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Dispersant storage, maintenance, transport and testing

A technical support document to accompany the IPIECA-IOGP guidance on surface and subsurface dispersant

Oil spill preparedness

THE GLOBAL OIL AND GAS INDUSTRY ASSOCIATION FOR ENVIRONMENTAL AND SOCIAL ISSUES

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A cautionary note regarding dispersants

This publication includes generic advice and guidance with respect to the storage, maintenance, transportation and testing of dispersant products. This does not replace applicable national regulations, manufacturers' instructions or information contained within a product's safety data sheet, which should be followed.

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IPIECA

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Introduction

Dispersant use can mitigate the overall impact of an oil spill by removing oil from the sea's surface (or avoiding oil surfacing in the case of subsea use), thereby protecting marine mammals, birds, coastal habitats and shorelines. Dispersant can also improve responder health and safety by reducing the concentrations of volatile organic compounds in the vicinity of a release, particularly in subsea scenarios. Their use can, however, result in a short-term increase in hydrocarbon exposure for aquatic organisms residing in the water column proximal to the dispersant application. Dispersants enhance the natural biodegradation processes that break down oil.[1]

Dispersant use identified as a response option in an oil spill contingency plan will be most effective in the early stages of an incident or for treating ongoing releases. This is when spilled oil is fresher and slicks may be in deeper, offshore waters that are best suited to dispersant application. Furthermore, the use of dispersant can be one of the most rapid response options, and can achieve the highest oil encounter rates through application by spraying from vessels and aircraft, or by subsea injection.

To facilitate rapid and effective dispersant use, thorough planning should be undertaken. This includes ensuring that authorization procedures for dispersant product approval and use are in place, application equipment and spraying/injection platforms are available, personnel are trained and suitable stockpiles of dispersant are established.

The oil and shipping industries and their regulators place a high priority on the prevention of oil spills. This has resulted in a welcome downward trend in the frequency of major spills. In turn, this has led to an increased likelihood that dispersant stockpiles may remain unused and stored for long periods, potentially many years. It is imperative that dispersant held within stockpiles remains effective and fit for purpose. This report examines the considerations for storage, maintenance, transportation and retesting of dispersant stocks.

PURPOSE OF THIS REPORT

This report provides guidance and recommendations only, and is aimed at personnel who may be responsible for the procurement or custodianship of dispersant stocks.

It is recognized that there may be variations in the circumstances and the ambient conditions of dispersant storage that require flexibility in the application of this guidance. Manufacturers' or suppliers' recommendations should be followed, which may be included in safety data sheets (SDS) or other technical documentation. There are also national regulations in some countries that mandate certain dispersant maintenance protocols, for example the periodicity of product retesting for effectiveness.

The guidance in this document applies to dispersants that are generally available on the international market, typically having passed product approval protocols in several jurisdictions.

[1] IPIECA-IOGP (2015). *Dispersants: surface application* (IOGP Report 532) and *Dispersants: subsea application* (IOGP Report 533). IPIECA-IOGP Good Practice Guide Series, Oil Spill Response Joint Industry Project (OSR-JIP). http://oilspillresponseproject.org

Key guidance and recommendations

- Hazard warnings apply to leaks or mishandling of the product.
- Clear and relevant labelling is integral to proper storage.
- Dispersants are not classified as dangerous goods under international transportation agreements.
- Dispersants are chemically stable and may have long, potentially unlimited, shelf lives if stored properly.
- Intermediate bulk containers (IBCs) are the most common type of storage container for dispersants.
- High-density polyethylene (HDPE) is the most common storage container construction material.
- Using ethylene vinyl alcohol (EVOH)-HDPE laminate technology for IBC construction greatly reduces permeation and improves the potential to achieve extended shelf lives.
- Nitrogen blanketing can be coupled with EVOH-HDPE construction to prevent distortion of IBC containers over time.
- Storage in ventilated and cool warehousing is preferred.
- Regular visual checks can identify storage units that may need replacement, or product that may require retesting.
- Thorough inspection and retesting records should be maintained.
- Retesting of the density and viscosity of a product may be used to screen or identify product in containers/ batches that should then be retested for efficacy.
- Retesting after an initial 10 years and then every 5 years is recommended for dispersant stored in IBCs or equivalent containers.
- The results from different test methodologies are not directly comparable and should not be extrapolated to describe potential effectiveness during real-world dispersant use.

Composition of dispersants

Understanding the composition of dispersants provides insight into their physical properties, low hazard and potential for extended shelf life. The precise formulations of most dispersants are proprietary information, although they may be supplied in confidence to national regulatory authorities. Dispersants typically consist of a blend of two or three non-ionic surfactants, and sometimes include an anionic surfactant, mixed with a low-toxicity substance that dissolves them to create a liquid mixture. Some dispersants contain other additives, e.g. anti-corrosives. Most modern surfactants used in dispersants are also used in many household products including skin cream, baby bath soaps, shampoo and mouthwash, and as emulsifiers in food.

The ingredients contained within several commonly stockpiled dispersants have been published, and a combined list of these ingredients is shown in Table 1.

Some of the most widely used non-ionic surfactants have a water-loving 'hydrophilic' part based on sorbitan (derived from sorbitol, a sugar) and an oil-loving 'oleophilic' part based on a fatty acid (a vegetable oil). These non-ionic surfactants are sorbitan esters and have the generic trade name of 'Spans'. Other non-ionic surfactants used are ethoxylated sorbitan esters which are generically known as 'Tweens'. Spans and Tweens have widespread applications in the pharmaceutical, cosmetic, food and agrochemical industries. The anionic surfactant used in many modern dispersants is DOSS (see Table 1). This surfactant is used in many household products, such as various types of cleaners, and is also used to treat or prevent constipation.

Table 1 Combined list of ingredients in several commonly stockpiled dispersants

CHEMICAL ABSTRACTS SERVICE NUMBER	NAME	GENERIC NAME
1338-43-8	Sorbitan, mono-(9Z)-9-octadecenoate	Surfactant (Span)
9005-65-6	Sorbitan, mono-(9Z)-9-octadecenoate, poly(oxy-1,2-ethanediyl) derivatives	Surfactant (Tween)
9005-70-3	Sorbitan, tri-(9Z)-9-octadecenoate, poly(oxy-1,2-ethanediyl) derivatives	Surfactant (Tween)
577-11-7	Butanedioic acid, 2-sulfo-, 1,4-bis(2-ethylhexyl) ester, sodium salt (1:1) [contains 2-Propanediol]	Surfactant (DOSS)
103991-30-6	Ethoxylated fish oil	Surfactant
8002-26-4	Tall oil	Surfactant
29911-28-2	Propanol, 1-(2-butoxy-1-methylethoxy)	Glycol ether solvent
64742-47-8	Distillates (petroleum), hydrotreated light	Hydrocarbon solvent
57-55-6	Propylene glycol	Solvent
111-76-2	Ethanol, 2-butoxy	Glycol ether solvent

Many surfactants are high-viscosity liquids and/or solids. They need to be blended into a low-toxicity substance (a solvent) to produce a dispersant of relatively low viscosity that can be easily sprayed. The solvent also helps the surfactant to penetrate the spilled oil. Some key physical properties are indicated in Table 2.

Some jurisdictions stipulate a maximum or minimum value for some dispersant properties. For example, 60°C is a minimum flashpoint for transportation and insurance purposes.

Table 2 Key physical properties of dispersants

PROPERTY	TYPICAL RANGE	COMMENT
Appearance	Orange/brown/amber clear liquid	Visual assessment
Dynamic viscosity at 0°C	60 to 250 mPas	Measure of the internal resistance to flow
Flashpoint	65 to 95°C	Temperature at which vapours will ignite
Pour point	-10 to -40°C	Temperature below which the liquid does not flow
Specific gravity at 20°C	0.85 to 1.035	Density relative to pure fresh water

Hazard classification and labelling

The United Nations' Globally Harmonized System of Classification and Labelling of Chemicals (GHS) provides an international system and criteria for:

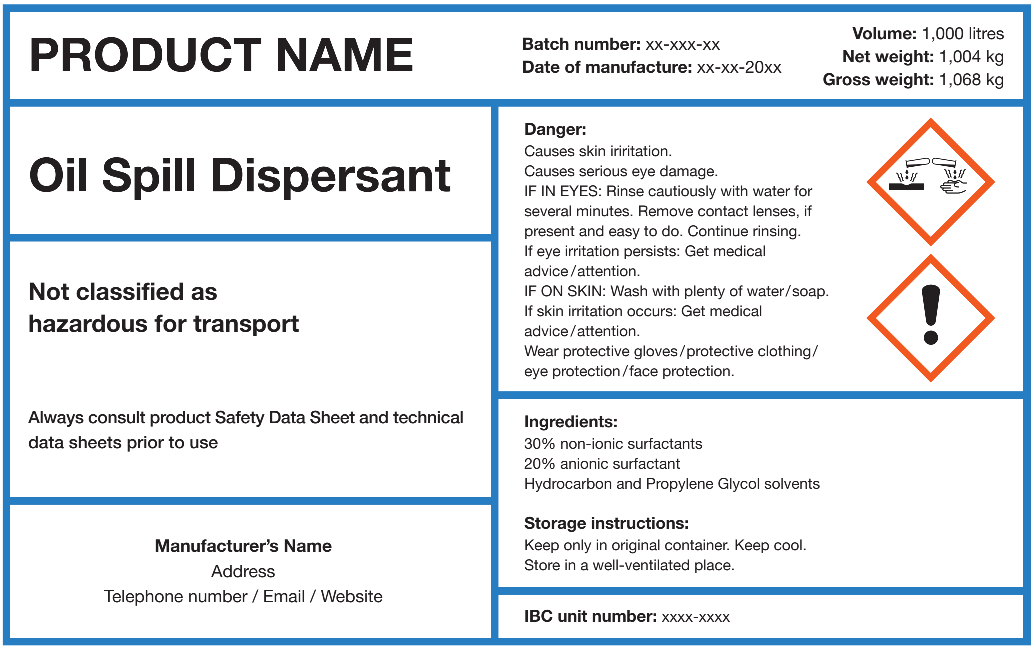
- classification of substances and mixtures according to their physical, environmental and health hazards; and
- hazard communication elements, including requirements for labelling and SDS.

The GHS becomes legally binding through a suitable national or regional legal mechanism. For example, European Regulation (EC) No 1272/2008 on classification, labelling and packaging of substances and mixtures applies in all European Union Member States. The US Occupational Safety and Health Administration (OSHA) has developed a Hazard Communication Standard (HCS) that includes hazard classification, labelling and SDS requirements in compliance with the provisions of the GHS. Various national administrations around the world are following suit with legislation aligned to the GHS. Further information on the GHS can be found in Annex 2 on page 23 of this guidance.

> **Key point**
> Hazard warnings apply to leaks or to mishandling of the product.

In their correctly stored form, i.e. safely contained, dispersants pose no risk to human health and the environment. The risk of exposure to dispersant only occurs in cases of leaks or incorrect storage, handling and use of the product. The most common hazard classes for dispersants are skin corrosion/irritation, and serious eye damage/irritation. Under the GHS, the SDS should identify relevant classes, with associated hazards and precautionary statements. These statements, together with relevant hazard pictograms, should be reproduced on the product's label. For further details, see Annex 2 on page 23 of this guidance.

A typical example of a generic hazard warning label. Labels should be weatherproof and capable of remaining legible throughout long periods of storage.



A manufacturer should be aware of the relevant regulations and should supply dispersant that is labelled accordingly. If not covered by the applicable regulations, all products and containers should be clearly labelled with the following information:

- product name;
- name, address and contact number of manufacturer or importer;
- unique reference code for the production batch and date;
- appropriate GHS hazard warning pictogram(s), signal word, hazard statement(s) and precautionary statement(s), or equivalent national requirements;
- date of container's manufacture and unique reference code (these may be branded onto the container);
- volume/weight of unit; and
- recommended storage instructions.

An example generic label is provided on page 7. The label should be weatherproof and capable of remaining legible throughout long periods of storage. Fixing the label to the container in two places (e.g. on the metal plates of an IBC) will help to ensure that a label is visible when containers are stacked. It is prudent to either have duplicate labels in stock or to have an arrangement with the supplier for obtaining replacements.

Key point

Clear and relevant labelling is integral to proper storage.

The hazards associated with accidental exposure to dispersant are identified and classified under the GHS as previously described. However, dispersants are not classified as dangerous goods under the following international agreements for transportation, and are therefore not regulated:

- ADR (European Agreement on International Carriage of Dangerous Goods by Road)
- IATA (International Air Transport Association)
- IMDG (International Maritime Dangerous Goods Code).

Under the UN classification for transportation, dispersants are categorized as 'Packing Group III: Substances presenting low danger'.

Key point

Dispersants are not classified as dangerous goods under international transportation agreements.

Shelf life

The surfactants and solvents in dispersants are chemically stable. The dispersant components do not undergo chemical reaction with each other or with the oil onto which they are applied. When stored in suitable facilities, they do not decompose or otherwise change, provided they are kept in suitable sealed containers that remain intact.

Consequently, most dispersant manufacturers or suppliers indicate that their products have long shelf lives. For example, 12 of the 18 dispersants listed on the US National Contingency Plan Product Schedule[2] (as of September 2017) have shelf lives stated as 'unlimited', 'indefinite' or 'potentially unlimited'. The remaining six products have stated shelf lives ranging from '≥ 2 years' to '15 years or more'. The suppliers typically place emphasis on the need for storage containers to remain sealed/unopened for these shelf lives to be achieved.

Key point
Dispersants are chemically stable and may have long, potentially unlimited, shelf lives if stored properly.

In the 1980s and 1990s, a series of controlled studies were undertaken in the UK by Warren Spring Laboratory[3] for the Institute of Petroleum and others, concerning the potential deterioration of dispersants products. This included testing a variety of products over several months, including at higher temperatures (up to 50°C), examining their possible loss of efficacy (i.e. effectiveness) and potential to corrode containers. The overall conclusions of this work included the following:

- If products are stored according to manufacturers' instructions, the loss of efficacy should be minimal.
- Limited corrosion of mild uncoated steel containers occurred with some products; there was no evidence that this led to reduced product efficacy.
- A recommendation was made that bulk storage of dispersants in mild steel containers should be avoided.
- At low temperatures, some cloudiness of products was observed. On return to ambient temperatures, the products returned to normal appearance when mixed, with no loss of efficacy.

Practical evidence of long shelf life is available. A US study[4] reported in 2008 that dispersant samples from stockpiles ranging from 10 to >30 years old retained acceptable effectiveness in laboratory tests. This study covered nine locations in the USA stretching from the Gulf of Mexico to Alaska. Storage containers consisted of a mix of drums, 'totes' (i.e. IBCs), bulk tanks and tank trailers.

If dispersants are exposed to the air, evaporation of solvent may occur. Loss of solvent may also occur through the walls of a container, depending on the construction material, or through cap vents if a container has them. Reduced solvent levels can lead to an increase in the product's viscosity, potentially rendering it difficult to spray and altering the formation under which it is licensed. Loss of solvent may also lead to reduced effectiveness, this being due to the diminished ability of the product to penetrate oil, i.e. the surfactant is less able to reach the oil/water interface. Ingress of oxygen through breather tubes or through the walls of a container may lead to oxidation of the surfactants, resulting in the formation of residues or gums. These residues may block spray nozzles, hindering or preventing the dispersant application.

2 See https://www.epa.gov/emergency-response/national-contingency-plan-subpart-j#schedule
3 Including *The storage stability of oil dispersants*, report no. LR 670, 1989; and *Storage stability of dispersants (6 years ambient storage)*, report no. LR 1012, 1994. Reports available from http://discovery.nationalarchives.gov.uk
4 See http://ioscproceedings.org/doi/pdf/10.7901/2169-3358-2008-1-695

Storage

The size of the stockpile and the possible need for onward transportation by road, sea or air will determine the types of containers that may be used for storage. Stockpile volumes can vary from a few cubic metres to many times this amount. For example, the international oil industry, through Oil Spill Response Limited, has established the 'Global Dispersant Stockpile', consisting of around 5,000 m^3 of dispersant stored at a network of worldwide locations. National government stockpiles can also be substantial. For example, the two largest national government-owned stockpiles in Europe are in France and the UK, each holding around 1,200 m^3 of dispersant. The European Maritime Safety Agency (EMSA) maintains around 800 m^3 of dispersant, equally distributed across four stockpiles in Europe.

The use of suitable containers kept in appropriate condition is fundamental to dispersant stockpiles achieving their potentially unlimited shelf lives.

While all dispersants are formulated for the same purpose and contain a mix of similar surfactants and solvent(s), their specific components and blends vary. For this reason, different products should not be mixed in the same container, either when in storage or in use. Such mixing could result in reduced effectiveness, cause operational issues with spraying gear and may contravene product approval protocols.

CONTAINER TYPES

Drums

Historically, dispersants were primarily supplied in steel drums with a nominal volume of 208 litres (55 US gallons/ 46 imperial gallons). While these can be palletized, they do not allow for the most efficient use of space. Drums can also be supplied in plastic materials in a wide range of sizes; this reduces the corrosion risk but does not overcome the space utilization issue. Drums also raise potential handling challenges when loading or unloading during land or sea transportation, slowing down response times. It is unlikely that significant quantities of new dispersant would be supplied in drums.

Intermediate bulk containers (IBCs)

IBCs are stackable containers or 'totes', mounted on a pallet to facilitate movement using a forklift or pallet truck. Composite IBCs commonly take the form of a white/translucent high-density polyethylene (HDPE) cube, sitting within a tubular galvanized steel cage. The pallet may be steel, plastic or wood. Alternatively, rigid heavy-duty HDPE IBCs are available with no steel cage and the option of an integral moulded pallet.

Typical IBC volumes are either 1,060 litres (280 US gallons/ 233 imperial gallons) brim-full, often described as having 1,000 litres capacity, or 1,250 litres (330 US gallons/ 275 imperial gallons). The gross weight when filled is likely to be in the range of 1,050 to 1,150 kg. (2,315 to 2,535 pounds). The fittings can also be stipulated by the client or supplier. IBCs have a filling cap at the top, and usually have a built-in discharge valve (tap/faucet/spigot) at their base.

Key point

Intermediate bulk containers are the most common type of storage container for dispersants.

A typical 1,000 litre IBC

Steel-caged HDPE IBCs are typically certified as suitable containers for dispersant products ('UN Packing Group III: Substances presenting low danger'). IBCs are by far the most common storage option for larger dispersant stockpiles. They are cost-effective and provide efficient utilization of storage space, as well as being relatively easy to inspect and transport. They have the operational advantage of relatively quick product transfer, which is of particular benefit to operators of larger-volume dispersant application systems.

Bulk tanks

Bulk storage of dispersant, e.g. in road tankers, ISO tank containers or vessel tanks, presents the risks of evaporation of solvent and the oxidation of surfactant. This is due to most large tanks having breathing tubes that are open to the air to allow for fluctuations in the volume of the tanks' contents due to changes in temperature. In the case of vessel tanks, there is also a risk that the dispersant may become contaminated with seawater.

There is documented evidence that dispersant can be maintained in vessel tanks for extended periods, while retaining suitable effectiveness. For example, a marine terminal in the UK has three tugs that were constructed between 1993–95, with dedicated tanks for storing dispersant, ranging from 12 to 30 m^3 in volume. The tanks are constructed from epoxy- or paint-coated steel, with a design that is narrow and deep to minimize the surface area and headspace. The dispersant products in these tanks has been tested every five years, and continued to meet the requirements of the UK efficacy test after more than 20 years. Furthermore, the US study[4] referred to on page 9 reported that dispersant sampled from 12 bulk tanks, 2 vessel tanks and 3 road trailers across five locations all maintained a suitable level of effectiveness after more than 20 years.

Conversely, there are reports of dispersant having failed effectiveness tests while stored in vessel tanks. This may have resulted from the tanks not having been designed for dispersant storage, or from contamination of the products, or a combination of both. For some dispersant products, there may be an increased risk of oxidation in bulk tanks compared to sealed IBCs; this can potentially lead to the formation of residue.

If dispersant is stored in bulk, care must be taken to avoid mixing different brands of dispersant. If only a portion of the product in a tank is used during an incident, the volume used should be replaced with the same product.

CONSTRUCTION MATERIALS

The dispersant supplier should provide the product in a container that is fit for purpose. In most cases the original container will be used for long-term storage and will only be changed if it shows signs of deterioration or damage. In some cases, an organization may choose to adopt a replacement procedure for containers.

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ISO tank containers may be used for bulk storage.

For example, the containers used to store the industry-owned Global Dispersant Stockpile (see page 10) are replaced every five years. This is not a regulatory requirement but is carried out to minimize the possibility of stocks in transit being delayed by freight-forwarders or border control officials. Note that a replacement container should be of at least the equivalent specification and quality compared to the original. Consultation with the dispersant supplier is advised to ensure that replacement containers are compatible with the particular brand of product being used.

Some suppliers may list suitable and unsuitable container materials in the product's SDS. UV-stabilized HDPE is now by far the most commonly used material.

Key point
HDPE is the most common storage container construction material.

Vessel tanks, bulk tanks and road tankers are typically constructed from coated steel. The Warren Spring Laboratory studies carried out in the UK during the 1980s and 1990s indicated that storing some dispersant products in uncoated mild steel containers may present a risk of corrosion.

As mentioned in the section on *Shelf life* on page 9, there is potential for loss of solvent and ingress of oxygen through the walls of a container, including through untreated HDPE. Fluorine treatment of HDPE provides a barrier that greatly reduces the permeation and loss of solvent through the walls of the container. More recently, the development of ethylene vinyl alcohol (EVOH) has enabled the production of laminates of EVOH and HDPE. These laminates greatly reduce both the loss of solvent and the inward permeation of oxygen through the container walls. This ensures that the product remains unchanged, retaining its effectiveness, reducing container distortion due to solvent loss and reducing the risk of surfactant oxidation. Some dispersant manufacturers are now using EVOH-HDPE laminate technology as standard when supplying product in IBCs. This will further enhance the ability to achieve extended shelf lives.

Key point
Using EVOH-HDPE laminate technology for IBC construction greatly reduces permeation and improves the potential to achieve extended shelf lives.

Furthermore, the use of EVOH-HDPE laminates also reduces the outward permeation of nitrogen, thus making feasible the addition of nitrogen to the headspace above the liquid dispersant within the sealed container. This nitrogen 'blanketing' displaces the headspace oxygen and thereby eliminates absorption of oxygen into the dispersant.

Key point
Nitrogen blanketing can be coupled with EVOH-HDPE construction to prevent distortion of IBC containers over time.


OSRL

Equipment used to add nitrogen to an IBC and eliminate oxygen from the headspace above the liquid dispersant.

This further minimizes potential warping or distortion of the sealed containers (see page 16). The procedure for adding nitrogen to the headspace is neither complex nor particularly hazardous. It requires the use of pressurized nitrogen in a cylinder with an associated regulator, discharge hose and long-reach blowgun to introduce the gas into the headspace. The operation is undertaken by a trained operator wearing suitable personal protective equipment in a well-ventilated area. Approximately 100 litres of nitrogen are typically used per IBC.

It is not possible for the body of the discharge valve to be moulded as part of an EVOH-HDPE-constructed IBC, therefore a fluoro-elastomer seal is used. Evidence available from storage of the industry-owned Global Dispersant Stockpile indicates that these seals do not degrade or leak.

OSRL

Orderly storage of IBCs in a warehouse; the neat rows allow visual inspections and facilitate emergency response if needed.

STORAGE FACILITIES

The facilities where dispersants are stored will need to take account of the spill risks they are covering.[5] Tier 1[6] stockpile locations might include ports, marine terminals, and aboard dedicated response vessels or standby vessels for offshore installations. Tier 2 stockpiles may include dedicated onshore facilities, including locations at or near airfields if aerial dispersant application is part of contingency plans. Tier 3 stockpiles are invariably dedicated facilities with extensive warehouse space to accommodate the high volumes of dispersant required.

Direct sunlight, high humidity and saltwater can cause damage to containers, hence their exposure should be minimized as far as possible. It is therefore preferable to store dispersant indoors, i.e. inside warehouse facilities that provide adequate ventilation. If storage outdoors is unavoidable, adequate shelter/cover should be provided. A product's SDS may include guidance on storage, and may incorporate relevant GHS Precautionary Statements (e.g. P234+P235: *Keep only in original container. Keep cool* and P403: *Store in a well-ventilated place*) or an equivalent.

Exposure to temperature extremes and fluctuations should also be avoided wherever feasible. In locations where high or low ambient temperatures are encountered, the use of climate-controlled facilities may be necessary. Temperatures should be kept as low as practicable, as this will help to achieve extended shelf lives. Storage temperatures below -10°C may result in some separation and layering of dispersant products, but this is unlikely to be permanent and will be resolved when the temperature rises. Storage at high ambient temperatures may reduce shelf life; wherever possible, the maximum storage temperature should be below 30°C.

Key point
Storage in ventilated and cool warehousing is preferred.

[5] IPIECA-IOGP (2013). *Dispersant logistics and supply planning.* Report of the IOGP Global Industry Response Group (GIRG) response to the Macondo incident in the Gulf of Mexico in April 2010, Oil Spill Response Joint Industry Project (OSR-JIP). http://oilspillresponseproject.org

[6] IPIECA-IOGP (2014). *Tiered preparedness and response.* IPIECA-IOGP Good Practice Guide Series, Oil Spill Response Joint Industry Project (OSR-JIP). IOGP Report Number 526. www.oilspillresponseproject.org

Contingency for possible leakage

It is good practice to store dispersant in a location where any leaks will be contained and not threaten contamination of adjacent land or watercourses. National pollution control regulations concerning impervious bunding capacity should be observed. In the absence of such regulations, it is recommended that bunding capacity is at least 25% of the total dispersant volume stored. Where bunding capacity is not available, emergency procedures should be in place to rapidly deploy drain blockers or plugging mats to prevent dispersant leaking into drains or watercourses. It is also good practice to maintain one or more spare empty IBCs, a gravity transfer hose, a suitable transfer pump including hoses and fittings, personal protective equipment and a first response chemical spill kit, in case of damage to containers leading to leaks. This would allow the transfer of dispersant from the damaged container safely and without delay. It is recommended that spare storage capacity is maintained at 1% of the total volume held. Any dispersant is likely to make a surface extremely slippery, and personnel should take care where responding to leaks. Specific guidance on first aid and accidental release measures will be included in a product's SDS.

Stacking

Steel-caged IBCs are designed to be stacked to maximize storage efficiency. The supplier or container manufacturer should provide recommendations on stacking weight restrictions. In practice, stacking up to a height of three steel-caged IBCs provides storage efficiency while allowing convenient visual inspections of all units. Purpose-built shelving may allow stacking to a height of four IBCs or higher. Ideally, IBCs should be stacked in neat rows, such that all units can be visually inspected. Units should have their discharge valves and front labels facing outwards. Consideration will also need to be given to emergency mobilization of stocks, i.e. the ability to rapidly access and move containers using a forklift or pallet truck. Older stocks should ideally be the most accessible, so that they can be used first during an incident.

Onward transportation to a port or airport during deployment to an incident is likely to involve road transportation. Transport vehicles, such as flatbed trucks or trailers, have weight restrictions that usually prevent steel-caged IBCs from being stacked during transport. It may be useful to cover IBCs during transportation if extended exposure to strong sunlight is anticipated.

Maintenance

VISUAL CHECKS

Unless national regulation requires otherwise, the following recommendations are made.

A general visual inspection of stockpiles is recommended at least every month. This would typically involve personnel walking between and around the containers to identify any signs of small leaks or damage to the IBCs or other containers. Labels should be checked for legibility and replaced if deteriorating.

The inspection should also include an observation of any abnormal appearance and colour of the product where this is feasible, e.g. through the walls of translucent IBCs. Dispersants are generally clear liquids. A product's colour is described in its SDS (e.g. orange, brown or amber). Over time, a product may take on a hazy or darker appearance, usually indicating the presence of suspended particulate or flocculent. The presence of fine particulates does not necessarily hinder the effectiveness of the product or its ability to pass through spray systems. Observed abnormalities might indicate a need for further investigation and a possible need for testing.

Containers that are in poor condition may not be suitable for safe transportation. This would compromise the operational effectiveness of a stockpile, as well as risk deterioration of the product.

A record should be made of each inspection, typically as part of a wider planned maintenance system for a response stockpile. It may be useful to include photographs of IBCs and any dispersant samples taken for testing. These images can create an historical library of appearance, against which future inspections can be compared. Depending on the scale and nature of any identified damage or abnormality, decisions should be made on container replacement and the need for the contents to be retested for effectiveness. An example of a visual inspection checklist is provided in Annex 1 on page 22.

Key point
Regular visual checks can identify storage units that may need replacement, or product that may require retesting.

AMOSC

Example of colour variation of the sample product within a stockpile.

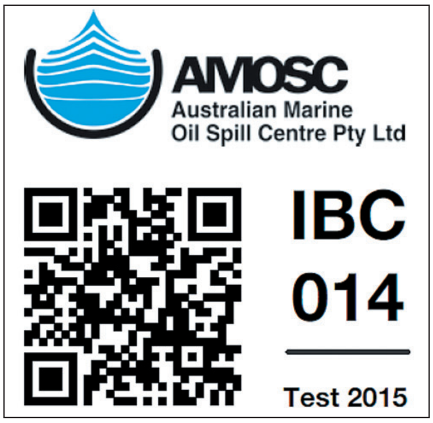
Every two to three years, each IBC should be given a thorough external visual inspection for cracks, warping/deformation, corrosion of the steel cage, abnormalities with the discharge valve and camlock fitting (if present) or any other damage. This inspection may require the movement of containers to allow all-around checks. Limited warping of HDPE IBCs is acceptable, although it should be noted that this can potentially lead to cracking of the HDPE, particularly at the corners, and should therefore prompt a detailed examination of the IBC to check for signs of possible cracks. The visual inspection should also include a check on the product's appearance and colour. As previously mentioned, it may be useful to take photographs to allow comparisons with earlier checks; photographs should be cross-referenced to individual storage units.

STOCK CONTROL

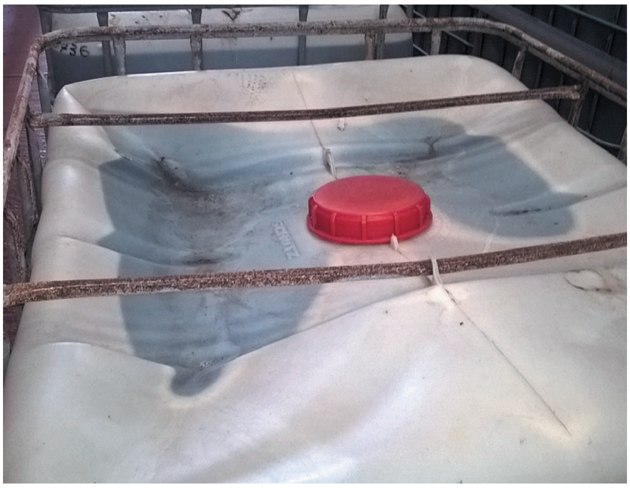
A maintenance record should include batch numbers and dates of dispersant manufacture. This will allow stocks to be utilized in order of age, so that older stock is deployed first. To facilitate this, the maintenance record should be accessible to an organization's emergency responders and incident management team (IMT). The IMT's logistics function should be aware of dispersant stock control procedures.

If dispersant is used during an incident, it is good practice to retain a small sample of all batches used. These could provide evidence of the effectiveness and possibly toxicity of the batches, if a subsequent challenge is made by regulators or others.

QR code label used to identify sampled containers and to recall inspection, sampling and testing data on-site at any time.



AMOSC



OSRL

Above: an example of IBC deformation caused by loss of solvent; the product remained effective, but this can be prevented by the use of EVOH-HDPE laminated technology.

Right: an example of visible residue formed during storage; in this case the residue remixed on pumping and did not affect the spraying equipment or product effectiveness.

OSRL

CONTAINER REPLACEMENT

If dispersant needs to be transferred from one container to another (e.g. if a container is damaged or if periodic IBC replacement is required), it is recommended that this is done using gravity rather than pumping, where feasible. Gravity transfer reduces the potential entrainment of air into the product, which could affect the dispersant quality during long-term storage. Where EVOH-HDPE laminate IBCs are used as replacements, a nitrogen blanket may be added to the headspace prior to sealing, to enhance the potential shelf life of the product.

DOCUMENTATION

It is important that key information and inspection/testing records are maintained. This information is typically incorporated within a database and is likely to encompass:

- safety data sheet details;
- replicate label information;
- a schedule for inspections and testing;
- a record of dates and personnel undertaking visual inspections, for both general and individual unit checks;
- notes of damaged or leaking containers and actions taken;
- referenced photographs stemming from visual checks; and
- sampling and retesting results—including any failures; note that dates of retesting may be added to the label affixed to the storage container.

Key point
Thorough inspection and retesting records should be maintained.

Steel drums showing signs of deterioration after 25 years. They were stored inside but occasional roof leaks caused water to pool on them which encouraged corrosion.

Splitting necks were observed on 25% of this stockpile of plastic drums after 10–20 years in storage. The specific cause was not known, but such damage could have an adverse impact on the product as it is likely to become exposed to the air.

An 18-year-old plastic drum with deformation presumed to be through loss of solvent. Inset shows a resulting crack, which ultimately led to a leak in the drum.

Retesting

In most jurisdictions, the dispersant product approval process includes laboratory testing for efficacy and toxicity; a biodegradability test may also be stipulated.[7] Some jurisdictions require periodic efficacy retesting. No known regulations mandate retesting for toxicity and biodegradability.

A dispersant stored in optimal conditions should not lose effectiveness to a significant extent. Studies undertaken in the UK by Warren Spring Laboratory for the Institute of Petroleum and others in the 1980s indicated that the greatest factor in the potential deterioration of dispersant effectiveness over time relate to non-optimal storage. This could include damaged or corroded containers, loss of solvent through the container walls and permeation of oxygen into the product, all of which may be exacerbated by high humidity, high temperature and exposure to direct sunlight. Following the storage guidance in this report can eliminate or greatly mitigate against these factors. It is noted that the original work undertaken by Warren Spring Laboratory suggested a five-yearly efficacy retesting period for dispersant. Subsequent experience with stored products has indicated that an initial period of 10 years prior to retesting is acceptable, unless visual inspections or changes in physical properties indicate otherwise.

It is prudent to undertake retesting to ensure that no deterioration has occurred that would render the product's effectiveness unacceptable. There are variations in national efficacy retesting requirements; the following guidance may be used in the absence of such regulatory stipulations.

PHYSICAL PROPERTIES

Initial retesting may be made on the density and viscosity of a product, and the results compared with the manufacturer's values for these parameters, e.g. as reported in the product's SDS. The manufacturer may provide a range of acceptable values or a single value. Any measurements outside of the reported range, or a significant change from a single value for either the density or viscosity, is likely to precede or indicate a possible reduction in product efficacy. Measurements of these physical properties are relatively straightforward; they can be performed on-site and do not require the services of a certified laboratory. Records of all tests undertaken, together with the results, should be included in the stockpile's database and documentation.

A sample for testing can be obtained using a disposable sample 'thief' (a glass or plastic tube that can be blocked with a thumb) or pipette, accessing the product via the top opening of an IBC, drum or tank. A sample thief may be used to sample near the middle of the IBC to get a representative subsample (i.e. not from near to the top or bottom of the container). It may be advantageous to use an agitator/ mixer set at relatively low speed, prior to taking the sample.

A common practice is to randomly select 10% of the containers in a batch for physical property retesting. These test results can then be used as a preliminary screening tool, wherein samples from containers found to exceed the manufacturer's acceptable density or viscosity values can then undergo efficacy retesting (described on the following pages).

Key point

Retesting of the density and viscosity of a product may be used to screen or identify product in containers/ batches that should then be retested for efficacy.

[7] IPIECA-IOGP (2014). *Regulatory approval of dispersant products and authorization for their use.* Report of the IOGP Global Industry Response Group (GIRG) response to the Macondo incident in the Gulf of Mexico in April 2010, Oil Spill Response Joint Industry Project (OSR-JIP). http://oilspillresponseproject.org

EFFICACY

Periodic retesting

For non-bulk storage in IBCs, unless defined differently by applicable national regulation, it is recommended that the initial efficacy retesting is carried out after 10 years provided that the product has remained sealed in its original containers. Subsequently the product should be retested every five years. The test should be carried out on at least 10% of samples from numerically referenced batches that have been stored in the same location under the same conditions (e.g. 1 in every 10 IBCs in a batch should be retested). After sampling, if EVOH-HDPE laminate IBCs are in use, a replacement nitrogen blanket should be introduced into the opened containers to replace the oxygen in the headspace above the product prior to resealing.

Key point
Retesting after an initial 10 years and then every 5 years is recommended for dispersant stored in IBCs or equivalent containers.

Where dispersant product is stored in steel drums, there may be heightened concerns that the containers are at risk of deterioration due to corrosion, particularly in hot and humid climates such as in the tropics. Deterioration of containers may ultimately lead to loss of solvent and/or oxidation of surfactant, with resultant reductions in product efficacy. It is recommended that an initial efficacy retest of dispersant product stored in steel containers is carried out after five years, and subsequent retests every three years. This applies to batches, in the same manner as for dispersant stored in IBCs (see above). If a regular visual inspection regime, reflecting that described under *Visual checks* on pages 15–16, unequivocally indicates that there is no deterioration of the drums, it is acceptable to revert to the testing regime as used for IBCs.

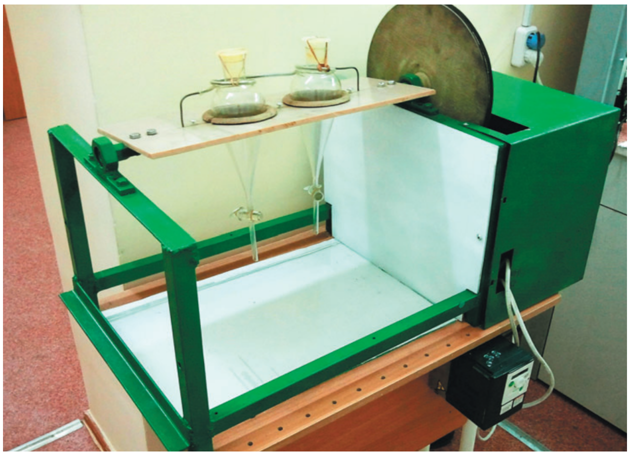
For bulk storage tanks, it is recommended that a sample is tested every five years from the date the tank is initially filled.

Discretionary retesting should be carried out on stored units that display damage or abnormalities noted under the visual inspection regime.

Test methodology

The volume of dispersant needed for laboratory testing is relatively small (only a few millilitres or less) and can be obtained using a disposable sample thief or pipette as described under *Physical properties* on page 18. It may be more practical to obtain a few tens of millilitres when sampling. Samples should be put into suitable small glass or HDPE bottles with Teflon™ caps/seals and labelled with a unique reference number linking them to the container from which they were sampled.

The laboratory test methodology for efficacy should mirror that used for the original product approval wherever possible. Where a test methodology is not stipulated by regulation, consideration should be given to using simple and widely recognized tests, e.g. the rotating flask, baffled flask or EXDET test protocols.[8] Each laboratory method uses different levels of mixing energy, none of which can accurately simulate the complex mixing scenarios and energies encountered in the marine environment. Approved or certified laboratories should be utilized for efficacy retesting whenever feasible.



Karaganda State University

A laboratory test can differentiate between good and poor products but does not replicate real-world open-water conditions.

[8] See NRC (2005). *Oil Spill Dispersants: Efficacy and Effects.* National Research Council of the National Academies, the National Academies Press, Washington D.C. www.nap.edu/openbook.php?record_id=11283

A jurisdiction typically sets a pass mark for an efficacy test as part of the initial product approval process. Recognizing the investment made in dispersant stockpiles, it is accepted that some loss of efficacy is permissible. For example, in the UK the pass mark for retesting is accepted as 75% of the original minimum. Thus, where the original minimum pass mark for product approval in the UK is 60%, the retest pass mark is 45% using the same methodology.

A summary of an example inspection and testing regime for dispersants is presented below, courtesy of the Australian Marine Oil Spill Centre (AMOSC).

Key point

Results from different test methodologies are not directly comparable and should not be extrapolated to describe potential effectiveness during real-world dispersant use.

SUMMARY OF AN EXAMPLE INSPECTION AND TESTING REGIME (AMOSC)

The Australian Marine Oil Spill Centre (AMOSC) maintains multiple stockpiles of dispersant for use by the oil and gas sector and to support Australia's national dispersant capability. The maintenance regime used to ensure operational readiness of AMOSC's stockpiles includes efficacy testing of dispersant using the EXDET laboratory test. This is a testing protocol designed to allow the comparison of oil dispersion effectiveness from different dispersant formulations and for individual dispersants against test oils, within the parameters of the test. EXDET is designed to provide robust, evaluative results that are not strongly influenced by either excessive or minimal mixing energy.

AMOSC's dispersant stockpiles are routinely inspected for visual changes, and dispersant batches are sampled and sent to the laboratory for efficacy testing. Results are returned as a percentage of oil dispersed—noting that these laboratory results only apply to the EXDET test.

EXDET laboratory test results' classification

% oil dispersed	Dispersability classification
>80	Excellent
60–79	Good
45–59	Average
30–44	Poor
0–29	Unsatisfactory

Based on the results, performance criteria are used to determine the frequency in which additional testing is required in the future. Where performance is below 49%, consideration of disposal and/or replacement of dispersant is recommended.

Dispersant effectiveness testing schedule

Visual inspection	Dispersant effectiveness testing	
Test frequency	Test frequency	Test result (% efficiency)
Once every three years	5 years	100% to 70%
	2 years	69% to 50%
	Stock may need to be replaced	49% to 0%

Disposal

Dispersants are relatively expensive products. The only reason that stockpiles are likely to be considered for disposal is if they have deteriorated to an extent that renders the product's effectiveness unacceptable. Where an operation has viable dispersant but no longer requires it, it is likely that the stock can be transferred to an alternative operation.

It may be possible for some manufacturers to reconstitute a returned product. However, if stocks are condemned, a framework of national industrial or hazardous waste regulations is likely to apply. It is recommended that the dispersant supplier or manufacturer is consulted for advice on disposal. It is possible that the only viable final disposal option is incineration, which will invariably require the services of approved waste handing companies.

If condemned stocks of dispersant are disposed of, or if a container is damaged but the dispersant remains effective and is transferred to a new container, the resulting empty containers should be taken to an approved waste handling site for recycling or disposal. If containers need to be managed on-site, the empty containers should be washed, with the wash water collected and treated. Clean empty containers may be disposed of or recycled following the site's waste management policy.

Annex 1: Visual inspection checklist

The following are generic examples of checklists, which may be utilized to support a consistent approach to visual inspections of dispersant stocks. Results will typically be recorded in a database.

Table A1 Monthly or more frequent checklist (walk through stockpile)

Location:	Anytown				
Dispersant:	Product A, 30,000 litres, stored in IBCs Product B, 20,000 litres, stored in IBCs				
Date	Name of inspector	Leaks observed?	Container damage observed?	Label integrity?	Warehouse condition and housekeeping
02-06-yyyy	J. Smith	None	None	IBC unit 1234-5678 label peeling. Replacement label affixed.	Good
01-07-yyyy	P. Jones	None	None	Good	Good
03-08-yyyy	P. Jones	None	None	Good	Good
dd-mm-yyyy					
dd-mm-yyyy					

Table A2 Detailed checklist for a visual inspection carried out every two-and-a-half years (for each container)

Location:	Anytown	
Dispersant:	Product A	
Batch number:	xx-xxxx-xxxx	
Container unit number:	xxxx-xxxx	
Previous container unit number (if relevant):	N/A	
Checks:	Any phase changes visible?	
	Any residue visible?	
	Colour abnormalities visible?	
	Any warping of IBCs?	
	Condition of IBC metal frames; any damage or corrosion?	
	Condition and legibility of label?	

Annex 2: The Globally Harmonized System of Classification and Labelling of Chemicals (GHS)

The GHS identifies physical, health and environmental hazard classes, and provides detailed guidance on whether a substance or mixture qualifies as hazardous. For each class, numbered categories indicate the hazard severity, with category 1 being the most severe. In some cases, there are subcategories (e.g. A, B, etc.) which can be used by authorities that require more than one designation within that category. Examples of two classes and their categories, which may be associated with dispersants, are given in Table A3. Other classes which may be associated with dispersant products include 'specific target organ toxicity—single exposure', 'respiratory or skin sensitization' and 'hazardous to the aquatic environment'. Reference should be made to a product's SDS for a full identification of the hazards.

LABELLING

Guidance on labelling forms part of the GHS; specific national regulations may also apply. Several GHS labelling elements are described below.

Signal words

The signal words used in the GHS are '**Danger**' (used for the more severe hazard categories, typically categories 1 and 2) and '**Warning**' (typically used for less severe categories). If the signal word '**Danger**' applies, the signal word '**Warning**' should not appear on a label.

Hazard statements

A hazard statement is a phrase assigned to a hazard class and category that describes the nature of the hazard and, where appropriate, the degree of hazard. A unique GHS hazard statement code can be used for reference purposes but should not be used to replace the statement on labels or within an SDS.

Table A3 Examples of two GHS classes and their categories

GHS CLASS	CATEGORIES
Skin corrosion/ irritation	Category 1 (skin corrosion) May be subdivided into 1A, 1B and 1C
	Category 2 (skin irritation)
	Category 3 (mild skin irritation)
Serious eye damage/ eye irritation	Category 1 (serious eye damage/irreversible effects on the eye)
	Category 2 (eye irritation/ reversible effects on the eye) May be subdivided into 2A and 2B

Precautionary statements

A precautionary statement is a phrase that describes recommended measures that should be taken to minimize or prevent adverse effects resulting from exposure to a hazardous product, or from improper storage or handling of a hazardous product.

A unique GHS precautionary statement code can be used for reference purposes but should not be used to replace the statement on labels or within an SDS. Examples are given in Table A4.

Table A4 Examples of GHS precautionary statements

GHS PRECAUTIONARY STATEMENT	
P305+P351+P33	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P337+P313	If eye irritation persists: Get medical advice/attention.
P302+P352	IF ON SKIN: Wash with plenty of water/soap.
P332+P313	If skin irritation occurs: Get medical advice/attention.
P280	Wear protective gloves/protective clothing/eye protection/face protection.
P264	Wash hands thoroughly after handling.
P234+P235	Keep only in original container. Keep cool.
P403	Store in a well-ventilated place.

Pictograms

A pictogram is a graphical composition comprising a symbol within a border. All pictograms used in the GHS consist of a square, set at one of its points, with a hazard symbol at its centre. Examples of GHS classifications and labelling requirements which might be associated with some dispersants are given in Table A5. Others may also apply and reference should be made to a product's SDS.

Older labelling systems or national systems may also be encountered as the GHS is not yet universally adopted (see examples on the right).

Examples of older/national labelling systems that may still be encountered

Harmful/irritant (now replaced by the GHS health hazard exclamation mark)

US National Fire Protection Association (NFPA)

Red = flammability, blue = health, yellow = instability, white = special hazard.
*For each coloured diamond: 0 = not significant, 1 = slight, 2 = moderate, 3 = high, 4 = extreme and * = chronic*

Table A5 Examples of GHS classifications and labelling

CLASSIFICATION		LABELLING			HAZARD STATEMENT CODE
Class	Category	Pictogram	Signal word	Hazard statement	
Serious eye damage/ eye irritation	1		Danger	Causes serious eye damage	H318
Skin corrosion/ irritation	2		Warning	Causes skin irritation	H315
Specific target organ toxicity—single exposure	3		Warning	May cause drowsiness of dizziness	H336
Hazardous to the aquatic environment, short term (Acute)	4	(no pictogram)	(no signal word)	Harmful to aquatic life	H402

IPIECA

IPIECA is the global oil and gas industry association for environmental and social issues. It develops, shares and promotes good practices and knowledge to help the industry improve its environmental and social performance, and is the industry's principal channel of communication with the United Nations.

Through its member-led working groups and executive leadership, IPIECA brings together the collective expertise of oil and gas companies and associations. Its unique position within the industry enables its members to respond effectively to key environmental and social issues.

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IPIECA also has an active global network of oil and gas industry association members. Please refer to the IPIECA website for a full list.

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