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Oil Spill Response Technology: Evaluation Process

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16. Abstract (MAXIMUM 200 WORDS)

The U.S. Coast Guard Research and Development Center (RDC) collaborated with the U.S. Coast Guard Office of Marine Environmental Response Policy (CG-MER) to develop a process to catalogue information regarding emerging spill response technologies in a standardized manner by pre-screening technology submittals against a set of fixed criteria. The Oil Spill Response Technology Evaluation Guidance ("guidance document") is provided to assist CG-MER in evaluating the technical aspects of oil spill response technology submittals and focus on emerging technologies with TRLs rated as 7 or higher. In this report, RDC captures the development of the guidance document and describes the mock evaluation using the oil spill response technologies submitted to RDC's Interagency Alternative Technology Assessment Program (IATAP) in 2010 during the Deepwater Horizon event. RDC incorporated feedback from participants involved in this mock evaluation into the final version of the guidance document, which is included in this report.

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EXECUTIVE SUMMARY

This report describes collaboration between the U.S. Coast Guard (USCG) Research and Development Center (RDC) and the USCG Office of Marine Environmental Response Policy (CG-MER) to develop the Oil Spill Response Technology Guidance document (hereafter referred to as the "guidance document"). CG-MER is undertaking an effort to catalogue information regarding emerging spill response technologies in a standardized manner by pre-screening technology submittals against a set of fixed criteria. The guidance document is provided to assist CG-MER in evaluating the technical aspects of an oil spill response technology. It is similar to the Alternative Response Tool Evaluation System (ARTES) that Regional Response Teams (RRTs) developed. However, the difference is that this guidance document (attached as Appendix A) focuses on emerging technologies with a Technology Readiness Level (TRL) rated as 7 or higher.

With a focus on technologies that can be immediately used in the field, CG-MER will be able to provide Unified Commands with quick access to detailed information about emerging technologies during an active oil spill incident. CG-MER can also use the information to conduct internal trend analyses on spill response technologies, provide input to the Shore Infrastructure Logistics Center (SILC) if/or when a contractor is seeking Basic Ordering Agreements (BOAs) for emergency contracting, and influence future Oil Spill Removal Organization (OSRO) guidelines. The overarching objective with the guidance document was to keep the evaluation process as simple as possible while still yielding useful information about relevant, emerging oil spill response technologies.

RDC began the project by researching the few evaluation processes currently in use by industry and Government. RDC also drew on previous experience evaluating the many thousands of submittals sent to RDC during the Deepwater Horizon event in the summer of 2010 through the Interagency Alternative Technology Assessment Program (IATAP). During the early stages of the guidance document construction, RDC worked closely with CG-MER to determine what type of information was needed to evaluate a submittal. This led to the formulation of evaluation factors and criteria. Once the structure of the evaluation process was established, RDC and CG-MER conducted a mock evaluation of 40 previously-submitted oil spill response technologies through the IATAP to improve the readability, simplicity, and flexibility of the guidance document for future reviewers.

RDC recommends the guidance document be refined over time. Emerging oil spill response technologies are expected to evolve, which will necessitate the addition or subtraction of evaluation factors.

RDC also recommends that CG-MER develop a submission template and make it available to the submitters in advance. With this template, the submitter would be able to provide the information that CG-MER requires and enhance the efficiency of the overall evaluation process.

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LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS

ARTES	Alternative Response Tool Evaluation System
BOA	Basic Ordering Agreement
BSEE	Bureau of Safety and Environmental Enforcement
CG	Coast Guard
CG-MER	Office of Marine Environmental Response Policy
DRAT	District Response Advisory Team
IATAP	Interagency Alternative Technology Assessment Program
NCP	National Contingency Plan
NDA	Non-Disclosure Agreement
NOAA	National Oceanic and Atmospheric Administration
NSFCC	National Strike Force Coordination Center
NSF COE	National Strike Force Center of Expertise
OSRO	Oil Spill Removal Organization
PPE	Personal Protective Equipment
RDC	Research and Development Center
ROM	Rough Order of Magnitude
RRT	Regional Response Team
SILC	Shore Infrastructure Logistics Center
SME	Subject Matter Expert
TET	Technical Evaluation Team
TRL	Technology Readiness Level
USCG	U.S. Coast Guard

1 INTRODUCTION

1.1 Objective

The objective of this report is to document the development of Oil Spill Response Technology Evaluation Guidance (hereafter referred to as the "guidance document"), which was assessed and refined during a mock evaluation of oil spill response technologies submitted to the U.S. Coast Guard (USCG) Research and Development Center's (RDC) Interagency Alternative Technology Assessment Program (IATAP) in 2010 during the Deepwater Horizon event. RDC incorporated feedback from participants involved in this mock evaluation into the final version, which is attached as Appendix A.

1.2 Background

The Coast Guard's (CG) Office of Marine Environmental Response Policy (CG-MER), is undertaking an effort to catalogue information regarding emerging spill response technologies in a standardized manner by pre-screening technology submittals against a set of fixed criteria. A guidance document similar to the Alternative Response Tool Evaluation System (ARTES) that Regional Response Teams (RRTs) II and III[1] developed and is available on the National Oceanic and Atmospheric Administration's (NOAA) website, would assist CG-MER in evaluating the technical aspects of an oil spill response technology. However, the difference is that the guidance document developed for this project (Appendix A) is structured to focus on emerging technologies with Technology Readiness Levels (TRLs) rated as 7 or higher (see Table A-1 for definitions of the TRL levels). If a Unified Command during an active oil spill response can have quick access to detailed information about emerging technologies, overall response efforts may be improved. CG-MER can also use the information to conduct internal trend analyses on spill response technologies, provide input to the Shore Infrastructure Logistics Center (SILC) if or when a contractor is seeking Basic Ordering Agreements (BOAs) for emergency contracting, and influence future Oil Spill Removal Organization (OSRO) guidelines.

After RDC developed a draft guidance document, its efficiency was evaluated in a mock evaluation. This allowed RDC to identify omissions that could lead to confusion on the part of an evaluator or incomplete evaluations of a technology submittal. Lessons learned from the mock evaluation were incorporated into the final version of the guidance document provided.

1.3 Overview of the Guidance Document

The current version of the guidance document is shown as a severable document from this report in Appendix A, and can be used by CG-MER as a tool to evaluate oil spill response technologies. The evaluation process is comprised of five main steps, which are captured in Figure 1.

[1]RRT II is the regional component of the National Response System for the states of New York and New Jersey. RRT III covers Delaware, Maryland, Pennsylvania, Virginia, West Virginia, and the District of Columbia. The Coast Guard and EPA co-chair each RRT; it is a planning, policy, and coordinating body and does not respond directly to an oil spill incident. RRTs provide assistance as requested by the On-Scene Coordinator during an incident.

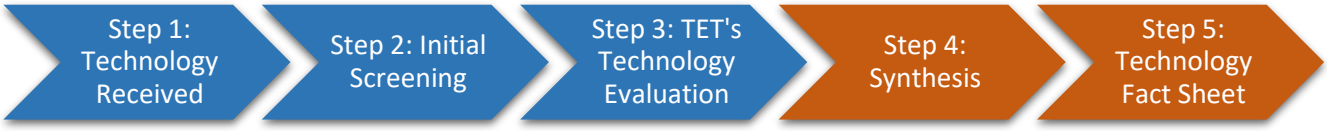


Figure 1. CG-MER's technology evaluation process (steps highlighted in blue are covered by current Oil Spill Response Technology Evaluation Guidance).

Blue arrows represent steps in the evaluation process that will be covered by this guidance document while the orange arrows describe steps in the process that fall outside of the scope of this document. For steps highlighted in orange, users should consult with CG-MER representatives for further directions.

Steps 2 and 3 are the most extensive components of the evaluation process and require the most attention on the evaluator's part. Step 2 covers initial screening of a technology and is broken down into three smaller steps: determining relevancy to CG-MER, assessing the TRL, and ensuring information sufficiency. Once CG-MER makes the judgement that a submittal meets all criteria in Step 2, it moves on to Step 3.

Step 3 is a more in-depth evaluation of a submittal; this analysis is made by a team of subject matter experts (SMEs) appropriately chosen for the type of technology being evaluated. The technology evaluation form (see Figure A-2) will help to organize the Technical Evaluation Team's (TET) review. This information is then forwarded back to CG-MER, who will follow Step 4 and 5 to develop its database of oil spill response technologies.

2 MOCK EVALUATION

2.1 Setup

During the Deepwater Horizon event, RDC established the IATAP as a methodology to collect and review thousands of oil spill response solutions from academia and equipment vendors. To conduct a mock evaluation of the guidance document developed for this project, RDC selected 40 submittals that showcased a range of TRLs and technology types. Although the submittals at the time were limited only to five pages, and thus short on technical data and descriptions, they proved useful for the mock evaluation in that each submittal describes what the product could do during a spill event.

2.2 Pre-TET Evaluation

The mock evaluation was formally kicked off by RDC and CG-MER evaluating each of the 40 submittals according to Step 2 of the guidance document. Personnel were tasked to determine whether the submittal should move forward to Step 3, which is the TET review. In order to do so, they had to determine if the technology described in the submittal had the minimum TRL of 7 required to move on to the next step and whether it contained sufficient information for the TET review. Again, one of the requirements imposed by the IATAP team was that each submittal could be no longer than five pages. Detailed information was in short supply, but the team understood and accepted this as a trial constraint.

From the 40 submittals, the team agreed on eight that should move on to TET review. During this level of review, several changes to the guidance document were recommended and incorporated into a new version that was distributed to the TET members for their evaluation. Section 2.2.1 highlights the major discussion points that were brought up at team meetings.

2.2.1 Discussion Points

The trial team agreed that one of the more challenging tasks during the pre-TET evaluation was to identify the technology's TRL based on the information given in the submittal. In a normal evaluation, the equipment vendor would access CG-MER's public website to find a list of recommended information to include in its submittal. If the vendor still does not provide adequate information for CG-MER to determine the technology's TRL, CG-MER may reach out to the vendor and ask them to provide more information. Additionally, during the evaluation, the team found it difficult to assess what the TRL was for a technology tested at Ohmsett. This was an important point to consider as Ohmsett is a premier oil spill response equipment testing facility and vendors with good success at the testing facility will emphasize this point in their marketing. RDC noted that a similar issue was encountered at a Bureau of Safety and Environmental Enforcement (BSEE)-led TRL workshop held at Ohmsett in 2015. The challenge is determining whether a technology is a full scale prototype or an integrated system, and if it was tested with the intended purpose of detecting or recovering oil. This must be considered on a case-by-case basis. As a result, clarification was added to Step 2B of the guidance document to aid future evaluators in assessing the TRL of a submitted technology.

A significant change during this review was the addition of Step 2A (Determining Relevancy to CG-MER). The team made the decision that the pre-TET evaluation should not be limited to only assessing the TRL and deciding whether sufficient information had been included for further TET review. There is also a need to determine whether the technology meets any one of CG-MER's previously identified capability gaps in the oil spill research area. Additionally, a submittal may include a chemical/biological solution that is outside of CG-MER's scope of work. Adding this layer of review allows CG-MER evaluators to screen out submittals that may not be relevant for further TET review.

Below are additional major discussion points and the changes that were incorporated in the guidance document.

- Assessing the TRL of a non-oil spill response technology: The team came across several submittals that included technologies with proven success in non-oil spill related scenarios. The vendors proposed to use them for oil spill responses, and CG-MER found it difficult to properly assign an estimated TRL. Step 2B was updated to include a helpful hint discussing that the technology being described should have test data with oil or have been used in an oil spill environment to achieve a high TRL rating. Otherwise, its TRL is on the same level as a proof-of-concept technology.
- Test results claims: Equipment vendors should support their claims with reliable test data; the team expects that submittals may include vague data. CG-MER is encouraged to reach out to the submitter and request additional information or clarifying statements. If there is plausible justification on the submitter's part in supporting its own TRL estimation, CG-MER may forward the submittal to the TET for its expert opinion. Step 2C was updated to reflect this.
- CG-MER representative liaison between vendor and TET: The team discussed the most efficient way that the TET members can communicate to the vendor if additional information is required for a complete evaluation. In the end, they decided that a single point of contact (i.e., a CG-MER representative) should serve as a liaison between the vendor and the TET. In other words, CG-MER will be the "gatherer" of all information needed for a complete evaluation. Step 3 was updated to reflect this.

- Commercially available technologies: Some submittals included commercially available technology, which is rated as TRL 9. CG-MER would like the catalog to avoid becoming a clearinghouse of existing oil spill response solutions, and instead focus primarily on emerging technologies. To address this, Step 2B was updated to indicate that CG-MER has the freedom to withhold a submittal for TET evaluation if it determines that a thorough review of the commercially available technology will not add value to the catalog.
- Oil spill response categories: During the pre-TET evaluation discussion, the team realized the guidance document was designed specifically for mechanical oil spill *recovery* equipment. The guidance document was amended to include criteria that would allow for the inclusion of oil *detection* technologies, as well as other equipment supporting response operations such as vehicles (and unmanned vehicles), decontamination equipment, or other spill response solutions.
- Operator training: CG-MER pointed out that it would like to understand the operating requirements of a technology in the field. The guidance document was amended so that the description of the extent of operator training needed is an additional requirement for a vendor's submittal.

2.3 TET Evaluation

The guidance document was updated with feedback and lessons learned from the pre-TET evaluation. Along with the eight selected technology submittals, RDC distributed the revised guidance document to TET members for the next step of the mock evaluation. Six representatives were selected that would comprise a typical team for future evaluations: one from the Coast Guard National Strike Force Coordination Center, one from BSEE, one from NOAA, and three from RDC. They were tasked to determine if the TRL was at least 7, and, if so, they would evaluate it according to the criteria in the guidance document.

After several weeks of evaluation, the TET members and CG-MER representatives held a teleconference meeting to discuss lessons learned and to recommend changes for the final version of the guidance document. The members also provided commentaries about the overall evaluation structure and how it may be strengthened for future emerging technology evaluations. Major discussion points from the meeting are captured below in Section 2.3.1.

2.3.1 Discussion Points

It was evident that a teleconference call needed to be held before the TET commenced its review of submittals to ensure that each member understood what was expected. This pre-evaluation conference call will provide a platform for the TET chairperson to clearly explain the reason for the TET review and what needs to be accomplished. This call will also provide an opportunity for TET members to ask clarifying questions. This will likely obviate the need to address uncertainties during the second meeting in which the TET members discuss the results of their reviews.

In addition, this teleconference meeting will be an opportunity for the TET chairperson to lay down "ground rules" as to how the evaluation should proceed during the TET review. After the mock evaluation, it was noted that each TET member followed a personal method of evaluation. For example, some TET members used an internet search engine to find out more information about the submitted technology; others evaluated only on the basis of what was available in the submittal. To address these uncertainties, RDC recommends that the TET chairperson formulate "ground rules." It may be that only a quick review is

needed; as such, TET members should convene at the next earliest availability and review the submittal during the meeting. Section 3 was updated to allow the TET chairperson to determine the nature of the TET evaluation.

Below are other major discussion points brought up during the TET meeting and the resulting changes to the guidance document.

- Informal consultation with SMEs during pre-TET evaluation: CG-MER suggested that it should have the freedom to contact SMEs during the pre-TET evaluation before it makes a final determination on whether it should proceed to TET review. Step 2A was updated to reflect this flexibility.

- Clarity of Suggested Information section of the guidance document: TET members indicated that it was difficult for them to determine which information was required of the submitter and noted that the evaluation criteria did not exactly match the Information section of the guidance document. To address this, RDC divided the information section into two parts: Minimum Required Information and Other Suggested Information. RDC also clarified where to find the list of "Factors" that were referred to in the evaluation criteria by adding in a clear label. The evaluation criteria now cover all information that is required of the submitter.

- Categories for technology to be established during TET review with specific evaluation criteria applied for that category: A TET member suggested that the TET should also be tasked to categorize the technology described in the submittal based on its capabilities, and evaluate that category based on specific evaluation criteria. The team considered this suggestion but ultimately decided that the goal of the evaluation process is to keep it as simple as possible for the reviewer. The existing evaluation criteria give CG-MER the information it needs about each emerging technology; including categories would make the process more complex. However, if CG-MER determines in the future that more specific evaluation criteria are needed for a specific type of technology, the guidance document can be updated to reflect this change.

- Standardized submission template: TET members agreed that a standardized submission template provided to the submitter in advance would simplify the review process. CG-MER indicates intent to develop this template and determine the best method in which it can be made available to the public.

- Minimum TRL: A TET member suggested that the minimum TRL should be reduced to 6 to include more technologies for TET review. RDC discussed this with CG-MER and decided that the minimum TRL of 7 should remain, as the goal is to get as many details as possible about emerging technologies that can feasibly be put into the field immediately.

3 RECOMMENDATIONS

After the mock evaluation of 40 previously-submitted oil spill response technologies, RDC updated the guidance document to improve readability, simplicity, and flexibility for reviewers. The overarching objective for the guidance document was to keep the evaluation process as simple as possible, while still yielding useful information about relevant, emerging oil spill response technologies for CG-MER's purposes. Throughout the construction of the guidance document and the ensuing mock evaluation, many different ideas and suggestions about the process were addressed, most of which were incorporated into the guidance document. However, some work was determined to be outside RDC's scope for this project effort, specifically where it pertains to policy decisions; those topics were shared directly with CG-MER. RDC recommends that CG-MER address each topic before it begins accepting submittals.

RDC envisions the guidance document can be refined with each technology evaluation. Emerging oil spill response technologies are expected to evolve over time, which may necessitate the addition or subtraction of evaluation factors.

Based on previous experience with technology evaluations, RDC understands a vendor's tendency to market its technology as much as possible. This tendency includes claims of the technology's capabilities or test performances. RDC recommends that since the vendor would be submitting proposals during times of non-emergency, CG-MER should request more information from the submitter as often as possible instead of recruiting SMEs to better understand what is being offered in the submittal if some information or test claims are unclear. Should the submitter not provide more information, CG-MER can mark the submittal as incomplete. To avoid uncertainties from a submitter, RDC recommends that CG-MER develop a submission template and make it available to the submitters in advance. With this template, the submitter would be able to provide the information that CG-MER requires. This would also enhance the efficiency of the overall evaluation process.

APPENDIX A. OIL SPILL RESPONSE TECHNOLOGY EVALUATION GUIDANCE

A.1 Purpose

The Coast Guard's (CG) Office of Marine Environmental Response Policy (CG-MER) is undertaking an effort to catalogue information regarding emerging spill response technologies in a standardized manner, by pre-screening technology submittals against a set of fixed criteria. This Oil Spill Response Technology Evaluation Guidance (hereafter referred to as "guidance document") will assist CG-MER in evaluating the technical aspects of an oil spill response technology[2]. Submittals are limited to oil spill response equipment or tools. Chemical and biological products including dispersants, herders, surface collecting agents, bioremediation agents, and other control agents such as chemical sorbents, should be referred to the National Contingency Plan (NCP) Product Schedule Manager with the Environmental Protection Agency.

The intended audience for this guidance document is CG-MER representatives who will lead the evaluation of oil spill response technologies submitted to CG-MER. It is expected that during times of non-emergency, submitters will include response equipment manufacturers, oil spill response subject matter experts (SMEs) or researchers, various CG members, Federal agency representatives, and stakeholders. The Coast Guard may also come across new and innovative response technologies through professional publications or oil spill response conferences. It may reach out to the equipment manufacturer to encourage a submittal for consideration.

CG-MER representatives will determine the Technology Readiness Level (TRL) of the submitted technology using the Bureau of Safety and Environmental Enforcement's (BSEE) definitions (see Table A-1). If it is TRL 7 or above, CG-MER may convene a Technical Evaluation Team (TET) to perform a more in-depth analysis of the technology. If it is below TRL 7, no further analyses will be performed, as the technology is not considered to be mature enough for evaluation using this guidance document. Regardless of the TRL that CG-MER assigns, the submitted technology will still be incorporated into CG-MER's catalog. This will enable CG-MER to track technology trends and conduct other analyses over time. Catalog access will be limited only to CG-MER representatives. Anybody else, including those within the CG, seeking access will need to receive permission from CG-MER.

A.2 Background

Regional Response Teams (RRTs) II and III developed the Alternative Response Tool Evaluation System (ARTES), and the process has been available on the National Oceanic and Atmospheric Administration's (NOAA) website since 2002 (NOAA). ARTES was used during the Deepwater Horizon incident in 2010, although the process can be used during non-emergency scenarios as well. Readers should be familiar with ARTES and the Selection Guide for Oil Spill Applied Technologies (NOAA), as they are still in use by RRTs today. ARTES also works in parallel with the NCP Product Schedule (NOAA). The evaluation process described in this guidance document is similar to ARTES except it is structured for CG-MER's

[2] Information described in this section is being collected for informational purposes only. This process does not bind USCG to any sort of follow-on action, including any acquisition or any type of approval, endorsement, or other characterization of the technology submittals.

specific purposes and focuses on emerging technologies with TRLs rated as 7 or higher. If a Unified Command during an active oil spill response can have quick access to detailed information about emerging technologies, overall response efforts may be enhanced.

This guidance document is intended to assist CG-MER in evaluating the technical aspects of an oil spill response technology. Figure A-1 demonstrates the overarching process from technology submittal to the final product that will be stored in CG-MER's catalog.

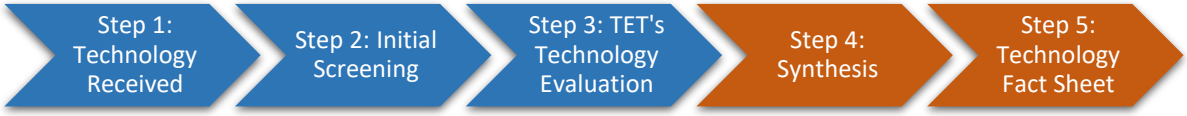


Figure A-1. CG-MER's technology evaluation process (steps highlighted in blue are covered by current Oil Spill Response Technology Evaluation Guidance).

Blue arrows represent steps in the evaluation process that will be covered by this guidance document while the orange arrows describe steps in the process that fall outside of the scope of this document. For steps highlighted in orange, users should consult with CG-MER representatives for further directions.

A.3 Communicating to Potential Submitters

Before Step 1 commences, it is advised that CG-MER communicate to potential submitters about what information is sought, so that a proper evaluation can be carried out by the TET with as little uncertainty as possible. Sufficient, relevant information should be provided in a clear and organized manner instead of being presented in some form of an advertisement. A submitter should understand that the technology may be reviewed by oil spill response SMEs across Government agencies, and that information about the technology will be used at CG-MER's discretion. Thus, all efforts on a submitter's part should be made to protect proprietary information before submission. A submitter will exercise its own judgment to remove sensitive information about the technology/equipment but still provide enough to allow a thorough evaluation by the TET.

Below is a guide that lists the types of information that should be included in a submittal to CG-MER and how it should be organized. It is recommended that CG-MER share the minimum required and suggested information and the evaluation criteria with potential submitters prior to submission. The overall submission, excluding drawings and photographs, should not be more than ten (10) pages.

A.3.1 Minimum Required Information for a Technology Submittal

- Detailed descriptions of the technology including operating principles and supporting science upon which the technology is based (schematic drawings, pictures, and videos are strongly encouraged);
- Answer to the following question: "Has the technology been previously tested/demonstrated and/or used during an actual oil spill?"
  - Submitter should provide its own estimated Technology Readiness Level and test data to support its claims, including photographs and/or videos if available. Test results provided by a third-party test facility are preferred.
  - If used in previous oil spills, the success of the technology should be described in quantifiable terms.

- Detailed descriptions addressing at least five factors listed below (not listed in order of preference) so that TET members have sufficient information to conduct an adequate evaluation;

  Factors

  1. Types of oil targeted (e.g., light, medium, or heavy oil, oil droplets, tarballs, dissolved oil, surface oil) and water depth limitation;
  2. Oil detection/recovery/mitigation potential in quantifiable terms (amount that can be detected/recovered/mitigated over time, or other relevant data);
  3. Minimization of toxicity or environmental impacts with a focus on wildlife and plant life;
  4. Extent of operational parameters in terms of environmental conditions, such as current, wave height, winds, day/night, inclement weather, etc.;
  5. Ability of results to be available in real time (for detection technologies only);
  6. Minimization of false alarms (for detection technologies only);
  7. Ability to digitally log field data (for detection technologies only);
  8. Ability to monitor technology's recovery/mitigation in real time during operation (for recovery technologies only);
  9. Technology's ease of use, including deployability, application, and recovery;
  10. Transportability and portability of equipment;
  11. Extent of support equipment that is necessary;
  12. Platform needed to operate/support equipment, if any;
  13. Operability in fresh/seawater;
  14. Reusability/disposal of technology after use; and
  15. Safety of personnel while using the technology and extent of personal protective equipment (PPE) required for operations.

- Amount of further developmental activities needed to permit use of technology during an oil spill response, if any;
- Extent of user training needed to operate technology in the field;
- Description of submitter's qualifications and experience in oil spill response; and
- Contact information to include at least one specific point of contact.

Other Suggested Information to be Included in a Technology Submittal

- Detailed descriptions addressing additional factors beyond the five required (see list above);
- Discussion of whether this technology was previously submitted to a local Regional Response Team or Coast Guard Area Command (Atlantic or Pacific) for consideration, when it was submitted, and what feedback was received, if any;
- List of users/customers of the technology, if any, and their contact information;
- Description of submitted technology innovation and discussion of whether or not it has a patent; and
- Rough Order of Magnitude (ROM) cost of technology and other benefits from usage (product support, warranties, etc.).

A.4 Technology Evaluation Process

This section discusses the steps in CG-MER's technology evaluation process, as shown in Figure A-1.

Step 1: Technology Received

The first step of the evaluation process begins with CG-MER acknowledgment of receipt. It must be clearly communicated to the submitter that the receipt of the submittal does not mean the enclosed technology is pre-approved, recommended, licensed, certified, or authorized by the Coast Guard for use during an oil spill incident.

Step 2: Initial Screening

Step 2A: Determining Relevancy to CG-MER

During initial screening, CG-MER representatives should attempt to determine if the submitted technology is relevant to the scope of their work. CG-MER representatives are free to decide if a submittal does not warrant further review because it does not meet any previously-identified capability gap in the oil spill response field.[3] If the submitted technology includes a chemical or biological solution as mentioned in the Purpose section (Section A.1), evaluation should be discontinued with a notation indicating that the technology is beyond the scope of this evaluation. For any other reason that CG-MER representatives may deem as appropriate, the submittal's review can end at this stage. However, the submittal will still be placed in CG-MER's catalog with a notation describing the reason(s) why this evaluation ended at this stage.

At this time or any other time during the evaluation, CG-MER representatives are free to contact the submitter to request further clarifications on the technology, or may proceed with an informal consultation with an oil spill response subject matter expert (SME) on an as-needed basis.

If CG-MER determines the technology to be relevant, it moves on to Step 2B.

Step 2B: Technology Readiness Level (TRL) Assessment

CG-MER representatives will use BSEE's TRL definitions (see Table A-1 below) at this stage of evaluation (Panetta & Potter, 2016). To determine the TRL of a proposed technology, CG-MER representatives will come to a consensus after reviewing each TRL definition below and answering its corresponding stage-gate questions. If it is clear that a "yes" answer cannot be produced for a given stage-gate question, the TRL is determined to be at the level for which the previous stage-gate questions can be answered with "yes". However, if CG-MER representatives cannot come to a consensus, they may ask the submitter to provide them with the information necessary to determine the TRL, or they may push the submittal forward for a TET review to receive the final TRL determination.

[3]CG-MER may disregard a submittal if it is a commonly-used product that can be provided any time during an oil spill such as aircraft, typical decontamination equipment, and vacuum trucks, to name a few.

TRL 1 to TRL 3: Technology Research and Development

TRL 1. Basic principles observed and reported

Basic scientific exploration of relevant biology, chemistry, or physics begins and leads to enhanced knowledge for a relevant subject area. One or more unproven ideas have been formulated that warrant transition to applied research related to oil spill technology. No analysis or experiments have been performed and the unproven ideas may be paper concepts.

Stage gate questions to achieve TRL 1

- Has the relevant science been identified?
- Has an idea been formulated for transition to applied research?

TRL 2. Technology concept and speculative application formulated

The technology concept has been formulated and the potential broad class of spill response applications has been identified. The viability and feasibility of technology concept has been considered. Limited experimentation has occurred and limited or preliminary data has been generated and analyzed.

Stage gate questions to achieve TRL 2

- Has the basic science to support the concept been confirmed?
- Has a class of spill response applications for the concept been identified?

TRL 3. Technology proof of concept demonstrated

The proof of concept of the relevant biological, chemical or physical principles or techniques has been shown on a relevant hydrocarbon product or model data generated for a specific scenario. The data have been reproduced and one or more hydrocarbon products or scenarios tested on a laboratory scale. Individual components or algorithms are tested in a bench top setting or an ad hoc system. For theoretical and modeling developments, the initial algorithm has been developed and the forward calculation completed to generate data.

Stage gate questions to achieve TRL 3

- Has the proof of concept been shown in a laboratory environment?
- Has data been reproduced on one or more hydrocarbon products?
- Has model data been generated?

TRL 4 to TRL 6: Technology Advancement, Development, and Demonstration

TRL 4. Technology prototype demonstrated in laboratory environment or model scenario

A prototype of the technology has been demonstrated in a laboratory environment. The prototype is advanced over the proof of concept either by hardware, software, and/or with reproducible data generated for specific scenarios on relevant hydrocarbon products or applications. The prototype can be less than full scale. The model data has been compared with experimental measurements of the relevant scenario.

Stage gate questions to achieve TRL 4

- Has a prototype of the technology been demonstrated in a laboratory environment?
- Has a model been compared with experimental data?

TRL 5. Technology prototype tested in relevant environments

A prototype of the technology with increased fidelity has been demonstrated in relevant environments. Accuracy and precision of the results have been documented. Separate components are acceptable if an integrated prototype is cost prohibitive. Multiple variables may be tested as well as several different hydrocarbon products in several relevant environments. Ground truthing of the model has occurred through validation with experimental data.

Stage gate questions to achieve TRL 5

- Has a prototype of the technology been demonstrated in relevant environments?
- Have accuracy and precision of results been documented?
- Has a model been ground truthed?

TRL 6. Full scale prototype demonstrated in relevant environments

A prototype of the technology has been demonstrated in relevant environments. The prototype is advanced over the proof of concept either in component integration, fidelity of the hardware or software, or with experimental or model data generated for specific scenarios to show applicability. Consideration of future regulatory approvals and industry standards are included in the test plan.

Stage gate questions to achieve TRL 6

- Has a prototype of the technology been demonstrated in relevant environments?
- Are future regulatory approvals and industry standards part of the test plan?

<u>TRL 7 to TRL 8: Technology Implementation in Operational Environments</u>

TRL 7. Integrated technology tested on a large scale or in open water

Full scale prototype integrated into intended operating system and tested on a simulated spill, in a relevant environment, in open water, or in a real spill environment. Intended operator is identified and system has been beta tested by others. Analysis and/or interpretation have become automated and the timeliness of the results has been determined (real time or post processed). Expected performance and specifications of the technology are defined through a performance test matrix. Safety parameters for technology deployment are considered. The test protocol and procedure have been defined and a user manual is being developed.

Stage gate questions to achieve TRL 7

- Has a full-scale and fully integrated prototype been tested in a relevant environment or a real spill environment?
- Has the intended operator been identified?
- Has data analysis and/or interpretation become automated?

TRL 8. Final integrated system tested in real or relevant environment

The final integrated system has been proven to function in a real or relevant environment with performance and operational specifications and limitations defined through performance and reliability testing on several scenarios and products. Reproducible data to support claims has been documented in publically available publications. As part of this level the system should be successfully used by the intended operator and is ready for spills of opportunity and field use. The user manual and training procedure have been finalized. Independent verification of data for all claims is recommended but not required. The safety parameters for technology deployment have been developed, documented, and validated through several deployments.

Stage gate questions to achieve TRL 8

- Have performance and operability limits been defined and tested?
- Is data to support performance claims publically available?
- Has the technology been used by the intended operator?
- Have regulatory requirements been met?
- Have safety parameters been developed, documented, and validated?

TRL 9: Technology Deployment in Real Spill Environment

TRL 9. Final integrated system deployed in real spill environment

Technology has been successfully operated on an intentional or unintentional spill in a real spill environment by the intended operator and meets the technology claims. Training and supporting documents including a user manual and any record of independent verification or certifications are included.

Stage gate questions to achieve TRL 9

- Has there been a successful operation of technology by the intended operator in a real spill environment?
- Has the technology met performance claims from previous TRLs?

Table A-1 below summarizes BSEE's TRL definitions and serves as a quick reference for readers. Determining the TRL of a technology can be difficult, even for oil spill response experts. This difficulty was the subject of a lengthy discussion at a TRL workshop at the National Oil Spill Response Research and Renewable Test Facility in 2016.

Table A-1. Summary of BSEE's oil spill response TRLs.

TRL	Title
Technology Research and Development	
1	Basic principles observed or reported
2	Technology concept and speculative application formulated
3	Technology proof of concept demonstrated
Technology Advancement, Development, and Demonstration	
4	Technology prototype demonstrated in laboratory environment or model scenario
5	Technology prototype tested in relevant environments
6	Full scale prototype demonstrated in relevant environments
Technology Implementation in Operational Environments	
7	Integrated technology tested on a large scale or in open water
8	Final integrated system tested in real or relevant environment
Technology Deployment in Real Spill Environment	
9	Final integrated system deployed in real spill environment

One helpful tip is for a CG-MER representative to ask themself whether the technology, no matter how developed, has ever been tested for the intended purpose that is being described. For instance, a submittal may describe in detail the success of a well-established technology when treating wastewater, but the submitter proposes to use it for treating crude oil. If there are no previous tests performed with crude oil, then the established technology would likely have a lower TRL in the oil spill response regime as opposed to the same technology in the field of wastewater treatment.

For the purposes of this effort, technologies with TRLs of 7 or 8 are the most sought-after for assembling a TET to conduct further assessment. TRL 9 technologies may be considered as well. The purpose is to focus resources on technologies that are closest to being ready for deployment if needed in an emergency response, without serving as a clearinghouse on existing and commercially-available products.

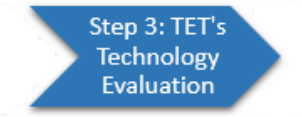
If the CG-MER representatives determine that the TRL is below a rating of 7, is not pertinent to address a gap, or for any other reason will not be sought after for further analysis by the convening of a TET, the submittal will be placed in CG-MER's catalog with notations regarding its viability of use and other relevant information. Technologies relevant to CG-MER's needs and that are assessed as TRL 7 or above may move forward to Step 2C of the Oil Spill Response Technology Evaluation Guidance.

Step 2C: Ensuring Information Sufficiency

The third and last requirement for the technology to move forward to Step 3 is to ensure that sufficient information has been provided by the submitter. CG-MER representatives can easily determine this by checking to see if the submitter provided all the necessary information as specified in the Minimum Required Information section (A.3.1) of this guidance document.

CG-MER representatives are encouraged to reach out to the submitter to request additional information, if needed. If they are unsure about the reliability of test data, but there is plausible justification on the submitter's part in supporting its own TRL estimation, the submittal may be forwarded for a TET evaluation. It is recommended that CG-MER representatives come to a consensus on information sufficiency before the technology is approved for Step 3 for a more in-depth evaluation. If the technology is not approved for Step 3, a notation describing the reason should be added to the submittal prior to inclusion in the catalog.

Step 3: Technical Evaluation Team's Technology Evaluation



Once CG-MER representatives agree that the technology described in the submittal is relevant, rated TRL 7 or higher, and that the submittal contains sufficient information, they will assemble the Technical Evaluation Team. The TET may consist of either three (3) or five (5) members to allow for majority rule. Also, a CG-MER representative will be identified as the TET chairperson during this time. The TET chairperson is the primary point of contact among all TET members, is responsible for distributing the submittal to the team, collects the TET members' answers to the evaluation form (see Figure A-2), and facilitates the TET meeting in which the technology's merits are discussed.

To assemble the TET, it is recommended that the TET chairperson reach out to appropriate oil spill response SMEs throughout the Coast Guard and other government agencies. They can be found at the Coast Guard's Research and Development Center (RDC), Coast Guard's District Response Advisory Teams (DRATs), BSEE, Coast Guard Sectors/Districts, the National Strike Force Coordination Center (NSFCC), the National Strike Force Center of Expertise (NSF COE), and National Oceanic and Atmospheric Administration (NOAA) Scientific Support Coordinators. Other CG-MER representatives can be included. The type of technology may guide the TET chairperson to identify the most appropriate SMEs. For example, if a proposed technology responds to oil spills in icy conditions, SMEs from Coast Guard District 9 or 17 or other government agencies, such as the U.S. Army Corp of Engineers Cold Regions Research and Engineering Laboratory (CRREL), would provide the most relevant feedback.

After all TET members have been identified, a non-disclosure agreement (NDA) will be sent to each for review and signature. Once the NDA form is signed, each TET member will receive the submittal and the associated evaluation form (Figure A-2). The TET chairperson will then schedule a short meeting via teleconference to explain the evaluation process and establish ground rules. Each TET chairperson's method of evaluation may differ, such as the allowance/disallowance of an internet search engine to be used as a tool to clarify uncertainties in the proposal, or if evaluation should be based only on information provided in the submittal. This teleconference will also be an opportunity for TET members to ask clarifying questions.

The TET members will review the submittal, fill out the evaluation form, and send it back to the TET chairperson. All the responses will be compiled into a single evaluation form, which will be distributed to the TET members before a second, and more in-depth meeting, if necessary. It is possible that most TET members arrive at the same conclusions about the proposed technology thus precluding the need for the second meeting. Also, the TET may determine that there is not enough information in the submittal to warrant a full review. In that case, the TET chairperson will need to communicate to the submitter and try to secure the additional information requested by the TET. If no further information is granted, the

evaluation may end at this time with a notation explaining that there was insufficient information for a full evaluation. In the end, the TET chairperson will make the decision on whether the second meeting is necessary or not.

However, if the second TET meeting is warranted, it will be held via teleconference and will allow all TET members the opportunity to discuss their responses and come to a consensus on each item on the evaluation form. The first item of the meeting will be to determine the level of agreement among the TET that the TRL is at least 7. Otherwise, further discussion is not necessary. If it is, then the technology's technical merits, scientific basis, and overall feasibility will be discussed. Results from the TET meeting will be utilized by CG-MER during Steps 4 and 5 of the overall technology evaluation process.

Steps 4 and 5: Synthesis of Results and Production of Technology Fact Sheet

CG-MER will use the technical information from Step 3 and determine the technology's relevance to the Unified Command's use in certain oil spill scenarios. Cost effectiveness, policy considerations, and further internal criteria regarding the technology in question may be discussed at this time. Other internal analyses may also be performed at CG-MER's discretion. Finally, facts about the technology will be organized in a manner suitable for CG-MER's purposes and added to the catalog. Further details about Steps 4 and 5 are not included in the scope of this guidance document.

Figure A-2. Technology Evaluation Form

Evaluation Form

Offeror:	[Name of Vendor]
Name of Technology:	[Name of Technology]
Evaluator's Name:	
Evaluation Date:	
Estimated TRL:	**[Numerical value, 1-9]**

Feasibility	1. Soundness of submitter's demonstrated approach based on operational principles and supporting science	[Insert comments]
	2. Degree to which the submitter's approach optimizes each of the listed factors described in the guidance document (discuss each factor addressed in proposal)	Factor 1: [Insert comments about Factor 1]
		Factor 2: [Insert comments about Factor 2]
		Factor 3: [Insert comments about Factor 3]
		Factor 4: [Insert comments about Factor 4]
		Factor 5: [Insert comments about Factor 5]
		Factor 6: [Insert comments about Factor 6]
		Factor 7: [Insert comments about Factor 7]
		Factor 8: [Insert comments about Factor 8]

		Factor 9: [Insert comments about Factor 9]
		Factor 10: [Insert comments about Factor 10]
		Factor 11: [Insert comments about Factor 11]
		Factor 12: [Insert comments about Factor 12]
		Factor 13: [Insert comments about Factor 13]
		Factor 14: [Insert comments about Factor 14]
		Factor 15: [Insert comments about Factor 15]
	3. Amount of developmental activities needed to achieve maximum effectiveness	[Insert comments]
	4. Amount of operator training necessary to use technology	[Insert comments]
	5. Demonstration of the skills, experience, and qualifications of the submitter	[Insert comments]
Technical and Scientific Basis	6. Credibility of test/previous spill data used to support claims	[Insert comments]
	7. Technology originality	[Insert comments]
	8. Amount of success achieved with technology in previous oil spill scenarios (if applicable)	[Insert comments]
	General Comments:	[Insert comments]

A.5 References

National Oceanic and Atmospheric Administration (NOAA) Office of Response and Restoration. Alternative Response Tool Evaluation System (ARTES). Retrieved from https://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/resources/alternative-response-tool-evaluation-system-artes.html

National Oceanic and Atmospheric Administration (NOAA) Office of Response and Restoration. Selection Guide for Oil Spill Response Countermeasures. Retrieved from https://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/response-tools/selection-guide-oil-spill-response-countermeasures

Panetta, P.D., and Potter, S. (2016). TRL Definitions for Oil Spill Response Technologies and Equipment, Report for Bureau of Safety and Environmental Enforcement, January 2016.

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