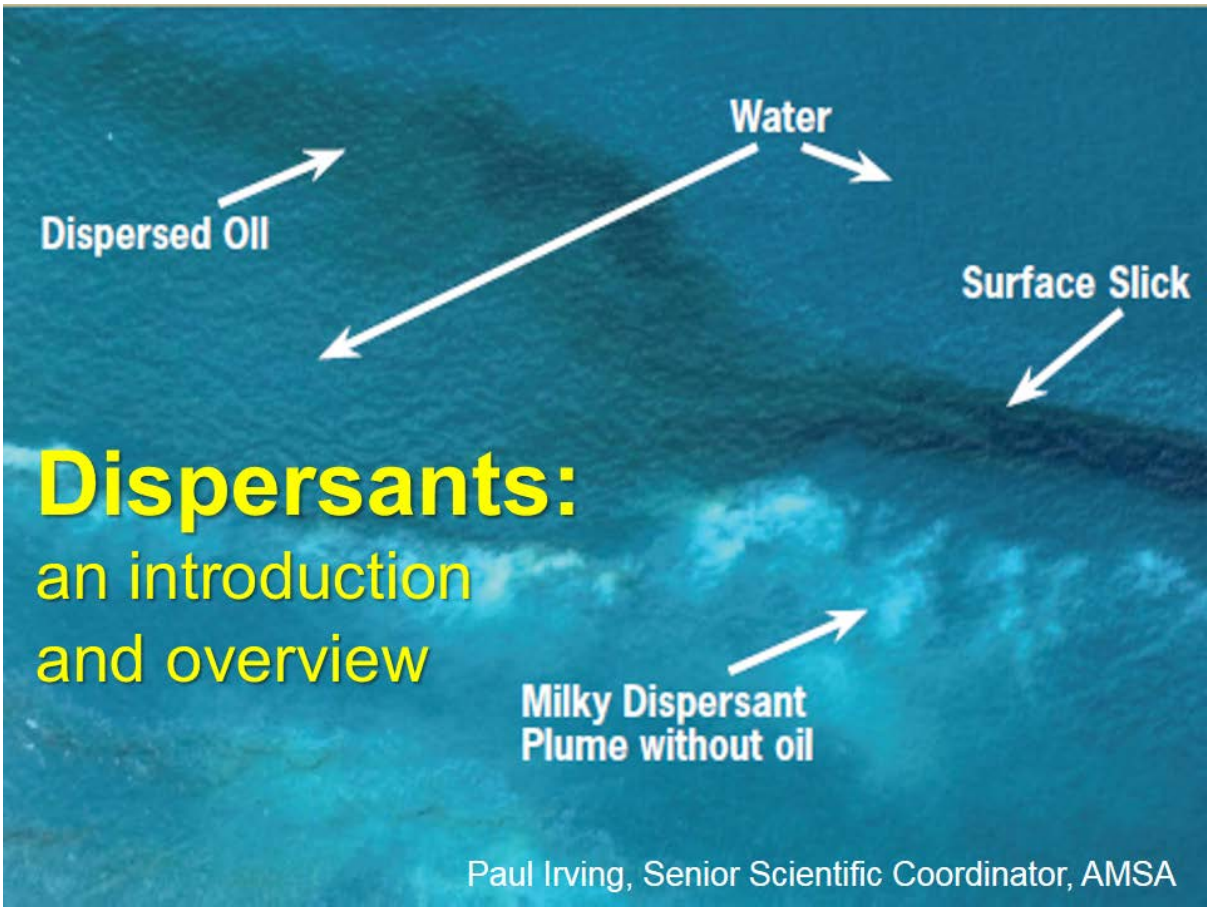

Dispersants: a brief overview

Produced for National Plan training and education purposes by:

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September 2015

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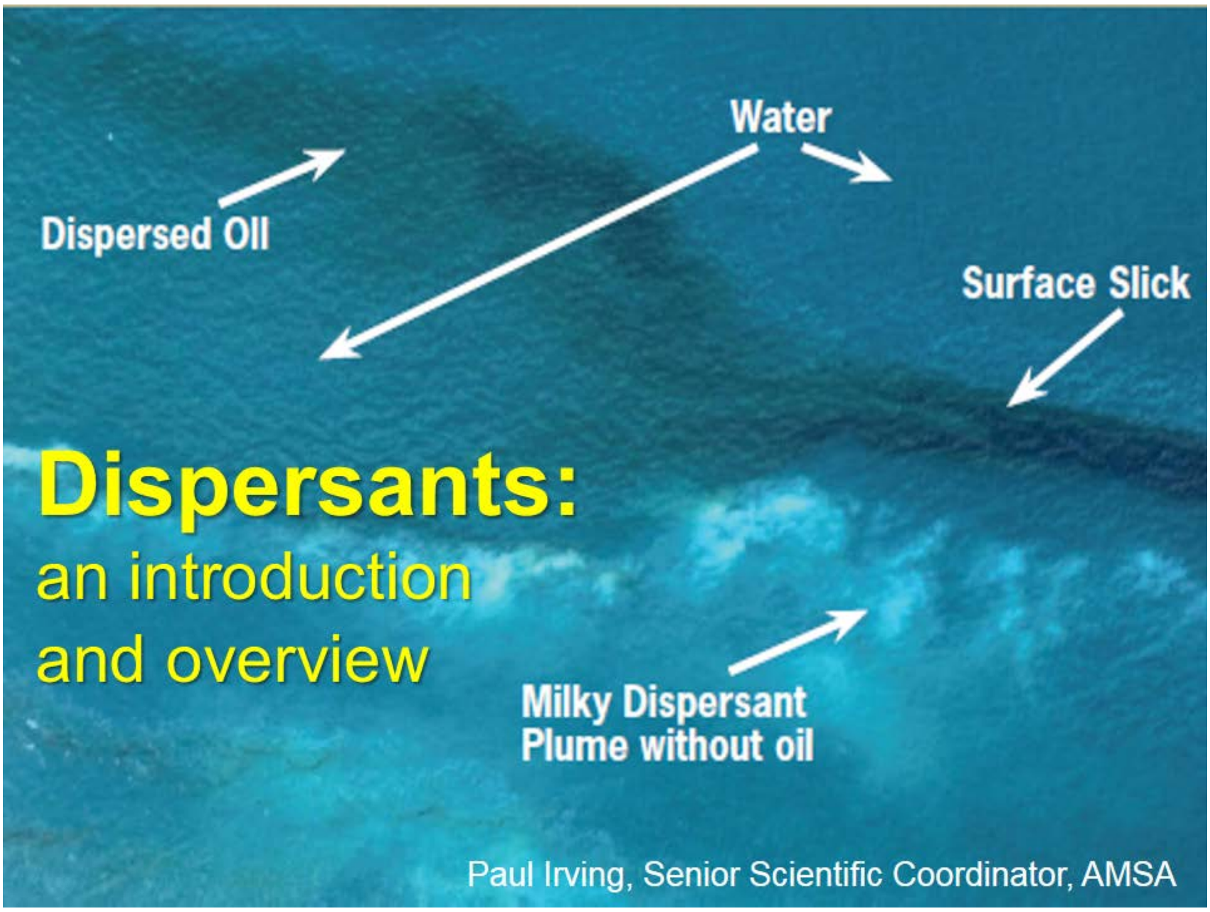
1. Introduction



This booklet was produced to for Australian National Plan for Maritime Environmental Emergencies National Response Team training, as an introduction and overview of dispersant use.

The key message readers should obtain from this booklet is: “In the right place, on the right oil, and at the right time, the use of chemical dispersants can be a safe and environmentally responsible response option”.

The information that follows should provide the logic and evidence for this.

2. Response Options

Responding to a spill involves options and choices, and the use of chemical dispersant is often relevant. The Australian National Plan considers chemical dispersant use to be a valid response option.

But the choice of what technologies and resources to apply, especially if chemical dispersants are being considered, must be underpinned by documented analysis and decision-making.

Mechanical Recovery is an important component of all response plans and should continue to be. It has the strong advantage of actually removing oil from the environment, and can be shown to do so. But on larger spills, its application can be limited by logistics and encounter rate.

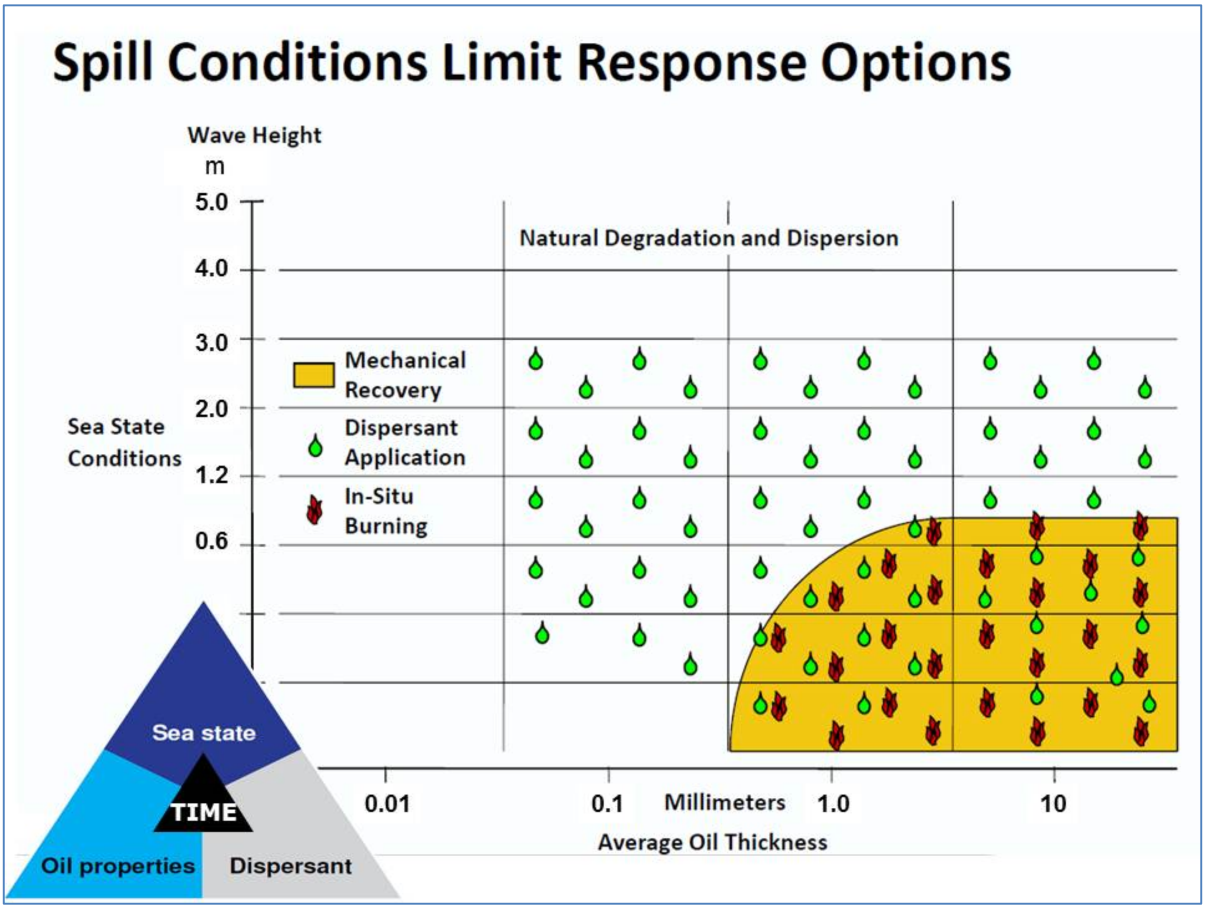
Shoreline Response is often required because of the limited effectiveness of the at-sea response options. The shoreline is the ultimate oil boom/barrier and depending on shoreline type, can assist in oil collection and recovery. But shoreline response is also highly visible and can be very disruptive of public and commercial values and uses.

In-situ Burning is not currently a response option in Australian waters, primarily because it requires specialized equipment and expert personnel, none of which we have here due to the infrequency of long-release spills. It is also a challenge to use effectively on a short-term release vessel spill. Where it has been used elsewhere in the world, and the major recent example was the Deepwater Horizon, it can effectively support other response techniques. But remember, if the oil is thick enough to burn, it is thick enough to recover.

Chemical dispersion is recognised in Australia as the primary response tool for many spills, but not those in waters too close to the coast. For large spills, dispersants are the only tool that can have a real impact on large spills.

And we are going to cover this in more detail as we go.

3. Limiting Conditions



Dispersant application is less limited by ambient conditions than other options. Mechanical recovery and in-situ burning can be limited by sea state and slick thickness.

Four factors will determine whether a chemical dispersant operation will be successful.

1. The oil properties at any given time - you should remember about oil properties changing through weathering.
2. The sea state and weather conditions generating mixing energy.
3. The dispersant type and logistical requirements in obtaining and applying it.
4. And all of these are strongly influenced by time.

It is also useful to remind ourselves that chemical dispersants are used to enhance natural dispersion, and this is driven by sea energy.

4. Encounter Rate Significance

You will all know that encounter rate drives response effectiveness. You have got to find and intercept the oil to deal with it.

This picture shows this quite clearly. In this aerial shot of one slick within the Gulf of Mexico, two mechanical recovery operations are obvious – the vessel track in the upper right and the vessel at the lower right in a clear patch. Both operations are limited and time-consuming. Aerial application of chemical dispersants has the potential to cover large areas of oil much faster than mechanical recovery.

5. What Are Dispersants

Dispersants – what are they?

Mixtures of surfactants (soaps) dissolved in a solvent (carrier)

Corexit 9500 Ingredients	Common Day-to-Day Use Examples
Span 80 (surfactant)	Skin cream, body shampoo, emulsifier in juice
Tween 80 (surfactant)	Baby bath, mouth wash, face lotion, emulsifier in food
Tween 85 (surfactant)	Body/Face lotion, tanning lotions
Aerosol OT or DOSS (surfactant)	Wetting agent in cosmetic products, gelatin, beverages, laxatives
Glycol butyl ether (solvent)	Household cleaning products
Isopar M (solvent)	Air freshener, cleaner

Before we go into the operational aspects of dispersants, I want to show you a little chemistry, and explain over the next few slides what dispersants are and how they work with oil. Don't worry, this won't be too detailed, but should be enough to help you understand the basic chemistry and the safety issues associated with dispersant use.

Dispersants are effectively a mixture of surfactants (soaps) in a mixture of solvents. The soaps attack the oil and create small droplets of oil-in-water emulsions (more on that in a moment) and the solvents are carriers to assist the surfactants to break the oil surface and do their job.

Even though AMSA is retiring its Corexit 9500A, I am using it as an example, as the component chemicals are well known, well studied and very similar to the other dispersants we have in Australia.

This list of Corexit 9500A component chemicals has been made public through the USEPA. Even so, some ill-informed commentators have stated that Corexit 9500A contains highly toxic components – this simply is not correct.

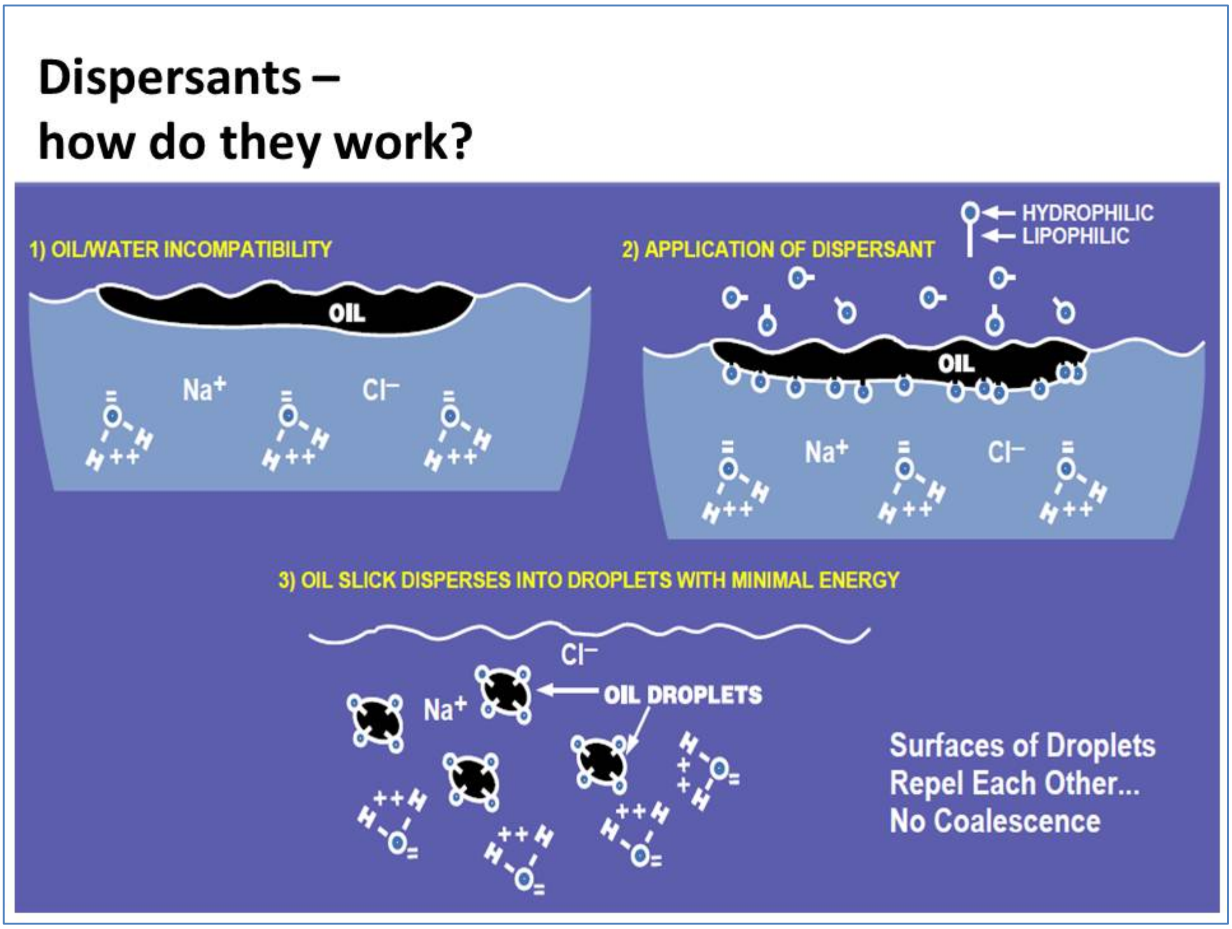
As you can see from the examples of other day-to-day uses, **all** of the chemical components are approved for close use with people, even to the point where they can be applied to the skin and/or consumed.

One specific chemical component I want to draw your attention to is the surfactant sold as *Aerosol OT*, which is also known as DOSS (you don't want to know the full chemical name). DOSS is in other Australian dispersants and is also the major constituent of a popular brand of laxatives used worldwide. It is also used as a pesticide in the US because of its effects on insect gills. This may explain why, in the aftermath of the Deepwater Horizon response, DOSS has reportedly been found in places where dispersants were never used.

However, it is important to remember and we will discuss it again later, that all chemicals can be harmful – it all depends on dose. A good way to remember this is drinking alcohol – the more you drink, the drunker you get.

Even a chemical as innocuous water can be dangerous – drowning, scalding and skiing accidents spring to mind.

6. How Dispersants Work



So how do dispersants work?

Despite the old adage that oil and water doesn't mix, oil can be dispersed in water as small droplets through energy from mechanical mixing.

Without this energy, oil and water won't mix and as oil is less dense than water it will float on top of the water and because oil sticks to itself, and repels water, the oil creates a slick. This is driven by surface tension, and is exactly the same effect as the beading of water you see on the paint of a freshly waxed car.

Adding wave or wind energy and small droplets of oil can be broken off the slicks and mixed into the water. But unless the energy continues, they rapidly float upward and coalesce to reform a surface slick.

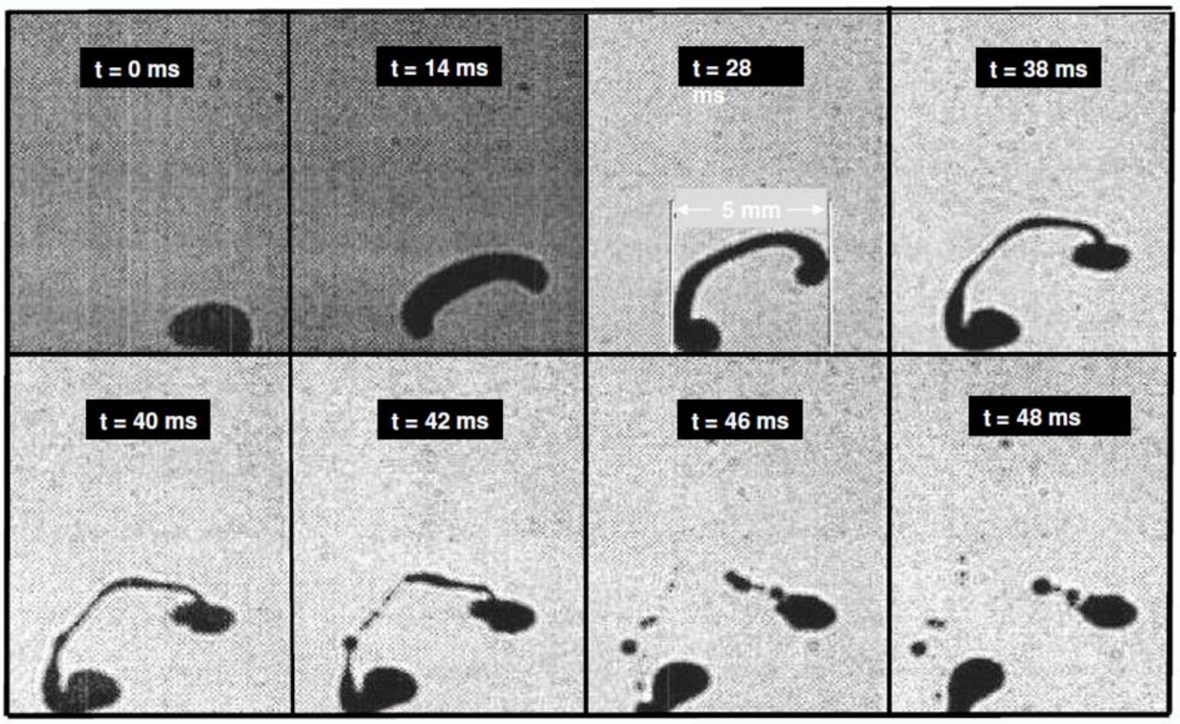
Application of a chemical dispersant changes the surface tension between the water and the oil. This allows the oil to be more easily broken into very small droplets of oil (generally much less than a millimeter in diameter) and with less mixing energy.

These small droplets form stable oil-in-water emulsions that tend to repel each other because of the surfactant coating and do not re-coalesce. The best example of this that you handle every day is probably homogenized milk. The oil (or cream) in this milk is beaten up to very small droplets and stays in suspension, unlike the old days when the cream floated to a clot at the top of the bottle.

After chemical dispersion, the oil droplets are also so small, not sticky, and neutrally buoyant. Local currents and mixing zones in the water column then spread the droplets both up and down and sideways throughout the water column. This results in a dispersion that dilutes the concentration by many orders of magnitude.

A useful safety outcome of chemical dispersant use is to lower the concentration of volatile hydrocarbons above a slick. These volatile hydrocarbons are more easily dispersed and so enter the water column more quickly. Unfortunately these are often also the most toxic part of the oil, but dilution soon solves that.

7. Small Droplets are Best

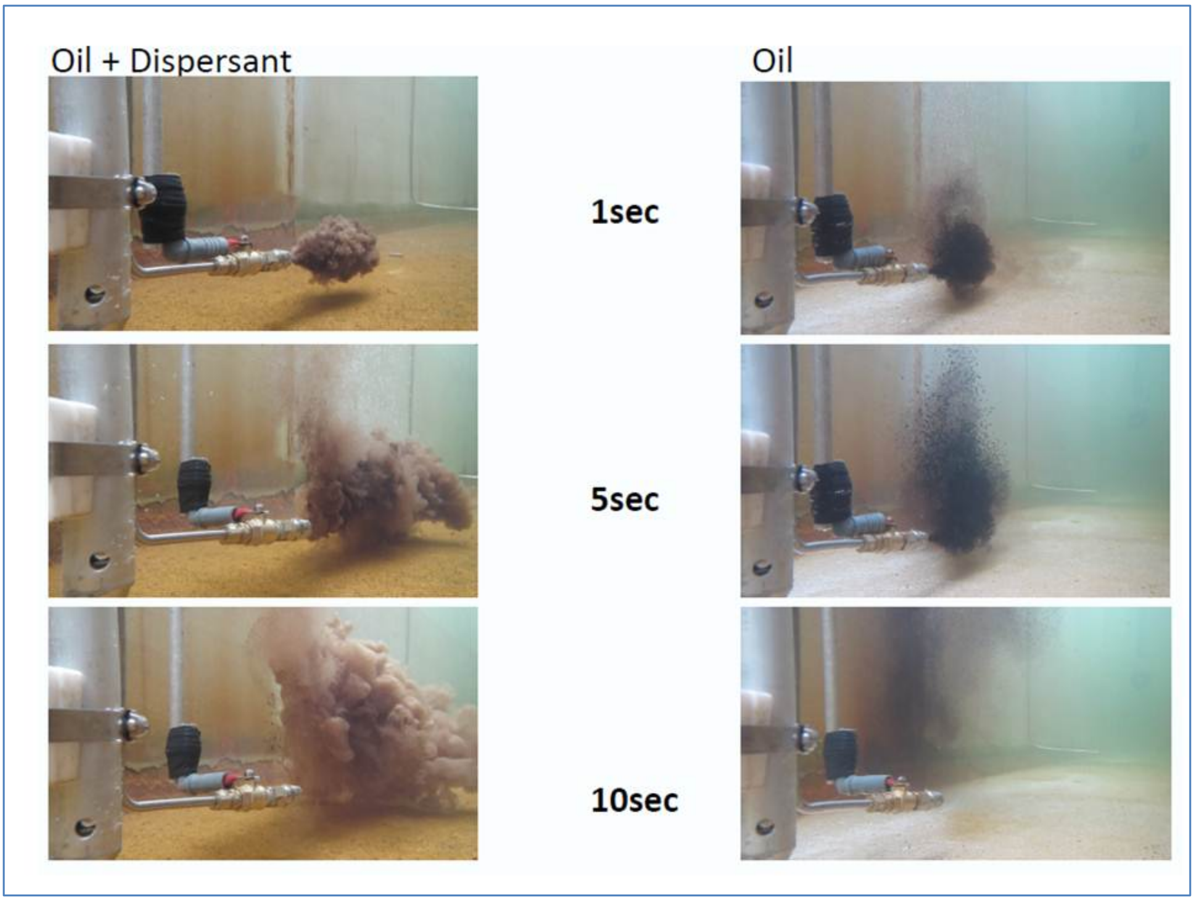


Extracted images from cinematic digital holography of turbulent break-up of crude oil mixed with dispersants into micro-droplets. Gopalan, B. and J. Katz (2010) Physical Review Letters 104, 054501

This series of images simply show how a small droplet of oil is broken into a group of even smaller droplets when mixed with dispersant. The original droplet is about 2-3mm across.

The 8 images cover less than 1/20th of a second.

8. An Oil Plume With and Without Dispersant

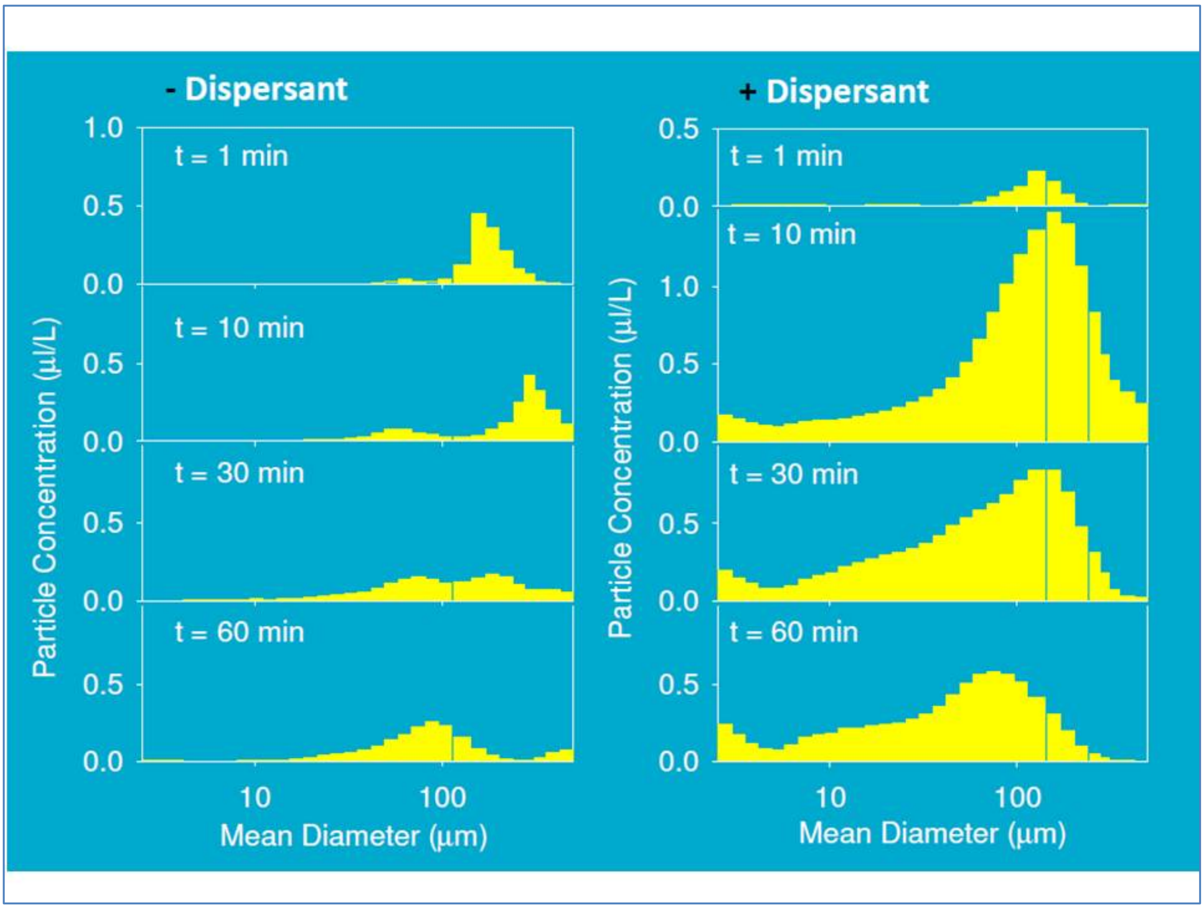


This series of pictures shows the real effects of dispersants on oil using a 5m water column and a mixture of oil and dispersant injected at depth..

On the left oil mixed with dispersant breaks up into a cloud-like formation of really small droplets. These hang around at depth from much longer, as they are neutrally buoyant. Local currents in the sea will move them around.

On the right is the same oil injected without dispersant. You can see that the droplets are clearly larger and more appear to float upwards out of frame after 10 seconds. These are much more likely to end up in a surface slick.

9. More, Smaller Droplets

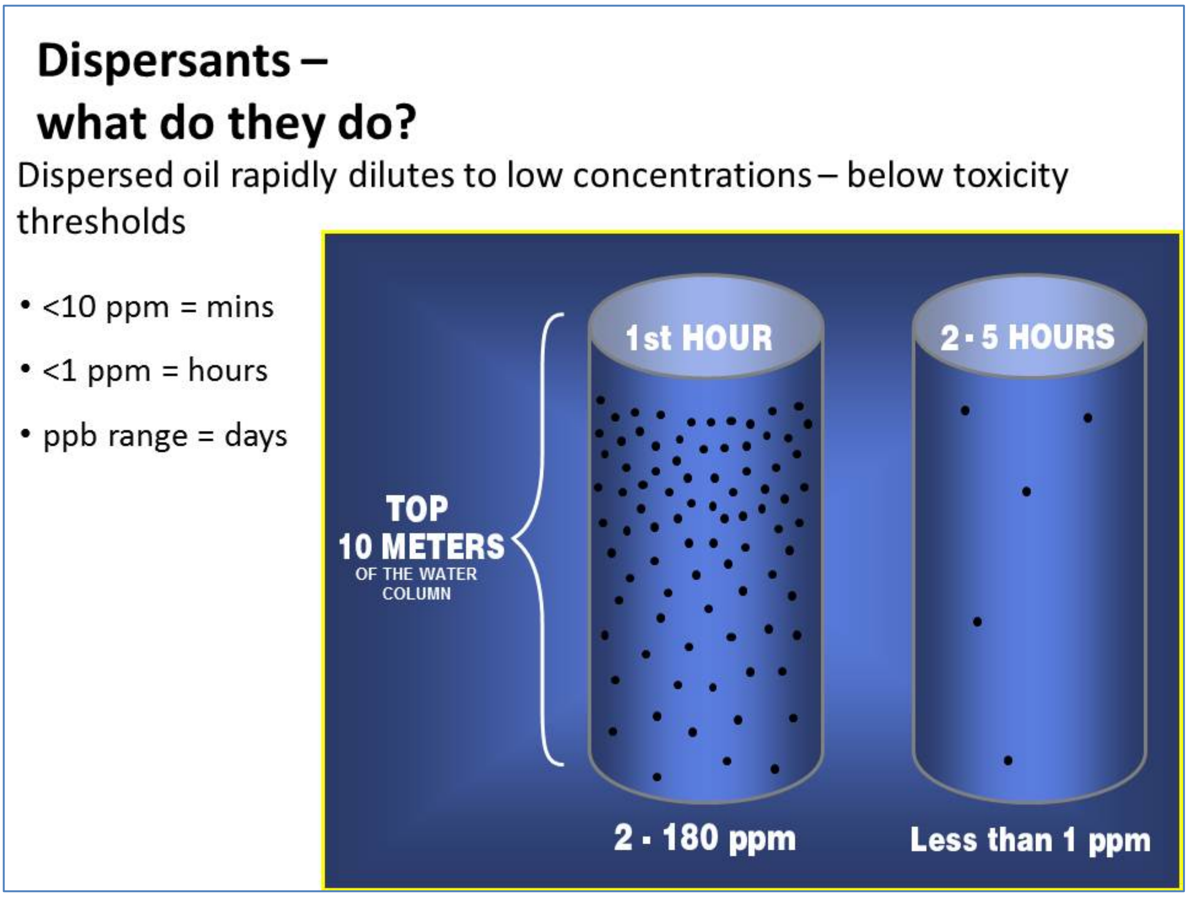


This set of graphs shows droplet size, frequency and longevity, without and with dispersant.

On the left, with no dispersant, over time the droplet size frequency remains larger (greater than 100 microns – around a tenth of a millimeter) and with fewer oil droplets per volume (the height of the bars).

Whereas, on the right, with dispersant, over the same time, the droplet size frequency range (i.e. the width of the yellow bars) is extended with many smaller droplets (down below 10 microns or a hundredth of a millimeter) and there is many time more of them at every size (as shown by the increased height of the yellow bars).

10. Dispersants Aid Rapid Dilution



So we can create more and smaller oil droplets with chemical dispersants, what happens next?

By creating smaller and less buoyant droplets, dispersants encourage local mixing currents (from waves, wind and sea temperature differences) to drive the oil droplets throughout the local surface mixing zone, which often extends down to 10 or even 20 metres. The mariners and divers among you will know that you can feel a one meter wave chop down to 20m depth.

So a high concentration at the surface (called a slick) can, over minutes to hours, become a very much lower concentration throughout the water column. This occurs simply by vertical and horizontal mixing and dilution.

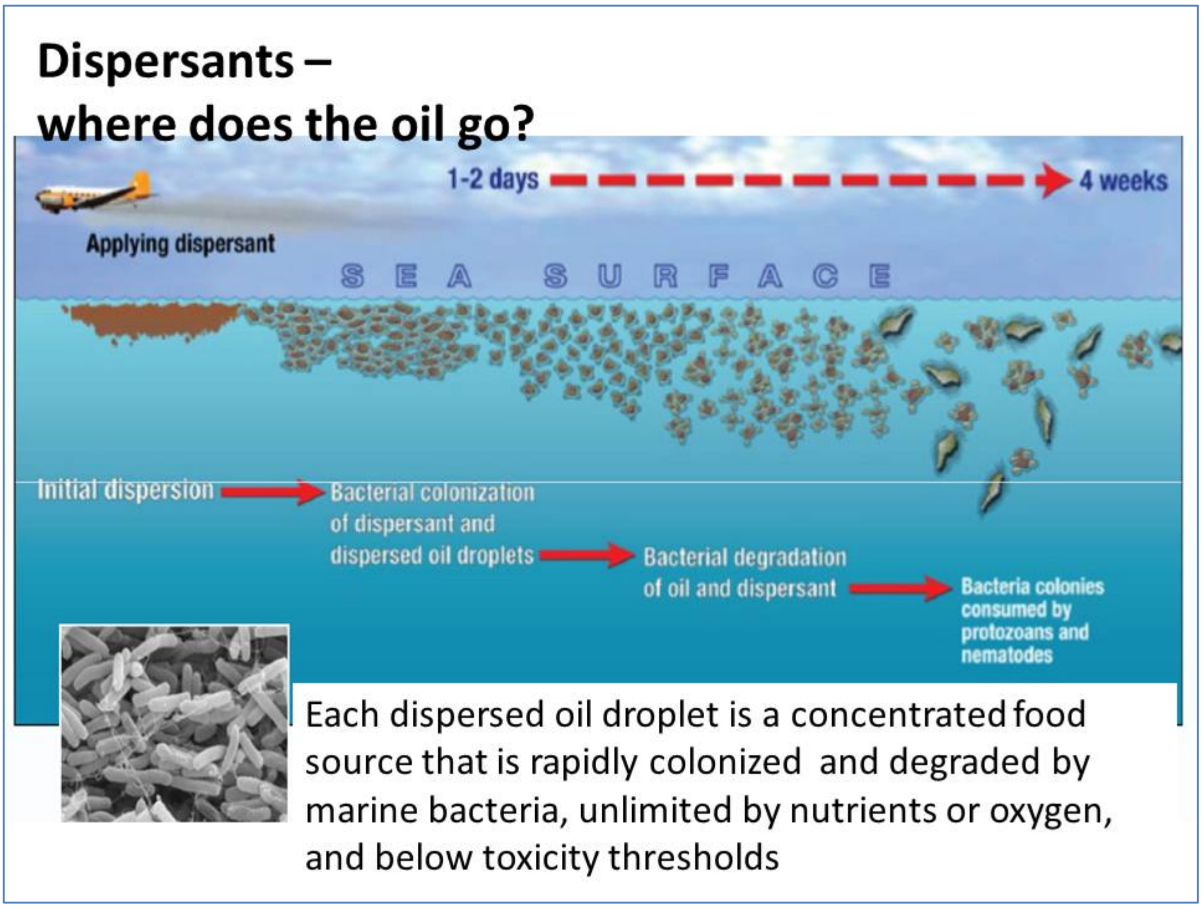
Most slicks spread out to become between 1 and 0.1mm thick. A 1mm slick is diluted 1000 times for every metre of depth. A 0.1mm slick dispersed down to 10m goes from full concentration at the surface to 10ppm average dilution throughout 10m.

At these concentration levels toxic effects are greatly reduced – remember toxicity is related to dose which is related to exposure, which is related to concentration.

Within days, it is often difficult to detect either oil or dispersants as they have been diluted to below detectable levels.

And this does not account for the fact that the small droplets of oil become desirable food for many species.

11. Rapid Dilution Promotes Microbial Feeding Frenzy



And as food, the diluted small oil droplets are quickly colonised by bacteria that eat various parts of the oil. The surfactant coating does not appear to deter bacteria colonizing the droplets.

Different species eats or digests different oil compounds, often in sequence. It is always the lightest part of the oil that is eaten first. This explains why diesel can be rapidly consumed and why tar-balls take longer.

In the ocean, the bacteria are always there. A dead fish or whale is made up of hydrocarbons (as oils and fats), and bacteria are always around to decompose these.

Also, much of the oil that leaks into the world's oceans comes from natural seeps and land-based pollution. So wherever there are hydrocarbons there will be oil-eating bacteria. The bacteria can multiply their numbers exponentially over hours.

Being the bottom of the food chain, the bacteria then become food for other life forms, like protozoans and nematode worms.

The toxic components in the oil are broken down as part of the digestion by the bacteria to carbon dioxide and water, and used as oxygen and nitrogen compounds for growth. Remember too, that oil taken up as food by bacteria does not bio-concentrate in the food chain.

12. Dispersant Handling and Application

Because we will cover risk and hazard management, and safety below, I will remind you of the supply and application chain related to dispersant application. I don't expect anything here will be new, but it is important to remember that prior to application, dispersants require acquisition, storage, delivery and logistics.

Dispersant containers are normally 200 litre drums and 1000 litre IBCs. These are heavy and require specialised handling, storage and transport, especially at the response site.

Aerial application can be through the smaller more nimble agricultural aircraft we have on four hour standby through the National Plan fixed wing aerial dispersant capability contract or may involve larger aircraft like the C130 from Singapore.

Maritime operations will likely use the new AFEDO spray systems. Dispersant is mixed into a water jet that creates a spray of droplets small enough to land on the slick and not punch through.

Each application system has its advantages.

13. Sea Versus Aerial Application

Dispersants –
which application system is best?

- Readily available in area
- Can treat relatively small area
- Long transit times
- Limited volumes of dispersant carried
- Less complex operation
- Effective monitoring platform
- Can be timely to deploy if vessel of opportunity and equipment not fitted or crews not trained

- Can get there fast and treat large areas
- Restricted to type 3 dispersants (concentrates)
- Crews already trained – standing contract
- Requires air support – delivery and safety
- Greater operational complexity
- Shorter transit times
- Various platforms available for operations
- Crew hours and refuelling

This slide is a more extensive comparison of the relative advantages of aerial and maritime dispersant operations. It is pretty self-explanatory and I won’t dwell on it too long. You can read it at your leisure. It really is a case of horses for courses.

14. The Australian National Plan – Dispersant "Approval"

Dispersants – how are they "approved"

Either a four stage process under the National Plan Oil Spill Control Agents (OSCA) or specific acceptance of an offshore petroleum Oil Pollution Emergency Plan (OPEP), because both systems:

- Want the best response tools to be available
- Need rapid deployment
- Provide for legal exemptions from marine discharge laws (EBPC and MARPOL)

1. **Acceptance** – transparent, scientifically valid recognition
2. **Logistical deployment** – strategic dispersant stockpiles and FWADC
3. **Approval to use** – using logical, well-documented expert advice to aid use decisions, including net benefit analysis
4. **Monitoring** – response phase and effects - scientifically sound and valid assessment to determine effectiveness and effects

In Australia we test any response chemicals for effectiveness, toxicity and biodegradability to ensure they do not add to the problem when used on a spill.

The National Plan refers to these response chemicals as Oil Spill Control Agents or OSCAs.

Getting to use a chemical dispersant requires a four stage process.

The first stage is getting tested and listed on the OSCA Register. We have a number of dispersants listed on the OSCA Register. Most recently Dasic Slickgone NS and EW have completed testing and are about equal in effectiveness. However, EW has been shown to be much less toxic.

AMSA also holds older stocks of Ardrox 6120 and Dasic Slickgone LTSW. These have been tested under previous processes and are OCSA listed until stock are exhausted.

Next is logistics. To be effective, dispersant should be available in suitable locations and with arrangements for transport and application. The National Plan Fixed Wind Aerial Dispersant Capability contract that AMSA shares with AMOSC provides agricultural spraying aircraft, on a 4 hour callout basis.

Nonetheless, the local Incident Controller needs to give approval for any dispersant use. The IC's decision will be based on operational, technical and scientific advice from their incident management team and should reflect local values and sensitive resources, as well as local laws and regulations. AMSA strongly recommends that a well-documented Net Benefit Analysis is used for this. We have a Guideline for this on the National Plan website.

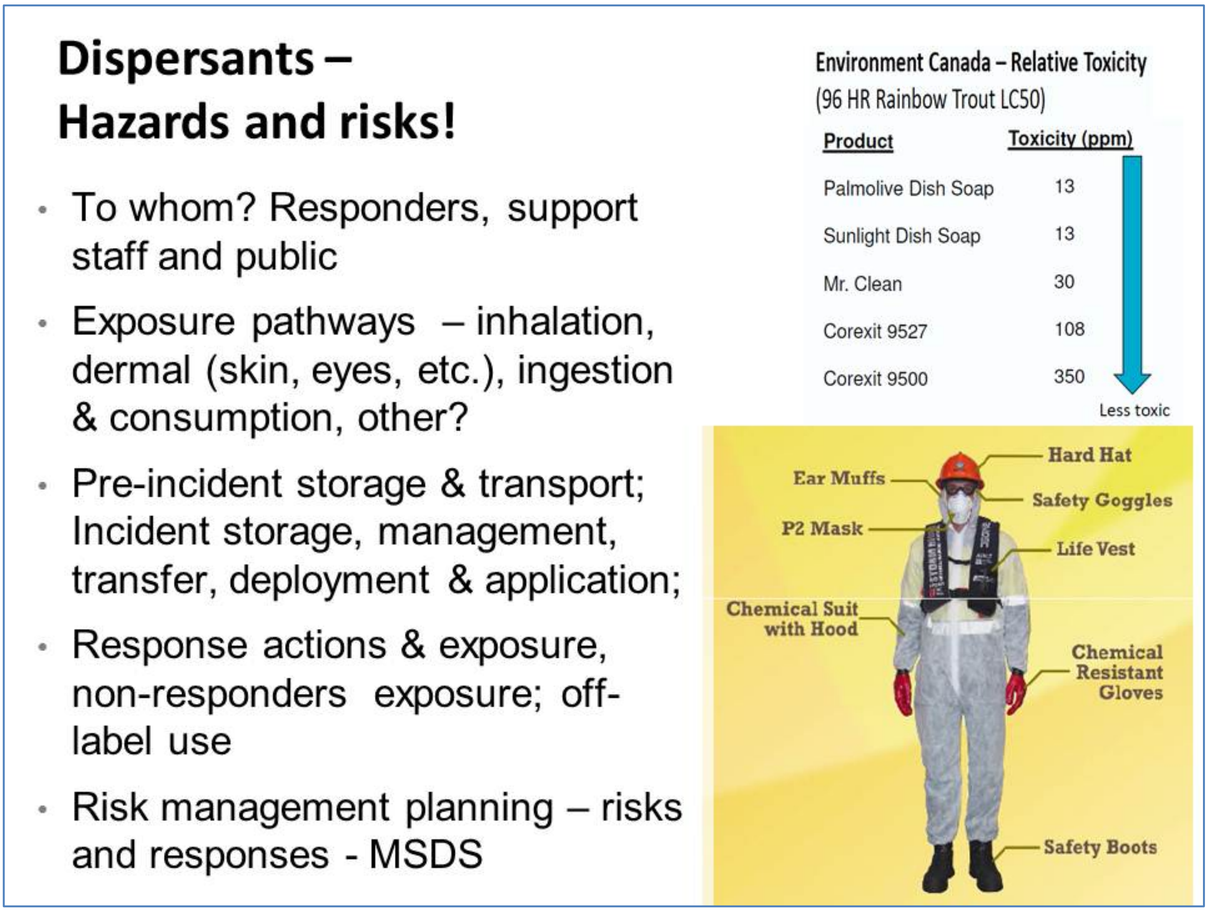
Finally, there needs to be some form of monitoring of dispersant operations. The responders need to know if the dispersant application is effective, when to cease operations, and where the dispersant and oil mixture is going. Since the oil is dispersed into the water column monitoring requires more than just noting the absence of slicks.

These four elements are also relevant for offshore petroleum sector use of dispersants. The Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 require that every petroleum activity in Commonwealth waters has an Environment Plan (EP) accepted by NOPSEMA. The EP must evaluate all the impacts and risks of the activity including oil spills and response strategies and detail control measures that will be used to reduce the risks to as low as reasonably practicable (ALARP) and an acceptable level.

Titleholders are required to evaluate the use of dispersants up-front for every petroleum activity as part of the ALARP demonstration for responding to oil spills. An EP must include an Oil Pollution Emergency Plan (OPEP) which details the proposed response arrangements, including those for using dispersants.

The EP and OPEP are the mechanism for acceptance of a proposed dispersant response strategy by the offshore petroleum industry. Selection of dispersants listed on the OSCA Register and a NEBA decision-making process are typically presented as management controls to demonstrate dispersant use will be ALARP and acceptable.

15. Dispersant Hazards and Risks



So when considering dispersants and the hazards and risks they create, where do you start?

Think first about who faces the risks and hazards. There are three general categories of people involved.

The closest to the action are the dispersant operations staff, such as loaders, pilots, AFEDO operators, and the like.

Then there are the general response staff, especially the maritime operations people who may be near dispersant operations.

And there is always the general public, and their involvement depends on local conditions, such as wind or proximity.

Next consider exposure pathways.

Dispersant contain solvents and operations create aerosols – all of which can be inhaled. Surfactants in the nose or lungs can be very irritating. This may be more of a problem for boat ops than aerial.

Splashes or drips or spray can come into skin contact, especially for loaders and applicators.

Ingestion shouldn't be problem, unless personal hygiene is an issue. Certainly don't bathe in or drink dispersant.

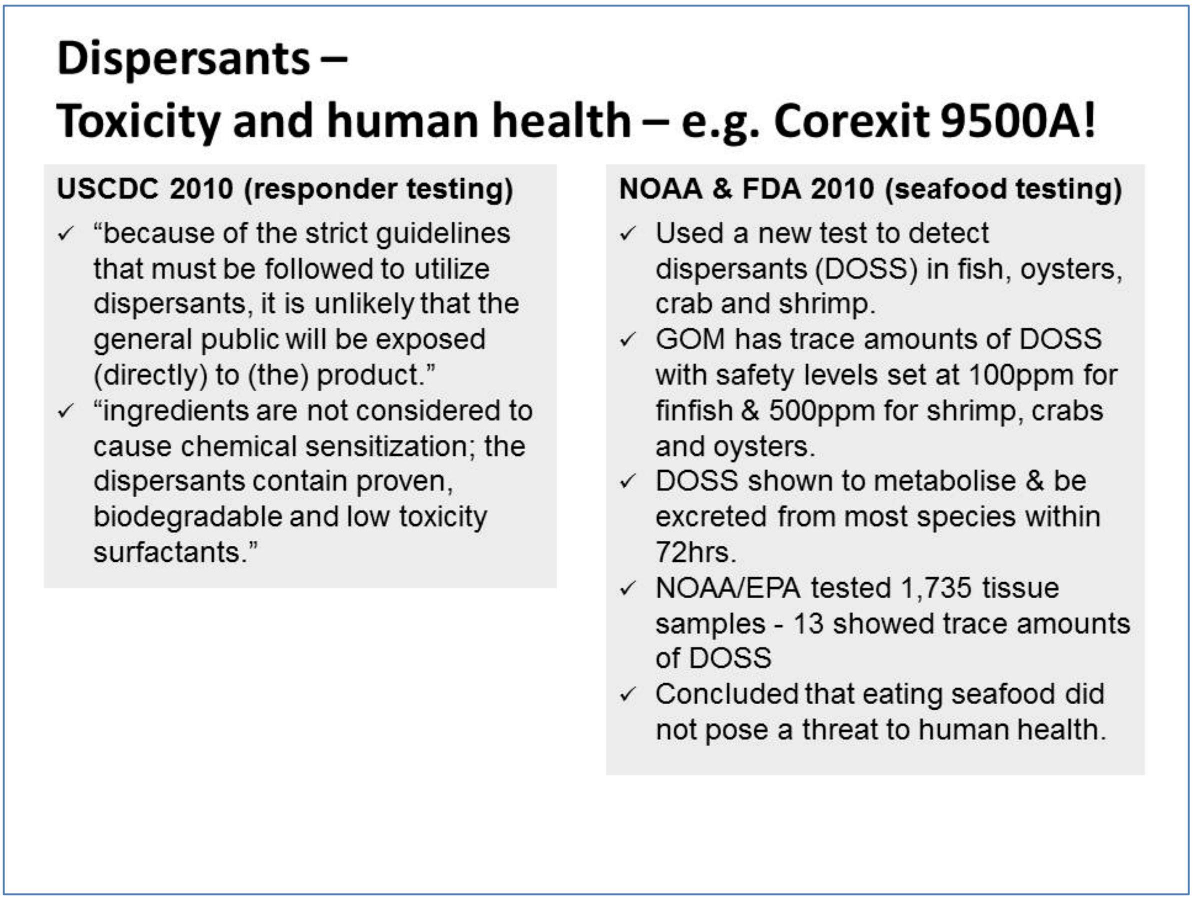
As I pointed out earlier, also consider the entire logistics chain. Are there hazards in normal storage or transport? What about particular hazards associated with temporary storage at the response operations site? And then what do you do with the empty or used dispersant containers?

Off-label use is another potential trap. During the Iron Baron response, in Tasmania many years ago, dispersant was used as a surface cleaner for rocky areas and penguin runs. However, I believe this kind of off-label experimenting is not good practise during a response.

It may means dispersant use falls through the tracking and monitoring processes. It could lead to workers not getting proper safety information. And it can lead to unwanted and unexplained chemical contamination in strange areas.

Finally, having considered all the risks and hazards, manage these in the normal manner. Know the product, its proper uses and have proper and up-to-date MSDS available. Use PPE as appropriate. Finally, plan to ensure medical support and first aid are available.

16. Dispersants - US Government Health Information



Over the next five slides I want to share with you some of the science around dispersant health and safety. I am doing this because I want you to see what I base my conclusions on, so it's not a trust-me approach.

You can follow this up for yourselves and share it with colleagues and family.

During and after the Gulf of Mexico spill, there was lot of good and bad science, and good and bad media.

This slide provides a summary of the conclusions of the three top US agencies responsible for human health monitoring and safety.

On the left, the Centre for Disease Control undertook responder testing during the response and concluded: "because of the strict guidelines that must be followed to utilize dispersants, it is unlikely that the general public will be exposed (directly) to (the) product" and "ingredients are not considered to cause chemical sensitization; the dispersants contain proven, biodegradable and low toxicity surfactants."

On the right, the National Oceanographic and Atmospheric Agency, and the Food and Drug Administration, undertook rigorous and extensive food testing across the Gulf.

They developed and used a new and sensitive test to detect dispersants (using the component DOSS as a proxy) in fish, oysters, crab and shrimp. Remember I mentioned DOSS earlier. And also remember that DOSS is already available in the Gulf from other sources – it's the laxative.

The local Gulf safety levels for DOSS are already set at 100ppm for finfish & 500ppm for shrimp, crabs and oysters. DOSS has been shown to breakdown and be excreted from most species within 72hrs.

NOAA/FDA tested 1,735 tissue samples – 13 showed trace amounts of DOSS, much lower than safety levels – and so concluded that eating seafood did not pose a threat to human health.

17. The Good Science!

Dispersants – Good science

Fabisiak & Goldstein 2012:

"Exposure of the general populace … to the major ingredients … should be considerably below the range expected to produce adverse effects based on a review of their toxicological profiles."

"Those individuals involved in clean-up operations that directly handled oil dispersants or worked in the immediate area of application probably encountered greater amounts of dispersants and might a greater risk of adverse effects, but, in general these should be mild and self-limiting."

"Importantly, for several of the major toxicities described in experimental animals, humans appear to comparatively resistant."

Next, let's look at some good science. The University of New Hampshire held a 2012 forum on dispersant use and health effects. The researchers who presented this literature review paper are respected scientists and physicians. They reached the following general conclusions:

The public should not be exposed to levels likely to cause effects

Responders were at a greater risk but the effects should be mild and self-limiting – i.e. easily managed.

Animals are much more susceptible to several of the major toxicities than people, who appear comparatively resistant.

An example of this latter issue, think dogs and chocolate – loved by people and lethal to dogs! Should we ban chocolate?

18. Some Misleading Science

Dispersants – misleading science

D'Andrea et al, 2013

"Corexit banned in UK due to health risks to workers." Reference does not refer and main author blames journal editors.

Blogs, media and congressional letters have become references!

All refers back to retracted 2010 NYT article that wont die, even after UK MMO corrected.

UK MMO states Corexit not presented for Rocky Shoreline test so requires specific approval for use in UK offshore

Rico-Martinez et al 2013

Corexit increases toxicity by up to 52 times.

Extreme modifications to standard and normal laboratory toxicity testing procedures.

Widely rubbished by recognised dispersant experts in subsequently published papers.

Long list of major criticisms include:

- Ignoring dilution to below toxicity thresholds.
- Dispersant to oil ratios of 1:10 (1:120 in GOM)
- Ignoring results which did not support them
- Least tolerant species & life stages tested.
- The most sensitive strain came from Russia.
- Local tolerant local species ignored.
- Cherry-picked procedures.
- The '52 times' comparison was between cysts and hatchlings.

There are plenty of examples where misleading science has either got into the literature or the media and created unnecessary angst.

The D' Andrea paper was published in the American Journal of Emergency Medicine, and has a number of untrue statements and poor science. But the most obvious is the statement that the UK banned the use of Corexit 9500 due to health risks to workers. This is totally incorrect on three levels.

1. Corexit 9500 not banned in UK – it is only available for use on the offshore – more than 3 nm offshore.
2. When UK changed testing to approve dispersants it amalgamated the shoreline test with the offshore test and Corexit was not presented for the shoreline test as it was never intended to be used close to shore.
3. According to the UK Marine Management Office, there has never been any concerns raised in the UK about worker safety and Corexit.

The Rico-Martinez paper caused even more concern. It stated that use of Corexit increases oil toxicity by 52 times. It has a long list of flaws and has since been roundly rubbished in the literature for very poor science. They fudged the species, the test, the concentrations, and the comparisons. It is simply rubbish science.

Unfortunately, the Rico-Martinez media hype was picked up by 60Minutes and stars in their similarly flawed analysis.

19. The "Crude Solution" exposé

Dispersants – a media exposé
"60 Minutes - *A Crude Solution*"

Producer: Jo Townsend
15 August 2013

"Last Sunday, 60 Minutes revealed that two chemicals, which become highly toxic when mixed with oil, have been used in Australian waters to clean up two recent oil spills.

The chemicals are COREXIT 9500 and COREXIT 9527.

Both chemicals were used in the Gulf of Mexico after BP's Deep Water Horizon oil spill in 2010 - the world's worst ever offshore oil disaster.

But people started getting sick and then people started dying.

In the three years since the US disaster, tens of thousands of Americans have fallen ill and some have died.

Now, this environmental disaster has become a health catastrophe.

The dispersant, when mixed with the oil, increases in toxicity by 52 times. This sickly, invisible toxin, still lurks in the water and absorbs straight into peoples' skin.

In this special 60 Minutes investigation, we reveal the same chemical dispersants have been sprayed on the Great Barrier Reef and off the north west coast of Australia.

They're still approved for use and our authorities are clueless as to how deadly they are."

All quoted directly from the 60Minutes website 31 January 2014

In August 2013, 60 Minutes Australia televised a so-called exposé of the use of toxic dispersants in the Gulf of Mexico, called "A Crude Solution."

20. Media Alarm

Dispersants – Media alarm

The program created concern and alarm amongst the public & responders, as the program leaves the viewer with a clear implication of cause and effect with dispersants and not oil.

They continue to refer to the Rico-Martinez "52-times more toxic" report, when already refuted in the literature, even at the time the program aired in Australia.

To support their allusion to illness and deaths, they include short snippets from a 14minute YouTube video interview with Lisa Nelson who lived and worked at Orange Beach, Louisiana*. This is 211kms NNE of the well & 85kms SSW of closest dispersant use.*

Lisa says her symptoms started on 22 Sept 2010. Prior to this she says she was working at the beach symptom-free. *All dispersant operations ceased 7 weeks earlier, on 15 July 2010.*

Lisa says she was medically diagnosed with mycoplasma pneumonia and is prescribed and takes "strong antibiotics" and "enough Prednisone to kill a horse…".

Prednisone is a strong corticosteroid immune-system suppressant used to treat allergic reactions, like mycoplasma pneumonia, and its side-effects include overall weight gain, facial swelling, blood thinning and bruising, as exhibited by Lisa in the video.

Lisa says she refuses further medical treatment, and uses home remedies, including drinking water and taking hot baths. *Unfortunately, Lisa is reported to die soon after.*

The program created concern amongst the public & responders by incorrectly implying that there is a clear cause and effect relationship between dispersant use and a myriad of public health problems.

It also makes a big deal of the Rico-Martinez "52-times more toxicity" report, even though the paper had already been refuted in the literature.

60 Minutes also made suggested connections between the use of dispersants in the response and the illness and death of a woman called Lisa Nelson, from Orange Beach, Louisiana.

These were based on a 14 minute You Tube video which was heavily edited in the 60 Minutes programme. In short, the video diary by the woman provides its own evidence that while she was clearly ill, many aspects of it, when addressed in full, strongly suggest that the use of dispersants was an unlikely cause. These were the bits not shown by the 60 Minutes programme.

Many aspects of the spill, the response and the effects presented by 60 Minutes as science and evidence do not stand up to scrutiny.

21. Review of Advantages and Disadvantages

Dispersants –

Advantages

- Safety benefit
- Rapid response over large areas
- Application in relatively rough weather
- May break / inhibit formation of emulsions
- Reduces the risk of inshore water/shoreline impacts

Disadvantages

- Redistribution of pollution
- Effects on pelagic organisms in the upper water column
- Increases in bioavailability of the oil
- Time window for effective use
- Monitoring arrangements / protocols
- Required resources – boats, planes, support staff

So, just to recap, the advantages of dispersant use are:

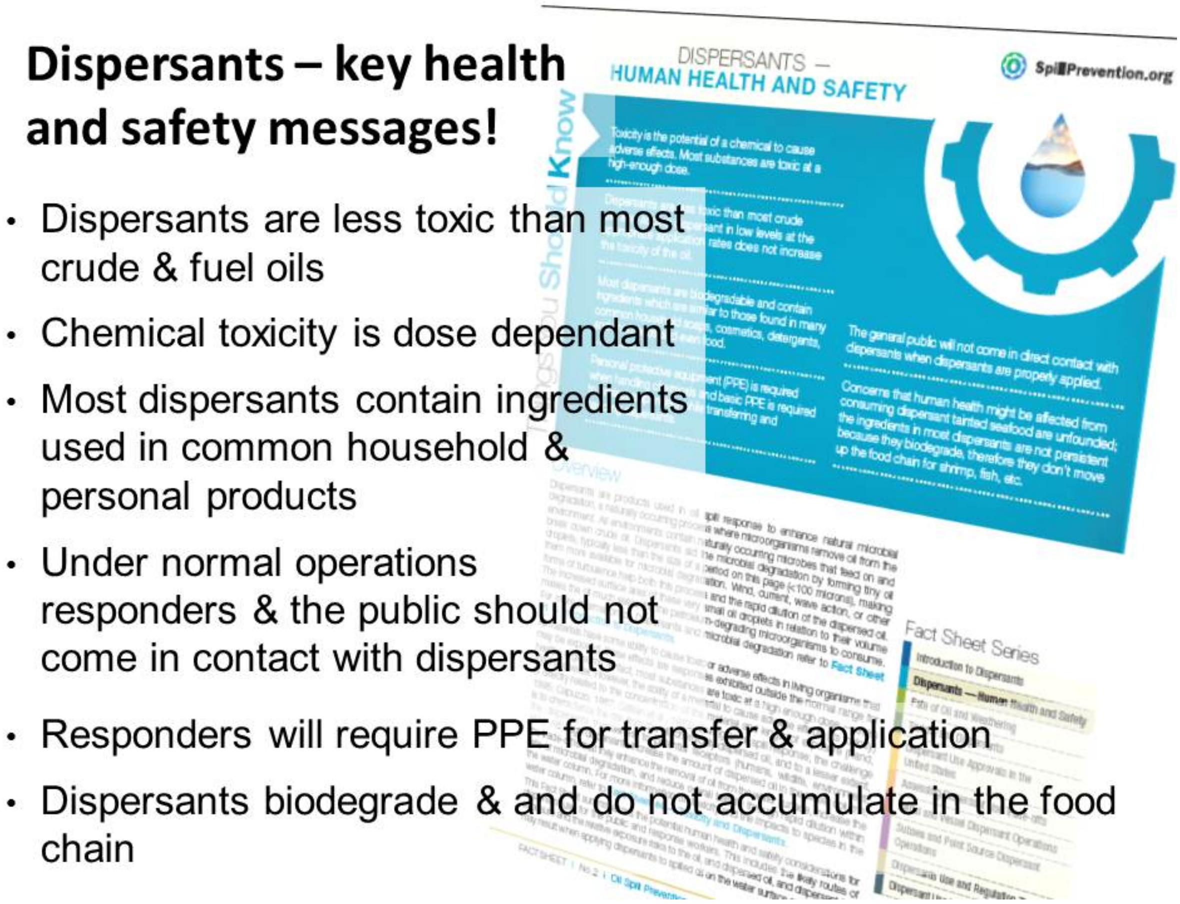
- Safety – it can lower the amounts of volatile components evaporating above a slick, as these are dispersed and dissolved into the water.
- It can be rapidly applied.
- Rough water and wind creates energy which enhances dispersion and chemical dispersion.
- It can deal with or prevent the nasty, sticky and persistent water-in-oil emulsions (mousses) that can be difficult for surface response to deal with.
- Dispersion dilutes the surface slick into the three dimensional water column, where it is less likely to make a shoreline and surface wildlife impact.

And the disadvantages:

- It does not remove the oil from the environment – it redistributes it to different and potentially more vulnerable areas and places.
- The oil is made more bio-available until full dilution occurs. This can be problematic for the more toxic water soluble and aromatic compounds that might otherwise evaporate.
- Oil weathering sets time windows for dispersant use, and logistical difficulties exacerbate this. The best time to use it often rapidly closes.

- Dispersant use requires monitoring to determine whether it has worked, and this needs to be deployed at the same time, if it is to be effective.
- AMSA is working on this problem with CSIRO, who are developing a rapid response monitoring capability.
- It is often more logistically complex to use than other response methods.

22. Key Health and Safety Messages



This is the key set of safety and health messages from this presentation. If there is nothing else you take from this, remember these six points.

The document shown is the 2013 API Human Health and Safety Information Sheet which is part of a set of material to take away from this course. AMSA has not produced its own as this is the best available and we contributed in a minor way to its development.

1. Oil is almost always much more toxic than dispersant. Oil (even processed oils) always contains a cocktail of hydrocarbons, and often contains aromatic and poly-aromatic chains that can be very toxic. Avoid the oil. Whereas dispersants (like Corexit 9500) are composed of components often found in households and USFDA approved for use, skin contact or ingestion. But that doesn't mean that prolonged or inappropriate exposure to a dispersant will be good for you. You can safely wash dishes with something that you might not want to drink!
2. Chemical toxicity is dose-dependent – the more I drink the drunker I get. So diluting oil slicks and dispersants in the volume of the sea means that they quickly dilute to be low

toxic levels, even if the dispersant starts out by making the inherent toxicity of the oil more available.

3. Responders and the public should not become exposed to dispersants if they are being used as designed and correctly by responders.
4. PPE is essential because even low toxicity substances can cause rashes and tummy upsets from prolonged operational exposure. Don't eat or drink the stuff!
5. Dispersants are hydrocarbons themselves and so break down in the environment just like oil. Sometimes through sunlight, mostly due to being eaten by bacteria along with the oil, but sometimes by itself if it misses the oil. Just like you eating olive oil, the dispersant breaks down to water and carbon dioxide. Dispersants do not accumulate like metals.

23. When all else fails - ask an Expert

And finally, when all else fails, ask your technical and environmental experts!

24. Acknowledgements

With special thanks for resources and material from Dr Ken Lee (CSIRO), Al Allen (Spiltec) and Tom Coolbaugh (ExxonMobil).

25. References and Resources

American Petroleum Institute Dispersant Fact Sheets:

1. Introduction to Dispersants
2. Dispersants — Human Health and Safety
3. Fate of Oil and Weathering
4. Toxicity and Dispersants

http://www.oilspillprevention.org/oil-spill-cleanup/oil-spill-cleanup-toolkit/dispersants

60 Minutes (2013) Crude Solution http://sixtyminutes.ninemsn.com.au/article.aspx?id=8711153 (accessed 11/09/2013)

Coelho, G., et al. (2013), Toxicity testing of dispersed oil requires adherence to standardized protocols to assess potential real world effects, Environmental Pollution, http://dx.doi.org/10.1016/j.envpol.2013.02.004

Dickey, Robert W. Ph.D. and Walton W. Dickhoff (2012), Ph.D. Dispersants and Seafood Safety, Assessment of the potential impact of COREXIT® oil dispersants on seafood safety, White paper prepared for workshop entitled, "Dispersant Use Initiative: Dispersant Use During Deepwater Horizon and Moving Forward." Sponsored by Coastal Response Research Center, University of New Hampshire & NOAA, Office of Response and Restoration. http://www.crrc.unh.edu/workshops/dispersant_future_11/Dispersant_Initiative_FINALREPORT.pdf

Fabisiak, J.P. and Goldstein, B. (2012) Oil Dispersants and Human Health Risks. White paper prepared for workshop entitled, "Dispersant Use Initiative: Dispersant Use During Deepwater Horizon and Moving Forward." Sponsored by Coastal Response Research Center, University of New Hampshire & NOAA, Office of Response and Restoration. http://www.crrc.unh.edu/workshops/dispersant_future_11/Dispersant_Initiative_FINALREPORT.pdf

Lee, K., et al. (2013) Lab tests on the biodegradation of chemically dispersed oil should consider the rapid dilution that occurs at sea. Mar. Pollut. Bull. http://dx.doi.org/10.1016/j.marpolbul.2013.06.005

Nelson, Lisa (2013) YouTube interview video. https://www.youtube.com/watch?v=JybIBe02-6Y (accessed 13/09/2013)

Nalco (2013) COREXIT® Ingredients, at:http://www.nalcoesllc.com/nes/1602.htm (accessed 13/09/2013)

National Research Council (2005). Understanding Oil Spill Dispersants: Efficacy and Effects. National Academy Press, Washington, D.C.

NOAA (2010) NOAA and FDA Announce Chemical Test for Dispersant in Gulf Seafood; All Samples Test Within Safety Threshold, accessed on 13 September 2013, at: http://www.noaanews.noaa.gov/stories2010/20101029_seafood.html

Rico-Martínez, R., Snell, T.W., Shearer, T.L. (2013). Synergistic toxicity of Macondo crude oil and dispersant Corexit 9500A to the Brachionus plicatilis species complex (Rotifera). Environmental Pollution 173, 5e10, http://dx.doi.org/10.1016/j.envpol.2012.09.024.