UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

October 10, 2003

OFFICE OF WATER

Memorandum

Subject: Clarification of Technology-based Sediment Toxicity and Biodegradation Limitations and Standards for Controlling Synthetic-based Drilling Fluid Discharges

From: Linda Y. Boornazian, Director
Water Permits Division, Office of Wastewater Management

Mary T. Smith, Director
Engineering and Analysis Division, Office of Science and Technology

To: Miguel Flores, Director
Water Quality Protection Division, Region 6

At the request of your staff, we are clarifying the requirements of the technology-based sediment toxicity and biodegradation limitations and standards for controlling synthetic-based drilling fluid (SBF) discharges. This clarification should help you and other EPA Regions with re-issuing NPDES permits for offshore oil and gas extraction activities. Based on our review of the record supporting these effluent guidelines, we recommend that NPDES permit writers reject any modifications to the technology-based sediment toxicity and biodegradation limitations and standards in any future NPDES permitting actions. Recent industry data further supports this recommendation. We are also clarifying the issue of significant digits and the appropriateness of rounding in determining compliance with the technology-based sediment toxicity and biodegradation limitations and standards. The attachment to this memorandum contains a more detailed discussion and evaluation of these issues.

EPA promulgated technology-based controls ("effluent guidelines") for controlling SBF discharges, in part, through product substitution reflecting best available technology and best available demonstrated technology. These effluent guidelines provide that only those synthetic materials and other base fluids which minimize potential loadings and toxicity may be discharged. EPA stated in the preamble to the SBF effluent guidelines that the technology basis for meeting the sediment toxicity and biodegradation limitations and standards is: (1) product substitution; or (2) zero discharge based on land disposal or cuttings re-injection. As documented in the SBF effluent guidelines record, operators may select from a large range of synthetic, oleaginous, and water miscible materials for formulating acceptable base fluids. EPA also identified that the SBF base fluids meeting all technology-based controls include vegetable esters, low viscosity esters, and C_{16}-C_{18} internal olefins.

Industry was clear in their comments during the SBF effluent guidelines rulemaking that the Agency should focus on discriminatory power, repeatability, and practicality in selecting the analytic tools for defining best available technology economically achievable (BAT). Additionally, industry commented that the Agency should use a relative standard (i.e., the sediment toxicity and biodegradation ratios) instead of numerical limitations in order to minimize the effects of method variability when complying with the sediment toxicity and biodegradation limitations and standards. The Agency agreed with these industry comments and selected the analytic methods recommended by industry and relative standards for both sediment toxicity and biodegradation.

Unfortunately, there is a common misunderstanding among some industry stakeholders about the application of the technology-based sediment toxicity and biodegradation limitations and standards. Industry stakeholders incorrectly assume that these sediment toxicity and biodegradation limitations and standards (e.g., 40 CFR 435.13, Footnotes 6, 7, & 8) call for statistical comparisons. Rather, the technology-based limitations and standards for sediment toxicity and biodegradation call for *deterministic* comparisons, with an absolute upper limit. There is no room in NPDES permits for modifying the calculation method (e.g., use of a "K-factor") for the sediment toxicity and biodegradation limitations and standards. Additionally, recent industry data clearly demonstrates that operators can have superior technical drilling performance and readily comply with the technology-based sediment toxicity and biodegradation limitations and standards without the need for any modifications.

We recommend that NPDES permit writers do not modify the calculation method (e.g., do not use a "K-factor") for the technology-based sediment toxicity and biodegradation limitations and standards in any future NPDES permits (e.g., NPDES permit for the Western Gulf of Mexico, GMG290000). These modifications to the technology-based sediment toxicity and biodegradation limitations and standards are inconsistent with the letter and spirit of the SBF effluent guidelines. We also re-affirm EPA's policy of encouraging operators to use better environmentally performing fluids (e.g., esters and internal olefin/ester blends).

Finally, we are clarifying the use of significant digits and the appropriateness of rounding in determining compliance with the technology-based sediment toxicity and biodegradation limitations and standards. We recommend that results demonstrating compliance with the SBF sediment toxicity and biodegradation limitations and standards be reported to two significant digits. A specific procedure for rounding is provided in the attachment to this memorandum.

Questions on this memorandum should be directed to Mr. Carey A. Johnston, P.E., U.S. EPA, Office of Science and Technology at: (202) 566 1014 or johnston.carey@epa.gov.

Cc: Water Division Directors, Regions 4, 9, and 10
Scott Wilson, Region 6
Karrie-Jo Shell, Region 4
Deborah G. Nagle, OWM-Water Permits Division
Jeff Smith, OWM-Water Permits Division
Marvin B. Rubin, OST-Engineering & Analysis Division
Carey A. Johnston, OST-Engineering & Analysis Division

<u>Attachment</u>

Attachment to Memorandum Titled "Clarification of Technology-based Sediment Toxicity and Biodegradation Limitations and Standards for Controlling Synthetic-based Drilling Fluid Discharges"

Overview

On June 4, 2001 (66 FR 29948) EPA proposed modifications to the EPA Region 6 Oil and Gas Extraction NPDES General Permit for Western Gulf of Mexico (GMG290000). These modifications were necessary to incorporate the January 22, 2001 (66 FR 6850) revisions to the effluent guidelines for this industry (Oil and Gas Extraction Point Source Category, 40 CFR 435.13 & §435.15). These effluent guidelines revisions establish technology-based best available technology economically achievable (BAT) limitations and new source performance standards (NSPS) for the discharge of pollutants from oil and gas drilling operations associated with the use of synthetic-based drilling fluids (SBFs) and other non-aqueous drilling fluids (NAFs) into waters of the United States.

The January 2001 SBF effluent guidelines ("SBF effluent guidelines") established a two part approach to control SBF-cuttings discharges: (1) product substitution through use of stock limitations (e.g., sediment toxicity, biodegradation, polynuclear aromatic hydrocarbons content, metals content) and discharge limitations (e.g., diesel oil prohibition, formation oil prohibition, sediment toxicity, aqueous toxicity); and (2) control of the quantity of SBF discharged with SBF-cuttings. EPA stated in the preamble to the final rule that the technology basis for meeting these limitations and standards is: (1) product substitution; or (2) zero discharge based on land disposal or cuttings re-injection. As documented in the SBF Technical Development Document (EPA-821-B-00-013, December 2000), operators may select from a large range of synthetic, oleaginous, and water miscible materials for formulating acceptable base fluids. EPA also identified that the SBF base fluids meeting all technology-based controls include vegetable esters, low viscosity esters, and C_{16}-C_{18} internal olefins. EPA promulgated the SBF effluent guidelines to encourage product substitution reflecting best available technology and best available demonstrated technology wherein only those synthetic materials and other base fluids which minimize potential loadings and toxicity may be discharged.

In comments on the proposed modifications to the Region 6 general permit, industry suggested that the revised GOM permit include changes in the method used to calculate compliance with the new SBF sediment toxicity and biodegradation limitations and standards published in the SBF effluent guidelines.[1] Specifically, industry commented that the toxicity and biodegradation limitations and standards (e.g., 40 CFR 435.13, Footnotes 6, 7, & 8) did not account for analytical variability in the test methods. For example, industry suggested the

[1]Satterlee, Kent. Letter from Offshore Operators Committee to EPA Region 6 Regional Administrator, GMG290000 Permit Modification Comments, August 2, 2001.

calculation of the anaerobic biodegradation limitation be changed from Equation 1 (40 CFR 435.13, Footnote 7) to Equation 2 (industry suggested limitation):

$$\frac{\text{Average ml gas from } C_{16}\text{-}C_{18} \text{ IOs /theoretical gas from } C_{16}\text{-}C_{18} \text{ IOs}}{\text{Average ml produced from test fluid/theoretical ml produced from test fluid}} < 1.0 \qquad (1)$$

$$\frac{\text{Average ml gas from } C_{16}\text{-}C_{18} \text{ IOs /theoretical gas from } C_{16}\text{-}C_{18} \text{ IOs}}{\text{Average ml produced from test fluid/theoretical ml produced from test fluid + K}} < 1.0 \qquad (2)$$

Industry identified the "K" value of 4% as the "kinetic constant" for the historic 95% confidence limits of compounds that biodegrade comparable to C_{16}-C_{18} internal olefins. Industry suggested a similar approach (i.e., a "K-factor") for the sediment toxicity limitations.

On December 18, 2001 (66 FR 65209) EPA finalized the modification to the EPA Region 6 Oil and Gas Extraction NPDES General Permit for Western Gulf of Mexico (GMG290000). As shown in Equations 3 though 5, the revised permit used this concept of a "K-factor" to modify the effluent guidelines sediment toxicity and biodegradation limitations and standards.

$$\frac{\text{10-day } LC_{50} \text{ Reference Material}}{\text{10-day } LC_{50} \text{ NAF + (0.20) * 10-day } LC_{50} \text{ Reference Material}} < 1.00 \qquad (3)$$

$$\frac{\text{96-hour } LC_{50} \text{ Reference Drilling Fluid}}{\text{96-hour } LC_{50} \text{ SBM + (0.25) * 96-hour } LC_{50} \text{ Reference Drilling Fluid}} < 1.00 \qquad (4)$$

$$\frac{\text{\% Theoretical gas production of reference fluid}}{\text{\% Theoretical gas production of NAF + 4\%}} < 1.0 \qquad (5)$$

Where:

NAF	=	stock base fluid being tested for compliance
Reference Fluid	=	C_{16}-C_{18} internal olefin or C_{12}-C_{14} or C_8 ester reference fluid

The permit also stated that no rounding or truncating should be used in the equations shown above for determining compliance with the NAF or SBM sediment toxicity limits.

This memorandum discusses the bases EPA used to develop these limitations and standards and why EPA is now rejecting modifications to these limitations and standards in future EPA Region 6 general permits. This memorandum also discusses the issue of significant digits and the appropriateness of rounding in determining compliance with the SBF sediment toxicity and biodegradation limitations and standards.

SBF Effluent Guidelines Economic Achievability

This section discusses the economic and engineering analyses EPA used to demonstrate that the SBF technology-based sediment toxicity and biodegradation limitations and standards (e.g., 40 CFR 435.13, Footnotes 6, 7, & 8) are economically and technically achievable. More supporting documentation is in the public record for this rulemaking (EPA Docket No. W-98-26).

EPA identified a range of widely used SBFs allowed for discharge with SBF-cuttings that are economically achievable through product substitution: internal olefins ($160/bbl), vegetable esters ($250/bbl), and low viscosity esters ($300/bbl). All fluids that pass the sediment toxicity and biodegradation limitations and standards (as well as all other BAT limitations and NSPS) were demonstrated to be economically achievable (including SBF based on pure low viscosity esters). In addition, the most expensive SBF-cuttings management option, zero discharge of SBF-cuttings, was also demonstrated to be technically achievable and economically achievable. The zero discharge option was rejected due to unacceptable non-water quality environmental impacts (NWQIs).

Based on industry data, EPA's economic and engineering analyses used four model wells: shallow water development (SWD), shallow water exploratory (SWE), deep water development (DWD), and deep water exploratory (DWE). Table VII-2 of the SBF Technical Development Document presents the data provided by API, and the hole volumes and total waste cuttings volumes that EPA calculated based on these data. For the four model wells, EPA determined that the volumes of cuttings generated by these SBF well intervals are, in barrels, 565 for SWD, 1,184 for SWE, 855 for DWD, and 1,901 for DWE.

Based on per-well data provided by API, EPA assumed a model SBF drilling fluid having a formulation consisting of 47% by weight synthetic base fluid, 33% solids, and 20% water. This formulation represents a 70%/30% ratio of synthetic base fluid to water, typical of commercially available SBFs. Industry supplied data also identified a typical synthetic base fluid density of 280 lbs/bbl. Applying the densities of the synthetic base fluid, barite, and water to the drilling fluid formulation, EPA calculated a drilling fluid weight of 9.65 lbs/gal (405 lbs/bbl) (see Table VII-1 of the SBF Technical Development Document). As shown in Table 1, the volumes of synthetic base fluid required for the SBF model well intervals are, in barrels, 384 for SWD, 805 for SWE, 581 for DWD, and 1,292 for DWE.

Table 1: Volumes of Synthetic Base Fluid Required for the SBF Model Well Intervals

SBF Model Well	Hole Volume (bbl)	Weight of SBF Required to Fill Hole Volume (lbs)	Weight of Synthetic Base Fluid Component (lbs)	Volume of Synthetic Base Fluid Component (bbl)
SWD	565	228,825	107,548	384
SWE	1,184	479,520	225,374	805
DWD	855	346,275	162,749	581
DWE	1,901	769,905	361,855	1,292

Note: SBF density = 405 lbs/bbl
Base fluid composition = 47% by weight synthetic base fluid
Synthetic base fluid density = 280 lbs/bbl

These volumes do not account for lost base fluid discharged with cuttings. As shown in Table VII-7 of the SBF Technical Development Document, the volumes of synthetic base fluid discharged with drilling cuttings or zero discharged with fines (i.e., the selected BAT option) for the SBF model well intervals are, in barrels, 81 for SWD, 170 for SWE, 123 for DWD, and 272 for DWE. Therefore the total volume of synthetic base fluid required for the SBF model well intervals are, in barrels, 465 for SWD, 975 for SWE, 704 for DWD, and 1,564 for DWE.

EPA's economic analyses (EPA-821-B-00-012, December 2000), identified typical well costs to evaluate the effect of different technology-based control options (including zero discharge). As shown in Table 5-1 of the SBF Economic Analyses, the baseline costs of well drilling are, in millions of dollars, 2.9 for SWD, 4.9 for SWE, 20.0 for DWD, and 25.0 for DWE. EPA specifically examined the economic impact of operators using synthetic base fluids more expensive than internal olefins and found them to be economically achievable (SBF Economic Analyses, Page 5-2):

> *"A certain percentage of wells might incur a higher cost for SBFs that meet the stock limitations over SBFs that do not. EPA also examined this type of increase by modeling a cost increase from \$160/bbl for the SBF and a primary shale shaker to \$300/bbl for the SBF and a cuttings dryer. The cost analysis uses a weighted average of SBF fluid costs (over \$200/bbl)."*

Using an extremely conservative example, the incremental cost of an operator switching from internal olefins (\$160/bbl) to the most expensive synthetic base fluid, low viscosity esters (\$300/bbl), represents no more than a 2.8% increase in overall drilling costs for wells in shallow water and less than 1% in overall drilling costs for wells in deep water. At the time of the final SBF effluent guidelines nor at the current time are operators using pure low viscosity esters in the U.S. OCS. Rather, many operators in the U.S. are using a blend of esters and internal olefins that are priced less than \$230/bbl. This more realistic assumption represents no more than a 1.5%

increase in overall drilling costs for wells in shallow water and less than 0.5% in overall drilling costs for wells in deep water. Furthermore, recent industry data suggests that the baseline costs of well drilling are, in millions of dollars, 3.2 to 3.5 for SWD and 25 to 30 for DWE. This would further reduce the percentage increase in overall drilling costs for these wells. As shown here and in the record for the SBF effluent guidelines, EPA evaluated the full range of different synthetic base fluids (from internal olefins to low viscosity esters) to estimate the incremental costs of operators using product substitution to comply with the SBF effluent guidelines and EPA found the technology-base SBF stock and discharge limitations to be economically achievable.

In short, the economic analyses show no difference in economic achievability between the different synthetic based fluids that are allowed for discharge with SBF-cuttings (i.e., internal olefins, low viscosity esters, and vegetable esters). In fact, under the most expensive SBF management option, zero discharge, the added costs range from about 1 to 3 percent of average drilling costs. EPA stated in the SBF Economic Analyses that these incremental costs are highly unlikely to change an operator's decision whether to drill a well. Once the operator has decided to drill a well, the regulation will be one of the factors in the operator's decision of which fluid to use.

Based on the economic and engineering analyses used to support the SBF effluent guidelines, operators can use product substitution (either complete product substitution or through the blending of better environmentally performing synthetic base fluids such as low viscosity esters and vegetable esters) to comply with the SBF technology-based sediment toxicity and biodegradation limitations and standards (e.g., 40 CFR 435.13, Footnotes 6, 7, & 8) without the need for a “K-factor.”

Basis for Rejecting Pure Esters as BAT

This section discusses: (1) why EPA rejected the option of basing sediment toxicity and biodegradation stock limitations and standards on pure vegetable esters; (2) the explicit demonstration in EPA’s economic and engineering analyses that operators may need to use fluids (or blends of fluids) with an environmental performance (e.g., sediment toxicity and biodegradation) equal to or better than pure C_{16}-C_{18} internal olefins.

In the SBF final effluent guidelines, EPA and industry sediment toxicity and biodegradation laboratory studies show that both vegetable esters and low viscosity esters have better environmental performance (*e.g.*, sediment toxicity, biodegradation) than all other SBF base fluids. Consequently, EPA promulgated higher retention on cuttings discharge limitations where esters are used to encourage operators to use esters when possible. EPA considered and rejected basing sediment toxicity and biodegradation stock limitations and standards on pure esters not blends of esters and other synthetic base fluids. It is important to note in this discussion of the “K-factor” what EPA knew about pure esters at the time of the final rulemaking and why EPA rejected pure esters as BAT.

At the time of the final rulemaking, EPA rejected the option of basing sediment toxicity and biodegradation stock limitations and standards on pure vegetable esters due to several technical limitations. These technical limitations of vegetable esters preclude their use in all areas of the GOM, Offshore California, and Cook Inlet, Alaska. For example, when drilling deviated wells in deep water, it is particularly important to control the down hole pressure. Too low viscosity of the drilling mud results in barite sag and poor hole cleaning, while too high a viscosity results in unacceptable circulating pressure and an increased risk for lost circulation. Pure vegetable ester technical limitations include: (1) high viscosity compared with other IO SBFs at all temperatures, with an increasing difference as temperature decreases, leading to lower rates of penetration in wells and greater probability of losses due to higher equivalent circulating densities; (2) high gel strength in risers that develops when a pure vegetable ester-based SBF is not circulated; (3) a high temperature stability limit ranging from about 225 ˚F to perhaps 320 ˚F – the exact value depends on the detailed chemistry of the pure vegetable ester (*i.e.*, the acid, the alcohol) and the drilling fluid chemistry; (4) reduction of the thermal stability limit through hydrolysis when pure vegetable esters are in contact with highly basic materials (*e.g.*, lime, green cement) at elevated temperatures; and (5) less tolerance of the muds to contamination by seawater, cement, and drill solids than is observed for IO-SBFs (Docket No. W-98-26: Record No. IV.A.a.3, Attachment A2 - "Limitations of Esters"; Record No. IV.A.a.13, Attachments Ester-51, 52, 53, 54, 56).

At the time of the final rulemaking, EPA noted that pure low viscosity esters may provide superior technical performance than other SBFs. Comments to the April 2000 NODA state that laboratory analyses, which were designed to simulate GOM conditions to which a fluid may be exposed, indicate that low viscosity esters have the following technical properties: (1) similar or better viscosity than C_{16}-C_{18} IOs; (2) can be used to formulate stable low viscosity ester-SBFs up to 300 ºF; (3) can be used to formulate low viscosity ester-SBFs to 16.0+ lbs/gal mud weight; (4) can reduce oil/water ratios to 70/30, thus reducing volumes of base fluid discharged; (5) high tolerance to drilled solids; (6) flat gels make it easier to break circulation, minimizing initial circulation pressures and subsequent risk of fracture; (7) high tolerance to seawater contamination; and (8) rheological properties can be adjusted by use of additives to suit specific conditions (Docket No. W-98-26, Record No. IV.A.a.7).

EPA also received information during the rulemaking process on one well section drilled with pure low viscosity esters. Some of the results from this pure low viscosity ester well section were compared to the results from another well section in the same location where C_{16}-C_{18} IOs were used. These results show that the low viscosity ester had: (1) comparable or better equivalent circulating densities (*i.e.*, acceptable fluid properties); and (2) faster ROP through better hole cleaning and higher lubricity (*i.e.*, fewer days required to drill to total depth which lead to less NWQIs and overall drilling costs).

Due to demonstrated or potential technical limitations of pure vegetable esters or low viscosity esters, EPA estimates that the pollutant loadings and NWQIs associated with establishing pure vegetable esters or pure low viscosity esters as the basis for stock limitation are similar to the pollutant loadings and NWQIs associated with the zero discharge option for all SBF-cuttings. EPA rejected the zero discharge option for SBF-cuttings based on unacceptable NWQIs. The final SBF guidelines set the technology-based sediment toxicity and biodegradation controls based on the use of pure C_{16}-C_{18} internal olefins (e.g., 40 CFR 435.13, Footnotes 6, 7, & 8), not pure vegetable or pure low viscosity esters.

However, explicit in EPA's economic and engineering analyses is the assumption that operators may need to use fluids (or blends of fluids) with an environmental performance (e.g., sediment toxicity and biodegradation) equal to or better than pure C_{16}-C_{18} internal olefins in order to meet the technology-based sediment toxicity and biodegradation limitations and standards based on pure C_{16}-C_{18} internal olefins (e.g., 40 CFR 435.13, Footnotes 6, 7, & 8). EPA specifically identified that, "A synthetic-based drilling fluid may include a combination of synthetic materials" (40 CFR 435.11(kk)). In the final SBF effluent guidelines, EPA identified SBFs (and blends of SBF) with an environmental performance (e.g., sediment toxicity and biodegradation) equal to or better than pure C_{16}-C_{18} internal olefin (e.g., 40 CFR 435.13, Footnotes 6, 7, & 8) as technically and economically achievable. See also the "**SBF Effluent Guidelines Economic Achievability**" section of this memorandum.

Again, it is important to note that EPA did not reject the use of pure esters based on economic impacts. At the time of the final rulemaking, EPA did not have sufficient information to determine whether pure low viscosity esters can be used in all or nearly all drilling conditions in the offshore U.S. waters (*e.g.*, differing formations, water depths, and temperatures). Since promulgation of the SBF effluent guidelines, operators have demonstrated that they are able to use internal olefin/ester blends in a variety of technically demanding deepwater and cold environments. EPA notes that operators have recent used internal olefin/ester blends to drill approximately 110 GOM wells in the shallow water (42 wells) and deep water (66 wells) environments for a combined distance of over 223 miles. Operators used these internal olefin/ester blends in a variety of high pressure (55 wells at greater than 13.5 ppg) and direction drilling (65 wells at greater than 35 degree deviation) operations.[2] There are a variety of suppliers for these ester and internal olefin/ester blends.[3]

In a recent example of a drilling operation using an internal olefin/ester blend the operator, Kerr McGee, field tested a internal olefin/ester blend in a 15,000-ft Green Canyon well in water depth of 4,000 ft. Rheological properties for this well proved more stable than other

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[2]Hinds, Aston A., 2003. Industry E-mail Communication with Carey A. Johnston, U.S. EPA, September 2003.

[3]International Association of Oil & Gas Producers, 2003. Environmental aspects of the use and disposal of non aqueous drilling fluids associated with offshore oil & gas operations, Report No. 342, May 2003.

SBFs the company had previously used.[4] Additionally, an internal olefin/ester blend won the Hart's E&P 2003 Special Meritorious Awards for Engineering Innovation. The award noted that the internal olefin/ester blend's low- and high temperature (– 40˚F to 350˚F) rheological properties allow unprecedented control over viscosity and equivalent circulating density. The award also noted that operators have the potential for significant cost savings. EPA's finding, made in the final SBF effluent guidelines, that SBFs (and blends of SBF) with an environmental performance equal to or better than pure C_{16}-C_{18} internal olefin are technically and economically achievable is further supported by these advances in drilling technology. The use of internal olefin/ester blends is economically and technically achievable and offer operators a "win-win" - both superior technical drilling performance and better environmental protection.

However, there may be some very rare occasions where ester/internal olefin blends cannot be used due to technical drilling limitations. In particular, we are still concerned that the molecular structure of esters presents more potential drilling problems than pure C_{16}-C_{18} internal olefins in very high temperature environments (e.g,. greater than 350˚F). In particular, some exploration of deep gas reserves in shallow waters may involve drilling in very high temperatures environments (e.g,. greater than 350˚F) at great depths (e.g., 18,000 to 20,000 feet vertical). In these very high temperatures environments (e.g,. greater than 350˚F) esters can also begin thermal degradation (i.e., break-down to their parent acids and alcohols) which will transform the ester-SBFs into a thick mass (Docket No. W-98-26, Record No. IV.A.a.3). The 50/50 C_{16}-C_{18} internal olefins/ester blend reference above is rated up to 350˚F. Increasing the ratio of C_{16}-C_{18} internal olefins in C_{16}-C_{18} internal olefins/ester blends will increase the upper temperature range available for the blend (e.g., a 80/20 C_{16}-C_{18} internal olefins/ester blend may able to perform at 375˚F). It is important to note that these very high temperature environments are very rarely seen in deep water wells were down-hole temperatures are typically below 300˚F. Therefore, in order to promote SBFs as a pollution prevention technology for the exploration of shallow water deep gas reserves, we would recommend a case-by-case enforcement discretion for any operators that can demonstrate the need to use pure C_{16}-C_{18} internal olefins (see 40 CFR 435.11(rr)) in order to compensate for very high temperature environments (e.g,. greater than 350˚F). You may wish to require operators to obtain your written permission on a case-by-case basis before any discharges of pure C_{16}-C_{18} internal olefins associated with drill cuttings.

Industry Data Submission on the Issue of the "K-Factor"

This section discusses the Agency's evaluation of industry submitted data on the issue of the "K-factor." The API/NOIA Synthetic Based Muds (SBM) Research Program recently submitted two reports to EPA regarding the use of a "K-factor" to modify the effluent guidelines sediment toxicity and biodegradation limitations and standards for the EPA Region 6 general

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[4]McFadyen, Mike; Vice, Philip J.; Womack, Claude; Wright, Tim; 2002. New synthetic fluid system provides stable cold-temperature rheologies, World Oil Magazine, Vol. 223, No. 6 June, 2002.

permit.[5,6] Louallen et al. (2003) did not differentiate between field samples:

> *"The database contains different synthetic drilling fluid formulations that were not differentiated in this analysis. With regard to the chemical composition of field samples, it is known that some were more similar to corresponding reference samples than others. Compositional data was not included in the given database and the impact of these or any unmonitored factors could not be assessed with regard to impact on the LC50 values. Such factors are assumed either to have negligible impact or to be impractical to standardize."*

The assumption made by the authors that the drilling fluid composition would have negligible impact on sediment toxicity is clearly not supported by both industry and EPA research used for developing the SBF effluent guidelines. As stated in the SBF Technical Development Document, industry and EPA research efforts clearly demonstrated that some SBF base fluids show greater sediment toxicity than other SBF base fluids. Consequently, data used by Louallen et al. (2003) may be based on blends of internal olefins and other base fluids with poorer sediment toxicity (e.g., linear alpha olefins) as these fluids may be able to pass the sediment toxicity ratio in the current EPA Region 6 general permit which uses a "K-factor." Therefore, no conclusions can be drawn from Louallen et al. (2003) due to the inability to differentiate the base fluid composition between different field samples.

Ziegel (2003) reported on variability of the biodegradation test method. This paper identifies that inherent variability may be an issue for comparing internal olefin test fluids with the same or similar internal olefin reference fluids. Consequently, in order to promote the SBFs as a pollution prevention technology, we would recommend a case-by-case enforcement discretion for any operators that can demonstrate the need to use pure C_{16}-C_{18} internal olefins (see discussion on "**Basis for Rejecting Pure Esters as BAT**" above).

Ziegel (2003) chose to exclude an observation that he considered to be an outlier based solely on the result of a statistical test for outliers. While this approach can be useful in identifying extremely large or extremely small measurement values that require additional review, it is not appropriate to remove them solely on the basis of a statistical procedure. Because extreme values can be expected to occur on occasion, due to the variability in discharge,

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[5]Louallen, J. T., Wong, D.C.L., and Dorn, P.B, 2003. Statistical Analysis of the Sediment Toxicity Ratio for Synthetic-Based Drilling Muds, Transmitted from the API/NOIA Synthetic Based Muds (SBM) Research Program to Mr. Carey A. Johnston, U.S. EPA, in a July 22, 2003, e-mail.

[6]Ziegel, Eric, 2003. Performance Evaluation Study for Statistical Methodology to Compare 275-Day Cumulative Gas Production Result of Closed Bottle Tests of Offshore Drilling Fluids to C1618 IO Standard, Transmitted from the API/NOIA Synthetic Based Muds (SBM) Research Program to Mr. Carey A. Johnston, U.S. EPA, in a July 22, 2003, e-mail.

a review of the laboratory records associated with the measurement may establish whether the extreme value was caused by failure to follow proper laboratory procedures. If laboratory failed to analyze the results properly, it may be appropriate to exclude the measurement result from the statistical analysis. In the absence of documented laboratory problems, outliers should not be excluded based solely on statistical tests.

Furthermore, excluding values from small sample sizes is especially problematic, because of the uncertainty about underlying distribution. Before excluding such values from small sample sizes, statisticians generally perform sensitivity analyses to determine the impact on the results of including or excluding these values. Finally, excluding outliers from the sample of the size 4 or 5 with significance level of 0.1 is generally not acceptable. Rarely is a significance level above 0.01 appropriate for analysis of outliers, let alone for small samples. We also disagree with Ziegel (2003) that a coefficient of variation exceeding 10% is "strong evidence" for the presence of an outlier.

Unfortunately, both Louallen et al. (2003) and Ziegel (2003) share the common fundamental misunderstanding which leads to their request for the use of a "K-factor." Both submissions incorrectly assume that the sediment toxicity and biodegradation limitations and standards (e.g., 40 CFR 435.13, Footnotes 6, 7, & 8) call for statistical comparisons. Rather, the technology-based limitations and standards for sediment toxicity and biodegradation call for *deterministic* comparisons, with an absolute upper limit. Therefore, there is no room in the EPA Region 6 permit for the use of a "K-factor" for the sediment toxicity and biodegradation limitations and standards.

It is important to note that Louallen et al. (2003) and Ziegel (2003) did not address the fundamental issue regarding the sediment toxicity and biodegradation rate ratio limitations and standards. As previously discussed in the "**SBF Effluent Guidelines Economic Achievability**," EPA costed a range of base fluid options for operators to comply with the sediment toxicity and biodegradation rate ratio limitations and standards. Except for some very rare circumstances, operators can blend in esters with C_{16}-C_{18} internal olefins or use C_{16}-C_{18} internal olefins with less branching in their structure to pass the sediment toxicity and biodegradation rate ratio limitations and standards without the need for a "K-factor."

Finally, EPA received sediment toxicity and biodegradation data from an ester manufacturer. This data clearly shows that 80%/20% blends of internal olefins/esters do not require a "K-factor" to pass the SBF biodegradation limitations and standards.[7]

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[7]Herzog, Nadja, 2003. Data Transmittal from Cognis Deutschland to Mr. Carey A. Johnston, U.S. EPA, via July 1, 2003, e-mail.

Significant Digits

This section discusses the appropriate use of significant digits and rounding in demonstrating compliance with the sediment toxicity and biodegradation rate ratio limitations and standards.

EPA identifies the required accuracy for demonstrating compliance with numerical limitations and standards through use of significant digits. As an example, EPA recently issued a minor clarification of national primary drinking water regulation for arsenic in response to a concern raised by a number of States and other stakeholders that State laws adopting the Federal arsenic standard as 0.01 mg/L might allow rounding of monitoring results above 0.01 mg/L so that the effective standard (in consideration of rounding of results) would be 0.014 mg/L (or 14 ppb), not 0.010 mg/L (10 ppb) (March 25, 2003; 68 FR 14501). EPA made clear that compliance with the new arsenic standard would be measured to three significant digits not two and that rounding of results to the nearest 0.01 mg/L would not be permitted.

We recommend that the EPA Region 6 NPDES permit be modified to address the issue of significant digits in demonstrating compliance with the sediment toxicity and biodegradation limitations and standards. We recommend that results demonstrating compliance with the SBF sediment toxicity and biodegradation limitations and standards be reported to two significant digits. This will maintain consistency with the effluent guidelines. In particular, we recommend the following procedure for rounding off digits that are not significant in the calculation of the sediment toxicity and biodegradation limitations and standards:

(1) If the digit 6, 7, 8, or 9 is dropped, increase preceding digit by one unit, Example: a calculated sediment toxicity ratio of 1.06 should be rounded to 1.1 and reported to EPA as a violation of the sediment toxicity ratio of 1.0.

(2) If the digit 0, 1, 2, 3, or 4 is dropped, do not alter the preceding digit. Example: a calculated sediment toxicity ratio of 1.04 should be rounded to 1.0 and reported to EPA as compliant with the sediment toxicity ratio of 1.0.

(3) If the digit 5 is dropped, round off preceding digit to the nearest even number. Example: a calculated sediment toxicity ratio of 1.05 should be rounded to 1.0 and reported to EPA as compliant with the sediment toxicity ratio of 1.0.[8]

Therefore, a calculated sediment toxicity ratio of 1.054 should be rounded to 1.0 (compliant with the effluent guidelines) while 1.055 should be rounded to 1.1 (not compliant with the effluent guidelines). Please note that this procedure should only be applied to the sediment toxicity and biodegradation limitations and standards in the permit.

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[8]American Public Health Association, 1989. Standard Methods for the Examination of Water and Wastewater, 17th Edition, page 1-28.

Legal Issues Associated with the "K-Factor"

This section discusses legal issues associated with any modifications to the technology-based sediment toxicity and biodegradation limitations and standards.

Effluent limitations act as a primary mechanism to control the discharges of pollutants to waters of the United States. These limitations are applied to individual facilities through NPDES permits issued by EPA or authorized States under Section 402 of the Clean Water Act. Permit writers should not misapply or miscalculate an applicable limit as required by effluent guidelines.[9] We are concerned that the use of a "K-factor" would unnecessarily open the Western GOM NPDES permit to legal challenge. The use of a "K-factor" changes the calculation of the sediment toxicity and biodegradation ratios and would likely be seen as an unauthorized change in applicable effluent guidelines limitations and standards. In particular, the use of a "K-factor" would likely be seen as allowing for discharge blends of internal olefins and poorer performing SBFs (i.e., SBFs that do not meet the technology-based sediment toxicity and biodegradation limitations and standards).

Conclusion

It is important to note that the issue of variability was discussed during the development of the SBF effluent guidelines. Industry was clear in their comments during the SBF effluent guidelines rulemaking that the Agency should focus on discriminatory power, repeatability, and practicality in selecting the analytic tools for defining BAT. Additionally, industry commented that the Agency should use a relative standard (i.e., the sediment toxicity and biodegradation ratios) instead of numerical limitations in order to minimize the effects of method variability when complying with the sediment toxicity and biodegradation limitations and standards. The Agency agreed with these industry comments and selected the analytic methods recommended by industry and relative standards for both sediment toxicity and biodegradation.

As stated in the analyses supporting the SBF effluent guidelines, EPA and industry generated extensive sediment toxicity data sets that show that the relative rankings of sediment toxicity for SBFs is consistent even as numeric LC_{50}'s fluctuate. It is important to note that not all pure C_{16}-C_{18} internal olefins (see 40 CFR 435.11(rr)) demonstrate the same sediment toxicity. Some pure C_{16}-C_{18} internal olefins have a more linear structure and are less toxic than pure C_{16}-C_{18} internal olefins that have a more branching. Despite this variability among different pure C_{16}-C_{18} internal olefins, the relative ranking remains constant for both pure synthetic base fluids and mud formulations of the different synthetic base fluids. For biodegradation, industry submitted closed bottle test data are consistent with historical rankings of base fluid biodegradation rates. Again, variability in these test methods is minimized through use of a relative limitation.

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[9]U.S. EPA, Central Tenets of the National Pollutant Discharge Elimination System (NPDES) Permitting, http://www.epa.gov/npdes/pubs/tenets.pdf, August 29, 2003.

As previously stated, operators should use product substitution (either complete product substitution or through the blending of better environmentally performing synthetic base fluids such as low viscosity esters and vegetable esters) to comply with the SBF technology-based sediment toxicity and biodegradation limitations and standards (e.g., 40 CFR 435.13, Footnotes 6, 7, & 8) without the need for a "K-factor." In the final SBF effluent guidelines, EPA identified SBFs (and blends of SBF) with an environmental performance (e.g., sediment toxicity and biodegradation limitations and standards) equal to or better than pure C_{16}-C_{18} internal olefin as technically and economically achievable. Operators have the ability to substitute better performing drilling fluids (in terms of technical drilling and environmental performance). We recommend that you reject the use of any "K-factor" in any future revisions to the EPA Region 6 Oil and Gas Extraction NPDES General Permit for Western Gulf of Mexico. We will also make this recommendation to other EPA Regions that are permitting oil and gas extraction activities in Federal and State waters.

In summary, the use of a "K-factor" is inconsistent with the letter and spirit of the SBF effluent guidelines. As previously stated, EPA specifically called out esters as better performing fluids in the SBF effluent guidelines and developed a higher retention on cuttings limitation to promote their use. We should continue to encourage operators to use better environmentally performing fluids (e.g., esters and internal olefin/ester blends) rather than continue the use of the "K-factor" in the Region 6 NPDES permit.