditions.

Code 4 – Discontinuous true oil colour (50 µm – 200 µm)

For oil slicks thicker than 50µm the true oil colour will gradually dominate the observed colour. **Brown oils will appear brown, black oils will appear black**. The broken or discontinuous nature of the colour is due to thinner and thicker areas within the slick. This is caused by spreading due to wind and current. Discontinuous colour shows true colour variations over full coverage and not non-polluted areas.

Code 5 – Continuous true oil colour (>200 µm)

The true colour of the specific oil creating the slick is the dominant effect in this category, giving homogenous colour, with no discontinuity. This category is strongly oil type dependent and colours may be more diffuse in overcast conditions.

E – Mousse or emulsion (weathered oil)

Spills of crude oil and some fuel oils rapidly form a water-in-oil emulsion (mousse) that are often characterised by dark colouration (often a mixture of brown, orange, red and tan) and a cohesive (thickened) appearance. These should be classed as "other" with a detailed description of the colours and nature of the spill.

Recording and reporting observations of pollution

All information gathered during observation should be recorded on the Aerial Observation Report form, which outlines the information that should be recorded. The form can be found on AMSA's website.

It is important that observers give a scale to their sighting and don't exaggerate its extent when recording information.

The observing aircraft should fly the perimeter of the polluted area at a constant altitude with the GPS operating. Reports should include:

- **Date and time**
- **Weather** conditions
- **Latitude and longitude** for the start/end trailing and side boundaries of the polluted area – noted with sketches on maps, on the Aerial Observation Report or electronically tagged as "waypoints"
- **Location** and orientation of pollution
- **Photographs/video imagery** at regular intervals

Reports should also provide detailed descriptions of:

- **Spill colour and characteristics** – to indicate type and amount of pollutant
- **Areas of heavy oil separate from sheen** – this will assist responders to estimate volume.

Australia has adopted the use of the **Bonn Agreement Oil Appearance Codes** – page 3. If you are not able to distinguish which appearance codes apply to what you observe, **ensure your recorded observations are as detailed and descriptive as possible.**

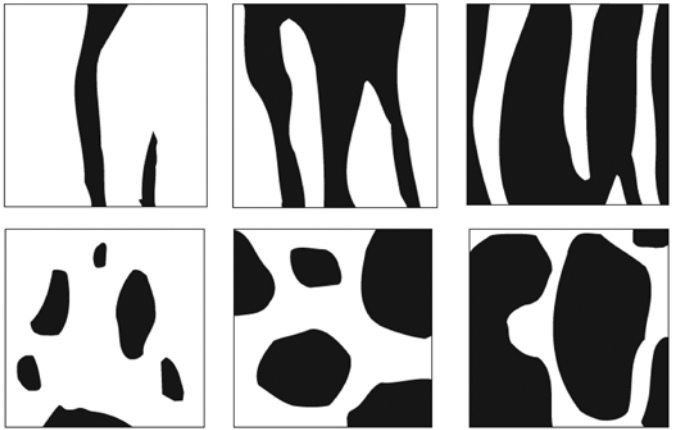
Describing proportion of total area coverage

These diagrams are a guide for describing oil coverage.

It is important to provide information regarding oil concentrations in order to respond effectively.

Response efforts need to be focussed on the **heaviest areas** of oil.

This is best done by **vertically** looking down on the oil and **assessing** its distribution.



25% 50% 75%

How oil reacts when it enters the marine environment

Oil initially **spreads out** and forms a continuous or cohesive patch on the surface of the water, often over a large area.

This area of oil absorbs energy and deadens out surface waves, making the area **appear smoother** compared with the surrounding water.

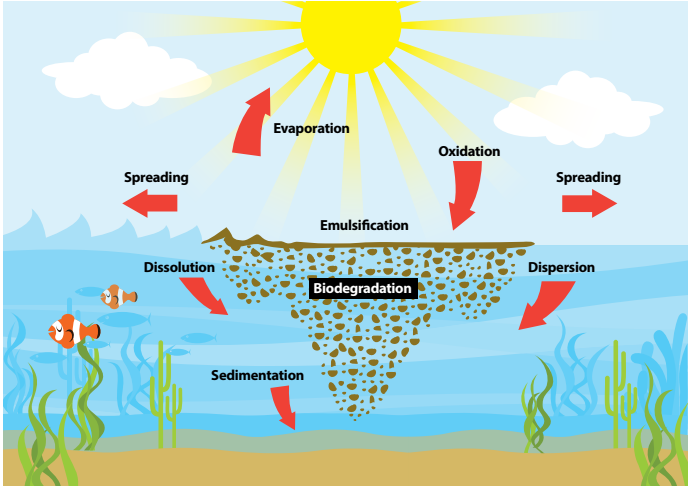
As the oil **becomes thinner**, it may be broken up by wave, wind, and current movement into smaller patched and narrow bands – or windrows – in the direction of the wind or current.

Light oils (eg. **diesel or gasoline**) may evaporate and disappear quite quickly.

Heavy oils (eg. **bunker fuel or crude oil**) spread to form smaller, discrete patches or streaks, ultimately becoming tar balls.

The colour, distribution and consistency of the oil's appearance indicate:

- **Type** of oil spilled
- **How long** it has been in the water
- **Its potential** for dispersion, containment and recovery.



Factors influencing the spread of oil

Movement - oil generally moves at the rate of **3% of the wind speed**, and at the **same speed as the water currents**. As a slick moves across the water surface it leaves behind sheens of thinner oil and begins to form 'windrows'.

Persistence is important to determine the rate of spreading, shoreline impact and cleanup. Oil persistence is determined by **pour point** which is the lowest temperature at which the oil will flow, and **viscosity** the measure of the substance's resistance to flow, and **density** – the mass per unit volume.

Persistent (fuel or crude) oils generally require a **clean-up response**.

Non-persistent (diesel or gasoline) oils generally **evaporate or disperse** quickly.

Temperature: Water temperature in a spill area alters the properties of oil, changing its spreading characteristics and weathering properties. With increased temperature, the persistence of oil decreases.

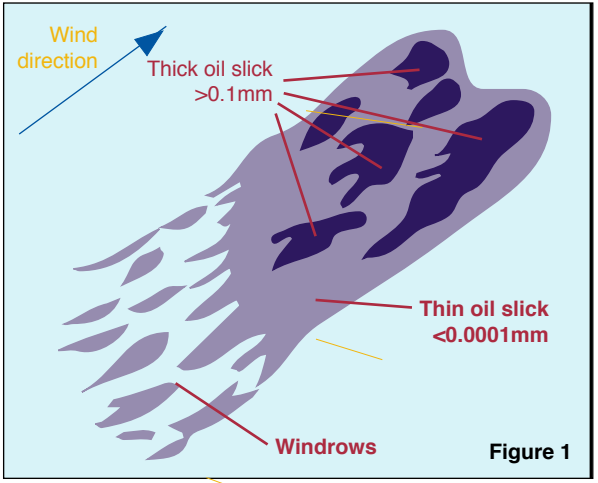


Figure 1

Common observation terms

Algal bloom: Algal blooms can occur throughout the year, but are most common in the warmer months. They take place when optimum growth conditions exist (warm waters and excess nutrients) and appear as accumulations of a coloured mass on or below the surface of the water. Colours range widely from reds to greens and browns/ orange. They do not appear to dampen or smooth the sea surface.

Convergence zone: A long, single, narrow band of oil (and possibly other flotsam) often created where two bodies of water with different salinities or temperature meet.

Coral spawn: During coral spawning events corals reproduce simultaneously by releasing egg and sperm bundles. These float to the surface, often forming large, thick, irregular white to pink slicks. The spawn scum can persist for around two days and may sometimes be misinterpreted as an oil slick.

Dispersion: The breaking up of an oil slick into very small droplets that are then entrained and mixed into the water column by wave action, chemical dispersant or other sea surface turbulence.

Mousse or emulsification: The formation of a water-in-oil-mixture. Different oils have different tendencies to emulsify, and emulsification is more likely to occur under high energy conditions (strong winds and waves). The presence of a mousse indicates that a slick has been on the water for some time. Mousse can range in colour from dark brown to nearly red or tan, and typically has a thickened or pudding-like consistency compared with fresh oil. The water can bulk up the oil to increase the apparent volume of oil by up to four times.

Pancakes: Isolated, roughly circular patches of oil ranging in size from a few metres across to hundreds of metres in diameter. Sheen may or may not be present.

Recoverable oil: Oil in a thick layer on the water that can be collected by conventional techniques and equipment, usually a combination of booms and skimmers. Only black or dark brown oil, mousse, and heavy sheens (which are dull brown in colour) are generally considered to be thick enough to be effectively recovered by skimming equipment.

Streamers: Narrow bands of oil with relatively clean water on either side. These may be caused by wind or currents moving the oil, but should not be confused with multiple parallel bands of oil associated with windrows or single, long convergence zones.

Tarballs: Weathered oil that has formed pliable balls or patches that float on the water. Tarballs can range in diameter from a few millimetres or a pinhead to 30 centimetres. Depending on how weathered, or hardened, the outer layer of the tarball is, sheen may or may not be present.

Weathering: A combination of physical and environmental processes, such as evaporation, dissolution, dispersion, and emulsification, which act on spilled oil to change its physical properties and composition.

Windrows: Multiple parallel streaks or bands of oil that line up well with the wind direction. They are created by localised rotating vortexes of surface water that produce alternating convergent and divergent zones. Windrows typically form early during a spill when the wind speed is at least 10 knots (>5 metres per second).

Decision guide for aerial observation of sea-surface irregularities

Surface or Subsurface Feature

Is the mass on the water surface?
(distinguished by wind-chop, waves, etc.)

NO → **What colour and shape is the mass?**

- Black or brown masses in shallow water - Kelp beds or seagrass
- Moving through water, area changing shape - School of fish
- Pink/blue transparent spots - Jellyfish
- Murky clouds of discoloured water trailing back to a coastal source - Suspended sediment

YES ↓

Does the mass appear to move quickly over the water surface?

NO → **Deadening**

Does the surface appear smoother or 'slicker' than the surrounding water?

NO → Rusty, brown colour with grey, green or purple streaks
(occurs more commonly in the warmer months)
- Algal bloom

YES ↓

Colour/Texture

Dark, frothy, transparent, rainbows, contain tarballs?, etc. (see definitions)

- Frothy brown to orange, may contain tar-balls - Weathered oil ('mousse' emulsion)
- Spreads to sheens and evaporates quickly, variety of colours from transparent to blue and rainbows - Fresh spill of a light oil
- Black to dark brown 'patches' - Fresh spill of a heavy fuel oil

YES ↓

Grey/black shadow on water surface, usually moving

- Cloud shadow

Aerial photography

It is important to capture an image of the slick leaking from the suspect vessel and clean water ahead of the vessel.

Include in your report: colour photographs, video footage and recorded radio communications with vessels suspected of involvement with the spill.

Photographs should be **taken**:

• At a recorded altitude and GPS position

• With the sun behind the observer

• From above and to one side of the slick

Photographs should **show**:

- An overall view of the pollution area – with suspect vessel
- Clear identification of suspect vessel – **name** and **IMO number**
- Any **activity** onboard the suspect vessel
- A series of close-up/detailed images at different altitudes – 1000ft, 500ft, 200ft and 100ft or lower if regulations permit
- Details of slick where there is no suspect source in the vicinity

The following photographs provide examples of preferred angles and vessel positions for use as evidence.

Long distance view of no oil in front of vessel and showing slick extending from vessel stern.

Approaching shot of vessel stern, clearly showing discharge and identification of ship name if possible.

Shot of vessel showing slick behind the ship and within its track.

Shot of vessel showing discharge trailing the vessel.

Close up shot of hull including vessel name if possible.

Forward photograph of bow of vessel showing no oil ahead of vessel.

Source: Coastwatch

Sectioned photographs along side of the vessel. May show discharge or activity on board.

Source: Coastwatch

EXAMPLES OF VISIBILITY OF OIL ON WATER

It is often difficult to assess if irregularities on the sea surface are oil spills or other phenomena with similar appearances

The following examples are provided to assist observers with their observations, decisions and reporting.

Read the decision guide on page 13 and then make an assessment of the circumstances and likely phenomenon.

OIL

1: Rainbow and metallic sheen.

2: Black oil breaking into streamers.

Source: NOAA

3: Rainbow and metallic sheen in an enclosed harbour.

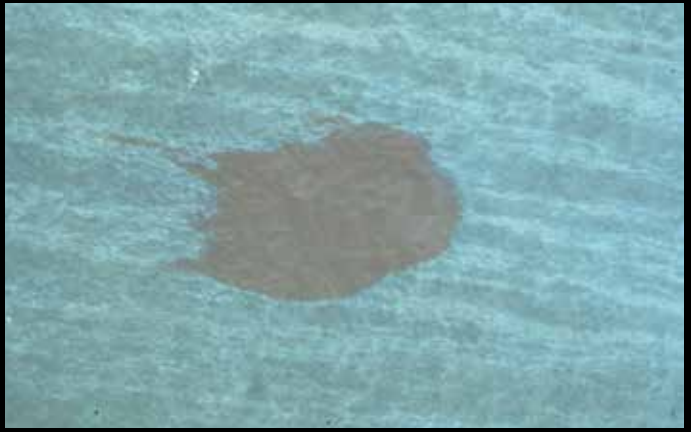
4: Heavy sheen.

5: Heavy dark oil, surrounded by halo of metallic sheen (no rainbow sheen).

6: Heavy fuel oil and phosphate mixture.

7: Crude oil entering mangrove intertidal areas.

Source: AMSA



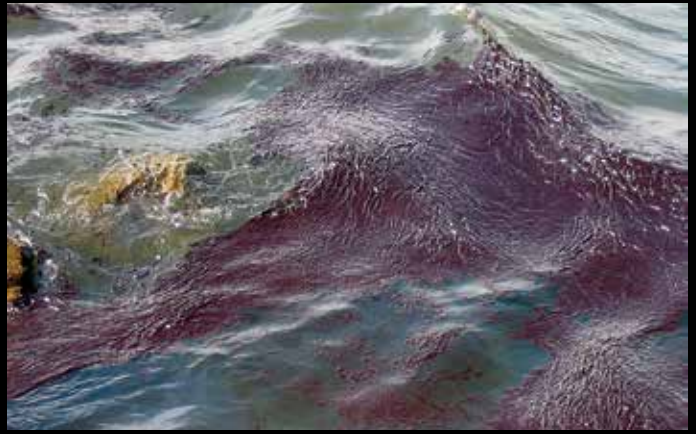
8: Isolated circular ‘pancake’ parch of heavy crude oil.

Source: NOAA

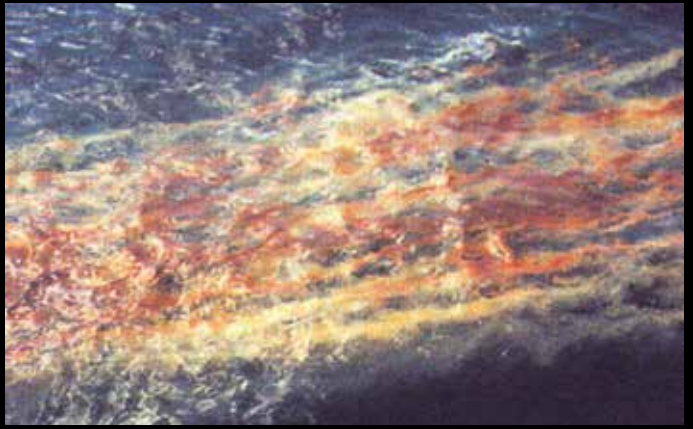
9: Submerged heavy fuel oil.

10: Vessel leaking and trailing heavy fuel oil.

Source: AMSA



11: Close-up of heavy emulsified oil.



12: Lines of orange/brown mousse with associated silver/metallic sheen.

Source: AMSA

13: Windrows of crude oil and sheen lining up in the same direction as the wind.

Source: AMSA

OTHER PHENOMENA

14: The orange-red colouration of coral spawn found in the tropical half of Australia's northern waters.

Source: GBRMPA

15: Algal bloom near NSW coast.

Source: NSW EPA

16: Vessel in shallow waters. The discolouration of the water is due to storm water runoff being disturbed by propeller wash.

Source: AMSA

17: River discharge into marine waters. Colour is caused by tannins from organic matter.

Source: AMSA

18: Jellyfish clusters may be misinterpreted as an oil slick

.

Source: Coastwatch

19: The dotting of transparent blue jellyfish.

Source: Coastwatch

20: Seagrass close to shore wihich may appear similar to oil.

Source: ITOPF

21: The dark patchy nature of kelp beds is often deceiving.

Source: NOAA

22: Subtidal seagrass beds close to shore.
Note the absence of surface deadening.

Source: ITOPF

23: Water depth differences indicated by a channel.
The channel also contains an algal bloom in its centre.

Source: NOAA

OTHER SHIP DISCHARGES

24: Sewage (urine) discharge from a livestock carrier.

Source: Coastwatch

25: The discoloured wake is caused by deck washing of coal dust.

Source: Coastwatch

26: Rig support vessel discharging drill mud taken from an exploration rig.

Source: Coastwatch

Where to report observations

Report marine pollution incidents from ships to the Australian Maritime Safety Authority:

Free call: 1800 641 792 (24 Hrs)

Fax: +61 2 6279 5076

Email: rccaus@amsa.gov.au

Reference material

AMSA - National Plan for Maritime Environmental Emergencies.

Bonn Agreement - Bonn Agreement Oil Appearance Code (BAOAC). (2007) Manual. Oil Pollution At Sea.

International Tanker Owners Pollution Federation (http://www.itopf.com)

- Aerial Observation Of Oil. Technical Information Paper Number 1. (2009)

- Fate of Marine Oil Spills. Technical Information Paper Number 2 (2010)

National Ocean and Atmospheric Administration - Open Water Oil Identification Job Aid For Aerial Observation, USA NOAA/ORCA. (2012)

OPSAR Commission - North Sea Manual on Maritime Oil Pollution Offences (2010)