FINAL

Peer Review Summary Report for the External Peer Review of

Gulf of Mexico Oil Spill Response Viability Analysis Interim Report

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Prepared by:

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1. INTRODUCTION

EnDyna was tasked with managing the external peer review process to evaluate the interim final report entitled, *Gulf of Mexico Oil Spill Response Viability Analysis Interim Report*. The interim final report was prepared for the Bureau of Safety and Environmental Enforcement (BSEE) by Nuka Research and Planning Group, LLC (Nuka Research) on November 17, 2017.


Gulf of Mexico
Oil Spill Response Viability Analysis
INTERIM REPORT
(PROJECT # 1077)
November 17, 2017

The peer reviewer selection process involved selecting three scientific experts who were available to participate in the peer review, including preparing individual written peer review comments during a specific timeframe (late April – May 2018). In recruiting these peer reviewers and managing the peer review, EnDyna evaluated the qualifications of peer reviewer candidates, conducted a thorough conflict of interest (COI) screening process, and independently selected the peer reviewers. EnDyna then provided management and oversight of the external peer review process, and produced this report that summarizes and synthesizes the peer reviewer responses.

The sections below provide background on the BSEE study, describe EnDyna's process for selecting expert peer reviewers for the interim final report entitled, *Gulf of Mexico Oil Spill Response Viability Analysis Interim Report* (Nuka Research report), describe BSEE's objective and scope for this peer review, discuss the peer reviewer questions compiled by the EnDyna Peer Review Lead as well as BSEE's written answers to the peer reviewer questions, and outline the organization of this report.

1.1 Background on BSEE Study

Part of BSEE's research is committed to ensuring that functional, safe, and environmentally responsible oil spill response methods are identified and used under appropriate conditions. Understanding oil spill response limitations in the Gulf of Mexico (GOM) is crucial for the U.S. government and industry to develop robust oil spill response plans. It is important for oil spill response plan holders to know which oil spill response tactic is appropriate to the on-scene conditions along with the resources available for an oil spill response, and to identify resources that must be invested in.

BSEE contracted Nuka Research and Planning Group, LLC, to perform an oil spill response viability analysis for the U.S. Outer Continental Shelf (OCS) in the GOM exclusive economic zone (EEZ). This analysis quantified the frequency that specific oil spill response tactics may not be feasible or "unduly" impacted such that response effectiveness is judged to be degraded due to metocean (i.e., the weather or ocean ("metocean")) conditions. The metocean conditions examined included wind speed, sea state (wave height), and visibility. Response options evaluated included mechanical recovery, in-situ burning, and the surface application of dispersants (aerial and vessel deployed). Limits of air reconnaissance and oil spill tracking were considered.

Nuka Research developed the interim final report: *Gulf of Mexico Oil Spill Response Viability Analysis Interim Report*. This report meets the criteria for "influential scientific information" under the Office of Management and Budget Memorandum on Peer Review (OMB M-05-03). Therefore, BSEE determined that this report contains new scientific information that shall be subjected to peer review.

1.2 Identification and Selection of Expert Peer Reviewers

EnDyna was tasked with independently selecting three scientific experts who collectively had the background and proven expertise for the following fields of expertise:

- Oil spill response operations
- Specific oil spill response tactics evaluated in this study:
    - Mechanical Recovery – Two Vessels with Boom
    - Mechanical Recovery – Single Vessel with Outrigger
    - Mechanical Recovery – Three Smaller Vessels with Boom
    - Dispersants – Vessel Application
    - Dispersants – Fixed-wing Application
    - Dispersants – Helicopter Application
    - In-situ Burning – Vessels with Fire Boom
- Meteorological and ocean monitoring.

EnDyna conducted an independent search for scientific experts in those three fields of expertise. The experts were identified through literature and internet searches of scientific journals, professional societies, universities, scientific meetings, nonprofit organizations, and governmental agencies. Both domestic and international affiliations were considered, as well as affiliations with industry, government, and academia. Specific examples of individuals and organizations contacted or used as a resource during the peer reviewer selection process include:

- National Oceanic and Atmospheric Administration (NOAA), Office of Response and Restoration (OR&R), Emergency Response Division (ERD);
- NOAA, OR&R, ERD, Gulf of Mexico Disaster Response Center, Mobile, AL;
- U.S. Coast Guard (USCG), District 8, New Orleans, LA;
- U.S. Coast Guard, National Strike Force Coordination Center, Elizabeth City, NC;
- National Response Team (NRT)/Regional Response Team (RRT) Region 6;
- Texas General Land Office, Oil Spill Prevention and Response Program;
- Oil Spill Response Organizations (OSROs): Clean Gulf Associates, Inc. (CGA), and Marine Spill Response Corporation (MSRC);
- Private consulting firms (e.g., Spiltec, RPS Group (RPS ASA–US), SINTEF, SL Ross Environmental Research Ltd.);
- Industry (e.g., Shell, ExxonMobil, Chevron, ConocoPhillips, Marathon);
- Universities (e.g., Louisiana State University, University of South Florida, Texas A&M University, New Jersey Institute of Technology, Florida State University, University of Miami); and
- Individual consultants (e.g., Ed Stanton (retired USCG), Pat Lynch).

EnDyna contacted approximately 45 people, of which 13 candidates were interested in participating and also available during the planned peer review timeframe. The other candidates were either not available during the peer review timeframe, had COI or upcoming workload conflicts that led them to decline, or did not respond to our invitation. Interested candidates provided their name, contact information, and curriculum vitae (CV)/resume and/or biographical sketch containing their education, employment history, area(s) of expertise, research activities, recent service on advisory committees, publications, and awards.

After reviewing the CV/resumes, EnDyna selected ten (10) interested candidate reviewers who best met the required fields of expertise and had no restrictions on availability during the planned peer review timeframe.

1.2.1 Conflict of Interest Screening Process

EnDyna initiated COI screening on the 10 interested candidate reviewers who best met the required fields of expertise to ensure that the experts had no COI or appearance of the lack of impartiality. The COI screening was conducted in accordance with the *BSEE Peer Review Process Manual* (dated August 2014) and the Office of Management and Budget (OMB) *Final Information Quality Bulletin for Peer Review*. The COI screening involved each expert completing a COI questionnaire to determine if they were involved with any other work and/or organizations that might create a real or apparent COI for this peer review.

Two (2) of those 10 interested candidate reviewers were excluded. After one (1) of the 10 interested individuals suggested conducting a shared review with several others at their company, EnDyna excluded them from further consideration in the selection process due to concerns that such sharing of responsibility for this peer review might risk circumventing the intent of the Non-Disclosure Agreement. Another one of the interested individuals provided a partially completed COI questionnaire, but then after several reminders, informed EnDyna that they would not be able to complete a COI questionnaire.

EnDyna received completed COI questionnaires from all of the remaining eight (8) interested candidate reviewers.[1] Although a delay occurred in receiving a completed COI questionnaire from two (2) of the eight (8) remaining interested candidate reviewers, those COI questionnaires were received prior to final peer reviewer selection.

EnDyna conducted COI screening on the eight (8) interested candidate reviewers who best met the required fields of expertise and had provided COI questionnaires. Although some candidates disclosed previous relationships with BSEE (i.e., consulting or peer review services), it was EnDyna's opinion that those relationships would not likely pose a real or apparent COI.

Because two (2) of those eight (8) interested candidate reviewers with completed COI questionnaires had disclosed COI issues, which EnDyna determined could potentially represent an apparent COI or appearance of the lack of impartiality, there were six (6) interested candidate reviewers remaining who best met the required fields of expertise that had provided COI questionnaires. Consequently, EnDyna's pool of experts then included six (6) interested candidate reviewers.

Because two (2) of the remaining six (6) interested candidate reviewers were from the same company, EnDyna selected the best qualified, and EnDyna's pool of experts then included five (5) candidate reviewers who best met the required fields of expertise.

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[1] An additional COI questionnaire was received from another individual from NOAA at the same time that EnDyna received their biographical sketch, which provided no information about experience/expertise with oil spill response operations in offshore environments. That individual did not respond to a follow-up request for information about offshore expertise/experience.

A signed Non-Disclosure Agreement (NDA) was obtained from the five (5) candidate reviewers who best met the required fields of expertise.

1.2.2 Selection of Peer Reviewers

In selecting the peer reviewers, EnDyna evaluated each peer reviewer candidate's credentials to select the three (3) experts that, collectively, covered the areas of expertise needed for this peer review, had no real or apparent COI or appearance of the lack of impartiality, and were available to complete the peer review within the planned timeframe.

After review and consideration of the available information described above, EnDyna selected the following three (3) expert peer reviewers: Dr. Victoria Broje, Mr. James Hanzalik, and Dr. William J. (Bill) Lehr. The names and affiliations of the three (3) expert peer reviewers selected by EnDyna, as well as a brief summary of areas of expertise for this peer review, are provided in Table 1.1 below. The key to the symbols in Table 1.1 is provided at the end of the table.

Table 1.1. Selected Peer Reviewers and Areas of Expertise

Name	Areas of Expertise				
	1) Oil spill response operations	2) Specific oil spill response tactics evaluated in study			3) Meteorological and ocean monitoring
		Mechanical Recovery	Dispersants	In-situ Burning	
Dr. Victoria Broje, Senior Emergency Response Scientist, Shell Exploration and Production Company, Houston, TX	SME	SME	SME	G	G
James Hanzalik, Captain, USCG (ret.), Assistant Executive Director, Clean Gulf Associates, New Orleans, LA	SME	G	G	G	—
Dr. William J. (Bill) Lehr, Lehr Science LLC, Seattle, WA	SME	G	G	SME	SME

Key:
SME: Primary area(s) of expertise/experience
G: Good knowledge/experience
L: Limited knowledge/experience
— No knowledge/experience

Table 1.2 provides an overview of the affiliations, advanced degrees, and selected publications for the three expert peer reviewers.

Table 1.2. Experience/Expertise Matrix for Selected Peer Reviewers

Name	Affiliation / Advanced Degrees	Areas of Expertise				
		1) Oil spill response operations	2) Specific oil spill response tactics evaluated in study			3) Meteorological and ocean monitoring
			Mechanical Recovery	Dispersants	In-situ Burning	
Dr. Victoria Broje	• Senior Emergency Response Scientist, Shell Exploration and Production Company, Houston, TX (2012-present) • Spill Response Specialist/Environmental Scientist, Shell Global Solutions/HSE Consultancy, USA (2006-2012) • Ph.D., Environmental Science and Management, University of California, Santa Barbara, 2006 • Master of Engineering and Technologies, Saint Petersburg State Technical University, Russia, 2001 Selected publications: • Broje V. and T. Nedwed (2016) "API Program to Advance Science of Subsea Dispersants Use in Oil Spill Response," Proceedings of the 39th Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Environment Canada. • Huber C., V. Broje, M. Cramer, and G. DeMarco (2015) "Aerial and Vessel Dispersant Preparedness and Operations Guide." Interspill Conference Proceedings. • Contributing author, American Petroleum Institute (API) Technical Report 1148. *Aerial and Vessel Dispersant Preparedness and Operations Guide*, 2015. • Broje V.A. and A. Keller (2007) "Effect of Operational Parameters on Oleophilic Drum Skimmer Recovery Efficiency," *Journal of Hazardous Materials*, 148, 136-143.	SME	SME	SME	G	G
James Hanzalik, Captain, USCG (ret.)	• Assistant Executive Director, Clean Gulf Associates, New Orleans, LA (2011-present) • Chief, Response Division & Incident Management Branch, U.S. Coast Guard, Eighth Coast Guard District, New Orleans, LA (2008-2011) • Deputy Commander/Executive Officer, USCG National Strike Force Coordination Center, Elizabeth City, NC (2003-2006) • Operations Officer, USCG Gulf Strike Team, Mobile, AL (1995-1998) • B.S., Geology, University of Southern Mississippi, Hattiesburg, MI, 1984 • 2010 Deputy Area Commander for pollution response, Deepwater Horizon Search and Rescue, and Major Spill, Gulf of Mexico • 2010 Deepwater Horizon, Incident Commander, Houma, LA	SME	G	G	G	—

Table 1.2. Experience/Expertise Matrix for Selected Peer Reviewers							
Name	Affiliation / Advanced Degrees	Areas of Expertise					
		1) Oil spill response operations	2) Specific oil spill response tactics evaluated in study			3) Meteorological and ocean monitoring
			Mechanical Recovery	Dispersants	In-situ Burning	
Dr. William J. Lehr	• Independent Consultant, Lehr Science LLC, Seattle, WA (April 2018-present) • Scientist Emeritus, National Ocean Service, National Oceanic and Atmospheric Administration (NOAA), Seattle, WA (April 2018-present) • Senior Scientist, Emergency Response Division, Office of Response and Restoration, NOAA, Seattle, WA (XXXX-March 2018) • Ph.D., Physics, Washington State University, 1976 • Simecek-Beatty, D. and W. Lehr (2017) "Extended oil spill spreading with Langmuir circulation," *Marine Pollution Bulletin*, 122, 1-2, 226-235. • Beegle-Krause, C.J. and W. Lehr (2015) "Oceanographic and Meteorological Effects on Spilled Oil" in *Handbook of Oil Spill Science and Technology*. Wiley publishing. • Lehr, W., A. Aliseda, E. Overton, and I. Leifer, "Computing Mass Balance for the Deepwater Horizon Spill," in Proceedings of the 2011 International Oil Spill Conference, Vol. 2011, No. 1 (March 2011). • Author or co-author for over 100 published scientific articles on oil spills, in peer-reviewed journals, conference proceedings, technical reports, or chapters in technical books. • Project co-lead for Deepwater Horizon Oil Budget Calculator, produced by an Interagency task force to estimate and record mass balance of spilled oil and effectiveness of various oil spill response strategies. • Project lead for ADIOS oil spill behavior program.	SME	G	G	SME	SME
Key: SME: Primary area(s) of expertise/experience G: Good knowledge/experience L: Limited knowledge/experience — No knowledge/experience						

Each of the three expert peer reviewers had provided a completed COI questionnaire and a signed NDA. In consultation with the BSEE COR (Mr. Steve Pearson), the Peer Review Materials Package sent by EnDyna to each of the three expert peer reviewers also included the following statement:

Conflict of Interest – Impartiality

Your signature on your Conflict of Interest (COI) Form certifies that you, as a peer reviewer, will provide an impartial, technically sound, objective review, or in other words, not provide a biased opinion in responding to BSEE's Charge Questions and in providing general impressions.

1.3 Peer Review Objective and Scope

The objective of this external letter-style peer review was for BSEE to receive comments from individual experts on the Nuka Research report entitled, *Gulf of Mexico Oil Spill Response Viability Analysis Interim Report*. This letter-style peer review was technical in nature, reviewing the methods, data quality, the strengths of any inferences made, and the overall strengths and limitations of the study.

BSEE Charge for the Scope of this Peer Review
BSEE had carefully defined the scope of this peer review for the Nuka Research report in order to focus the peer review process effectively on BSEE's Charge Questions. The peer reviewers were directed to keep their written comments within the BSEE scope, which is defined below:

The scope of the peer review is focused on the methodology used in this study for response viability analysis, along with the assumptions, inputs, and results of that analysis. As such, the peer reviewers should focus on providing comments on the technical nature of the report. Because the peer review is technical in nature, the peer reviewers should not focus on editorial style.

A response viability analysis estimates the percentage of time that conditions in a particular area would be favorable, marginal, or not favorable to the deployment and operation of a particular response system. Peer reviewer comments should focus on the following seven (7) oil spill response systems selected by BSEE for analysis in this study and the following five (5) metocean conditions for response deployment in the Gulf of Mexico:

Selected oil spill response systems:

1. Mechanical Recovery – Two Vessels with Boom
2. Mechanical Recovery – Single Vessel with Outrigger
3. Mechanical Recovery – Three Smaller Vessels with Boom
4. Dispersants – Vessel Application
5. Dispersants – Fixed-wing Application
6. Dispersants – Helicopter Application
7. In-situ Burning – Vessels with Fire Boom

Metocean conditions for response deployment:

1. Wind speed
2. Wave height
3. Daylight/darkness
4. Horizontal visibility
5. Vertical visibility (cloud ceiling)

BSEE is not interested in suggestions for alternative oil spill response systems or alternative metocean conditions for response deployment; the research for this study is completed.

1.4 Peer Reviewer Questions and BSEE Responses

The *BSEE Peer Review Process Manual* provides that BSEE may consult the research product authors or other BSEE subject matter experts (SMEs) in order to appropriately address peer review comments. The EnDyna Peer Review Lead coordinated with the BSEE COR, Mr. Steve Pearson, to submit peer reviewer questions to BSEE, obtain BSEE's written answers to those peer reviewer questions, and distribute them to all three peer reviewers.

On April 10, 2018, the EnDyna Peer Review Lead contacted the three (3) peer reviewers and requested that if any peer reviewers had any major scientific/technical questions after initial review of the peer review materials that the reviewers provide a concise narrative of their question(s) by April 23, 2018. Any such major scientific/technical questions had to be directly related to improving a reviewer's ability to respond effectively to a specific Charge Question, and also be within the BSEE Charge for the Scope of this Peer Review (see Section 1.3). The EnDyna Peer Review Lead reviewed and, as appropriate, compiled four relevant (e.g., within scope) peer reviewer questions, with the identity of each peer reviewer kept anonymous, and sent them to the BSEE COR (Mr. Pearson) requesting written answers.

Section 6 (Appendix B) presents the four relevant (e.g., within scope) peer reviewer questions that were compiled by the EnDyna Peer Review Lead and submitted to BSEE on April 24, 2018 as well as the written BSEE responses received by the EnDyna Peer Review Lead on May 3, 2018. The EnDyna Peer Review Lead distributed these peer reviewer questions and written BSEE responses to all three peer reviewers on May 4, 2018 to help ensure that the peer reviewers had sufficient information for an effective peer review.

In addition, BSEE will use the written answers to the peer reviewer questions in Section 6 (Appendix B) along with internal BSEE expertise in developing BSEE's responses to the external peer review comments provided in this peer review summary report.

1.5 Organization of Report

This peer review report is comprised of seven sections, as listed below:

- ***Section 1*** describes the process for this external letter-style peer review.
- ***Section 2*** presents the charge questions sent to each of the peer reviewers for comments.
- ***Section 3*** includes the synthesis of the peer reviewer comments.
- ***Section 4*** provides the peer review comments of each reviewer organized by charge question.
- ***Section 5*** (Appendix A) consists of the individual peer reviewers' comments.
- ***Section 6*** (Appendix B) provides the questions from the peer reviewers and written BSEE answers to the peer reviewer questions.
- ***Section 7*** (Appendix C) notes that the peer review materials packages were attached separately.

2. CHARGE QUESTIONS

The objective of this external letter-style peer review was to obtain written peer review comments from individual experts on the Nuka Research report entitled, *Gulf of Mexico Oil Spill Response Viability Analysis Interim Report*. Each peer reviewer was charged with evaluating the Nuka Research report, providing their overall impressions of the scientific merit of this interim final report, and responding to the nine (9) charge questions presented in Table 2.1 below.

Table 2.1. Charge Questions
1. Were the objectives of the report clearly defined? If not, what are your recommendations for improving the description of the objectives?
2. Was the methodology used for the oil spill response viability analysis (Sections 2 and 3) appropriately designed and clearly described? Were there any apparent weaknesses, omissions, or errors? Provide an explanation for your answers.
3. Were the limitations of the approach (Section 3.3) clearly identified and described? If not, what are your recommendations for improving the description of the limitations of the approach (Section 3.3)? Also comment on whether the limitations of the approach were addressed throughout the report in a thorough and understandable way in order for the reader to evaluate the impact of limitations on this study's analysis or results.
4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.
5. Were the inputs used for the metocean data and were the five (5) metocean conditions included in the study based on modeled data used (Sections 3 and 4) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.
6. Were the results (Section 6, Appendices A and C) of the oil spill response viability analysis conducted for each of the seven (7) selected oil spill response systems appropriate and clearly described? Were the associated graphical outputs clearly presented? Provide an explanation for your answers.
7. Were there any critical results or limitations not discussed or adequately addressed in the report?
8. Were the study findings and discussion (Section 7) and conclusions (Section 8) logical and appropriate based on the results? Are there any additional study findings or conclusions that could be drawn? Provide an explanation for your answers.
9. Does this report present sufficient new data and knowledge, and are the study findings useful for informing oil spill response planning?

3. SUMMARY OF PEER REVIEWER COMMENTS

This section provides a synthesis of the peer reviewers' comments, including general impressions (see Section 3.1) and responses to the charge questions (see Section 3.2). This synthesis was based on the individual peer reviewer's final written peer review comments (see Section 5 (Appendix A)).

Throughout Section 3, each reviewer is represented by initials, typically placed at the end of text related to a reviewer's comments. The initials representing the three expert peer reviewers, as used throughout Section 3, are described below:

- VB represents Dr. Victoria Broje,
- JH represents Mr. James Hanzalik, and
- BL represents Dr. Bill Lehr.

3.1 General Impressions

The reviewers were asked to provide overall impressions of the Nuka Research report entitled, *Gulf of Mexico Oil Spill Response Viability Analysis Interim Report* (Nuka Research report), addressing the accuracy of information presented, clarity of presentation, and soundness of conclusions. The three expert peer reviewers provided varied comments regarding general impressions of the Nuka Research report, which are summarized below.

All three reviewers generally agreed that the Nuka Research report adequately addressed BSEE's required scope for this study:

- One reviewer commented that the Nuka Research report represented "a yeoman's effort" to assemble existing metocean databases and process the data into easily understood seasonal charts, which the reviewer stated were suitable for the target audience. This reviewer acknowledged that because the Nuka Research report kept within BSEE's required scope for this study, much detailed and available information was not used in this study.[BL]
- Another reviewer stated that the Nuka Research report addressed the BSEE project scope as it was defined, and also commented that the report used approaches and methodologies used in previous similar studies.[VB]
- One reviewer acknowledged that the response systems were dictated by BSEE in this study, and commented that the Nuka Research report accurately, for the most part, detailed the limitations of the mechanical recovery, dispersant, and in-situ burn equipment systems and weather data used in this study. This reviewer commented that this study had solid methodology and was comprehensive in its approach, although limited in scope to achieve its goals. This reviewer believed that the Nuka Research report provided a fair and accurate past documentation of GOM weather patterns and of future effectiveness of an oil spill response using those BSEE-specified response systems in the GOM.[JH]

<u>Presentation of Report</u>

Two reviewers commented on the presentation of the report.[VB,JH] One reviewer stated that the Nuka Research report was written in "clear language" with "good graphic visualization" of the results.[VB] Another reviewer commented that the Nuka Research report was "an easy read," and was "well presented." This reviewer believed that overall the Nuka Research report was "very well written."[JH]

Selection of Response Systems and Operating Limits

The reviewers provided varied comments regarding the selection of response systems and operating limits for this study. One reviewer generally supported the approach, but acknowledged that the response systems were dictated by BSEE in this study.[JH] One reviewer supported the selection of response systems; however, this reviewer expressed concerns about the approach for selecting operating limits.[VB] Another reviewer, while acknowledging that the Nuka Research report kept within BSEE's required scope for this study, expressed concerns about the broad grouping of response system options and the broadly categorized operating environment (weather conditions), as well as the pre-defined operating limits.[BL]

The reviewer that generally supported the approach noted that weather conditions, optimum or inclement, have had an effect on the efficiency and effectiveness of oil spill response equipment under such various weather conditions. This reviewer believed that the Nuka Research report was the first study that took a comprehensive approach to all response methods, and tied in weather and time of day in the GOM. The reviewer commented that the Nuka Research report provided a general and objective account of certain oil spill response methods, as specified by BSEE, and how they could be affected by past and potential future weather in the GOM.[JH]

The reviewer that supported the selection of response systems, but expressed concerns about the approach for selecting operating limits, commented that the response systems evaluated in this study illustrated good diversity of possible types of response operations. This reviewer observed that the Nuka Research report was missing both clear references and a rationale for selection of the operating limits for the selected response systems. This reviewer argued that those operating limit parameters were fundamental for this study's results and conclusions. Because the reviewer had questions about the values used for some of the selected response systems (see Charge Question #4), the reviewer recommended that selection of operating limits should be carefully verified, and a rationale and references for selecting the operating limits should be provided where possible in the Nuka Research report.[VB]

The reviewer that expressed concerns about the broad groupings for parameters in this study stated that oil spill response effectiveness is a function of three broad input categories:

1) Operating environment,
2) Properties and amount of the spilled product, and
3) Characteristics of the response system.

Acknowledging that the Nuka Research report kept within BSEE's required scope for this study, this reviewer commented that the Nuka Research report ignored category two (2) and divided the other two categories above using "a very coarse screening matrix." This reviewer provided the following examples of broad groupings for parameters in this study:

- Skimmers were grouped into three choices related to the skimming platform that ignored the actual skimmer type,
- Wave spectrum model results that return more than a dozen wave frequencies in a similar number of directions were reduced to a single number (significant wave height), and
- Dispersant efficiencies that are a strongly non-linear function of wave energy were represented by a three-value step function.

This reviewer concluded that much detailed and available information was not used in the Nuka Research report.[BL]

Three Viability Categories

Two reviewers commented on the three categories (favorable, marginal, and not favorable) for oil spill response viability used in the Nuka Research report. One reviewer supported using these three categories,[JH] while another reviewer expressed concerns about the meaning and interpretation of the "marginal" category.[VB]

The reviewer that supported using the three categories commented that the use of red, yellow, and green (favorable, marginal, and not favorable) for the different response systems in the methodology made it easy "to get a general snapshot of if and when a system may be used or effective." Overall, this reviewer believed that the Nuka Research report provided a fair and accurate representation of future effectiveness of an oil spill response in the GOM using those response system specified by BSEE for this study.[JH]

The reviewer that expressed concerns about the meaning and interpretation of the "marginal" category stated that the division of viability ranges for favorable, marginal, and non-favorable made sense and was easy to calculate mathematically. This reviewer emphasized; however, that the operational meaning of "marginal" was different for different response systems and parameters. The reviewer recommended that the Nuka Research report should carefully evaluate the meaning and interpretation of this "marginal" category. The reviewer noted that it appeared the "marginal" category was used in the Nuka Research report to cover situations when response systems can be used, but with decreased efficiency. Yet the reviewer also noted that the Nuka Research report stated on page 2 that:

> "This study does not consider the impact of the above conditions – or others – on … response efficiency or effectiveness. …Instead, this study focuses on whether conditions would affect the deployment or general operations of a response system."

This reviewer commented that some of the "marginal" metocean conditions did affect the ability to deploy response systems (e.g., wave height), but some of the other "marginal" conditions only affected the effectiveness of oil recovery, not the operation of the response systems as such (e.g., visibility for mechanical recovery). The reviewer argued that BSEE must carefully consider the current equal treatment of parameters affecting operations and parameters affecting recovery/dispersion efficiency in the Nuka Research report and whether visibility should be separated from the operational parameters, at least for on-water assets. This reviewer provided more detailed comments under Charge Question #4.[VB]

Potential Missing Category: Response is not possible, but not needed due to natural dispersion

One reviewer stated that some challenges will occur with interpretation and practical utilization of the results from the Nuka Research report, especially by the general public, related to misinterpretation of situations when response is not possible, but needed because oil is on the surface, versus when response is not possible, but not needed because there is not any oil on the surface. The reviewer expressed concerns that the Nuka Research report did not distinguish between these two situations.

This reviewer noted that natural dispersion/attenuation is an important process in the GOM and is, in fact, a baseline to which other response techniques should be compared to. The reviewer stated that focusing this study only on response techniques, without a natural baseline, may lead to misinterpretation of study results. The reviewer commented that it would be useful to also map environmental conditions resulting in oil not being present on the surface due to natural dispersion and not requiring response activities. This reviewer argued that such mapping would make the "gap" when oil is present on the surface and requires response, but response techniques are not available, more visible and this "gap" would have greater operational meaning. This reviewer provided related comments under Charge Question #4 and Charge Question #6.

This reviewer observed that it seemed an overarching intent of this study was: "Do we have response tools and techniques to respond to an oil spill in GOM?." The reviewer emphasized that oil spill response systems are not mutually exclusive, and noted that the Nuka Research report presented the results for different response techniques individually, as if they were mutually exclusive, and not as a "toolbox" as they are actually used. This reviewer stated that oil spill response systems are complementary and act with greater success in various weather ranges. As an example, the reviewer explained that when mechanical recovery starts to fail, dispersants become most effective.

This reviewer commented that recognizing response techniques are not mutually exclusive in the Nuka Research report may better illustrate actual oil spill response capabilities to the public and clearly show the time when response is needed, but no response technique is available due to weather limitations. In an operational sense, the reviewer argued that response techniques cover both ends of the wave/wind spectrum and that a gap between them as a "toolbox" is smaller than if it was calculated and mapped for each response technique individually. The reviewer suggested that the results section of the Nuka Research report would benefit from an additional set of maps and diagrams showing when at least one response technique was available.[VB]

<u>Usefulness for Oil Spill Response Planning or Regulatory Decision-Making</u>

All three reviewers provided comments with caveats about the usefulness of the Nuka Research report for oil spill response planning or regulatory decision-making:

- One reviewer, as noted above, commented that the seasonal charts were easily understood and suitable for the target audience. This reviewer; however, was unsure whether the results from the Nuka Research report, given the pre-defined operating limits, will prove to be useful.[BL]
- Another reviewer commented that the analysis in the Nuka Research report provided useful insights for response professionals, but this reviewer also stated that because of concerns identified by the reviewer (e.g., the meaning and interpretation of the "marginal" category), the results should not be used "as is" for response or regulatory decision-making, or by the general public, without careful issue-specific interpretation by professionals.[VB]
- One reviewer commented that the Nuka Research report from a practical viewpoint provided some sense of the limits of the use of those response systems specified by BSEE for this

study. The reviewer; however, stated that this study has limited value for any specific oil spill response scenario in the GOM:

- From an overall oil spill response planning perspective, the reviewer commented that the Nuka Research report provided a general sense of response effectiveness based on weather conditions for response systems and could be used to provide an "overall practical response factor" for a given system in a seasonal weather "window" in a particular area of the GOM.
- From a regulatory sense, the reviewer commented that the Nuka Research report provided some value in prescribing types of equipment that could be effective in the GOM based on past weather patterns.
- From an actual response perspective, acknowledging this was not a goal of this study, the reviewer commented that the Nuka Research report provided little value based on the timing of oil spills and the real-time weather that may be forecasted and the systems employed for actual oil spill responses.[JH]

3.2 Responses to Charge Questions

The section below provides the synthesis of the three peer reviewers' comments, concerns, and suggestions regarding the charge questions.

1. Were the objectives of the report clearly defined? If not, what are your recommendations for improving the description of the objectives?
The reviewers varied in their responses about whether the objectives of the report were clearly defined.[VB,JH,BL] One reviewer provided a recommendation to improve the description of the objectives,[VB] and another reviewer provided a recommended summary of what this reviewer believed was the overall objective of this study.[JH] • One reviewer stated that the objectives of the Nuka Research report were expressed succinctly in Section 1.1, Project Scope. This reviewer noted that the Nuka Research report produced a viability analysis for the GOM Region.[BL] • Another reviewer commented that this study's objectives as such were not specifically stated in the report, but the reviewer acknowledged that the objectives could be guessed from the executive summary and introduction sections. This reviewer recommended that the Nuka Research report should start with a section describing goals, objectives, scope, limitations, and the intended use for this study.[VB] • Another reviewer commented that the objectives of the report were not clearly stated and recommended that the description of the objectives could be improved, as summarized below.[JH] The reviewer that commented that the report's objectives were not clearly stated and recommended improving the description of the objectives, stated that the Nuka Research report had assumed that the objectives were "a viability analysis of response systems given weather conditions in various areas of the GOM." Instead, this reviewer believed that the overall objective of this study and the Nuka Research report was to: "Based on specifically defined oil spill response systems with specified limitations for the study, and based on published standards based the last ten years of captured weather data, this

1. Were the objectives of the report clearly defined? If not, what are your recommendations for improving the description of the objectives?
study provides a general seasonal effectiveness of those systems in specified areas of the GOM under past weather conditions. Specifically: • Using specified response systems used in most of the areas of the U.S., this study defines the optimum timeframes for their use under certain weather and daylight conditions; • It uses captured government meteorological data from 2005-2014 to provide a basis for the weather that could be seen in the future in an oil spill response in the GOM; • It synthesizes weather and astronomical data in areas of the GOM and specific chosen equipment effectiveness to provide a general overall analysis of oil spill response equipment “windows;” • That ultimately provides an additional planning factor for oil spill response plans given oil type, size, and other planning factors.”[JH]

2. Was the methodology used for the oil spill response viability analysis (Sections 2 and 3) appropriately designed and clearly described? Were there any apparent weaknesses, omissions, or errors? Provide an explanation for your answers.

One reviewer stated simply that the methodology used for the oil spill response viability analysis (Sections 2 and 3) was appropriately designed and clearly described.[VB] Another reviewer commented that the methodology was a very strong point of this study, although this reviewer took the metrological data at face value along with the pre-defined response systems used and their pre-defined limitations; however, this reviewer identified some exceptions as summarized below.[JH] Another reviewer acknowledged that the choice of methodology (e.g., three response viability categories) was to a large extent dictated by BSEE; however, this reviewer expressed concerns about the methodology as summarized below. As a more general comment about the methodology used for the oil spill response viability analysis, this reviewer noted that some of the methodology's requirements seemed arbitrary because the reviewer observed such requirements were announced with little additional explanation in the Nuka Research report.[BL]

With respect to the three response viability categories, one reviewer commented that the use of red, yellow, and green (favorable, marginal, and not favorable) for the different response systems in the methodology made it easy "to get a general snapshot of if and when the defined response system may be used or effective."[JH]

Sensitivity Analysis

One reviewer expressed concerns about the approach for sensitivity analysis used in the methodology for the oil spill response viability analysis. This reviewer stated that the sensitivity analysis method employed in this study appeared to involve "increasing the green or yellow limits for each response system and seeing how the resulting color fractions change." As an example, the reviewer commented that the result was essentially that increased wind or wave states (similar for the other parameters) would be included in the green (or yellow) category. This reviewer stated that this was a much reduced approach compared to traditional sensitivity analysis that would examine the functional dependence of the normalized first derivative (e.g., "Sensitivity analysis in oil spill models: Case study using ADIOS," Overstreet et al., IOSC 1995).[BL]

Potential Bias/Credibility Issues

One reviewer stated that the Nuka Research report produced seasonal spatial maps of viability conditions and weekly charts of viability conditions for a single point in each of the six regions. This reviewer expressed concerns about why this element of the methodology was restricted to a single point instead of using an average of all the grid points for each region. The reviewer argued that choosing a single point in each of the six regions would open the results to bias if the chosen point was not representative of the region.[BL]

2. Was the methodology used for the oil spill response viability analysis (Sections 2 and 3) appropriately designed and clearly described? Were there any apparent weaknesses, omissions, or errors? Provide an explanation for your answers.

Another reviewer expressed concerns about the credibility of this study's results for vertical visibility (Section 3.2.4) because of the four airports[2] around the GOM that were selected to obtain cloud ceiling data for the methodology. This reviewer commented that there are primarily two airports (Houma Terrebonne, LA, and Stennis, MS) and a total of three airports (also Galveston, TX) where aerial dispersants have been and are deployed in the GOM. The reviewer argued that this study would have better credibility by using those three airports (Houma Terrebonne, LA; Stennis, MS; Galveston, TX) versus the four airports selected to obtain cloud ceiling data for the methodology.[JH]

<u>Arbitrary Decision about 200-meter Bathymetry Line</u>

Two reviewers expressed concerns about the use of the 200-meter bathymetry line to apply an approximate bisection of each planning area into "nearshore" and "offshore" for the purposes of this study.[JH,BL] Those concerns are summarized below.

As noted above, one reviewer commented that some of the methodology's requirements seemed arbitrary because the reviewer observed such requirements were announced with little additional explanation in the Nuka Research report. As an example, this reviewer stated that there was presumably a reason to define the 200-meter bathymetry line as the divider between nearshore and offshore, but this reviewer observed that no reason was given in the Nuka Research report other than BSEE agreed to it. The reviewer commented that alternatives exist and pointed out that the Nuka Research report stated in a footnote at the bottom of page 10 that other options were considered for dividing the planning areas for the purpose of this study.[BL]

Another reviewer commented that the 200-meter bathymetry line was somewhat arbitrary. This reviewer argued that the 200-meter bathymetry line served no use in this study based on the pre-defined limitations of the pre-defined response systems in the methodology. The reviewer also noted that the weather parameters were stated and the equipment systems were fixed (e.g., logistics) for this study. The reviewer stated that most of the response systems specified in the methodology would operate at the same efficiency and effectiveness on both sides of the 200-meter bathymetry line. This reviewer recommended removing the 200-meter bathymetry line delineation because it served no real technical purpose in this study.[JH]

<u>Dispersants</u>

[2] The Nuka Research report states on page 19: Four airports were selected because they are near the shore and generally distributed around the study area. These are: Louis Armstrong Airport (Louisiana), Scholes International (Texas), Apalachicola Regional (Florida), and St. Petersburg-Clearwater Airport (Florida). (See Figure 4-4.) Data are from the same time period (2005-2014) as the gridded dataset.

2. Was the methodology used for the oil spill response viability analysis (Sections 2 and 3) appropriately designed and clearly described? Were there any apparent weaknesses, omissions, or errors? Provide an explanation for your answers.
One reviewer commented that it appeared that the Nuka Research report assumed a linear decrease in oil spill response viability with wind and/or waves. However, as this reviewer also commented about under Charge Question #4, the effectiveness for chemical dispersants is not linear with respect to wind and/or waves. This reviewer commented that this assumption of a linear decrease in oil spill response viability also may not work exactly for other response systems in this study because the reviewer stated that their effectiveness is not strictly linear in relation to the metocean parameters. The reviewer acknowledged; however, that in fairness to the Nuka Research report, their method may be sufficient given this study's limitation of oil spill response viability to a three-value step function for dispersants.[BL] Another reviewer acknowledged (as noted above) taking the metrological data at face value along with the pre-defined response systems used and their pre-defined limitations; however, this reviewer identified the following areas in the Nuka Research report where the reviewer identified concerns with the methodology used for dispersants in the oil spill response viability analysis: • Page 5, Section 2.2, third paragraph, the Nuka Research report stated – "If there is abundant natural wave energy, adding chemical dispersants may not be necessary." The reviewer generally agreed with this statement, but commented that it was situational dependent specifically with respect to a defined quantity spill versus an unsecured source. The reviewer recommended removing this sentence based on MC-252 spill experience where dispersants were used in a high wave energy environment due to an unsecured source. • For Table 2-1 under "Metocean Conditions and High air temperature" under the "Dispersants" column, the Nuka Research report stated – "Optimal storage temperatures may be exceeded." The reviewer stated that the boiling point of most dispersants is 140 degrees Celsius and explained that most dispersants do not recommend a specific storage temperature. This reviewer stated that dispersants were stored on deck during MC-252 for vessel spraying, and stored in large tanks in direct sunlight on the tarmac for aerial application in the middle of summer in 90 degrees Fahrenheit plus heat, and this had no effect on the efficacy of the dispersants used. The reviewer noted that Nalco, the manufacturer of Corexit Products stated: "COREXIT products can retain a nearly unlimited shelf life as long as the product has remained in their original sealed containers and contamination has been prevented." Because the reviewer did not consider this a relevant factor, the reviewer recommended that "Optimal storage temperatures may be exceeded" should be changed to "Not Applicable."

2. Was the methodology used for the oil spill response viability analysis (Sections 2 and 3) appropriately designed and clearly described? Were there any apparent weaknesses, omissions, or errors? Provide an explanation for your answers.

- For Table 2-2 under the column for "Metocean Conditions and Sea state" under "Aircraft Operations," the Nuka Research report stated – "Extremely high waves could impact low flying helicopter."

  The reviewer explained, based on the reviewer's experience, that helicopters and fixed wing aircraft spray dispersants at 50-100 feet AGL (above ground limit). The reviewer commented that if waves are that high, oil spill responders would probably not be flying in those weather conditions. The reviewer also stated that currently (although this could change) there are no helicopter spray systems in the GOM for dispersant application. The reviewer recommended that "Extremely high waves could impact low flying helicopter" should be changed to "Not Applicable" for the GOM.

- For Table 2-2 under the column for "Metocean Conditions and Darkness" under "Aircraft Operations."

  The reviewer commented that dispersants are not aerially sprayed in darkness and this reviewer did not see any changes in this current practice due to safety concerns. The reviewer recommended changing "Ability to carry out mission due to lack of visibility" to "Not Applicable."

- For Table 3-2 under "System" for "Dispersants – Helicopter Application" under "Method," the Nuka Research report stated – "Change darkness from red to yellow."

  The reviewer recommended this should be left red (versus yellow), due to safety conditions and the ability of aircraft to see at night and the limited range of helicopters with a dispersant payload.[JH]

<u>Mechanical Recovery</u>

The reviewer that acknowledged (as noted above) taking the metrological data at face value along with the pre-defined response systems used and their pre-defined limitations, also identified the following areas in the Nuka Research report where the reviewer identified concerns with the methodology used for mechanical recovery in the oil spill response viability analysis:

- For Table 2-1 under "Metocean Conditions and High air temperature" under the "Mechanical Recovery" column.

  The reviewer recommended replacing the "Not Applicable" with "Health effects due to high VOCs." The reviewer noted there could be a problem with high volatile organic compounds (VOCs) for mainly crude oil, which could keep workers "sheltered in place" for periods of time, especially during the initial stages of a spill or for unsecured sources.

2. Was the methodology used for the oil spill response viability analysis (Sections 2 and 3) appropriately designed and clearly described? Were there any apparent weaknesses, omissions, or errors? Provide an explanation for your answers.
• For Table 2-2 under the column for "Metocean Conditions and Darkness" under the "Vessel Operations" column. The reviewer observed that the Nuka Research report stated that for mechanical recovery those systems are equipped with adequate detection systems, and pointed out with such systems then darkness or low light conditions would have less of an effect. The reviewer recommended that during periods of "low light" there is a "decreased ability to target and maintain operations to recover oil."[JH]

3. Were the limitations of the approach (Section 3.3) clearly identified and described? If not, what are your recommendations for improving the description of the limitations of the approach (Section 3.3)? Also comment on whether the limitations of the approach were addressed throughout the report in a thorough and understandable way in order for the reader to evaluate the impact of limitations on this study's analysis or results.

Two reviewers commented that overall the limitations of the approach (Section 3.3) were clearly identified and described in the Nuka Research report; however, each of those two reviewers identified a limitation that could be addressed in the report more thoroughly to allow readers to evaluate the impact of limitations on this study's analysis or results.[JH,BL] More specifically for those two reviewers:

- One reviewer stated that the limitations of the approach for this response viability analysis that this study would provide a "useful" tool for oil spill response planning were clearly defined and explained. This reviewer emphasized that the limitations of the approach for this study would also confine the use of this study as a planning tool to those response systems included in this study.[JH]
- The other reviewer stated that Section 3.3 did "a robust job" of listing many of the limitations of the approach used in the Nuka Research report. The reviewer commented that Section 3.3 had noted that logistics and other practical constraints may change the response viability analysis determined by metocean conditions. The reviewer pointed out that the sixth paragraph (Simplified incorporation of response degradation) on page 13 under Section 3.3 recognized the fact that the metocean conditions themselves may change between the time when the spill occurs and the time when equipment could be deployed onsite. This reviewer suggested, although acknowledging it would be outside the scope of this study, that the impact of this effect could have been estimated by mapping the average duration of each metocean category over the geographical grid.[BL]

The other reviewer did not comment specifically about whether the limitations of the approach were clearly identified and described; however, this reviewer provided recommendations for improving the description of the limitations of the approach.[VB]

The subsections below summarize the three reviewer's recommendations for improving the description of the limitations of the approach in the Nuka Research report.

<u>Broad Grouping of Response System Options</u>

The reviewer that stated Section 3.3 did "a robust job" of listing many of the limitations of the approach used in the Nuka Research report, also identified one limitation that this reviewer recommended required further discussion: the broad grouping of response system options. This reviewer expressed concerns that this study's broad assignment of response system options to groups would mask the significant variability found within each grouping.

As an example of the broad grouping of response system options, the reviewer commented that the CONCAWE field guide notes that disk skimmers may work with 3-meter wave heights, while other skimmers require smaller waves. As another example, the reviewer commented that similarly different fire booms for in-situ burning will have different metocean requirements.

3. Were the limitations of the approach (Section 3.3) clearly identified and described? If not, what are your recommendations for improving the description of the limitations of the approach (Section 3.3)? Also comment on whether the limitations of the approach were addressed throughout the report in a thorough and understandable way in order for the reader to evaluate the impact of limitations on this study's analysis or results.

This reviewer also expressed concerns that the broad assignment used in this study's approach also applied to the metocean conditions themselves. As an example, this reviewer commented that chop waves have a different impact on mechanical recovery than swells of the same height. As another example, the reviewer commented that a particular grid location may be suitable for in-situ burning depending not only upon wind speed but also wind direction as soot impact on coastal areas would be different.[BL]

Clarification of "Marginal"

One reviewer commented that the interpretation of "marginal" could be clarified because this reviewer observed that the interpretation of "marginal" was different for different response systems and parameters in this study. The reviewer noted that for some response systems, "marginal" may mean standard operation at slightly reduced efficiency (mechanical recovery at night), but for other response systems "marginal" may mean that they cannot be used for some portions of the time or operations could be substantially compromised (mechanical recovery by smaller systems in "marginally high" waves).[VB]

Lower Salinity Waters and Dispersants

The reviewer that stated the limitations of this study's approach for response viability analysis that it would provide a "useful" tool were clearly defined and explained, also commented about one of the limitations described in the Nuka Research report on page 14 under Section 3.3: "it is generally accepted that dispersants are less effective in lower-salinity waters." This reviewer commented that would be a true statement in the general sense, but the reviewer expressed concerns that this statement was not practical for the GOM.

The reviewer explained that the EPA standard for effectiveness for dispersants is 50% or greater to be listed on the EPA Product Schedule. The reviewer further noted that most dispersants used in the GOM are in excess of 80-90% effectiveness or greater, and higher with the crudes extracted in the GOM.

The reviewer expressed concerns that with the lower water salinity in the GOM, it could be inferred that a higher dispersant effectiveness would negate the limitations based on lower-salinity waters. The reviewer commented that given the tradeoffs for dispersant use and practically speaking, lower water salinities in the GOM would not override dispersant use. The reviewer stated that of all the dispersant operations conducted historically in the GOM, no dispersant operation conducted was limited by water salinity but rather limited based on the dispensability of the oil to be treated.[JH]

3. Were the limitations of the approach (Section 3.3) clearly identified and described? If not, what are your recommendations for improving the description of the limitations of the approach (Section 3.3)? Also comment on whether the limitations of the approach were addressed throughout the report in a thorough and understandable way in order for the reader to evaluate the impact of limitations on this study's analysis or results.

Subsea Dispersants Injection (SSDI)

One reviewer recommended that the Nuka Research report should provide the rationale behind selecting seven (7) specific response systems as well as the rationale behind exclusion of other potential response techniques from this study. For example, this reviewer specifically pointed out that subsea dispersants injection (SSDI)) was excluded from this study. The reviewer commented that the absence of SSDI will be noticed by readers of the Nuka Research report and recommended that limitation should be explained in the report.

This reviewer commented that SSDI is one of the existing response techniques uniquely relevant for the GOM. The reviewer emphasized that understanding SSDI operational limits and response viabilities would be as important for the GOM as understanding operating limits for other oil spill response techniques. The reviewer commented that it could be argued that in-situ burning with the use of herders was not included in this study due to its limited availability in the GOM, the fact that it is not presently included in contingency plans, and regulatory approval processes are not readily available. The reviewer expressed concerns that, in contrast, SSDI capabilities in the GOM are well established, available 24/7, and the process for seeking regulatory approval and monitoring techniques exist and have been practiced in exercises.

The reviewer stated that SSDI is especially relevant for the GOM and has its own operational limits based on the ability of the injection vessel to maintain operations in high winds and waves. This reviewer suggested that the same metocean datasets used in this study could easily be used to determine SSDI response viability for the GOM.[VB]

4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.

All three reviewers identified issues associated with the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis.[VB,JH,BL] The reviewers' comments about various weaknesses, omissions, and errors are summarized in the subsections below:

- Relevance of arctic response operating limits to GOM or Deep Water Horizon (MC-252) response in GOM,
- Need clarity about selection of maximum values for operating limits,
- Need references for all operating limits and for effects of metocean conditions on operating limits for response systems,
- Delete irrelevant metocean conditions,
- Reconsider horizontal visibility-related limits,
- Reconsider vertical visibility-related limits,
- Provide better specification of mechanical recovery equipment,
- Need clarification/correction for the dispersant response system operating limits, and
- Need correction for in-situ burning.

Two reviewers suggested the Response Options Calculator was another source of publicly available data, and those suggestions are described in more detail below.[JH,BL]

As an overall summary for this Charge Question, with respect to the operating limits used in the Nuka Research report for the three categories of response systems in this study:

- **Mechanical Recovery:** One reviewer commented that overall the specific mechanical recovery operating limits for wind speed and sea state appeared to use numbers referenced in known literature and were generally appropriate for those types of response systems in the Nuka Research Report. Nevertheless, this reviewer also commented about the need to provide references for all operating limits and for clarity in the report regarding the selection of maximum values for the operating limits (see subsection below).[VB] Another reviewer commented that if the Nuka Research report included better specification of mechanical recovery systems based on the equipment available in the GOM (see examples below under the Mechanical Recovery Equipment subsection), that would provide more credibility to this study and its results.[JH]
- **Dispersants:** Two reviewers recommended that the operating limits for dispersant response systems needed clarification or correction (see Dispersant Response System Operating Limits subsection below).[VB,BL] One of those reviewers also commented about the need to provide references for all operating limits and for clarity in the report regarding the selection of maximum values for the operating limits (see subsection below).[VB] Another reviewer noted that helicopters were not used for dispersant application during MC-252.[JH]
- **In-situ Burning:** One reviewer commented that overall the specific in-situ burning operating limits for wind speed and sea state appeared to use numbers referenced in known literature and were generally appropriate for those types of response systems in the Nuka Research Report.

4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.

Nevertheless, this reviewer also commented about need to provide references for all operating limits and for clarity in the report regarding the selection of maximum values for the operating limits (see subsection below).[VB]

Relevance of Arctic Response Operating Limits to GOM or Deep Water Horizon (MC-252) Response in GOM

Two reviewers commented about issues related to relevance to the GOM, with one of those reviewers questioning the relevance of assumptions for the Arctic to the GOM,[BL] and the other reviewer suggesting that the Nuka Research report authors could have conducted additional research on the response systems used in this study based on past responses (e.g., MC-252) in the GOM.[JH] These comments are summarized below.

One reviewer expressed concerns about how the operating limits were chosen for the Nuka Research report. The reviewer emphasized that selection of operating limits was a key parameter in this study and commented that it was necessary to carefully examine the method for and analysis of operating limits. The reviewer prefaced more detailed comments about the relevance of assumptions for the Arctic to the GOM with the following observations:

- The reviewer pointed to Table 3.1 (page 9) in the Nuka Research report that provided the definitions for the three response viability categories (green/favorable, yellow/marginal, and red/not favorable). This reviewer noted that according to the Nuka Research report (page 8), those definitions in Table 3-1 for the three response viability categories were agreed to at a 2015 Arctic Council Emergency Prevention, Preparedness, and Response Workgroup (EPPR) event that included government, industry, and other organizations.
- The reviewer also commented that the Nuka Research report (page 9 and Section 5.2 on page 21) stated that the actual operating limits for the response systems selected for this study were based upon a panel of experts from an EPPR project on Arctic waters that used published limits where possible.
- The reviewer also pointed to Section 5.2 (page 21) in the Nuka Research report that described two modifications that were made to those Arctic response operating limits. The reviewer noted that the first modification dealt with the limits for sea ice, which is not an issue in the GOM. The reviewer also noted that some wave height limits were modified after consultation with BSEE because the original EPPR study values exceeded ASTM International ratings for boom used in the GOM.

This reviewer commented about the following concerns regarding how the operating limits were chosen for the Nuka Research report:

- The reviewer acknowledged that oil properties *per se* were not in the scope of the Nuka Research report; however, the reviewer commented the Nuka Research report authors still needed to make some assumptions about the spilled product that would be treated during a

4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.

response. The reviewer stated that the EPPR workgroup experts must have implicitly assumed a generic oil that would be transported or produced in Arctic regions in determining their operating limits. The reviewer commented that a similar expert panel looking at GOM oils might arrive at a very different generic oil choice (e.g., most GOM oils are more susceptible to emulsification than most North Sea oils). The reviewer recommended that the Nuka Research report should, at minimum, list the basic oil bulk properties that were assumed in setting the response limits for this study.

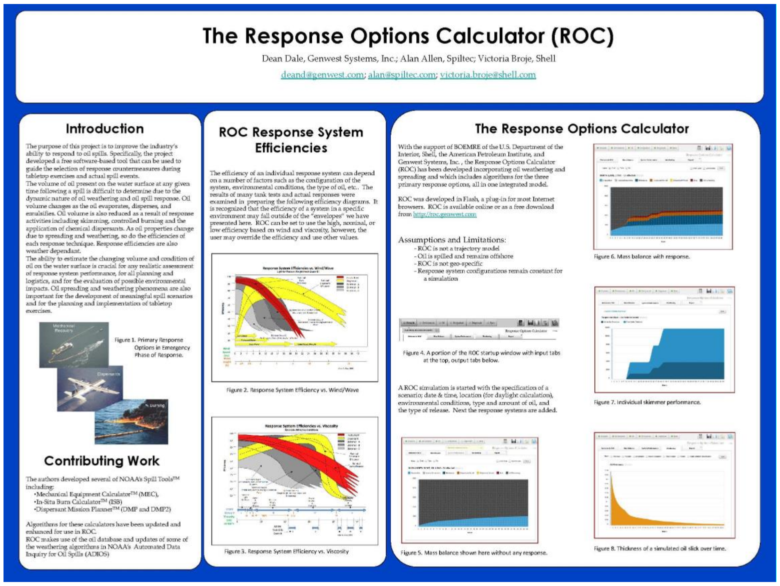
- The reviewer commented that the operating limits used in the Nuka Research Report did not seem to match widely used operating limits in certain cases. More specifically, this reviewer recommended that the operating limits for dispersants needed clarification or correction (see Dispersant Response System Operating Limits subsection below).[BL]

The reviewer that suggested that the Nuka Research report authors could have conducted additional research on the systems used in this study based on past responses in the GOM, stated that many of these systems were used extensively with minor modifications during MC-252. More specifically, the reviewer stated that MC-252 had especially used the mechanical recovery systems and the aerial dispersants, but not helicopters for dispersant application. This reviewer explained under Charge Question #2 that currently (although this could change) there are no helicopter spray systems in the GOM for dispersant application.

This reviewer commented that, based on experience with MC-252, at waves of 5 feet and higher, offshore mechanical recovery (skimming) was suspended for all areas of the GOM during MC-252. The reviewer acknowledged that this suspension of mechanical recovery operations may have been a safety consideration; however, the reviewer argued that such operating limits could have been or can be included in this study.

This reviewer referred to what the reviewer described as "Al Allen's/Spiltec diagram, 2009" (see below) that the reviewer stated was used extensively by NOAA in training classes based on this reviewer's experience with MC-252. The reviewer recommended that information from this diagram (see below) could have assisted in further evaluation of the response systems described in the Nuka Research report. This reviewer commented that using information from this diagram (see below) could affect the categorization of all categories of response systems components and the results in Section 5 in the Nuka Research report.

4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.



This reviewer pointed to a specific chart (see below) from the above diagram. The reviewer commented that explanations for the operating limits in the Nuka Research report were very similar to those provided on that chart (see below). The reviewer was not sure if the Response Options Calculator (see diagram above and chart below) was used to determine the operating limits of the equipment for response systems selected for the Nuka Research report. The reviewer stated that this diagram was very accurate in providing the limitations for the use of various mechanical recovery (skimmers), dispersant, and in-situ burning response systems. This reviewer commented that using this information from the Response Options Calculator (see diagram above and chart below) might change the values for operating limits for the mechanical recovery systems selected for the Nuka Research report.[JH]

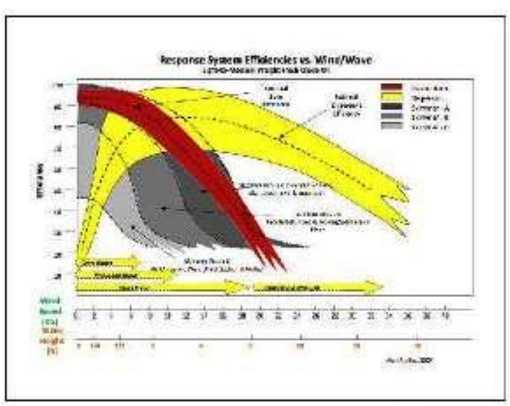


Figure 2. Response System Efficiency vs. Wind/Wave

Chart from Response Options Calculator (see diagram above), provided as illustrative example[JH]

4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.

Need Clarity about Selection of Maximum Values for Operating Limits

One reviewer expressed concerns that the maximum values for operating limits shown in Figure 5-8 and Figure 5-9 in the Nuka Research report were not specified in those charts and thus were not clearly described in the report. The reviewer acknowledged that Figure 5-8 (page 30) in the Nuka Research report showed a “nice visualization” of response system operating limits used in the Nuka Research report, and this reviewer also acknowledged that Figure 5-8 is “likely to be quoted for other reports and operational guidance.” In part because it may be quoted, the reviewer commented that it was unfortunate that the Nuka Research report was not clear about how the maximum values for the bars were selected and also that those values were not specified in Figure 5-8 (page 30) or Figure 5-9 (page 31).

The reviewer pointed to Figure 5-9 (page 31) and asked whether or not this chart might be showing that the maximum value for wind speed was 60 knots and the maximum value for wave height was 20 feet. If those were indeed the maximum values used in this study, the reviewer questioned whether those cutoffs were based on some physical principle. The reviewer stated that all the operating limits used in this study needed a cutoff or maximum value, because at some point the values do not have physical meaning or relevance. The reviewer stated that the Nuka Research report did not clearly describe what the numbers for the maximum values were or how those maximum values were chosen.

The reviewer commented that the red “gap” length in Figure 5-8 (page 30) could be doubled for all response systems used in this study, if a much higher number was randomly selected as a maximum value for the wind speed or wave height parameters. The reviewer recommended using a logical cutoff for Figure 5-8 and Figure 5-9, and commented that using a logical cutoff may also produce some additional information in other relevant charts in the Nuka Research report.

More specifically, the reviewer commented that Figure 5-8 (page 30) in the Nuka Research report showed that periods with wind speed higher than 35-39 knots were “not favorable;” however, the reviewer expressed concerns that the report did not also mention that response systems actually are not needed since oil dispersion is accomplished by natural mixing. The reviewer recommended that the operating conditions or limits, for example, of 35-40 knot wind speeds and 10-foot wave heights (when oil is simply not available on the surface and is being dispersed naturally) should be used as a logical cutoff for all evaluated response systems in Figure 5-8 (page 30). The reviewer argued that beyond this limit, the response viability capabilities of the response systems are irrelevant because no oil is available to recover.

This reviewer stated that providing transparency in the Nuka Research report about operating conditions or limits when no oil is available at the surface to recover is important for identification of improvements that are needed for different response techniques. As an example, the reviewer commented that the Nuka Research report suggested that response efficiency could be improved if

4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.

dispersants could be applied at higher wind speeds and wave heights. The reviewer stated that this is factually not correct because no oil is available at the surface at higher wind speeds and wave heights. The reviewer recommended that the GOM oil spill response viability analysis should be focused on technological improvements for addressing other gaps (e.g., operations at night, or improving skimming encounter rates).

The reviewer commented that wind and waves have a well-known relationship, and referred to https://en.wikipedia.org/wiki/Beaufort_scale as an example. This reviewer observed that Figure 5-8 (page 30) in the Nuka Research report plotted the wind and wave scales next to each other to show relative oil spill response viability limits. The reviewer questioned whether the wind and wave scales were reasonably aligned with each other, or was each plotted up to a randomly selected maximum (and unreported) value, which the reviewer questioned might be skewing the bars.

In concluding comments about the need for clarity in the Nuka Research report regarding the selection of maximum values for the operating limits, this reviewer commented that without revisions that would more adequately characterize the operating limits, Figure 5-8 (page 30) was misleading and identified gaps in areas where such gaps may not be present or relevant. This reviewer stated that at the very least, this issue could be addressed by:

- Stating clearly what the maximum value was for each operating limit used in this study and providing a reference for where each maximum value came from; and
- Introducing an additional bar above the wind and waves bars in Figure 5-8 (page 30), or covering the wind and waves bars with shaded areas in the range higher than the maximum value for each operating limit and marking that specific shaded area as "no action" or "no available oil zone."[VB]

Need References for all Operating Limits and for Effects of Metocean Conditions on Operating Limits for Response Systems

The reviewer that commented about the need for clarity in the Nuka Research report regarding the selection of maximum values for the operating limits, also commented that the Nuka Research report should provide references for all operating limits used in this study. This reviewer provided several reasons for this suggestion to provide references for all operating limits, which are summarized below:

- The reviewer observed that the Nuka Research report had acknowledged there are several sources of this information (e.g., publications by ASTM, Allen, Fingas, SL Ross, IPIECA, Exxon, etc.) with slightly different operating limit values. The reviewer emphasized that it was important that the Nuka Research report be transparent and clarify which sources of information were used for operating limits in this response viability analysis.
- The reviewer observed that the operating limits used in this study appeared to be modified, in some cases, based upon best professional judgment to reflect and contrast performance differences of the response systems evaluated in this study. The reviewer stated that using

4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.

modifications based on best professional judgement was a valid approach; however, this reviewer commented that the Nuka Research report should provide the information necessary to understand the rationale behind these modifications to better understand their performance differences.

- This reviewer pointed to Table 2-1 (page 6) and noted that operating limits for the same response system may be based on different processes as described in that table. As an example, the reviewer pointed to Section 2.2 (page 5) where for in-situ burning the Nuka Research report stated: "Wind and waves must be calm enough to allow for ignition and a sustained burn." The reviewer stated that the main factor affecting the response viability of in-situ burning with the boom is the ability to collect and maintain oil inside the boom, not the ignition process. The reviewer further stated that ignition parameters may depend on oil type and burn efficiencies, which were taken out of the analysis for this study. The reviewer concluded that without providing specific references the Nuka Research report may not provide enough clarity to describe the specific process that this study considered to be limiting for a specific response system.
- The reviewer again pointed to Table 2-1 (page 6) and stated this table would be more informative if it were focused on the specific parameters used in this study and indicated the specific values for the described limitations along with references for those specific values. The reviewer suggested that those revisions to Table 2-1 would make it easier to see how operating limits for the response system were selected from the potential range of limits for different processes.
- The reviewer also commented that Table 2-2 (page 7) would be more informative if it were focused on the specific parameters used in this study and indicated the specific values for the described limitations along with references for those specific values.[VB]

<u>Delete Irrelevant Metocean Conditions</u>

One reviewer suggested deleting two metocean conditions listed in Table 2-1 (page 6): "Fast currents" and High air temperature," for the reasons summarized below:

- The reviewer commented that the metocean condition "Fast currents" was not evaluated in the Nuka Research report. The reviewer explained that fast currents are relevant for river and shoreline booming, but fast currents typically are not relevant for offshore environments. This reviewer commented that fast currents do not affect dispersant application, and that fast currents do not affect in-situ burning and mechanical recovery because both response systems can drift with the spilled oil hence their relative speed to currents can be varied.
- The reviewer commented that the metocean condition "High air temperature" was also not evaluated in the Nuka Research report. The reviewer stated that exceedance of optimal storage temperatures for dispersants "seems to be speculation." The reviewer also stated that even if exceedance of optimal storage temperatures for dispersants did occur, the outcome would relate to dispersion efficiency (which is out of scope for this Nuka Research report) and not the

4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.

> response viability of dispersants.[VB] Another reviewer also provided comments about the relevance of optimal storage temperatures for dispersants in the GOM under Charge Question #2.[JH]

<u>Reconsider Horizontal Visibility-related Limits</u>

Two reviewers questioned the assumption described in the Nuka Research report (page 22) that the horizontal visibility-related limits used in this study included the assumption "that the on-water response systems include some technology to aid the system in targeting the slick in the immediate vicinity during darkness."[VB,JH] These comments are summarized below.

One reviewer expressed concerns that this assumption for detection technology was too limited because it only provided for targeting spilled oil in the immediate vicinity during darkness. This reviewer believed that this assumption would result in making the use of forward-looking infrared (FLIR) / infrared (IR) technology useless in low light conditions unless the target was in close proximity (within 1 mile or less). Given the assumption for such close proximity, this reviewer stated that this limiting assumption for detection technology would essentially not allow mechanical recovery in darkness. The reviewer explained that most detection systems are equipped with X-band radar that would increase the range of the system and make the FLIR/IR much more effective. Based on the reviewer's experience with a recent spill in the GOM, vessels mounted with X-band/FLIR/IR had the ability and were able to effectively mechanically remove oil from the surface during periods of complete darkness. The reviewer stated that 24-hour mechanical recovery (skimming) is possible with X-band radar and adequate FLIR/IR cameras, but with limitations as described in the Response Options Calculator (see diagram above).[JH]

Another reviewer commented that only aerial (plane and helicopter) dispersant operations should be affected by night time operations and classified as "marginal" during periods of darkness. First, this reviewer commented that the Nuka Research report authors may want to reconsider attributing "marginal" conditions to mechanical recovery, in-situ burning, and vessel-based dispersant operations in darkness. The reviewer also noted that the Nuka Research report stated on page 2 that:

> "This study does not consider the impact of the above conditions – or others – on … response efficiency or effectiveness. …Instead, this study focuses on whether conditions would affect the deployment or general operations of a response system."

Second, this reviewer also pointed to the assumption described in the Nuka Research report (page 22) that stated:

> "Horizontal visibility-related limits are included, but these do not include detecting slick location. Instead, they assume that the on-water response systems include some

4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.

> technology to aid the system in targeting the slick in the immediate vicinity during darkness."

The reviewer commented that introducing visibility-based limits to aerial (plane and helicopter) dispersant operations made sense, because they are not in the "immediate vicinity" and would be operationally challenged in applying dispersants to the slick. On the other hand, the reviewer stated that because this study assumed that all on-water response techniques have tools to allow working in the slick in darkness and bad visibility, their deployment and operations would not be affected by darkness—they would have lights allowing them to monitor the immediate vicinity as well as tools to further enhance their capabilities.

This reviewer noted that regardless of whether their effectiveness and efficiency may or may not be affected, the Nuka Research report (page 2) stated that response efficiency or effectiveness parameters were specifically excluded from this study. Consequently, this reviewer concluded that based on project definition and description of response systems capabilities, only aerial systems should be affected by night time operations and marked as "marginal" during periods of darkness.[VB]

Reconsider Vertical Visibility-related Limits

This reviewer commented that it was not clear in the Nuka Research report why on-water response systems would be limited by vertical visibility because that would assume that their ability to navigate relied on aerial assets only. This reviewer explained that GOM response vessels do not rely on aerial assets only, but that GOM response vessels use modern navigation tools as well as on-vessel detection equipment (IR and X-band radar). This reviewer noted that the Nuka Research report (page 2) stated that response efficiency or effectiveness parameters were specifically excluded from this study, which instead only focused on the ability to deploy and operate a response system.

The reviewer suggested that it could be appropriate that this vertical visibility-related limit assuming the ability to navigate relied on aerial assets only, should be kept in this study for the vessel of opportunity system. The reviewer suggested that this vertical visibility-related limit assuming the ability to navigate relied on aerial assets only, should be removed from the two other mechanical recovery systems illustrating dedicated response vessels. Based on this reviewer's experience, these suggested revisions would correctly illustrate the contrast in their capabilities as vessels of opportunity may need aerial support for operations, while other mechanical recovery systems already have these tools on dedicated response vessels.[VB]

Provide Better Specification of Mechanical Recovery Equipment

Two reviewers commented about mechanical recovery equipment, with one reviewer recommending better specification for the mechanical recovery equipment in the Nuka Research report[JH] and another

4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.

reviewer pointing out an incorrect description/illustration for System 5.3.3 (Mechanical Recovery – Three Smaller Vessels with Boom).[VB] These comments are summarized below.

One reviewer acknowledged that the response systems used in this study were described in detail in the Nuka Research report; however, this reviewer commented that those descriptions did not include boom sizes for this study but described them in more general terms. This reviewer also expressed concerns that some response systems used in the Nuka Research report did not match the types of response systems used in the GOM.

As an example, this reviewer noted that Section 5.3.1, *Table 5-1: System components and baseline specifications for Mechanical Recovery – Two Vessels with Boom*, specified the containment system as "boom suited up to 6 feet rough seas" and the skimming system as "high volume oleophilic skimmer suited up to 6 feet rough seas." Also Section 5.3.1, Table 5-1, specified the vessel platform for the mechanical recovery system components as a 245-foot response vessel and 65-foot towing vessel. The reviewer commented that the actual systems used in the GOM are a 210-foot response vessel and a 32-foot towing vessel with 67-inch boom and a weir skimmer (or an oleophilic skimmer).

The reviewer provided other examples in the Nuka Research report of the use of weir skimmers (Section 5.3.2, *Table 5-3: System components and baseline specifications for Mechanical Recovery – Single Vessel with Outrigger*) and oleophilic skimmers (Section 5.3.3, *Table 5-5: System components and baseline specifications for Mechanical Recovery – Three Smaller Vessels with Boom*) with no explanation of why one or the other skimmers were used in this study. The reviewer commented there were more examples of response systems actually used in the GOM that did not particularly match those response systems used in this study. The reviewer understood the need to generalize the equipment to match previous studies, but recommended that a better specification based on the equipment available in the GOM would provide more credibility to this study and its results.[JH]

The other reviewer that pointed out an incorrect description/illustration for System 5.3.3 (Mechanical Recovery – Three Smaller Vessels with Boom) in the Nuka Research report commented that illustration seemed to be a high speed (Buster) rather than active booming system. This reviewer referred to the definition of mechanical recovery devices for an active booming system in this source: http://www.oilspillresponseproject.org/wp-content/uploads/2017/01/At-sea_containment_and_recovery_2016.pdf.[VB]

<u>Need Clarification/Correction for Dispersant Response System Operating Limits</u>

Two reviewers questioned the operating limits used for the dispersant response systems in the Nuka Research report.[VB,BL] One of those reviewers provided "a more sound set" of dispersant limits.[BL] Another one of those reviewers provided detailed questions about the dispersant systems used in the Nuka Research report.[VB] These comments are summarized below.

4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.

One reviewer commented that the Nuka Research report (page 5) correctly stated that: "Regardless of the platform, there must also be enough mixing energy present during or soon after the application for the dispersant to be effective. If there is abundant natural wave energy, adding chemical dispersants may not be necessary." This reviewer stated that it would be very useful to know what percent of time this 100% natural dispersion would take place, especially when the Nuka Research report described the operating limits for dispersants use. The reviewer commented that this information was easily obtainable using the same environmental datasets and processes already used in this study.[VB]

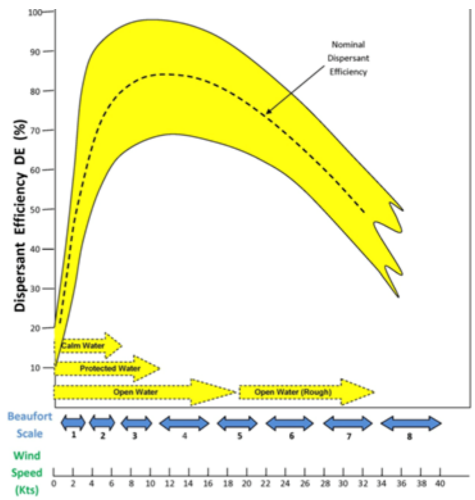
Another reviewer explained that it is well understood that some surface ocean turbulence is required for efficient oil dispersion. The reviewer referred to the widely used Response Options Calculator, as an example, that recommends at least a 6-knot wind speed to achieve optimum dispersion. This reviewer expressed concerns that the operating limits used in the Nuka Research report did not seem to match widely used operating limits in certain cases. As an example, the reviewer commented that the Nuka Research report listed any winds less than 21 knots as favorable to dispersant operations, meaning that calm seas would be included in computing the fraction of time segments considered "favorable" for dispersant use in this study.

The reviewer recommended that "a more sound set" of dispersant operating limits might be:

$$Green \rightarrow \{6\,knots < wind\,speed < 20\,knots\}$$
$$Yellow \rightarrow \{(3\,knots < wind\,speed < 6\,knots) \cup (20\,knots < wind\,speed < 30\,knots)\}$$

This reviewer also explained that very high wind speeds and the resulting breaking waves would not need added surfactant to disperse the oil. The reviewer expressed concerns that the Nuka Research report included such sea states as "unfavorable" for dispersant use in this study.[BL]

4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.



Response Options Calculator Dispersant Efficiency Chart, provided as illustrative example[BL]

The reviewer that provided detailed questions about the dispersant systems used in the Nuka Research report expressed the concerns listed below. For those concerns, this reviewer questioned exactly which operating limits the Nuka Research report described and which references were used for the report:

- The reviewer suggested that a reference should be provided for the 39 knots limit for vessel application of dispersants.
- The reviewer stated that a reference or verification was needed for the 21-30 knots wind speed for aerial dispersant application from the plane. The reviewer questioned whether the 21 knots could be a parameter that was "carried over" from the vessel application table (Table 5-8). The reviewer identified the following references that state the limits for these systems should be 30-35 knots:
  - ExxonMobil 2000 in Fingas 2004,
  - http://www.oilspillresponseproject.org/wp-content/uploads/2017/01/Dispersants-surface_application_2016.pdf, and
  - https://crrc.unh.edu/sites/crrc.unh.edu/files/exxonmobil_dispersant_guidelines_2008.pdf (page 45).
- The reviewer questioned whether the wave height range limit for dispersant application from a plane should be 17-23 feet rather than 10-16 feet. The reviewer questioned whether this wave height range limit could be also a "carry over" from the vessel application table (Table 5-8). Based on operational experience, this reviewer explained that it was logical that wave height limits for plane applications would be higher than for vessel application of dispersants. The reviewer pointed to this reference. https://crrc.unh.edu/sites/crrc.unh.edu/files/exxonmobil_dispersant_guidelines_2008.pdf (page 45).
- The reviewer commented that a 5000-foot ceiling requirement for aerial dispersant application could be questioned. The reviewer explained that standard operational requirements for

4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.

dispersant planes are a 1000-foot ceiling and 3 miles visibility, hence those standard operational requirements should limit the "favorable" range. The reviewer stated those standard operational requirements are also clearly reflected in documents for Regional Response Team 6 as well as aviation guidance for daylight Visible Flight Rule conditions (see: http://www.losco.state.la.us/pdf_docs/RRT6_Dispersant_Preapproval_2001.pdf). The reviewer commented that these numbers were also used in BSEE's Estimated Dispersant System Potential (EDSP) Calculator (see: http://www.genwest.com/wp-content/uploads/2017/04/dispersants-man.pdf). Overall, the reviewer commented that if there was no suitable rationale with a proper reference for selecting the upper boundary for the "marginal" category for this parameter, it could be made of only two categories – "favorable" and "not favorable." The reviewer noted that unlike other techniques and parameters that gradually degrade over time, if this parameter was based on a "fly/no fly" cutoff decision, then the reviewer stated it should not have the "marginal" category. The reviewer suggested that a rationale for the helicopter operations may also need to be verified in similar fashion. The reviewer suggested that maybe similar parameters could be used for both areal systems, if there was a valid rationale and reference.

- The reviewer commented that it seemed very unlikely that a helicopter with a sling load under it would have the same operational limitations for wind and waves as a large plane. The reviewer stated that logic would suggest that operating limits for such helicopters should be lower. The reviewer identified a reference that confirmed that those operating limits should be 17-27 knots for wind and 6-17 feet for waves: https://crrc.unh.edu/sites/crrc.unh.edu/files/exxonmobil_dispersant_guidelines_2008.pdf (page 145).[VB]

Finally, as noted above under the Mechanical Recovery Equipment subsection, one reviewer commented there were more examples of response systems actually used in the GOM that did not particularly match those response systems used in this study. The reviewer understood the need to generalize the equipment to match previous studies, but recommended that a better specification based on the equipment available in the GOM would provide more credibility to this study and its results.[JH]

<u>Need Correction for In-situ Burning</u>

One reviewer commented that Table 2-1 (page 6) included an incorrect statement that high air temperature may enhance burn efficiency for in-situ burning. The reviewer explained that oil evaporates faster at higher temperatures. This reviewer commented that if high air temperature had any effect on in-situ burning, the effect would instead be a decrease in burn efficiency and window of opportunity.[VB]

Finally, as noted above under the Mechanical Recovery Equipment subsection, one reviewer commented there were more examples of response systems actually used in the GOM that did not

4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.
particularly match those response systems used in this study. The reviewer understood the need to generalize the equipment to match previous studies, but recommended that a better specification based on the equipment available in the GOM would provide more credibility to this study and its results.[JH]

5. Were the inputs used for the metocean data and were the five (5) metocean conditions included in the study based on modeled data used (Sections 3 and 4) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.

Two reviewers provided generally favorable comments about whether the inputs used for the metocean data in this study based on modeled data used (Sections 3 and 4) for the oil spill response viability analysis were clearly described and adequately characterized.[JH,BL] One reviewer questioned whether the wave heights data used in this study might be more conservative (on the higher end) than actual wave heights in the GOM.[VB] The other two reviewers provided a few suggestions to address possible weaknesses,[JH,BL] which are summarized in the subsections below.

One reviewer suggested that other well-known data sources or models could have been used as either complementary to the Oceanweather dataset or as a check on the Oceanweather results (see Other Publicly Available Data subsection below).[BL]

Inputs used for Metocean Data: Adequate Characterization

One reviewer commented that the Nuka Research report used the modeled dataset from the Oceanweather Inc. models for wind and waves. The reviewer noted that the grid resolution was 12 kilometers (7.5 miles) on a side, which this reviewer stated was adequate for the purpose of the Nuka Research report.[BL]

Another reviewer believed that the data inputs used were logically described and inputs adequately characterized with the exceptions noted in this reviewer's responses to Charge Questions #2 and #4. The reviewer stated that the areas used (BOEM planning areas) and methodology with the grid system made perfect sense with the exception of 200-meter bathymetry line (see Charge Question #2). The reviewer also commented that use of red, yellow, and green (favorable, marginal, and not favorable) for the different response systems in the methodology made it easy "to get a general snapshot of if and when a system may be used or effective."[JH]

Inputs used for Metocean Data: Potential Improvements

The reviewer that stated the grid resolution was adequate for the purpose of the Nuka Research report expressed concerns that the model used for this study does not resolve water depth of less than 10 meters, which includes a large part of the Mississippi River Delta region, an area of heavy oil activity and spillage. The reviewer commented that it was unclear whether this limitation was approved by BSEE prior to this study, and pointed out that the Nuka Research report should recognize that the dispersant response system options would face severe regulatory approval restrictions for such shallow conditions.

This reviewer stated that the choice of well-calibrated modeled data was appropriate, given the limited complete field measurement datasets over the 10-year period that was used for the Nuka Research report (e. g., no NOAA National Data Buoy Center (NDBC) complete dataset for waters off Louisiana). The reviewer expressed concerns; however, that the Nuka Research report

5. Were the inputs used for the metocean data and were the five (5) metocean conditions included in the study based on modeled data used (Sections 3 and 4) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.

comparison between measured and modeled results discussed on page 19 was of questionable value if the same measured data was used to calibrate the model, as seemed likely to this reviewer. As noted in the subsection below, this reviewer suggested other well-known data sources or models could have been used as either complementary to the Oceanweather dataset or as a check on the Oceanweather results.[BL]

Another reviewer recommended checking on whether databases for wave heights used in this study were more conservative (on higher end) than actual data measured by buoys in the GOM. This reviewer stated that if the wave heights data used in this study were indeed more conservative (on the higher end) than actual wave heights measured in the GOM, then the Nuka Research report should mention the conservative nature of the oil spill response viability analysis.[VB]

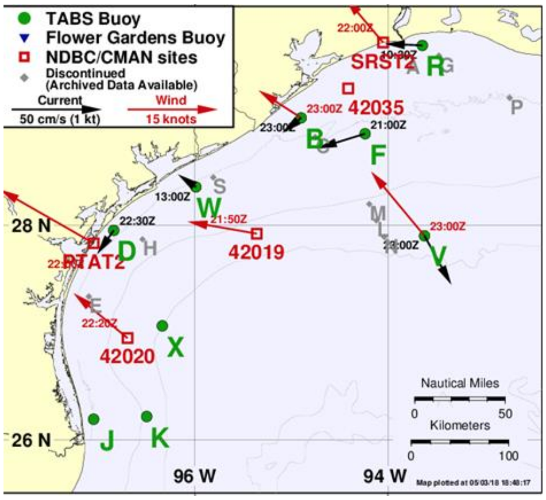
Metocean Conditions: Exclude Extreme Weather Events

One reviewer commented about whether the five (5) metocean conditions included in this study based on modeled data used (Sections 3 and 4) for the oil spill response viability analysis were clearly described and adequately characterized in the Nuka Research report. This reviewer stated that without better knowledge of the Oceanweather model itself, the reviewer was unable to ascertain how extreme weather conditions were assimilated in the modeled data used for the oil spill response viability analysis. The reviewer commented that because no response option is either viable or needed during extreme weather events, the reviewer suggested that a more relevant statistical mapping for this analysis would probably have excluded extreme weather events from its underlying dataset.[BL]

Other Publicly Available Data

One reviewer was not aware of any publicly available weather data or systems data (not already noted) that should have been considered in this study.[JH] Another reviewer commented that other well-known data sources, such as the Texas Automated Buoy System (TABS), and other wave forecast models such as the NOAA Wavewatch III, could have been used as either complementary to the Oceanweather dataset or as a check on the Oceanweather results in this study.[BL]

5. Were the inputs used for the metocean data and were the five (5) metocean conditions included in the study based on modeled data used (Sections 3 and 4) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.



Texas Automated Buoy System (TABS) [BL]

6. Were the results (Section 6, Appendices A and C) of the oil spill response viability analysis conducted for each of the seven (7) selected oil spill response systems appropriate and clearly described? Were the associated graphical outputs clearly presented? Provide an explanation for your answers.

The reviewers varied in responses about whether the results (Section 6, Appendices A and C) of the oil spill response viability analysis conducted for each of the seven (7) selected oil spill response systems were appropriate and clearly described, as summarized below.[VB,JH,BL] One reviewer provided a suggestion to improve the results of the oil spill response viability analysis, with this suggestion based on the reviewer's comments that response systems are not mutually exclusive.[VB] All three reviewers agreed that the associated graphical outputs were clearly presented.[VB,JH,BL]

<u>Results of Oil Spill Response Viability Analysis</u>

Two reviewers generally agreed that this study's results were appropriate and clearly described, given BSEE's required scope for this study:

- Solely based on the response systems used as described in the Nuka Research report and the oil spill response viability analysis used in this study, the Nuka Research report was very effective in using the metocean data (sea state, wind, etc.) and explaining the effects on response systems through the use of various charts. This reviewer found no surprises with the ability for the mechanical recovery, in-situ burning, and dispersant response systems to function in the weather conditions (favorable, marginal, and unfavorable) and wave/wind sensitivities expected in the GOM.[JH]
- One reviewer commented that given the adoption of BSEE's requirements for this study's methodology, the tables and charts in Section 6 of the Nuka Research report did an adequate job in providing easily comprehended results.[BL]

Another reviewer expressed concerns about the selection of the parameters that were used in the oil spill response viability analysis as well as operational/regulatory interpretation of these results; moreover, this reviewer was especially concerned about interpretation of the operational meaning of the "marginal" category. This reviewer commented about interpretation of the "marginal" category in more detail under Charge Question #3.

This reviewer commented that the mathematical analysis of the sensitivity of this study's parameters was interesting; however, the reviewer expressed concerns that practical operational considerations were not really factored in and suggested this study may benefit from more practical interpretation by knowledgeable response professionals. In particular, this reviewer recommended that the results of the oil spill response viability analysis should clearly specify practical improvement areas in which response system capabilities could achieve the greatest benefit.[VB]

<u>Response Techniques are Not Mutually Exclusive</u>

One reviewer observed that it seemed an overarching question of this study was: "do responders have tools to respond in GOM?" This reviewer recommended that the results (Section 6,

6. Were the results (Section 6, Appendices A and C) of the oil spill response viability analysis conducted for each of the seven (7) selected oil spill response systems appropriate and clearly described? Were the associated graphical outputs clearly presented? Provide an explanation for your answers.
Appendices A and C) in the Nuka Research Report needed an additional set of maps and diagrams showing when at least one response technique is available as reflected in the Nuka Research report's conclusions. This reviewer acknowledged that representing results by individual response systems was correct, but the reviewer emphasized that oil spill response systems are not mutually exclusive. This reviewer stated that response systems are, in fact, **complementary** and act with greater success in various weather ranges. As an example, the reviewer explained that when mechanical recovery starts to fail, dispersants become most effective. This reviewer commented that recognizing response techniques are not mutually exclusive in the Nuka Research report may better illustrate actual oil spill response capabilities to the public and clearly show the time when no response is possible. The reviewer further commented that the Nuka Research report should carefully explain the time when no response is possible, although this reviewer specifically recommended explaining this in terms of whether: 1) response is not possible, but oil is on the surface and needs to be removed eventually; or 2) response is not possible and not necessary as natural dispersion removed all oil from the surface.[VB] Graphical Outputs of Oil Spill Response Viability Analysis The reviewer that expressed concerns about the selection of parameters that were used in the oil spill response viability analysis commented that the graphical illustration of the mathematical results was clear and appropriate.[VB] Another reviewer commented specifically that this study did "an excellent job" of providing graphical outputs using charts and colors to delineate effectiveness; however, this reviewer stated that comment was solely based on the response systems used as described in the Nuka Research report and the oil spill response viability analysis used in this study.[JH] As noted above, one reviewer commented that given the adoption of BSEE's requirements for this study's methodology, the tables and charts of Section 6 of the Nuka Research report did an adequate job in providing easily comprehended results.[BL]

7. Were there any critical results or limitations not discussed or adequately addressed in the report?

One reviewer stated that Section 7.2 of the Nuka Research report had useful recommendations and commended all of them to BSEE for future studies. As this reviewer had also suggested under Charge Question #3, the reviewer stated that expanding the number of groupings for response systems would certainly be valuable. This reviewer commented that the utility of Nuka Research report results could be strengthened through considering two limitations not adequately addressed in the report: adding even a simplified oil behavior model and adding a library of oil types.[BL]

One reviewer described the critical results or limitations not discussed or adequately addressed in the report by including that description in the details for this reviewer's comments under earlier charge questions (see Charge Question #3 and Charge Question #4).[VB]

One reviewer provided detailed explanations about two limitations that this reviewer believed were not discussed or adequately addressed in the Nuka Research report: 1) nearshore vessel limitations/classification, and 2) the geographical range of response assets. Those two limitations are summarized in the subsections below.

<u>Nearshore Vessel Limitations/Classification</u>

This reviewer believed that vessel draft is a greater limiting factor that also could have been used to delineate nearshore and offshore response systems in this study. The reviewer stated that vessel draft is typically the limiting factor for mechanical recovery systems and their ability to skim oil in the nearshore area. Based on this reviewer's experience, vessels of 5 feet draft or greater typically would be considered "offshore" and vessels of lesser draft considered nearshore (lakes, bays, sounds, bayous, etc.) in the GOM.

The reviewer noted that another consideration is the vessel's ability to provide overnight accommodations for response operations in the offshore category. The reviewer explained that in commercial service (with the exception of uninspected fishing vessels), most inspected vessels that are expected to operate over 24 hours, are required to have additional crews and overnight accommodations, and as a result, may have the endurance to operate offshore. The reviewer commented that consequently vessels not fulfilling those requirements would be considered in the nearshore category. The reviewer acknowledged that this is not a hard and fast rule; however, the reviewer commented that it should be considered or explained in this study. The reviewer stated that these limitations would allow for only daytime operations for the nearshore areas.

<u>Geographical Range of Response Systems</u>

This reviewer also stated that the geographical range of response systems could have an effect on the results of the data captured in some areas in the Nuka Research report because those response systems would not have the ability to operate in some offshore areas. The reviewer provided two examples:

- The reviewer also stated that many of the smaller mechanical recovery systems and also helicopter dispersant systems have a limited range and fuel capacity. As an example, a 50-

7. Were there any critical results or limitations not discussed or adequately addressed in the report?
foot fishing vessel may be able to skim oil over 100 miles offshore but with limited fuel capacity, and loitering time, the reviewer commented that these systems would be relegated to nearshore areas. • The reviewer stated that helicopter dispersant systems are limited in the amount of dispersants (300-700 gallons) that could be used and their range drastically reduced (due to weight). The reviewer commented that use of helicopters would also limit dispersant systems to nearshore applications.[JH]

8. Were the study findings and discussion (Section 7) and conclusions (Section 8) logical and appropriate based on the results? Are there any additional study findings or conclusions that could be drawn? Provide an explanation for your answers.

The reviewers generally agreed that the study findings and discussion (Section 7) and conclusions (Section 8) were logical and appropriate based on the results, although each reviewer provided caveats about the broader applicability of the study findings or conclusions.

- One reviewer commented that subject to BSEE's required scope for and methodology of this study, the study findings in the Nuka Research report were the rational results. In addition, as this reviewer commented under Charge Question #7, this reviewer recommended that BSEE consider all of the recommendations in Section 7.2 of the Nuka Research report for future studies.[BL]
- Another reviewer commented that, based on this reviewer's experience in the GOM, the study findings and discussion and conclusions in the Nuka Research report were consistent with the data and response systems used in this study (see subsection below).[JH]
- One reviewer commented that the Nuka Research report's conclusions and recommendations reflected the mathematical nature of the findings and the analyzed data given the limited focus of this study; however, this reviewer stated that the study findings and conclusions do not necessarily address operational conclusions or future needs.[VB]

Two reviewers commented about whether there were any additional study findings or conclusions that could be drawn:

- One reviewer strongly recommended applying the metocean data to existing mechanical recovery systems in the GOM. This reviewer stated that this study would have more credibility and provide useful information for planners and the response community as a whole by including the following systems: well containment equipment, the introduction of rigid skimming arms, the use of large platform and offshore supply vessels (PSVs/OSVs), large oleophilic skimmers, and IR/FLIR/X-band systems.[JH]
- This reviewer also commented that based on the metocean data provided, there were storms (hurricanes and tropical storms) during the 10-year period that has been included in this study. The reviewer was not certain; however, whether analyzing hurricane-related or flood-related spills would add much to this study.[JH]
- As summarized under Charge Question #3, another reviewer stated that SSDI is especially relevant for the GOM and has its own operational limits based on the ability of the injection vessel to maintain operations in high winds and waves. This reviewer suggested that the same metocean datasets used in this study could easily be used to determine SSDI response viability for the GOM.[VB]
- As one reviewer also summarized under Charge Question #2, the reviewer commented that adding or substituting the Houma, Stennis, and Galveston airports would lend more credibility to this study for the vertical visibility data over water recommendations. This reviewer commented that although dispersants could be staged from the four airports used in this study, the reviewer believed that was unlikely, especially in the eastern GOM where there is no offshore activity. The reviewer was uncertain, without sufficient data, whether the vertical visibility conclusions would be the same at the primary airports (Houma, Stennis, and Galveston) where dispersants have been used or based in the GOM.[JH]

8. Were the study findings and discussion (Section 7) and conclusions (Section 8) logical and appropriate based on the results? Are there any additional study findings or conclusions that could be drawn? Provide an explanation for your answers.
Finally, one reviewer commented that additional findings would have needed to utilize additional data (e.g., detailed wave structure) that were not employed because such data were outside BSEE's required scope for this study.[BL] <u>Comparison of Conclusions in Nuka Research Report to Experience in GOM</u> One reviewer provided the following comments about the study findings and discussion and conclusions in the Nuka Research report based on the reviewer's experience in the GOM: • The most favorable weather conditions (summer) in the study findings were consistent with the reviewer's experience with oil spill responses in the GOM. • The reviewer agreed with the recommendation for incorporating wave steepness because the GOM is known for shorter period wave length.[JH]

9. Does this report present sufficient new data and knowledge, and are the study findings useful for informing oil spill response planning?

None of the reviewers commented about whether the Nuka Research report presented sufficient new data and knowledge. The reviewers varied in responses about whether the study findings were useful for informing oil spill response planning:

- One reviewer commented that the study findings provided “great insight” but mainly to responders outside the GOM.[JH]
- Another reviewer recommended that the study findings must be weighted based on their application only to oil spill response planning, and this reviewer suggested it was obvious that a response viability analysis based upon climatology is of little use in an actual spill event as the specific forecast would be used instead.[BL]
- One reviewer commented that this response viability analysis provided useful insights for response professionals, but this reviewer recommended that because of the issues raised by the reviewer under the other charge questions, the study findings and results should not be used “as is” for response or regulatory decision-making, or by the general public, without careful issue-specific interpretation by knowledgeable response professionals.[VB]

The reviewer that commented that the study findings provided “great insight” but mainly to responders outside the GOM, noted that there is a constant churn of USCG and private industry personnel in and out of the GOM area, and this study will give them a sense of the weather conditions that they may not have experienced in other areas of the country. The reviewer stated that this study’s methodology was excellent and would be useful for oil spill response planners and responders because it provided an expectation of how well these spill response methods will work in the GOM. From an overall oil spill response planning perspective, the reviewer believed that this study provided a general sense of response effectiveness based on weather conditions for response systems in the GOM and could be used to provide an “overall practical response factor” for a given system in seasonal weather “windows” in the various areas of the GOM.[JH]

The reviewer that recommended that the study findings must be weighted based on their application only to oil spill response planning (versus an actual spill event), recognized the critical need to translate complex environmental data into a simple format that can assist in such planning. This reviewer commented that the Nuka Research report authors should be commended for the approach used to display the study findings.

More generally, this reviewer assumed that stakeholders have found such response viability analyses and display useful in the past for oil spill response planning purposes because this is the third edition of similar studies. The reviewer expressed concerns that precisely how stakeholders have found such response viability analyses and display useful in the past for planning purposes was a conundrum to the reviewer. The reviewer observed that some important oil spill response planning factors were excluded from the Nuka Research report’s purpose, specifically the probability of spill size and spill location, amount of response equipment and personnel, or their staging location. Similarly, the reviewer observed that exclusion of other relevant factors (e.g., oil type determination, weathering state of the spilled oil, resources at risk) would preclude doing a net environmental benefit analysis on the different choices of response techniques.[BL]

4. PEER REVIEWER COMMENTS BY CHARGE QUESTION AND BSEE RESPONSES

This section provides the peer review comments of each reviewer, including each peer reviewer's general impressions, and the peer reviewer's written peer review comments organized by charge question.

4.1 General Impressions

This section provides the peer reviewer's general impressions, including overall impressions addressing the accuracy of information presented, clarity of presentation, and soundness of conclusions.

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Dr. Victoria Broje This study addresses the BSEE project scope as it is defined. The evaluated systems illustrate good diversity of possible types of response operations. The Nuka Research interim final report (Nuka Research report) is written in clear language with good graphic visualization of the results. It uses approaches and methodologies used in similar studies earlier. This Nuka Research report is missing clear references and rationale for operational limitations selection. Since these parameters are fundamental for the study results and conclusions, and since there are questions about the values used for some of the response systems, the selection of operational limits should be carefully verified and rationale/references provided where possible. While division of viability ranges for favorable, marginal, and non-favorable makes sense and is easy to calculate mathematically, the operational meaning of "marginal" is different for different response systems and parameters. The meaning and interpretation of this "marginal" category has to be carefully evaluated. It appears that it covers situations when systems can be used, but with decreased efficiency, yet on page 2 of the Nuka Research report the scope of work states: "This study does not consider the impact of the above conditions – or others – on … response efficiency or effectiveness. …Instead, this study focuses on whether conditions would affect the deployment or general operations of a response system." Some of the "marginal" conditions do affect ability to deploy response systems (wave height), but some others only affect the effectiveness of oil recovery, not the operation of the response system as such (e.g., visibility for mechanical recovery). BSEE needs to carefully consider current equal treatment of parameters affecting operations and parameters affecting recovery/dispersion efficiency and whether visibility should be separated from operational parameters, at least for on-water assets. More discussion on it below. Some challenges with interpretation and practical utilization of these results, especially by general public, may be related to two factors: • This Nuka Research report does not distinguish between situations when response is not possible, but needed, versus when response is not possible, but not needed because there is not oil on the surface. Natural dispersion/attenuation is an important process in the Gulf of

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Mexico (GOM) and is in fact a baseline to which other techniques should be compared to. Focusing on response techniques only (without natural baseline) may lead to misinterpretation of study results. It would have been helpful to also map environmental conditions resulting in oil not being present on the surface due to natural dispersion and not requiring response activities. This way the "gap" when oil is present on the surface and requires response, but response techniques are not available will be more visible and have greater operational meaning.

- An overarching intent of this study seems to be to answer the question: "Do we have response tools and techniques to respond to an oil spill in GOM?." This Nuka Research report represents results for different response techniques individually, as if they were mutually exclusive, and not as a "toolbox" as they are actually used. Response techniques are complementary and act with greater success in different weather ranges. When mechanical recovery starts to fail, dispersants become more effective. In an operational sense, they cover both ends of the wave/wind spectrum and a gap between them as a "toolbox" is smaller than if it was calculated and mapped for each of them individually. The results section could benefit from an additional set of maps and diagrams showing when at least one response technique is available. This would better illustrate actual response capabilities to the public and clearly show the time when response is needed, but no technique is available due to weather limitations.

This analysis provides useful insights for response professionals, but because of the above issues its results should not be used "as is" for response or regulatory decision-making, or by the general public, without careful issue-specific interpretation by professionals.

Mr. James Hanzalik

In the past, it is obvious that weather conditions, optimum or inclement, have had an effect on the efficiency and effectiveness of spill response equipment under various weather conditions. Although my forte is not oceanography or meteorology, in my mind, this the first time that I have seen a study that takes a comprehensive approach to all response methods, and ties in weather and time of day in the Gulf of Mexico (GOM). It gives the reader a general and objective account of certain specified spill methods and how they could be affected by past and potential future weather in the GOM. The study was an easy read, had solid methodology, and was well presented. I believe overall the study was very well written, comprehensive in its approach, and limited in scope to achieve its goals. Although the systems were dictated by BSEE in the study, it accurately, for the most part, detailed the limitations of the mechanical recovery, dispersant, and in-situ burn equipment systems and weather used. The use of red, yellow, and green (favorable, marginal, and not favorable) for the different response systems methodology made it easy to get a general snapshot of if and when a system may be used or effective. I believe it provided a fair and accurate past documentation of GOM weather patterns and of future effectiveness of an oil spill response using those specified systems in the GOM. In essence, the study from a practical viewpoint provides some sense of the limits of the use of these response systems but it has limited value for any specific oil spill response scenario in the GOM. From an overall oil spill response planning perspective, it gives a general sense of response effectiveness based on weather conditions for

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response systems and could be used to provide an "overall practical response factor" for a given system in a seasonal weather "window" in a particular area of the GOM. From a regulatory sense, it provides some value in prescribing types of equipment that could be effective in the GOM based on past weather patterns. Although not a goal of the study, from an actual response perspective, it provides little value based on the timing of spills and the real-time weather that may be forecasted and the systems employed.
Dr. Bill Lehr Spill response effectiveness is a function of three broad input categories: (1) operating environment, (2) properties and amount of the spilled product, and (3) characteristics of the response system. Keeping within the BSEE scope of work, the authors of the Nuka Research interim final report (Nuka Research report) ignore category two (2) and divide the other two categories using a very coarse screening matrix. For example: • Skimmers are grouped into three choices related to the skimming platform that ignores the actual skimmer type, • Wave spectrum model results that return more than a dozen wave frequencies in a similar number of directions are reduced to a single number (significant wave height), and • Dispersant efficiencies that are a strongly non-linear function of wave energy are represented by a three-value step function. Hence, much detailed and available information is not used. The authors of the Nuka Research report have done a yeoman's effort to assemble existing metocean databases and process the data into easily understood seasonal charts, suitable for the target audience. Whether the results, given the pre-defined operating limits, will prove to be useful is outside the purview of this review.

4.2 Responses to Charge Questions

This section provides the written peer review comments of each reviewer organized by charge question.

1. Were the objectives of the report clearly defined? If not, what are your recommendations for improving the description of the objectives?

Dr. Victoria Broje

Study objectives as such were not specifically stated, but could be guessed from executive summary and introduction sections. It is recommended to start the Nuka Research report with a section describing goals, objectives, scope, limitations, and intended use for this study.

Mr. James Hanzalik

No, I do not believe that the objectives are clearly stated. The description of the objectives could be improved. It assumes that the objective of this Nuka Research interim final report (Nuka Research report) is a viability analysis of response systems given weather conditions in various areas of the GOM.

I believe the overall objective of the study was to:

> Based on specifically defined oil spill response systems with specified limitations for the study, and based on published standards based the last ten years of captured weather data, this study provides a general seasonal effectiveness of those systems in specified areas of the GOM under past weather conditions. Specifically:

- Using specified response systems used in most of the areas of the U.S., this study defines the optimum timeframes for their use under certain weather and daylight conditions;
- It uses captured government meteorological data from 2005-2014 to provide a basis for the weather that could be seen in the future in an oil spill response in the GOM;
- It synthesizes weather and astronomical data in areas of the GOM and specific chosen equipment effectiveness to provide a general overall analysis of oil spill response equipment "windows;"
- That ultimately provides an additional planning factor for oil spill response plans given oil type, size, and other planning factors.

Dr. Bill Lehr

The objectives of the Nuka Research report are expressed succinctly in Section 1.1, Project Scope. The Nuka Research report produces a viability analysis for the Gulf of Mexico (GOM) Region.

2. Was the methodology used for the oil spill response viability analysis (Sections 2 and 3) appropriately designed and clearly described? Were there any apparent weaknesses, omissions, or errors? Provide an explanation for your answers.

Dr. Victoria Broje

Yes

Mr. James Hanzalik

The methodology was a very strong point of the study. Taking the metrological data at face value, and the defined systems used and their limitations pre-defined, I think the overall methodology is solid with the following exceptions:

- The 200-meter bathymetry line is somewhat arbitrary and serves no use in the study based on the limitations of the equipment that has been pre-defined. The weather parameters are stated and the equipment systems fixed (logistics, etc.). Most of the systems specified would operate at the same efficiency and effectiveness on both sides of the 200-meter bathymetry line. I recommend removing this delineation that serves no real technical purpose in the study.
- Page 5, Section 2.2, third paragraph – The statement that: "If there is abundant natural wave energy, adding chemical dispersants may not be necessary." I generally agree with this statement but it is situational dependent – for a defined quantity spill versus an unsecured source. I would recommend removing this sentence based on MC-252 spill experience where dispersants were used in a high wave energy environment due to an unsecured source.
- For Table 2-1:
    - Under "Metocean Conditions and High air temperature" under the "Dispersants" column, the Nuka Research report states – "Optimal storage temperatures may be exceeded." The boiling point of most dispersants is 140 degrees Celsius and most dispersants do not recommend a specific storage temperature. They were stored on deck during MC-252 for vessel spraying, stored in large tanks in direct sunlight on the tarmac for aerial application in the middle of summer in 90 degrees Fahrenheit plus heat, and this had no effect on the efficacy of the dispersants used. Nalco, the manufacturer of Corexit Products stated: "COREXIT products can retain a nearly unlimited shelf life as long as the product has remained in their original sealed containers and contamination has been prevented." Thus I do not see this as a factor – recommend it should be "Not Applicable."
    - Under "Metocean Conditions and High air temperature" under the "Mechanical Recovery" column there could be a problem with high volatile organic compounds (VOCs) for mainly crude oil, which could keep workers "sheltered in place" for periods of time, especially during the initial stages of a spill or for unsecured sources. I would recommend replacing the "Not Applicable" with "Health effects due to high VOCs."
- For Table 2-2:

2. Was the methodology used for the oil spill response viability analysis (Sections 2 and 3) appropriately designed and clearly described? Were there any apparent weaknesses, omissions, or errors? Provide an explanation for your answers.

  - Under the column for "Metocean Conditions and Darkness" under "Vessel Operations" – If the systems are equipped with adequate detection systems – as stated for mechanical recovery, then darkness or low light conditions would have less of an effect. I would recommend that during periods of "low light" there is a "decreased ability to target and maintain operations to recover oil."
  - Under the column for "Metocean Conditions and Sea state" under "Aircraft Operations," the Nuka Research report states – "Extremely high waves could impact low flying helicopter." It is my experience that helicopters and fixed wing aircraft spray dispersants at 50-100 feet AGL (above ground limit). If you have waves that high, you probably are not flying in those weather conditions. FYI – Currently, (could change) there are no helicopter spray systems in the GOM for dispersant application. I recommend changing that to "Not Applicable" for the GOM.
  - Under the column for "Metocean Conditions and Darkness" under "Aircraft Operations" – Dispersants are not aerially sprayed in darkness and I do not see any changes due to safety concerns – I recommend changing to "Not Applicable."
- The use of red, yellow, and green (favorable, marginal, and not favorable) for the different response systems methodology made it easy to get a general snapshot of if and when the defined response system may be used or effective.
- For Table 3-2 under "System" for "Dispersants – Helicopter Application" – under "Method," the Nuka Research report says "Change darkness from red to yellow." This should be left red due to safety conditions and the ability of aircraft to see at night and the limited range of helicopters with a dispersant payload.
- For Section 3.2.4 Vertical visibility – There are primarily two airports (Houma Terrebonne, LA and Stennis, MS) and a total of three airports (also Galveston, TX), where aerial dispersants have been and are deployed in the GOM. It would provide better credibility for the study to use those three airports versus the airports used in the study.

Dr. Bill Lehr

The choice of methodology (e.g., three response viability categories) was to a large extent dictated by BSEE. Some of the requirements seem arbitrary since they are announced with little additional explanation. Presumably, there was a reason to define the 200-meter bathymetry line as the divider between nearshore and offshore, but no reason is given in the Nuka Research report other than BSEE agreed to it. As the Nuka Research report notes in a footnote at the bottom of page 10, alternatives exist.

The Nuka Research report produces seasonal spatial maps of viability conditions and weekly charts of viability conditions for a single point in each of the six regions. Why restrict the latter to a single point instead of an average of all the grid points in the region? Choosing a single point opens the results to bias if the chosen point is not representative of the region.

2. Was the methodology used for the oil spill response viability analysis (Sections 2 and 3) appropriately designed and clearly described? Were there any apparent weaknesses, omissions, or errors? Provide an explanation for your answers.
The sensitivity analysis method employed appears to involve increasing the green or yellow limits for each response system and seeing how the resulting color fractions change. In essence, increased wind or wave states (similar for the other parameters) would be included in the green (or yellow). As such, it is a much reduced approach compared to traditional sensitivity analysis that would examine the functional dependence of the normalized first derivative (e.g., "Sensitivity analysis in oil spill models: Case study using ADIOS," Overstreet et al., IOSC 1995). It appears that the Nuka Research report assumes a linear decrease in viability with wind and/or waves. However, as noted in the reviewer comments for Charge Question #4, this is not the case for chemical dispersants and may not work exactly for other response options as well since their effectiveness is not strictly linear in the metocean parameters. In fairness to the Nuka Research report, their method may be sufficient given the limitation of viability to a three-value step function for dispersants.

3. Were the limitations of the approach (Section 3.3) clearly identified and described? If not, what are your recommendations for improving the description of the limitations of the approach (Section 3.3)? Also comment on whether the limitations of the approach were addressed throughout the report in a thorough and understandable way in order for the reader to evaluate the impact of limitations on this study's analysis or results.

Dr. Victoria Broje

Interpretation of "marginal" could be clarified as it is different for different response systems and parameters. For some it may mean standard operation at slightly reduced efficiency (mechanical recovery at night), but for others it may mean that they cannot be used for some portions of the time, or operations could be substantially compromised (mechanical recovery by smaller systems in "marginally high" waves).

The rationale behind selecting seven (7) specific response systems, as well as the rationale behind exclusion of other potential response techniques (e.g., of subsea dispersants – subsea dispersants injection (SSDI)) from this evaluation should be provided in the Nuka Research report. SSDI is one of the existing response techniques uniquely relevant for the GOM. Understanding of its limits and viabilities would be as important as for other techniques. It could be argued that in-situ burning with the use of herders was not included in this study due to its limited availability in the GOM, the fact that it is not presently included in contingency plans, and regulatory approval processes not being readily available. In contrast, SSDI capabilities in the GOM are well established, available 24/7, the process for seeking regulatory approval and monitoring techniques exist and have been practiced in exercises. This technique is especially relevant for the GOM and has its own operational limitations based on the ability of the injection vessel to maintain operations in high winds and waves. Same metocean datasets used in this work can be easily used to determine SSDI viability for the GOM. Absence of this technique will be noticed by readers of the Nuka Research report and should be explained.

Mr. James Hanzalik

The limitations of the approach for this response viability analysis that it would provide a "useful" tool was clearly defined and explained. With those limitations used, it also confines the use of the study as a planning tool to those response systems in the study.

One of the limitations described in the Nuka Research report on page 14 was that it is "generally accepted that dispersants are less effective in lower-salinity waters." This would be a true statement in the general sense but not practical in the GOM. The EPA standard for effectiveness for dispersants is 50% or greater to be listed on the EPA Product Schedule. Most dispersants used in the GOM are in excess of 80-90% effectiveness or greater, and higher with the crudes extracted in the GOM. With a lower salinity, it could be inferred that a higher effectiveness would negate the limitations based on salinity. Given the tradeoffs for their use and practically speaking, lower water salinities in the GOM would not override dispersant use. Of all the dispersants operations conducted historically in the GOM, no dispersant operation conducted was limited by water salinity but rather limited based on the dispensability of the oil to be treated.

3. Were the limitations of the approach (Section 3.3) clearly identified and described? If not, what are your recommendations for improving the description of the limitations of the approach (Section 3.3)? Also comment on whether the limitations of the approach were addressed throughout the report in a thorough and understandable way in order for the reader to evaluate the impact of limitations on this study's analysis or results.

Dr. Bill Lehr

Section 3.3 does a robust job of listing many of the limitations of the approach used in the Nuka Research report. As noted, logistics and other practical constraints may change the viability analysis determined by metocean conditions. In fact, the metocean conditions themselves may change between the time when the spill occurs and the time when equipment could be deployed onsite. This circumstance is recognized in the sixth paragraph on page 13. While outside the scope of the assignment, the impact of this affect could have been estimated by mapping the average duration of each metocean category over the geographical grid.

One limitation that requires further textual discussion is the broad grouping of response options. This broad assignment masks the significant variability found within each grouping. For example, CONCAWE in their field guide notes that disk skimmers may work with 3-meter wave heights, while other skimmers require smaller waves. Similarly, different fire booms have different metocean requirements. This broad brush also applies to metocean conditions themselves. Chop waves, for instance, have a different impact on mechanical recovery than swells of the same height. A particular grid location may be suitable for in-situ burning depending not only upon wind speed but also wind direction as soot impact on coastal areas would be different.

4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.

Dr. Victoria Broje

Page 30 shows nice visualization of response system operating limits used in the Nuka Research report, which is likely to be quoted for other reports and operational guidance. Unfortunately, it is not clear how the maximum values for the bars were selected and their values are not specified on this diagram. From the following chart (page 31) those may be 60 knots and 20 feet? Were these cutoffs selected based on some physical principle? Red "gap" length could be doubled for all systems if a much higher number is randomly selected as a maximum wave or wind parameter. What are these numbers and how were they chosen? They all need to be cut off, as at some point values do not have physical meaning or relevance. I would like to suggest a logic cutoff for this Figure 5-8 as well as Figure 5-9. A logic cutoff may also produce some additional information in other relevant diagrams.

It is correctly stated in the Nuka Research report on page 5 that: "Regardless of the platform, there must also be enough mixing energy present during or soon after the application for the dispersant to be effective. If there is abundant natural wave energy, adding chemical dispersants may not be necessary." It would be very useful to know what percent of time this would take place, especially when dispersants use limitations are described. This information is easily obtainable using the same environmental datasets and processes already used in the study. In the current format, periods with wind speed higher than 35-39 knots are shown as "not favorable" without mentioning that they are also not needed since the same dispersion is accomplished by natural mixing. This transparency is important for identification of improvements that are needed for different response techniques. The present format suggests that response efficiency could be improved if dispersants could be applied at higher wind speeds and wave heights. In fact, that is not correct as no oil is available at the surface. Technological improvements should be focused on addressing other gaps (e.g., operations at night, or improving skimming encounter rates). This limit, for example, 35-40 knots winds and 10-foot waves (when oil is simply not available on the surface and is being dispersed naturally) should be used as a cutoff for all evaluated systems for Figure 5-8 on page 30. Beyond this limit, capabilities of the system are irrelevant as no oil is available to recover.

At very least, this issue could be addressed by:

- Stating what the maximum value is and where it came from; and
- Introducing an additional bar above the wind and waves bars on page 30, or covering the wind and waves bars with the shaded areas in the range higher than these limits and marking this specific area as "no action," or "no available oil zone." Otherwise the diagrams on page 30 are misleading and identifying gaps in the areas where they may not be present or relevant.

4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.

Also, on page 30, wind and waves have a well-known relationship. For example, https://en.wikipedia.org/wiki/Beaufort_scale. Figure 5-8 on page 30 plots wind and wave scales next to each other to show relative viability areas. Are they reasonably aligned with each other, or is each plotted up to a randomly selected maximum (and unreported) value, skewing the bars?

References should be provided for all used operational limits for two reasons:

- As acknowledged in the Nuka Research report, there are several sources of this information (e.g., publications by ASTM, Allen, Fingas, SL Ross, IPIECA, Exxon, etc.) with slightly different operating limit values. It is important to be transparent and clarify which ones were used in this assessment. In some cases, these limits appear to be modified based on the best professional judgment to reflect and contrast performance differences of the evaluated response systems. This is a valid approach, but the user may need to understand the rationale behind these changes to better appreciate their performance differences.
- Operational limits for the same system may be based on different processes as described in Table 2-1 (page 6). For example, in Section 2.2 on page 5, for in-situ burning the Nuka Research report states: “Wind and waves must be calm enough to allow for ignition and a sustained burn.” In fact, the main factors affecting viability of in-situ burning with the boom is the ability to collect and maintain oil inside the boom, not the ignition process. Ignition parameters may depend on oil type and burn efficiencies, which were taken out of this analysis. Without specific references provided it may not be clear to the reader which process you considered to be limiting for a specific system.

Table 2-1: Fast currents are relevant for rivers and shoreline booming, but typically not for offshore environments. They do not affect dispersants application, or in-situ burning and mechanical recovery (which can drift with oil hence relative speed to currents can be varied). You also did not evaluate this parameter in the Nuka Research report, so suggest deleting. Also suggest deleting “High temperature” line. It was also not evaluated in the Nuka Research report. Exceedance of optimal storage temperatures for dispersants seems to be speculation, and even if it did take place, the outcome would relate to dispersion efficiency (which is out of scope for this Nuka Research report) and not viability of dispersants operations. The statement of temperature enhancing in-situ burning is simply incorrect. Oil evaporates faster at higher temperatures and if anything it will decrease burning efficiency and window of opportunity. This Table 2-1 would be more informative if it focused on parameters used in this study and indicated (with references) specific values for the described limitations. Then it would be easier to see how limits for the response system were selected from the collection of limits for different processes. This comment also relates to Table 2-2.

Authors may want to reconsider attributing “marginal” conditions to mechanical recovery, in-situ burning, and vessel-based dispersants operations in darkness. The description of the study on page

4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.
2 of the Nuka Research report states: "This study does not consider the impact of the above conditions – or others – on … response efficiency or effectiveness. …Instead, this study focuses on whether conditions would affect the deployment or general operations of a response system." The Nuka Research report also states on page 22: "Horizontal visibility-related limits are included, but these do not include detecting slick location. Instead, they assume that the on-water response systems include some technology to aid the system in targeting the slick in the immediate vicinity during darkness." Based on this, introducing visibility based limits to aerial (plane and helicopter) dispersants operations makes sense, since they are not in "immediate vicinity" and will be operationally challenged in applying dispersants to the slick. On the other hand, since this study assumes that all on-water techniques have tools to allow them working in the slick in darkness and bad visibility, their deployment and operations will not be affected by darkness (they have lights allowing them to monitor the immediate vicinity as well as tools to further enhance their capabilities). Their effectiveness and efficiency may or may not be affected, but these parameters were specifically excluded from the study. Based on project definition and description of the systems capabilities, only aerial systems should be affected by night time operations and marked as "marginal" during this period. Related to this comment – it is not clear why on-water recovery techniques would be limited by vertical visibility. This assumes that their ability to navigate relies on aerial assets only, which is not the case for GOM response vessels, which use modern navigation tools as well as on-vessel detection equipment (infrared (IR) and X-band radar). Per study objective, it is not evaluating system efficiency, but only an ability to deploy and operate system. It could be appropriate to leave this limitation for the vessel of opportunity system, but remove from the two other mechanical recovery systems illustrating dedicated response vessels. This will correctly illustrate the contrast in their capabilities as vessels of opportunity may need aerial support for operations, while other systems already have these tools on dedicated response vessels. Please note that System 5.3.3 (Mechanical Recovery – Three Smaller Vessels with Boom) is not correctly described/illustrated in the Nuka Research report. Refer to definition of mechanical recovery devices for active booming system http://www.oilspillresponseproject.org/wp-content/uploads/2017/01/At-sea_containment_and_recovery_2016.pdf. What seems to be illustrated in the Nuka Research report is a high speed (Buster) rather than active booming system. Specific mechanical recovery and in-situ burning limits for wind speed and sea state appear to be using numbers referenced in known literature and be generally appropriate to described system types. There are some questions about dispersants systems: 1) Is there a reference for 39 knots limit for vessel application of dispersants?

4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.

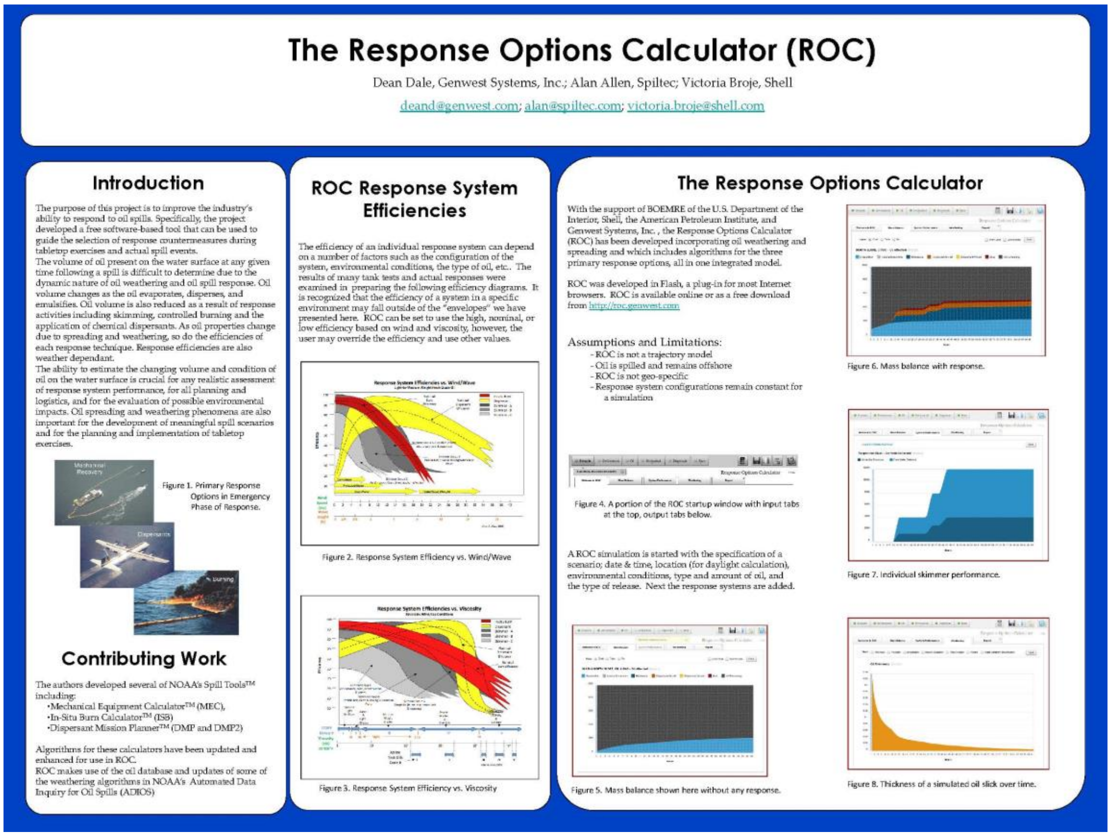
2) A reference or verification is needed for the 21-30 knots wind speed for aerial dispersant application from the plane. Could the 21 knots be a parameter that was "carried over" from the vessel application table (Table 5-8)? These references state that limits for these systems should be 30-35 knots (ExxonMobil 2000 in Fingas 2004). And http://www.oilspillresponseproject.org/wp-content/uploads/2017/01/Dispersants-surface_application_2016.pdf and https://crrc.unh.edu/sites/crrc.unh.edu/files/exxonmobil_dispersant_guidelines_2008.pdf (page 45). Also, per last reference, wave height range limit for plane application is 17-23 feet rather than 10-16 feet. Could these be also a "carry over" from the vessel application table (Table 5-8)? Operationally speaking, it is pretty logical that limits for plane applications would be higher than for vessel application. Exactly which limitations does this Nuka Research report describe and which references does this report use?
3) A 5000-foot ceiling requirement for aerial dispersant application can be questioned. Standard operational requirements for dispersants planes are 1000-foot ceiling and 3 miles visibility, hence they should limit favorable range. This is also clearly reflected in RRT 6 documents as well as aviation guidance for daylight Visible Flight Rule (VFR) conditions http://www.losco.state.la.us/pdf_docs/RRT6_Dispersant_Preapproval_2001.pdf. These numbers were also used in BSEE's Estimated Dispersant System Potential (EDSP) Calculator http://www.genwest.com/wp-content/uploads/2017/04/dispersants-man.pdf. If there is no suitable rationale with proper reference for selecting upper "marginal" boundary for this parameter, it could be made of only two categories – favorable and not-favorable. Unlike other techniques and parameters that gradually degrade over time, if this parameter is based on "fly/no fly" cutoff decision, then it should not have the "marginal" category. A rationale for the helicopter operations may also need to be verified in similar fashion. If it is valid, maybe similar parameters could be used for both areal systems.
4) It seems to be very unlikely that a helicopter with a sling load under it would have the same operational limitations for wind and waves as large plane. Logic suggests that they should be lower and this reference https://crrc.unh.edu/sites/crrc.unh.edu/files/exxonmobil_dispersant_guidelines_2008.pdf (page 145) confirms that they should be 17-27 knots for wind and 6-17 feet for waves.

Mr. James Hanzalik

With the limitations I believe the authors could have conducted additional research on the systems used based on past responses in the GOM. Many of these systems were used extensively with minor modifications during MC-252, especially the mechanical recovery systems and the aerial dispersants (less helicopters). I know from experience that at waves of 5 feet and higher, offshore skimming was suspended for all areas of the GOM during MC-252 – this may have been a safety consideration but nonetheless, could have been or can be included in the study. In addition, the use of Al Allen's/Spiltec diagram, 2009 (see below) (used extensively by NOAA in training classes

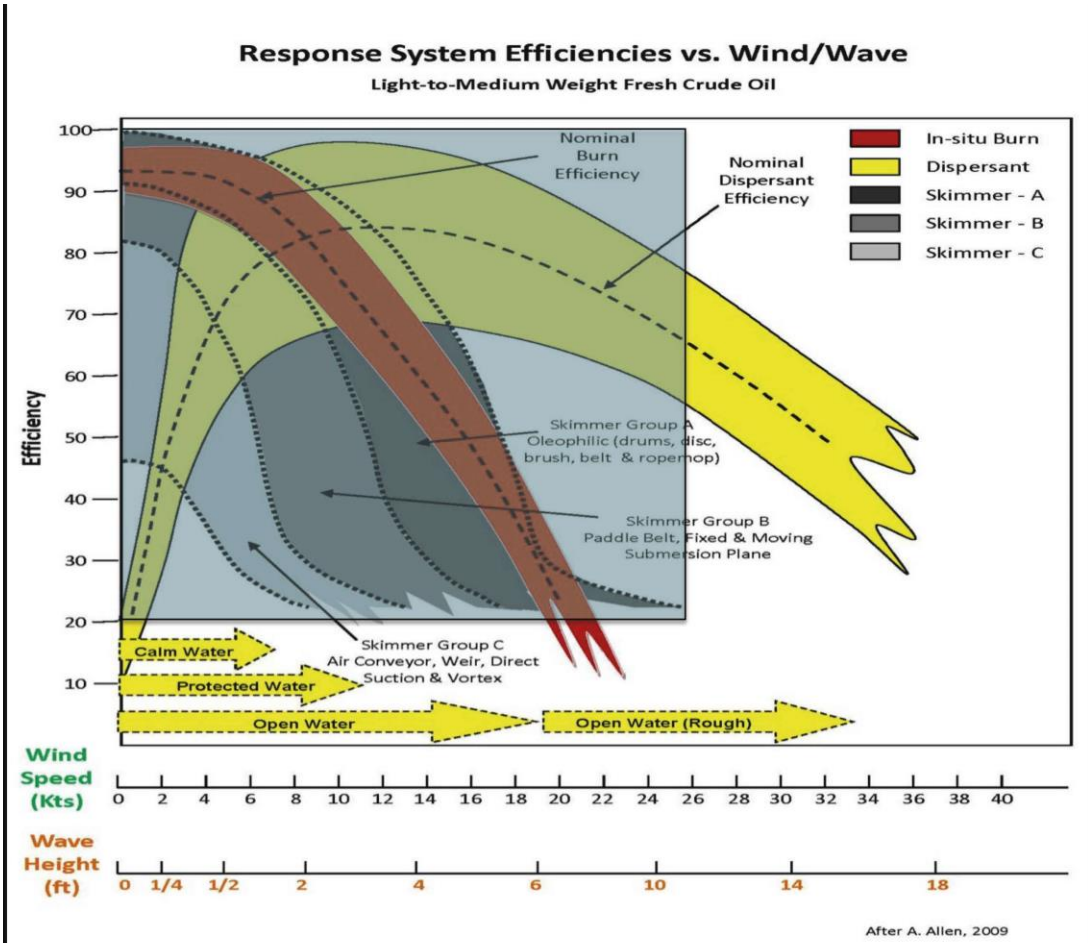
4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.

based on what I know from experience) could have also assisted in further evaluation of the systems described in this study. This may affect all categories of systems components and results in Section 5 in the Nuka Research report.



The explanations for the limitations in the Nuka Research report were very similar to those on the chart (see below) [from Al Allen's/Spiltec diagram, 2009] but it is unknown if the diagrams were used to determine the operating limitations of the equipment. This diagram is, in my opinion, very accurate in the limitations of various skimmers/mechanical recovery, dispersant, and in-situ burn use. If considered, this may change some operating limitation values of those mechanical recovery systems listed in the Nuka Research report.

4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.



Detection technology described on page 22 of the Nuka Research report only provides for targeting in the immediate vicinity during darkness. This in my opinion renders the use of forward-looking infrared (FLIR) / infrared (IR) technology useless in low light conditions unless the target is in close proximity (within 1 mile or less). So, in essence the systems would not allow mechanical recovery in darkness. Most detection systems are equipped with X-band radar that would increase the range of the system and make the FLIR/IR much more effective. In a recent spill in the GOM, vessels mounted with X-band/FLIR/IR had the ability and were able to effectively mechanically remove oil from the surface during periods of complete darkness. With X-band radar and adequate FLIR/IR cameras, 24-hour skimming is possible but with limitations as described above.

The response systems used in the study were described in detail in the Nuka Research report; however, the descriptions did not include boom sizes for the study but described them, for

4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.

example in Section 5.3.1, Table 5-1, as "boom suited up to 6 feet rough seas" or "high volume oleophilic skimmer suited up to 6 feet rough seas." For instance, for Section 5.3.1, Table 5-1, the mechanical recovery system components are a 245-foot response vessel and 65-foot towing vessel. The actual systems in the GOM are a 210-foot response vessel and a 32-foot towing vessel with 67-inch boom and a weir skimmer (or an oleophilic skimmer). There are also examples in the Nuka Research report of the use of weir skimmers (Section 5.3.2, Table 5-3) and oleophilic skimmers (Section 5.3.3, Table 5-5) with no explanation of why one or the other skimmers were used in the study. There are more examples of systems used in the GOM that do not particularly match those used in the study. I understand the need to generalize the equipment to match previous studies but a better specification based on the equipment available in the GOM would provide more credibility to the study and its results.

Dr. Bill Lehr

The definitions of the three response limits are given in Table 3.1 and, according to the Nuka Research report (see page 8), were agreed to at a 2015 Arctic Council Emergency Prevention, Preparedness, and Response Workgroup (EPPR) event that included government, industry, and other organizations. The actual operating limits were based upon a panel of experts from an EPPR project on Arctic waters that used published limits where possible, according to page 9 in the Nuka Research report. Two modifications were made to the response limits that dealt with sea ice (not an issue in the GOM) and wave height limits. Some wave height limits were modified (see Section 5.2) after consultation with BSEE because the original EPPR study values exceeded ASTM International ratings for boom used in GOM.

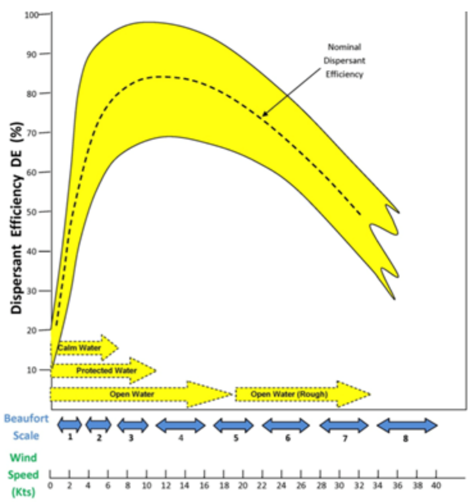
Limit selection is a key parameter in the study so careful examination of the method and analysis is required. The reviewer has some concerns about how the limits were chosen:

- While oil properties *per se* are not in the scope of the Nuka Research report, the authors still needed to make some assumptions about the product to be treated. The EPPR workgroup experts must have implicitly assumed a generic oil that would be transported or produced in Arctic regions in determining their operating limits. A similar expert panel looking at GOM oils might arrive at a very different generic oil choice (e.g., most GOM oils are more susceptible to emulsification than most North Sea oils). At minimum, the authors should list the basic oil bulk properties assumed in setting the response limits.
- The limits do not seem to match widely used operating limits in certain cases. For example, the Nuka Research report lists any winds less than 21 knots as favorable to dispersant operations, meaning that calm seas would be included in computing the fraction of favorable time segments for dispersant use. However, it is well understood that some surface ocean turbulence is required for efficient oil dispersion. The widely used Response Options Calculator (ROC), for instance, recommends at least a 6-knot wind speed to achieve optimum dispersion. A more sound set of dispersant limits might be:

4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.

$$Green \rightarrow \{6\,knots < wind\,speed < 20\,knots\}$$
$$Yellow \rightarrow \{(3\,knots < wind\,speed < 6\,knots) \cup (20\,knots < wind\,speed < 30\,knots)\}$$

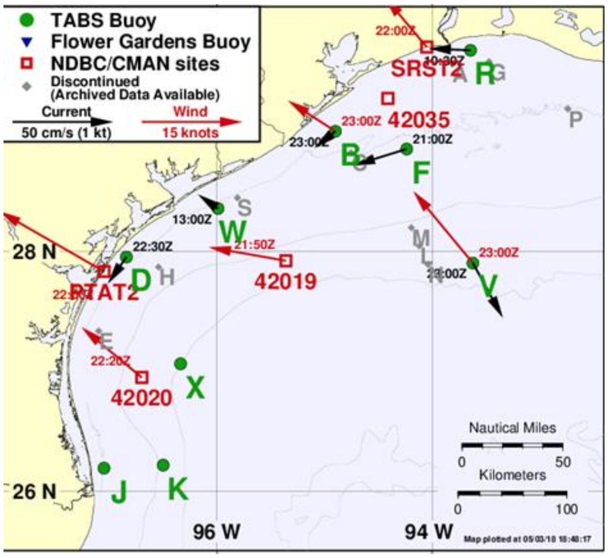
Very high wind speeds and the resulting breaking waves would not need added surfactant to disperse the oil but the Nuka Research report includes such sea states as unfavorable.



ROC Dispersant efficiency chart

5. Were the inputs used for the metocean data and were the five (5) metocean conditions included in the study based on modeled data used (Sections 3 and 4) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.
Dr. Victoria Broje I am not a metocean specialist, but I would check whether databases for wave heights used in this study are more conservative (on higher end) than actual data measured by buoys. If so, conservative nature of this analysis should be mentioned in the Nuka Research report.
Mr. James Hanzalik I believe that the data inputs used were logically described and inputs adequately characterized with the exceptions noted in the answers to Charge Questions #2 and #4. The areas used (BOEM planning areas) and methodology with the grid system made perfect sense with the exception of 200-meter bathymetry line. The use of red, yellow, and green (favorable, marginal, and not favorable) for the different response systems methodology made it easy to get a general snapshot of if and when a system may be used or effective. I am not aware of any publicly available weather data or systems data (not already noted) that should have been considered.
Dr. Bill Lehr The Nuka Research report authors chose the modeled dataset from the Oceanweather Inc. models for wind and waves. The grid resolution is 12 km (7.5 mi) on a side, which is adequate for the purpose of the Nuka Research report. The model does not resolve water depth of less than 10 meters, which includes a large part of the Mississippi River Delta region, an area of heavy oil activity and spillage. It is unclear to the reviewer whether this limitation was approved by BSEE prior to the study, recognizing that the dispersant option would face severe regulatory approval restrictions for such shallow conditions. Given the limited complete field measurement sets over the 10-year period used for the Nuka Research report (e. g., no NOAA National Data Buoy Center (NDBC) complete dataset for waters off Louisiana), the choice of well-calibrated modeled data was appropriate. However the Nuka Research report comparison between measured and modeled results discussed on page 19 is of questionable value if the same measured data was used to calibrate the model, as seems likely. As an alternative, other well-known data sources, such as the Texas Automated Buoy System (TABS), and other wave forecast models such as the NOAA Wavewatch III could have been used as either complementary to the Oceanweather set or as a check on the Oceanweather results. Without better knowledge of the Oceanweather model itself, the reviewer is unable to ascertain how extreme weather conditions were assimilated. Given that no response option is either viable or needed during extreme weather events, a more relevant statistical mapping would probably exclude such events from its underlying dataset.

5. Were the inputs used for the metocean data and were the five (5) metocean conditions included in the study based on modeled data used (Sections 3 and 4) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.



Texas Automated Buoy System

6. Were the results (Section 6, Appendices A and C) of the oil spill response viability analysis conducted for each of the seven (7) selected oil spill response systems appropriate and clearly described? Were the associated graphical outputs clearly presented? Provide an explanation for your answers.
Dr. Victoria Broje The graphical illustration of mathematical results is clear and appropriate. My concern is more in selection of the parameters that were used in the analysis as well as operational/regulatory interpretation of these results especially in interpretation of the operational meaning of "marginal" category. Mathematical analysis of the parameter's sensitivity is interesting, but did not really factor in practical operational considerations and may benefit from more practical interpretation by knowledgeable response professionals. Especially clearly specify which practical improvement areas can response capabilities benefit from most. Since an overarching question of this study seems to be "do responders have tools to respond in GOM?," the results section needs to have an additional set of maps and diagrams showing when at least one response technique is available as reflected in the Nuka Research report's conclusions. Representing results by individual systems is correct, but they are not mutually exclusive. In fact, they are **complementary** and act with greater success in various weather ranges. When mechanical recovery starts to fail, dispersants become most effective. This may better illustrate actual response capabilities to the public and clearly show the time when no response is possible. This needs to be carefully explained, though in terms of whether: 1) it is not possible, but oil is on the surface and needs to be removed eventually; or 2) it is not possible and not necessary as natural dispersion removed all oil from the surface.
Mr. James Hanzalik Solely based on the systems used as described in the Nuka Research report and the analysis, the study did an excellent job providing graphical outputs using charts and colors to delineate effectiveness. The study was very effective in using the metocean data (sea state, wind, etc.) and explaining the effects on response systems through the use of various charts. From my perspective, I saw no surprises with the ability for the mechanical, in-situ burn, and dispersant systems to function in the weather conditions (favorable, marginal, and unfavorable) and wave/wind sensitivities expected in the GOM.
Dr. Bill Lehr Given the adoption of the study methodology, the tables and charts of Section 6 of the Nuka Research report do an adequate job in providing easily comprehended results.

7. Were there any critical results or limitations not discussed or adequately addressed in the report?
Dr. Victoria Broje Yes. Described in the details under earlier charge questions.
Mr. James Hanzalik Nearshore vessel limitations/classification: I believe that vessel draft is a greater limiting factor that also could have been used to delineate nearshore and offshore systems. This is typically the limiting factor for these systems and their ability to skim oil in the nearshore area. Typically, vessels of 5 feet draft or greater would be considered "offshore" and those of lesser draft considered nearshore (lakes, bays, sounds, bayous, etc.). Another consideration is the vessel's ability to provide overnight accommodations for offshore application. In commercial service (with the exception of uninspected fishing vessels), most inspected vessels that are expected to operate over 24 hours, are required to have additional crews and overnight accommodations, and as a result, may have the endurance to operate offshore. As such, vessels not in this category would be considered in the nearshore category. It is not a hard and fast rule but should be considered or explained in the study. These limitations would allow for only daytime operations for the nearshore areas. The geographical range of response assets: Many of the smaller mechanical recovery systems and also helicopter dispersant systems have a limited range and fuel capacity. For instance, a 50-foot fishing vessel may be able to skim oil over 100 miles offshore but with limited fuel capacity, and loitering time, these systems would be relegated to nearshore areas. In addition, helicopter dispersant systems are limited in the amount of dispersants (300-700 gallons) that could be used and their range drastically reduced (due to weight). The use of helicopters would also limit dispersant systems to nearshore applications. This could have an effect on the results of the data captured in some areas in the Nuka Research report because those systems would not have the ability to operate in some offshore areas.
Dr. Bill Lehr The Nuka Research report authors make several useful recommendations in Section 7.2. The reviewer commends all of them to BSEE for future studies. Certainly expansion of the number of system groupings would be valuable. Addition of even a simplified oil behavior model and library of oil types would strengthen the utility of the Nuka Research report results.

8. Were the study findings and discussion (Section 7) and conclusions (Section 8) logical and appropriate based on the results? Are there any additional study findings or conclusions that could be drawn? Provide an explanation for your answers.
Dr. Victoria Broje Please refer to some of the above points. The Nuka Research report's conclusions and recommendations reflect the mathematical nature of the findings and analyzed data as per the limited focus of this study, but they do not necessarily address operational conclusions or future needs.
Mr. James Hanzalik Based on my experience in the GOM, the discussion and conclusions in the Nuka Research report are consistent with the data and systems used in the study. The most favorable weather conditions (summer) are consistent with my experience. I am not sure that the vertical visibility conclusions would be the same at the primary airports where dispersants have been used or based without sufficient data (as noted earlier, Houma, Stennis, and Galveston). Although dispersants could be staged from those airports used in the study, it is unlikely, especially in the eastern GOM where there is no offshore activity. As stated earlier, adding or substituting these airports would lend more credibility to the study and the vertical visibility data over water recommendations. I agree with the recommendations for incorporating wave steepness as the GOM is known for shorter period wave length. I am not sure that hurricane or flood-related spills would add much to the study. Based on the metocean data provided, there were storms (hurricanes and tropical storms) during that 10-year period that has been included in the study. I am not sure flood-related spills will provide any new information. I strongly recommend applying the metocean data to existing mechanical recovery systems in the GOM. Along with well containment equipment, the introduction of rigid skimming arms, the use of large platform and offshore supply vessels (PSVs/OSVs), large oleophilic skimmers, and IR/FLIR/X-band systems, it would be useful information for planners and the response community as a whole to include these systems. As stated earlier, it would provide more credibility to the study.
Dr. Bill Lehr Subject to the required scope and methodology of the study, the findings are the rational results. Additional findings would have needed to utilize the additional data (e.g., detailed wave structure) that were not employed as they were outside the project scope.

9. Does this report present sufficient new data and knowledge, and are the study findings useful for informing oil spill response planning?
Dr. Victoria Broje This analysis provides useful insights for response professionals, but because of the above issues its results should not be used "as is" for response or regulatory decision-making, or by the general public, without careful issue-specific interpretation by knowledgeable response professionals.
Mr. James Hanzalik The study provides great insight mainly to responders outside the GOM. With the constant churn of USCG and private industry personnel in and out of the GOM area, it will give them a sense of the weather conditions that they may have not experienced in other areas of the country. The methodology is excellent and would be useful for oil spill response planners and responders because it provides an expectation of how well these spill response methods will work in the GOM. From an overall oil spill response planning perspective, it gives a general sense of response effectiveness based on weather conditions for response systems in the GOM and could be used to provide an "overall practical response factor" for a given system in seasonal weather "windows" in the various areas of the GOM.
Dr. Bill Lehr Obviously, an analysis that is based upon climatology is of little use in an actual spill event as the specific forecast would be used instead. Therefore, the study findings must be weighed based upon their application only to spill response planning .The reviewer recognizes the critical need to translate complex environmental data into a simple format that can assist in such planning. Certainly, the Nuka Research report authors are to be commended in their manner for their findings displayed. As this is the third edition of similar studies, the reviewer must assume that stakeholders have found such analysis and display useful in the past for planning purposes. Precisely how this happens is a conundrum to the reviewer. Since probability of spill size and spill location is not considered, amount of response equipment and personnel, or their staging location, are excluded from the Nuka Research report's purpose. Similarly, lack of oil type determination, weathering state of the spilled oil, resources at risk and other relevant factors preclude doing a net environmental benefit analysis on the different choices of response.

5. APPENDIX A: INDIVIDUAL REVIEWER COMMENTS

This appendix provides the individual peer reviewers' comments.

5.1 Dr. Victoria Broje

Gulf of Mexico Oil Spill Response Viability Analysis Interim Report
NAME: Dr. Victoria Broje
AFFILIATION: Senior Emergency Response Scientist, Shell Exploration and Production Company
DATE: May 17, 2018
I. GENERAL IMPRESSIONS
This study addresses the BSEE project scope as it is defined. The evaluated systems illustrate good diversity of possible types of response operations. The Nuka Research interim final report (Nuka Research report) is written in clear language with good graphic visualization of the results. It uses approaches and methodologies used in similar studies earlier. This Nuka Research report is missing clear references and rationale for operational limitations selection. Since these parameters are fundamental for the study results and conclusions, and since there are questions about the values used for some of the response systems, the selection of operational limits should be carefully verified and rationale/references provided where possible. While division of viability ranges for favorable, marginal, and non-favorable makes sense and is easy to calculate mathematically, the operational meaning of "marginal" is different for different response systems and parameters. The meaning and interpretation of this "marginal" category has to be carefully evaluated. It appears that it covers situations when systems can be used, but with decreased efficiency, yet on page 2 of the Nuka Research report the scope of work states: "This study does not consider the impact of the above conditions – or others – on … response efficiency or effectiveness. …Instead, this study focuses on whether conditions would affect the deployment or general operations of a response system." Some of the "marginal" conditions do affect ability to deploy response systems (wave height), but some others only affect the effectiveness of oil recovery, not the operation of the response system as such (e.g., visibility for mechanical recovery). BSEE needs to carefully consider current equal treatment of parameters affecting operations and parameters affecting recovery/dispersion efficiency and whether visibility should be separated from operational parameters, at least for on-water assets. More discussion on it below. Some challenges with interpretation and practical utilization of these results, especially by general public, may be related to two factors: • This Nuka Research report does not distinguish between situations when response is not possible, but needed, versus when response is not possible, but not needed because there is not oil on the surface. Natural dispersion/attenuation is an important process in the Gulf of Mexico (GOM) and is in fact a baseline to which other techniques should be compared to.

Gulf of Mexico Oil Spill Response Viability Analysis Interim Report

NAME: Dr. Victoria Broje

AFFILIATION: Senior Emergency Response Scientist, Shell Exploration and Production Company

Focusing on response techniques only (without natural baseline) may lead to misinterpretation of study results. It would have been helpful to also map environmental conditions resulting in oil not being present on the surface due to natural dispersion and not requiring response activities. This way the "gap" when oil is present on the surface and requires response, but response techniques are not available will be more visible and have greater operational meaning.

- An overarching intent of this study seems to be to answer the question: "Do we have response tools and techniques to respond to an oil spill in GOM?." This Nuka Research report represents results for different response techniques individually, as if they were mutually exclusive, and not as a "toolbox" as they are actually used. Response techniques are complementary and act with greater success in different weather ranges. When mechanical recovery starts to fail, dispersants become more effective. In an operational sense, they cover both ends of the wave/wind spectrum and a gap between them as a "toolbox" is smaller than if it was calculated and mapped for each of them individually. The results section could benefit from an additional set of maps and diagrams showing when at least one response technique is available. This would better illustrate actual response capabilities to the public and clearly show the time when response is needed, but no technique is available due to weather limitations.

This analysis provides useful insights for response professionals, but because of the above issues its results should not be used "as is" for response or regulatory decision-making, or by the general public, without careful issue-specific interpretation by professionals.

II. RESPONSE TO CHARGE QUESTIONS

1. Were the objectives of the report clearly defined? If not, what are your recommendations for improving the description of the objectives?

Study objectives as such were not specifically stated, but could be guessed from executive summary and introduction sections. It is recommended to start the Nuka Research report with a section describing goals, objectives, scope, limitations, and intended use for this study.

2. Was the methodology used for the oil spill response viability analysis (Sections 2 and 3) appropriately designed and clearly described? Were there any apparent weaknesses, omissions, or errors? Provide an explanation for your answers.

Yes

3. Were the limitations of the approach (Section 3.3) clearly identified and described? If not, what are your recommendations for improving the description of the limitations of the

Gulf of Mexico Oil Spill Response Viability Analysis Interim Report
NAME: Dr. Victoria Broje
AFFILIATION: Senior Emergency Response Scientist, Shell Exploration and Production Company
approach (Section 3.3)? Also comment on whether the limitations of the approach were addressed throughout the report in a thorough and understandable way in order for the reader to evaluate the impact of limitations on this study's analysis or results.
Interpretation of "marginal" could be clarified as it is different for different response systems and parameters. For some it may mean standard operation at slightly reduced efficiency (mechanical recovery at night), but for others it may mean that they cannot be used for some portions of the time, or operations could be substantially compromised (mechanical recovery by smaller systems in "marginally high" waves). The rationale behind selecting seven (7) specific response systems, as well as the rationale behind exclusion of other potential response techniques (e.g., of subsea dispersants – subsea dispersants injection (SSDI)) from this evaluation should be provided in the Nuka Research report. SSDI is one of the existing response techniques uniquely relevant for the GOM. Understanding of its limits and viabilities would be as important as for other techniques. It could be argued that in-situ burning with the use of herders was not included in this study due to its limited availability in the GOM, the fact that it is not presently included in contingency plans, and regulatory approval processes not being readily available. In contrast, SSDI capabilities in the GOM are well established, available 24/7, the process for seeking regulatory approval and monitoring techniques exist and have been practiced in exercises. This technique is especially relevant for the GOM and has its own operational limitations based on the ability of the injection vessel to maintain operations in high winds and waves. Same metocean datasets used in this work can be easily used to determine SSDI viability for the GOM. Absence of this technique will be noticed by readers of the Nuka Research report and should be explained.
4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.
Page 30 shows nice visualization of response system operating limits used in the Nuka Research report, which is likely to be quoted for other reports and operational guidance. Unfortunately, it is not clear how the maximum values for the bars were selected and their values are not specified on this diagram. From the following chart (page 31) those may be 60 knots and 20 feet? Were these cutoffs selected based on some physical principle? Red "gap" length could be doubled for all systems if a much higher number is randomly selected as a maximum wave or wind parameter. What are these numbers and how were they chosen? They all need to be cut off, as at some point values do not have physical meaning or relevance. I would like to suggest a logic cutoff for this

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Figure 5-8 as well as Figure 5-9. A logic cutoff may also produce some additional information in other relevant diagrams.

It is correctly stated in the Nuka Research report on page 5 that: "Regardless of the platform, there must also be enough mixing energy present during or soon after the application for the dispersant to be effective. If there is abundant natural wave energy, adding chemical dispersants may not be necessary." It would be very useful to know what percent of time this would take place, especially when dispersants use limitations are described. This information is easily obtainable using the same environmental datasets and processes already used in the study. In the current format, periods with wind speed higher than 35-39 knots are shown as "not favorable" without mentioning that they are also not needed since the same dispersion is accomplished by natural mixing. This transparency is important for identification of improvements that are needed for different response techniques. The present format suggests that response efficiency could be improved if dispersants could be applied at higher wind speeds and wave heights. In fact, that is not correct as no oil is available at the surface. Technological improvements should be focused on addressing other gaps (e.g., operations at night, or improving skimming encounter rates). This limit, for example, 35-40 knots winds and 10-foot waves (when oil is simply not available on the surface and is being dispersed naturally) should be used as a cutoff for all evaluated systems for Figure 5-8 on page 30. Beyond this limit, capabilities of the system are irrelevant as no oil is available to recover.

At very least, this issue could be addressed by:

- Stating what the maximum value is and where it came from; and
- Introducing an additional bar above the wind and waves bars on page 30, or covering the wind and waves bars with the shaded areas in the range higher than these limits and marking this specific area as "no action," or "no available oil zone." Otherwise the diagrams on page 30 are misleading and identifying gaps in the areas where they may not be present or relevant.

Also, on page 30, wind and waves have a well-known relationship. For example, https://en.wikipedia.org/wiki/Beaufort_scale. Figure 5-8 on page 30 plots wind and wave scales next to each other to show relative viability areas. Are they reasonably aligned with each other, or is each plotted up to a randomly selected maximum (and unreported) value, skewing the bars?

References should be provided for all used operational limits for two reasons:

- As acknowledged in the Nuka Research report, there are several sources of this information (e.g., publications by ASTM, Allen, Fingas, SL Ross, IPIECA, Exxon, etc.) with slightly different operating limit values. It is important to be transparent and clarify which ones were used in this assessment. In some cases, these limits appear to be modified based on the best professional judgment to reflect and contrast performance differences of

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the evaluated response systems. This is a valid approach, but the user may need to understand the rationale behind these changes to better appreciate their performance differences.

- Operational limits for the same system may be based on different processes as described in Table 2-1 (page 6). For example, in Section 2.2 on page 5, for in-situ burning the Nuka Research report states: “Wind and waves must be calm enough to allow for ignition and a sustained burn.” In fact, the main factors affecting viability of in-situ burning with the boom is the ability to collect and maintain oil inside the boom, not the ignition process. Ignition parameters may depend on oil type and burn efficiencies, which were taken out of this analysis. Without specific references provided it may not be clear to the reader which process you considered to be limiting for a specific system.

Table 2-1: Fast currents are relevant for rivers and shoreline booming, but typically not for offshore environments. They do not affect dispersants application, or in-situ burning and mechanical recovery (which can drift with oil hence relative speed to currents can be varied). You also did not evaluate this parameter in the Nuka Research report, so suggest deleting. Also suggest deleting “High temperature” line. It was also not evaluated in the Nuka Research report. Exceedance of optimal storage temperatures for dispersants seems to be speculation, and even if it did take place, the outcome would relate to dispersion efficiency (which is out of scope for this Nuka Research report) and not viability of dispersants operations. The statement of temperature enhancing in-situ burning is simply incorrect. Oil evaporates faster at higher temperatures and if anything it will decrease burning efficiency and window of opportunity. This Table 2-1 would be more informative if it focused on parameters used in this study and indicated (with references) specific values for the described limitations. Then it would be easier to see how limits for the response system were selected from the collection of limits for different processes. This comment also relates to Table 2-2.

Authors may want to reconsider attributing “marginal” conditions to mechanical recovery, in-situ burning, and vessel-based dispersants operations in darkness. The description of the study on page 2 of the Nuka Research report states: “This study does not consider the impact of the above conditions – or others – on … response efficiency or effectiveness. …Instead, this study focuses on whether conditions would affect the deployment or general operations of a response system.” The Nuka Research report also states on page 22: “Horizontal visibility-related limits are included, but these do not include detecting slick location. Instead, they assume that the on-water response systems include some technology to aid the system in targeting the slick in the immediate vicinity during darkness.” Based on this, introducing visibility based limits to aerial (plane and helicopter) dispersants operations makes sense, since they are not in “immediate vicinity” and will be operationally challenged in applying dispersants to the slick. On the other hand, since this study assumes that all on-water techniques have tools to allow them working in the slick in darkness and

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bad visibility, their deployment and operations will not be affected by darkness (they have lights allowing them to monitor the immediate vicinity as well as tools to further enhance their capabilities). Their effectiveness and efficiency may or may not be affected, but these parameters were specifically excluded from the study. Based on project definition and description of the systems capabilities, only aerial systems should be affected by night time operations and marked as "marginal" during this period.

Related to this comment – it is not clear why on-water recovery techniques would be limited by vertical visibility. This assumes that their ability to navigate relies on aerial assets only, which is not the case for GOM response vessels, which use modern navigation tools as well as on-vessel detection equipment (infrared (IR) and X-band radar). Per study objective, it is not evaluating system efficiency, but only an ability to deploy and operate system.

It could be appropriate to leave this limitation for the vessel of opportunity system, but remove from the two other mechanical recovery systems illustrating dedicated response vessels. This will correctly illustrate the contrast in their capabilities as vessels of opportunity may need aerial support for operations, while other systems already have these tools on dedicated response vessels.

Please note that System 5.3.3 (Mechanical Recovery – Three Smaller Vessels with Boom) is not correctly described/illustrated in the Nuka Research report. Refer to definition of mechanical recovery devices for active booming system http://www.oilspillresponseproject.org/wp-content/uploads/2017/01/At-sea_containment_and_recovery_2016.pdf. What seems to be illustrated in the Nuka Research report is a high speed (Buster) rather than active booming system.

Specific mechanical recovery and in-situ burning limits for wind speed and sea state appear to be using numbers referenced in known literature and be generally appropriate to described system types. There are some questions about dispersants systems:

1) Is there a reference for 39 knots limit for vessel application of dispersants?
2) A reference or verification is needed for the 21-30 knots wind speed for aerial dispersant application from the plane. Could the 21 knots be a parameter that was "carried over" from the vessel application table (Table 5-8)? These references state that limits for these systems should be 30-35 knots (ExxonMobil 2000 in Fingas 2004). And http://www.oilspillresponseproject.org/wp-content/uploads/2017/01/Dispersants-surface_application_2016.pdf and https://crrc.unh.edu/sites/crrc.unh.edu/files/exxonmobil_dispersant_guidelines_2008.pdf (page 45). Also, per last reference, wave height range limit for plane application is 17-23 feet rather than 10-16 feet. Could these be also a "carry over" from the vessel application table (Table 5-8)? Operationally speaking, it is pretty logical that limits for plane

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applications would be higher than for vessel application. Exactly which limitations does this Nuka Research report describe and which references does this report use?

3) A 5000-foot ceiling requirement for aerial dispersant application can be questioned. Standard operational requirements for dispersants planes are 1000-foot ceiling and 3 miles visibility, hence they should limit favorable range. This is also clearly reflected in RRT 6 documents as well as aviation guidance for daylight Visible Flight Rule (VFR) conditions http://www.losco.state.la.us/pdf_docs/RRT6_Dispersant_Preapproval_2001.pdf. These numbers were also used in BSEE's Estimated Dispersant System Potential (EDSP) Calculator http://www.genwest.com/wp-content/uploads/2017/04/dispersants-man.pdf. If there is no suitable rationale with proper reference for selecting upper "marginal" boundary for this parameter, it could be made of only two categories – favorable and not-favorable. Unlike other techniques and parameters that gradually degrade over time, if this parameter is based on "fly/no fly" cutoff decision, then it should not have the "marginal" category. A rationale for the helicopter operations may also need to be verified in similar fashion. If it is valid, maybe similar parameters could be used for both areal systems.
4) It seems to be very unlikely that a helicopter with a sling load under it would have the same operational limitations for wind and waves as large plane. Logic suggests that they should be lower and this reference https://crrc.unh.edu/sites/crrc.unh.edu/files/exxonmobil_dispersant_guidelines_2008.pdf (page 145) confirms that they should be 17-27 knots for wind and 6-17 feet for waves.

5. Were the inputs used for the metocean data and were the five (5) metocean conditions included in the study based on modeled data used (Sections 3 and 4) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.

I am not a metocean specialist, but I would check whether databases for wave heights used in this study are more conservative (on higher end) than actual data measured by buoys. If so, conservative nature of this analysis should be mentioned in the Nuka Research report.

6. Were the results (Section 6, Appendices A and C) of the oil spill response viability analysis conducted for each of the seven (7) selected oil spill response systems appropriate and clearly described? Were the associated graphical outputs clearly presented? Provide an explanation for your answers.

The graphical illustration of mathematical results is clear and appropriate. My concern is more in selection of the parameters that were used in the analysis as well as operational/regulatory interpretation of these results especially in interpretation of the operational meaning of "marginal" category.

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Mathematical analysis of the parameter's sensitivity is interesting, but did not really factor in practical operational considerations and may benefit from more practical interpretation by knowledgeable response professionals. Especially clearly specify which practical improvement areas can response capabilities benefit from most. Since an overarching question of this study seems to be "do responders have tools to respond in GOM?," the results section needs to have an additional set of maps and diagrams showing when at least one response technique is available as reflected in the Nuka Research report's conclusions. Representing results by individual systems is correct, but they are not mutually exclusive. In fact, they are **complementary** and act with greater success in various weather ranges. When mechanical recovery starts to fail, dispersants become most effective. This may better illustrate actual response capabilities to the public and clearly show the time when no response is possible. This needs to be carefully explained, though in terms of whether: 1) it is not possible, but oil is on the surface and needs to be removed eventually; or 2) it is not possible and not necessary as natural dispersion removed all oil from the surface.
7. Were there any critical results or limitations not discussed or adequately addressed in the report?
Yes. Described in the details under earlier charge questions.
8. Were the study findings and discussion (Section 7) and conclusions (Section 8) logical and appropriate based on the results? Are there any additional study findings or conclusions that could be drawn? Provide an explanation for your answers.
Please refer to some of the above points. The Nuka Research report's conclusions and recommendations reflect the mathematical nature of the findings and analyzed data as per the limited focus of this study, but they do not necessarily address operational conclusions or future needs.
9. Does this report present sufficient new data and knowledge, and are the study findings useful for informing oil spill response planning?
This analysis provides useful insights for response professionals, but because of the above issues its results should not be used "as is" for response or regulatory decision-making, or by the general public, without careful issue-specific interpretation by knowledgeable response professionals.

5.2 Mr. James Hanzalik

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DATE: May 15, 2018

I. GENERAL IMPRESSIONS

In the past, it is obvious that weather conditions, optimum or inclement, have had an effect on the efficiency and effectiveness of spill response equipment under various weather conditions. Although my forte is not oceanography or meteorology, in my mind, this the first time that I have seen a study that takes a comprehensive approach to all response methods, and ties in weather and time of day in the Gulf of Mexico (GOM). It gives the reader a general and objective account of certain specified spill methods and how they could be affected by past and potential future weather in the GOM. The study was an easy read, had solid methodology, and was well presented. I believe overall the study was very well written, comprehensive in its approach, and limited in scope to achieve its goals. Although the systems were dictated by BSEE in the study, it accurately, for the most part, detailed the limitations of the mechanical recovery, dispersant, and in-situ burn equipment systems and weather used. The use of red, yellow, and green (favorable, marginal, and not favorable) for the different response systems methodology made it easy to get a general snapshot of if and when a system may be used or effective. I believe it provided a fair and accurate past documentation of GOM weather patterns and of future effectiveness of an oil spill response using those specified systems in the GOM. In essence, the study from a practical viewpoint provides some sense of the limits of the use of these response systems but it has limited value for any specific oil spill response scenario in the GOM. From an overall oil spill response planning perspective, it gives a general sense of response effectiveness based on weather conditions for response systems and could be used to provide an "overall practical response factor" for a given system in a seasonal weather "window" in a particular area of the GOM. From a regulatory sense, it provides some value in prescribing types of equipment that could be effective in the GOM based on past weather patterns. Although not a goal of the study, from an actual response perspective, it provides little value based on the timing of spills and the real-time weather that may be forecasted and the systems employed.

II. RESPONSE TO CHARGE QUESTIONS

1. Were the objectives of the report clearly defined? If not, what are your recommendations for improving the description of the objectives?

No, I do not believe that the objectives are clearly stated. The description of the objectives could be improved. It assumes that the objective of this Nuka Research interim final report (Nuka Research report) is a viability analysis of response systems given weather conditions in various areas of the GOM.

I believe the overall objective of the study was to:

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Based on specifically defined oil spill response systems with specified limitations for the study, and based on published standards based the last ten years of captured weather data, this study provides a general seasonal effectiveness of those systems in specified areas of the GOM under past weather conditions. Specifically:

- Using specified response systems used in most of the areas of the U.S., this study defines the optimum timeframes for their use under certain weather and daylight conditions;
- It uses captured government meteorological data from 2005-2014 to provide a basis for the weather that could be seen in the future in an oil spill response in the GOM;
- It synthesizes weather and astronomical data in areas of the GOM and specific chosen equipment effectiveness to provide a general overall analysis of oil spill response equipment "windows;"
- That ultimately provides an additional planning factor for oil spill response plans given oil type, size, and other planning factors.

2. Was the methodology used for the oil spill response viability analysis (Sections 2 and 3) appropriately designed and clearly described? Were there any apparent weaknesses, omissions, or errors? Provide an explanation for your answers.

The methodology was a very strong point of the study. Taking the metrological data at face value, and the defined systems used and their limitations pre-defined, I think the overall methodology is solid with the following exceptions:

- The 200-meter bathymetry line is somewhat arbitrary and serves no use in the study based on the limitations of the equipment that has been pre-defined. The weather parameters are stated and the equipment systems fixed (logistics, etc.). Most of the systems specified would operate at the same efficiency and effectiveness on both sides of the 200-meter bathymetry line. I recommend removing this delineation that serves no real technical purpose in the study.
- Page 5, Section 2.2, third paragraph – The statement that: "If there is abundant natural wave energy, adding chemical dispersants may not be necessary." I generally agree with this statement but it is situational dependent – for a defined quantity spill versus an unsecured source. I would recommend removing this sentence based on MC-252 spill experience where dispersants were used in a high wave energy environment due to an unsecured source.
- For Table 2-1:
    - Under "Metocean Conditions and High air temperature" under the "Dispersants" column, the Nuka Research report states – "Optimal storage temperatures may be exceeded." The boiling point of most dispersants is 140 degrees Celsius and most dispersants do not recommend a specific storage temperature. They were stored on deck during MC-252 for vessel spraying, stored in large tanks in direct sunlight on the tarmac for aerial application in the middle of summer in 90 degrees Fahrenheit

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plus heat, and this had no effect on the efficacy of the dispersants used. Nalco, the manufacturer of Corexit Products stated: "COREXIT products can retain a nearly unlimited shelf life as long as the product has remained in their original sealed containers and contamination has been prevented." Thus I do not see this as a factor – recommend it should be "Not Applicable."

- Under "Metocean Conditions and High air temperature" under the "Mechanical Recovery" column there could be a problem with high volatile organic compounds (VOCs) for mainly crude oil, which could keep workers "sheltered in place" for periods of time, especially during the initial stages of a spill or for unsecured sources. I would recommend replacing the "Not Applicable" with "Health effects due to high VOCs."

- For Table 2-2:
  - Under the column for "Metocean Conditions and Darkness" under "Vessel Operations" – If the systems are equipped with adequate detection systems – as stated for mechanical recovery, then darkness or low light conditions would have less of an effect. I would recommend that during periods of "low light" there is a "decreased ability to target and maintain operations to recover oil."
  - Under the column for "Metocean Conditions and Sea state" under "Aircraft Operations," the Nuka Research report states – "Extremely high waves could impact low flying helicopter." It is my experience that helicopters and fixed wing aircraft spray dispersants at 50-100 feet AGL (above ground limit). If you have waves that high, you probably are not flying in those weather conditions. FYI – Currently, (could change) there are no helicopter spray systems in the GOM for dispersant application. I recommend changing that to "Not Applicable" for the GOM.
  - Under the column for "Metocean Conditions and Darkness" under "Aircraft Operations" – Dispersants are not aerially sprayed in darkness and I do not see any changes due to safety concerns – I recommend changing to "Not Applicable."
- The use of red, yellow, and green (favorable, marginal, and not favorable) for the different response systems methodology made it easy to get a general snapshot of if and when the defined response system may be used or effective.
- For Table 3-2 under "System" for "Dispersants – Helicopter Application" – under "Method," the Nuka Research report says "Change darkness from red to yellow." This should be left red due to safety conditions and the ability of aircraft to see at night and the limited range of helicopters with a dispersant payload.
- For Section 3.2.4 Vertical visibility – There are primarily two airports (Houma Terrebonne, LA and Stennis, MS) and a total of three airports (also Galveston, TX), where aerial dispersants have been and are deployed in the GOM. It would provide better credibility for the study to use those three airports versus the airports used in the study.

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3. Were the limitations of the approach (Section 3.3) clearly identified and described? If not, what are your recommendations for improving the description of the limitations of the approach (Section 3.3)? Also comment on whether the limitations of the approach were addressed throughout the report in a thorough and understandable way in order for the reader to evaluate the impact of limitations on this study's analysis or results.
The limitations of the approach for this response viability analysis that it would provide a "useful" tool was clearly defined and explained. With those limitations used, it also confines the use of the study as a planning tool to those response systems in the study. One of the limitations described in the Nuka Research report on page 14 was that it is "generally accepted that dispersants are less effective in lower-salinity waters." This would be a true statement in the general sense but not practical in the GOM. The EPA standard for effectiveness for dispersants is 50% or greater to be listed on the EPA Product Schedule. Most dispersants used in the GOM are in excess of 80-90% effectiveness or greater, and higher with the crudes extracted in the GOM. With a lower salinity, it could be inferred that a higher effectiveness would negate the limitations based on salinity. Given the tradeoffs for their use and practically speaking, lower water salinities in the GOM would not override dispersant use. Of all the dispersants operations conducted historically in the GOM, no dispersant operation conducted was limited by water salinity but rather limited based on the dispensability of the oil to be treated.
4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.
With the limitations I believe the authors could have conducted additional research on the systems used based on past responses in the GOM. Many of these systems were used extensively with minor modifications during MC-252, especially the mechanical recovery systems and the aerial dispersants (less helicopters). I know from experience that at waves of 5 feet and higher, offshore skimming was suspended for all areas of the GOM during MC-252 – this may have been a safety consideration but nonetheless, could have been or can be included in the study. In addition, the use of Al Allen's/Spiltec diagram, 2009 (see below) (used extensively by NOAA in training classes based on what I know from experience) could have also assisted in further evaluation of the systems described in this study. This may affect all categories of systems components and results in Section 5 in the Nuka Research report.

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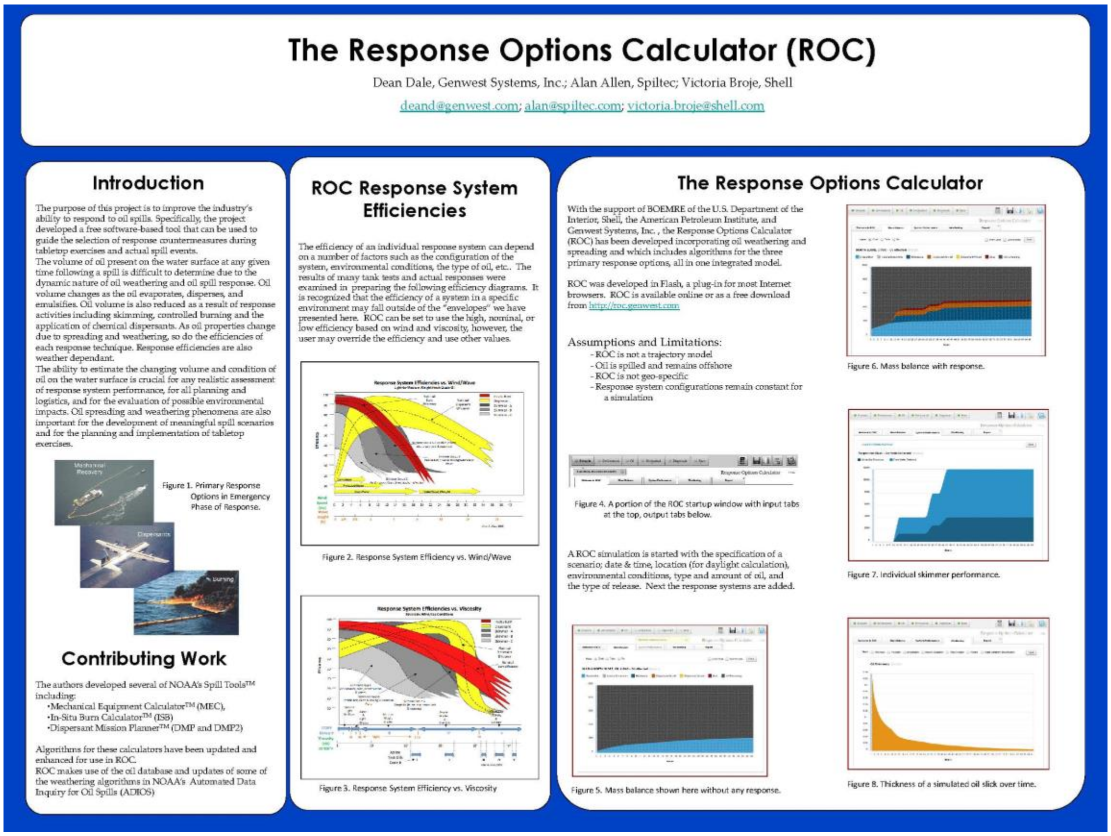

The explanations for the limitations in the Nuka Research report were very similar to those on the chart (see below) [from Al Allen's/Spiltec diagram, 2009] but it is unknown if the diagrams were used to determine the operating limitations of the equipment. This diagram is, in my opinion, very accurate in the limitations of various skimmers/mechanical recovery, dispersant, and in-situ burn use. If considered, this may change some operating limitation values of those mechanical recovery systems listed in the Nuka Research report.

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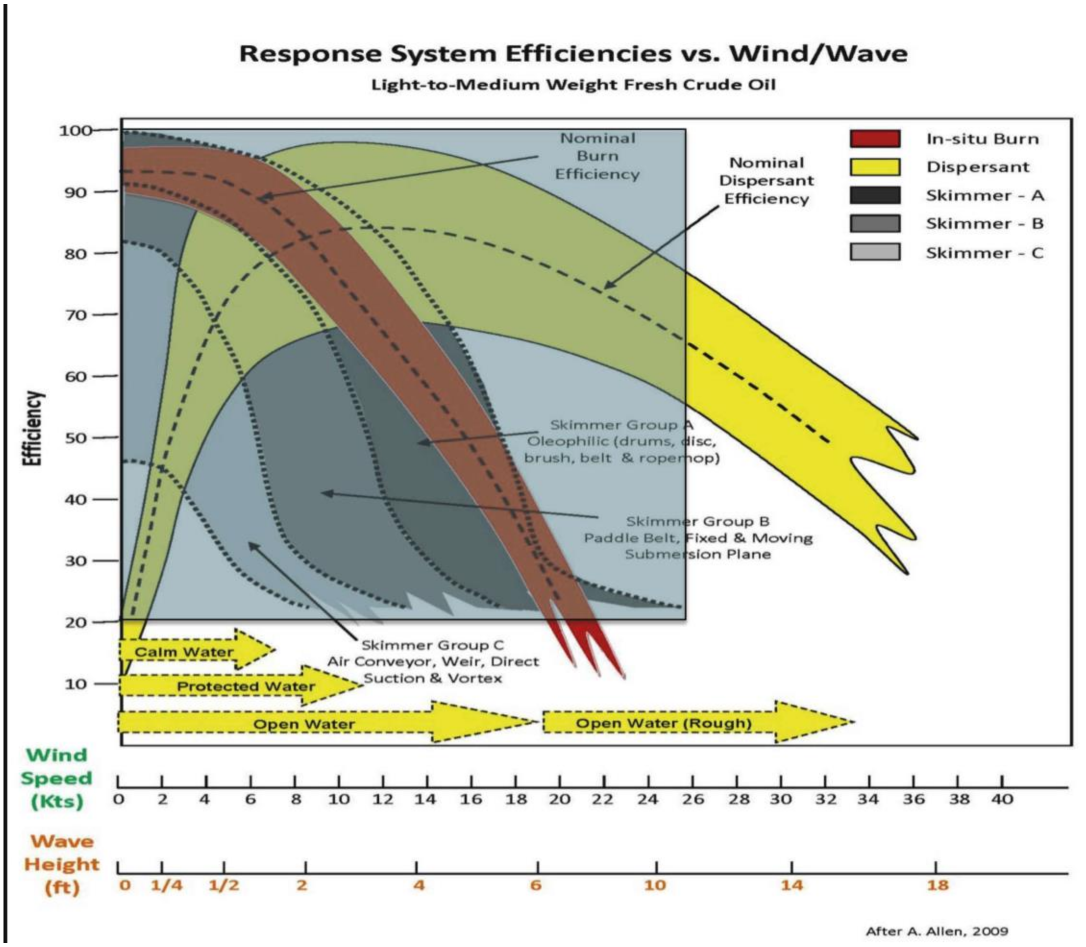

Detection technology described on page 22 of the Nuka Research report only provides for targeting in the immediate vicinity during darkness. This in my opinion renders the use of forward-looking infrared (FLIR) / infrared (IR) technology useless in low light conditions unless the target is in close proximity (within 1 mile or less). So, in essence the systems would not allow mechanical recovery in darkness. Most detection systems are equipped with X-band radar that would increase the range of the system and make the FLIR/IR much more effective. In a recent spill in the GOM, vessels mounted with X-band/FLIR/IR had the ability and were able to effectively mechanically remove oil from the surface during periods of complete darkness. With X-band radar and adequate FLIR/IR cameras, 24-hour skimming is possible but with limitations as described above.

The response systems used in the study were described in detail in the Nuka Research report; however, the descriptions did not include boom sizes for the study but described them, for example in Section 5.3.1, Table 5-1, as “boom suited up to 6 feet rough seas” or “high volume

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oleophilic skimmer suited up to 6 feet rough seas.” For instance, for Section 5.3.1, Table 5-1, the mechanical recovery system components are a 245-foot response vessel and 65-foot towing vessel. The actual systems in the GOM are a 210-foot response vessel and a 32-foot towing vessel with 67-inch boom and a weir skimmer (or an oleophilic skimmer). There are also examples in the Nuka Research report of the use of weir skimmers (Section 5.3.2, Table 5-3) and oleophilic skimmers (Section 5.3.3, Table 5-5) with no explanation of why one or the other skimmers were used in the study. There are more examples of systems used in the GOM that do not particularly match those used in the study. I understand the need to generalize the equipment to match previous studies but a better specification based on the equipment available in the GOM would provide more credibility to the study and its results.
5. Were the inputs used for the metocean data and were the five (5) metocean conditions included in the study based on modeled data used (Sections 3 and 4) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.
I believe that the data inputs used were logically described and inputs adequately characterized with the exceptions noted in the answers to Charge Questions #2 and #4. The areas used (BOEM planning areas) and methodology with the grid system made perfect sense with the exception of 200-meter bathymetry line. The use of red, yellow, and green (favorable, marginal, and not favorable) for the different response systems methodology made it easy to get a general snapshot of if and when a system may be used or effective. I am not aware of any publicly available weather data or systems data (not already noted) that should have been considered.
6. Were the results (Section 6, Appendices A and C) of the oil spill response viability analysis conducted for each of the seven (7) selected oil spill response systems appropriate and clearly described? Were the associated graphical outputs clearly presented? Provide an explanation for your answers.
Solely based on the systems used as described in the Nuka Research report and the analysis, the study did an excellent job providing graphical outputs using charts and colors to delineate effectiveness. The study was very effective in using the metocean data (sea state, wind, etc.) and explaining the effects on response systems through the use of various charts. From my perspective, I saw no surprises with the ability for the mechanical, in-situ burn, and dispersant systems to function in the weather conditions (favorable, marginal, and unfavorable) and wave/wind sensitivities expected in the GOM.
7. Were there any critical results or limitations not discussed or adequately addressed in the report?
Nearshore vessel limitations/classification:

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I believe that vessel draft is a greater limiting factor that also could have been used to delineate nearshore and offshore systems. This is typically the limiting factor for these systems and their ability to skim oil in the nearshore area. Typically, vessels of 5 feet draft or greater would be considered “offshore” and those of lesser draft considered nearshore (lakes, bays, sounds, bayous, etc.). Another consideration is the vessel’s ability to provide overnight accommodations for offshore application. In commercial service (with the exception of uninspected fishing vessels), most inspected vessels that are expected to operate over 24 hours, are required to have additional crews and overnight accommodations, and as a result, may have the endurance to operate offshore. As such, vessels not in this category would be considered in the nearshore category. It is not a hard and fast rule but should be considered or explained in the study. These limitations would allow for only daytime operations for the nearshore areas. The geographical range of response assets: Many of the smaller mechanical recovery systems and also helicopter dispersant systems have a limited range and fuel capacity. For instance, a 50-foot fishing vessel may be able to skim oil over 100 miles offshore but with limited fuel capacity, and loitering time, these systems would be relegated to nearshore areas. In addition, helicopter dispersant systems are limited in the amount of dispersants (300-700 gallons) that could be used and their range drastically reduced (due to weight). The use of helicopters would also limit dispersant systems to nearshore applications. This could have an effect on the results of the data captured in some areas in the Nuka Research report because those systems would not have the ability to operate in some offshore areas.
8. Were the study findings and discussion (Section 7) and conclusions (Section 8) logical and appropriate based on the results? Are there any additional study findings or conclusions that could be drawn? Provide an explanation for your answers.
Based on my experience in the GOM, the discussion and conclusions in the Nuka Research report are consistent with the data and systems used in the study. The most favorable weather conditions (summer) are consistent with my experience. I am not sure that the vertical visibility conclusions would be the same at the primary airports where dispersants have been used or based without sufficient data (as noted earlier, Houma, Stennis, and Galveston). Although dispersants could be staged from those airports used in the study, it is unlikely, especially in the eastern GOM where there is no offshore activity. As stated earlier, adding or substituting these airports would lend more credibility to the study and the vertical visibility data over water recommendations. I agree with the recommendations for incorporating wave steepness as the GOM is known for shorter period wave length. I am not sure that hurricane or flood-related spills would add much to the study. Based on the metocean data provided, there were storms (hurricanes and tropical storms) during that 10-year period that has been included in the study. I am not sure flood-related spills will provide any new information.

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I strongly recommend applying the metocean data to existing mechanical recovery systems in the GOM. Along with well containment equipment, the introduction of rigid skimming arms, the use of large platform and offshore supply vessels (PSVs/OSVs), large oleophilic skimmers, and IR/FLIR/X-band systems, it would be useful information for planners and the response community as a whole to include these systems. As stated earlier, it would provide more credibility to the study.
9. Does this report present sufficient new data and knowledge, and are the study findings useful for informing oil spill response planning?
The study provides great insight mainly to responders outside the GOM. With the constant churn of USCG and private industry personnel in and out of the GOM area, it will give them a sense of the weather conditions that they may have not experienced in other areas of the country. The methodology is excellent and would be useful for oil spill response planners and responders because it provides an expectation of how well these spill response methods will work in the GOM. From an overall oil spill response planning perspective, it gives a general sense of response effectiveness based on weather conditions for response systems in the GOM and could be used to provide an “overall practical response factor” for a given system in seasonal weather “windows” in the various areas of the GOM.

5.3 Dr. Bill Lehr

Gulf of Mexico Oil Spill Response Viability Analysis Interim Report
NAME: Dr. William J. (Bill) Lehr
AFFILIATION: Lehr Science LLC
DATE: May 6, 2018
I. GENERAL IMPRESSIONS
Spill response effectiveness is a function of three broad input categories: (1) operating environment, (2) properties and amount of the spilled product, and (3) characteristics of the response system. Keeping within the BSEE scope of work, the authors of the Nuka Research interim final report (Nuka Research report) ignore category two (2) and divide the other two categories using a very coarse screening matrix. For example: • Skimmers are grouped into three choices related to the skimming platform that ignores the actual skimmer type, • Wave spectrum model results that return more than a dozen wave frequencies in a similar number of directions are reduced to a single number (significant wave height), and • Dispersant efficiencies that are a strongly non-linear function of wave energy are represented by a three-value step function. Hence, much detailed and available information is not used. The authors of the Nuka Research report have done a yeoman's effort to assemble existing metocean databases and process the data into easily understood seasonal charts, suitable for the target audience. Whether the results, given the pre-defined operating limits, will prove to be useful is outside the purview of this review.
II. RESPONSE TO CHARGE QUESTIONS
1. Were the objectives of the report clearly defined? If not, what are your recommendations for improving the description of the objectives?
The objectives of the Nuka Research report are expressed succinctly in Section 1.1, Project Scope. The Nuka Research report produces a viability analysis for the Gulf of Mexico (GOM) Region.
2. Was the methodology used for the oil spill response viability analysis (Sections 2 and 3) appropriately designed and clearly described? Were there any apparent weaknesses, omissions, or errors? Provide an explanation for your answers.
The choice of methodology (e.g., three response viability categories) was to a large extent dictated by BSEE. Some of the requirements seem arbitrary since they are announced with little additional explanation. Presumably, there was a reason to define the 200-meter bathymetry line as the divider between nearshore and offshore, but no reason is given in the Nuka Research report other than BSEE agreed to it. As the Nuka Research report notes in a footnote at the bottom of page 10, alternatives exist.

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NAME: Dr. William J. (Bill) Lehr

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The Nuka Research report produces seasonal spatial maps of viability conditions and weekly charts of viability conditions for a single point in each of the six regions. Why restrict the latter to a single point instead of an average of all the grid points in the region? Choosing a single point opens the results to bias if the chosen point is not representative of the region.

The sensitivity analysis method employed appears to involve increasing the green or yellow limits for each response system and seeing how the resulting color fractions change. In essence, increased wind or wave states (similar for the other parameters) would be included in the green (or yellow). As such, it is a much reduced approach compared to traditional sensitivity analysis that would examine the functional dependence of the normalized first derivative (e.g., "Sensitivity analysis in oil spill models: Case study using ADIOS," Overstreet et al., IOSC 1995). It appears that the Nuka Research report assumes a linear decrease in viability with wind and/or waves. However, as noted in the reviewer comments for Charge Question #4, this is not the case for chemical dispersants and may not work exactly for other response options as well since their effectiveness is not strictly linear in the metocean parameters. In fairness to the Nuka Research report, their method may be sufficient given the limitation of viability to a three-value step function for dispersants.

3. Were the limitations of the approach (Section 3.3) clearly identified and described? If not, what are your recommendations for improving the description of the limitations of the approach (Section 3.3)? Also comment on whether the limitations of the approach were addressed throughout the report in a thorough and understandable way in order for the reader to evaluate the impact of limitations on this study's analysis or results.

Section 3.3 does a robust job of listing many of the limitations of the approach used in the Nuka Research report. As noted, logistics and other practical constraints may change the viability analysis determined by metocean conditions. In fact, the metocean conditions themselves may change between the time when the spill occurs and the time when equipment could be deployed onsite. This circumstance is recognized in the sixth paragraph on page 13. While outside the scope of the assignment, the impact of this affect could have been estimated by mapping the average duration of each metocean category over the geographical grid.

One limitation that requires further textual discussion is the broad grouping of response options. This broad assignment masks the significant variability found within each grouping. For example, CONCAWE in their field guide notes that disk skimmers may work with 3-meter wave heights, while other skimmers require smaller waves. Similarly, different fire booms have different metocean requirements. This broad brush also applies to metocean conditions themselves. Chop waves, for instance, have a different impact on mechanical recovery than swells of the same height. A particular grid location may be suitable for in-situ burning depending not only upon wind speed but also wind direction as soot impact on coastal areas would be different.

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4. Were the inputs and approach used to develop the operating limits for the seven (7) selected oil spill response systems (Sections 3 and 5, Appendix B) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.

The definitions of the three response limits are given in Table 3.1 and, according to the Nuka Research report (see page 8), were agreed to at a 2015 Arctic Council Emergency Prevention, Preparedness, and Response Workgroup (EPPR) event that included government, industry, and other organizations. The actual operating limits were based upon a panel of experts from an EPPR project on Arctic waters that used published limits where possible, according to page 9 in the Nuka Research report. Two modifications were made to the response limits that dealt with sea ice (not an issue in the GOM) and wave height limits. Some wave height limits were modified (see Section 5.2) after consultation with BSEE because the original EPPR study values exceeded ASTM International ratings for boom used in GOM.

Limit selection is a key parameter in the study so careful examination of the method and analysis is required. The reviewer has some concerns about how the limits were chosen:

- While oil properties *per se* are not in the scope of the Nuka Research report, the authors still needed to make some assumptions about the product to be treated. The EPPR workgroup experts must have implicitly assumed a generic oil that would be transported or produced in Arctic regions in determining their operating limits. A similar expert panel looking at GOM oils might arrive at a very different generic oil choice (e.g., most GOM oils are more susceptible to emulsification than most North Sea oils). At minimum, the authors should list the basic oil bulk properties assumed in setting the response limits.
- The limits do not seem to match widely used operating limits in certain cases. For example, the Nuka Research report lists any winds less than 21 knots as favorable to dispersant operations, meaning that calm seas would be included in computing the fraction of favorable time segments for dispersant use. However, it is well understood that some surface ocean turbulence is required for efficient oil dispersion. The widely used Response Options Calculator (ROC), for instance, recommends at least a 6-knot wind speed to achieve optimum dispersion. A more sound set of dispersant limits might be:

$$Green \rightarrow \{6\,knots < wind\,speed < 20\,knots\}$$
$$Yellow \rightarrow \{(3\,knots < wind\,speed < 6\,knots) \cup (20\,knots < wind\,speed < 30\,knots)\}$$

Very high wind speeds and the resulting breaking waves would not need added surfactant to disperse the oil but the Nuka Research report includes such sea states as unfavorable.

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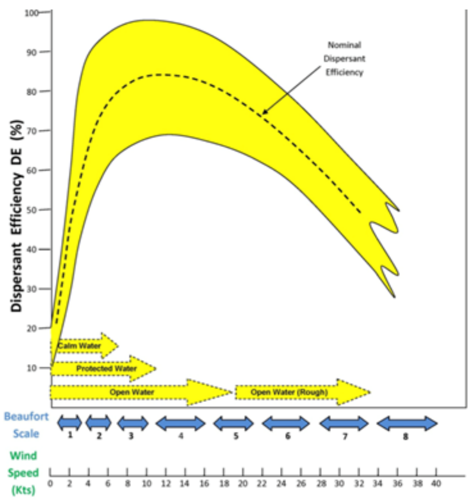

ROC Dispersant efficiency chart

5. Were the inputs used for the metocean data and were the five (5) metocean conditions included in the study based on modeled data used (Sections 3 and 4) for the oil spill response viability analysis clearly described and adequately characterized? Were there any apparent weaknesses, omissions, or errors? Is there any other publicly available data that should have been considered? Provide an explanation for your answers.

The Nuka Research report authors chose the modeled dataset from the Oceanweather Inc. models for wind and waves. The grid resolution is 12 km (7.5 mi) on a side, which is adequate for the purpose of the Nuka Research report. The model does not resolve water depth of less than 10 meters, which includes a large part of the Mississippi River Delta region, an area of heavy oil activity and spillage. It is unclear to the reviewer whether this limitation was approved by BSEE prior to the study, recognizing that the dispersant option would face severe regulatory approval restrictions for such shallow conditions.

Given the limited complete field measurement sets over the 10-year period used for the Nuka Research report (e. g., no NOAA National Data Buoy Center (NDBC) complete dataset for waters off Louisiana), the choice of well-calibrated modeled data was appropriate. However the Nuka Research report comparison between measured and modeled results discussed on page 19 is of questionable value if the same measured data was used to calibrate the model, as seems likely. As an alternative, other well-known data sources, such as the Texas Automated Buoy System (TABS), and other wave forecast models such as the NOAA Wavewatch III could have been used as either complementary to the Oceanweather set or as a check on the Oceanweather results.

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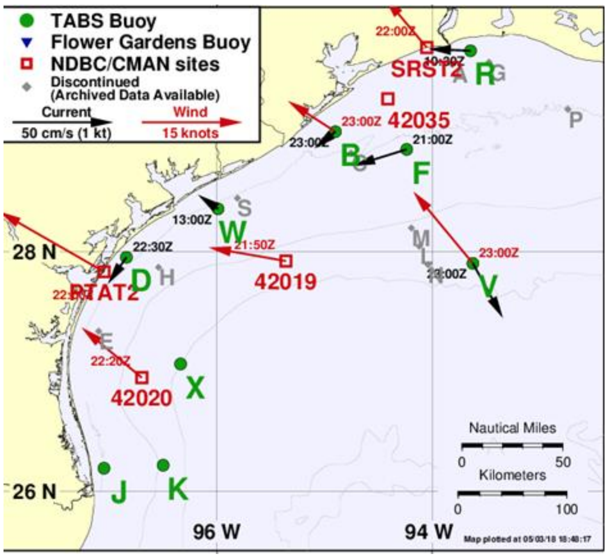
Without better knowledge of the Oceanweather model itself, the reviewer is unable to ascertain how extreme weather conditions were assimilated. Given that no response option is either viable or needed during extreme weather events, a more relevant statistical mapping would probably exclude such events from its underlying dataset.



Texas Automated Buoy System

6. Were the results (Section 6, Appendices A and C) of the oil spill response viability analysis conducted for each of the seven (7) selected oil spill response systems appropriate and clearly described? Were the associated graphical outputs clearly presented? Provide an explanation for your answers.

Given the adoption of the study methodology, the tables and charts of Section 6 of the Nuka Research report do an adequate job in providing easily comprehended results.

7. Were there any critical results or limitations not discussed or adequately addressed in the report?

The Nuka Research report authors make several useful recommendations in Section 7.2. The reviewer commends all of them to BSEE for future studies. Certainly expansion of the number of system groupings would be valuable. Addition of even a simplified oil behavior model and library of oil types would strengthen the utility of the Nuka Research report results.

Gulf of Mexico Oil Spill Response Viability Analysis Interim Report
NAME: Dr. William J. (Bill) Lehr
AFFILIATION: Lehr Science LLC
8. Were the study findings and discussion (Section 7) and conclusions (Section 8) logical and appropriate based on the results? Are there any additional study findings or conclusions that could be drawn? Provide an explanation for your answers.
Subject to the required scope and methodology of the study, the findings are the rational results. Additional findings would have needed to utilize the additional data (e.g., detailed wave structure) that were not employed as they were outside the project scope.
9. Does this report present sufficient new data and knowledge, and are the study findings useful for informing oil spill response planning?
Obviously, an analysis that is based upon climatology is of little use in an actual spill event as the specific forecast would be used instead. Therefore, the study findings must be weighed based upon their application only to spill response planning .The reviewer recognizes the critical need to translate complex environmental data into a simple format that can assist in such planning. Certainly, the Nuka Research report authors are to be commended in their manner for their findings displayed. As this is the third edition of similar studies, the reviewer must assume that stakeholders have found such analysis and display useful in the past for planning purposes. Precisely how this happens is a conundrum to the reviewer. Since probability of spill size and spill location is not considered, amount of response equipment and personnel, or their staging location, are excluded from the Nuka Research report's purpose. Similarly, lack of oil type determination, weathering state of the spilled oil, resources at risk and other relevant factors preclude doing a net environmental benefit analysis on the different choices of response.

6. APPENDIX B: PEER REVIEWER QUESTIONS AND BSEE RESPONSES

This appendix provides the four (4) peer reviewer questions that were compiled by the EnDyna Peer Review Lead and submitted to BSEE on April 24, 2018 as well as the written BSEE responses received by the EnDyna Peer Review Lead on May 3, 2018. The EnDyna Peer Review Lead distributed these four (4) peer reviewer questions and written BSEE responses to all three peer reviewers on May 4, 2018. The written BSEE responses are highlighted below in bold.

Question #1

Section 3.1.1 of the report states that the metocean data was obtained by BSEE and that BSEE provided the metocean dataset to Nuka Research and DNV GL for the purpose of this project. The introductory paragraph to Section 3.1 states that the metocean data are one of two sets of inputs to the response viability analysis. Moreover, the introductory paragraphs of Section 3 state that compiling metocean conditions requires building an historic dataset of metocean conditions for the parameters studied/used for the metocean conditions.

- What were the criteria and/or parameters used to make decisions about selecting the type of metocean data for 2005-2014 obtained by BSEE for this study?
- Were Nuka Research and DNV GL involved in making such decisions and/or did BSEE make decisions about selecting the type of metocean data obtained for 2005-2014 for this study? Could BSEE provide any relevant clarification about the metocean data selection process for this research project?
- Could BSEE provide any relevant clarification about BSEE's research project SOW with respect to the responsibility for making decisions and developing the technical approach for 1) selecting the metocean data and 2) developing the metocean dataset?

The decision for BSEE to provide the METOCEAN data was a collaborate decision between BSEE and the contractors, influenced heavily by previous experience with the two previous Arctic projects. Additionally, BSEE had a subscription with Oceanweather to access GOMOS 2014 data. It was decided that BSEE would renew the subscription and provide the data to Nuka.

Question #2

Could BSEE clarify if the red-yellow-green categorization was required by BSEE's research project SOW and, if so, what was the rationale for using the red-yellow-green categorization for this study?

The Green/Red/Yellow categorization was developed by Nuka for the BSEE 2013 Arctic Gap Analysis project and used by DNV in the 2016 EPPR Circumpolar Viability Study. Since this was the third similar study, BSEE decided it was best to continue with the same categorization.

Question #3

BSEE has indicated that subsea dispersants injection was specifically excluded from the SOW for this research project that was awarded to Nuka Research. Consequently, Nuka Research could not include that response technique in this study because BSEE had specifically listed subsea dispersants injection as out-of-scope for this research project. The BSEE staff that originally wrote the SOW for the research project are not all still with the agency; however, BSEE said if possible they would clarify why BSEE decided to specifically exclude subsea dispersants injection from the research project SOW. Could BSEE provide any clarification about the rationale for this portion of BSEE's research project SOW for this study?

Subsea dispersants were excluded in the original project. BSEE determined to include the three strategies, mechanical, dispersants, and in-situ burn, that are approved in the National Response Plan/Area Contingency plans.

Question #4

ASTM International (2000) *Standard Practice for Classifying Water Bodies for Spill Control Systems*. F625-94, is listed in the references for this report and a reviewer requested that BSEE provide a copy, if available, for a more effective peer review. Could BSEE provide this reference as Supplementary Material (as such, it would be covered by NDA) for purposes of this peer review?

BSEE cannot provide the requested ASTM. Per ASTM license requirements, users must procure own copies.

7. APPENDIX C: PEER REVIEW MATERIALS PACKAGES

The peer review materials packages that were sent to the reviewers are attached separately.