FINAL

Peer Review Summary Report for the External Peer Review of

Oil Spill Response Plan Equipment Capabilities Review, consisting of

Volume I–Worst Case Discharge Analysis

and

Volume II–Oil Spill Response Equipment Capabilities Analysis

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1. INTRODUCTION

The EnDyna Team was tasked with managing the peer review process to evaluate the BSEE study entitled *Oil Spill Response Plan Equipment Capabilities Review*, which consists of two volumes: *Volume I–Worst Case Discharge Analysis* and *Volume II–Oil Spill Response Equipment Capabilities Analysis*. The report was prepared for the U.S. Department of the Interior (DOI), Bureau of Safety and Environmental Enforcement (BSEE) by Booz Allen Hamilton, RPS ASA, Environmental Research Consulting, and SEA Consulting in 2016.

The peer review selection process involved selecting three scientific experts who were available to participate in the peer review, including preparing written comments and attending a 2-day peer review panel meeting during a specific timeframe (September 6 through 16, 2016). In recruiting peer reviewers and coordinating the peer review, the EnDyna Team evaluated the qualifications of peer review candidates, conducted a thorough conflict of interest (COI) screening process, and independently selected the peer reviewers. The EnDyna Team then provided coordination and oversight of the peer review process, and produced this report that summarizes and synthesizes peer reviewer responses.

The sections below provide background on the BSEE study, describe the EnDyna Team's process for selecting external peer reviewers for the *Oil Spill Response Plan Equipment Capabilities Review* report (BSEE study report), and describe BSEE's objective and scope for this peer review.

1.1 Background on BSEE Study

BSEE is charged with the responsibility to permit, oversee, and enforce the laws and regulations associated with the development of energy (oil and natural gas) resources on the Outer Continental Shelf (OCS). BSEE's Oil Spill Preparedness Division (OSPD) is responsible for developing and administering regulations (30 CFR 254) that oversee the oil and gas industry's preparedness to contain, recover, and remove oil discharges from facilities operating seaward of the coastline. Current regulations require that operators of these offshore oil and gas facilities submit an Oil Spill Response Plan (OSRP) that identifies the procedures and contracted spill response resources necessary to respond, to the maximum extent practicable, to a facility's worst case discharge (WCD).

It has been nearly two decades since BSEE's OSRP regulations have been updated. During that time, changes occurred in drilling trends as well as the risks associated with oil spills. The national response system has matured, as reflected by revisions to the National Oil and Hazardous Substances Contingency Plan (NCP). Regional Contingency Plans (RCPs) have been developed and approved that now contain preauthorized strategies for the use of dispersants and in-situ burning. Area Contingency Plans (ACPs) have been built out with site-specific geographical response plans that catalogue and prioritize sensitive resources, and contain extensive oil removal and protection strategies. Remote sensing technologies have been improving and are now commercially available. In an effort to meet this changing environment, BSEE needs to understand and analyze the changes concerning offshore oil spill risks, as well as the current oil spill response industry's ability to mitigate this risk through its equipment stockpiles, technology, and strategies.

BSEE awarded a contract in 2014 to fill this information need, which generated a two volume study report. Volume I is *Worst Case Discharge Analysis* and Volume II is *Oil Spill Response Equipment Capabilities Analysis*. Parts of this two volume study report may be used to support the anticipated rulemaking effort, and meet the criteria for "influential scientific information" under the Office of Management and Budget's Memorandum on Peer Review (OMB M-05-03). Therefore, BSEE determined that selected sections of the two volumes of the BSEE study report containing new scientific information should be subjected to peer review.

1.2 Identification and Selection of Experts

The EnDyna Team was tasked with selecting three experts to evaluate the BSEE study report. The EnDyna Team conducted an independent search for scientific experts in the following fields of expertise: 1) oil spill modeling in ocean or coastal environments; 2) practical, on-scene, oil spill response operations in ocean or coastal environments; and 3) oil spill preparedness/response plans, as a practitioner or regulator.

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. Examples of organizations or types of individuals contacted or used as a resource include:

- U.S. Coast Guard (USCG) (i.e., Strike Force and Research and Development Center),
- National Oceanic and Atmospheric Administration (NOAA),
- Private consulting firms (i.e., Spiltec),
- Industry (i.e., Shell and Conoco),
- Universities (i.e., Texas A&M), and
- Individual consultants.

The EnDyna Team contacted approximately 15 people, of which five (5) were interested in participating and also available in the proposed peer review panel meeting timeframe. The other candidates were either not available during the peer review timeframe, had 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) and/or biographical sketch containing their education, employment history, area(s) of expertise, research activities, recent service on advisory committees, publications, and awards.

1.2.1 Conflict of Interest Screening Process

The EnDyna Team initiated COI screening on the five (5) interested individuals 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 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 perceived COI for this peer review.

The EnDyna Team received completed COI questionnaires for five (5) candidates and evaluated each expert’s professional and financial information. No real or apparent COI issues were identified. Although some candidates disclosed previous relationships with the BSEE study report authors, industry, or BSEE (i.e., consulting or peer review services), the EnDyna Team determined that these relationships would not likely pose a real or apparent COI. Instead, these relationships are perceived

COIs. Perceived COI does not necessarily disqualify an individual from participating, but it is important that any perceived COI is disclosed.

Dr. Galt disclosed that although he is essentially retired from Genwest Systems (i.e., works only a few hours monthly advising on the use of existing models or reviewing reports), Genwest has recently supported BSEE in developing several BSEE Response Equipment Calculators as oil spill response planning tools. Dr. Galt had only limited involvement in developing those BSEE Calculators.

Dr. Socolofsky disclosed that he was contracted by NOAA to review the RPS ASA Nearfield Blowout Modeling report that they conducted as part of the Deepwater Horizon (DWH) Natural Resource Damage Assessment (NRDA) process for NOAA. Dr. Socolofsky was only a reviewer of this report, and did not contribute to it. Dr. Socolofsky also disclosed that he serves as a technical reviewer for the American Petroleum Institute (API), to review reports and modeling approaches from the API's D3 Task Force on Subsea Dispersant Effectiveness.

A signed Non-Disclosure Agreement (NDA) was also collected from each reviewer.

1.2.2 Selection of Peer Reviewers

In selecting the peer reviewers, the EnDyna Team evaluated each candidate's credentials to select the 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 desired timeframe, including participation at a peer review panel meeting between September 6 and 16, 2016 in the Washington DC Metropolitan Area. After review and consideration of the available information described above, the EnDyna Team selected the three (3) peer reviewers that met those criteria. The names, affiliations, education, and expertise of the three peer reviewers are provided below.

Peer Reviewers Selected by the EnDyna Team:

1.	**NAME:**	Dr. Jerry Galt, PhD
	AFFILIATION:	Genwest Systems; Information Use Strategist / Chief Oceanographer
	EDUCATION:	Ph.D. Physical Oceanography/Geophysical Fluid Dynamics, University of Washington, 1969 M.S. Oceanography, University of Washington, 1967 B.S. Applied Mathematics, University of Washington, 1967 B.S. Physics, University of Washington, 1963
	EXPERTISE:	Dr. Galt has extensive experience in computerized data systems, oil spill response, and oceanographic modeling. He supervised the Hazardous Materials Response Division of NOAA. He directed a multidisciplinary scientific program combining theoretical research and real-time computer applications at accidental spill scenes. He directed the computer modeling component at over 1,000 oil and chemical spill responses during his career. At NOAA, Dr. Galt directed the model development for NOAA's Oil Spill Simulation Model (OSSM), General NOAA Operational Modeling Environment (GNOME), and Current Analysis for Trajectory Simulations (CATS).

		As a Dispersant Mission Planner, he participated in the refinement of earlier models (developed by Genwest Systems and Allen, Spiltec) to facilitate the assessment of system performance and Effective Daily Application Capacities (EDACs) involving the use of chemical dispersants. He also continued development and refinement of system performance simulations leading to the Response Options Calculator (ROC). Dr. Galt was a member of the Minerals Management Service (MMS, BSEE's predecessor agency) Modeling Review Board. For the MMS Modeling Review Board, he reviewed the progress and quality of modeling in the Bering Sea and Atlantic Ocean, assisted in the implementation of a new ocean circulation modeling initiative in the Gulf of Mexico, reviewed ongoing circulation modeling studies in the OCS regions, and the integration of the study results in the Oil Spill Risk Analysis (OSRA) model.
2.	**NAME:**	Mr. Gary Ott
	AFFILIATION:	Independent Consultant
	EDUCATION:	Master of Public Administration, New York University, 1981 B.S. Education and Public Administration, Ohio State University, 1967
	EXPERTISE:	Mr. Ott is a retired Science Support Coordinator (SSC) for NOAA. Mr. Ott has extensive experience in on-scene oil spill response and preparedness/response plans. As a NOAA SSC, he provided scientific and technical support to the USCG during hundreds of vessel strandings, collisions, and sinkings, including several years in Alaska in support of the Exxon Valdez, support to the Saudi Government during the oil spills and well fires resulting from the first Gulf War (1991), support to the Spanish Government during the sinking of the Oil Tanker PRESTIGE (2003), and in the aftermath of several catastrophic floods and hurricanes. For DWH, Mr. Ott participated in several roles, including significant participation in the dispersant approval process. Mr. Ott also actively supported the Regional Response Team (RRT) and Area Committee (AC) processes and was Committee Chair of many of the RRT and AC workgroups, technical review boards, and program committees. He has participated in the development and teaching of Incident Command System at the USCG's Training Center (since 1990) and at EMSI Services (since 2008). He has published professional papers on dispersant use, responder safety/training, and evaluation of response plans. Mr. Ott understands the roles of models in emergency response planning and response, and has participated with the National Atmospheric Release Advisory Center (NARAC) for modeling support for scheduled Spill of National Significance (SONS) exercises.
3.	**NAME:**	Dr. Scott Socolofsky, PhD
	AFFILIATION:	Texas A&M University

	Offshore Technology Research Center
EDUCATION:	Ph.D. Civil and Environmental Engineering, Massachusetts Institute of Technology, 2001 M.S. Civil and Environmental Engineering, Massachusetts Institute of Technology, 1997 B.S. Civil and Environmental Engineering, University of Colorado at Boulder, 1994
EXPERTISE:	Dr. Socolofsky's areas of expertise include environmental fluid mechanics, multiphase flow, subsea oil well blowouts, lake and reservoir oxygen management, direct ocean carbon sequestration, stratified fluids, shallow flow stability, shallow starting jet vortices, tidal inlet mixing, and wave transformation through constructed wetlands. He has extensive experience in modeling of oil spills. He has been Chief Scientist since 2011 for the Gulf Integrated Spill Research Consortium, with a stated mission to understand and predict the fundamental behavior of petroleum fluids in the ocean environment. His research roles include applying and coupling of his numerical blowout model to a far-field transport model, conducting new laboratory experiments on multiphase plumes, and leading two field experiments to study natural seeps and a controlled injection of gas to simulate a blowout plume. Mr. Socolofsky is a member of the API Technical Advisory Committee for the D3 Task Force on Subsea Dispersant Effectiveness for mitigation of accidental oil well blowouts. For API, he also reviews biodegradation model approaches used in subsea blowouts, including the SIMAP modeling suite. He is the author of the subsea blowout computer model called the Texas A&M Oilspill Calculator (TAMOC), which will be embedded in NOAA's GNOME model.

1.3 Peer Review Objective and Scope

The objective of this panel-style peer review was for BSEE to receive comments from individual experts on the selected sections of the two volumes of the study entitled, *Oil Spill Response Plan Equipment Capabilities Review*, consisting of Volume I–*Worst Case Discharge Analysis* and Volume II–*Oil Spill Response Equipment Capabilities Analysis*. This panel-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 two volumes of the BSEE study 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 defined below.

The scope of the peer review was focused on the modeling and final recommendations components of the two volumes of the BSEE study report. The review was technical in nature, and did not extend to the regulatory benchmarking analysis, DWH response case study summary, the analysis of changing regional WCD profiles, or other sections of Volume I and II that were not related to modeling or the recommendations. The peer reviewers could refer to these out-of-scope sections when providing written comments on the recommendations section, which drew from both the non-technical analyses and the oil spill modeling contained in the two volumes of the BSEE study report.

Supplementary Materials:
Volume II of the BSEE study report referenced three new BSEE Response Equipment Calculators (BSEE Calculators). These were supplementary materials, which were made available for the peer reviewers to look at any of these tools, which were used to estimate the removal capabilities of the response equipment modeled in the BSEE study, and are recommended for use by industry in the Volume II of the BSEE study report. Provided below is a link to the BSEE website where the three new BSEE Calculators and their user manuals are located:
http://www.bsee.gov/About-BSEE/Divisions/OSPD/Response-System-Planning-Calculators/

1.4 Peer Review Panel Meeting

Each peer reviewer prepared an initial written review of the two volumes of the study entitled, "*Oil Spill Response Plan Equipment Capabilities Review*," consisting of Volume I–*Worst Case Discharge Analysis* and Volume II–*Oil Spill Response Equipment Capabilities Analysis*. The peer reviewers submitted their initial written review to EnDyna prior to the September 8-9, 2016 peer review panel meeting. EnDyna compiled these initial written comments for distribution to the peer reviewers prior to the peer review panel meeting. Each of the peer reviewers reviewed the compiled initial written comments on the BSEE study report prior to the peer review panel meeting.

The peer review panel meeting was held on September 8-9, 2016 at EnDyna's office in McLean, Virginia. Section 6 (Appendix B) presents the final minutes for the panel meeting as well as the agenda prepared prior to the panel meeting.

After the peer review panel meeting, BSEE provided to the EnDyna Team a compilation of BSEE's responses to questions that arose about the modeling during the peer review panel meeting (see Section 1.5). Those modeling questions are listed below:

- How is droplet size distribution calculated in the modeling approach used by the BSEE study? What was the equation used to predict droplet size distribution? How is droplet size used in the modeling approach for the BSEE study?
- What type of distribution was used for start times in SIMAP (Poisson or random)?
- How did SIMAP calculate oil thickness values in the BSEE study? How were oil layers addressed?
- What combination of algorithms was used in SIMAP for oil weathering?
- How were climatology parameters selected for the modeling approach used by the BSEE study?
- How was climate data sampled for the 100 simulations?
- How did the modeling approach in the BSEE study address "situation space" or ensemble states? Can more information be provided to understand how they collected the ensemble state in order to understand whether it represented the environment?

- How did SIMAP transition from Lagrangian to Eulerian distribution? In addition, can more information be provided to understand the Eulerian distributions in the model?
- Did the way the model was set up and processes used for the models in the BSEE study, especially SIMAP, use all of the model's capabilities? For example, was OILMAPDeep run with ambient stratification and currents? As another example, was dissolution considered in SIMAP and overall is it possible to itemize all the fate processes modeled for SIMAP simulations?

Each of the peer reviewers developed and submitted their final written comments on the BSEE study report. For the most part, the peer reviewers based their final written comments on the actual content of the BSEE study report, especially with respect to information that was critical for understanding the assumptions, methodology, modeling results, and conclusions based on the modeling results. The reviewers agreed; however, that BSEE's responses to the modeling questions were helpful and also that this additional modeling information would be helpful for the BSEE in addressing the peer review comments.

The EnDyna Team used the peer reviewer's final written comments to develop this peer review summary report. The organization of this peer review summary report is outlined in Section 1.6.

1.5 BSEE SME Consultation

The *BSEE Peer Review Process Manual* provides that BSEE may consult the research product authors or other BSEE experts in order to appropriately address peer review comments. After the panel meeting, BSEE consulted with the BSEE study report authors in order to begin BSEE's process of assessing the peer review comments. This resulted in the compilation of BSEE's responses to the modeling questions, which is provided in Appendix C: BSEE Subject Matter Expert (SME) Consultation. BSEE will use the responses to the modeling questions in Appendix C along with internal BSEE expertise in developing BSEE's responses to the external peer review comments provided in this peer review summary report.

EnDyna provided this information to the peer reviewers, at BSEE's request, before the peer reviewers finalized their written peer review comments. Dr. Galt decided that because this information was not presented in the BSEE study report, he focused his final peer review comments only on the actual BSEE study report without considering any BSEE SME responses. Dr. Socolofsky believed that although he now had answers to some of his modeling questions, he stated that the BSEE study report did not explain that information in sufficient detail, and he emphasized that information was critical for evaluating the BSEE study results. Thus, in his final peer review comments, Dr. Socolofsky included those questions about modeling issues that he believed BSEE should expect anyone reading the BSEE study report to also ask or need to know. Mr. Ott reviewed this information; however, modeling was not his area of expertise on the panel.

1.6 Organization of Report

This peer review report is comprised of nine sections. ***Section 2*** provides the charge questions sent to each of the peer reviewers for comments, ***Section 3*** provides the synthesis of their peer review comments, and ***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 final minutes from the September 8-9, 2016 peer review panel meeting. ***Section 7*** (Appendix C) provides the responses to modeling questions provided from the BSEE SME consultation, for use by BSEE in assessing the peer review comments. ***Section 8*** (Appendix D) provides a list of acronyms. The peer review materials packages in ***Section 9*** (Appendix E) are attached separately.

2. CHARGE QUESTIONS

The purpose of this review was to obtain written comments from individual experts on the BSEE study report entitled, *Oil Spill Response Plan Equipment Capabilities Review*, consisting of *Volume I–Worst Case Discharge Analysis* and *Volume II–Oil Spill Response Equipment Capabilities Analysis*. Each peer reviewer was charged with evaluating the BSEE study report, providing their overall impressions of the scientific merit of the report, responding to ten charge questions (five charge questions for each volume of the report), and providing any other specific comments on the report. The ten charge questions provided to the peer reviewers are presented below.

Volume I–Worst Case Discharge Analysis	
1.1	Were the Worst Case Discharge (WCD) sites selected for analysis a valid sample to evaluate the probabilities and scope of oil contacting the environment in each region?
1.2	Are the limitations and uncertainties clearly identified and adequately characterized for the oil plume, fate and effects, and transport mechanisms used in the stochastic trajectory modeling? Please note that the impact of a WCD is not a probable impact, or representative of risk; but the largest volume possible from an uncontrolled blowout (30 CFR 257.47 (b)), a very unlikely and low probability scenario.
1.3	Are the assumptions of the modeling clearly defined and appropriate?
1.4	Are there strengths or weaknesses of the analytical methods used for the modeling?
1.5	Do the modeling results describe with reasonable accuracy the probability, scope and minimum travel times for oil to potentially contact the environment in the event of a WCD for the selected scenarios?
Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.1	Are the limitations and uncertainties clearly identified and adequately characterized for the deterministic trajectory and response countermeasure modeling?
2.2	Are the assumptions of the modeling in Volume II clearly defined and appropriate? Assumptions evaluated should include, but are not limited to: a) Fate and transport of the oil b) Application of temporary source control measures c) Application of spill response countermeasures.
2.3	Are there strengths or weaknesses of the analytical methods used for the modeling?

2.4	Are the conclusions drawn from the oil spill response capabilities analysis logical and appropriate based on the modeling results?
2.5	Are the recommendations logical, appropriate, and supported by the analysis and modeling results? The scope of the recommendations pertains to all recommendations, not just those derived from the modeling results.

3. SUMMARY OF PEER REVIEWERS COMMENTS

This section provides the synthesis of peer reviewers' comments, including general impressions and responses to charge questions.

3.1 General Impressions

The reviewers provided a range of comments on the BSEE study report, ranging from agreement to concerns about the modeling complexity and various uncertainties. The reviewers provided their general impressions on the choice of models; the modeling in Volume I, including uncertainty, ensemble state or "situation space," and droplet size distribution (DSD); the modeling in Volume II; and recommendations. One reviewer also provided overall comments about the BSEE study's objectives.

The reviewers generally kept within BSEE's scope for this peer review (see Section 1.3), which was focused on the modeling and final recommendations components of the two volumes of this BSEE study report: *Oil Spill Response Plan Equipment Capabilities Review*, consisting of *Volume I–Worst Case Discharge Analysis* and *Volume II–Oil Spill Response Equipment Capabilities Analysis*. Any peer review comments that were identified by BSEE as out-of-scope for this peer review (see Section 1.3) were not included in this peer review summary report.

In addition, one reviewer commented that the BSEE study report had a number of critical findings, which the reviewer had identified within Volume II. This reviewer listed those critical findings by page number in the reviewer's Specific Observations.[1, GO]

Choice of Models

Two reviewers commented that the BSEE study used industry standard models that had been well tested and widely applied over many years.[GO; 2, SS] One reviewer expressed concerns about the complexity of the models selected for the BSEE study.[3, JG]

Comment [A1]: See A1

One reviewer commented that the BSEE study presented a major modeling exercise, supported by a significant collection of input data. The reviewer noted that the BSEE study used a comprehensive oil spill modeling platform (OILMAPDeep and SIMAP) that simulated the buoyant plume rise in the near field of a blowout, through Lagrangian transport in the subsurface water column, and subsequent fate and transport on the sea surface. This reviewer commented that both OILMAPDeep and SIMAP are industry standard simulation packages that have undergone many years of application, testing, and refinement.[SS] Another reviewer commented several times under different charge questions (instead of General Impressions) that the models used in the BSEE study are presumed correct or acceptable when used as part of a formal NRDA Type A process. This reviewer also noted that multiple technical reviews of these models exist because they have been used by the ongoing DWH damage assessment process and as the NRDA Type A model.[GO]

Comment [A2]: Same as A1

Comment [A3]: See A2

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[1] GO = Mr. Gary Ott
[2] SS = Dr. Scott Socolofsky
[3] JG = Dr. Jerry Galt4

One reviewer commented that the models used to develop the BSEE study’s conclusions were essentially built around a set of quite complex models and algorithms. The reviewer expressed concerns that it was not obvious that the complexity of the model components was justified. The reviewer commented that many of the BSEE study’s conclusions attributed to “the model” were actually little more than what an experienced spill responder would consider as common knowledge. Given that the models provided results that would be expected by an experienced spill responder, this reviewer noted that the selected models probably did not provide any obvious erroneous results.[JG]

Comment [A4]: See A4

Comment [A5]: See A3

Modeling: Volume I

Two reviewers commented on uncertainty in the modeling, including the limited number of simulations[SS] and how long the models can run before their information content was degraded to the point where data assimilation was necessary.[JG] These two reviewers also commented on whether the ensemble state or “situation space” elements used to initialize scenarios represented a realistic climatology.[JG,SS] One reviewer commented about the impacts of DSD on the modeling.[SS]

Uncertainty

One reviewer commented that the WCD scenarios were simulated using a multiple-ensembles approach (stochastic modeling) where the results of 100 deterministic spill simulations were analyzed to produce probabilistic maps of spill effects. The reviewer stated that 100 simulations was a modest number of simulations, but the reviewer commented that this decision likely balanced the competing needs of having a large number of simulations, while completing the analysis in a reasonable amount of time.[SS]

Comment [A6]: See B1

Another reviewer stated that a complex model used in a purely planning mode may not have the advantage of a reality check in the form of available assimilation data; however, this reviewer argued that cannot be considered a reason for ignoring cumulative uncertainty. This reviewer stated that a key issue with respect to the veracity of the overall BSEE study conclusions was that the plume rise and trajectory models were combinations of dozens of individual algorithms. Those algorithms required parametric inputs, each of which introduced some degree of uncertainty, which were then linked together in a chain of logic propagating uncertainties into a final compound uncertainty. This reviewer believed that, as a result, no expert really knows, for example, what “skill levels” to expect from SIMAP, or how rapidly its information content degrades with time, and ultimately how soon “data assimilation” would be required to restore confidence in the modeling results. The reviewer emphasized that this was not a problem unique to SIMAP, but was found with all complex geophysical models. This reviewer also emphasized that is the reason why virtually all operational geophysical fluid dynamics transport models and trajectory models have data assimilation components.[JG]

Comment [A7]: See B2

Ensemble State / Situation Space

With respect to the WCD scenarios, one reviewer commented that these simulations each had different environmental forcing, but all the simulations used the same model parameters for each

WCD scenario. The reviewer noted that environmental forcing was selected at random from a database of existing weather and currents for each region. This reviewer commented that no attempt was made to ensure that the canonical variability of the climate in each region was sampled. Consequently, this reviewer commented that although the 100 simulations represented plausible outcomes for spills during the period of the measured data, the results from those simulations may not represent the full climate variability or the model uncertainty.[SS]

Comment [A8]: See C3

Comment [A9]: See C1

Another reviewer noted that, in general, the veracity of the models used in any study should at least move in a central tendency toward the right answer (possibly subject to chaotic sensitivity to initial conditions). This reviewer emphasized that when that occurs, the statistics of the ensemble use of such models then totally depends on the climatology or "situation space" used to initialize model runs. The reviewer commented that a weakness of this BSEE study report was that it had virtually no discussion of the sampling approach for the "situation space" in which the models operated. The reviewer stated there was no discussion about whether the 100 scenarios spanned the expected cardinality of the environmental driving parameters, but this issue regarding cardinality of the ensemble state or "situation space" used to form the run scenarios should have been explained. The reviewer commented that this problem applied to all of the basic regions covered by the BSEE study report, and emphasized that the modeling experts involved in the BSEE study should have information to address this issue in the BSEE study report.[JG]

Comment [A10]: See C2

Comment [A11]: See C4…awaiting reply from RPS

Droplet Size Distribution

One reviewer stated that one of the most important factors in the numerical modeling was the prediction of the initial DSDs. The reviewer explained that smaller oil droplets will rise slower, allowing for greater subsurface transformation and wider dispersal. The reviewer noted that the simulations in the BSEE study likely used the DSD prediction equation developed by Applied Science Associates (ASA) for the DWH NRDA. The reviewer noted that this tool has been calibrated to a comprehensive set of available laboratory data. This reviewer emphasized that it was important to point out that no data are available for DSDs in the parameter space of a full-scale blowout, and no measurements were made of DSD near the DWH breakup region. Given the lack of data, the reviewer stated that it would be necessary to trust that extrapolation from the currently available laboratory data to the field scale is appropriate. The reviewer emphasized that the validity of such extrapolation can only be verified by larger-scale experiments.[SS]

Comment [A12]: See D1

This reviewer also commented that the effect of the DSD prediction equation on the modeling was most significant for evaluating the efficacy of subsurface dispersant injection (SSDI), because SSDI was modeled in the simulations by adjusting the interfacial tension (IFT) between the oil and water and predicting a new DSD with this IFT. The reviewer stated that this approach was the current practice for predicting the effects of SSDI. The reviewer emphasized that if the DSD prediction equation over- or under-predicted the treated DSD, then the modeling conclusions would over- or under-predict the efficacy of SSDI. The reviewer commented that the review of the DWH accident supported the conclusion that SSDI is an effective and important response strategy for accidental blowouts, and this conclusion was also supported by the BSEE study's model simulations. The reviewer stated that two unresolved questions that remain are:

Comment [A13]: See D2

- Whether or not surface dispersant application will be needed once effective SSDI (i.e., 100% treatment at 1:100 dispersant to oil ratios (DORs), which was not achieved during the DWH accident) is achieved; and
- What the relative removal rates due to SSDI and mechanical removal will be during a future spill.[SS]

Modeling: Volume II

One reviewer commented that the deterministic model simulations in Volume II all appeared to overestimate the removal capability of mechanical removal and underestimate the removal rates for in-situ burning when compared to estimates of removal rates during the DWH accident. The reviewer stated that this issue could be due to many complicating factors. The reviewer commented about one factor, which was that SIMAP tracked the available inventory for mechanical removal and in-situ burning and mapped inventory to spill locations where oil of the appropriate state was located. The reviewer commented that this might overestimate the ability of mechanical recovery equipment to gain access to appropriate oil and this also limited in-situ burning to the stockpile of available boom. Because burning boom is expensive, the estimated pre-spill stockpile of burning boom was smaller than might become available during an actual spill. The reviewer emphasized that this issue was important because one of the final recommendations (NAT 25.1) appeared to recommend (based on the information provided in the current BSEE study report) that significantly greater oil recovery capacity will be required in the future than presently. The reviewer stated that this recommendation was somewhat confusing, and needed further clarification, especially given that simulations in Section 2.4 of Volume II appeared to demonstrate that adding recovery capacity quickly resulted in diminishing returns due to limitations of weather and daylight.[SS,4]

Comment [A14]: See E1

Recommendations

One reviewer commented that Section 6 of Volume II provided a comprehensive list of recommendations that BSEE may consider including in future regulations. The reviewer commented that this list appeared to be exhaustive and fairly prescriptive. The reviewer noted that, among the various recommendations, was the requirement for operators to be capable of real-time response modeling and forecasting in the event of a spill. The reviewer observed that this was currently the responsibility of NOAA’s Office of Response and Restoration (OR&R). The reviewer suggested that there should to be a discussion about how the operator and NOAA forecasts might be reconciled and a justification for why the operator will be asked to perform tasks that overlap with NOAA’s responsibilities.[SS]

Comment [A15]: See E2

Another reviewer commented more specifically on the BSEE study recommendations for how much and how fast various oil spill response equipment should be on-scene during an oil spill response, which was addressed in detail in Tables 104-115, pages 289-302. This reviewer commented that the choices and recommendations in those tables made sense.[GO]

Comment [A16]: See E3

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[4] Appendix C: BSEE SME Consultation provides some information to clarify mechanical recovery capabilities recommendations derived from the modeling results that BSEE will use along with internal BSEE expertise in developing BSEE’s responses to the peer review comments in this report.

With respect to making recommendations and decisions about oil spill response equipment capabilities, this reviewer commented that it can be useful to consider what is certain and what is not certain. The reviewer emphasized that it was certain that oil spill response equipment, when employed against an overwhelming WCD, will have limited success and referred to page 259 of Volume II. The reviewer commented that when planning for an overwhelming WCD, what is not certain, for example, are WCD volumes, site locations, oil types, droplet sizes, the capabilities and availability of oil spill response equipment, weather, sea state and tides, and crew availabilities. For each of these many uncertainties, the reviewer noted that planners must make choices based on where they have technical confidence and suggested that modeling experts must know equipment and modeling capabilities/limitations.[GO]

Objectives

Another reviewer commented that the BSEE study report did not list objectives for each task. For purposes of preparing peer review comments, this reviewer identified the BSEE study report's objectives as listed below:

- Volume 1: Illustrate the overall scale of WCD releases from representative well locations (Gulf, Pacific, Arctic).
- Volume II: Identify potential for reducing shoreline oiling for each countermeasure (source control, dispersant, mechanical, in-situ burning), using the following objectives:
    - Best planning practices (strategically focused for command/control, communications, logistical) that can improve response readiness; and
    - Operational best practices that maximize the effectiveness of oil spill response countermeasures.[GO]

Comment [A17]: See E4

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.

Volume I–Worst Case Discharge Analysis	
1.1	*Were the Worst Case Discharge (WCD) sites selected for analysis a valid sample to evaluate the probabilities and scope of oil contacting the environment in each region?*
Comments:	The peer reviewers generally agreed that the WCD sites selected for analysis were a valid sample.[JG,GO,SS] One reviewer stated that the BSEE study made reasonable efforts to select WCD sites that cover a wide range of potential blowout scenarios and environmental impacts, but also noted several weaknesses (described below).[SS] Another reviewer provided a "qualified yes" given the size and the general circulation scales of each region; however, this reviewer also commented that the BSEE study could have selected WCD sites that addressed smaller scale features (described below) that have proven important in historical spills.[JG] Another reviewer stated that the sites selected representing WCD and near-shore, offshore, and open-ocean in each region made sense. This reviewer agreed that the site selected for the BSEE study impacting the Santa Barbara Channel represented WCD in the Pacific region.

Comment [A18]: F1

Comment [A19]: See F2

Comment [A20]: See F1

Volume I–Worst Case Discharge Analysis

1.1 *Were the Worst Case Discharge (WCD) sites selected for analysis a valid sample to evaluate the probabilities and scope of oil contacting the environment in each region?*

This reviewer also agreed with the Alaska sites selected for the Arctic region.[GO]

The reviewer that provided a “qualified yes” specifically emphasized that each of the regions for the BSEE study had smaller scale circulation features and commented that the BSEE study report did not provide sufficient information about how the analysis addressed these important smaller scale features. With respect to selecting WCD sites, this reviewer pointed out examples of specific smaller scale features that the reviewer stated have proven important in historical spills:

- Central Gulf: Details of the Mississippi Delta freshwater outflow and mixing close to the delta are intricate.
- Western Gulf: A near-shore low salinity frontal interface caused by fresh water runoff typically extends from the Atchafalalya, past Calacsieu to Galveston, which results in a convergence band that traps floating pollutants and may locally offset trajectories tens of miles to the west.
- Santa Barbara Channel: The complex eddy structure in the Santa Barbara Channel itself and the directional shifts associated with California Current versus Davidson Current periods around the channel are an issue.
- Chukchi and Beaufort regions, Arctic: Details of the ice cover circulation and banded currents found along the North Slope will certainly degrade the veracity of forecasts.[JG]

Comment [A21]: See F2

One reviewer stated that the BSEE study made reasonable efforts to select WCD sites, but also noted several weaknesses; however, this reviewer acknowledged that in most cases, the BSEE study report provided a justification for selecting each WCD. This reviewer pointed out that the BSEE study was limited by the fact that only a fraction of existing wells have data within the OSRP dataset. The reviewer acknowledged that this limited dataset will limit the available range of sites that could be selected for the BSEE study. The reviewer stated that this limited dataset especially impacted the Gulf of Mexico Eastern Planning Area (where the selected WCD site was actually in the Central Planning Area) and the Gulf of Mexico Western Planning Area (where the sites in the OSRP dataset were well to the east of many existing wells within the planning area).[SS]

Comment [A22]: See F1

Comment [A23]: See F3

This reviewer also commented that in several regions, the largest spill size selected for analysis was smaller than the WCD among all of the OSRP data points. The reviewer acknowledged that the BSEE study report had mostly

Volume I–Worst Case Discharge Analysis	
1.1	*Were the Worst Case Discharge (WCD) sites selected for analysis a valid sample to evaluate the probabilities and scope of oil contacting the environment in each region?*
	explained the reasons for the selected cases. However, this reviewer commented that the site selection process for the BSEE study would become more solid if the BSEE study report also explained why higher flow rate cases were not selected when they were present in the OSRP dataset for a given region. This reviewer provided specific examples to illustrate selected cases where a higher flow rate WCD was not selected: • In the Southern California Planning Area, the selected WCD site was 5,200 bbl/d; whereas, the highest flow rate WCD in the OSRP dataset was 12,000 bbl/d—over double the case analyzed in the BSEE study. The reviewer commented that the BSEE study report provided a good justification that the selected case was situated geographically near the Channel Islands National Marine Sanctuary and National Park Unit (page 93, third paragraph). However, the reviewer pointed out that the wells at the selected case were all fairly close together. The reviewer recommended that the BSEE study report should also provide a reason why the higher flow rate case was not selected. • For the Alaska Planning Region, the selected WCD sites have flow rates between 15,000 and 25,000 bbl/d; whereas, the highest flow rate WCD site was an estimated 85,000 bbl/d. The reviewer acknowledged that the BSEE study report emphasized that in both the Pacific and Arctic regions, the OSRP data for WCD are per platform instead of per well. The reviewer questioned whether this was perhaps part of the reason that the BSEE study did not analyze the higher WCD cases. This reviewer recommended that because the single, high flowrate WCD in the Arctic region appeared to be an outlier, that the BSEE study report should provide more information about it.[SS]

Comment [A24]: See F4

Volume I–Worst Case Discharge Analysis	
1.2	*Are the limitations and uncertainties clearly identified and adequately characterized for the oil plume, fate and effects, and transport mechanisms used in the stochastic trajectory modeling? Please note that the impact of a WCD is not a probable impact, or representative of risk; but the largest volume possible from an uncontrolled blowout (30 CFR 257.47 (b)), a very unlikely and low probability scenario.*
Comments:	The reviewers differed in their assessment of whether the BSEE study clearly identified and adequately characterized the limitations and uncertainties for the stochastic trajectory modeling. One reviewer raised several issues with respect to accounting for uncertainties (described below) and recommended those issues be further explained in the BSEE study report, specifically the use

Volume I–Worst Case Discharge Analysis	
1.2	*Are the limitations and uncertainties clearly identified and adequately characterized for the oil plume, fate and effects, and transport mechanisms used in the stochastic trajectory modeling? Please note that the impact of a WCD is not a probable impact, or representative of risk; but the largest volume possible from an uncontrolled blowout (30 CFR 257.47 (b)), a very unlikely and low probability scenario.*
	of fixed model parameters for almost all aspects of the stochastic modeling, initializing the blowout at different start times to simulate uncertainties in environmental forcing, and not analyzing the different environmental forcings to ensure that the simulations considered the range of climate variability at a site.[SS] Another reviewer commented that overall the process used in the BSEE study to characterize each region's "largest credible release" made sense and the proposed scenarios seemed appropriate for this study. This reviewer, however, stated that SIMAP may have introduced unnecessary complexities (described below).[JG] One reviewer commented that because the BSEE study had used models that were well reviewed, the limitations and uncertainties in the modeling for the BSEE study were probably characterized adequately.[GO] The reviewer that did not raise any issues about the limitations and uncertainties of the modeling commented that the models used in the BSEE study are presumed correct or acceptable when used as part of a formal NRDA Type A process. This reviewer believed that the models had a reasonable range of accuracies, limitations, uncertainties, and assumptions, and that the model's strengths and weakness were presumed acceptable. This reviewer also noted that multiple technical reviews of these models exist because they have been used by the ongoing DWH damage assessment process and as the NRDA Type A model.[GO] One reviewer explained that SIMAP may have introduced unnecessary complexities for the BSEE study, because WCD has limitations and SIMAP is a model with a strong history of development to cover actual damage functions associated with WCD. The reviewer stated that for purposes of the BSEE study, SIMAP was encumbered with many unused parametric algorithms that may have introduced more complexity to this study than was necessary. Nevertheless, the reviewer noted that any number of simple particle tracking models would work as well as SIMAP.[JG] The reviewer that raised several issues with respect to accounting for uncertainties commented that the stochastic simulations had used fixed model parameters for all aspects of the modeling except for the ambient environmental forcing. Because of those fixed model parameters, this reviewer argued that the stochastic simulations did not account for any uncertainties in model or spill parameters. More specifically, this reviewer noted that plume entrainment rate, oil composition, biodegradation rates,

Comment [A25]: Summary of comments captured individually below

Comment [A26]: See A2

Comment [A27]: See A4

Volume I–Worst Case Discharge Analysis	
1.2	*Are the limitations and uncertainties clearly identified and adequately characterized for the oil plume, fate and effects, and transport mechanisms used in the stochastic trajectory modeling? Please note that the impact of a WCD is not a probable impact, or representative of risk; but the largest volume possible from an uncontrolled blowout (30 CFR 257.47 (b)), a very unlikely and low probability scenario.*
	initial DSDs, surface transformation process models, and other elements were all identical in all simulations within each scenario.[SS] This reviewer also noted that uncertainty was modeled in the stochastic simulations by initializing the blowout at different start times (i.e., on different days) throughout the time span of available model forcing, with each simulation representing a separate ensemble. The reviewer stated that this approach used in the BSEE study was reasonable for simulating the uncertainty of ambient currents and weather on the behavior of a blowout. However, this reviewer suggested that the BSEE study report should provide further explanation about how this uncertainty was modeled; more specifically, whether start times were equally spaced over the available time span of input data or whether start times were selected from a random distribution. If a random distribution of start times was used, this reviewer recommended that the BSEE study report should provide the probability density function of the distributions. This reviewer also recommended that, in either case, the BSEE study report should provide an appendix listing the start times for all simulations used in the stochastic modeling.[SS,5] Finally, this reviewer commented that the different environmental forcings in the BSEE study were not analyzed to ensure that a site's full range of climate variability was considered in the stochastic simulations. The reviewer argued that these results should be viewed as potential outcomes for spills that might have occurred during the span of data in the environmental forcing database. The reviewer stated that these results may not represent the actual total variability over the canonical modes of climate behavior at each site.[SS] One reviewer provided comments under Charge Question 1.1 that are also related to this charge question. This reviewer commented that the BSEE study report did not provide detailed information about how the underlying geophysical flow models addressed important smaller scale circulation features in each of the regions for the BSEE study. This reviewer stated that the BSEE study report did not directly discuss the underlying hydrodynamics, and argued that the general references did not provide sufficient understanding. With respect to whether the limitations and uncertainties in in the SIMAP model were clearly identified and adequately characterized, this

Comment [A28]: See C3

Comment [A29]: See C5

Comment [A30]: See C2

Comment [A31]: See C1

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[5] Appendix C: BSEE SME Consultation provides further information about how uncertainty was modeled that BSEE will use along with internal BSEE expertise in developing BSEE's responses to the peer review comments in this report.

Volume I–Worst Case Discharge Analysis	
1.2	*Are the limitations and uncertainties clearly identified and adequately characterized for the oil plume, fate and effects, and transport mechanisms used in the stochastic trajectory modeling? Please note that the impact of a WCD is not a probable impact, or representative of risk; but the largest volume possible from an uncontrolled blowout (30 CFR 257.47 (b)), a very unlikely and low probability scenario.*
	reviewer pointed out examples of specific smaller scale features (repeated below from Charge Question 1.1) that the reviewer stated have proven important in historical spills: • Central Gulf: Details of the Mississippi Delta freshwater outflow and mixing close to the delta are intricate. • Western Gulf: A near-shore low salinity frontal interface caused by fresh water runoff typically extends from the Atchafalalya, past Calacsieu to Galveston, which results in a convergence band that traps floating pollutants and may locally offset trajectories tens of miles to the west. • Santa Barbara Channel: The complex eddy structure in the Santa Barbara Channel itself and the directional shifts associated with California Current versus Davidson Current periods around the channel are an issue. • Chukchi and Beaufort regions, Arctic: Details of the ice cover circulation and banded currents found along the North Slope will certainly degrade the veracity of forecasts.[JG]

Comment [A32]: See F2

Volume I–Worst Case Discharge Analysis	
1.3	*Are the assumptions of the modeling clearly defined and appropriate?*
Comments:	Two reviewers commented on whether the modeling assumptions were clearly defined.[JG,SS] One reviewer stated that the modeling assumptions were generally clear and well stated, with one notable exception (discussed below) related to how the Eulerian field data were calculated from the aggregated Lagrangian particles.[JG] One reviewer expressed several concerns (summarized below) about whether the modeling assumptions were adequately described.[SS] Two reviewers commented on whether the modeling assumptions were appropriate.[GO,SS] One reviewer stated that the assumptions for the OILMAPDeep simulations were appropriate for the purposes of determining the intrusion level of a blowout. This reviewer also stated that the assumptions for the SIMAP simulations appeared appropriate for the purposes of determining the fate of oil in the water column.[SS] As stated above under Charge Question 1.2, another reviewer commented that the models used in this report are presumed correct, including the assumptions, when used as part

Comment [A33]: See G3

Volume I–Worst Case Discharge Analysis	
1.3	*Are the assumptions of the modeling clearly defined and appropriate?*
	of a formal NRDA Type A process.[GO] The reviewer that expressed concerns about whether the assumptions of the modeling were adequately described, began by expressing general concerns that the BSEE study report did not clearly state all the processes used in the modeling. This reviewer commented that the BSEE study report's main text briefly outlined the processes considered in the blowout plume model (OILMAPDeep, nearfield plume model) and the far-field model (SIMAP). The reviewer noted that the BSEE study report's appendices provided more details of those model's capabilities. This reviewer observed that the appendices actually enumerated all of these model's capabilities and pointed out that it was possible that the BSEE study did not use all the model's capabilities. The reviewer emphasized it was important that the BSEE study report's main text clearly stated all processes used in the modeling to clarify the capabilities of the models specifically used in the BSEE study.[SS,6] Another reviewer also commented that lack of information on the mathematical operations used in the modeling was a persistent shortcoming throughout the BSEE study report.[JG,7] The reviewer that expressed concerns about whether the assumptions of the modeling were adequately described, stated that the assumptions of the OILMAPDeep model were adequately described with the exception of whether OilMAPDeep accounted for ambient currents. Based on the reviewer's understanding of OILMAPDeep, the reviewer believed that gas was treated as pure methane and allowed to dissolve and that oil does not undergo fate processes in the nearfield plume model. The reviewer emphasized that this should be clearly stated in Section 2.3.1 of the BSEE study report. Also based on the reviewer's understanding of OILMAPDeep, the reviewer believed that the model inputs included the ambient stratification profile and currents. The reviewer commented that ambient stratification profile and currents were not listed as inputs in Section 2.3.1 in the second paragraph on page 15 of the BSEE study report. This reviewer emphasized that the BSEE study report was not clear about whether or not OILMAPDeep accounted for ambient currents. The reviewer recommended that if ambient currents were not used (and therefore, not needed as inputs), this should be explicitly stated in the BSEE study report.[SS,8]

Comment [A34]: See C6

Comment [A35]: See G1

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[6] Appendix C: BSEE SME Consultation provides further information about processes used in the modeling that BSEE will use along with internal BSEE expertise in developing BSEE's responses to the peer review comments in this report.

[7] Appendix C: BSEE SME Consultation provides further information about mathematical operations used in the modeling that BSEE will use along with internal BSEE expertise in developing BSEE's responses to the peer review comments in this report.

[8] Appendix C: BSEE SME Consultation provides further information about OilMAPDeep assumptions related to ambient currents that BSEE will use along with internal BSEE expertise in developing BSEE's responses to the peer review comments in this report.

Volume I–Worst Case Discharge Analysis	
1.3	*Are the assumptions of the modeling clearly defined and appropriate?*
	This reviewer also stated that it was not clear in the BSEE study report whether dissolution was considered as a fate process for the SIMAP simulations. Based on the reviewer's understanding of SIMAP, the reviewer believed that SIMAP was capable of modeling dissolution during transport from the subsurface intrusion to the surface. The reviewer commented that the BSEE study report on page 16 only listed biodegradation as a subsurface fate process. The reviewer further commented that SIMAP results subsequently presented in the BSEE study report suggested that dissolution was modeled. This reviewer emphasized that the BSEE study report should clearly itemize all fate processes modeled for the SIMAP simulations.[SS,9] The reviewer that commented about one notable exception to the clarity of the modeling assumptions, first described how the Lagrangian particles were modeled. This reviewer understood from the BSEE study report that the model tracked "spillets" to obtain "areas painted by an ensemble of spills" and minimum "travel times," which the reviewer understood was binary raster data for area and minimum time raster data for time. The reviewer stated that multiple hits in the first field will not change the answer and observed that obviously will work fine with Lagrangian particles given coordinate data. The reviewer also stated that the modeling results were somewhat dependent on raster size, but noted that using smoothing that conserves mass will usually result in contourable results. The BSEE study report also presented the thickness of the floating or beached oil, which was Eulerian field data and was dimensional (mass/area). The reviewer stated this should be calculated from the aggregated Lagrangian particles and possibly corrected for individual "spillet" spreading. The reviewer commented that the mathematics of these calculations were tricky and noted that the BSEE study report did not explain how the model operated for those calculations.[JG,10]

Comment [A36]: See G2

Comment [A37]: See G3

Volume I–Worst Case Discharge Analysis	
1.4	*Are there strengths or weaknesses of the analytical methods used for the modeling?*
Comments:	The reviewers differed in their approach to this charge question. One reviewer commented, as stated above under Charge Question 1.2, that the models used

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[9] Appendix C: BSEE SME Consultation provides further information about SIMAP assumptions related to dissolution that BSEE will use along with internal BSEE expertise in developing BSEE's responses to the peer review comments in this report.

[10] Appendix C: BSEE SME Consultation provides further information about assumptions related to how the Eulerian field data were calculated from the aggregated Lagrangian particles that BSEE will use along with internal BSEE expertise in developing BSEE's responses to the peer review comments in this report.

Volume I–Worst Case Discharge Analysis	
1.4	*Are there strengths or weaknesses of the analytical methods used for the modeling?*

in the BSEE study report are presumed correct, including the strengths and weaknesses of the analytical methods, when used as part of a formal NRDA Type A process.[GO] Another reviewer summarized the strengths of the WCD modeling, including complex and thorough simulations (summarized below), but also pointed out two weaknesses. One weakness was the choice made in the BSEE study to simulate only the effects of environmental forcing (described below), but not other model inputs, although the reviewer commented that choice was adequate for the BSEE study. Another weakness was the current lack of initial DSD data for a full-scale blowout (described below), but the reviewer noted that addressing this current data gap was not part of the BSEE study.[SS] Another reviewer emphasized that the strength of the analytical methods used in the modeling for the BSEE study was absolutely dependent on two considerations (listed below).[JG]

Strengths

The reviewer that summarized the strengths of the WCD modeling explained that both OILMAPDeep and SIMAP are process-oriented models that simulate the physical, chemical, and biological processes affecting oil fate and transport in the environment. The reviewer stated that industry has used both models for many years and that these models have benefited from rigorous testing across many diverse projects. The reviewer commented that the model inputs have been carefully evaluated based on a wide range of available data. The reviewer also commented that these model's simulations were forced by high-quality simulation data for environmental parameters (e.g., winds and currents). This reviewer believed that the simulations generated from these models were complex and thorough.[SS]

One reviewer stated that the strength of the analytical methods used in the modeling for the BSEE study was absolutely dependent on two considerations: 1) whether the ensemble state or "situation space" elements used to initialize scenarios spanned a realistic climatology, and 2) how long the models can run before their information content was degraded to the point where data assimilation was necessary. This reviewer emphasized that those two considerations did not seem to be covered in the BSEE study report and should be discussed.[JG]

Weaknesses

One reviewer stated that one weakness of the modeling was that the BSEE study only evaluated the stochastic nature of the environmental forcing and did not consider simulating effects of other model inputs (i.e., parameters

Comment [A38]: See A2

Comment [A39]: See C3

Comment [A40]: See D1

Volume I–Worst Case Discharge Analysis	
1.4	*Are there strengths or weaknesses of the analytical methods used for the modeling?*
	describing the oil as well as model parameters such as entrainment rate, biodegradation rates, and other model coefficients). The reviewer acknowledged that an exhaustive analysis of model uncertainty was probably beyond the scope of the BSEE study. This reviewer commented that the choice to consider only the effects of environmental forcing resulted in an adequate picture of the potential contact of the spilled oil with the environment.[SS] This reviewer identified an important weakness that the reviewer emphasized was out of the control of the modelers, specifically that no data are currently available for initial DSD in the parameter space of a full-scale blowout. The reviewer explained that all existing laboratory and field data that can be used to calibrate and validate DSD models have been collected for smaller values of the governing non-dimensional parameters (e.g., Weber number, Reynolds number, Ohnesorge number, and Viscosity number). Consequently, for any possible model, the DSD predictions will be extrapolations from the available data and thus subject to greater uncertainty than for other aspects of a model. For instance, the entrainment coefficient for the nearfield plume model can be simulated in the laboratory at the same non-dimensional scale as a full-scale blowout; hence, that aspect of the plume model does not have to extrapolate to unmodeled values. The reviewer argued that this uncertainty was important because, especially in a deep water blowout, the initial DSD would control the fate processes of oil in the water column; the location, thickness, and properties of oil on the surface; and is an integral part in evaluation of the efficacy of SSDI. This reviewer suggested that it would be valuable for the BSEE study report to discuss this weakness, and evaluate its potential impact on the simulations. The reviewer also suggested that the BSEE study report could perhaps recommend to BSEE the need to fill this current gap with initial DSD data from larger-scale experiments.[SS]

Comment [A41]: See C3

Comment [A42]: See D1

Volume I–Worst Case Discharge Analysis	
1.5	*Do the modeling results describe with reasonable accuracy the probability, scope and minimum travel times for oil to potentially contact the environment in the event of a WCD for the selected scenarios?*
Comments:	Two peer reviewers provided an overall agreement that the modeling results presented in the BSEE study report described with reasonable accuracy the probability, scope, and minimum travel times for oil to potentially contact the environment in the event of a WCD for the selected scenarios.[GO,SS] Another peer reviewer provided an assessment of which outputs from the BSEE study modeling were the strongest (described below).[JG]

Volume I–Worst Case Discharge Analysis

1.5 *Do the modeling results describe with reasonable accuracy the probability, scope and minimum travel times for oil to potentially contact the environment in the event of a WCD for the selected scenarios?*

One of the reviewers that provided overall agreement commented that the BSEE study used industry-standard models, which were developed based on all available data. This reviewer also commented that the BSEE study modeling used the best understanding of input parameters for the selected WCD scenarios. The reviewer concluded that the BSEE study simulations provided the best available estimate of the scope, probability, and time scales of oil contact with the environment for such discharges.[SS]

Comment [A43]: See H2

Another one of the reviewers that provided overall agreement commented that the BSEE study used validated models that have benefited from lessons learned during DWH. This reviewer concluded that the BSEE study simulation results provided the best available estimate with reasonable accuracy for the probability, scope, and travel times for oil to potentially contact with the environment.[GO]

Comment [A44]: See H3

The peer reviewer that provided an assessment of which outputs from the BSEE study modeling were the strongest emphasized that the oil hit, or cumulative spill footprint (independent of an estimate of quantitative values), and minimum time of travel raster data were likely some of the strongest outputs from BSEE study. The reviewer concluded those outputs were the strongest because these fields were determined by the time dependent particle position information. The reviewer noted that Lagrangian models provided this as primitive data. The reviewer stated that this type of forecast was inherently stronger than derived information, such as Eulerian density fields.[JG]

Comment [A45]: See H1

However, this reviewer qualified that assessment of which outputs from the BSEE study were the strongest by emphasizing again that the comments this reviewer provided under Charge Question 1.4 certainly applied to these fields and that a poor choice of initial ensemble states will compromise the accuracy of all of the modeling results. More specifically, as this reviewer stated under Charge Question 1.4, the strength (and accuracy) of the analytical methods used in the modeling for the BSEE study was absolutely dependent on two considerations: 1) whether the ensemble state or "situation space" elements used to initialize scenarios spanned a realistic climatology, and 2) how long the models can run before their information content was degraded to the point where data assimilation was necessary.[JG]

Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.1	*Are the limitations and uncertainties clearly identified and adequately characterized for the deterministic trajectory and response countermeasure modeling?*
Comments:	The peer reviewers differed in their approach to this charge question. One reviewer stated the response countermeasure modeling was adequately characterized (i.e., met the BSEE study's objectives) in evaluating how much each response countermeasure would reduce WCD exposures, specifically because the modeling used validated approaches (e.g., BSEE Calculators) and expert input on variables such as environmental conditions.[GO] One reviewer stated that the BSEE study approach for analysis of oil spill response equipment capabilities was reasonable, but commented that the BSEE study report should define the approach more clearly and provide more justification for the metrics used to select the worst case simulation (summarized below).[SS] Another reviewer identified two problem areas where the BSEE study report was vague about quantifying uncertainties (summarized below), and this reviewer also commented that overall the BSEE study report consistently lacked explanation of the statistical assumptions used to support conclusions.[JG] The reviewer that stated the BSEE study approach was reasonable noted that the analysis of oil spill response equipment capabilities was based on one simulation out of the 100 ensemble simulations conducted for the WCD analysis in Volume I. The reviewer also noted that the one simulation selected was identified as the worst case among all of the ensemble simulations; however, the reviewer commented that the BSEE study report was too vague in describing why that worst case simulation was selected. The reviewer observed that the early parts of Volume II stated only that the one selected deterministic simulation was the worst case among the ensembles. The reviewer also pointed out that later in Volume II the one selected simulation was further defined to be the worst case in terms of shoreline oiling. This reviewer suggested that the BSEE study report should clearly define the objective function that was maximized in selecting the worst case ensemble simulation, for example: the reviewer asked whether it was length of oiled shoreline, volume of oil deposited on the shoreline, or some combination of these types of metrics. The reviewer concluded by stating it was reasonable for the BSEE study to select the worst case simulation as the single, deterministic run, but commented that the criteria for evaluating the worst case conditions must be clearly stated in the BSEE study report.[SS,11] This reviewer also argued that while it was reasonable to analyze oil spill response equipment capabilities using a single, deterministic run, there was no

Comment [A46]: See I1

Comment [A47]: See I2

Comment [A48]: Restart here

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[11] Appendix C: BSEE SME Consultation provides further information about selection of that worst case simulation for deterministic modeling in Volume II that BSEE will use along with internal BSEE expertise in developing BSEE's responses to the peer review comments in this report.

Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.1	*Are the limitations and uncertainties clearly identified and adequately characterized for the deterministic trajectory and response countermeasure modeling?*
	analytical requirement to select a single scenario. The reviewer noted that using the worst case ensemble might be considered a conservative estimate, but only for the metric (i.e., shoreline impact) used to select the worst case simulation. This reviewer commented that alternatively, the same oil spill response equipment capabilities analysis could have been applied stochastically to all of the simulations in Volume I. The reviewer suggested that it would be helpful for Volume II to justify that shoreline impact was the most important impact to minimize in the response and that selecting the worst case ensemble in terms of shoreline impact would provide the most conservative estimate of the efficiency and capability of response equipment.[SS] The reviewer that identified two problem areas where the BSEE study report was vague about quantifying uncertainties, also noted that it may not be possible to completely remove these uncertainties in formulating a planning model, but suggested those uncertainties certainly could be more formally addressed in the BSEE study report. The two problem areas with respect to quantifying uncertainties identified by this reviewer were: • The cumulative compound propagation of uncertainty and chaotic processes in the complex models that are not subject to any feedback in the form of data assimilation (also see Charge Questions 1.4 and 1.5). • The uncertainly of the cardinality of the ensemble state or “situation space” used to form the run scenarios (also see Charge Questions 1.4 and 1.5).[JG]

Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.2	*Are the assumptions of the modeling in Volume II clearly defined and appropriate? Assumptions evaluated should include, but are not limited to:* *a) Fate and transport of the oil* *b) Application of temporary source control measures* *c) Application of spill response countermeasures.*
Comments:	All three reviewers commented about the assumptions for the fate and transport of oil for the modeling in Volume II.[JG,GO,SS] Two reviewers commented about the assumptions related to application of temporary source control measures,[GO,SS] and two reviewers commented about the assumptions related to application of oil spill response countermeasures.[GO,SS]

Volume II–Oil Spill Response Equipment Capabilities Analysis

2.2 *Are the assumptions of the modeling in Volume II clearly defined and appropriate? Assumptions evaluated should include, but are not limited to:*

- *a) Fate and transport of the oil*
- *b) Application of temporary source control measures*
- *c) Application of spill response countermeasures.*

Fate and Transport of Oil

Two reviewers expressed concerns about the assumptions related to fate and transport of oil.[JG,SS] One reviewer generally supported the assumptions used in the BSEE study report.[GO]

One reviewer expressed concerns that the documentation in the BSEE study report did not explain what combination of algorithms was used in the analysis related to assumptions about oil fate and transport. This reviewer commented that oil weathering was important when using BSEE's Estimated Recovery System Potential (ERSP) Calculator because this calculator was fundamentally based on encounter rate, which will in turn, depend on oil thickness and water content, and secondarily on oil viscosity. The reviewer noted that the ERSP Calculator used default daily values, but an earlier version (Response Options Calculator, or ROC) included a weathering model. This reviewer explained that SIMAP also included an oil weathering model and an unknown Eulerian to Lagrangian transformation. The reviewer suggested including additional documentation in the BSEE study report to explain how oil fate and transport assumptions were defined.[JG]

Comment [A49]: See J1

One reviewer commented that the assumptions used for the fate and transport of oil in Volume II remained the same as in Volume I of the BSEE study. This reviewer referred to Charge Question 1.3 where this reviewer expressed concerns about whether the assumptions used for the modeling in Volume I were adequately described. Specifically, this reviewer suggested that the BSEE study report should: 1) provide additional information about whether the assumptions used for the OILMAPDeep model accounted for ambient currents; and 2) clearly itemize all fate processes modeled for the SIMAP simulations, especially whether dissolution was considered as a fate process for the SIMAP simulations.[SS]

Comment [A50]: See J2

Another reviewer commented more generally that the assumptions in the BSEE study report were documented by experienced experts and met the BSEE study's objectives. More specifically, for oil fate and transport, this reviewer stated that expert stochastic models provided reasonable oil thickness and viscosity thresholds used to determine suitability for mechanical, in-situ burning, or dispersant applications. This reviewer referenced page 8 of the BSEE study report.[GO]

Comment [A51]: See J3

Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.2	*Are the assumptions of the modeling in Volume II clearly defined and appropriate? Assumptions evaluated should include, but are not limited to:* *a) Fate and transport of the oil* *b) Application of temporary source control measures* *c) Application of spill response countermeasures.*

Temporary Source Control Measures

One reviewer commented about the reasonableness of the assumptions related to temporary source control measures, and provided an additional comment about capping stacks.[SS] Another reviewer generally supported the assumptions used in the BSEE study report.[GO]

One reviewer stated that the timelines for application of temporary source control measures appeared to be a reasonable compromise between the times required during DWH (which were longer due to the fact that this technology was being designed during that spill) and what the reviewer anticipated were likely response times during future spills.[SS]

Additionally, this reviewer argued that the BSEE study report did not address one element of temporary source control, which was the possibility that a capping stack might be installed but for various reasons (mostly well bore integrity), it might not be allowed to be closed. The reviewer stated that, in that case, responders might try to produce all of the spilled fluids to the surface, but the reviewer noted that there was no discussion in the BSEE study report about whether the full well flow rate could be stored and transported allowing full spill control. This reviewer suggested that the actual spill impact will likely lie between the baseline and the source controlled simulations.[SS]

Another reviewer commented more generally that the assumptions in the BSEE study report were documented by experienced experts and met the BSEE study's objectives. More specifically, for temporary source control measures, this reviewer noted assumptions about the availability and timing (15-45 days) of source control measures, and referenced pages pxii, 282, 283, and 254 of the BSEE study report.[GO]

Oil Spill Response Countermeasures

One reviewer commented about the reasonableness of the assumptions related to spill response countermeasures, and expressed concerns about source control assumptions.[SS] One reviewer generally supported the assumptions used in the BSEE study report.[GO]

One reviewer stated that the spill response countermeasures appeared to be modeled reasonably, and for the most part, the amount of oil removed by these

Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.2	*Are the assumptions of the modeling in Volume II clearly defined and appropriate? Assumptions evaluated should include, but are not limited to:* *a) Fate and transport of the oil* *b) Application of temporary source control measures* *c) Application of spill response countermeasures.*
	response countermeasures was similar to what has been historically achieved. This reviewer identified two modest exceptions, specifically, the reviewer stated that in comparison to estimates from the DWH accident, the BSEE study modeling appeared to: • Overestimate removal by mechanical methods, and • Underestimate removal by in-situ burning. This reviewer suggested that the BSEE study report should specify quantitatively how the mechanical removal methods were simulated. The reviewer noted that for a spillet that has the appropriate characteristics (e.g., thickness, viscosity), the BSEE study assumed that spillet will be removed at the remaining available removal capacity within the region occupied by the spillet. The reviewer stated that, in other words, the modeling assumptions did not account for accessibility of skimming vessels to appropriate surface oil, travel time between slicks and to shore, the limited spatial extent of the skimming vessels, and the difficulties of finding and tracking recoverable oil. This reviewer commented that these details were not specified in the BSEE study report and argued that providing those details would make it easier to evaluate the model simulations for mechanical removal.[SS] This reviewer also expressed concerns about source control assumptions, and commented that the BSEE study report needed to explicitly state that source control was assumed to reduce the oil discharge to zero. The reviewer explained that it was difficult to figure this fact out, given the current text in the BSEE study report. The reviewer believed that this was confusing because the capping stack for DWH was installed and operating for several days before the discharge stopped; however, the discharge was reduced as some oil was produced up the capping stack line. Given that sequence of events at DWH, this reviewer suggested that it would be valuable to more explicitly state in the BSEE study report that source control was assumed to be 100% containment and that there was no gradual reduction in flow before containment.[SS] Another reviewer commented more generally that the assumptions in the BSEE study report were documented by experienced experts and met the BSEE study's objectives. More specifically, for spill response countermeasures, this reviewer noted the following assumptions and referenced the following pages of the BSEE study report: • Mechanical: equipment availability, time travel, recovery and storage capabilities, night / fog / wind / weather limitations, access to suitable

Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.2	*Are the assumptions of the modeling in Volume II clearly defined and appropriate? Assumptions evaluated should include, but are not limited to:* *a) Fate and transport of the oil* *b) Application of temporary source control measures* *c) Application of spill response countermeasures.*
	oil (within range of age, viscosity, debris); page 15. - In-situ burning: fire-proof boom availability, supporting towing systems, air monitoring requirements, weather limitations, access to suitable oil; page 19. - Dispersants: approved dispersant availability, supporting towing or subsurface application systems, weather limitations, access to suitable oil; page 18.[GO]

Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.3	*Are there strengths or weaknesses of the analytical methods used for the modeling?*
Comments:	Two peer reviewers discussed strengths of the analytical methods used for the modeling (summarized below).[GO,SS] One reviewer noted that using the ERSP Calculator was a good approach.[JG] All three peer reviewers identified weaknesses in the analytical methods used for the modeling (listed below).[GO,JG,SS] One reviewer provided additional comments related to analytical methods for the modeling.[JG,SS] **Strengths** One reviewer stated that the modeling for Volume II had the important strength of using an industry-tested, process-oriented comprehensive spill modeling system. This reviewer also commented that the BSEE study included tremendous efforts to quantify the available removal equipment infrastructure for each spill scenario and to simulate realistic removal efficiencies.[SS] Another reviewer stated that the strengths of the methods used for the oil spill response equipment capabilities analysis were that the modeling used validated approaches (e.g., BSEE Calculators) and expert input on variables such as environmental conditions. This reviewer commented that the analytical methods met the BSEE study's objectives for evaluating how much each countermeasure would reduce WCD exposures.[GO] **ERSP Methodology** Although another reviewer also supported using the ERSP Calculator, this reviewer noted that the ERSP Calculator (with or without) set predetermined oil thickness "daily" values offered the opportunity to input local

Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.3	*Are there strengths or weaknesses of the analytical methods used for the modeling?*

environmental data (e.g., hours of daylight, statistical wind data).[~~JG~~]

Weaknesses

With respect to weaknesses of the analytical methods used for the modeling, the reviewers provided the following comments:

- One reviewer commented that one weakness of the Volume II analytical methods was that a single, deterministic spill scenario was evaluated instead of an ensemble of all 100 stochastic runs from Volume I. This reviewer stated that this weakness was justified if the primary metric of concern was shoreline oiling, because the simulation with the worst shoreline oiling was selected for the deterministic modeling.[SS]
- One reviewer stated that the models used were unnecessarily complex, because they were dependent on dozens of parametric settings, many of which were not related to the BSEE study. The reviewer acknowledged that issue did not make the models wrong, but commented that the unnecessary complexity introduced additional levels of uncertainty into the modeling results.[JG]
- One reviewer commented that the analytical methods assumed no mechanical breakdowns and also did not assume any aircraft, equipment, crew, or weather limitations.[GO]

Additional Comments

Although not specifically noted as a weakness, one reviewer referred back to related comments under Charge Question 1.4, and stated that the uncertainty in the SSDI results in Volume II was increased by the lack of data for oil DSDs at a large scale and more importantly, the effectiveness of SSDI at a large scale. In general, this reviewer believed that it is very likely, and indeed was evidenced during DWH, that SSDI is an effective response tool. However, the fraction of oil removed by SSDI is uncertain because currently only limited data exists at a sufficiently large scale to test SSDI effectiveness at the field scale. The reviewer believed that it is wholly possible that SSDI is even more effective than was simulated in the BSEE study, especially if DOR levels of 1:100 are achieved with 100% mixing into the discharge in the field. This reviewer suggested that the BSEE study report should discuss the lack of model validation data at the appropriate field scale.[SS]

Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.4	*Are the conclusions drawn from the oil spill response capabilities analysis logical and appropriate based on the modeling results?*
Comments:	The three peer reviewers generally agreed that the conclusions from the oil spill response capabilities analysis were logical and appropriate based on the response countermeasures modeling results.[GO,JG,SS] One reviewer identified critical findings (listed below) from the oil spill response capabilities analysis.[GO] Another reviewer argued that the BSEE study report needed more explanation of oil thickness to fully understand the conclusions based on the modeling results (summarized below).[JG] One reviewer provided a detailed description of one element of the analysis that the reviewer noted might be confusing (described below), and suggested addressing this in the BSEE study report by improving graphical data presentation to remove the possibility of confusion.[SS] With respect to the three reviewers' general agreement about the appropriateness of the conclusions from the oil spill response capabilities analysis, one reviewer stated that the general distribution and timing of the forecasts developed in the BSEE study seemed reasonable.[JG] Another reviewer stated that, for the most part, the analysis for each of the response countermeasures modeling scenarios presented in Chapter 2.0 (Oil Spill Response Capabilities Analysis) of the BSEE study report was logical and sound.[SS] Another reviewer stated that the scenarios modeled provided a capacity to recognize which of the response countermeasures would be the most successful, by location, in reducing WCD exposures.[GO] One reviewer commented in more detail about the planning values for how much and how fast various response countermeasures should be on-scene during a response, which were highlighted in Tables 104-115 (pages 289-302). The reviewer stated that these recommendations were based on critical partnerships with expert analysis of detailed response countermeasure capabilities or limitations, and detailed analysis of all oil spill response equipment for the oil spill modeling. This reviewer commented that such collaboration met the BSEE study's root objectives and was a foundation for the BSEE study report's technical merit.[GO] **Critical Findings** One reviewer commented that the capability analysis by oil spill response equipment and modeling experts was logical and appropriate in helping to produce results with critical findings. The reviewer identified the following critical findings in the Volume II report: • Response countermeasures employed against an overwhelming WCD have limited success. For example, see the DWH baseline: dispersant 8%, in-situ burning 5%, mechanical removal 4% (pages 237-239).

Volume II–Oil Spill Response Equipment Capabilities Analysis

2.4 *Are the conclusions drawn from the oil spill response capabilities analysis logical and appropriate based on the modeling results?*

- Source control has the most significant impact in reducing WCD exposures (page pxii).
- Surface dispersant application and, to a larger degree, SSDI reduces shoreline oiling more than mechanical removal (page 235).
- Use of SSDI is a powerful response option (pages pxxii, xvi).
- Increasing mechanical removal equipment resources does not (necessarily) reduce shoreline oiling (page 235).
- Sufficient dispersant stockpiles are not available (pages 292, 293).[GO]

Oil Thickness

One reviewer emphasized that the documentation in the BSEE study report for the details of oil thickness values was questionable, and suggested that a more complete explanation was needed to fully understand the conclusions based on the modeling results. This reviewer commented that it would be interesting to provide a mass balance of the thick to thin portions of the developing plume in the modeling scenarios. This reviewer could not find any information about how the model calculated oil thickness and argued that the incomplete explanation of the details of oil thickness values in the BSEE study report raised questions about this component of the response countermeasures modeling.[JG,12]

Graphical Data Presentation

One reviewer provided a detailed description of one element of the analysis that the reviewer noted might be confusing, and suggested that this should be addressed in the BSEE study report to remove the possibility of confusion. This reviewer began by explaining that for each scenario, the following information was provided in the BSEE study report:

- A bar chart showing well flow, potential maximum removal and achieved removal broken out by response countermeasure (as an example, see Figure 15 for Scenario 1);
- A pie chart showing the fate of oil by the end of the simulation for each response countermeasure (as an example, see Figure 16 for Scenario 1);
- A table showing oil removal volumes and percentages based on different response capabilities (as an example, see Table 21 for Scenario 1); and

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[12] Appendix C: BSEE SME Consultation provides further information about how oil thickness was calculated as well as how that affected modeling results and conclusions that BSEE will use along with internal BSEE expertise in developing BSEE's responses to the peer review comments in this report.

Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.4	*Are the conclusions drawn from the oil spill response capabilities analysis logical and appropriate based on the modeling results?*
	• A paragraph summarizing the general behavior of the scenario (as an example, this began on Page 41, first paragraph for Scenario 1). This reviewer further explained that, in many cases, the fraction removed by dispersants shown in the bar chart appeared to be the largest fraction and did not always appear to be in agreement with the fractions shown in the pie chart. Moreover, this reviewer explained that the summary paragraph for most of the response countermeasures stated that, among other mechanisms, “mechanical recovery was the primary tool that removed oil.” This reviewer emphasized that, in many scenarios, the bar chart appeared to indicate that dispersants removed more oil. Using Scenario 1 as an example, this reviewer observed that the subsurface dispersant category of the achieved daily flow bar was the largest, yet the pie chart showed surface and subsurface dispersants only affected 7% of the oil; however, skimming removed 9%. This reviewer concluded observations on this issue by stating that the tables and pie charts seemed to agree and usually agreed with the summary paragraph text. However, the bar charts always appeared to show different fractions for the achieved removal, especially for dispersants. The reviewer stated that there was no error in the BSEE study report, and noted that the bar chart presented mechanical removal separated by type, and the table and pie chart summed all mechanical removal together. The reviewer suggested that even though there was no error, this apparent contradiction between the bar charts versus the tables and pie charts, which occurred in almost all of the scenarios, should be addressed in the BSEE study report to remove the possibility of confusion.[SS]

Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.5	*Are the recommendations logical, appropriate, and supported by the analysis and modeling results? The scope of the recommendations pertains to all recommendations, not just those derived from the modeling results.*
Comments:	The peer reviewers provided overall comments on the BSEE study recommendations (summarized below)[GO,JG,SS] as well as specific comments on the national recommendations (listed below)[GO,JG,SS] and regional recommendations (listed below).[GO] Two reviewers provided broader comments on the ERSP Calculator,[JG,SS] which was part of the national recommendations. One reviewer commented about oil spill tracking models and forecasting during responses, and how that related to the BSEE study recommendations.[SS]

Volume II–Oil Spill Response Equipment Capabilities Analysis

2.5 *Are the recommendations logical, appropriate, and supported by the analysis and modeling results? The scope of the recommendations pertains to all recommendations, not just those derived from the modeling results.*

Overall Comments on BSEE Study Recommendations

Two of the peer reviewers generally agreed that the BSEE study recommendations were appropriate.[GO,SS] Of those two reviewers, one reviewer stated that the BSEE study recommendations appeared to be comprehensive, covering all possible OSRP requirements that might be chosen by BSEE. This reviewer commented that the rationale for including each recommendation seemed to be supported by the analysis and modeling results. However, this reviewer provided comments about a few exceptions (described below) for which this reviewer identified a recommendation that was not supported by the modeling and analysis.[SS] Another one of those two reviewers emphasized that the BSEE study recommendations should be based on the BSEE study's root objectives, which this reviewer identified as: 1) best planning practices (strategically focused for command/control, communications, logistical) that can improve response readiness; and 2) operational best practices that maximize the effectiveness of oil spill response countermeasures (source control, dispersant, mechanical, in-situ burning).[GO] Another reviewer stated that the BSEE study recommendations seemed to be overlapping and unduly complicated.[JG] One of the reviewers that agreed the BSEE study recommendations were appropriate also noted that it was not clear whether interactions among the BSEE study recommendations were considered, and stated that an optimum set of recommendations may include a subset of all the BSEE study recommendations currently listed in Chapter 6 of Volume II.[SS]

ERSP Calculator

Two reviewers commented on the ERSP Calculator.[JG,SS] One reviewer stated that Effective Daily Recovery Capacity (EDRC) based on pump rate did not make sense, and commented that it was an appropriate recommendation for BSEE to migrate toward using ERSP instead.[JG] Another reviewer commented that the BSEE study report pointed out that plan holders will be affected if the recovery rates of their equipment were reduced by switching to ERSP. The reviewer noted that this would be true if the required capacity is not adjusted. This reviewer commented that because BSEE's current required capacity is based on the higher EDRC, it was logical for BSEE to consider reducing the required capacity to align with the new ERSP metric. The reviewer suggested that BSEE's requirements should match an equivalent capacity between EDRC and ERSP and commented that although Chapter 6 of Volume II addressed this issue, the Executive Summary did not.[SS]

Volume II–Oil Spill Response Equipment Capabilities Analysis

2.5	*Are the recommendations logical, appropriate, and supported by the analysis and modeling results? The scope of the recommendations pertains to all recommendations, not just those derived from the modeling results.*

Oil Spill Tracking

One reviewer commented about oil spill tracking models and forecasting during responses. This reviewer commented that BSEE should consider, in general, how the BSEE study recommendations may interact with the USCG and NOAA forecasters during an oil spill incident. The reviewer observed that, for example, a permit holder may be required to have a real-time oil spill tracking model and to make forecasts that set response zones. This reviewer noted that was currently the responsibility of NOAA OR&R, which the reviewer stated uses the General NOAA Operational Modeling Environment (GNOME) model. The reviewer commented that there was no mention of GNOME or NOAA forecasts in Chapter 6 of Volume II.[SS]

National Recommendations

Two reviewers provided more specific comments on the national recommendations under Charge Question 2.5.[GO,SS] Two reviewers provided other comments on the national recommendations under Specific Observations, which have been consolidated into the summary below.[JG,SS] As noted above, one the reviewers emphasized that the BSEE study recommendations should be based on the BSEE study's root objectives, which this reviewer identified as: 1) best planning practices (strategically focused for command/control, communications, logistical) that can improve response readiness; and 2) operational best practices that maximize the effectiveness of oil spill response countermeasures (source control, dispersant, mechanical, in-situ burning).[GO]

One reviewer also provided overall comments related to the BSEE study recommendations. This reviewer stated that BSEE should consider including time-honored oil spill response activities, which have proved effective in the past, as part of the BSEE study recommendations. The reviewer provided selected examples: extended duration capability with personnel and equipment, overflight guidance of collection and response platforms, pollutant tracking and mapping, and effective information integration with a Unified Command.[JG]

6.1.1. Oil Characterization (NAT 1)

One reviewer commented that this met the BSEE study's root objectives (as defined above by the reviewer).[GO]

Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.5	*Are the recommendations logical, appropriate, and supported by the analysis and modeling results? The scope of the recommendations pertains to all recommendations, not just those derived from the modeling results.*
	One reviewer commented that the list of oil properties included under NAT 1 should be developed in coordination with NOAA, which maintains an oil properties database. This reviewer argued that all inputs to the NOAA database and forecast models should ideally be included in this list under NAT 1. Also, this reviewer commented that gas chromatography/mass spectrometry (GC/MS) measurements will not be available for exploration wells and, furthermore, that it may not be possible to estimate GC/MS measurements for exploration wells as indicated under NAT 1.[SS] *6.1.2. Modeling, CONOPS, COP (NAT 2-6)* One reviewer commented that the best practices that were outlined met the BSEE study's root objectives (as defined above by the reviewer) by increasing situational awareness for what is possible during an oil spill response. This reviewer stated that it was appropriate that the BSEE study recommendations had listed best practices that optimize the effectiveness of oil spill response equipment (because oil moves, spreads, changes viscosity, water content, and thickness). This reviewer commented that access to "good" oil (with the best oil properties for recovery) by competing oil spill response equipment would be improved by use of the recommended management controls. Although best practices that would increase situational awareness were important, the reviewer also suggested that BSEE should consider that understanding and communicating the scale of what-is-not-possible during and oil spill response was also important.[GO] For NAT 2, one reviewer asked why deterministic trajectory modeling should be used to establish the CONOPS. Instead, this reviewer stated that stochastic modeling at the planning stage should be used. The reviewer explained that NOAA uses stochastic ensemble modeling during a spill to predict the most likely oil trajectories. The reviewer emphasized that BSEE should not exclude the option of using stochastic or probabilistic modeling. As an example, the reviewer referred to Figure 153 in the BSEE study report, and commented that the light-gray hashed region was mostly to the east and did not extend offshore. This light-gray hashed region in Figure 153 was developed for one deterministic scenario. The reviewer stated that during DWH, this region would have been much more to the west, and that depending on the current, it could also have covered the deep Gulf of Mexico. The reviewer argued that stochastic modeling should be applied to determine the locations of these regions during the planning stage.[SS]

Volume II–Oil Spill Response Equipment Capabilities Analysis

2.5 *Are the recommendations logical, appropriate, and supported by the analysis and modeling results? The scope of the recommendations pertains to all recommendations, not just those derived from the modeling results.*

6.1.3. Temporary Source Control Capabilities (NAT 7-11)

One reviewer commented that one of the critical findings of the BSEE study report was that the first priority for an oil spill response should be the prompt implementation of source control. The reviewer referred to pages 282 and xii with respect to this critical finding.[GO]

This reviewer also noted that NAT 7 outlined dramatic reduction in shoreline impact by implementation of source control. The reviewer noted that NAT 8 would require sustained oil spill response resources, NAT 9 would require effective source control plan coordination with OSRP, and NAT 10 would require coordination between subsurface and surface activities. The reviewer commented that these prescriptive best practices met the BSEE study's root objectives (as defined above by the reviewer).[GO]

6.1.4. Resource Readiness and Mobilization Time Factors (NAT 12-13)

One reviewer commented that this met the BSEE study's root objectives (as defined above by the reviewer).[GO]

6.1.5. Oil Spill Tracking and Surveillance Capabilities (NAT 14-16)

One reviewer commented that this met the BSEE study's root objectives (as defined above by the reviewer).[GO]

For NAT 14, one reviewer commented that NOAA OR&R was responsible for providing oil spill tracking data to the USCG in the event of a spill. The reviewer suggested that the BSEE study report should consider how NAT 14 should integrate with NOAA responsibilities.[SS]

6.1.6. Mechanical Recovery Capabilities (NAT 17-27)

One reviewer commented that this met the BSEE study's root objectives (as defined above by the reviewer).[GO]

For NAT 25, under Specific Observations (for page 290, paragraph 4), one reviewer commented that ERSP thresholds should be significantly greater than the WCD, but stated that this was not supported by the modeling. The reviewer noted that ERSP thresholds are already lower than EDRC values. This reviewer stated that the modeling showed that present removal capability was not maximized due to limitations of daylight and weather (see

Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.5	*Are the recommendations logical, appropriate, and supported by the analysis and modeling results? The scope of the recommendations pertains to all recommendations, not just those derived from the modeling results.*
	summarization on page 290 in paragraph 2). This reviewer expressed concerns that requiring a significantly higher capacity for removal than present was not consistent with this modeling conclusion.[SS,13] For NAT 25, under Specific Observations (for page 289-291), one reviewer commented that the tables (and other tables that follow in the BSEE study report) relating to response times and stockpiles of available supplies were presented as resulting from detailed analysis based on the whole BSEE study, but the reviewer expressed concerns that there did not seem to be any discussion in the BSEE study report about how the details in those tables were derived. The reviewer commented that it was logical that local environmental conditions were likely to be determinative, and this reviewer suggested that it might be appropriate for BSEE to consider modeling ensembles based on local climatology data.[JG] *6.1.7. Dispersant Stockpile Requirements (NAT 28-40)* One reviewer commented that this met the BSEE study's root objectives (as defined above by the reviewer).[GO] For NAT 37, one reviewer agreed that BSEE should promote additional research in order to establish improved guidance regarding SSDI DORs. This reviewer provided related comments under Charge Question 2.3. The reviewer argued that improved guidance should include additional experimental modeling. Assuming that experimental modeling might be either cost prohibitive or impossible given the need to obtain environmental permits, the reviewer suggested that BSEE write a regulation that would allow the responsible party for the next spill to test different DORs and demonstrate a minimum DOR that satisfies their SSDI objective. The reviewer stated that unless nearly full-scale experiments can be conducted to test SSDI effectiveness, there was not a very good basis to specify DORs using currently available data.[SS] *6.1.8. In-situ Burning Capabilities (NAT 41-42)* One reviewer commented that this met the BSEE study's root objectives (as defined above by the reviewer).[GO]

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[13] Appendix C: BSEE SME Consultation provides some information to clarify mechanical recovery capabilities recommendations derived from the modeling results that BSEE will use along with internal BSEE expertise in developing BSEE's responses to the peer review comments in this report.

Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.5	*Are the recommendations logical, appropriate, and supported by the analysis and modeling results? The scope of the recommendations pertains to all recommendations, not just those derived from the modeling results.*
	6.1.9. Offshore Response Logistics Recommendations (NAT 43) One reviewer commented that this met the BSEE study's root objectives (as defined above by the reviewer).[GO] **Regional Recommendations: Gulf** *6.2.1. RCP and ACP Recommendations* One reviewer commented that this met the BSEE study's root objectives (as defined above by the reviewer).[GO] *6.2.2. Surface-Applied Dispersant Capability Recommendations* One reviewer commented that this was already given due to the fact that the Region IV and VI RRTs have pre-approved surface dispersant use greater than 3 nautical miles offshore with the caveat that "mechanical recovery is the preferred oil spill response option." The reviewer referred to page 25 with respect to this comment.[GO] **Regional Recommendations: Pacific** *6.3.1. Mechanical Recovery Recommendations* One reviewer commented that this met the BSEE study's root objectives (as defined above by the reviewer).[GO] *6.3.2. Surface-Applied Dispersant Capability Recommendations* One reviewer commented that this was already given due to the fact that the Region IX RRT has pre-approved surface dispersant use greater than 3 nautical miles offshore, except for areas within the National Marine Sanctuaries or within 3 nautical miles of the Mexico border or Oregon state boundary. The reviewer referred to page 141 with respect to this comment.[GO] *6.3.3. In-situ Burning Recommendations* One reviewer commented that this met the BSEE study's root objectives (as defined above by the reviewer).[GO]

Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.5	*Are the recommendations logical, appropriate, and supported by the analysis and modeling results? The scope of the recommendations pertains to all recommendations, not just those derived from the modeling results.*
	Regional Recommendations: Arctic *6.4.1. Arctic RCP and ACP Recommendations* One reviewer commented that this met the BSEE study's root objectives (as defined above by the reviewer).GO *6.4.2. Arctic OSRP Review Recommendations* One reviewer commented that this met the BSEE study's root objectives (as defined above by the reviewer).GO *6.4.3. Dispersant Capability Recommendations* One reviewer commented that this was already given due to the fact that dispersants are not pre-approved. The reviewer referred to page 160 with respect to this comment.GO

4. PEER REVIEWER COMMENTS BY CHARGE QUESTIONS

This section provides the peer review comments of each reviewer organized by charge question. Any peer review comments that were identified by BSEE as out-of-scope for this peer review (see Section 1.3) were not included in this peer review summary report.

4.1 General Impressions

GENERAL IMPRESSIONS	
Provide overall impressions (approximately 1/2 page in length) addressing the accuracy of information presented, clarity of presentation, and soundness of conclusions.	
Dr. Jerry Galt	It seems that the conclusions presented in these two volumes are essentially built around a set of quite complex models and algorithms. It is not obvious that the complexity of the components is justified and many of the conclusions attributed to “the model” are in fact little more than what an experienced spill responder would consider as common knowledge. The models probably do not give obvious erroneous results. More of an issue for the veracity of the overall report conclusions is that the plume rise and trajectory models are combinations of dozens of individual algorithms, which require parametric inputs each of which introduce some degree of uncertainty, which is then linked together in a chain of logic propagating uncertainties into a final compound uncertainty. As a result, I do not believe anyone really knows, for example, what “skill levels” to expect from SIMAP, or how rapidly its information content degrades with time, and ultimately how soon “data assimilation” would be required to restore confidence. I should be quick to point out that this is not a problem that is unique to SIMAP, but is found with all complex geophysical models. Therefore, virtually all operational geophysical fluid dynamics transport models and trajectory models have data assimilation components. A complex model used in a purely planning mode may not have the advantage of a reality check in the form of available assimilation data, but this can't be used as a dodge for ignoring cumulative uncertainty. As a final general point, the veracity of the models used should at least move in a central tendency towards the right answer (possibly subject to chaotic sensitivity to initial conditions). The statistics of the ensemble use of such models then totally depends on the climatology or “situation space” used to initialize model runs. A short coming of this report is that there is virtually no discussion of the sample space in which the models operate. 100 scenarios are run, but whether these span the expected cardinality of the environmental driving parameters is not discussed and should be. This problem applies to all the basic regions covered by the report and the researchers with the experience of the principles should have something to say about this.

GENERAL IMPRESSIONS	
Provide overall impressions (approximately 1/2 page in length) addressing the accuracy of information presented, clarity of presentation, and soundness of conclusions.	
Mr. Gary Ott	**Root Objectives /Tasks Assumed for this Report** No listing for objectives/tasks was provided. Based on comments in the report, my review is based on these working objective/task assumptions. Volume I: Illustrate the overall scale of Worst Case Discharge (WCDs) releases from representative well locations – Gulf, Pacific, Arctic. Volume II: Identified for each countermeasure **– source control, dispersants, ISB, mechanical –** potential in reducing shoreline exposures using these assumed objectives: • Best planning (strategic, command/control/communications, logistical) practices that can improve response readiness. • Operational best practices maximize countermeasures effectiveness. **Critical Findings of this Report:** Scattered within Volume II are several critical findings. These critical findings, which I believe to be true, were my foundation for reviewing modeling and recommendations. They are listed by page number at part III SPECIFIC OBSERVATIONS. **Technical Confidence:** What's certain, countermeasures, when employed against an overwhelming WCD, have limited success (p. 259). When planning for an overwhelming WCD, what's not certain (some examples) WCD volumes, site locations, oil types, droplet sizes, countermeasures capabilities/ availabilities, weather/ sea state/ tides, and crew availabilities. For each of these many uncertainties, planners must make choices based on where they have technical confidence, i.e., countermeasures and modeling experts know equipment and modeling capabilities / limitations. • WCD planner's choices and their recommendations, based on their technical competence, make sense for how much and how fast various countermeasures should be on-scene (tables 104-115 p. 289-302).
Dr. Scott Socolofsky	The "Oil Spill Response Plan Equipment Capabilities Review" presents a major modeling exercise, supported by a significant collection of input data. The modeling system used in the review is a comprehensive oil spill modeling platform (OILMAPDeep and SIMAP) that simulates the buoyant plume rise in the near field of a blowout, through Lagrangian transport in the subsurface water column, and subsequent fate and transport on the sea surface. Both OILMAPDeep and SIMAP are industry standard simulation packages that have undergone many years of application, testing, and refinement. The Worst Case Discharge (WCD) scenarios are simulated using a multiple-ensembles approach (stochastic modeling) where the results of 100 deterministic spill simulations are analyzed to produce probabilistic maps of

GENERAL IMPRESSIONS	
Provide overall impressions (approximately 1/2 page in length) addressing the accuracy of information presented, clarity of presentation, and soundness of conclusions.	
Dr. Scott Socolofsky, continued	spill effects. 100 simulations is a modest number of simulations, which likely balances the competing needs of having a large number of simulations while completing the analysis in a reasonable amount of time. These simulations each have different environmental forcing, but all utilize the same model parameters for each WCD scenario. The environmental forcing is selected at random from a database of exiting weather and currents for each region. No attempt is made to ensure that the canonical variability of the climate in each region is sampled. Hence, these simulations represent plausible outcomes for spills during the period of the measured data and may not represent the full climate variability or the model uncertainty. One of the most important factors in the numerical modeling is the prediction of the initial oil droplet and gas bubble size distributions (DSD). Smaller oil droplets rise slower, allowing for greater subsurface transformation and wider dispersal. The simulations presented here likely use the DSD prediction equation developed by Applied Science Associates (ASA) for the Deepwater Horizon Natural Resource Damage Assessment (NRDA). This tool has been calibrated to a comprehensive set of available laboratory data. However, it is important to point out that no data are available for DSDs in the parameter space of a full-scale blowout, and no measurements were made of DSD near the Deepwater Horizon breakup region. Hence, one must trust that extrapolation from the present available laboratory data to the field scale is appropriate. This can only be verified by larger-scale experiments. The effect of the DSD model is most significant for evaluating the efficacy of subsea dispersant injection (SSDI) since SSDI is modeled in the simulations by adjusting the interfacial tension (IFT) between the oil and water and predicting a new DSD with this IFT. This is the current practice for predicting the effects of SSDI. If the DSD model over- or under-predicts the treated DSD, then the conclusions will over- or under-predict the efficacy of SSDI. The review of the Deepwater Horizon accident supports the conclusion that SSDI is an effective and important response strategy for accidental blowouts, and this conclusion is also supported by the present model simulations. Open questions that remain are: 1.) whether or not surface dispersant application will be needed once effective SSDI (i.e., 100% treatment at 1:100 DOR, which was not achieved during the Deepwater Horizon accident) is achieved and 2.) what the relative removal rates due to SSDI and mechanical removal will be during a future spill. The deterministic model simulations in Vol. II all appear to overestimate the removal capability of mechanical removal and underestimate the rates of removal by in-situ burning when compared to estimates of removal rates during the Deepwater Horizon accident. This could be due to many

GENERAL IMPRESSIONS	
Provide overall impressions (approximately 1/2 page in length) addressing the accuracy of information presented, clarity of presentation, and soundness of conclusions.	
Dr. Scott Socolofsky, continued	complicating factors. One factor is that SIMAP tracks the available inventory for mechanical removal and burning and maps inventory to spill locations where oil of the appropriate state is located. This might overestimate the ability of mechanical recovery equipment to gain access to appropriate oil and also limits burning to the stockpile of available boom. Because burning boom is expensive, the pre-spill stock pile is smaller than might become available during a spill. These aspects of the modeling are important, since one of the final recommendations (NAT 25.1) appears to recommend that significantly greater oil recovery capacity may be required in the future than presently. This is somewhat confusing, especially given that simulations in section 2.4 demonstrated that adding recovery capacity quickly resulted in diminishing returns due to limitations of weather and daylight. Finally, Section 6.0 of Vol. II provides a comprehensive list of recommendations that BSEE may consider including in future regulations. This list appears to be exhaustive and fairly prescriptive. Among the various recommendations is the requirement for operators to be capable of real-time response modeling and forecasting in the event of a spill. This is currently the task of the NOAA Office of Response and Restoration. There ought to be a discussion about how the operator and NOAA forecasts might be reconciled and a justification for why the operator will be asked to perform tasks that overlap with the NOAA responsibility.

4.2 Responses to Charge Questions

RESPONSE TO CHARGE QUESTIONS	
Volume I–Worst Case Discharge Analysis	
1.1	*Were the Worst Case Discharge (WCD) sites selected for analysis a valid sample to evaluate the probabilities and scope of oil contacting the environment in each region?*
Dr. Jerry Galt	Given the size of the regions and the general circulation scales of each, the answer is a qualified yes, but in each of the studied regions there are smaller scale circulation features and it is not shown in the report that the underlying geophysical flow models resolve the details. Features that have proved important in historical spills include: Central Gulf: Details of the Mississippi Delta freshwater outflow and mixing close to the delta are intricate. Western Gulf: A near shore low salinity frontal interface caused by fresh water run off typically extends from the Atchafalaya, past Calcasieu to Galveston. This results in a convergence band that traps floating pollutants and may locally off set trajectories tens of miles to the west. Santa Barbara Channel: Here the details associated with the eddy structure in the Santa Barbara channel itself and the directional shifts associated with the California Current vs. the Davidson Current periods are at issue. In the Chukchi and Beaufort regions details of the ice cover circulation and banded currents found along the North Slope will certainly degrade the veracity of the forecasts. The report does not seem to discuss the underlying hydrodynamics directly. I do not think general references provide enough understanding.
Mr. Gary Ott	Sites selected representing near-shore, offshore, open-ocean (in each planning region) and largest potential release make sense. In the Pacific, the site selected impacting the Santa Barbara Channel would be the worst case. The Alaska sites in two regions are given.
Dr. Scott Socolofsky	Yes, the authors have made reasonable efforts to select WCD sites that cover a wide range of potential blowout scenarios and environmental impacts. In most cases, the review text provides a justification for why each WCD site was selected. The authors were limited by the fact that only a fraction of the existing wells have data within the Oil Spill Response Plan (OSRP) dataset. This limits the available range of sites that can be selected. This limited dataset especially impacts the Gulf of Mexico Eastern Planning Area (where the selected WCD site is in the Central Planning Area) and the Western Planning Area (where the sites in the OSRP datasets are well to the east of many existing wells within the planning area).

RESPONSE TO CHARGE QUESTIONS	
Volume I–Worst Case Discharge Analysis	
1.1	*Were the Worst Case Discharge (WCD) sites selected for analysis a valid sample to evaluate the probabilities and scope of oil contacting the environment in each region?*
Dr. Scott Socolofsky, continued	One weakness of the text is that in several regions, the largest spill size selected for analysis is smaller than the WCD among all of the OSRP data points. The document mostly explains the reasons for the selected cases. It would help make the selection process more solid if the review also explained why higher flow rate cases were not selected when they are present in the OSRP data for a given OCS region. For example, in the Southern California Planning Area, the selected WCD is 5,200 bbl/d; whereas, the highest flow rate WCD in the OSRP dataset is 12,000 bbl/d—over double the analyzed case. The text states that the selected case is situated geographically near the Channel Islands National Marine Sanctuary and National Park Unit (Page 93, 3rd paragraph). This is good justification. However, the wells are all fairly close together. Can the authors also give a reason why the higher flow rate case was not selected? This situation is also true for the Alaska Planning Regions, where the selected WCD sites have flow rates between 15,000 and 25,000 bbl/d; whereas, the highest discharge WCD site has an estimated 85,000 bbl/d. The text emphasizes that in both the Pacific and Arctic regions, the OSRP data for WCD are per platform instead of per well. Is this perhaps part of the reason these higher WCD cases were not analyzed? Since the single, high flowrate WCD in the Arctic region appears to be an outlier, it would be valuable for the text to address it.

RESPONSE TO CHARGE QUESTIONS	
Volume I–Worst Case Discharge Analysis	
1.2	*Are the limitations and uncertainties clearly identified and adequately characterized for the oil plume, fate and effects, and transport mechanisms used in the stochastic trajectory modeling? Please note that the impact of a WCD is not a probable impact, or representative of risk; but the largest volume possible from an uncontrolled blowout (30 CFR 257.47 (b)), a very unlikely and low probability scenario.*
Dr. Jerry Galt	Given the fact that SIMAP has a strong historical development to cover actual damage functions, for this study, its algorithms are encumbered with many unused parametric algorithms and may introduce more complexity to this study than is necessary. Any number of simple particle tracking models might work as well. With all that said, the process that the investigators used to zero in on each region “largest credible release” make sense and their proposed scenarios

RESPONSE TO CHARGE QUESTIONS	
Volume I–Worst Case Discharge Analysis	
1.2	*Are the limitations and uncertainties clearly identified and adequately characterized for the oil plume, fate and effects, and transport mechanisms used in the stochastic trajectory modeling? Please note that the impact of a WCD is not a probable impact, or representative of risk; but the largest volume possible from an uncontrolled blowout (30 CFR 257.47 (b)), a very unlikely and low probability scenario.*
Dr. Jerry Galt, continued	seem appropriate for this study.
Mr. Gary Ott	By definition, the models used in this report are presumed correct when used as part of a formal NRDA Type A process. Reasonable range of accuracies, limitations, uncertainties, assumptions, strengths and weakness are presumed acceptable. Citations listing multiple technical reviews of these models used by the 1) ongoing DWH damage assessment process and 2) the NRDA Type A model are available.
Dr. Scott Socolofsky	The stochastic simulations use fixed model parameters for all aspects of the modeling except for the ambient environmental forcing. In this sense, the simulations do not account for any uncertainties in model or spill parameters (e.g., plume entrainment rate, oil composition, biodegradation rates, initial droplet size distributions, surface transformation process models, etc. are all identical in all simulations within each scenario). Uncertainty is modeled in the stochastic simulations by initializing the blowout on different days throughout the time span of available model forcing, each simulation representing a separate ensemble. This is a reasonable approach to simulating the uncertainty of ambient currents and weather on the behavior of a blowout. It would be valuable to state in the text whether start times are equally spaced over the available time span of input data or whether start times are selected from a random distribution. If a random distribution of start times is used, provide the probability density function of the distributions. In either case, provide an appendix listing the start times for all simulations used in the stochastic modeling. In addition, the different environmental forcing is not analyzed to ensure that the full range of climate variability at a site is considered in the simulations. These results should be viewed as potential outcomes for spills that might have occurred during the span of data in the environmental forcing database. This may not represent the actual total variability over the canonical modes of climate behavior at each site.

RESPONSE TO CHARGE QUESTIONS	
Volume I–Worst Case Discharge Analysis	
1.3	*Are the assumptions of the modeling clearly defined and appropriate?*
Dr. Jerry Galt	The modeling assumptions are generally clear and well stated, with one notable exception. The model tracks "spillets" to obtain "areas painted by an ensemble of spills" and minimum "travel times". This is, as I understand it, binary raster data in terms of area and minimum time raster data for time. Multiple hits in the first field will not change the answer. This obviously works fine with Lagrangian particles given coordinate data. The answers are somewhat dependent on raster size, but using smoothing that conserves mass will usually result in contourable results. In another context, the thickness of the floating or beached oil is presented. This is Eulerian field data and is dimensionally (mass/area) and should be calculated from the aggregated Lagrangian particles and possibly corrected for individual "spillet" spreading. This is a mathematically tricky operation and the investigators present no clues that I found about how they do it. This is a persistent shortcoming throughout the report.
Mr. Gary Ott	Yes. See above.
Dr. Scott Socolofsky	The report main text briefly outlines the processes considered in the blowout plume model (OILMAPDeep, nearfield model) and the far-field model (SIMAP). The appendices give more details of the capabilities of these models. Since the appendices enumerate all of the capabilities of the model and it is possible that not all capabilities were used in the review simulations, it is important that the text of the review document clearly state all processes used in the modeling. My understanding of OILMAPDeep is that gas is treated as pure methane and allowed to dissolve and that oil does not undergo fate processes in the nearfield plume model. This should be clearly stated in section 2.3.1. Also, the inputs to the model include the ambient stratification profile and currents—these are not listed as inputs on Page 15, 2nd paragraph of section 2.3.1. Moreover, it is not clear to me whether or not OILMAPDeep accounts for ambient currents; if ambient currents are not used (and therefore, not needed as inputs), the text should explicitly state this. Otherwise, the assumptions of the nearfield model are adequately described. For the purposes of determining the intrusion level of a blowout, the OILMAPDeep simulations are appropriate. For SIMAP, it is not clear in the text whether dissolution was considered as a fate process for the present simulations. I understand that SIMAP is capable of modeling dissolution during transport from the subsurface intrusion to the surface, but page 16 only lists biodegradation as a subsurface fate process.

RESPONSE TO CHARGE QUESTIONS	
Volume I–Worst Case Discharge Analysis	
1.3	*Are the assumptions of the modeling clearly defined and appropriate?*
Dr. Scott Socolofsky, continued	Subsequent model results suggest dissolution is modeled. Clearly itemize in this section all fate processes modeled for the SIMAP simulations. For the purposes of determining the fate of oil in the water column, the SIMAP simulations appear appropriate.

RESPONSE TO CHARGE QUESTIONS	
Volume I–Worst Case Discharge Analysis	
1.4	*Are there strengths or weaknesses of the analytical methods used for the modeling?*
Dr. Jerry Galt	The strength of the analytical methods used in the projects modeling is dependent on whether the ensemble set of “situation space “elements used to initialize scenarios spans a realistic climatology and how long the models can run before their information content is degraded to the point where data assimilation is required. These kinds of considerations don't seem to be covered in the report and should be discussed.
Mr. Gary Ott	Yes. See above.
Dr. Scott Socolofsky	The strength of the WCD modeling is that both OILMAPDeep and SIMAP are process-oriented models that simulate the physical, chemical, and biological processes affecting the oil fate and transport in the environment. Both models have been used in industry for many years and have benefited from rigorous testing across many diverse projects. The model inputs have been carefully evaluated based on a wide range of available data. The simulations are also forced by high-quality simulation data for environmental parameters (e.g., winds and currents). The simulations are complex and thorough. One weakness of the modeling is that only the stochastic nature of the environmental forcing is evaluated and no simulation of the effects of other model inputs are considered. These other model inputs include parameters describing the oil as well as model parameters such as entrainment rate, biodegradation rates, and other model coefficients. Likely, an exhaustive analysis of model uncertainty is beyond the scope of this study, and the choice to consider only the effects of environmental forcing gives an adequate picture of the potential contact of the spilled oil with the environment. Another weakness that is out of the control of the modelers, but nonetheless important, is that no data for initial oil droplet size distributions (DSD) in the parameter space of a full-scale blowout are available. Laboratory and field

RESPONSE TO CHARGE QUESTIONS	
Volume I–Worst Case Discharge Analysis	
1.4	*Are there strengths or weaknesses of the analytical methods used for the modeling?*
Dr. Scott Socolofsky, continued	data that can be used to calibrate and validate DSD models have all been collected for smaller values of the governing non-dimensional parameters (e.g., Weber number, Reynolds number, Ohnesorge number, and Viscosity number). Hence, the DSD predictions used in any possible model will be extrapolations from the available data, and hence, subject to greater uncertainty than for other aspects of the model. For instance, the entrainment coefficient for the nearfield plume model can be simulated in the laboratory at the same non-dimensional scale as a full-scale blowout; hence, that aspect of the plume model does not have to extrapolate to unmodeled values. This uncertainty is important because, especially in deep water, the DSD controls the fate processes in the water column, the location, thickness, and properties of oil on the surface, and is an integral part in the evaluation of the efficacy of subsurface dispersant injection. It would be valuable for the present review to discuss this weakness, evaluate its potential impact on the present simulations, and perhaps recommend to BSEE the need to fill this gap with data from larger-scale experiments.

RESPONSE TO CHARGE QUESTIONS	
Volume I–Worst Case Discharge Analysis	
1.5	*Do the modeling results describe with reasonable accuracy the probability, scope and minimum travel times for oil to potentially contact the environment in the event of a WCD for the selected scenarios?*
Dr. Jerry Galt	The oil hit, or cumulative spill foot print (independent of an estimate of quantitative values) and minimum time of travel raster data are likely to be some of the strongest output from the study since these fields are determined by the time dependent particle position information. Lagrangian models provide this as primitive data. This kind of forecast is inherently stronger than derived information such as Eulerian density fields. However, it should once again be emphasized that the comments in 1.4 above certainly apply to these fields and that a poor choice of initial ensemble states will compromise all of the model results.
Mr. Gary Ott	The validated models used in this study have benefited from lessons learned during DWH and their results, accuracy, probability and scope of travel times to potential contact with the environment would be the best available estimate.
Dr. Scott Socolofsky	The model results presented here utilize industry-standard models, developed based on all available data, and use our best understanding of the input parameters for the WCD scenarios described in the report. Hence, these

RESPONSE TO CHARGE QUESTIONS	
Volume I–Worst Case Discharge Analysis	
1.5	*Do the modeling results describe with reasonable accuracy the probability, scope and minimum travel times for oil to potentially contact the environment in the event of a WCD for the selected scenarios?*
Dr. Scott Socolofsky, continued	simulations give the best available estimate of the scope, probability, and time scales of oil contact with the environment for such discharges.

RESPONSE TO CHARGE QUESTIONS	
Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.1	*Are the limitations and uncertainties clearly identified and adequately characterized for the deterministic trajectory and response countermeasure modeling?*
Dr. Jerry Galt	There are two problem areas where this report is vague about quantifying uncertainties: The first is due to the cumulative compound propagation of uncertainty and chaotic processes in the complex models that are not subject to any feedback in the form of data assimilation. The second is due to the uncertainly of the cardinality of the ensemble “situation space” used to form the run scenarios. In a planning formulation, it may not be possible to completely remove these, but they certainly could be more formally addressed. There is a consistent lack of explaining the statistical assumptions used to support report conclusions.
Mr. Gary Ott	Response countermeasures modeling: Validated approaches – ERSP, ReSET, EDSP, and EBSP calculators - and expert’s input on variables such as environmental conditions, met the Report’s objectives in evaluation of how much each countermeasure would reduce WCD exposures.
Dr. Scott Socolofsky	The analysis of the capabilities of oil spill response equipment is based on one simulation out of the 100 ensemble simulations conducted for the WCD analysis in Vol. I. The simulation that was selected was deemed to be the worst case among all of the ensemble simulations. Early parts of Vol. II state only that the selected deterministic simulation is the worst case among the ensembles. Later, this is further defined to be the worst case in terms of shoreline oiling. It would be best if the authors can clearly define the objective function that was maximized in selecting the worst case ensemble simulation: was it length of oiled shoreline? volume of oil deposited on the shoreline? some combination of these types of metrics? It is reasonable for the authors to select the worst-case simulations as their single, deterministic run, but the criteria for evaluating the worst case conditions need to be clearly stated. While it is reasonable to analyze the capabilities of response equipment using a single, deterministic run, there is no analytical requirement that a single

RESPONSE TO CHARGE QUESTIONS	
Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.1	*Are the limitations and uncertainties clearly identified and adequately characterized for the deterministic trajectory and response countermeasure modeling?*
Dr. Scott Socolofsky, continued	scenario be selected. One might argue that using the worst case ensemble is a conservative estimate, but only for the metrics used to select the worst case simulation: here, that metric was shoreline impact. The same analysis could have been applied in a stochastic way to all of the simulations in Vol. I. It would be helpful for the Vol. II text to justify that shoreline impact is the most important impact to minimize in the response and that selecting the worst-case ensemble in terms of shoreline impact gives the most conservative estimate of the efficiency and capability of response equipment.

RESPONSE TO CHARGE QUESTIONS	
Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.2	*Are the assumptions of the modeling in Volume II clearly defined and appropriate? Assumptions evaluated should include, but are not limited to:* *a) Fate and transport of the oil* *b) Application of temporary source control measures* *c) Application of spill response countermeasures.*
Dr. Jerry Galt	The weathering of the oil is important when using the ERSP calculator because it is fundamentally based on encounter rate, which will in turn depend on thickness and water content, and secondarily on viscosity. The ERSP calculator uses default daily values, but an earlier version (ROC) included a weathering model. SIMAP also includes an oil weathering model and an unknown Eulerian to Lagrangian transformation. The documentation presented does not explain what combination of these algorithms are used in the analysis.
Mr. Gary Ott	Assumptions documented by experienced experts in countermeasures met objectives: • Fate and transport: expert stochastic models provided reasonable oil thickness and viscosity thresholds used to determine suitability for mechanical, ISB, or dispersant applications. p.8 • Source control: availability, time 15-45 days p.xii, p.282, p.283, p.254 • Countermeasures: o Mechanical: equipment availability, time travel, recovery and storage capabilities, night / fog / wind / weather limitations, access to suitable oil (within range of age, viscosity, debris). p.15 o ISB: fire-proof boom availability, supporting towing systems, air monitoring requirements, weather limitations, access to suitable oil. p.19

RESPONSE TO CHARGE QUESTIONS	
Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.2	*Are the assumptions of the modeling in Volume II clearly defined and appropriate? Assumptions evaluated should include, but are not limited to:* *a) Fate and transport of the oil* *b) Application of temporary source control measures* *c) Application of spill response countermeasures.*
Mr. Gary Ott, continued	○ Dispersant: approved dispersant availability, supporting towing or subsea application systems, weather limitations, access to suitable oil. p.18
Dr. Scott Socolofsky	The assumptions of the fate and transport of the oil remain the same as in Vol. I, and evaluation of these assumptions is provided above in Question 1.3. The timelines for application of the temporary source control measures appear to be a reasonable compromise between the times required during Deepwater Horizon (which were longer due to the fact that this technology was being designed during the spill) and likely response times during future spills. One element of the temporary source control that is not really addressed in the report is the possibility that a capping stack might be installed but for various reasons (mostly well bore integrity), it might not be allowed to be closed. In that case, one might try to produce all of the spilled fluids to the surface, but there was no discussion about whether the full well flow rate could be stored and transported allowing full spill control. Likely, the actual spill impact will lie between the baseline the source controlled simulations. The spill response measures appear to be modeled reasonably, and for the most part, the amount of oil removed by these measures is similar to what has been historically achieved. The modest exceptions to this case are that the present modeling appears to overestimate removal by mechanical methods and underestimate removal by in-situ burning. The report should specify quantitatively how the mechanical removal methods were simulated. For a spillet that has the appropriate characteristics (e.g., thickness, viscosity, etc.), it is assumed that that spillet will be removed at the remaining available removal capacity with the region occupied by the spillet. In other words, the model does not account for accessibility of skimming vessels to appropriate surface oil, travel time between slicks and to shore, limited spatial extent of the skimming vessel, and the difficulties of finding and tracking recoverable oil. These details are not specified in the report and would make it easier to evaluate the model simulations for mechanical removal. At some point, more general in the report, the text needs to explicitly state that source control is assumed to reduce the oil discharge to zero. It was difficult for me to figure this fact out. This is confusing since the capping stack for the Deepwater Horizon was installed and operating for several days before the discharge stopped. Yet, the discharge reduced as some oil was produced up

RESPONSE TO CHARGE QUESTIONS	
Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.2	*Are the assumptions of the modeling in Volume II clearly defined and appropriate? Assumptions evaluated should include, but are not limited to:* *a) Fate and transport of the oil* *b) Application of temporary source control measures* *c) Application of spill response countermeasures.*
Dr. Scott Socolofsky, continued	the capping stack line. With that sequence of events in a reader's mind, it is valuable to spell out in this report that source control is assumed to be 100% containment and that there is no gradual reduction in flow before containment.

RESPONSE TO CHARGE QUESTIONS	
Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.3	*Are there strengths or weaknesses of the analytical methods used for the modeling?*
Dr. Jerry Galt	See the comments from section 2.1 above. It seems to me that the models used are unnecessarily complex. They are dependent on dozens of parametric settings, many of which are not related to the problem at hand. This does not make them wrong, but does cloak the answers in additional levels of uncertainty. The use of the ERSP calculator (with or without) set predetermined oil thickness "daily" values offers a strong advantage to input local environmental data, such as hours of day light, statistical wind rose data, etc.
Mr. Gary Ott	• Strength: Validated approaches – ERSP, ReSET, EDSP, and EBSP calculators - and expert's input on variables such as environmental conditions, met objectives for how much each countermeasure would reduce WCD exposures. • Weakness: Methods assume no mechanical breakdowns or aircraft/equipment/crew/weather limitations.
Dr. Scott Socolofsky	As with the modeling in Vol. I, the modeling for Vol. II has the important strength of using an industry-tested, process-oriented comprehensive spill modeling system. In addition, the authors have made tremendous efforts to quantify the available removal infrastructure for each spill scenario and to simulate realistic removal efficiencies. One weakness of the analytical methods is that a single, deterministic spill scenario is evaluated, instead of an ensemble of all 100 stochastic runs. This weakness is justified if the primary metric of concern is shoreline oiling, since the simulation with the worst shoreline oiling is the one that was selected for

RESPONSE TO CHARGE QUESTIONS	
Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.3	*Are there strengths or weaknesses of the analytical methods used for the modeling?*
Dr. Scott Socolofsky, continued	the deterministic modeling. As mentioned above under Question 1.4, the lack of data for oil droplet size distributions at large scale and more importantly, the effectiveness of SSDI at large scale, increase the uncertainty in the results for SSDI presented in the present report. It is very likely, and indeed was evidenced during the Deepwater Horizon accident, that SSDI is an effective response tool. However, the fraction of oil removed by SSDI is uncertain since there is limited data at sufficient scale to test SSDI effectiveness at field scale. It is wholly possible that SSDI is even more effective than was simulated here, especially if DOR levels of 1:100 are achieved with 100% mixing into the discharge. The review report should discuss the lack of validation data at the appropriate field scale.

RESPONSE TO CHARGE QUESTIONS	
Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.4	*Are the conclusions drawn from the oil spill response capabilities analysis logical and appropriate based on the modeling results?*
Dr. Jerry Galt	The general distribution and timing of the forecasts developed by this project seem reasonable. From the documentation, the details of thickness values are questionable and await a more complete explanation. A mass balance of the thick to thin portions of the developing plume would be interesting. Maybe it is hidden somewhere in the report and I just missed it.
Mr. Gary Ott	• The 9 scenarios modeled provided a capacity to recognize which of the countermeasures tools would be the most successful, by location, in reducing WCD exposures. • Capability analysis by equipment and modeling experts was logical and appropriate helping to identify these kinds of critical findings: o Response countermeasures employed against an overwhelming WCD have limited success. (example DWH base line: dispersant 8%, ISB 5%, mechanical 4%, p.237-239) o Source control has the most significant impact in reducing WCD exposures p.xii o Surface and to a larger degree subsurface dispersant reduce oiling more than mechanical p.235 o Use of subsurface dispersant injection is a powerful response option p.xxii, xvi o Increasing mechanical equipment resources does not (necessarily)

RESPONSE TO CHARGE QUESTIONS	
Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.4	*Are the conclusions drawn from the oil spill response capabilities analysis logical and appropriate based on the modeling results?*
Mr. Gary Ott, continued	reduce shoreline oiling p.235 o Sufficient dispersant stockpiles are not available p.292, 293 Planning values for how much and how fast various countermeasures should be on-scene are highlighted in tables 104-115, p.289-302. These recommendations were based on critical partnerships with expert analysis of detailed countermeasures capabilities/ limitations and detailed equipment/ oil spill modeling. This collaboration met the report's root objectives and the foundation for the report's technical merit.
Dr. Scott Socolofsky	For the most part, the analysis of each modeling scenario presented in Chapter 2.0 of the report is logical and sound. There is one element of the analysis that may come across as confusing. For each scenario, there is a bar chart showing well flow, potential maximum removal and achieved removal broken out by removal method (see, e.g., Figure 15 for Scenario 1), there is a pie chart showing the fate of oil by the end of the simulation for each removal method (e.g., Figure 16 for Scenario 1), there is a table showing oil removal volumes and percentages based on different response capabilities (e.g., Table 21 for Scenario 1), and a paragraph summarizing the general behavior of the scenario, which begins on Page 41, first paragraph for Scenario 1. In many cases, the fraction removed by dispersants shown in the bar chart appears to be the largest fraction and does not always appear to agree with the fractions shown in the pie chart. Moreover, the summary paragraph for most of the methods states that, among other mechanisms, "mechanical recovery was the primary tool that removed oil." However, in many scenarios, the bar chart looks like dispersants removed more oil. This is the case, for instance in Scenario 1: the subsurface dispersant rubric of the achieved daily flow bar is the largest, yet the pie chart shows surface and subsurface dispersants only affected 7% of the oil; whereas, skimming removed 9%. The table and pie charts seem to agree and usually agree with the summary paragraph text. However, the bar charts always appear to show different fractions for the achieved removal, especially for dispersant. There is no error in the report: the bar chart presents mechanical recovering separated by type and the table and pie chart sum all mechanical recovering together. Nonetheless, this apparent contradiction, which occurs in most all of the scenarios, should be addressed in the text to remove the possibility of confusion.

RESPONSE TO CHARGE QUESTIONS		
Volume II–Oil Spill Response Equipment Capabilities Analysis		
2.5	*Are the recommendations logical, appropriate, and supported by the analysis and modeling results? The scope of the recommendations pertains to all recommendations, not just those derived from the modeling results.*	
Dr. Jerry Galt	The recommendations seem to be overlapping and unduly complicated. The following comments are presented for consideration: 1) EDRC based on pump rate does not make sense so a migration towards ERSP seems in order. 2) Time honored response activities that have proved effective in the past, such as: extended duration capability with personnel and equipment, overflight guidance of collection and response platforms, pollutant tracking and mapping, effective information integration with a Unified Command; should all be considered as part of the recommendations.	
Mr. Gary Ott	***Objectives:***	Recommendations should be based on assumed root objectives: • Best planning (strategic, command/control/communications, logistical) practices that can improve response readiness. Operational best practices that maximize countermeasures effectiveness: **source control, dispersant, mechanical, ISB.**
	6.1.1. Oil Characterization	Met objectives
	6.1.2 Modeling, CONOPS, COP	• Best practices that were outlined met objectives by increasing situational awareness for what-is-possible. • Best practices that optimize effectiveness of countermeasures (oil moves, spreads, changes viscosity, water content, thickness) were listed. • Access to “good” oil (best properties for recovery) by competing countermeasures would be improved by use of recommended management controls. Best practices that would also increase situational awareness - understanding and communicating the scale of what-is-not-possible - should also be considered.
	6.1.3. Temporary Source Control Capabilities	• **Success Objective:** One of the report’s critical findings is that the response’s priority should be the prompt implementation of source control. (p.282, xii) • NAT 7 outlines dramatic reduction in shoreline impact by implementation of source control, Nat 8

RESPONSE TO CHARGE QUESTIONS		
Volume II–Oil Spill Response Equipment Capabilities Analysis		
2.5	*Are the recommendations logical, appropriate, and supported by the analysis and modeling results? The scope of the recommendations pertains to all recommendations, not just those derived from the modeling results.*	
Mr. Gary Ott, continued		requires sustained response resources, Nat 9 requires effective source control plan coordination with OSRP, and Nat 10 requires coordination between subsurface and surface activities. These prescriptive best practices meet report's objectives.
	6.1.4. Resource Readiness and Mobilization Time Factors	Met objectives
	6.1.5. Oil Spill Tracking and Surveillance Capabilities	Met objectives
	6.1.6. Mechanical Recovery Capabilities	Met objectives
	6.1.7. Dispersant Stockpile Requirements	Met objectives
	6.1.8. In-situ Burning Capabilities	Met objectives
	6.1.9. Offshore Response Logistics Recommendations	Met objectives
	Site Specific Recommendations	
	Gulf	
	6.2.1 RCP and ACP Recommendations	Met objectives
	6.2.2 Surface-Applied Dispersant Capability Recommendations	Given: Region IV and VI RRTs have **pre-approved surface** dispersant use >3nm with the caveat that "mechanical recovery is the preferred oil spill response option." p.25
	Pacific	
	6.3.1 Mechanical Recovery Recommendations	Met objectives
	6.3.2 Surface-Applied Dispersant Capability Recommendations	Given: Region IX RRT has **pre-approved surface** dispersants use >3nm except for areas within the National Marine Sanctuaries or within 3nm of the Mexico border or Oregon State boundary. p.141
	6.3.3 In-situ Burning Recommendations	Met objectives
	Arctic	

<table>
<tr><th colspan="2">RESPONSE TO CHARGE QUESTIONS</th></tr>
<tr><td colspan="2"><i>Volume II–Oil Spill Response Equipment Capabilities Analysis</i></td></tr>
<tr><td>2.5</td><td><i>Are the recommendations logical, appropriate, and supported by the analysis and modeling results? The scope of the recommendations pertains to all recommendations, not just those derived from the modeling results.</i></td></tr>
<tr><td><i>Mr. Gary Ott, continued</i></td><td><table>
<tr><td>6.4.1 RCP and ACP Recommendations</td><td>Met objectives</td></tr>
<tr><td>6.4.2 OSRP Review Recommendations</td><td>Met objectives</td></tr>
<tr><td>6.4.3 Dispersant Capability Recommendations</td><td>Given: Dispersants are not pre-approved. p.160</td></tr>
</table></td></tr>
<tr><td><i>Dr. Scott Socolofsky</i></td><td>The recommendations appear to be comprehensive, covering all possible requirements that might be chosen by BSEE. The rationale for including each recommendation seems to be supported by the modeling and the analysis. A few exceptions are noted below in the Specific Observations section. It is not clear that interactions among recommendations has been considered--an optimum set of recommendations may include a subset of all recommendations listed in Chapter 6.0.

The report points out that plan holders will be affected if the recovery rates of their equipment is reduced by switching to the Estimated Recovery System Potential (ERSP). This is true if the required capacity is not adjusted. But since the current required capacity is based on the higher Effective Daily Recovery Capacity (EDRC), it is logical to consider reducing the required capacity to align with the new ERSP metric. Thus, requirements should match an equivalent capacity between the two measures. Chapter 6.0 brings out this possibility. The Executive Summary does not.

One element of the recommendations in general that should be considered is how these recommendations may interact with the USCG and NOAA forecasters during a spill event. For example, the permit holder may be required to have a real-time oil spill tracking model and to make forecasts that set response zones. This is currently the responsibility of the NOAA Office of Response and Restoration, which uses the General NOAA Operational Modeling Environment (GNOME). There is no mention of GNOME or NOAA forecasts in this section.

The following comments address specific NATs:

NAT 1: The properties included in the list should be coordinated with NOAA, who maintains an oil properties database. Ideally, the inputs to the NOAA database and forecast models should be included in this list. Also, GC/MS measurements will not be available for exploration wells and may not be estimable.

NAT 2: Why should deterministic trajectory modeling be used to establish the</td></tr>
</table>

RESPONSE TO CHARGE QUESTIONS	
Volume II–Oil Spill Response Equipment Capabilities Analysis	
2.5	*Are the recommendations logical, appropriate, and supported by the analysis and modeling results? The scope of the recommendations pertains to all recommendations, not just those derived from the modeling results.*
Dr. Scott Socolofsky, continued	CONOPS? Stochastic modeling at the planning stage should be used. During a spill, NOAA uses stochastic ensemble modeling to predict most likely oil trajectories. Do not close the door on stochastic or probabilistic modeling. See, for example, Figure 153. The light-gray hashed region is mostly to the east and does not extend offshore. This region was developed for one deterministic scenario. During Deepwater Horizon, this region would have been much more to the west. Depending on the look current, it could also have covered the deep Gulf of Mexico. Stochastic modeling should be applied to determine the locations of these regions during the planning stage. NAT 14: NOAA OR&R is charged with providing this data to the USCG in the event of a spill. How this requirement should integrate with NOAA should be considered in the report. NAT 37: This recommendation agrees with my summary statement above. Improved guidance should include additional experimental modeling. Assuming that is either cost prohibitive or impossible given the need to environmental permits, write a regulation that would allow the responsible party for the next spill to test different DORs and demonstrate a minimum DOR that satisfies their SSDI objective. Unless nearly full-scale experiments can be conducted, there is not a very good basis to specify DORs using present available data.

4.3 Specific Observations

SPECIFIC OBSERVATIONS			
NAME: Dr. Jerry Galt			
Provide specific observations or comments on the report mentioning page and paragraph.			
Volume	***Page***	***Paragraph***	***Comment or Question***
Volume I–Worst Case Discharge Analysis (Task 1)			
Dr. Jerry Galt			None Provided
Volume II–Oil Spill Response Equipment Capabilities Analysis (Task 2)			
Dr. Jerry Galt	289-291	NAT 25	The tables on this page and the ones that follow relating to response times and stockpiles of available supplies are presented as being the result of detailed analysis based on the rest of the report, but there does not seem to be any discussion about how their details were derived. The comment that local environmental conditions are likely to be determinative seems logical and once again suggests that model ensembles based on regional climatology might be appropriate.

SPECIFIC OBSERVATIONS			
NAME: Mr. Gary Ott			
Provide specific observations or comments on the report mentioning page and paragraph.			
Volume	***Page***	***Paragraph***	***Comment or Question***
Volume I–Worst Case Discharge Analysis (Task 1)			
Mr. Gary Ott			None Provided
Volume II–Oil Spill Response Equipment Capabilities Analysis (Task 2)			
Mr. Gary Ott	Scattered within Volume II are a number of critical findings. These findings might be highlighted because they provided a foundation for modeling and recommendations evaluation.		
	237-259		Response countermeasures, when employed against an overwhelming WCD, have limited success.
	243,256		DWH: 4% mechanical recovery
	248		DWH: 5% ISB
	258		DWH: 8% dispersant
	xii, 282		…modeling…strong evidence… most significant impact in reducing oil release is prompt implementation of source control…
	xxii, xvi		Use of subsurface dispersant injection is powerful response option significantly reduces amount of oil stranded on shorelines is supported

SPECIFIC OBSERVATIONS			
NAME: Mr. Gary Ott			
Provide specific observations or comments on the report mentioning page and paragraph.			
Volume	***Page***	***Paragraph***	***Comment or Question***
Mr. Gary Ott (Volume II), continued			by modeling results.
	235		Use of surface and to a larger degree subsea dispersants reduced oiling more than was achieved through additional mechanical equipment.
	235		Increasing mechanical equipment resources does not (necessarily) reduce shoreline oiling.
	292, 293		Sufficient dispersants stockpiles are not sufficient for long duration, high volume/ maximum effort use when subsea and surface dispersants are being applied simultaneously.

SPECIFIC OBSERVATIONS			
NAME: Dr. Scott Socolofsky			
Provide specific observations or comments on the report, mentioning page and paragraph.			
Volume	***Page***	***Paragraph***	***Comment or Question***
Volume I–Worst Case Discharge Analysis (Task 1)			
Dr. Scott Socolofsky	7	1	Typo: MC 157 should be MC 252.
	9	Table 4 and Footnote 37	Flow rate range in the table (28,800-35,000) is not consistent with that in the footnote (62,000 to 53,000). Are the table ranges in error or reduced by the amount of capture? The footnote ranges are the reservoir flow rates.
	15	4	Add the oil and gas composition, the ambient stratification profile, and, if applicable, the ambient currents to the list of model inputs to OILMAPDeep.
	16	2	State here whether SIMAP included oil dissolution. Also, state explicitly that fate processes were modeled during subsurface transport and on the sea surface.
	16	2	"decay rate is typically higher in warm water environments…" A surprising observation during Deepwater Horizon is that biodegradation rates were high in the deep, cold, subsurface plume. It may not be universally accepted that temperature is the most important factor in determining biodegradation rates. Pressure and species adaptation are also critical.
	22	4	Somewhere near this point in the report, the text

SPECIFIC OBSERVATIONS			
NAME: Dr. Scott Socolofsky			
Provide specific observations or comments on the report, mentioning page and paragraph.			
Volume	***Page***	***Paragraph***	***Comment or Question***
Dr. Scott Socolofsky (Volume I), continued			should state what velocity data for the ocean currents and winds were used. These are only mentioned in the appendices; they should also be cited in the report text.
	114	Figure 78	What happens at day 4 to dramatically change the weathering behavior of this instantaneous release simulation? The results are unusual and warrant explanation in the text.
	117	1	Include a summary in the text of the amount of oil that was bound to ice.
Volume II–Oil Spill Response Equipment Capabilities Analysis (Task 2)			
Dr. Scott Socolofsky	viii	1	"Deepwater Horizon spill response over [?]," insert the number of days of the spill?
	ix	Table ES 2	Provide the units for values in this table. If unitless, state so in the caption.
	xiv	Bulleted list	Should satellites be included in this list?
	xviii	4	There is a lot of effort in this review to prescribe mechanical recovery response quantities and times. Yet, the plan holder will want to minimize their environmental impact during a spill and will likely naturally maximize their recovery capability.
	1	5	"Dispersants applied to the subsurface [may] have the same…" Insert qualifier. Now that SSDI is a known technology, new dispersants may be designed that are specifically tailored to the high-pressure, hot, live oil exiting the wellhead at a blowout. These would not be the same as surface-applied dispersants in the future.
	71	2	"No subsurface dispersants…" Somewhere the report should explain the criteria for which subsea dispersants are applied and the rationale. Since SSDI localizes dispersant application, it should not matter whether the oil reaches the sea surface or not; hence, one might expect SSDI to be used in shallow water accidents.
	84ff	--	Scenario 4 shows large amounts of oil impacting the Flower Gardens Banks National Marine Sanctuary. Should this fact be discussed in the review document? Should special counter-measures in such cases be considered?

SPECIFIC OBSERVATIONS			
NAME: Dr. Scott Socolofsky			
Provide specific observations or comments on the report, mentioning page and paragraph.			
Volume	***Page***	***Paragraph***	***Comment or Question***
Dr. Scott Socolofsky (Volume II), continued	237	4	It is surprising that the amount collected by skimmers during the Deepwater Horizon was not measured. This capability is added to the recommendations. It is important going forward that skimmers report the amount of oil collected.
	246	2	“subsurface dispersants also served as a means to reduce VOC emissions.” The text should probably state by what mechanism: VOCs were probably reduced because they were dissolved into the water column before the fresh oil surfaced. They may also have been reduced by slowing the rate of ascent so that fresh oil surfaced away from the response zone. This effect may not occur in a shallow blowout, where VOCs have inadequate time to dissolve and surface near the response zone. Nonetheless, SSDI might be desirable for the shallow release to aid in oil dispersal after surfacing.
	270	Table 95	GC/MS characterization will not be known during exploration. Also, in the last row, allow the plan holder to test a range of dispersants instead of a selected one.
	270	bullet 5	Three-dimensional models may not be required for the nearfield plume. There are acceptable zero-dimensional correlation equations. Also, the nearfield plume modeling done using OILMAPDeep for the Deepwater Horizon NRDA what two-dimensional (currents were not considered, so the plume rose vertically upward). The SIMAP side of the model (far field) needs to be three-dimensional. This casual bullet needs to be refined and made specific.
	278	2	“if regulatory requirements for capability levels are to remain the same.” Presumably, regulatory requirements have been calibrated to the higher EDRC metric. It is natural and logical that regulatory requirements should go down when compared to the lower and more realistic ERSP.
	290	4	ERSP thresholds should be significantly greater than the WCD. This is not supported by the modeling. ERSP are already lower than EDRC

SPECIFIC OBSERVATIONS			
NAME: Dr. Scott Socolofsky			
Provide specific observations or comments on the report, mentioning page and paragraph.			
Volume	***Page***	***Paragraph***	***Comment or Question***
Dr. Scott Socolofsky (Volume II), continued			values. The modeling showed that present removal capability is not maximized due to limitations of daylight and weather (already summarized on page 290 in paragraph 2). Requiring a significantly higher capacity for removal than present is not consistent with this conclusion of the modeling.

5. APPENDIX A: INDIVIDUAL REVIEWER COMMENTS

This appendix provides the individual peer reviewers' comments. Any peer review comments that were identified by BSEE as out-of-scope for this peer review (see Section 1.3) were not included in this peer review summary report.

5.1 Dr. Jerry Galt

Oil Spill Response Plan Equipment Capabilities Review,* consisting of Volume I–*Worst Case Discharge Analysis* and Volume II–*Oil Spill Response Equipment Capabilities Analysis.	
NAME: Dr. Jerry Galt	
AFFILIATION: Genwest Systems, Inc.	
DATE: October 25, 2016	
GENERAL IMPRESSIONS	
Provide overall impressions (approximately one page in length, or longer as needed) addressing the accuracy of information presented, clarity of presentation, and soundness of conclusions.	
Comments:	It seems that the conclusions presented in these two volumes are essentially built around a set of quite complex models and algorithms. It is not obvious that the complexity of the components is justified and many of the conclusions attributed to "the model" are in fact little more than what an experienced spill responder would consider as common knowledge. The models probably do not give obvious erroneous results. More of an issue for the veracity of the overall report conclusions is that the plume rise and trajectory models are combinations of dozens of individual algorithms, which require parametric inputs each of which introduce some degree of uncertainty, which is then linked together in a chain of logic propagating uncertainties into a final compound uncertainty. As a result, I do not believe anyone really knows, for example, what "skill levels" to expect from SIMAP, or how rapidly its information content degrades with time, and ultimately how soon "data assimilation" would be required to restore confidence. I should be quick to point out that this is not a problem that is unique to SIMAP, but is found with all complex geophysical models. Therefore, virtually all operational geophysical fluid dynamics transport models and trajectory models have data assimilation components. A complex model used in a purely planning mode may not have the advantage of a reality check in the form of available assimilation data, but this can't be used as a dodge for ignoring cumulative uncertainty. As a final general point, the veracity of the models used should at least move in a central tendency towards the right answer (possibly subject to chaotic sensitivity to initial conditions). The statistics of the ensemble use of such models then totally depends on the climatology or "situation space" used to initialize model runs. A short coming of this report is that there is virtually no discussion of the sample space in which the models operate. 100 scenarios are run, but whether these span the expected cardinality of the environmental driving parameters is not discussed and should be. This problem applies to all

Oil Spill Response Plan Equipment Capabilities Review,* consisting of Volume I–*Worst Case Discharge Analysis* and Volume II–*Oil Spill Response Equipment Capabilities Analysis.	
NAME: Dr. Jerry Galt	
	of the basic regions covered by the report and the researchers with the experience of the principles should have something to say about this.
RESPONSE TO CHARGE QUESTIONS	
Task 1. Worst Case Discharge Analysis (Volume I)	
Provide narrative responses to each of the five Charge Questions below.	
1.1	*Were the Worst Case Discharge (WCD) sites selected for analysis a valid sample to evaluate the probabilities and scope of oil contacting the environment in each region?*
Comments:	Given the size of the regions and the general circulation scales of each the answer is a qualified yes, but in each of the studied regions there are smaller scale circulation features and it is not shown in the report that the underlying geophysical flow models resolve the details. In particular, features that have proved important in historical spills include: Central Gulf: Details of the Mississippi Delta freshwater outflow and mixing close to the delta are intricate. Western Gulf: A near shore low salinity frontal interface caused by fresh water run off typically extends from the Atchafalalaya, past Calacsieu to Galveston. This results in a convergence band that traps floating pollutants and may locally off set trajectories tens of miles to the west. Santa Barbara Channel: Here the details associated with the eddy structure in the Santa Barbara channel itself and the directional shifts associated with the California Current vs. the Davidson Current periods are at issue. In the Chukchi and Beaufort regions details of the ice cover circulation and banded currents found along the North Slope will certainly degrade the veracity of the forecasts. The report does not seem to discuss the underlying hydrodynamics directly. I do not think general references provide enough understanding.
1.2	*Are the limitations and uncertainties clearly identified and adequately characterized for the oil plume, fate and effects, and transport mechanisms used in the stochastic trajectory modeling? Please note that the impact of a WCD is not a probable impact, or representative of risk; but the largest volume possible from an uncontrolled blowout (30 CFR 257.47 (b)), a very unlikely and low probability scenario.*
Comments:	Given the fact that SIMAP has a strong historical development to cover actual damage functions, for this study, its algorithms are encumbered with many unused parametric algorithms and may introduce more complexity to this study than is necessary. Any number of simple particle tracking models

Oil Spill Response Plan Equipment Capabilities Review,* consisting of Volume I–*Worst Case Discharge Analysis* and Volume II–*Oil Spill Response Equipment Capabilities Analysis.	
NAME: Dr. Jerry Galt	
	might work as well. With all that said, the process that the investigators used to zero in on each regions “largest credible release” make sense and their proposed scenarios seem appropriate for this study.
1.3	*Are the assumptions of the modeling clearly defined and appropriate?*
Comments:	The modeling assumptions are generally clear and well stated, with one notable exception. The model tracks “spillets” to obtain “areas painted by an ensemble of spills” and minimum “travel times”. This is, as I understand it, binary raster data in terms of area and minimum time raster data for time. Multiple hits in the first field will not change the answer. This obviously works fine with Lagrangian particles given coordinate data. The answers are somewhat dependent on raster size, but using smoothing that conserves mass will usually result in contourable results. In another context, the thickness of the floating or beached oil is presented. This is Eulerian field data and is dimensionally (mass/area) and should be calculated from the aggregated Lagrangian particles and possibly corrected for individual “spillet” spreading. This is a mathematically tricky operation and the investigators present no clues that I found about how they do it. This is a persistent shortcoming throughout the report.
1.4	*Are there strengths or weaknesses of the analytical methods used for the modeling?*
Comments:	The strength of the analytical methods used in the projects modeling is absolutely dependent on whether the ensemble set of “situation space “elements used to initialize scenarios spans a realistic climatology and how long the models can run before their information content is degraded to the point where data assimilation is required. These kinds of considerations don't seem to be covered in the report and should be discussed.
1.5	*Do the modeling results describe with reasonable accuracy the probability, scope and minimum travel times for oil to potentially contact the environment in the event of a WCD for the selected scenarios?*
Comments:	The oil hit, or cumulative spill foot print (independent of an estimate of quantitative values) and minimum time of travel raster data are likely to be some of the strongest output from the study since these fields are determined by the time dependent particle position information. Lagrangian models

Oil Spill Response Plan Equipment Capabilities Review, **consisting of Volume I–*Worst Case Discharge Analysis* and Volume II–*Oil Spill Response Equipment Capabilities Analysis.***	
NAME: Dr. Jerry Galt	
	provide this as primitive data. This kind of forecast is inherently stronger than derived information such as Eulerian density fields. However, it should once again be emphasized that the comments in 1.4 above certainly apply to these fields and that a poor choice of initial ensemble states will compromise all the model results.
Task 2. Oil Spill Response Equipment Capabilities Analysis (Volume II)	
Provide narrative responses to each of the five Charge Questions below.	
2.1	*Are the limitations and uncertainties clearly identified and adequately characterized for the deterministic trajectory and response countermeasure modeling?*
Comments:	There are two problem areas where this report is vague about quantifying uncertainties: The first is due to the cumulative compound propagation of uncertainty and chaotic processes in the complex models that are not subject to any feedback in the form of data assimilation. The second is due to the uncertainly of the cardinality of the ensemble "situation space" used to form the run scenarios. In a planning formulation, it may not be possible to completely remove these, but they certainly could be more formally addressed. There is a consistent lack of explaining the statistical assumptions used to support report conclusions.
2.2	*Are the assumptions of the modeling in Volume II clearly defined and appropriate? Assumptions evaluated should include, but are not limited to:* *a) Fate and transport of the oil* *b) Application of temporary source control measures* *c) Application of spill response countermeasures.*
Comments:	The weathering of the oil is important when using the ERSP calculator because it is fundamentally based on encounter rate, which will in turn depend on thickness and water content, and secondarily on viscosity. The ERSP calculator uses default daily values, but an earlier version (ROC) included a weathering model. SIMAP also includes an oil weathering model and an unknown Eulerian to Lagrangian transformation. The documentation presented does not explain what combination of these algorithms are used in the analysis.
2.3	*Are there strengths or weaknesses of the analytical methods used for the modeling?*
Comments:	See the comments from section 2.1 above. It seems to me that the models used are unnecessarily complex. They are dependent on dozens of parametric settings, many of which are not related to the problem at hand. This does not make them wrong, but does cloak the

Oil Spill Response Plan Equipment Capabilities Review,* consisting of Volume I–*Worst Case Discharge Analysis* and Volume II–*Oil Spill Response Equipment Capabilities Analysis.	
NAME: Dr. Jerry Galt	
	answers in additional levels of uncertainty. The use of the ERSP calculator (with or without) set predetermined oil thickness “daily” values offers a strong advantage to input local environmental data, such as hours of day light, statistical wind rose data, etc.
2.4	*Are the conclusions drawn from the oil spill response capabilities analysis logical and appropriate based on the modeling results?*
Comments:	The general distribution and timing of the forecasts developed by this project seem reasonable. From the documentation, the details of thickness values are questionable and await a more complete explanation. A mass balance of the thick to thin portions of the developing plume would be interesting. Maybe it is hidden somewhere in the report and I just missed it.
2.5	*Are the recommendations logical, appropriate, and supported by the analysis and modeling results? The scope of the recommendations pertains to all recommendations, not just those derived from the modeling results.*
Comments:	The recommendations seem to be overlapping and unduly complicated. The following comments are presented for consideration: 1) EDRC based on pump rate does not make sense so a migration towards ERSP seems in order. 2) Time honored response activities that have proved effective in the past, such as: extended duration capability with personnel and equipment, overflight guidance of collection and response platforms, pollutant tracking and mapping, effective information integration with a Unified Command; should all be considered as part of the recommendations.

SPECIFIC OBSERVATIONS			
Task 1. Worst Case Discharge Analysis (Volume I)			
Provide specific observations or comments on Volume 1 of the study, mentioning page and paragraph (expand table if needed).			
	Page	***Paragraph***	***Comment or Question***
			None Provided
Task 2. Oil Spill Response Equipment Capabilities Analysis (Volume II)			
Provide specific observations or comments on Volume II of the study, mentioning page and paragraph (expand table if needed).			
	Page	***Paragraph***	***Comment or Question***
	289-291	NAT 25	The tables on this page and the ones that follow relating to response times and stockpiles of available supplies are presented as being the

Oil Spill Response Plan Equipment Capabilities Review,* consisting of Volume I–*Worst Case Discharge Analysis* and Volume II–*Oil Spill Response Equipment Capabilities Analysis.			
NAME: Dr. Jerry Galt			
			result of detailed analysis based on the rest of the report, but there does not seem to be any discussion about how there details were derived. The comment that local environmental conditions are likely to be determinative seems logical and once again suggests that model ensembles based on regional climatology might be appropriate.

5.2 Mr. Gary Ott

Oil Spill Response Plan Equipment Capabilities Review,* consisting of Volume I–*Worst Case Discharge Analysis* and Volume II–*Oil Spill Response Equipment Capabilities Analysis.	
NAME: Mr. Gary Ott	
AFFILIATION: NOAA Office of Response and Restoration (retired)	
DATE: October 30, 2016	
GENERAL IMPRESSIONS	
Provide overall impressions (approximately one page in length, or longer as needed) addressing the accuracy of information presented, clarity of presentation, and soundness of conclusions.	
Comments:	**Root Objectives /Tasks Assumed for this Report** No listing for objectives/tasks was provided. Based on comments in the report, my review is based on these working objective/task assumptions. Volume I: Illustrate the overall scale of Worst Case Discharge (WCDs) releases from representative well locations – Gulf, Pacific, Arctic. Volume II: Identified for each countermeasure **– source control, dispersants, ISB, mechanical –** potential in reducing shoreline exposures using these assumed objectives: • Best planning (strategic, command/control/communications, logistical) practices that can improve response readiness. • Operational best practices maximize countermeasures effectiveness. **Critical Findings of this Report:** Scattered within Volume II are a number of critical findings. These critical findings, which I believe to be true, were my foundation for reviewing modeling and recommendations. They are listed by page number at part III SPECIFIC OBSERVATIONS. **Technical Confidence:** What's certain, countermeasures, when employed against an overwhelming WCD, have limited success (p.259). When planning for an overwhelming WCD, what's not certain (some examples) WCD volumes, site locations, oil types, droplet sizes, countermeasures capabilities/ availabilities, weather/ sea state/ tides, and crew availabilities. For each of these many uncertainties, planners must make choices based on where they have technical confidence, i.e., countermeasures and modeling experts know equipment and modeling capabilities / limitations. • WCD planner's choices and their recommendations, based on their technical competence, make sense for how much and how fast various countermeasures should be on-scene (tables 104-115 p.289-302).
RESPONSE TO CHARGE QUESTIONS	
Task 1. Worst Case Discharge Analysis (Volume I)	
Provide narrative responses to each of the five Charge Questions below.	
1.1	*Were the Worst Case Discharge (WCD) sites selected for analysis a valid sample to evaluate the probabilities and scope of oil contacting the*

Oil Spill Response Plan Equipment Capabilities Review,* consisting of Volume I–*Worst Case Discharge Analysis* and Volume II–*Oil Spill Response Equipment Capabilities Analysis.	
NAME: Mr. Gary Ott	
	environment in each region?
Comments:	Sites selected representing near-shore, offshore, open-ocean (in each planning region) and largest potential release make sense. In the Pacific, the site selected impacting the Santa Barbara Channel would be the worst case. The Alaska sites in two regions are given.

1.2	*Are the limitations and uncertainties clearly identified and adequately characterized for the oil plume, fate and effects, and transport mechanisms used in the stochastic trajectory modeling? Please note that the impact of a WCD is not a probable impact, or representative of risk; but the largest volume possible from an uncontrolled blowout (30 CFR 257.47 (b)), a very unlikely and low probability scenario.*
Comments:	By definition, the models used in this report are presumed correct when used as part of a formal NRDA Type A process. Reasonable range of accuracies, limitations, uncertainties, assumptions, strengths and weakness are presumed acceptable. Citations listing multiple technical reviews of these models used by the 1) ongoing DWH damage assessment process and 2) the NRDA Type A model are available.

1.3	*Are the assumptions of the modeling clearly defined and appropriate?*
Comments:	Yes. See above.

1.4	*Are there strengths or weaknesses of the analytical methods used for the modeling?*
Comments:	Yes. See above.

1.5	*Do the modeling results describe with reasonable accuracy the probability, scope and minimum travel times for oil to potentially contact the environment in the event of a WCD for the selected scenarios?*
Comments:	The validated models used in this study have benefited from lessons learned during DWH and their results, accuracy, probability and scope of travel times to potential contact with the environment would be the best available estimate.
Task 2. Oil Spill Response Equipment Capabilities Analysis (Volume II)	
Provide narrative responses to each of the five Charge Questions below.	
2.1	*Are the limitations and uncertainties clearly identified and adequately characterized for the deterministic trajectory and response countermeasure modeling?*
Comments:	Response countermeasures modeling: Validated approaches – ERSP, ReSET, EDSP, and EBSP Calculators - and expert's input on variables such as environmental conditions, met the Report's objectives in evaluation of how much each countermeasure would reduce WCD exposures.

Oil Spill Response Plan Equipment Capabilities Review, **consisting of Volume I–*Worst Case Discharge Analysis* and Volume II–*Oil Spill Response Equipment Capabilities Analysis.***	
NAME: Mr. Gary Ott	
2.2	*Are the assumptions of the modeling in Volume II clearly defined and appropriate? Assumptions evaluated should include, but are not limited to:* *a) Fate and transport of the oil* *b) Application of temporary source control measures* *c) Application of spill response countermeasures.*
Comments:	Assumptions documented by experienced experts in countermeasures met objectives: • Fate and transport: expert stochastic models provided reasonable oil thickness and viscosity thresholds used to determine suitability for mechanical, ISB, or dispersant applications. p.8 • Source control: availability, time 15-45 days p.xii, p.282, p.283, p.254 • Countermeasures: ○ Mechanical: equipment availability, time travel, recovery and storage capabilities, night / fog / wind / weather limitations, access to suitable oil (within range of age, viscosity, debris) p.15 ○ ISB: fire-proof boom availability, supporting towing systems, air monitoring requirements, weather limitations, access to suitable oil p.19 ○ Dispersant: approved dispersant availability, supporting towing or subsea application systems, weather limitations, access to suitable oil. p.18
2.3	*Are there strengths or weaknesses of the analytical methods used for the modeling?*
Comments:	• Strength: Validated approaches – ERSP, ReSET, EDSP, and EBSP Calculators - and expert's input on variables such as environmental conditions, met objectives for how much each countermeasure would reduce WCD exposures. • Weakness: Methods assume no mechanical breakdowns or aircraft/equipment/crew/weather limitations.
2.4	*Are the conclusions drawn from the oil spill response capabilities analysis logical and appropriate based on the modeling results?*
Comments:	• The 9 scenarios modeled provided a capacity to recognize which of the countermeasures tools would be the most successful, by location, in reducing WCD exposures. • Capability analysis by equipment and modeling experts was logical and appropriate helping to identify these kinds of critical findings: ○ Response countermeasures employed against an overwhelming WCD have limited success. (example DWH base line: dispersant 8%, ISB 5%, mechanical 4%, p.237-239)

Oil Spill Response Plan Equipment Capabilities Review,* consisting of Volume I–*Worst Case Discharge Analysis* and Volume II–*Oil Spill Response Equipment Capabilities Analysis.	
NAME: Mr. Gary Ott	
	○ Source control has the most significant impact in reducing WCD exposures p.xii ○ Surface and to a larger degree subsurface dispersant reduce oiling more than mechanical p.235 ○ Use of subsurface dispersant injection is a powerful response option p.xxii, xvi ○ Increasing mechanical equipment resources does not (necessarily) reduce shoreline oiling p.235 ○ Sufficient dispersant stockpiles are not available p.292, 293 Planning values for how much and how fast various countermeasures should be on-scene are highlighted in tables 104-115, p.289-302. These recommendations were based on critical partnerships with expert analysis of detailed countermeasures capabilities/ limitations and detailed equipment/ oil spill modeling. This collaboration met the report’s root objectives and the foundation for the report’s technical merit.
2.5	*Are the recommendations logical, appropriate, and supported by the analysis and modeling results? The scope of the recommendations pertains to all recommendations, not just those derived from the modeling results.*
Objectives:	Recommendations should be based on assumed root objectives: • Best planning (strategic, command/control/communications, logistical) practices that can improve response readiness. Operational best practices that maximize countermeasures effectiveness: **source control, dispersant, mechanical, ISB.**
6.1.1. Oil Characterization	Met objectives
6.1.2 Modeling, CONOPS, COP	• Best practices that were outlined met objectives by increasing situational awareness for what-is-possible. • Best practices that optimize effectiveness of countermeasures (oil moves, spreads, changes viscosity, water content, thickness) were listed. • Access to “good” oil (best properties for recovery) by competing countermeasures would be improved by use of recommended management controls. Best practices that would also increase situational awareness - understanding and communicating the scale of what-is-not-possible - should also be considered.
6.1.3. Temporary Source Control Capabilities	• **Success Objective:** One of the report’s critical findings is that the response’s priority should be the prompt implementation of source control. (p.282, xii) • NAT 7 outlines dramatic reduction in shoreline impact by implementation of source control, Nat 8 requires sustained response resources, Nat 9 requires effective source control plan coordination with OSRP, and Nat 10

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	requires coordination between subsurface and surface activities. These prescriptive best practices meet report's objectives.
6.1.4. Resource Readiness and Mobilization Time Factors	Met objectives
6.1.5. Oil Spill Tracking and Surveillance Capabilities	Met objectives
6.1.6. Mechanical Recovery Capabilities	Met objectives
6.1.7. Dispersant Stockpile Requirements	Met objectives
6.1.8. In-situ Burning Capabilities	Met objectives
6.1.9. Offshore Response Logistics Recommend-ations	Met objectives
Site Specific Recommendations	
Gulf	
6.2.1 RCP and ACP Recommend-ations	Met objectives
6.2.2 Surface-Applied Dispersant Capability Recommend-ations	Given: Region IV and VI RRTs have **pre-approved surface** dispersant use >3nm with the caveat that "mechanical recovery is the preferred oil spill response option." p.25
Pacific	
6.3.1 Mechanical Recovery Recommend-ations	Met objectives
6.3.2 Surface-Applied Dispersant Capability Recommend-ations	Given: Region IX RRT has **pre-approved surface** dispersants use >3nm except for areas within the National Marine Sanctuaries or within 3nm of the Mexico border or Oregon State boundary. p.141
6.3.3 In-situ	Met objectives

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Burning Recommendations	
Arctic	
6.4.1 RCP and ACP Recommendations	Met objectives
6.4.2 OSRP Review Recommendations	Met objectives
6.4.3 Dispersant Capability Recommendations	Given: Dispersants are **not pre-approved**. p.160

SPECIFIC OBSERVATIONS			
Task 1. Worst Case Discharge Analysis (Volume I)			
Provide specific observations or comments on Volume 1 of the study, mentioning page and paragraph (expand table if needed).			
	Page	***Paragraph***	***Comment or Question***
			None Provided
Task 2. Oil Spill Response Equipment Capabilities Analysis (Volume II)			
Provide specific observations or comments on Volume II of the study, mentioning page and paragraph (expand table if needed).			
	Page	***Paragraph***	***Comment or Question***
	Scattered within Volume II are a number of critical findings. These findings might be highlighted because they provided a foundation for modeling and recommendations evaluation.		
	237-259		Response countermeasures, when employed against an overwhelming WCD, have limited success.
	243,256		DWH: 4% mechanical recovery
	248		DWH: 5% ISB
	258		DWH: 8% dispersant
	xii, 282		…modeling…strong evidence… most significant impact in reducing oil release is prompt implementation of source control…
	xxii, xvi		Use of subsurface dispersant injection is powerful response option significantly reduces amount of oil stranded on shorelines is supported by modeling results.
	235		Use of surface and to a larger degree subsea

			dispersants reduced oiling more than was achieved through additional mechanical equipment.
	235		Increasing mechanical equipment resources does not (necessarily) reduce shoreline oiling.
	292, 293		Sufficient dispersants stockpiles are not sufficient for long duration, high volume/ maximum effort use when subsea and surface dispersants are being applied simultaneously.

5.3 Dr. Scott Socolofsky

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NAME: Dr. Scott Socolofsky	
AFFILIATION: Texas A&M University	
DATE: November 1, 2016	
GENERAL IMPRESSIONS	
Provide overall impressions (approximately one page in length, or longer as needed) addressing the accuracy of information presented, clarity of presentation, and soundness of conclusions.	
Comments:	The "Oil Spill Response Plan Equipment Capabilities Review" presents a major modeling exercise, supported by a significant collection of input data. The modeling system used in the review is a comprehensive oil spill modeling platform (OILMAPDeep and SIMAP) that simulates the buoyant plume rise in the near field of a blowout, through Lagrangian transport in the subsurface water column, and subsequent fate and transport on the sea surface. Both OILMAPDeep and SIMAP are industry standard simulation packages that have undergone many years of application, testing, and refinement. The Worst Case Discharge (WCD) scenarios are simulated using a multiple-ensembles approach (stochastic modeling) where the results of 100 deterministic spill simulations are analyzed to produce probabilistic maps of spill effects. 100 simulations is a modest number of simulations, which likely balances the competing needs of having a large number of simulations while completing the analysis in a reasonable amount of time. These simulations each have different environmental forcing, but all utilize the same model parameters for each WCD scenario. The environmental forcing is selected at random from a database of exiting weather and currents for each region. No attempt is made to ensure that the canonical variability of the climate in each region is sampled. Hence, these simulations represent plausible outcomes for spills during the period of the measured data and may not represent the full climate variability or the model uncertainty. One of the most important factors in the numerical modeling is the prediction of the initial oil droplet and gas bubble size distributions (DSD). Smaller oil droplets rise slower, allowing for greater subsurface transformation and wider dispersal. The simulations presented here likely use the DSD prediction equation developed by Applied Science Associates (ASA) for the Deepwater Horizon Natural Resource Damage Assessment (NRDA). This tool has been calibrated to a comprehensive set of available laboratory data. However, it is important to point out that no data are available for DSDs in the parameter space of a full-scale blowout, and no measurements were made of DSD near the Deepwater Horizon breakup region. Hence, one must trust that extrapolation from the present available laboratory data to the field scale is appropriate. This can only be verified by larger-scale experiments.

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The effect of the DSD model is most significant for evaluating the efficacy of subsea dispersant injection (SSDI) since SSDI is modeled in the simulations by adjusting the interfacial tension (IFT) between the oil and water and predicting a new DSD with this IFT. This is the current practice for predicting the effects of SSDI. If the DSD model over- or under-predicts the treated DSD, then the conclusions will over- or under-predict the efficacy of SSDI. The review of the Deepwater Horizon accident supports the conclusion that SSDI is an effective and important response strategy for accidental blowouts, and this conclusion is also supported by the present model simulations. Open questions that remain are: 1.) whether or not surface dispersant application will be needed once effective SSDI (i.e., 100% treatment at 1:100 DOR, which was not achieved during the Deepwater Horizon accident) is achieved and 2.) what the relative removal rates due to SSDI and mechanical removal will be during a future spill.

The deterministic model simulations in Vol. II all appear to overestimate the removal capability of mechanical removal and underestimate the rates of removal by in-situ burning when compared to estimates of removal rates during the Deepwater Horizon accident. This could be due to many complicating factors. One factor is that SIMAP tracks the available inventory for mechanical removal and burning and maps inventory to spill locations where oil of the appropriate state is located. This might overestimate the ability of mechanical recovery equipment to gain access to appropriate oil and also limits burning to the stockpile of available boom. Because burning boom is expensive, the pre-spill stock pile is smaller than might become available during a spill. These aspects of the modeling are important, since one of the final recommendations (NAT 25.1) appears to recommend that significantly greater oil recovery capacity may be required in the future than presently. This is somewhat confusing, especially given that simulations in section 2.4 demonstrated that adding recovery capacity quickly resulted in diminishing returns due to limitations of weather and daylight.

Finally, Section 6.0 of Vol. II provides a comprehensive list of recommendations that BSEE may consider including in future regulations. This list appears to be exhaustive and prescriptive. Among the various recommendations is the requirement for operators to be capable of real-time response modeling and forecasting in the event of a spill. This is currently the task of the NOAA Office of Response and Restoration. There ought to be a discussion about how the operator and NOAA forecasts might be reconciled and a justification for why the operator will be asked to perform tasks that overlap with the NOAA responsibility.

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NAME: Dr. Scott Socolofsky	
RESPONSE TO CHARGE QUESTIONS	
Task 1. Worst Case Discharge Analysis (Volume I)	
Provide narrative responses to each of the five Charge Questions below.	
1.1	*Were the Worst Case Discharge (WCD) sites selected for analysis a valid sample to evaluate the probabilities and scope of oil contacting the environment in each region?*
Comments:	Yes, the authors have made reasonable efforts to select WCD sites that cover a wide range of potential blowout scenarios and environmental impacts. In most cases, the review text provides a justification for why each WCD site was selected. The authors were limited by the fact that only a fraction of the existing wells have data within the Oil Spill Response Plan (OSRP) dataset. This limits the available range of sites that can be selected. This limited dataset especially impacts the Gulf of Mexico Eastern Planning Area (where the selected WCD site is in the Central Planning Area) and the Western Planning Area (where the sites in the OSRP datasets are well to the east of many existing wells within the planning area). One weakness of the text is that in several regions, the largest spill size selected for analysis is smaller than the WCD among all the OSRP data points. The document mostly explains the reasons for the selected cases. It would help make the selection process more solid if the review also explained why higher flow rate cases were not selected when they are present in the OSRP data for a given OCS region. For example, in the Southern California Planning Area, the selected WCD is 5,200 bbl/d; whereas, the highest flow rate WCD in the OSRP dataset is 12,000 bbl/d—over double the analyzed case. The text states that the selected case is situated geographically near the Channel Islands National Marine Sanctuary and National Park Unit (Page 93, 3rd paragraph). This is good justification. However, the wells are all close together. Can the authors also give a reason why the higher flow rate case was not selected? This situation is also true for the Alaska Planning Regions, where the selected WCD sites have flow rates between 15,000 and 25,000 bbl/d; whereas, the highest discharge WCD site has an estimated 85,000 bbl/d. The text emphasizes that in both the Pacific and Arctic regions, the OSRP data for WCD are per platform instead of per well. Is this perhaps part of the reason these higher WCD cases were not analyzed? Since the single, high flowrate WCD in the Arctic region appears to be an outlier, it would be valuable for the text to address it.

1.2	*Are the limitations and uncertainties clearly identified and adequately characterized for the oil plume, fate and effects, and transport mechanisms used in the stochastic trajectory modeling? Please note that the impact of a*

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	WCD is not a probable impact, or representative of risk; but the largest volume possible from an uncontrolled blowout (30 CFR 257.47 (b)), a very unlikely and low probability scenario.
Comments:	The stochastic simulations use fixed model parameters for all aspects of the modeling except for the ambient environmental forcing. In this sense, the simulations do not account for any uncertainties in model or spill parameters (e.g., plume entrainment rate, oil composition, biodegradation rates, initial droplet size distributions, surface transformation process models, etc. are all identical in all simulations within each scenario). Uncertainty is modeled in the stochastic simulations by initializing the blowout on different days throughout the time span of available model forcing, each simulation representing a separate ensemble. This is a reasonable approach to simulating the uncertainty of ambient currents and weather on the behavior of a blowout. It would be valuable to state in the text whether start times are equally spaced over the available time span of input data or whether start times are selected from a random distribution. If a random distribution of start times is used, provide the probability density function of the distributions. In either case, provide an appendix listing the start times for all simulations used in the stochastic modeling. In addition, the different environmental forcing is not analyzed to ensure that the full range of climate variability at a site is considered in the simulations. These results should be viewed as potential outcomes for spills that might have occurred during the span of data in the environmental forcing database. This may not represent the actual total variability over the canonical modes of climate behavior at each site.

1.3	*Are the assumptions of the modeling clearly defined and appropriate?*
Comments:	The report main text briefly outlines the processes considered in the blowout plume model (OILMAPDeep, nearfield model) and the far-field model (SIMAP). The appendices give more details of the capabilities of these models. Since the appendices enumerate all the capabilities of the model and it is possible that not all capabilities were used in the review simulations, it is important that the text of the review document clearly state all processes used in the modeling. My understanding of OILMAPDeep is that gas is treated as pure methane and allowed to dissolve and that oil does not undergo fate processes in the nearfield plume model. This should be clearly stated in section 2.3.1. Also, the inputs to the model include the ambient stratification profile and currents—these are not listed as inputs on Page 15, 2nd paragraph of section 2.3.1. Moreover, it is not clear to me whether or not OILMAPDeep accounts

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	for ambient currents; if ambient currents are not used (and therefore not needed as inputs), the text should explicitly state this. Otherwise, the assumptions of the nearfield model are adequately described. For the purposes of determining the intrusion level of a blowout, the OILMAPDeep simulations are appropriate. For SIMAP, it is not clear in the text whether dissolution was considered as a fate process for the present simulations. I understand that SIMAP is capable of modeling dissolution during transport from the subsurface intrusion to the surface, but page 16 only lists biodegradation as a subsurface fate process. Subsequent model results suggest dissolution is modeled. Clearly itemize in this section all fate processes modeled for the SIMAP simulations. For the purposes of determining the fate of oil in the water column, the SIMAP simulations appear appropriate.

1.4	*Are there strengths or weaknesses of the analytical methods used for the modeling?*
Comments:	The strength of the WCD modeling is that both OILMAPDeep and SIMAP are process-oriented models that simulate the physical, chemical, and biological processes affecting the oil fate and transport in the environment. Both models have been used in industry for many years and have benefited from rigorous testing across many diverse projects. The model inputs have been carefully evaluated based on a wide range of available data. The simulations are also forced by high-quality simulation data for environmental parameters (e.g., winds and currents). The simulations are complex and thorough. One weakness of the modeling is that only the stochastic nature of the environmental forcing is evaluated and no simulation of the effects of other model inputs are considered. These other model inputs include parameters describing the oil as well as model parameters such as entrainment rate, biodegradation rates, and other model coefficients. Likely, an exhaustive analysis of model uncertainty is beyond the scope of this study, and the choice to consider only the effects of environmental forcing gives an adequate picture of the potential contact of the spilled oil with the environment. Another weakness that is out of the control of the modelers, but nonetheless important, is that no data for initial oil droplet size distributions (DSD) in the parameter space of a full-scale blowout are available. Laboratory and field data that can be used to calibrate and validate DSD models have all been collected for smaller values of the governing non-dimensional parameters (e.g., Weber number, Reynolds number, Ohnesorge number, and Viscosity number). Hence, the DSD predictions used in any possible model will be

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	extrapolations from the available data, and hence, subject to greater uncertainty than for other aspects of the model. For instance, the entrainment coefficient for the nearfield plume model can be simulated in the laboratory at the same non-dimensional scale as a full-scale blowout; hence, that aspect of the plume model does not have to extrapolate to unmodeled values. This uncertainty is important because, especially in deep water, the DSD controls the fate processes in the water column, the location, thickness, and properties of oil on the surface, and is an integral part in the evaluation of the efficacy of subsurface dispersant injection. It would be valuable for the present review to discuss this weakness, evaluate its potential impact on the present simulations, and perhaps recommend to BSEE the need to fill this gap with data from larger-scale experiments.

1.5	*Do the modeling results describe with reasonable accuracy the probability, scope and minimum travel times for oil to potentially contact the environment in the event of a WCD for the selected scenarios?*
Comments:	The model results presented here utilize industry-standard models, developed based on all available data, and use our best understanding of the input parameters for the WCD scenarios described in the report. Hence, these simulations give the best available estimate of the scope, probability, and time scales of oil contact with the environment for such discharges.

Task 2. Oil Spill Response Equipment Capabilities Analysis (Volume II)	
Provide narrative responses to each of the five Charge Questions below.	
2.1	*Are the limitations and uncertainties clearly identified and adequately characterized for the deterministic trajectory and response countermeasure modeling?*
Comments:	The analysis of the capabilities of oil spill response equipment is based on one simulation out of the 100 ensemble simulations conducted for the WCD analysis in Vol. I. The simulation that was selected was deemed to be the worst case among all of the ensemble simulations. Early parts of Vol. II state only that the selected deterministic simulation is the worst case among the ensembles. Later, this is further defined to be the worst case in terms of shoreline oiling. It would be best if the authors can clearly define the objective function that was maximized in selecting the worst case ensemble simulation: was it length of oiled shoreline? volume of oil deposited on the shoreline? some combination of these types of metrics? It is reasonable for the authors to select the worst case simulations as their single, deterministic run, but the criteria for evaluating the worst case conditions need to be clearly stated. While it is reasonable to analyze the capabilities of response equipment using

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	a single, deterministic run, there is no analytical requirement that a single scenario be selected. One might argue that using the worst case ensemble is a conservative estimate, but only for the metrics used to select the worst case simulation: here, that metric was shoreline impact. The same analysis could have been applied in a stochastic way to all of the simulations in Vol. I. It would be helpful for the Vol. II text to justify that shoreline impact is the most important impact to minimize in the response and that selecting the worst-case ensemble in terms of shoreline impact gives the most conservative estimate of the efficiency and capability of response equipment.

2.2	*Are the assumptions of the modeling in Volume II clearly defined and appropriate? Assumptions evaluated should include, but are not limited to:* *a) Fate and transport of the oil* *b) Application of temporary source control measures* *c) Application of spill response countermeasures.*
Comments:	The assumptions of the fate and transport of the oil remain the same as in Vol. I, and evaluation of these assumptions is provided above in Question 1.3. The timelines for application of the temporary source control measures appear to be a reasonable compromise between the times required during Deepwater Horizon (which were longer due to the fact that this technology was being designed during the spill) and likely response times during future spills. One element of the temporary source control that is not really addressed in the report is the possibility that a capping stack might be installed but for various reasons (mostly well bore integrity), it might not be allowed to be closed. In that case, one might try to produce all of the spilled fluids to the surface, but there was no discussion about whether the full well flow rate could be stored and transported allowing full spill control. Likely, the actual spill impact will lie between the baseline the source controlled simulations. The spill response measures appear to be modeled reasonably, and for the most part, the amount of oil removed by these measures is similar to what has been historically achieved. The modest exceptions to this case are that the present modeling appears to overestimate removal by mechanical methods and underestimate removal by in-situ burning. The report should specify quantitatively how the mechanical removal methods were simulated. For a spillet that has the appropriate characteristics (e.g., thickness, viscosity, etc.), it is assumed that that spillet will be removed at the remaining available removal capacity with the region occupied by the spillet. In other words, the model does not account for accessibility of skimming vessels to appropriate surface oil, travel time between slicks and to shore, limited spatial extent of the skimming vessel, and the difficulties of finding and tracking recoverable

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	oil. These details are not specified in the report and would make it easier to evaluate the model simulations for mechanical removal. At some point, more general in the report, the text needs to explicitly state that source control is assumed to reduce the oil discharge to zero. It was difficult for me to figure this fact out. This is confusing since the capping stack for the Deepwater Horizon was installed and operating for several days before the discharge stopped. Yet, the discharge reduced as some oil was produced up the capping stack line. With that sequence of events in a reader's mind, it is valuable to spell out in this report that source control is assumed to be 100% containment and that there is no gradual reduction in flow before containment.

2.3	*Are there strengths or weaknesses of the analytical methods used for the modeling?*
Comments:	As with the modeling in Vol. I, the modeling for Vol. II has the important strength of using an industry-tested, process-oriented comprehensive spill modeling system. In addition, the authors have made tremendous efforts to quantify the available removal infrastructure for each spill scenario and to simulate realistic removal efficiencies. One weakness of the analytical methods is that a single, deterministic spill scenario is evaluated, instead of an ensemble of all 100 stochastic runs. This weakness is justified if the primary metric of concern is shoreline oiling, since the simulation with the worst shoreline oiling is the one that was selected for the deterministic modeling. As mentioned above under Question 1.4, the lack of data for oil droplet size distributions at large scale and more importantly, the effectiveness of SSDI at large scale, increase the uncertainty in the results for SSDI presented in the present report. It is very likely, and indeed was evidenced during the Deepwater Horizon accident, that SSDI is an effective response tool. However, the fraction of oil removed by SSDI is uncertain since there is limited data at sufficient scale to test SSDI effectiveness at field scale. It is wholly possible that SSDI is even more effective than was simulated here, especially if DOR levels of 1:100 are achieved with 100% mixing into the discharge. The review report should discuss the lack of validation data at the appropriate field scale.

2.4	*Are the conclusions drawn from the oil spill response capabilities analysis logical and appropriate based on the modeling results?*
Comments:	For the most part, the analysis of each modeling scenario presented in Chapter 2.0 of the report is logical and sound. There is one element of the analysis that may come across as confusing. For each scenario, there is a bar chart

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	showing well flow, potential maximum removal and achieved removal broken out by removal method (see, e.g., Figure 15 for Scenario 1), there is a pie chart showing the fate of oil by the end of the simulation for each removal method (e.g., Figure 16 for Scenario 1), there is a table showing oil removal volumes and percentages based on different response capabilities (e.g., Table 21 for Scenario 1), and a paragraph summarizing the general behavior of the scenario, which begins on Page 41, first paragraph for Scenario 1. In many cases, the fraction removed by dispersants shown in the bar chart appears to be the largest fraction and does not always appear to be in agreement with the fractions shown in the pie chart. Moreover, the summary paragraph for most of the methods states that, among other mechanisms, “mechanical recovery was the primary tool that removed oil.” However, in many scenarios, the bar chart looks like dispersants removed more oil. This is the case, for instance in Scenario 1: the subsurface dispersant rubric of the achieved daily flow bar is the largest, yet the pie chart shows surface and subsurface dispersants only affected 7% of the oil; whereas, skimming removed 9%. The table and pie charts seem to agree and usually agree with the summary paragraph text. However, the bar charts always appears to show different fractions for the achieved removal, especially for dispersant. There is no error in the report: the bar chart presents mechanical recovering separated by type and the table and pie chart sum all mechanical recovering together. Nonetheless, this apparent contradiction, which occurs in most all of the scenarios, should be addressed in the text to remove the possibility of confusion.

2.5	*Are the recommendations logical, appropriate, and supported by the analysis and modeling results? The scope of the recommendations pertains to all recommendations, not just those derived from the modeling results.*
Comments:	The recommendations appear to be comprehensive, covering all possible requirements that might be chosen by BSEE. The rationale for including each recommendation seems to be supported by the modeling and the analysis. A few exceptions are noted below in the Specific Observations section. It is not clear that interactions among recommendations has been considered--an optimum set of recommendations may include a subset of all recommendations listed in Chapter 6.0. The report points out that plan holders will be affected if the recovery rates of their equipment is reduced by switching to the Estimated Recovery System Potential (ERSP). This is true if the required capacity is not adjusted. But since the current required capacity is based on the higher Effective Daily Recovery Capacity (EDRC), it is logical to consider reducing the required capacity to align with the new ERSP metric. Thus, requirements should match an equivalent capacity between the two measures. Chapter 6.0 brings

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	out this possibility. The Executive Summary does not. One element of the recommendations in general that should be considered is how these recommendations may interact with the USCG and NOAA forecasters during a spill event. For example, the permit holder may be required to have a real-time oil spill tracking model and to make forecasts that set response zones. This is currently the responsibility of the NOAA Office of Response and Restoration, which uses the General NOAA Operational Modeling Environment (GNOME). There is no mention of GNOME or NOAA forecasts in this section. The following comments address specific NATs: NAT 1: The properties included in the list should be coordinated with NOAA, who maintains an oil properties database. Ideally, the inputs to the NOAA database and forecast models should be included in this list. Also, GC/MS measurements will not be available for exploration wells and may not be estimable. NAT 2: Why should deterministic trajectory modeling be used to establish the CONOPS? Stochastic modeling at the planning stage should be used. During a spill, NOAA uses stochastic ensemble modeling to predict most likely oil trajectories. Do not close the door on stochastic or probabilistic modeling. See, for example, Figure 153. The light-gray hashed region is mostly to the east and does not extend offshore. This region was developed for one deterministic scenario. During Deepwater Horizon, this region would have been much more to the west. Depending on the look current, it could also have covered the deep Gulf of Mexico. Stochastic modeling should be applied to determine the locations of these regions during the planning stage. NAT 14: NOAA OR&R is charged with providing this data to the USCG in the event of a spill. How this requirement should integrate with NOAA should be considered in the report. NAT 37: This recommendation agrees with my summary statement above. Improved guidance should include additional experimental modeling. Assuming that is either cost prohibitive or impossible given the need to environmental permits, write a regulation that would allow the responsible party for the next spill to test different DORs and demonstrate a minimum DOR that satisfies their SSDI objective. Unless nearly full-scale experiments can be conducted, there is not a very good basis to specify DORs using present available data.

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SPECIFIC OBSERVATIONS

Task 1. Worst Case Discharge Analysis (Volume I)

Provide specific observations or comments on Volume 1 of the study, mentioning page and paragraph (expand table if needed).

Page	***Paragraph***	***Comment or Question***
7	1	Typo: MC 157 should be MC 252.
9	Table 4 and Footnote 37	Flow rate range in the table (28,800-35,000) is not consistent with that in the footnote (62,000 to 53,000). Are the table ranges in error or reduced by the amount of capture? The footnote ranges are the reservoir flow rates.
15	4	Add the oil and gas composition, the ambient stratification profile, and, if applicable, the ambient currents to the list of model inputs to OILMAPDeep.
16	2	State here whether SIMAP included oil dissolution. Also, state explicitly that fate processes were modeled during subsurface transport and on the sea surface.
16	2	“decay rate is typically higher in warm water environments…” A surprising observation during Deepwater Horizon is that biodegradation rates were high in the deep, cold, subsurface plume. It may not be universally accepted that temperature is the most important factor in determining biodegradation rates. Pressure and species adaptation are also critical.
22	4	Somewhere near this point in the report, the text should state what velocity data for the ocean currents and winds were used. These are only mentioned in the appendices; they should also be cited in the report text.
114	Figure 78	What happens at day 4 to dramatically change the weathering behavior of this instantaneous release simulation? The results are unusual and warrant explanation in the text.
117	1	Include a summary in the text of the amount of oil that was bound to ice.

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Task 2. Oil Spill Response Equipment Capabilities Analysis (Volume II)

Provide specific observations or comments on Volume II of the study, mentioning page and paragraph (expand table if needed).

	Page	***Paragraph***	***Comment or Question***
	viii	1	"Deepwater Horizon spill response over [?]," insert the number of days of the spill?
	ix	Table ES 2	Provide the units for values in this table. If unitless, state so in the caption.
	xiv	Bulleted list	Should satellites be included in this list?
	xviii	4	There is a lot of effort in this review to prescribe mechanical recovery response quantities and times. Yet, the plan holder will want to minimize their environmental impact during a spill and will likely naturally maximize their recovery capability.
	1	5	"Dispersants applied to the subsurface [may] have the same…" Insert qualifier. Now that SSDI is a known technology, new dispersants may be designed that are specifically tailored to the high-pressure, hot, live oil exiting the wellhead at a blowout. These would not be the same as surface-applied dispersants in the future.
	71	2	"No subsurface dispersants…" Somewhere the report should explain the criteria for which subsea dispersants are applied and the rationale. Since SSDI localizes dispersant application, it should not matter whether the oil reaches the sea surface or not; hence, one might expect SSDI to be used in shallow water accidents.
	84ff	--	Scenario 4 shows large amounts of oil impacting the Flower Gardens Banks National Marine Sanctuary. Should this fact be discussed in the review document? Should special counter-measures in such cases be considered?
	237	4	It is surprising that the amount collected by skimmers during the Deepwater Horizon was not measured. This capability is added to the recommendations. It is important going forward that skimmers report the amount of oil collected.
	246	2	"subsurface dispersants also served as a means to reduce VOC emissions." The text should probably state by what mechanism: VOCs were

Oil Spill Response Plan Equipment Capabilities Review,* consisting of Volume I–*Worst Case Discharge Analysis* and Volume II–*Oil Spill Response Equipment Capabilities Analysis.			
NAME: Dr. Scott Socolofsky			
			probably reduced because they were dissolved into the water column before the fresh oil surfaced. They may also have been reduced by slowing the rate of ascent so that fresh oil surfaced away from the response zone. This effect may not occur in a shallow blowout, where VOCs have inadequate time to dissolve and surface near the response zone. Nonetheless, SSDI might be desirable for the shallow release to aid in oil dispersal after surfacing.
	270	Table 95	GC/MS characterization will not be known during exploration. Also, in the last row, allow the plan holder to test a range of dispersants instead of a selected one.
	270	bullet 5	Three-dimensional models may not be required for the nearfield plume. There are acceptable zero-dimensional correlation equations. Also, the nearfield plume modeling done using OILMAPDeep for the Deepwater Horizon NRDA what two-dimensional (currents were not considered, so the plume rose vertically upward). The SIMAP side of the model (far field) needs to be three-dimensional. This casual bullet needs to be refined and made specific.
	278	2	"if regulatory requirements for capability levels are to remain the same." Presumably, regulatory requirements have been calibrated to the higher EDRC metric. It is natural and logical that regulatory requirements should go down when compared to the lower and more realistic ERSP.
	290	4	ERSP thresholds should be significantly greater than the WCD. This is not supported by the modeling. ERSP are already lower than EDRC values. The modeling showed that present removal capability is not maximized due to limitations of daylight and weather (already summarized on page 290 in paragraph 2). Requiring a significantly higher capacity for removal than present is not consistent with this conclusion of the modeling.

6. APPENDIX B: PANEL MEETING MINUTES

Minutes of Peer Review Panel Meeting

September 8-9, 2016

For the two volumes of the BSEE study:

"*Oil Spill Response Plan Equipment Capabilities Review*"

Volume I–*Worst Case Discharge Analysis*

Volume II–*Oil Spill Response Equipment Capabilities Analysis*

Prepared for:

BSEE

Oil Spill Preparedness Division

Prepared by:

EnDyna, Inc.

October 3, 2016

6.1 Introduction

EnDyna selected a peer review panel of three senior scientists with expertise in oil spill modeling in ocean or coastal environments; practical, on-scene, oil spill response operations in ocean or coastal environments; and oil spill preparedness/response plans, as a practitioner or regulator.

Each peer reviewer prepared an initial written review of the two volumes of the study entitled, "*Oil Spill Response Plan Equipment Capabilities Review*," consisting of Volume I–*Worst Case Discharge Analysis* and Volume II–*Oil Spill Response Equipment Capabilities Analysis*. The peer reviewers submitted their initial written review to EnDyna prior to the September 8-9, 2016 peer review panel meeting. EnDyna compiled these initial written comments for distribution to the peer reviewers prior to the peer review panel meeting. Each of the peer reviewers reviewed the compiled initial written comments on the two volumes of the study prior to the peer review panel meeting.

The peer review panel meeting was held on September 8-9, 2016 at EnDyna's office in McLean, Virginia. Section 2 presents the minutes for the panel meeting. Section 3 presents the agenda prepared prior to the panel meeting.

The objective and scope of this peer review are summarized below, as outlined in the peer review charge document provided to the peer reviewers. In addition, the "ground rules" for the peer review meeting are outlined below.

6.1.1 Peer Review Objective and Scope

The objective of this panel-style peer review was for BSEE to receive comments from individual experts on the selected sections of the two volumes of the study entitled, "*Oil Spill Response Plan Equipment Capabilities Review*," consisting of Volume I–*Worst Case Discharge Analysis* and Volume II–*Oil Spill Response Equipment Capabilities Analysis*. This panel-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 two volumes of this study 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 defined below. It is important to remember that this panel-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.

The scope of the peer review is focused on the modeling and final recommendations components of the two volumes generated by this study. The review is technical in nature, and does <u>not</u> extend to the regulatory benchmarking analysis, Deepwater Horizon response case study summary, the analysis of changing regional Worst Case Discharge (WCD) profiles, or other sections of Volume I and II that are not related to modeling or the recommendations. You may refer to these out-of-scope sections when providing comments on the recommendations section, which draws from both the non-technical analyses and the oil spill modeling contained in the two volumes of the study.

6.1.2 Peer Review Panel Meeting "Ground Rules"

The "ground rules" provided to the peer reviewers both prior to and during the peer review panel meeting are listed below:

- An external peer review is intended to solicit individual reviewer feedback, to increase the independence of the review process.
- The panel is not asked to, and should not attempt to, form consensus or collective recommendations, ratings, or opinions, and panel reviewers must understand that they should provide individual feedback on the research product.
- Any BSEE staff that may attend the panel meeting can only provide background information on the research product to the peer reviewers, which can occur only during the panel meeting run by EnDyna, and at EnDyna's request.
- The panel meeting will not include discussion related to BSEE policy recommendations and decisions.

6.2 Peer Review Panel Meeting Minutes

The peer review panel meeting was held on September 8-9, 2016 at EnDyna's office in McLean, Virginia. This section presents the minutes that summarize the discussion at the panel meeting.

Attendees:
Dr. Smita Siddhanti, EnDyna, Facilitator
Dr. Jerry Galt, Expert Peer Reviewer
Mr. Gary Ott, Expert Peer Reviewer
Dr. Scott Socolofsky, Expert Peer Reviewer
Ms. Amy Doll, EnDyna, Peer Review Lead

Presenter (Background on BSEE Study): Mr. John Caplis, BSEE, Emergency Oil Spill Response Coordinator

6.2.1 Day-1: September 8, 2016

Dr. Smita Siddhanti opened Day-1 of the panel meeting at 9:00am by asking all the attendees and the presenter to introduce themselves and provide some brief background on their expertise. Dr. Siddhanti also summarized the "ground rules" for the panel meeting and discussed the schedule for the final written peer review comments after the panel meeting.

BSEE Background Information Presentation

Mr. John Caplis made his presentation, "Background Information for OSRP Equipment Analysis," to provide useful background on the two volumes of the BSEE study entitled, "*Oil Spill Response Plan Equipment Capabilities Review*," consisting of Volume I–*Worst Case Discharge Analysis* and Volume II–*Oil Spill Response Equipment Capabilities Analysis*. He emphasized that the two volumes of the BSEE study are final now, although BSEE will take into consideration any peer review comments about their strengths and weaknesses.

Dr. Galt asked whether the recommendations outlined in the BSEE study create any obligation to BSEE. Mr. Caplis stated that BSEE was not bound to those recommendations, but he anticipated that BSEE would probably try to follow most of the recommendations. As part of Charge Question 2.5, if the peer reviewers identify any problems with the recommendations, then that should be included in the reviewer's answer to this charge question.

Mr. Caplis mentioned that BSEE might possibly do a small follow-on contract for more work on the recommendations. He emphasized that BSEE wants to know if there are any fundamental flaws in the modeling that might either cause or encourage BSEE to conduct more work on this study. He mentioned that the project schedule got compressed, so this study may not be as comprehensive as BSEE had initially planned.

Mr. Caplis reviewed the status of BSEE's current oil spill response plan (OSRP) regulations under the Clean Water Act, as amended by the Oil Pollution Act. The final rule was published in 1997 and has never been amended. Instead, BSEE has used the Notice to Lessee's (NTL) to provide administrative direction with additional clarification on the 1997 requirements. BSEE is planning to use their 20 years of experience for updating their regulations. Mr. Caplis reviewed the following points about the current state of BSEE's OSRP regulations:

- No specific requirements for oil characterization
- Trajectory analysis must identify resources at risk and longest distance oil could travel from source
- No specific requirements for source control (NTL N10-2010 required source control capabilities)
- No requirements for spill detection or tracking capability beyond description of spill monitoring procedures
- No "stated" target levels or response times for any listed countermeasures (planning sustainment period is 30 days)
- Effective Daily Recovery Capacity (EDRC) is the metric for mechanical recovery
    - Operators must calculate EDRC for listed equipment
    - Historically, BSEE has required operators to match their worst case discharge (WCD) volume with an equivalent amount of EDRC
    - While there is no allowance in regulations, BSEE has allowed operators to use ADIOS to reduce the WCD volumes with regard to oil removal
- Dispersant and in-situ burn plans are required (no metrics are identified for these countermeasures).

Because the lessons learned from Deepwater Horizon (DWH) indicated that BSEE's regulations should be updated, BSEE initiated a series of supporting regulatory studies and development work in 2013. These efforts resulted in the Response Calculators and the OSRP Equipment Capabilities Analysis (BSEE study). Mr. Caplis briefly reviewed the Response Calculators, which are now available on the BSEE website.

With respect to the BSEE study, Mr. Caplis explained that it was designed to examine WCD portfolios and provide BSEE with recommendations for capability requirements for the pending regulatory update. He stated that the BSEE study was expected to provide a multi-point rationale for:

- Required capability types (source control, mechanical recovery, in-situ burning, dispersants, etc.)
- Planning target levels
- Accompanying response times
- Critical support elements (oil characterization, modeling, detection and tracking, etc.).

Mr. Caplis described the sections of the two volumes of the study, and how it all came together to form the recommendations for oil spill response capabilities. He provided an overview of the Gulf of Mexico (GOM) WCD modeling scenarios as well as the Pacific and Arctic WCD modeling scenarios. He clarified that BSEE selected the locations for the GOM WCD modeling scenarios. He explained that the dots in the scatterplots of WCDs in OSRPs are the volume associated with OSRPs and that each dot may represent multiple facilities. He also noted that BSEE experts in California selected the location for the Pacific WCD modeling scenario, and that BSEE selected the two locations in the Arctic WCD modeling scenario to represent current (2011-12) drilling sites.

Mr. Caplis reviewed how the response simulations for each WCD scenario included:

- No response
- Source control only
- Source control with additional mechanical recovery
- Source control with additional mechanical recovery and dispersants
- Source control with additional mechanical recovery, dispersants, and in-situ burning
- Source control with subsea dispersant and all surface response options.

Mr. Caplis provided a brief overview of how the offshore concept of operations was modeled by drawing polygons where oil spill response countermeasure assets/equipment would be assigned. He noted that the high volume recovery division focused on areas where oil is thickest and fresh. The scenario response divisions are based on oil weathering and trajectories, and also can include nearshore recovery, secondary recovery, dispersant application, and in-situ burn divisions. Assets were assigned to polygons if the oil and site conditions met certain parameters. A removal rate was assigned to the assets assumed to be in the polygon.

Dr. Galt noted that a constant work day and wind speed are not realistic assumptions for Arctic conditions. Dr. Socolofsky commented that the model did not take into account getting assets to the polygon, and Mr. Caplis confirmed it did not. Dr. Galt stated that he could not identify where the BSEE study report explained how oil thickness was calculated, and Dr. Socolofsky added that he also noticed this. Mr. Caplis explained that oil viscosity maps were developed for each scenario, showing how viscosity changes as spilled oil is in the environment longer. He further explained that this was important because viscosity ranges were assigned to each type of mechanical recovery equipment.

Mr. Caplis discussed how the response modeling found that the windows for each response countermeasure (equipment type) were significantly affected by changes in oil viscosity. For example, oil viscosity affects skimmer performance, with the level of impact depending on the characteristics of the skimmer. Different types of skimmer equipment were assigned to three skimmer groups for this study. Mr. Caplis emphasized that oil removal was highly dependent upon oil viscosity changes driven by onsite conditions (sea state and weather).

Mr. Caplis and the three peer reviewers discussed several graphs for one WCD scenario, along with issues associated with "potential maximum daily removal" and "average achieved daily removal" in the model. Through a summary graph with selected scenarios, Mr. Caplis discussed that there was no consistent relationship between mechanical recovery capability employed, daily discharge flowrate, and the oil removal achieved from scenario-to-scenario. He also presented graphs showing that multiple countermeasure response capabilities were more effective than using just mechanical recovery. Mr. Ott commented that during actual on-scene oil response operations, "removal" can become a politically charged word.

General Impressions: ***Overall impressions addressing the accuracy of information presented, clarity of presentation, and soundness of conclusions.***

Dr. Siddhanti began this session with a brief discussion of BSEE's scope for the peer review. She explained that the process for the panel meeting would be that each reviewer would summarize their comments, and then all the reviewers would have an opportunity for discussion and questions.

Dr. Socolofsky noted that the BSEE study used well-known industry models (OILMAPDeep and SIMAP), and did not consider other state-of-the-art models now available. The modeling approach for the WCD scenarios was reasonable, and he believed that 100 simulations were good enough to capture seasonal variability given the project schedule. He commented that the same model parameters were used for each WCD scenario. Dr. Socolofsky emphasized that not varying any model parameters was a weakness. Dr. Socolofsky also emphasized that the BSEE study did not provide enough detail on droplet size distribution (DSD) in the modeling approach. He argued that DSD is important because no laboratory experiments have been done in dynamic similitude (at the appropriate non-dimensional scale) to a full-scale blowout. He explained that extrapolation from current laboratory data to the field scale can over- or under-estimate droplet size, and that BSEE should strive to have DSD data at the right scale. Dr. Socolofsky expressed concerns that DSD was always the same in ASA's model, and he understood that the National Oceanic and Atmospheric Administration (NOAA) stated that droplet size is the governing parameter. Estimating DSD too large would over-estimate oil removal and estimating DSD too small would under-estimate oil removal by mechanical removal. Dr. Socolofsky stated that DSD was the model parameter that has the most significant impact, and creates an unknown uncertainty. Nevertheless, he accepted the BSEE study's conclusion that subsurface dispersant injection was effective.

Dr. Socolofsky commented that because Volume II modeled only one scenario, it did not include stochastic modeling like Volume I. He also noted that Volume II used the largest shoreline oil exposure as the scenario. He acknowledged that the project schedule and budget may have been too limited to run more scenarios on more spills for Volume II. Dr. Socolofsky also commented that the weather would be a big factor in how the polygons were created in Volume II.

Dr. Galt commented that WCD implies damages, but the model does not address damages. Dr. Galt stated that the BSEE study followed the approach used historically by the Minerals Management Service (MMS, BSEE's predecessor agency) in developing a binary hit map of Lagrangian particles. He noted that although this approach shows where the oil went, it does not show how much oil. Dr. Galt suggested that the NOAA Trajectory Analysis Planner (TAP) methodology would provide information on both how much oil and where it went. Dr. Galt also suggested that using other statistics to determine where the oil went in the BSEE model might work better versus the binary hit statistics.

Dr. Galt expressed concerns about how the model addressed oil layers and thickness. He noted that SIMAP had somehow introduced thickness, but it was not possible to understand how that works from the information provided in the BSEE study. He stated that the binary hit diagrams in the BSEE study have no thickness.

Dr. Galt emphasized that the approach used to select climatology parameters is important, but it was uncertain how the BSEE study picked the model's climate parameters. He stated that for leases, BSEE takes 10 years of climatological data and then samples it. Dr. Galt also emphasized that it is important to understand the problem of determining cardinality of driving parameters. First, he noted that the DWH response effort ended up using NOAA's TAP methodology because it was better for climatological parameters. Second, there is a mathematical approach to determine cardinality of climate, and this will indicate variance and inform modelers about how large the sample size should be. Dr. Galt believed that SIMAP has never considered this, but also acknowledged there are few cases where cardinality of climate has been determined. Dr. Galt stated that a high level of uncertainty was introduced into the modeling by not having climatology.

Dr. Galt believed that SIMAP was an overly complicated model, with algorithms that feed into each other and with all of them introducing additional uncertainty into the model. Dr. Galt and Dr. Socolofsky discussed that the BSEE study report needs to explain what type of distribution was used (Poisson or uniform random) for start times. Dr. Galt confirmed that SIMAP uses a cumulative hit binary pixel map. Dr. Galt and Dr. Socolofsky discussed that spillets and Lagrangian particles are different. A Lagrangian particle is only a tracer, and although there are many ways to do this, it was not possible to tell how SIMAP did it. Dr. Galt commented that Thiessen polygons would be a better approach for the BSEE study.

Mr. Ott expressed concerns that the BSEE study report did not list objectives. He suggested that a shared objective for all the stakeholders involved in oil spill response might be to reduce shoreline oil exposures. He also suggested that the BSEE model's success should be measured by how well it predicted changes in shoreline oiling. For each countermeasure in Volume II, the BSEE study should identify its potential for reducing shoreline oil exposures using two objectives: 1) best planning (strategic, command/control/communications, logistical) practices that can improve response readiness, and 2) operational best practices that maximize countermeasure effectiveness.

Mr. Ott also had concerns about whether the BSEE study should have modeled Maximum Most Probable Discharge (MMPD) instead of WCD. Dr. Siddhanti encouraged him to include this concern under General Impressions in his final written comments.

Mr. Ott recommended that the BSEE study report should list critical findings that he believed were too buried within the report. One example of a critical finding was that source control was important and should be done using an engineering approach. Another example of a critical finding was that dispersants must have approval, and success should be measured by whether or not such approval is available instead of on whether equipment is available.

Dr. Siddhanti agreed with Mr. Ott that it is important to know the BSEE study's objectives to evaluate the model and she asked Mr. Caplis for additional background information. Mr. Caplis stated that a primary purpose of the BSEE study was for the contractor to develop a methodology to come up with recommendations about what should be required in an OSRP. He explained that the relevant Regional Contingency Plans (RCPs) and Area Contingency Plans (ACPs) were reviewed by the contractor. Mr. Ott and Dr. Galt emphasized that pre-approval was necessary before using some oil spill response tools (i.e., countermeasures), such as dispersants. Mr. Caplis noted that the ACPs usually documented pre-approval of dispersants along with any approved response tools.

Charge Question 1.1: ***Were the Worst Case Discharge (WCD) sites selected for analysis a valid sample to evaluate the probabilities and scope of oil contacting the environment in each region?***

Dr. Socolofsky expressed concern about how much he should discuss whether the WCD sites were a representative sample, and asked whether this issue was within BSEE's scope for this peer review. Dr. Siddhanti suggested that he include that issue in his final written comments. Mr. Caplis confirmed that any comments on the representativeness of the sample were within BSEE's scope for this peer review. In addition, Dr. Socolofsky noted that BSEE's Background Information Presentation in the morning had made him realize that the model provided WCD for each data point.

Dr. Socolofsky stated that overall the BSEE study did a good job of selecting WCD sites. He commented that the sites selected for the GOM Planning Areas seemed reasonable. Dr. Socolofsky argued that the BSEE study report should have explained why some higher flow rate cases were not selected for several regions. He suggested that BSEE should also explain why they did not select other sites that were not included in the BSEE study report, instead of only explaining the reasons for the selected cases.

Dr. Galt commented that basically the BSEE study covered selection of WCD sites in a reasonable way. However, Dr. Galt had issues with the model not providing a definition of how it handled certain factors that are known to be critical in certain areas. Examples of such factors include flooding in the Mississippi River for the Central GOM and freshwater flows from the Atchafalalya River into the Western GOM. Dr. Galt emphasized that small-scale critical factors can have a significant impact and change a model's result. Another example is the directional shifts in the California Current versus the Davidson Current in the Santa Barbara Channel in California. In the Artic, ice cover is the main critical factor. Dr. Galt added that outflow from the MacKenzie River can be an important factor for the Beaufort region in the Arctic.

Mr. Ott commented that the WCD sites that were selected made sense. He emphasized that sites selected for the Santa Barbara Channel are a good choice for the worst case in the Pacific region.

Charge Question 1.2: ***Are the limitations and uncertainties clearly identified and adequately characterized for the oil plume, fate and effects, and transport mechanisms used in the stochastic trajectory modeling? Please note that the impact of a WCD is not a probable impact, or representative of risk; but the largest volume possible from an uncontrolled blowout (30 CFR 257.47 (b)), a very unlikely and low probability scenario.***

Dr. Socolofsky observed that there was limited discussion of the selection process for model runs on the stochastic trajectory side of the modeling effort. He also noted that none of the model parameters were varied for the stochastic modeling. Dr. Socolofsky commented that the model has uncertainty that was not tested. He suggested that the 100 simulations need explanation of how climate data was sampled, which was not in the BSEE study report. He also suggested that the report needs an appendix listing the start times for all simulations used in the stochastic modeling. Knowing the date, or start time, would be helpful to understand how climate affected the model's results.

Dr. Galt commented that, in general, he believed that WCD was not a good term and that he preferred "largest credible release." Different stakeholders have very different ideas on what is worst. Dr. Galt argued that a substantial issue for him was how the model went from Lagrangian to Eulerian distributions and the lack of documentation in the BSEE study report was problematic.

Mr. Ott commented that he understood that WCD is used because of regulations, but in his experience, WCD did not work for planning. A WCD can overwhelm all possible resources.

Mr. Ott explained that the formal Natural Resource Damage Assessment (NRDA) Type A process has made certain models a legal reality, and commented that the models used in this report are presumed correct or acceptable when used as part of a formal NRDA Type A process. Mr. Ott also noted that multiple technical reviews of these models exist because they have been used by the ongoing DWH damage assessment process and as the NRDA Type A model.

Dr. Galt added that SIMAP is a planning model, not a state-of-the-art model. Dr. Socolofsky confirmed that SIMAP is a planning model. Dr. Galt also mentioned that although SIMAP has limitations, no other planning models are necessarily better or more accurate. He emphasized that SIMAP algorithms can build up error, and that compounded uncertainty is a problem. Dr. Galt explained that NOAA uses data to recalibrate their models back to reality, to reduce uncertainty problems. He added that another way to check uncertainty is that a Lagrangian model has 1-to-1 mapping and that can be used to calculate the information content of the model and how it degrades with time.

Charge Question 1.3: ***Are the assumptions of the modeling clearly defined and appropriate?***

Dr. Socolofsky commented that the main text of the BSEE study report does not have detail about how the model was set up or all the processes used in the modeling. He stated that it was important to know whether the BSEE study had set up the model to use all of the model's capabilities. He noted that the appendices list all of the capabilities of the model, but the report does not clearly state how the model was used in the BSEE study.

More specifically, Dr. Socolofsky observed that the BSEE study report does not clearly state whether OILMAPDeep was run with ambient currents and did not list ambient currents or stratification profiles as input. He suggested that the main text should explicitly state that the model was run with ambient stratification and whether it accounts for ambient currents. He argued that it was important to understand how they affect plume behavior in the model. Dr. Socolofsky also observed for SIMAP that the BSEE study report only said that biodegradation was turned on. It was not clear whether dissolution was considered in SIMAP and he would like to have clear itemization of all fate processes modeled for the SIMAP simulations.

Dr. Galt reinforced that horizontal currents interact with DSD in an important way, and explained that not accounting for those currents can make the initial oil thickness wrong. Dr. Galt stated that dissolution by pseudocomponents was an important issue that must be addressed. Dr. Galt noted that overall the report does not explain how the BSEE study implemented the model algorithms.

Mr. Ott referred to his previous comment that the models used in this report are presumed correct, including the assumptions, when used as part of a formal NRDA Type A process.

Charge Question 1.4: ***Are there strengths or weaknesses of the analytical methods used for the modeling?***

Dr. Socolofsky commented that a strength of the analytical methods was that OILMAPDeep and SIMAP are models that have been used by industry and are well known. He explained that one weakness of the modeling was that only the stochastic nature of the environmental forcing was modeled and not the variability of the model coefficients as well. Another weakness was that the BSEE study report does not explain the equation used to predict DSD. Dr. Socolofsky commented that droplet size is very important, but was not discussed in the BSEE study report.

Dr. Galt stated that the BSEE study report does not provide any information about how well the model addressed "situation space" used to represent the environmental variations. He suggested that the model inputs need more discussion in the report.

Mr. Ott referred to his previous comment that the models used in this report are presumed correct, including the strengths and weaknesses of the analytical methods, when used as part of a formal NRDA Type A process.

Charge Question 1.5: ***Do the modeling results describe with reasonable accuracy the probability, scope and minimum travel times for oil to potentially contact the environment in the event of a WCD for the selected scenarios?***

Dr. Socolofsky explained that his assessment was the model's experts probably applied their own model correctly, so the BSEE study report probably provides adequate description. Dr. Socolofsky added that the issue of ensemble states that was raised by Dr. Galt in his written comments should be considered, and noted that Dr. Galt had explained that NOAA does ensemble states in different ways.

Dr. Galt commented that certain kinds of data are well captured by binary hit space, especially time of travel. However, the probability of hits was not well defined by the model. Dr. Galt suggested that it would be necessary to model dynamics in the same manner as NOAA's TAP methodology to get specific data. Dr. Galt also observed that the BSEE study report did not provide sufficient information to understand the Eulerian distributions in the model.

Dr. Socolofsky observed that the BSEE study report may have adequately characterized WCD scenarios from more of an engineering approach versus a scientific approach. Dr. Galt also observed that the BSEE study report was more oriented toward an engineering simulation. Dr. Galt added that the BSEE study report did not evaluate the sensitivity of the model. Dr. Socolofsky noted that the BSEE study only had very limited evaluation of the sensitivity of the model.

Mr. Ott commented that the fine points of modeling often get lost when a large-scale oil release occurs, which can overwhelm natural and human resources. He suggested that the lessons learned from DWH had benefited the models used in the BSEE study.

Dr. Galt noted that Mr. Ott had mentioned it was important to look at the defined objectives and desirable outcomes of the BSEE study to evaluate how the model algorithms were used. Dr. Galt commented that it will be important for BSEE to understand how to interpret the model in terms of developing future BSEE policies. Mr. Ott asked the other peer reviewers whether there was a critical weakness with respect to whether the BSEE study met its objectives. Dr. Socolofsky stated that DSD would affect the volume of oil, but may not affect the geographic extent of shoreline oil exposure. Mr. Ott stated that he believed understanding shoreline oil exposure was a critical objective. Dr. Socolofsky also stated that DSD would affect oil thickness, but that was more relevant to Volume II of the BSEE study.

Dr. Siddhanti asked the reviewers if they would like to proceed with the charge questions for Volume II of the BSEE study, which had been scheduled for Day-2 on the agenda, and the reviewers agreed to begin discussing the next charge question.

Charge Question 2.1: ***Are the limitations and uncertainties clearly identified and adequately characterized for the deterministic trajectory and response countermeasure modeling?***

Dr. Socolofsky stated a limitation of Volume II of the BSEE study was that it only simulated one deterministic run out of the 100 stochastic runs conducted for the WCD analysis in Volume I. He observed this decision was probably due to limited project resources. Dr. Socolofsky commented that the one simulation that was selected for Volume II seemed to be the worst case in terms of shoreline oiling from Volume I. He observed that Volume II never explained why this was selected as the worst case simulation for the one deterministic run.

Dr. Socolofsky emphasized that the model results for Volume II will only be representative of that one deterministic run, but it still might be possible for the modeling in Volume II to get the relative importance of different oil removal rates right. He suggested that if any model gets into BSEE's future regulations that users of such a model would want an ability to change the model parameters, select their own model, and to choose their own approach to evaluate WCD scenarios.

Dr. Galt suggested that if BSEE's future regulations include any specific approach that they need a trajectory analysis instead of a model. Dr. Socolofsky noted that he will add more into his written comments about how adequate the characterization in the model for Volume II of the BSEE study was for analyzing the capabilities of oil response equipment.

Dr. Galt stated a significant limitation was that the BSEE study does not explain how the ensemble "situation space" states were done to form the run scenarios. Dr. Galt commented that there are enough vagaries in the model such that it was not possible to distinguish limitations from uncertainties. The adequacy of the ensemble sampling could be a limitation. Dr. Galt emphasized that it was important to explain what the BSEE study did with the model in Volume II, in particular, how they collected the ensemble state in order to provide better understanding of whether it represented the environment that responder will be working in.

Dr. Socolofsky added that using only one WCD scenario at each well cannot cover all environmental forcings, such as the range of possible climate/weather factors at each well. Dr. Galt asked whether BSEE considered the type of statistics available from NOAA's TAP methodology. Mr. Caplis confirmed that TAP-like statistics were not considered in the BSEE study. Dr. Galt developed a diagram on the flip chart to illustrate how the TAP methodology worked for trajectory analysis to provide a range of scenarios and removal targets over time. Dr. Galt noted that results of trajectory analysis can ultimately provide information needed for an oil spill response equipment capability assessment.

Mr. Ott commented that BSEE's Response Calculators are industry validated and capable of evaluating how much each countermeasure would reduce WCD exposures.

Charge Question 2.2: ***Are the assumptions of the modeling in Volume II clearly defined and appropriate? Assumptions evaluated should include, but are not limited to:***

- ***a) Fate and transport of the oil***
- ***b) Application of temporary source control measures***
- ***c) Application of spill response countermeasures.***

Dr. Socolofsky stated that the assumptions for oil fate and transport are the same in Volume I and Volume II, so he referred to his related comments for Volume I. He explained that the timelines for temporary source control measures seemed reasonable and conservative. Dr. Socolofsky commented that the model's assumption that an oil spill stops when temporary source control measures are installed may not be realistic. He noted that DWH showed that it may not always be possible to use a capping stack to shut-in a well and not enough secondary containment may be available, so part of the oil spill would still enter the environment.

Dr. Socolofsky also commented that the BSEE study report did not address the need to have secondary storage capacity on site. He observed that in reality, not every skimming ship can get to an oil spill when the oil is ready to be collected.

Dr. Socolofsky commented that the model overestimated mechanical recovery removal because, in reality, all equipment probably cannot reach the site quickly. He also commented that the model underestimated removal by in-situ burning. Dr. Socolofsky asked why the BSEE study assumed that the boom inventory would be so low. Mr. Ott stated that some booms are very expensive, with the most expensive up to $1,000 per foot, so generally there is not a large boom inventory.

Dr. Galt stated that lack of information in the BSEE study report was a limitation in evaluating the oil fate and transport assumptions. SIMAP includes an oil weathering model and an unknown Lagrangian to Eulerian transformation. The documentation in the report does not explain what combination of those algorithms was used in modeling for the BSEE study. Dr. Socolofsky stated that he had similar concerns.

Mr. Ott stated that the assumptions were documented by experienced experts in countermeasures and the assumptions met the objectives. He noted that the documentation of assumptions can be found within the BSEE study report, and that he had identified those page numbers in his written comments. Mr. Ott believed that criticizing the BSEE calculator’s validated assumptions or expert input on variables in the model used for the BSEE study probably would not significantly change the outcome, even if input variables were varied up or down slightly.

Dr. Siddhanti concluded Day-1 of the panel meeting at 5:30pm.

6.2.2 Day-2: September 9, 2016

Dr. Siddhanti opened the Day-2 of the panel meeting at 8:30am by asking the reviewers if they preferred a working lunch, and the reviewers agreed to continue discussion during lunch.

Charge Question 2.3: ***Are there strengths or weaknesses of the analytical methods used for the modeling?***

Dr. Socolofsky commented that a strength of the modeling in Volume II, like the modeling in Volume I, was that the BSEE study used an industry-tested, process-oriented, comprehensive spill modeling system. He stated another strength of the modeling for Volume II was that the BSEE study included a significant effort to quantify the available equipment capacity for oil spill response methods in each region. He believed that this significant effort at identifying available equipment capacity made those numbers robust.

Dr. Socolofsky commented that a weakness was that only one deterministic run was evaluated, but observed that this was probably justified if the primary metric of concern was minimizing shoreline oiling. He argued that, in his opinion, he would probably not want this to be the only metric of concern.

Dr. Socolofsky discussed how DSD data was lacking and that the BSEE study report did not explain what equation was used. In addition, the report did not evaluate what the scatter would be and did not indicate what the new droplet size was after subsurface dispersant injection.

Dr. Galt added that, based on his knowledge of SIMAP, droplet size was a key parameter. He also commented that the BSEE study report did not explain how the model in the BSEE study handled droplet size. Dr. Galt observed that it makes a big difference whether a dispersant has a water-based or oil-based carrier fluid.

Mr. Caplis provided additional background information to clarify that the BSEE study used three measures: 1) length of shoreline, 2) surface area, and 3) volume on shore. Dr. Socolofsky commented that length of shoreline was the only criterion used to select the one deterministic run.

Dr. Socolofsky commented that depending on how much droplet size was reduced, it was hard to know the usefulness of subsurface dispersant injection. He stated that he would be cautious about whether the model provides a conservative estimate—it is possible that the benefit of subsurface dispersant injection is more than predicted in the BSEE study.

Mr. Caplis provided more background information to clarify that the modeling in the BSEE study started subsurface dispersant injection on Day-5 or Day-6. Both Dr. Socolofsky and Dr. Galt commented that the model's result was plausible, but it was not possible to understand how the model provided that result. Dr. Galt observed that a recurring theme during the panel meeting and in the reviewer's written comments was that the BSEE study report does not disclose what model in the BSEE study did. In addition, Dr. Galt observed that the model documentation in the BSEE study report was really their user's manual, and did not explain how the runs were modeled specifically for this study. Mr. Ott observed that maybe such detailed documentation was withheld intentionally, if it was proprietary.

Mr. Caplis explained that the model never varied the amounts of equipment to evaluate how that affected the results. At the end of the study, they conducted some examples of extra runs with additional mechanical recovery. Mr. Ott stated that the results related to additional mechanical recovery from these extra runs were a critical finding from the BSEE study.

Mr. Ott asked what aircraft were modeled for dispersants, and explained that some aircraft are designed for dispersant application but during response operations other aircraft might also be used. Mr. Caplis stated that they only modeled aircraft that are dedicated for dispersants. Mr. Ott added that firefighting planes were used during DWH to provide additional capacity.

Dr. Galt commented that SIMAP, as a model, is too complex and has many features that are not needed for the BSEE study. He expressed concerns that those unnecessary features add to the model run time and costs. Dr. Galt suggested that NOAA's TAP methodology is easier to run. He also suggested that BSEE's ERSP calculator is another option.

Dr. Socolofsky stated that he understood the modeling had first weathered the oil in SIMAP and then developed spillets that could be removed. Mr. Caplis stated that was correct, and added that the capacity of equipment to remove oil came from the ERSP calculator. Mr. Caplis also explained that removal rates were by polygon, not the spillet time step. Each spillet had a viscosity attached to it, depending on how long it had been weathered. SIMAP only removed the spillets that were young enough to be removed by the equipment. After this additional background information provided by Mr. Caplis, there was some general discussion of problems that can occur with equipment during response operations and cause delays in oil removal effectiveness, including turtles and otters getting caught in skimmers.

Mr. Ott noted that the documentation of assumptions for Volume II can be found within the BSEE study report, and that he had identified those page numbers in his written comments. Mr. Ott stated that a weakness was there was no information about whether the model accounted for mechanical breakdowns of equipment. Mr. Caplis provided clarification that mechanical breakdowns were not modeled.

Charge Question 2.4: ***Are the conclusions drawn from the oil spill response capabilities analysis logical and appropriate based on the modeling results?***

Dr. Socolofsky commented that the model results seemed congruous with expectations. He noted that the Executive Summary did not include much synthesis of results, but observed it was probably appropriate to look at the BSEE study report for the details. Dr. Socolofsky also commented that the ERSP calculator was good. Dr. Socolofsky stated that overall the conclusions seemed logical and appropriate, and were reasonable and consistent with expectations from the history of U.S. oil spills.

Dr. Galt commented that the forecasts from the model seemed reasonable, so he believed there was not much reason to doubt the model results. Dr. Galt emphasized that he had concerns about how the model calculated oil thickness and again noted that the incomplete explanation of the details of oil thickness values raised questions about this component of the modeling. Dr. Galt stated that overall the BSEE study provided a significant amount of information to lead to scenario-based modeling for OSRP development.

Mr. Ott commented that the critical findings from the BSEE study were impressive, but they got hidden in the BSEE study report. He suggested that the BSEE study report should highlight the critical findings. Dr. Galt and Dr. Socolofsky both added that Mr. Ott’s observation about critical findings was very useful and that highlighting them would improve the BSEE study report.

Mr. Ott stated that one critical finding from the BSEE study was that response countermeasures employed against an overwhelming WCD have limited success. As an example, Mr. Ott referred to the DWH baseline in the BSEE study report: dispersant 8%, in-situ burning 5%, and mechanical recovery 4% (pp. 237-239). Mr. Ott observed that there is a big gap between what oil spill responders can achieve compared to what stakeholders want. Mr. Ott emphasized that expectation management is important for oil spill responses. He commented that the role of those managing an oil spill response is to understand the expectations of the public and other stakeholders, not to criticize or judge them.

Mr. Ott stated that another critical finding from the BSEE study was that source control had the most significant impact in reducing WCD exposures. Mr. Ott emphasized that the model results showing surface and, to a larger degree, subsurface dispersants reduce surface and shoreline oiling impacts more than mechanical recovery was also a critical finding. Another critical finding was that the use of subsurface dispersant injection was a powerful response option in the model results. Mr. Ott also stated that the model results that showed increasing mechanical equipment resources does not necessarily reduce shoreline oiling was a critical finding.

Dr. Socolofsky added that most research results show that mechanical recovery was the most effective method, but the BSEE study found that adding dispersants was more effective than doubling mechanical recovery. Mr. Ott, Dr. Galt, and Dr. Socolofsky had a general discussion about the advantages of dispersants for oil spill response operations. Mr. Ott concluded that discussion among the reviewers by adding that the stockpile of dispersants considered sufficient was another critical finding from the BSEE study for OSRPs that include subsurface dispersant injection. If dispersant stockpiles are needed for both surface and subsurface dispersant application at the same time, the stockpile may not be sufficient. Mr. Ott noted that he will add this observation as another critical finding in his written comments and referred the other reviewers to NAT 31 in Volume II of the BSEE study. Dr. Galt added that another critical finding of the BSEE study was that expanding the toolbox was important for achieving better results for oil spill responses.

Charge Question 2.5: ***Are the recommendations logical, appropriate, and supported by the analysis and modeling results? The scope of the recommendations pertains to all recommendations, not just those derived from the modeling results.***

Dr. Socolofsky began his comments on the recommendations by noting that he took the approach of asking whether the rationale for the recommendations made sense. He commented that, for the most part, the rationale for including each recommendation seemed to be supported by the modeling and analysis. Dr. Socolofsky emphasized that he did not want this observation to be considered an endorsement, because he recommended that the BSEE study needed to review them again and synthesize the recommendations to reduce the interactions among recommendations. He observed that the recommendations currently in Volume II looked like a menu. Dr. Socolofsky also commented that the recommendation that the responsible party should provide real-time oil spill tracking does not account for NOAA's role in providing forecasting during an oil spill incident. Dr. Galt added that NOAA forecasts are done twice a day during oil spills.

Dr. Galt stated that the recommendations were overly complicated and overlapping. He also recommended that the recommendations be synthesized. Dr. Galt noted that he had four specific comments about the recommendations. First, Dr. Galt commented that plan holders should not be required to have a trajectory model. He emphasized that such models are expensive and, to be effective, must be run by modelers that have specific training and continuous drilling to stay current. He noted that NOAA requires regular drills, which could be expensive for plan holders to conduct in order to keep modeling specialists up-to-date. Dr. Galt suggested that instead of a trajectory model, what BSEE needed was an archive of trajectory analysis results that could be used by all response organizations. All the reviewers looked at NAT 2 in Volume II, and especially questioned the last sentence in the first paragraph.

As his second comment about the recommendations, Dr. Galt noted that EDRC needs updating, but everybody knows that, and commented that migrating to ERSP was good. Third, Dr. Galt stated that he believed localized environmental inputs should be used in modeling instead of all plan holders using general inputs. The trajectory analysis archive that he suggested in his first comment on the recommendations would be a better way to develop those statistics. He noted that Alaska is very different from GOM. Dr. Galt emphasized that the Arctic may have a short operational period because of wind speeds. For some oil spills in the Arctic, for example, he noted there may be only four days for operating to remove oil because of high wind speeds. Dr. Socolofsky commented that planning scenarios would provide that wind information according to the recommendations in the BSEE study.

Dr. Galt commented that he does not like that much of the climatology is a binary switch (either on or off) in SIMAP. Moreover, local climatological effects on oil removal efficiency are not in SIMAP. Dr. Galt stated that the important local climatology factors include wind speed and the number of daylight hours. He mentioned a study by the Nuka group that used localized statistical inputs on climatology. Dr. Galt believed that local climatology will be the largest area of uncertainty in oil spill response planning.

Mr. Caplis provided clarification that the trajectory analysis in the recommendations was more about rightsizing equipment, in terms of the type of equipment needed.

For his fourth comment on the recommendations, Dr. Galt noted that some obvious oil spill response activities that have been proven effective should be included in the recommendations. These response activities include extended duration capability with personnel and equipment, overflight guidance of collection and response platforms, pollutant tracking and mapping, and effective information integration with a Unified Command.

Mr. Ott commented that the recommendations should be based on the BSEE study's objectives. Dr. Siddhanti asked Mr. Caplis to clarify the objective for the BSEE study. Mr. Caplis stated that the study objective was to provide recommendations on how to develop the best requirements for oil spill response equipment capabilities.

Mr. Ott stated that the recommendations in the BSEE study should be based on the objective to reduce shoreline oil exposure. He suggested that the recommended operational best practices should be maximizing oil spill response equipment effectiveness instead of capability. Mr. Ott argued that effectiveness is much better than capability, for planning purposes. Mr. Ott also commented that the best planning is defined as strategic, and suggested that should be included in the recommendations.

With respect to the recommendations, Mr. Ott commented that 6.1.1 (Oil Characterization) met the objectives that he had just outlined (see above). For 6.1.2 (Modeling CONOPS COP), Mr. Ott suggested source control planning should be done by engineers rather than oil spill responders. Engineering processes should be considered to identify failure paths and detailed source control planning (see NAT 8). Mr. Ott commented that for 6.1.2 best practices should focus more on understanding what is not possible and communicating that to stakeholders. Mr. Ott again noted that managing expectations is important, even during the planning phase. He commented that the skill set of talking to stakeholders is different from modeling.

Mr. Ott stated that for 6.1.3 (Temporary Source Control) engineers need an audit system to figure out and make sure temporary source control gets done. He suggested that BSEE needs to consider whether OSRPs can accomplish this and also consider best practices for an audit to evaluate whether source control will be successful. Mr. Ott noted that, in his opinion, 6.1.4 through 6.1.9 met objectives.

For the site-specific recommendations, for 6.2.2, 6.3.2, and 6.4.3 (Surface Dispersant Capability Recommendations), Mr. Ott noted that the limiting factor on dispersants, which could also be called the critical path, is pre-approval for dispersant use. Mr. Ott argued that without pre-approval there is no encouragement for obtaining equipment for dispersants. Dr. Socolofsky and Mr. Ott then discussed whether some operators may see this as effective oil spill response equipment and obtain it, then work for pre-approval for surface dispersant use.

Mr. Ott suggested that BSEE should have a role in encouraging pre-approval for use of dispersants. He suggested that either BSEE or EPA develop a national standard for dispersants. There was discussion about a recent proposed national standard from EPA and the issues that arose. Mr. Ott commented that stakeholder fear of dispersants is the key issue and getting approval is becoming much more difficult. He argued that looking at best practices that maximize dispersant inventories and application capabilities is not enough to achieve success. Mr. Ott suggested also including best practices to negotiate for expedited approval for use of dispersants at an oil spill. Without considering this part of dispersant planning, the opportunity for using dispersants promptly during a WCD takes too much effort and the window of opportunity for using dispersants is lost.

With respect to NAT 1, Dr. Socolofsky commented that the BSEE model requirements should include producing information for inputs that NOAA’s GNOME (General NOAA Operational Modeling Environment) model needs. He noted that the current list of model requirements in the BSEE study does not provide information that GNOME needs. In addition, for NAT 1, Dr. Socolofsky commented that gas chromatography-mass spectrometry measurements are needed to get pseudocomponents for modeling, but that these are not likely available during planning for a new well.

For NAT 2, Dr. Socolofsky questioned whether deterministic trajectory modeling should be used to establish CONOPS. He expressed concerns about whether a BSEE requirement to perform a deterministic model run would preclude the use of other modeling or analytical approaches. Dr. Galt commented that another way to look at this is establishing a scaling argument. Dr. Socolofsky stated that it would help to have a scaled approach for response planning and to use a scaling analysis. Dr. Galt and Dr. Socolofsky discussed that there are many simpler ways to do this than the recommendations in the BSEE study. Dr. Socolofsky noted that it could be important to strike a balance between being too prescriptive and so general that there is no guidance to help planners. Mr. Caplis asked whether deleting the word “deterministic” from the sentence beginning with “The deterministic modeling should . . .” on page 280 would help and there was general support from the reviewers. Dr. Galt also suggested when revising that sentence to use “A” instead of “The” when referring to a model.

For NAT 14, Dr. Socolofsky asked what tracking meant and Mr. Caplis stated it meant flyovers. Dr. Socolofsky commented that the text was vague and he thought tracking meant modeling at NOAA.

For NAT 37, Dr. Socolofsky questioned whether 1:100 for Dispersant to Oil Ratio (DOR) should be codified in regulations for subsurface dispersant injection. He agreed with the recommendations that BSEE needs more research, including experimental modeling, to obtain more data. It might turn out that lower DORs (less dispersant injection) are just as effective. Dr. Galt also commented that BSEE needs more research for more data to specify DORs.

Dr. Galt stated that overall he believed the recommendations in the BSEE study could be reduced to around 10 recommendations instead of the over 30 recommendations in the BSEE study report. In addition, Dr. Galt emphasized that there are other approaches to modeling.

Dr. Socolofsky asked a general question to all the reviewers about whether there might be a way to build in incentives to encourage more mechanical recovery. Dr. Galt commented that at oil spills the data on oil collected is always bad data, and explained that at some spills the amount of oil collected according to the data reported is more than the amount spilled.

Ms. Doll reminded the peer reviewers about the Non-Disclosure Agreement (NDA) they had signed prior to starting the peer review, and that the discussion at the panel meeting was covered by the NDAs. All the discussion throughout the panel meeting was confidential for the participants only, and for the reviewers to consider in developing their final written peer review comments.

Dr. Siddhanti concluded Day-2 of the panel meeting at 2:15pm.

6.3 Agenda

The draft agenda distributed prior to the panel meeting is presented below.

Thursday, September 8, 2016

8:45am	**Arrive at EnDyna office**
9:00-9:15am	**Welcome and Introductions** **Review of Agenda/Process for 2-day Panel Meeting** Smita Siddhanti, EnDyna
9:15-9:45am	**Background on BSEE Study** John Caplis, BSEE
9:45-10:15am	**General Impressions:** Overall impressions addressing the accuracy of information presented, clarity of presentation, and soundness of conclusions.
10:15-10:30am	BREAK
10:30-11:30pm	**Charge Question 1.1:** Were the Worst Case Discharge (WCD) sites selected for analysis a valid sample to evaluate the probabilities and scope of oil contacting the environment in each region?
11:30-1:00pm	LUNCH (on your own)
1:00-2:00pm	**Charge Question 1.2:** Are the limitations and uncertainties clearly identified and adequately characterized for the oil plume, fate and effects, and transport mechanisms used in the stochastic trajectory modeling? Please note that the impact of a WCD is not a probable impact, or representative of risk; but the largest volume possible from an uncontrolled blowout (30 CFR 257.47 (b)), a very unlikely and low probability scenario.
2:00-3:00pm	**Charge Question 1.3:** Are the assumptions of the modeling clearly defined and appropriate?
3:00-3:15pm	BREAK
3:15-4:15pm	**Charge Question 1.4:** Are there strengths or weaknesses of the analytical methods used for the modeling?
4:15-5:15pm	**Charge Question 1.5:** Do the modeling results describe with reasonable accuracy the probability, scope and minimum travel times for oil to potentially contact the environment in the event of a WCD for the selected scenarios?
5:15-5:30pm	**Conclusion and Preparation for Day-2** Smita Siddhanti, EnDyna

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5:15-5:30pm	**Conclusion and Preparation for Day-2** Smita Siddhanti, EnDyna

7. APPENDIX C: BSEE SUBJECT MATTER EXPERT (SME) CONSULTATION

The following RPS ASA Responses to Reviewer Questions on Modeling was provided to the EnDyna Team on October 11, 2016 by Mr. John Caplis, after BSEE consultation with one of the BSEE study report authors: RPS ASA (see Section 1.5). After the peer review panel meeting, at BSEE's request, EnDyna prepared a list of modeling questions that arose during the peer reviewer's panel discussion (see Section 1.4) and provided this list to BSEE. BSEE plans to use the RPS ASA Responses to Reviewer Questions on Modeling in developing BSEE's responses to the external peer review comments on the two volumes of the study entitled, *Oil Spill Response Plan Equipment Capabilities Review*, consisting of Volume I–*Worst Case Discharge Analysis* and Volume II–*Oil Spill Response Equipment Capabilities Analysis*.

EnDyna provided the RPS ASA Responses to Reviewer Questions on Modeling (see below) to the peer reviewers, at BSEE's request, before the peer reviewers finalized their written peer review comments. The two peer reviewers who had modeling questions at the peer review panel meeting considered this information as described below:

- Dr. Galt decided that because this information was not presented in the BSEE study report, he focused his final peer review comments only on the actual BSEE study report without considering any BSEE SME responses.
- Dr. Socolofsky believed that although he now had the answers to some of his modeling questions at the panel meeting, he stated that the BSEE study report did not explain that information in sufficient detail, and he emphasized that information was critical for evaluating the BSEE study results. Thus, in his final peer review comments, Dr. Socolofsky included those questions about modeling issues that he believed BSEE should expect anyone reading the BSEE study report to also ask or need to know.

RPS ASA Responses to Reviewer Questions on Modeling

1. How is droplet size distribution calculated in the modeling approach used by the BSEE study? What was the equation used to predict droplet size distribution? How is droplet size used in the modeling approach for the BSEE study?

RPS ASA Response: SIMAP initializes at the trap height with the specified oil droplet size distribution as predicted by OILMAPDeep. OILMAPDeep produces the input to SIMAP in which the volume of release (e.g., tons, gallons or bbls) parsed out at each time step of the release with the specified droplet size distribution. The equations used to predict the droplet size distribution for the BSEE study can be found in Crowley et. al. (2014), included herein.

2. What type of distribution was used for start times in SIMAP (Poisson or random)?

RPS ASA Response: It is a random distribution used to select start times in SIMAP. The start times in SIMAP are randomly selected from the long-term record of winds and currents by years, day, day in the month, and start time (by hour).

3. How did SIMAP calculate oil thickness values in the BSEE study? How were oil layers addressed?

RPS ASA Response: It is important to note that the model calculates mass loading (e.g., g/m^2) as opposed to a real thickness. The spillets (or Lagrangian particles), each representing some known volume of oil are overlaid on a fixed grid (e.g., the habitat grid) and the mass of the spillet is projected into the fixed grid cell. Then, the mass of all spillets are then summed within one fixed grid cell.

The mass of monoaromatic hydrocarbons (MAHs) and polynuclear aromatic hydrocarbons (PAHs) in the water column is contoured on a three-dimensional Lagrangian grid system. This grid (of up to 200 X 200 cells in the horizontal and up to 100 vertical layers) is scaled each time step to just cover the volume occupied by aromatic particles, including the dispersion around each particle center. This maximizes the resolution of the contour map at each time step and reduces error caused by averaging mass over large cell volumes. Distribution of mass around the particle center is described as Gaussian in three dimensions, with one standard deviation equal to twice the diffusive distance (2*Dgxt* in the horizontal, 2*Dgzt* in the vertical, where *Dgx* is the local small-scale horizontal diffusion rate, *Dgz* is the local small-scale vertical diffusion rate, and *t* is particle age). The values of *Dgx* and *Dgz* are user inputs, and need not equal *Dx* and *Dz* that apply to spillet centers (which are on a larger scale). The plume grid edges are set at two standard deviations out from the outer-most particle.

4. What combination of algorithms was used in SIMAP for oil weathering?

RPS ASA Response: Please refer to French McCay (2004) and French McCay (2016), attached herein, for a description of the algorithms used in SIMAP for oil weathering. Please also refer to French McCay et. al. (2015), the RPS ASA's oil fate modeling technical report for DWH which is available for download at: https://www.fws.gov/doiddata/dwh-ar-documents/830/DWH-AR0285776.pdf.

5. How were climatology parameters selected for the modeling approach used by the BSEE study?

RPS ASA Response: We used the most comprehensive data for hydrodynamics, winds and climatology (e.g., temperature, salinity, etc.) available at the time of the study. The full description of the hydrodynamics and winds are provided within the final reports.

For all regions in this study, temperature and salinity values to characterize the water column were obtained from the World Ocean Atlas 2013 (WOA13) high resolution dataset, Version 2. The WOA13 dataset is compiled and maintained by the United States National Oceanographic Data Center (www.nodc.noaa.gov). The World Ocean Atlas originated from the Climatological Atlas of the World Ocean (Levitus 1982) and was updated with new data records in 1994, 1998, 2001, and 2013 (Conkright et. al. 2002). These data records consist of observations obtained from various global data management projects. After a comprehensive quality control process, the remaining data were averaged yearly, seasonally, and monthly and interpolated to fit a global grids with 5, 1, and ¼ degree horizontal resolution. The ¼ degree horizontal resolution grid was used in this project. The yearly dataset, used in this study, includes up to 33 depth bins from the surface down to depth.

Conkright, M.E., Antonov, J.I., Baranova, O., Boyer, T.P., Garcia, H.E., Gelfeld, R., Johnson, D., Locarnini, R.A., Murphy, P.P., O'Brien, T.D., Smolyar, I., and Stephens, C. 2002. *World Ocean Database 2001, Volume 1: Introduction.* Sydney Levitus (ed.). NOAA Atlas NESDIS 42, U.S. Government Printing Office, Washington, D.C., 167 pp.

Levitus, S. 1982. *Climatological Atlas of the World Ocean*, NOAA/ERL GFDL Professional Paper 13, Princeton, N.J., 173 pp. (NTISPB83-184093).

6. How was climate data sampled for the 100 simulations?

RPS ASA Response: Each of the 100 simulations had a randomly selected start date that was chosen from multiple years of currents and wind data (as outlined in Appendix D of the Task 1 report). Each of the individual 100 simulations—beginning on different randomly sampled start dates and times—was then run for relatively long simulation durations (ranging from 73 to 227 days depending on the scenario in each of the 3 geographic locations: Gulf of Mexico, Pacific, and the Arctic). Therefore, over the course of all of the 100 simulations for each of the scenarios, the climate data was sufficiently sampled.

7. How did the modeling approach in the BSEE study address "situation space" or ensemble states? Can more information be provided to understand how they collected the ensemble state in order to understand whether it represented the environment?

RPS ASA Response: While spill start date was randomly sampled, as described in #6 above, it is important to note that other model inputs were not varied due to the project scope. Other possible inputs that could have been varied in this modeling—if it were within the project scope—include spill volume, location (e.g., spill site), oil type per scenario, duration of the release, etc. However, for the purpose of this project (to compare between scenarios to determine equipment capabilities and use of various countermeasures to respond to a specific spill scenario), the Project Team and BSEE determined that the random sampling of start dates over multiple years and environmental conditions was sufficient to address "situation space" or ensemble state.

8. How did SIMAP transition from Lagrangian to Eulerian distribution? In addition, can more information be provided to understand the Eulerian distributions in the model?

RPS ASA Response: As a default, the physical fates model in SIMAP uses a variable time step to resolve transient concentrations in the water column, and to efficiently compute long-term concentration changes in the sediments. The model computes a reference time step, Δt, based on the Eulerian (fixed) grid size established on the seafloor and the (time-variable) maximum water column transport velocity Umax:

$$\Delta t = (\Delta x\ \Delta y)½ / (2\ \text{Umax})$$

where x and y are the grid cell dimensions in the x and y directions. A second constraint is that the time step may be limited by horizontal mixing.

$$\Delta t < 0.25\ (\Delta x\ \Delta y) / 6Dxy$$

In shallow water, the time step may be limited by the vertical mixing velocity, in which case an imbedded time step,

$$\Delta t = 0.25\ d2 / (6\ Dz)$$

where d is depth, is used in the advection computations.

The initial time step is then set equal to a fraction of the reference value, and allowed to increase with time to the reference value. A small initial value is necessary to allow resolution of evaporation processes for floating oil. Thereafter, the time step is equal to the time-variable reference value, until all water column concentrations are below a specified threshold value, and all contaminants in the water column have been advected outside the fixed grid boundaries or settled to the bottom sediments.

9. Did the way the model was set up and processes used for the models in the BSEE study, especially SIMAP, use all of the model's capabilities? For example, was OILMAPDeep run with ambient stratification and currents? As another example, was dissolution considered in SIMAP and overall is it possible to itemize all the fate processes modeled for SIMAP simulations?

RPS ASA Response: The BSEE study, especially SIMAP, did use all of the model's capabilities. OILMAPDeep, which are conducted outside of SIMAP, is run with ambient stratification and currents from a select point. Dissolution was considered in SIMAP and in the weathering and fates results (e.g., mass balance), but was not specifically presented in the report. For a full description of the fate processes modeled for SIMAP simulations, refer to French McCay (2004), included herein.

OTHER REFERENCES PROVIDED BY RPS ASA:

Crowley, D., Mendelsohn, D., Mulanaphy, N.W., Zi, L., and Spaulding, M. 2014. Modeling Subsurface Dispersant Applications for Response Planning and Preparation. *2014 International Oil Spill Conference*. Abstract 300204, 20 pp.

French McCay, D. 2004. Oil Spill Impact Modeling: Development and Validation. *Environmental Toxicology and Chemistry*, Vol. 23, No. 10, pp. 2441-2456.

French McCay, D., Li, Z., Horn, M., Crowley, D., Spaulding, M., Mendelsohn, D., and Turner, C. 2016. Modeling Oil Fate and Subsurface Exposure Concentrations from the Deepwater Horizon Oil Spill. *Proceedings of the Thirty-ninth AMOP Technical Seminar*. Environment and Climate Change Canada. Ottawa, ON. pp. 115-150.

8. APPENDIX D: LIST OF ACRONYMS

Acronym	Definition
AC	Area Committee
ACP	Area Contingency Plan
API	American Petroleum Institute
ASA	Applied Science Associates
BSEE	Bureau of Safety and Environmental Enforcement
CFR	Code of Federal Regulations
COI	Conflict of Interest
CONOPS	Concept of Operations
COP	Common Operating Picture
DOI	U.S. Department of the Interior
DOR	Dispersant to Oil Ratio
DMP	Dispersant Management Plan
DSD	Droplet Size Distribution(s)
DWH	Deepwater Horizon
EBSP	Estimated Burn System Potential (BSEE Calculator for advancing controlled burn system, or towed fire boom system)
EDRC	Effective Daily Recovery Capacity (planning standard for skimming systems; will be replaced by ERSP Calculator)
EDSP	Estimated Dispersant System Potential (BSEE Calculator for aircraft or vessel dispersant application systems; provides a technology update to USCG's Dispersant Mission Planner 2)
EPA	U.S. Environmental Protection Agency
ERSP	Estimated Recovery System Potential (BSEE Calculator for skimming systems; provides a systems-based approach that is significant improvement over existing EDRC planning standard)
GC-MS	Gas chromatography-mass spectrometry
GNOME	General NOAA Operational Modeling Environment

Acronym	Definition
GOM	Gulf of Mexico
IFT	Interfacial Tension
ISB	In-situ Burning
MAH	Monoaromatic hydrocarbons (used in SIMAP)
MMPD	Maximum Most Probable Discharge
MMS	Minerals Management Service (BSEE's predecessor agency)
NCP	National Oil and Hazardous Substances Contingency Plan, known as the National Contingency Plan
NDA	Non-Disclosure Agreement
NOAA	National Oceanic and Atmospheric Administration
NTL	Notice to Lessee's
NRDA	Natural Resource Damage Assessment
OCS	Outer Continental Shelf
OILMAPDeep™	Blowout plume model (near-field model) – used to determine near-field buoyant and gas plume dynamics for each blowout scenario (all subsurface discharges originating at seafloor)
OMB	Office of Management and Budget
OR&R	Office of Response and Restoration (NOAA)
OSPD	Oil Spill Preparedness Division
OSRP	Oil Spill Response Plan
PAH	Polynuclear aromatic hydrocarbons (used in SIMAP)
RCP	Regional Contingency Plan
ReSET	Recovery System Evaluation Tool (BSEE Calculator for mechanical recovery systems)
ROC	Response Options Calculator (older tool)
RRT	Regional Response Team

Acronym	Definition
SIMAP™	Far-field model -- used to determine far-field transport and weathering of oil in water column and on water surface (stochastic model)
SSC	Scientific Support Coordinator
SSDI	Subsurface dispersant injection; sometimes referred to as subsea dispersant injection
TAP	Trajectory Analysis Planner (NOAA)
USCG	U.S. Coast Guard
WCD	Worst Case Discharge

9. APPENDIX E: PEER REVIEW MATERIALS PACKAGES

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