Approval Process to Support Subsurface Dispersant Use – Background and Recommendations

Mark F Kirby

Cefas, Lowestoft Laboratory, Pakefield Road, Lowestoft, Suffolk, UK, NR33 0HT

Abstract

The Macondo well blow out resulted in unprecedented use of dispersant. In addition to conventional surface use this also included substantial subsea dispersant application directly to the oil plume at the well head in depths of ~1500m. The effectiveness of this strategy continues to be assessed but plausible claims are made of benefits for the health and safety of response staff and the environment. It is generally accepted in the UK across industry, scientists, regulators and responders that this technique could be beneficially used during certain subsea incidents in UK waters. The use of dispersants in UK waters, including subsea application, is regulated by the Marine Management Organisation (England and Wales), Marine Scotland and the Northern Irish Department of the Environment and their decision making process for granting an approval for dispersant use is based in the provision of sound underpinning scientific advice. However, in comparison to other modes of use (e.g. sea surface), the scientific knowledge regarding the effectiveness and environmental impacts/benefits of subsea dispersant use is less well understood. Against this background the regulators have engaged with the industry to identify and address where the primary knowledge gaps exist so that the decision making process can be improved. This presentation provides an overview of a scoping study commissioned under the auspices of OSPRAG (Oil Spill Prevention and Response Advisory Group) to assess the current understanding of relevant scientific issues and

the key recommendations made to fill the scientific gaps necessary to enable regulators to make decisions on subsea dispersant use with appropriate levels of scientific rigour.

Note: The main report on which this document is based was produced by a collaboration of a wide range of scientific experts and regulators (see acknowledgements) on behalf of OSPRAG (now OSRF) and that the key recommendations are those of the authors and are currently under consideration by OSRF.

Introduction

'At approximately 9:50 p.m. on the evening of April 20, 2010, while the crew of the Deepwater Horizon rig was finishing work after drilling the Macondo exploratory well, an undetected influx of hydrocarbons (commonly referred to as a "kick") escalated to a blowout. Shortly after the blowout, hydrocarbons that had flowed onto the rig floor through a mud-gas vent line ignited in two separate explosions. Flowing hydrocarbons fueled a fire on the rig that continued to burn until the rig sank on April 22. Eleven men died on the Deepwater Horizon that evening. Over the next 87 days, almost five million barrels of oil were discharged from the Macondo well into the Gulf of Mexico'. (The Bureau of Ocean Energy Management, Regulation and Enforcement - Report Regarding the Causes of the April 20, 2010 Macondo Well Blowout - September 14, 2011).

These were the stark facts surrounding one of the most media-covered oil pollution incidents in recent times. The Deepwater Horizon (DWH) incident resulted in some of the biggest logistical challenges that the spill response community had ever faced. In parallel to the engineering activity to stem the flow and the massive spill response operation, this incident also posed an immense challenge to the scientific community that were called upon to provide the necessary advice and evidence that informed remediation activity and kept government officials and the general public appropriately informed with assessments based in sound science. The lessons being learnt from the incident are ongoing and are being reviewed by scientists, the industry, responders and regulators worldwide to identify and implement any necessary changes to national and international procedures should similar incidents occur in the future.

Some of the key activities and decisions associated with any marine oil spill pertain to the use of oil spill treatment products as part of the spill remediation response. Primary amongst treatment options, especially when dealing with large scale offshore incidents, can be the use of chemical oil spill dispersants. Dispersants are a formulated mix of surfactants and solvents that reduce surface tension between oil and water and therefore allow the oil to be broken up into small droplets that facilitates is dilution, dispersion and degradation. Conventional dispersant use normally involves the application to a surface slick but a blowout scenario affords the opportunity for the subsea injection of dispersant directly into the oil flow. The DWH incident saw the largest ever use of subsea/plume injected dispersants to help combat the spill, and their use in this manner was the subject of much debate and controversy.

'The use of dispersants in the aftermath of the Macondo deepwater well explosion was controversial for three reasons. First, the total amount of dispersants used was unprecedented: 1.84 million gallons. Second, 771,000 of those gallons were applied at the wellhead, located 5,067 feet below the surface. Little or no prior testing had been done on the effectiveness and potential adverse environmental

consequences of subsea dispersant use, let alone at those volumes. Third, the existing federal regulatory system pre-authorized dispersant use in the Gulf of Mexico without any limits or guidelines as to amounts or duration. Faced with an emergency, the government had to make decisions about high-volume and subsea dispersant use within time frames that denied officials the opportunity to gather necessary information'. (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling - The Use of Surface and Subsea Dispersants During the BP Deepwater Horizon Oil Spil - Staff Working Paper No. 4 - Originally Released October 6, 2010 and updated January 11, 2011).

The ultimate effectiveness of the use of subsea dispersants continues to be assessed and debated in the light of the evidence emerging from the DWH studies. However, plausible claims are being made that its use had benefits both for the health and safety of response staff, by reducing concentrations of volatile organic compounds (VOCs) in the vicinity of wellhead operations, and the environment, by reducing surface and/or beached oil and potentially promoting oil degradation. While the practice has generated much debate about its benefits it has been generally accepted in the UK by the industry, scientists, regulators and responders alike that it is a technique that could have potential beneficial uses for certain subsea incidents which might occur on the UK continental shelf (UKCS).

Exploration and production drilling activity on the UKCS is moving into ever deeper waters. In general, the oil fields of the northern North Sea are in water depths between 100 and 200 metres and, while this is a long way short of the 1500 m depth of the Macondo well, these areas could still be considered as candidates for the use of subsea dispersant in the event of a blowout. However, it is probably in the areas in the West of Shetland (WoS) basin that most would consider as ‘deepwater’ drilling from a UKCS perspective. In the WoS area there is already current production at fields such as Foinaven and Schiehallion in depths of 400-600 m and, north of that, discoveries are being exploiting in the Tormore and Laggan fields in depths of > 600 m. These current operations along with the potential for exploration to occur in depths >1500 m on the UKCS mean that deepsea blowout scenarios remain a possibility for the UK and, therefore, appropriate deepsea spill mitigation techniques need to be considered as part of the national response strategy.

While it is evident that deepsea blowout incidents are a possibility on the UKCS it has to be acknowledged that the nature of the oil reservoirs and the operational environments representative of the west of Shetland and northern North Sea areas are substantially different from those in the Gulf of Mexico. Therefore, while much can and should be learned from the DWH incident, careful consideration needs to be given to the characteristics of the specific deepsea operational areas on the UKCS, in particular the characteristics of the oils and the reservoir pressures. This will enable the risk of a large and continuous release to be assessed and to determine whether such a release would be treatable using dispersants.

The use of dispersants in UK waters is regulated by the Marine Management Organisation (England and Wales), Marine Scotland (Scotland) and the Northern Ireland Department of the Environment (Northern Ireland). The regulatory authorities, with support from their conservation and scientific advisors, provide effective and prompt decisions when requested to permit the use of oil spill treatment products. The process is well developed in the UK and aims to provide the necessary decision within one hour, a short timescale being necessary to facilitate the response activity. Nevertheless this process is mostly activated in response to a request to use dispersants on the surface of the sea or, occasionally, on a shoreline, and concerns have been raised by the regulators that there would be less confidence associated with the decision making process for the permitting of subsea dispersant use. They have therefore requested that a scoping study is undertaken, taking account of their main issues of concern. Once completed, along with any follow on research as necessary, the regulators will have much greater confidence in their approval processes as pertains to subsea dispersant use.

In the UK the decision making process for granting an approval for dispersant (or other option) use in the marine environment is based in the provision of sound underpinning scientific advice. There can be no doubt that, in comparison to other modes of use (e.g. sea surface), the scientific knowledge regarding the effectiveness and likely environmental impacts/benefits of subsea dispersant use is less than optimal.

Much of this industry/regulator engagement has been facilitated by the establishment in the United Kingdom of the Oil Spill Prevention and Response Advisory Group (OSPRAG). In this respect a specific sub-group was formed, under the auspices of OSPRAG, called the ‘Oil Spill Emergency Response Review Group’ which had as one of its objectives to address issues surrounding the issue of subsea dispersant injection.

This list is not exhaustive or necessarily representative of areas where it is known that there are large and/or significant gaps in knowledge pertinent to the use of subsea dispersants, but the topics are considered as those that are important to consider in the process.

Overview of Issues Considered

Dispersant application issues

Issues around understanding the efficiency of dispersants in subsea environments, both in terms of laboratory assessment and in-situ measurements were considered. Establishing whether a treatment option is likely to work in the first place is a cornerstone of the current UK permissions process for conventional use of dispersants. Therefore research to help establish the effectiveness with UK oils and under UK subsea conditions was considered highly relevant to informing the decision process. Furthermore, it was considered that any research undertaken to establish whether current formulations (primarily designed for aerial application onto surface slicks) were appropriate for subsea use, or whether the development of product formulations specifically for subsea use offered important advantages, would also be highly beneficial. The appropriateness of the toxicity and efficacy testing regime to enable oil spill treatment products to be approved for use in UK waters was also considered in the context of subsea use.

Plume characteristics

Issues around plume formation as it might occur under UK subsea conditions were considered. Including issues such as vertical velocity profiles for released oil, the influence of entrained gas bubbles and the influence of dispersant use on these parameters. It was concluded that an immediate lack of plume formation knowledge would not hinder the decision making process for the regulator and therefore could be considered of lower priority.

Hydrodynamic factors influencing transport

This section considered the status of understanding with respect to the hydrodynamic factors that influence water (and therefore oil/dispersed oil) transport in the region of concern. Again, while acknowledging the wider usefulness of generating better hydrodynamic data for the general region, these issues were considered of relatively low priority from a regulatory decision making perspective.

Modelling

The modelling section considered issues around whether the currently available hydrodynamic spill and fate models gave sufficient predictive power for assessment of the likely behaviour and fate of oil and dispersed oil following subsea releases in the regions in question. In conclusion, it was recognised that good fate/spill models for subsea releases are an important tool that regulators would want to see applied to provide information to inform their decisions. Therefore, research and reviews that assess the currently available models and the sensitivity of their predictions to hydrodynamic data relevant to the region is considered a high priority. It is also considered important that relevant laboratory and/or field research to help understand the impact of dispersant use on model outcomes would be beneficial. If any work/review concluded that there was a need for better plume modelling or hydrodynamic data to improve the modelling those issues (regarded initially as low priority above) may become a higher priority.

Environmental persistence of dispersed oil

The current understanding of the likely persistence of oil and dispersed oil in the regions under consideration was considered. It primarily focussed on the likely presence of oleophilic (‘oil eating’) microbial communities and their potential to degrade the oil and mitigate any long term effects or accumulation. It was acknowledged that there are substantial gaps in our current understanding with respect to this subject. However, in general, it was not considered a high priority for the regulators as it was difficult to establish how further information on this front would directly influence their decision process. What was regarded as of higher importance and priority was to understand the direct effect of the addition of dispersant on the viability of any oil degraders that might facilitate the ultimate degradation of the oil.

Wider ecological issues

This section of the report addressed the current understanding and issues relevant to subsea dispersant use for a wide spectrum of marine organisms and communities. The types considered ranged from higher animals, such as birds and mammals, to the planktonic and benthic communities in the region. It also considered the potential impact on fisheries and, via this route, whether there was a route to the human foodchain and how this may be influenced by dispersant use.

Environmental monitoring

If a decision is made to permit, or prohibit, the use of dispersants on a subsea oil spill it is considered essential that the techniques and means are in place to assess the ultimate effectiveness of that decision. In order to do this a process for effective environmental monitoring is necessary and a review to ensure that the equipment and capabilities exist to undertake a large scale environmental monitoring programme.

Key Recommendations

Following expert contributions to the report and, in particular, the gap analysis and priority discussions held in conjunction with the regulatory authorities a number of general recommended areas for future research and review activity were made.

These are the areas of research and review considered as high priority to enable the regulatory authorities to confidently make decisions about the permission to use dispersants on subsea oil releases.

It is recommended that the following review/research areas are considered as high priority:

KR1. To review and, if necessary, develop methods for the assessment of dispersant efficiency when used in subsea incidents in UK waters. Options to be considered could include predictive techniques, in-situ measurements and laboratory testing or field-based verification.

KR2. To research whether current dispersant formulations are the most effective for subsea use with respect to toxicity and efficiency. To investigate the case for dispersants formulated specifically for subsea use and how these might differ with respect to composition, performance and toxicity compared to conventional products.

KR3. To establish whether current UK dispersant testing practices are appropriate for the approval of products for subsea use. This may require the development of testing procedures to mimic subsea use and comparison with conventional test results.

KR4. A full review of currently available spill models and their ability to provide effective transport predictions of oil and dispersed oil from subsea wellhead releases on the UK continental shelf.

KR5. A trial of selected predictive models using a range of scenarios and operational data in order to establish the need for improved or higher resolution hydrodynamic data to ensure that models are available to effectively predict oil and/or dispersed oil fate for future incidents.

KR6. Research to establish the toxicity and inhibitory effects of dispersants and dispersed oil on oleophilic microbial communities and whether these significantly impact their ability to degrade hydrocarbon residues following spills.

KR7. Research to establish the type, extent and diversity of benthic habitats in the vicinity of deepwater drilling areas on the UKCS.

KR8. Research to investigate the interaction of dispersant/dispersed oil with benthic sediments and organisms. This work will also need to investigate the toxicity of dispersant/dispersed oil to key benthic organisms and assess the potential for impact and subsequent recovery.

KR9. Research to investigate the threat of dispersant and dispersed oil to fish species of commercial and ecological value. To include an understanding of the differing sensitivities of eggs and different life stages and what this could mean at the population level.

KR10. Research to investigate the potential for hydrocarbon bioaccumulation and depuration in commercial fish species both directly and from uptake from contaminated feed and how this is affected by dispersant usage. Also to investigate avoidance behaviour and to use this information to investigate the potential for hydrocarbon contamination to enter the human foodchain as a result of a subsea oil spill and consequent dispersant use.

KR11. Research into the socio-economic impact (for example on the fishing industry) of subsea oil spill scenarios on the UKCS and how this might be affected by dispersant use.

KR12. A review of skills/techniques, capabilities and equipment availability relevant to the environmental monitoring of a subsea spill following treatment with dispersants.

KR13. The production of environmental monitoring guidelines (aligned to the overarching Premiam principles) specifically for use following subsea oil releases and any subsequent treatment (e.g. the subsea application of dispersants).

Acknowledgements:

The reports on which the content of this document is based was commissioned by OSPRAG (Oil Spill Prevention and Response Advisory Group) and now overseen by the OSRF (Oil Spill Response Forum). This work was a collaboration between a range of expert contributors as listed below. The key recommendations listed in this paper were generated by Cefas, with reference to expert recommendations, in consultation with the regulators for dispersant use in UK waters (the Marine

Management Organisation and Marine Scotland) and are currently being considered by a OSRF sub-group on dispersant use.

Contributing authors to the OSPRAG report were:

Mark Kirby[1], John Aldridge[1] ,Chris Barrio Frojan[1], Aonghais Cook[2], Liam Fernand[1], Nicholas Greenwood[3], Kate Grellier[4], Robin Law[1], Alun Lewis[5,] Jim McKie[6], Steve Milligan[1], Jon Moore[7], Jon Rees[1], David Righton[1], Ainsley[1] Riley[1], Melanie Sapp[1] and Jan Balaam[1]

[1]Cefas (Centre for Environment, Fisheries and Aquaculture Science).
[2]BTO (British Trust for Ornithology).
[3]MMO (Marine Management Orgnisation) .
[4]SMRU Ltd (Sea Mammal Research Unit).
[5]Alun Lewis Consultancy.
[6]Marine Scotland Marine Laboratory.
[7]CALM (Coastal Assessment, Liaison & Monitoring).