Recommendations to Verify and Sustain Prevention and Response System Readiness in Prince William Sound

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The opinions expressed in this PWSRCAC-commissioned report are not necessarily those of PWSRCAC.

Executive Summary

In 2018, Edison Chouest Offshore (ECO) will replace Crowley Marine Services as the provider of tugs, barges, equipment, and personnel for Alyeska Pipeline Service Company's (Alyeska) Ship Escort/Response Vessel System (SERVS). This transition will bring new tugs, barges, and equipment to Prince William Sound. New personnel will also come to Valdez, playing key roles in oil spill prevention and response for the Valdez Marine Terminal and associated tanker traffic.

The arrival of new tugs and custom-built response barges to Prince William Sound provides an excellent opportunity for improved oil spill prevention and response. In order to verify that this improvement is realized, it will be important to verify the capabilities of new crew, vessels, barges, and other equipment. The Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) contracted Little River Marine Consultants and Nuka Research and Planning Group, LLC to recommend options for to verify readiness of the new resources during the transition and in the future.

The authors recommend a combination of computer (mathematical) hydrodynamic modeling, full mission bridge simulations, scale-model testing, field demonstrations, and table top exercises (the latter related only to personnel and response decision-making). We recommend a series of activities to verify the capability of the new tugs and barges to assure their capability to perform oil spill prevention and response:

1. Conduct initial computer hydrodynamic modeling and full mission bridge simulations to identify the tug maneuvers most likely to be effective with the different tug and tanker configurations, and evaluate whether rescue maneuvers would be expected to stop a tanker within the distance available in different parts of the Sound up to worst-case conditions.
2. Conduct field demonstrations in a narrower range of conditions to validate the tug modelling results, beginning in calm conditions and working in up to at least 90th percentile conditions for both wind and waves based on data from Seal Rocks buoy near Hinchinbrook Entrance. (Based on 2013-2016 data, 90th percentile conditions are 22-knot winds and 12-foot seas.)
3. Use a combination of on-water and table top exercises to verify that the response system can deploy and sustain the response tactics according to the timeline and other specifications necessary to meet state response planning requirements.
4. Conduct ongoing exercises to sustain readiness related to both prevention and response for all crews and in all seasons.

The recommendations are based on U.S. Coast Guard and Alaska Department of Environmental Conservation regulations applicable to assessing oil spill prevention and response for tankers in Prince William Sound. Recommendations regarding verifying tug rescue capabilities follow the approach used when the current escort vessels were introduced in 1999-2001.

Acronyms

ABS – American Bureau of Shipping
ADEC – Alaska Department of Environmental Conservation
ARPA – Automatic radar plotting aid
BAT – Best Available Technology
DWT – deadweight tons
ECDIS – Electronic Chart Display and Information System
ECO – Edison Chouest Offshore
ETT – Enhanced Tractor Tugs
FLIR – Forward-looking infrared
PRT – Prevention Response Tugs
PWSRCAC – Prince William Sound Regional Citizens' Advisory Council
RMROL – Realistic Maximum Response Operating Limits
RPS – Response Planning Standard
SERVS – Ship Escort/Response Vessel System
STCW – Standards of Training, Certification, and Watchkeeping for Seafarers
TAPS – Trans Alaska Pipeline System
VERP – Vessel Escort Response Plan

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1 Introduction

With a new marine services provider coming to Prince William Sound in 2018, the Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) is interested in validating the assets and personnel readiness of Edison Chouest Offshore (ECO) who will replace Crowley Marine Services to prevent or respond to an oil spill in Prince William Sound. Little River Marine Consultants and Nuka Research and Planning Group, LLC developed this report to PWSRCAC recommending options for initial and ongoing evaluation of "readiness" of resources in Prince William Sound.

This transition will bring new – and in many cases, newly-constructed – tugs, barges, and equipment to Prince William Sound. Personnel will also come to Valdez, playing key roles in spill prevention and response for the Valdez Marine Terminal and Trans Alaska Pipeline System (TAPS) trade tankers transiting the Sound.

1.1 Scope

The scope of this report can be considered from three perspectives:

- **Oil spill prevention and response.** Both prevention and response operations will change with new vessels, equipment, and personnel.

- **Diverse methods in assessment toolbox.** It is impossible to predict exactly what will happen in any given emergency, whether a disabled tanker or oil release to water, so a range of tools are needed to evaluate the safety and effectiveness of emergency procedures absent an actual emergency. This report offers options including computer modeling, field demonstrations, drills, and exercises to evaluate safety and effectiveness.

- **Initial and on-going assessment.** This report considers both initial assessments that may be conducted prior to or upon arrival of new assets to Prince William Sound, as well as on-going drills or exercises for the purpose of training and demonstration of sustained readiness as have been conducted in Prince William Sound since 1989. Equipment selection, maintenance, and inspections are also important, but are not included here.

1.2 Purpose and Approach

The purpose of this document is to recommend a combination of modeling, field demonstrations, drills, and exercises to verify that new on-water assets and personnel are adequately prepared to respond and that practices are in place to ensure that preparedness, readiness, and response capabilities are sustained over time.

Recommendations provided are based on State of Alaska and federal regulatory requirements, international standards, precedent and past practices, and, in some cases, the best professional judgment of the authors.

This report does not evaluate the current transition process, or of planned or completed assessments or demonstration by Alyeska or ECO of their capabilities.

1.2.1 Organization of Report

The report first provides background information, then presents requirements and recommendations for initial demonstration of capabilities during the transition of new assets into Prince William Sound, followed by on-going exercises to ensure sustained readiness.

2 Background

This section provides general background regarding the relevant requirements that apply to SERVS. A more in-depth overview of the previous methods used to assess new tugs is provided in "Development of the Current Prince William Sound Escort System: Regulations, Analysis, and System Enhancements," by Nuka Research (2017).

New vessels include:

- Five Escort Tugs (ASD 4517 vessels are 140 feet long with 12,336 horsepower)
- Four General Purpose Tugs (ASD 3212 vessels are 102 feet long with 6,008 horsepower)
- The *Ross Chouest*, (257-foot, 11,400 horsepower utility vessel)

In addition, four new purpose-built response barges will replace older barges.

2.1 Prevention

Tugs in Prince William Sound play the following prevention roles:

- Assisting with docking and un-docking tankers at the Valdez Marine Terminal (both on a routine basis and in an emergency, such as a fire at the Terminal),
- Escorting tankers through the Sound (tethered to the tanker, escorting closely but not tethered, or standing by as a sentinel depending on the location in the Sound and whether the tanker is laden),
- Scouting for ice or other hazards, and
- Aiding a disabled tanker to prevent grounding, allision, or collision.

Tugs also standby with response barges located around the Sound and contribute to response, as discussed in the next section.

Tugs must be capable of implementing rescue maneuvers that have been developed for the current Enhanced Tractor Tugs (ETT) and Prevention Response Tugs (PRT) through extensive computer modeling, tank tests, and full-scale demonstrations. Implementing these maneuvers successfully will depend on the vessel's design and capabilities, the performance of equipment such as the rendering winches and tow wires, and towlines used. The success of any rescue will also depend on the size of the tanker, weather conditions at the time, location within the Sound (i.e., available sea room). The intent of any analyses or exercises is to increase the chance of success when the system is called on to prevent an accident or oil spill.

The use of two escorts for laden tankers within the Sound is required under federal regulations (33 CFR 168) which also describe the minimum performance requirements (see Section 3). The system is also described in Alyeska's Vessel Escort Response Plan (VERP). The VERP (Alyeska, 2013) describes the escort vessels and equipment, communications, normal and emergency procedures, and other aspects of the system.

Tugs are also included in the State of Alaska-required Prince William Sound Tanker Oil Discharge Prevention and Contingency Plan (Tanker C-Plan) and associated SERVS Technical Manual. Regarding tug escorts, state regulations require:

- *Prevention measures.* The spill prevention role of tug escorts is cited in that plan's required discussion of spill prevention measures in place (Tanker C-Plan Section 2.1.6).[1]
- *Prevention – or other mitigating – measures in place when conditions exceed Realistic Maximum Response Operating Limits (RMROL),* as specified in Tanker C-Plan Section 3.4.[2]

[1] 18 AAC 75.425(e)(2)(D)
[2] 18 AAC 75.425(e)(3)(D) and 18 AAC 75.445(f)

- *A tanker under escort must be operated in a manner that allows the escort to, "be available immediately to provide the intended assistance to the tank vessel."*[3] Alaska Department of Environmental Conservation (ADEC) Guidance (2016) states that if an escort system is used, the plan must describe that system including the escort vessel's "relative ability to stop, turn, and tow loaded tank vessels under prevailing wind, sea, and current conditions."[4]
- *Escort tugs and towlines must be "best available technology" (BAT).*[5] BAT is defined in regulation according to 8 criteria:[6]
    - i. Best in use in similar situations,
    - ii. Transferrable for use by the operator,
    - iii. Reason to expect it will improve spill prevention/response,
    - iv. Cost,
    - v. Age and condition of current equipment used,
    - vi. Compatibility with existing systems,
    - vii. Feasibility, and
    - viii. Environmental impacts associated with its use do not offset anticipated environmental benefits.

BAT regulations apply to a wide range of equipment across different types of operations. They are not prescriptive regarding how a piece of equipment's relative benefits are compared to other similar equipment.

This report identifies or recommends methods for verifying the capabilities of the escort vessels to meet the State's requirements.

2.1.1 Response

If a response is needed, tugs would shift to response roles, including maneuvering a lightering barge or assisting the tanker, maneuvering response barges, and, if used, applying dispersants. The response barges are used in the event of an oil spill as a platform for skimming operations, recovered fluid storage, crew housing, logistical support, command center, and lightering oil from a stricken tanker. If there are other tankers in the system, tugs will also remain with them as needed to meet escort requirements.[7]

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[3] 18 AAC 75.027(e)

[4] We understand from this statement that operators have flexibility in tug selection (e.g., using a smaller tug for smaller tankers) and that the tugs used should be able to perform their roles in the conditions in which tankers will be operating in the Sound and the Gulf of Alaska.

[5] 18 AAC 75.425(e)(4)(A)(iii)

[6] 18 AAC 75.445(k)(3)(A-H)

[7] A 2005 workshop sponsored by Alyeska/SERVS and the Prince William Sound Tanker Owners concluded that the minimum number of tugs needed for an RPS-sized spill response is 10 (Harvey, 2005).

As an integral part of the response system, barges and associated tugs contribute to meeting the response planning standard (RPS) under Alaska regulations.[8] The Tanker C-Plan[9] must indicate procedures to clean up the largest possible spill resulting from the operation covered,[10] but oil recovery estimates based on equipment in the region must meet specific metrics based on the size of the tanker and any reductions granted for prevention measures in place.[11] The recovery that could theoretically be achieved using resources from both within the region and those brought from elsewhere must also meet a certain standard.[12] The applicable standards for Prince William Sound tankers are summarized in Table 1.

Table 1. Response planning standards in the Tanker C-Plan

Tanker C-Plan RPS based on equipment within the region (Prince William Sound Subarea)	Tanker C-Plan RPS based on both in-region and out-of-region equipment
Must have sufficient equipment kept within the region to contain/control and cleanup a minimum volume that reaches water based on vessel size in 72 hours	Must have sufficient equipment operating in 72 hours to contain, control, and cleanup at least 60 percent of total cargo capacity, less prevention credits.
In-region RPS volume = 300,000 barrels (bbl) for tankers with cargo volume greater than 500,000 bbl [18 AAC 75.438(b)(2)	Volume of largest tanker (190,000 DWT) 1,300,311 bbl 60 percent of volume [per 18 AAC 75.438(c)] 780.210 bbl Prevention credit for tanker double hulls/bottoms -234,063 bbl **Total RPS Volume = 546,147 bbl**

State of Alaska C-Plans must identify resources and procedures sufficient to meet the RPS.[13] They must include scenarios that describe a response to the two RPS volumes, as well as procedures to stop the spill at its source, lighter oil from a stricken vessel, mitigate fire risk, track the slick, transfer recovered fluids, store and ultimately dispose of recovered oil or other contaminated materials, rescue wildlife, and clean up the shoreline.[14] The Tanker C-Plan also describes shipper compliance with federal response regulations,[15] using a cross-reference to show the applicable section of the plan or associated SERVS Technical Manual. These requirements include identifying salvage, lightering, and firefighting resources, as well as

[8] 18 AAC 75.438 and 18 AAC 75.438(c)

[9] There is a separate c-plan for the Valdez Marine Terminal which also includes response to spills reaching the water, with the same assets designated for that response. This report focuses on the Tanker C-Plan because it covers the tankers through the Sound and all aspects of the escort system.

[10] 18 AAC 75.430(a)

[11] 18 AAC 75. 438. The escort system is a prevention measure, but where there are multiple prevention measures in place, the total credit given for prevention may not exceed 30 percent of the volume.

[12] 18 AAC 75.430(c)

[13] 18 AAC 75.425(a)

[14] 18 AAC 75.425(e)(1)(F)

[15] 33 CFR 155, Subpart D

identifying sufficient skimming, containment, and storage assets to respond to a worst-case discharge.[16]

In the Tanker C-Plan, the scenarios assume that open-water recovery[17] will continue to be deployed during darkness (RPG, 2017). The Tanker C-Plan also identifies the weather and oceanographic conditions that will limit the response system. Table 2 identifies the quantified realistic maximum response operating limits (RMROL) for mechanical recovery as identified in the Tanker C-Plan. Other conditions that may affect a response and are identified but not quantified include: currents, precipitation, ice, and darkness/fog.

Table 2. RMROL from Tanker C-Plan

Condition	RMROL per 2017 Tanker C-Plan
Wind speed	30-40 knots
Wave height	10 feet
Visibility	0.125 nautical miles
Wind chill	< 15 degrees Fahrenheit air temperature, winds of 24-28 knots

Response is considered to be BAT if it meets the RPS.[18] As meeting the RPS is required for ADEC approval, response equipment is not subject to the BAT analysis required for escort vessels and other system elements identified in the regulations. However, this provision reinforces the importance of ensuring that the boom, skimmers, barges, storage, vessels, and other resource are sufficient to meet the RPS requirements.

The response system is described in the Tanker C-Plan, Valdez Marine Terminal Oil Discharge Prevention and Contingency Plan, and SERVS Technical Manual. Response planning scenarios refer to tactics in the SERVS Technical Manual which describe how equipment and vessels will be configured for deployment and personnel needs for each. Recommendations are offered in this report for demonstrating the effective deployment of response tactics with the new tugs and barges coming into the Sound.

2.1.2 Assumptions Regarding Baseline Vessel Inspection and Classification

This report assumes that the new vessels will be inspected by the U.S. Coast Guard and classed by the American Bureau of Shipping (ABS), so we do not discuss related evaluation criteria. ECO has indicated that they will use ABS classification. While this is typical for U.S.-built vessels, we do note that the requirements for "escort" classification with ABS are less specific and less rigorous than those undertaken internationally by DNV GL or Lloyd's Register. More

[16] 33 CFR 155.1120

[17] On-water recovery is conducted in both open-water (using the barges discussed here) and the nearshore environment (primarily by fishing and other vessels brought into the response).

[18] 18 AAC 75.445(k)(1) applies to equipment used for containment, storage, transfer, and cleanup.

information may be found in "Industry and Class Standards for Escort Tugboats," by Little River Marine Consultants (2017).

3 Demonstration of Capabilities for Transition

This section recommends an approach to demonstrating that the new assets are capable of fulfilling their necessary roles in Prince William Sound. We recommend doing so through a combination of modeling and simulations with on-water trials. In doing so, we draw on federal and state regulatory requirements as well as precedent set in previous reviews of new equipment in Prince William Sound.

3.1 Prevention

For their spill prevention role, tugs must meet requirements for a dual escort system in Prince William Sound, established under U.S. Coast Guard regulations under the Oil Pollution Act of 1990. They must also be the BAT for their respective roles under ADEC regulations.

After demonstrating that tug vessels meet ABS and U.S. Coast Guard requirements, we suggest both modeling/simulations and field demonstrations. These would be used in tandem:

- Initial modeling to indicate the maneuvers that are most likely to be effective (and whether they would be expected to stop a tanker within the distance available in different parts of the Sound) and in the full range of wind and sea conditions,
- Full-scale field demonstrations with tugs and tankers to validate the model results, beginning in calm conditions and working up to at least 90th percentile conditions for both wind and waves based on Seal Rocks buoy data, and
- On-going exercises to sustain readiness. (Discussed in Section 4.)

While there is precedent for conducting field demonstrations in closure conditions (as done with the *Overseas Ohio* in 2004), we recommend in this case that full-scale field demonstrations should be done first in calm conditions, then repeated as needed in building conditions until 90th percentile conditions for both wind and waves (based on Seal Rocks buoy) have been demonstrated.[19] (This may require separate exercises to cover both wind conditions and wave

[19] The National Data Buoy Center's buoy #46061 near Seal Rocks is widely accepted as the most consistent, reliable source of observational marine data in the Hinchinbrook Entrance area. It is used to establish closure conditions for laden tankers. In using this data, we acknowledge that the National Weather Service recognizes that moored buoys tend to under-report sustained wind speeds when large or steep waves are present. Sustained wind speeds are recorded as the average wind over eight minutes. The under-reporting occurs for two reasons: (1) in large waves, the buoy is shielded from wind when in the trough, and (2) in steep waves, the buoy will tip such that the anemometer is no longer perpendicular to the surface wind and reported wind speed is reduced. Both effects are exacerbated the higher or steeper the waves become (Zingone, 2004). Because of these effects as well as the location of Seal Rocks buoy in a relatively sheltered location, it is estimated that when closure conditions of 45-knot winds or 15-foot seas are recorded at Seal Rocks buoy, actual conditions in the adjacent Gulf of Alaska could be 57-knot winds or 20-foot significant wave height (Robert Allan Ltd., 2016).

conditions, which will not necessarily be concurrent.) While modeling and computer simulations can easily extend to worst-case conditions, field demonstrations in rough conditions raise safety concerns, though also provide valuable crew training to enhance safety.[20]

Although exercising in the worst conditions that ships are allowed to transit would provide the best information and contribute to building a safe system, using the 90th percentile conditions for Hinchinbrook Entrance will provide the necessary information on forces exerted and vessel performance to validate the modeling. As Table 3 shows, the 90th percentile conditions are actually not quite half way between calm and worst case conditions. This approach means that around 10 percent of the time throughout the year, conditions can be expected to be worse than those exercised.[21] Greater than 90th percentile conditions are exceeded approximately 20 percent of the time in December, January, and February (NDBC, 2017). Tugs will still be expected to respond as long as tankers are in the system.

Based on 2013-2016 data from the Seal Rocks buoy, the 90th percentile wind speed is 21.58 knots and wave height 12.2 feet.[22] When recommending use of 90th percentile conditions throughout this report, we round to 22-knot winds and 12-foot seas. Annual percentiles for 2013-2016 are shown in Table 3.

Table 3. Annual percentiles for Seal Rocks buoy (2013-2016 data)

Percentile	Average wind speed* (knots)	Significant wave height** (feet)
Min	0.00	0.00
25th	5.83	3.64
50th	10.30	5.51
75th	15.75	8.56
80th	17.30	9.45
90th	***21.58***	***12.2***
95th	25.46	14.73
Max	41.60	28.44

*Wind speed is averaged over an 8-minute period and reported hourly.
**Significant wave height is the average of the highest one-third of all wave heights taken during a 20-minute sampling period.

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[20] Vessel captains *always* have the discretion to stop an exercise at any time due to safety concerns.

[21] Closure conditions are reached less than 2 percent of the time, per the 2017 Tanker C-Plan. However, as closure conditions apply only to outbound laden tankers transiting the Sound (Alyeska, 2013), a rescue may be needed in higher conditions for a tanker in ballast transiting the Sound, or for a tanker in the Gulf of Alaska that is not transiting the Sound whether laden or in ballast.

[22] A Small Craft Advisory in Alaska is defined as, “Sustained winds or frequent gusts of 23 to 33 knots. A small craft advisory for rough seas may be issued for sea/wave conditions deemed locally significant, based on user needs, and should be no lower than 8 feet.” NWS, 2014). The Escort Tugs and General Purpose Tugs are not considered small craft.

3.1.1 Demonstrating minimum requirements for dual escort in Prince William Sound

Dual escort requirement. The U.S. Coast Guard requires a dual escort for laden tankers in Prince William Sound.[23] With nine new tugs and one new utility vessel, the number of SERVS vessels will remain the same with the new assets. As long as the capability of each vessel type is proven, the overall number of vessels indicates that the dual escort requirement will be met and further evaluation is unnecessary.

Escort vessel performance requirements. U.S. Coast Guard regulations specify minimum capabilities for escort vessels. Those requirements are that the two escorts can achieve the three performance standards below working either separately or in tandem:[24]

1. *Towing the tanker at 4 knots in calm conditions, and holding it in steady position against a 45-knot headwind.*

2. *Holding the tanker on a steady course against a 35-degree locked rudder at a speed of 6 knots.*

3. *Turning the tanker 90 degrees, assuming a free-swinging rudder and a speed of 6 knots, within the same distance (advance and transfer) that it could turn itself with a hard-over rudder.*

The U.S. Coast Guard regulations are silent regarding exactly how these capabilities must be proven. They are also silent on the applicable weather conditions (except one reference to wind speed), geography (e.g., ensuring that a tanker could be taken under control within available sea room), or tanker size. However, as the regulations are part of the requirement for a dual escort in Prince William Sound, any exercise to qualify the tug under 33 CFR 168.50 would best be executed in Prince William Sound, utilizing the tankers that the tugs will be responsible for escorting and the conditions in which tankers will be operating. The results of the exercises should be documented, and information used to inform the activities described in the next section. If an exercise is being conducted in 45-knot winds to demonstrate item 1, above, it could provide helpful information towards validating the modeling suggested below.

3.1.2 Ensuring tug escort system is sufficient for Prince William Sound

The new vessels coming to Prince William Sound are different designs than the current vessels. They are slightly more powerful than the current vessels and have updated features including render-recover winches, load monitors, and integrated forward looking infrared

[23] 33 CFR 168.40(a). The regulations define “escort vessel” as, “Escort vessel means any vessel that is assigned and dedicated to a tanker during the escort transit, and that is fendered and outfitted with towing gear as appropriate for its role in an emergency response to a disabled tanker (33 CFR 168.05). This could include either the “Escort Tugs” (Damen 4517) or “General Purpose Tugs” (Damen 3212) vessels being constructed for Prince William Sound.

[24] 33 CFR 168.50(b)(1-4). *There is no requirement at 33 CFR 168(b)(2).*

(FLIR). However, it is just as important to verify tug and crew capabilities and identify the most effective rescue maneuvers as has been done in the past. In order for the system to be sufficient for Prince William Sound, it must at minimum meet State of Alaska requirements in addition to the U.S. Coast Guard requirements discussed above.

When the current tugs were introduced to Prince William Sound in 1999-2001, substantial precedent was established through a collaborative effort to determine that the vessels were BAT at that time (see "Development of the Current Prince William Sound Escort System: Regulations, Analysis, and System Enhancements" by Nuka Research for a detailed description of this process), ultimately resulting in an ADEC finding that the system would be BAT with the (then) new vessels. Because BAT is examined during each contingency plan renewal, ADEC has upheld that finding (ADEC, 2017), though this must be revisited when a new Tanker C-Plan is submitted for renewal describing the new assets or if technology changes warrant a reconsideration of BAT. The previous approach to approving new tugs as BAT for Prince William Sound therefore provides an applicable precedent for the introduction of new tugs this time.

The approach focused on Valdez Narrows[25] and Hinchinbrook Entrance. Both areas have limited sea room compared to other parts of the Sound. Hinchinbrook Entrance is also recognized for its potential high winds and seas. We recommend a somewhat streamlined version of the approach used in 1999-2001. Wherever possible, information gained during the 1999-2001 process can be applied to minimize the effort required this time. For example, worst case tanker trajectories have already been established.

The approach recommended in this report provides a conservative (with field demonstrations in less than maximum operating conditions) means of assessing expected tug performance and comparing that performance to the current vessels (ETT and PRT). While the first BAT criteria – that the escort vessels be the best in use in similar situations – clearly intends a consideration of escort technologies globally (and the Tanker C-Plan discusses systems in Scotland; Newfoundland, Canada; and Norway) (RPG, 2017), a comparison of the performance of proposed *new* vessels provides a prudent *minimum* requirement and mirrors the process applied in the past.[26]

The analyses recommended here are not only relevant verifying the tugs as BAT, but will also provide critical information for the tanker operators regarding the best maneuvers to use in different locations or situations. These are described in the 2013 VERP for the current system.

Use established worst-case tanker trajectories at Hinchinbrook Entrance to assess tugs. Worst case tanker trajectories have already been established, including wind, wave, and current conditions as well as rudder failure (see below). As the scenario parameters for worst-case

[25] Speed restrictions and tethering were put in place for Valdez Narrows following the 1994 Disabled Tanker Towing Study analysis. (The Glosten Associates, Inc., 1993; 1994)

[26] When ADEC approved the current ETTs as BAT in 1999, they offered the reasoning that the tugs represented an improvement over the vessels that had been in place until that time. They also indicated that they had considered tug technology more globally, and were not aware of anything better at that time (ADEC, 1999).

trajectories were already developed and agreed to by Alyeska, ADEC, and PWSRCAC (under ADEC's requirements), and the trajectories used to determine the necessary rescue procedures and compare the performance of different tugs in achieving those rescues, we do not see a need to conduct additional trajectory analysis.

The following parameters were used for previous worst case trajectory analyses (RPG, 2000):

- ***Tanker:*** 211,000 DWT laden (other sizes studied in previous analyses)
- ***Failure scenario:*** Rudder fails, followed by shutdown of propulsion at 30 seconds (rudder failures between 0 – 10 degrees)
- ***Tanker speed:*** 10 knots
- ***Winds:*** 45 and 50 knots; direction variable (southeast, astern, headwind)
- ***Wave height:*** 15 feet; wave period 13 seconds (for Hinchinbrook Entrance) and 14.5 seconds (for Gulf of Alaska)
- ***Currents:*** None or 2.5 knots

Conduct modeling to inform and establish maneuvers, including in worst case trajectory conditions. Modeling can provide an initial indication of tug performance without the expense or risk associated with on-water exercises. Establishing maneuvers best-suited to the tanker/tug interactions is critical to both evaluating system performance and training operators.

Rapid steering assistance to a tanker requires that the escort tug be tethered to the stern of the tanker to apply steering and/or braking forces in the event of a mechanical failure. In the event of a failure, the tug is utilized to reduce off-track transfer and to begin to move the tanker away from a hazard. When rapid assist is needed, and exactly how it should be executed is a key aspect of demonstrating that current procedures established for escort and rescue in Prince William Sound will be effective (or demonstrating others if new procedures are warranted with the new tugs).

There are several types of modeling that have been applied previously and will have value in assessing the new system:

- **Computer hydrodynamic models** utilize mathematical formulas created to mimic the reaction of the ship to external forces such as tug steering and braking forces, wind, and sea conditions. The output is a plot of the ship's speed, advance and transfer during the exertion of external forces (Hensen, 1997). Modeling conducted in 2000 established the off-track distances within which a tanker could be brought under control assuming both rapid steering assist (within 4 minutes) as well as a 30-second delay before any mitigation action is taken (RPG, 2000). These results all provide metrics that can be used when applying the new tugs to the worst-case trajectories.

- **Full mission bridge simulations** incorporate vessel operator inputs through a "live" simulation using actual vessel controls. The inputs from the computer combined with the commands given by the person handling the controls provide both a visual representation on a simulated vessel bridge and a graphic plot of the trajectory of the ship during the exercise.

- **Self-propelled scaled vessel models** in a test tank provide real life data about the behavior and stability of the modeled vessel in various maneuvering scenarios. Tank tests can be used to validate seakeeping predictions, scaled forces exerted on a tanker during indirect maneuvers, and intact vessel stability during the occurrence of deck edge immersion.

Table 4 indicates recommendations for minimum tug modeling following the prior approach.

Table 4. Recommendations for minimum tug modeling and analyses

	Key Action	Purpose
1	Computer hydrodynamic modeling *and* full mission bridge simulations of **tanker control under both 45-knot winds and 15-foot seas as well as worst-case conditions** based on the established worst-case trajectories established for Hinchinbrook Entrance. Should be conducted for any vessels serving escort roles at Hinchinbrook Entrance. (Escort Tug, General Purpose Tug, *Ross Chouest)*	Provide performance data on the capabilities of vessels to carry out the intended service through Hinchinbrook Entrance in both closure conditions (45-knot winds or 15-foot seas) and established worst-case wave period, wind direction, current speed, and direction using current TAPS tanker profiles. Establish the theoretical operating limitations for the tug to prevent a grounding until tanker is taken under tow.
2	**Scale model testing** of free running speed trials starting with calm water, then up to at least 20-foot sea state. Vessel should be in loaded condition (power vs. speed) at 10-16 knots. Use both bare hull and self-propelled model in ship model basin or towing tank. (Escort Tug, General Purpose Tug, *Ross Chouest)*	Determine response and escort speeds vs. sea state. Determine speed loss vs. power, acceleration, motion amplitude at critical working locations on board the tug, sea keeping, and deck wetness.
3	Computer hydrodynamic modeling *and* full mission bridge simulations of **indirect steering and braking** maneuvers in: • Simulated calm water conditions • Worst-case conditions • Winds at intervals between calm and worst-case, including different directions (ahead, astern abeam, on forward and aft quarters) Vary vessel speeds: 6, 8, 10, and 12 knots. (Escort Tug, General Purpose Tug, *Ross Chouest)*	Establish approximate tow line forces, heel angle, deck wetness, and deck edge immersion parameters for safety of vessels and crews in addition to tanker advance and transfer distances. Identify any applicable limitations on safe operations in different conditions for the three vessels.
4	**Self-propelled model testing** of indirect steering and braking maneuvers in simulated varying sea states up to at least 10 feet and speeds of 6, 8, 10 knots. (Escort Tug, General Purpose Tug, *Ross Chouest)*	Establish approximate tow line forces, heel angle, deck wetness, and deck edge immersion parameters for safety of vessels and crews. This is a step towards validating the results of computer modeling.
5	**Develop tug maneuvers** (using rapid steering assist when warranted) based on model results. (Escort Tug, General Purpose Tug, *Ross Chouest,* according to how they would be used*)*	Determine best possible procedures for new vessels in all operating areas, including which roles each is suited for and any limitations (e.g., whether for small tankers only). Procedures may be the same as current procedures, but this needs to be demonstrated or any necessary changes identified.

Conduct field demonstrations to demonstrate tug roles and collect data to validate modeling. By necessity, modeling requires a simplification of complex processes into mathematical algorithms. As documented in the Disabled Tanker Towing Study (Part 2) (The Glosten Associates, Inc., 1994), computer modeling tends to over-estimate the actual performance of escort tugs because it cannot possibly account for all variables (e.g., operator ability, difficulty keeping the vessel at the optimum angle of attack to produce maximum tow line forces, and variable environmental conditions during the live exercise). Field demonstrations are an important way to validate model results, while also giving crew members a valuable training opportunity.

Not all field demonstrations need to include tankers: just demonstrating the tug (or utility) vessel's behavior in high winds and waves can provide useful data and understanding of a vessel's capabilities or possible limitations. The ability to operate safely in rough conditions should be considered a prerequisite to assuming a vessel and crew could operate safely when maneuvering around and attempting to control a tanker in those same conditions. This information can be used to validate any modeled seakeeping analyses.

Full-scale tug field demonstrations – with a tanker – should be conducted in various sea, wind, and operational conditions as described in each of the items listed in Table 5. The *purpose* of all exercises listed is to verify vessel suitability and crew skill in carrying out appropriate steering and braking force capability maneuvers that would be used throughout the tanker transit route (both tethered and un-tethered escorts). The exercises can also verify steering and braking force predictions and winch performance against the forces generated. Data should be recorded from the exercise to demonstrate the proposed tugs as BAT (see next step) and to revise any model inputs if additional analyses were to be deemed necessary, though further modeling should not be needed unless the field demonstrations indicate a significant deviation from expected performance.

Table 5. Recommendations for minimum field demonstrations to validate model results and demonstrate tug capability

	Key Action	Purpose
1	**Seakeeping exercises** *without* a tanker in both 45-knot winds and 15-foot seas. (Escort Tug, General Purpose Tug, *Ross Chouest)*	Validate seakeeping analysis and model results regarding heel angle, deck wetness, and deck edge immersion parameters for safety of vessels and crews.
2	Conduct full scale demonstrations of **indirect steering and braking** maneuvers in up to at least 90th percentile conditions based on Seal Rocks buoy and speeds at 6, 8, and 10 knots. (Escort Tug, General Purpose Tug)	Validate maneuvers developed based on model results. Document and collect data.
3	Conduct full scale exercises of the escort vessel(s) **approaching, making up to, and towing** a disabled laden tanker at 6 knots for a period of 30 minutes executing a 90 degree turn during the exercise, from both bow and stern in the **Gulf of Alaska.** *This area is different from areas within the Sound due to the southerly fetch of the wind, length of time taken in the tug reaching the tanker, and attitude of the tanker in the seas by the time the tug arrives.* Demonstrate in calm conditions and up to at least 90th percentile wind/waves based on Seal Rocks buoy. (Escort Tug, General Purpose Tug, *Ross Chouest)*	Validate maneuvers developed based on model results. Document and collect data.
4	Test **assist/oppose the turn maneuvers** with loaded tanker using tugs in anticipated escort roles at 6, 8, and 10 knots. Demonstrate in calm conditions and up to at least 90th percentile wind/waves based on Seal Rocks buoy. (Escort Tug, General Purpose Tug, *Ross Chouest)*	Establish turning radius, course stability (ahead/astern), and indirect performance in varying sea state conditions.
5	Where TETHERED escort would be used, demonstrate indirect braking and steering maneuvers on a loaded tanker from a tethered position to: • Oppose the turn • Assist the turn Use Escort Tugs and General Purpose Tugs in anticipated escort roles at 6, 8, and 10 knots. Demonstrate in calm conditions and up to at least 90th percentile wind/waves based on Seal Rocks buoy.	Validate maneuvers developed based on model results. Document and collect data.

	Key Action	Purpose
6	Where UNTETHERED escort is used only, demonstrate indirect braking and steering maneuvers from a close escort position (1/4-nautical mile) to: • Oppose the turn • Assist the turn Use Escort Tugs and General Purpose Tugs in anticipated escort roles at 6, 8, and 10 knots. Demonstrate in calm conditions and up to 90th percentile wind/waves based on Seal Rocks buoy.	Validate maneuvers developed based on model results. Document and collect data.

Compare results of field demonstrations and modeling for proposed vessels to those generated for ETT and PRT to demonstrate that new tugs and personnel maintain or improve the current level of prevention in Prince William Sound.

Since the primary purpose of the escort system is to prevent a vessel grounding, the comparison should be based on tanker advance, transfer, set, and drift. The VERP (2013) states that computer modeling indicates an ETT and PRT (current tugs) together can control a laden tanker up to 211,000 DWT within the maximum allowable off-track distance of 900 feet by "opposing the turn." In Valdez Arm, an escort should be able to control the tanker by "assisting the turn" within 3,000 feet. The VERP identifies the modeling results for 211,000 DWT and 90,000 DWT tankers in 40-knot winds and 6-9-foot seas both opposing and assisting the tanker turn (at 6, 8, and 10 knot speeds). These are based on computer model simulations assuming a hard-over rudder and no current. This information will need to be updated for the VERP anyway, as it provides critical guidance regarding the procedures where a tug would or *would not* be expected to achieve an off-track distance to keep the tanker within the safety zone. Based on this data, the VERP recommends that while the current tugs can control the largest tankers within the maximum allowable off-track distance in Valdez Narrows (at 6 knots), when the tanker speeds up in Valdez Arm (8 or 10 knots), the standard maneuver should be to "assist the turn" in order to control the tanker in time, as the "oppose the turn" method is not likely to work. (Alyeska, 2013)

3.2 Response

On the response side, no modeling is required. However, it will be necessary for replacement response crews to demonstrate that they can deploy equipment to meet the RPS. This includes deploying equipment according to the timeline and configurations (tactics) described in the Tanker C-Plan scenarios. Deployment should be demonstrated with on-water exercises in conditions up to RMROL, should include elements that will be necessary to sustain operations for the necessary amount of time (e.g., crew shift changes from barges with Current Busters deployed alongside) and response in darkness where that is a planning assumption (e.g., use of lighting, FLIR, etc.). In its most recent findings document at the conclusion of the 2016-2017 Tanker C-Plan review, ADEC indicated a commitment to continuing to work with plan holders to ensure operations in darkness are a focus of future exercises and training, and to evaluate operations in various weather conditions (ADEC, 2017). Exercises during the transition process provide an excellent opportunity to examine both.

Exercises should also be used to assess the number and required competencies of personnel involved in each activity, and whether the number identified in the Tanker C-Plan is sufficient. Personnel are an explicit element of the deployment strategies that must be identified [18 AAC 75.445(c)].

Additionally, as noted previously, response equipment must be demonstrated to meet the RPS in order to be considered BAT.

The recommended exercise objectives in Tables 6 and 7 below can be combined in one or more on-water response exercises. (The purpose of all of these items is the same: to demonstrate the ability to meet the RPS based on tactic configurations, personnel, and other planning assumptions as described in the Tanker C-Plan.) While practice exercises are recommended, ultimately these elements should also be *demonstrated* in conditions up to RMROL.

Because new equipment primarily affects open-water recovery, which is largely based on the response barges, the fishing vessel program that comprises the majority of the nearshore recovery system will remain unchanged.

Table 6. Response system elements to be demonstrated – Open water recovery systems

	Key Action	Purpose
1	Test timing for deployment of **open-water response barges** at hypothetical spill site. Drill should be: - Under accepted weather conditions for planning purposes (17-knot winds and 6 foot seas) - Conducted in central or southern Prince William Sound - Unannounced with no advance notice for prep on barges	Verifying how long it takes to get barges under tow and reach spill location is critical to meeting RPS. ***Unannounced drill.***
2	Demonstrate deployment of **all relevant on-water recovery tactics** based on open-water response barges, in all conditions up to RMROL.[27] Document any cases where either on-site mobilization or operations are impacted by conditions and would necessitate seeking coverage in sheltered areas.	Response equipment must be suitable for the RMROL conditions described in the plan. If this is not demonstrated in an on-water exercise, then acquired data will need to be extrapolated to determine if the RMROL calculations used in the plan are sufficient. If barges must transit to a protected location to deploy equipment in adverse weather conditions, determine effects on meeting RPS based on recovery time calculations used in plan.
3	Demonstrate **decontamination procedures** and equipment are in place for open-water recovery operations. Demonstrate use of a written plan describing set up and use of decontamination method for each barge, determine how many people are required to set it up and support its use, and determine how long it takes crews away from other duties. Decontamination should be set up prior to beginning recovery.	Verify adequacy of classroom training. ***Should be conducted in conjunction with #1 to ensure personnel numbers are adequate.***
4	Verify **skimmer operations**, including skimmer disk speed rotation; debris removal; efficiency; impact of wind/waves, oil conditions, or debris on skimming operations; and operator competency. Document any limitations to skimmer operation. Operators should be asked how they determine when debris needs to be removed and demonstrate debris removal. This should take into consideration the different tactic configurations in which the barges could be used.	Determine personnel and equipment needed for all elements of the response as per the plan. ***Conduct up to RMROL conditions; could be done in conjunction with #2, above.***

[27] During initial testing of the prototype open-water barge there were some challenges deploying the boom and setting the skimmers into the pocket in other than calm conditions.

	Key Action	Purpose
5	Demonstrate **open-water recovery operations in darkness** with each barge. This element of the response cannot be taught to crews solely under classroom conditions, and includes ensuring all barges are adequately equipped. They should start with the basic elements of the response and advance until all functions of the response are carried out in darkness. If safety is called into question, then measures should be developed to ensure safety can be achieved in the event of an actual response, and those measures incorporated into the Tanker C-Plan.	Assess personnel capabilities. In order to be able to successfully carryout all response functions in times of darkness, multiple drills must be done during different seasons.
6	Demonstrate oil tracking to keep open-water barges in the thickest concentrations of oil. Include: - Tug crew operating forward-looking infrared (FLIR) system and applying the information to adjust barge position - Management of task force to maximize skimming operations	In a tabletop exercise, show decision making process needed to stay in the thickest oil by reacting to screen shots from the FLIR which depict oil on the water in various thicknesses. Additionally, demonstrate communication with the Task Force Leader and Unified Command. (It is not intended that oil would be released for this demonstration.)
7	Demonstrate ability to conduct **atmospheric testing** prior to (and during) a response. Atmospheric testing must continue in order to ensure that crews remain safe and operations can be sustained as planned.	Verify classroom training adequacy and determine crewing needs. Ensure resources and personnel are in place to conduct testing *before* response begins. ***Could be conducted with #1, above.***
8	Demonstrate ability to **offload open-water recovery barges** safely and that all necessary equipment if available.	Verify classroom training adequacy, equipment, and determine crewing needs. Focus is on decision-making process, coordination with captain of receiving vessel, etc. Does not require actual offloading.
9	Demonstrate ability to **decant** free water from open-water barges and *Valdez Star*, if it remains part of planning assumptions. Includes: - Verifying that decanting plan is on board (both barges and *Valdez Star)* - Identify who is designated to implement decanting - Assess any impact to other activities on recovery platforms (due to tankage issues or crew needs)	Verify classroom training adequacy, equipment, and determine crewing needs.

	Key Action	Purpose
10	Demonstrate **deployment of the *Valdez Star*** both with and without the secondary storage barge alongside. Includes: - Operation of the skimming systems - Maneuvering with engines and thruster - Continual offloading to the secondary barge on a real-time basis - Decanting - Debris removal from the hopper.	Requires deployment of support vessel used to maneuver storage barge (when barge used).
11	Demonstrate **deployment of mechanical recovery** from the Escort Tugs includes: - Deployment of containment boom - Operation of the skimming systems	Demonstration of understanding of equipment and ability to deploy equipment.
12	Demonstrate deployment of the **dispersant application** booms from the Escort Tugs	Demonstration of understanding of equipment and ability to deploy equipment.
13	Demonstrate **overall personnel numbers** are adequate for the response to continue without stoppages due to crew fatigue or shortages during rest periods. Will require long-term exercise, and should include crew transfers on-and-off barges.	As noted, personnel numbers are critical to deploying the necessary equipment to meet the RPS.
14	Ensure adequate system and training in place to **locate and transport additional crew** to deployment on barges, based on the times specified in the plan. As described in the plan, for a major response crews will need to be brought in to backfill for the initial crews within a specified timeframe.	***Could be a tabletop exercise.***
15	All aspects of **recovery** based on response barges should be conducted **in long period waves** consistent with realistic conditions in the Gulf of Alaska.	Based on Gulf of Alaska Agreement (BP Oil Shipping Company and Alyeska Pipeline Services Company, 1999).

Table 7. Response system elements to be demonstrated – Nearshore Support, Lightering, and Dispersant Application

	Key Action	**Purpose**
1	Drill **lightering/secondary nearshore support barge** to ensure: - Crew trained for both lightering from tanker and nearshore support, including offloading nearshore storage devices and decontamination - Personnel numbers as identified in plan are adequate - All necessary components are onboard and in working condition for both lightering and all necessary aspects of nearshore support (including offloading out-of-region nearshore storage devices) - Lighting for night operations is adequate	Demonstrate ability to conduct lightering operations as required at 18 AAC 75.027 (offloading volume of largest tanker cargo tank in 24 hours)
2	Drill **Nearshore Support Barge** on time to get barge underway and ability to maneuver and anchor barge on site. Compare results to calculations used in the plan.	(Critical to RPS.)
3	Drill **tug dispersant application** to demonstrate crew ability to determine application rates, track oil, and use the tugs propulsion system to enhance mixing action should be significant components of the drill objectives.	Demonstrate compliance with 18 AAC 75. 425 (G): "If dispersant capabilities are to be considered for use during a response, all components of the system must be drilled to ensure it is a viable option."

4 Sustaining Readiness through Drills and Exercises

Sustaining readiness requires ongoing training, both to keep skills fresh and to ensure new personnel are adequately trained.

4.1 Prevention

Ensuring crews manning the Escort Tugs, General Purpose Tugs, and *Ross Chouest* will have sufficient training and skills to execute the maneuvers to meet the requirements of 18 AAC 75.027(e)[28] is a key part of the Prince William Sound Tanker Oil Discharge Prevention and Contingency Plan (Part 2 Prevention Plan).

[28] An escort vessel is a vessel that is assigned and dedicated to a tank vessel during a transit and is capable of providing the intended escort service. The function of escort vessels is to be immediately available to warn of impending danger, to assist tank vessels in case of emergency and to assist in initial oil spill response.

The Tanker C-Plan defines basic guidelines for the training and certification of the escort vessel operators and crew. Section 2.1.1 of the Tanker C-Plan, General Prevention Training Programs,[29] establishes a framework for required training and documentation. Although the C-Plan has not been updated to reflect new oil spill prevention and response equipment, the principles of ensuring competency remains the same.

Bridge-watch personnel on board the tank vessel must comply with U.S. Coast Guard licensing requirements, including Standards of Training, Certification and Watchkeeping for Seafarers (STCW). They must also receive interactive bridge management courses and simulator training. Escort Vessel Masters and licensed Pilots attend similar training.

Tug Masters should continue to be promoted from Chief Mates operating on the same type of vessel. Before a Mate is given command of an escort vessel, the standing Master must sign off that the Mate is fully competent in the following areas:

- "Escort vessel familiarization,
- Light escort vessel operations underway,
- Maneuvering into and away from mooring buoys,
- Maneuvering into and away from docks and vessels,
- Performing inbound and outbound escorts,
- Performing tethering make-up on tank vessel stern,
- Performing untethering operations,
- Standing tether watch in Valdez Arm to Bligh Reef and Valdez Harbor and Narrows,
- Completing a tether exercise with tank vessel, and
- Managing and operating escort vessel as responsible operator." (RPG, 2017)

The current Tanker C-Plan specifies periodic drills and inspections to include:

- Quarterly drills and inspections of tank vessel towing equipment and packages,
- A minimum of four towing drills annually,
- Emergency tethering exercises "throughout the year."[30] (RPG, 2017)

In keeping with the general framework described above, Table 8 recommends simulator and on-water exercises conducted regularly. In addition, licensed personnel must be trained in utilizing all navigational electronics including FLIR Digital Signal Processing RADAR, Electronic Chart Display and Information System (ECDIS), and automatic radar plotting aid (ARPA).

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[29] 18 AAC 75.007(d) and .020

[30] The 2013 VERP specifies that towing drills will be conducted four times per year. It also describes tethered tug exercises, but does not specify the frequency. According to the VERP, "tethered tug exercises" are conducted with a hard-over rudder, engine failure at 6 knots, and a 60-second notification delay. Through the exercise, the tug is used to re-establish heading and steer the tanker for five minutes (Alyeska, 2013).

Table 8. Prevention training for tug/escort operators

	Key Action	Purpose	Participants
1	***Annual full-bridge*** simulator practice (in Alaska or elsewhere). Should also be conducted following any significant collision, allision, or grounding incident with a tug.	• Reinforce bridge resource management principles and practices during escort operations • Review Escort Operating Policies and Procedures, escort tug configurations and capabilities, escort techniques and emergency response and procedures, and escort tug maneuvering • Test qualifications of tug operators	Tug operators, tanker masters, and pilots
2	Documented Escort Vessel and General Purpose Tug **operator training and certification** program.	• Provides assurance that vessel personnel can communicate properly and work as a team • Ensures proficiency and consistency of tug operators • Familiarize tug operators with local operations and failure scenarios • Build trust between entities	Masters/crew for General Purpose Tugs and Escort Tugs
3	**Weekly** tether exercises conducted in the Port of Valdez and mid-Sound utilizing steering and braking forces in various wind and sea conditions. (Each tug operator and tanker captain should participate in at least one exercise annually.)	Practice and demonstrate ability to use tugs in anticipated roles at 6, 8, and 10 knots.	Masters/crew for General Purpose Tugs and Escort Tugs
4	**Bi-monthly** towing drills with laden tanker conducted in mid Prince William Sound. (Each tug operator and tanker captain should participate in at least one drill annually.)[31]	Practice and demonstrate ability to: • Stop tanker headway and swing • Tow from the tanker stern, or pass a towline to the bow of the tanker • Tow at 6 knots for 30 minutes with a simulated 35 degree locked rudder or turning the tanker 90 degrees, assuming a free-swinging rudder within the same distance (advance and transfer) that it could turn itself with a hard-over rudder	Masters/crew for Escort Tugs and *Ross Chouest*
5	**Quarterly** firefighting exercises simulating a tanker, terminal, or Port fire.	Utilize tug FFV (monitors, deluge system, and shore connections) to practice the methods and tactics of supporting firefighting needs for marine fires	Masters/crew for General Purpose Tugs and Escort Tugs

[31] Note that this frequency is specified once all captains are fully trained in Prince William Sound.

4.2 Response

Tables 6 and 7 identify exercises needed to validate response readiness related to the new ECO equipment entering Prince William Sound. On-going training should play this same role, though for the full range of response systems (e.g., including the fishing vessel program, outside the scope of this study). The exercise objectives identified above should be conducted at least annually, ensuring that all personnel gain the necessary experience in the range of conditions (RMROL, daylight/darkness, etc.) identified. It will also be important for each shipper to engage in open-water barge offloading and tanker lightering specifically, and overall response management as the potential responsible party.

5 Conclusion

ADEC is responsible for ensuring compliance with State of Alaska statutes and regulations. Since new legislation was passed after *Exxon Valdez,* Alaska's regulations have been a key driver behind the development of the world-class oil spill prevention and response system in the Sound.

During the establishment of the current oil spill prevention and response system, ADEC determined what information was necessary to ensure the then-newly proposed system could meet regulatory requirements. That process proved successful, and shaped the system that has been in place for nearly two decades. Significant changes to that system are now being proposed, so ADEC will again need complete and reliable information to ensure regulatory mandates are met. The recommendations in this report are based on the key elements of the approach applied in the past. ADEC will need this information to ensure regulatory mandates are met, and that the resources and people of Alaska are protected.

Safety must always be taken into consideration when establishing and testing a successful and reliable oil spill prevention and response system. The PWS shippers have committed through their State-approved Tanker C-Plan that they will respond to a disabled tanker and carry out a spill response in all conditions in which tankers will be operating. Conducting exercises in the conditions listed in this report will allow safety hazards to be identified under controlled situations rather than under the pressures of conducting operations during a real-time event in what could be far-worse conditions. This will allow solutions to be developed and crews can then be trained to remain safe. Waiting to experience unexpected safety issues during a real-time event is contradictory to safety goals.

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