Environmental Resources Management

1218 3rd Avenue
Suite 1412
Seattle, WA 98101
(425) 462-8591
(425) 455-3573 (fax)

7 July 2011

Mr. Jay Wright
AIRA Program Manager
National Fish and Wildlife Foundation
1133 15th Street, NW Suite 1100
Washington, D.C. 20005

Subject: Phase A – Aleutian Islands Risk Assessment
Risk Reduction Options Evaluation Report Deliverable

Dear Mr. Wright,

ERM-West, Inc. (ERM) and Det Norske Veritas (U.S.A.), Inc. (DNV) appreciate the opportunity to provide our consulting services for the Phase A – Aleutian Islands Risk Assessment (AIRA). This cover letter transmits the Risk Reduction Options (RRO) Evaluation Report. The RRO Evaluation Report covers the following two tasks of Phase A Preliminary Risk Assessment (PRA):

- Task 6 – Ranking of High Risk Scenarios and Qualitative Assessment of Risk Reduction Options; and
- Task 7 – Evaluation of Risk Reduction Options.

The Phase A PRA consists of eight main tasks. However, it is imperative to recognize that each task is defined by the scope of work and is not a discrete unit of analysis. This report follows the cumulative body of work completed to date for the Phase A PRA and serves to document the following expert judgment solicitation processes from the AIRA Advisory Panel meetings convened in Anchorage, Alaska:

- Task 6 Ranking of High Risk Scenarios and Qualitative Assessment of Risk Reduction Options Workshop held 21-22 September 2010; and
- Task 7 Evaluation of RROs Workshop held 12-15 October 2010. In addition, this report summarizes the approach and results of the accident scenario ranking and RRO evaluation process.

The enclosed RRO Evaluation Report incorporates revisions to address cumulative comments received from the Peer Review Panel and Management Team on the draft report submitted on 7 March 2011.

This report covers the scope of work for Tasks 6 and 7 as presented in the AIRA Request for Proposal and the Risk Analysis Team's Proposal. The objectives of RRO Evaluation Report are to 1) provide a review of the work completed to date; 2) document the process and stakeholder engagement from the Task 6 and Task 7 workshops; and 3) summarize the results of the accident scenario ranking and RRO evaluation and ranking process.

Based on this information, the RRO report provides a qualitative analysis of potential high-risk scenarios that could take place in the Aleutian Islands area, ranking the spill scenarios, documenting the development of the list of RROs, and describing the evaluation and ranking of the RROs.

The RRO evaluation process involved the following main steps:

- Scoring of the Spill Scenarios: The scoring of the spill scenarios evaluated as part of the consequence analysis is a challenging and subjective process. An approach was developed to obtain a single consequence score for each scenario for purposes of mapping to the risk matrix. The result of the process is that scenarios with higher total weighted rating are considered to represent greater potential impacts (severity).
- Developing frequencies for the Spill Scenarios: To rank the highest risk scenarios, the next step involved developing frequencies for the spill scenarios. Frequencies for five categories, ranging from improbable (least likelihood) to probable (more likely), were assigned based on Task 2 analysis and Marine Accident Risk Calculation System (MARCS) output results.
- Mapping the risks into the risk matrix: Based on the ranking of the spill scenarios, they were mapped to the risk matrix to identify the highest risk scenarios.
- Reviewing the RRO list and evaluating the RROs based on effectiveness, cost, and practicality (see Sections 3 and 4). The list of RROs evaluated as part of the Phase A PRA was evaluated and finalized during the Task 7 Workshop.

As mentioned above, the three main considerations addressed in the RRO Evaluation Report that determine the decision to implement are:

- Is the RRO effective at reducing risk?
- Is the RRO affordable?
- Is the RRO practicable?

Examination of the results indicates that no one RRO is evaluated as best for effectiveness, cost, and practicality. That is, there is no RRO identified by this

analysis that is clearly the best. However, RRO categories most effective at reducing risks associated with the Spill Scenarios, based on the RRO evaluation process conducted for this study, include:

- Enhance Vessel Monitoring Program;
- Establish VTS in Unimak and Akutan Pass;
- Increase Rescue Tug Capability; and
- Increase Spill Response Capability.

It is best **not** to analyze these risk results in a way that implies they are quantitative, because this truly has been a semi-quantitative exercise. The results are based on a mixture of semi-quantitative and qualitative inputs (with quantitative intermediate processing such as modeling).

It should be noted that the RRO evaluation process is a Decision-Support Tool, not a Decision-Making Tool. The prioritization of RROs for implementation involves making choices of the relative importance of the RRO effectiveness, cost, and practicality. It may also take into account factors outside the scope of this risk assessment, such as additional stakeholder input and human fatality risk.

The Risk Analysis Team appreciates the opportunity to work with the Management Team and other stakeholders as part of the AIRA Phase A Program. If you have questions or inquiries concerning this submittal, please contact Laura Tesch at 425-214-0453 or laura.tesch@erm.com.

Sincerely,

Laura Tesch
AIRAProgram Director

Dr. Jack Colonell
Partner-in-Charge

Enclosure via email:
Risk Reduction Options Evaluation Report

cc: David Pertuz, DNV
Leslie Pearson, Pearson Consulting

Prepared for:
National Fish and Wildlife Foundation,
United States Coast Guard, and
Alaska Department of Environmental Conservation

Risk Reduction Options Evaluation Report

Phase A – Aleutian Islands Risk Assessment
Aleutian Islands, Alaska

Tasks 6 and 7

July 2011

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National Fish and Wildlife Foundation
United States Coast Guard
Alaska Department of Environmental Conservation

Risk Reduction Options Evaluation Report

Phase A - Aleutian Islands Risk Assessment
Aleutian Islands, Alaska

July 2011
Project No. 105563

Laura Tesch
AIRA Risk Analysis Team Project Director

Jack Colonell, Ph.D.; P.E.
Partner in Charge

Prepared by AIRA Risk Analysis Team:

ERM-West, Inc.
341 West Tudor Road, Suite 206
Anchorage, AK 99503

Det Norske Veritas (U.S.A.), Inc. (DNV)
1400 Ravello Drive
Katy, TX 77449

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ADEC	Alaska Department of Environmental Conservation
AIRA	Aleutian Islands Risk Assessment
AIS	Automatic Identification System
AP	Advisory Panel
ATB	Articulated Tug Barge
ATBA	Areas To Be Avoided
bbl	barrels
COPT	Captain-of-the-Port
DNV	Det Norske Veritas (U.S.A.), Inc.
ERM	ERM-West, Inc.
ESA	Endangered Species Act
ETS	Emergency Towing System
IMO	International Maritime Organization
MARCS	Marine Accident Risk Calculation System
MT	Management Team
OPA 90	Oil Pollution Act of 1990
OSRO	Oil Spill Removal Organization
OTF	Oil Type Factor
PPOR	Aleutian Subarea Potential Places of Refuge
PAWSA	Ports and Waterways Safety Assessment
PRA	Preliminary Risk Assessment
PRAC	Primary Response Action Contractor
PSSA	Particularly Sensitive Sea Area
RRO	Risk Reduction Option
SEF	Socioeconomic Factor
SF	Sensitivity Factor
TA	Total Area
TRB	Transportation Research Board
US	United States
USCG	United States Coast Guard

VTS	vessel tracking system

The Risk Analysis Team (ERM-West, Inc., and Det Norske Veritas [U.S.A.], Inc.) prepared this Risk Reduction Options (RRO) Evaluation Report, on behalf of the Management Team, as part of the Aleutian Islands Risk Assessment (AIRA) Phase A Preliminary Risk Assessment (PRA). Phase A includes the following main tasks:

1) Establishing the Advisory Panel (completed);

2) Contracting a Risk Analysis Team (completed);

3) Selecting a Peer Review Panel (completed);

4) Drafting a spill risk report on vessel traffic and spill likelihood (Tasks 1 and 2 completed);

5) Developing a risk matrix and consequence analysis (Tasks 3, 4, and 5, completed);

6) Conducting a qualitative assessment and evaluation of RROs (Tasks 6 and 7; this submittal); and

7) Prioritization of RROs (Task 8).

The RRO Evaluation Report covers the following two tasks of Phase A:

- Task 6 – Ranking of High Risk Scenarios and Qualitative Assessment of Risk Reduction Options; and
- Task 7 – Evaluation of Risk Reduction Options.

This report follows the cumulative body of work completed to date for the Phase A PRA and serves to document the following expert judgment solicitation processes from the AIRA Advisory Panel meetings convened in Anchorage, Alaska: Task 6 Ranking of High Risk Scenarios and Qualitative Assessment of Risk Reduction Options Workshop held September 21-22, 2010, and the Task 7 Evaluation of RROs Workshop held October 12-15, 2010. In addition, this report summarizes the approach and results of the accident scenario ranking and RRO evaluation process.

The scoring and ranking of the Spill Scenarios evaluated as part of the Task 4 Consequence Analysis is a challenging and subjective process. An approach was developed to obtain a single consequence score for each scenario for purposes of mapping to the risk matrix.

Scoring and ranking of the consequences of the spill scenarios was conducted using a weighting summation technique to express a consistent comparative rating of the scenarios based on environmental, physical, and socioeconomic categories. The method includes numeric representations of the magnitude of potential impact to the receptor/resource categories evaluated during Task 4 (in terms of area impacted), probability of impact (in terms of percent from probability from spill model) and the relative importance (i.e., sensitivity) of each category. The resulting Spill Scenario Consequence Scoring/Ranking Matrix, provided in Appendix A, provides a way to compare the potential impacts of an oil spill for all receptor/resource categories relative to each scenario by developing a Total Consequence Score for each spill scenario.

The resulting Total Consequence Score represents a comparative value of the potential consequences associated with each example spill scenario. The result of the process is that scenarios with higher total weighted rating are considered to represent greater potential impacts. The five accident scenarios representing the greatest potential impact (severity) are summarized below.

Top five scenarios with highest Total Consequence Scores (beginning with highest score)

Scenario 2	Bulk carrier, vessel collision North of Unimak Pass, Bunker C spill of 15,000 barrels (bbl)
Scenario 16	Bulk carrier, drift grounding North of Urilia Bay, Bunker C spill of 15,000 bbl
Scenario 3	Crude Oil tanker, vessel collision North of Unimak Pass, Crude Oil spill of 400,000 bbl
Scenario 8	Crude Oil tanker, drift grounding off Sanak Island, Crude Oil spill of 400,000 bbl
Scenario 12	Crude Oil tanker, drift grounding Holtz Bay on Attu Island, Crude Oil spill of 400,000 bbl

As stated in Special Report 293 (TRB 2008), "it is not straightforward to combine consequences that are often quite different in nature and difficult to quantify (e.g., damage to the environment, socioeconomic impact). It can be helpful to assign severity levels by type of consequence and then combine these values into an overall consequence rating. However, special care must be taken in performing this type of subjective prioritization. Although an overall risk rating is a helpful tool for comparing and prioritizing alternatives, it can be misleading when consequences and their likelihoods of occurrence have significantly different magnitudes."

To rank the highest risk scenarios, the next step involved developing frequencies for the spill scenarios. Frequencies for five categories, ranging from improbable (least likelihood) to probable (more likely), were assigned based on Task 2 analysis and Marine Accident Risk Calculation System (MARCS) output results (ERM/DNV 2010b). Each category has an associated range of frequencies it represents. This analysis chose to apply the median or middle value from the relevant range to each of the scenarios. It should be noted that the frequency information available from the model represents the frequency of such a spill anywhere in the study area and, as such, is not specific to each spill location.

Once the consequences and frequencies were estimated for each of the scenarios, the risks could be mapped back into the risk matrix. Based on the matrix mapping, Table ES.1 summarizes the scenarios posing the greatest risk.

Table ES.1 Highest Risk Scenarios

Scenario	Description
Scenario 16	Bulk carrier, drift grounding North of Urilia Bay, 15,000 bbl Bunker C spill
Scenario 2	Bulk carrier, vessel collision North of Unimak Pass, 15,000 bbl Bunker C spill
Scenario 8	Crude Oil tanker, drift grounding off Sanak Island, 400,000 bbl Crude Oil spill

It is best **not** to analyze these risk results in a way that implies they are quantitative, because this truly has been a semi-quantitative exercise. The results are based on a mixture of semi-quantitative and qualitative inputs (with quantitative intermediate processing such as modeling).

The third and final step of the evaluation process involved reviewing the RRO list and evaluating the RROs based on effectiveness, cost, and practicality (see Sections 3 and 4). The list of RROs evaluated as part of the Phase A PRA during the Task 7 Workshop is summarized in Table ES.2 below. Appendix B provides detailed descriptions and background information of the main RROs considered in the Phase A PRA. The brief descriptions available to the Risk Analysis Team for each RRO are provided in Table ES.2.

Table ES.2 RROs Evaluated During Task 7 Workshop

RRO No.	RRO Name	Description of RRO Evaluated
1	**Enhance Vessel Monitoring Program**	
1a	Satellite tracking plus AIS	Increase areas coverage, increase number of vessels covered, implement an alarm system; integration of all monitors
2	**Establish Vessel Tracking System (VTS) in Unimak and Akutan Passes**	
2a	Manned VTS/Direct Communication with Vessels	Meets IMO procedures and standards; new equipment, personnel, integration of systems
2b	Traffic Separation Scheme in Unimak Pass	Voluntary; mark lanes on nautical chart to control traffic direction
3	**Increase Rescue Tug Capability**	
3a	Dedicated rescue tug(s)	Open sea capability, always available
3b	Non-dedicated rescue tug	Open sea capability, similar capability to dedicated tug but with cost-sharing, variable availability
3c	Seasonal, dedicated tug	Open sea capability, similar capability to dedicated tug but only available seasonally (Oct 1 thru May 30)
3d	Tugs of Opportunity Program	Tug regardless of size but available to respond; implement a program
4	**Increase Emergency Towing System (ETS) Capabilities**	
4a	Expand shore-based ETS	There is an ETS system in Dutch Harbor; expanding system in Dutch Harbor to other locations (e.g., add one in Adak and one in location to be determined); provide greater coverage
4b	Require emergency towing arrangements on deep draft vessels	For vessels not in innocent passage
5	**Enhanced USCG Capabilities**	
5a	Enhance towing capabilities on cutters	See Tugs of Opportunity
5b	Increase number of USCG cutters	
6	**Establish Restricted Areas**	

RRO No.	RRO Name	Description of RRO Evaluated
	Identify certain areas (to be defined) that should be avoided to reduce environmental or socioeconomic consequences/impacts	
6a	IMO PSSA/ATB/SA	Measure does not reduce spill severity once it occurs but there is a benefit to reduce severity due to preventing the accident from happening
7	**Increase Spill Response Capability**	
7a	Ocean-rated OSRO/PRAC - Open Ocean	No response capability except an Oil Spill Response Organization (OSRO) with only inland capability; this measure assumes Open Ocean
7b	Near-shore rated OSRO/PRAC	
7c	Increase Salvage and Firefighting Capability via Regulations	New regulations go into effect in Feb 2011 for tank vessels; includes tugs, marine salvagers available, increase capability of lightering; ensure the regulations adequately address and are tailored for the Aleutian Islands. Salvage and marine firefighting regulations (subpart I) would apply
8	**Bolster Area Contingency Plans**	
8c	Develop more geographic response strategies	Tail end of causal chain; enables a minimizing of impacts with prompt and proper response
9	**Raise Liability Limits and Civil Penalties**	
9b	Increase State civil penalties	Intent to encourage better operations of vessel and vessel company

The objective of most risk assessments, including the AIRA Phase A, is to identify potential RROs and, for each RRO, determine the prioritization for implementation. The four main considerations addressed in this report that determine the decision to implement are:

- Is the RRO effective at reducing risk?
- Is the RRO affordable?
- Is the RRO practicable?

The RROs were ranked for effectiveness separately for frequency and severity. However, overall effectivness of reducing risk considers both frequency and severity. The RROs ranked highest for effectiveness are as follows:

- Satellite tracking and Automatic Identification System (AIS) (RRO 1a) was evaluated as the most effective RRO at reducing accident frequency.
- Near-shore rated OSRO/Primary Response Action Contractor (PRAC) (RRO 7b) was evaluated as the most effective RRO at reducing accident severity.
- Satellite tracking and AIS (RRO 1a) was evaluated as the most effective RRO at reducing spill accident risk (severity and risk).

The RROs ranked highest based on cost (that is, least costly to implement) are as follows:

- Traffic Separation Scheme in Unimak Pass (RRO 2b);
- Increased State Civil Penalties (RRO 9b);
- Satellite tracking and AIS (RRO 1a);
- Tugs of Opportunity Program (RRO 3d);
- Expand shore-based ETS (RRO 4a);
- IMO Particularly Sensitive Sea Area (PSSA) and associated measures (RRO 6a); and
- Develop more geographic response strategies (RRO 8c).

The RROs ranked highest based on practicality are as follows:

- Satellite tracking and AIS (RRO 1a); and
- Increased State Civil Penalties (RRO 9b);
- Tugs of Opportunity Program (RRO 3d); and
- Expand shore-based ETS (RRO 4a).

Table ES.3 summarizes the observations based on the qualitative cost-benefit analysis.

Table ES.3 Summary of Most Effective RROs based on Cost-Benefit Analysis

Most effective RRO at reducing risk (frequency and severity)	RRO 1a	Satellite Tracking and AIS
	RRO 4b	Require emergency towing arrangements on deep draft vessels
	RRO 4a	Expand shore-based ETS
	RRO 6a	IMO PSSA and associated measures (e.g., Areas To Be Avoided)
Least expensive RRO	RRO 2b	Traffic Separation Scheme in Unimak Pass
RROs 2b and 9b tied for least expensive	RRO 9b	Increased State Civil Penalties
	RRO 1a	Satellite Tracking and AIS
RROs 1a, 3d, 4a, and 6a, and 8c tied for second	RRO 3d	Tugs of Opportunity Program
	RRO 4a	Expand Shore-based ETS
	RRO 6a	IMO PSSA and associated measures (e.g., ATBA)
	RRO 8c	Develop more geographic response strategies
Most practical RRO	RRO 1a	Satellite Tracking and AIS
Listed RROs all tied as most practical	RRO 3d	Tugs of Opportunity Program
	RRO 4a	Expand Shore-based ETS
	RRO 9b	Increased State Civil Penalties
Most cost effective	RRO 1a	Satellite Tracking and AIS
Cheapest and easiest	RRO 9b	Increased State Civil Penalties

Examination of the results indicates that no one RRO is evaluated as best for effectiveness, cost, and practicality. That is, there is no RRO identified by this analysis that is clearly the best.

An evaluation of RRO effectiveness on the accident scenarios is presented in Section 5.0. The expert judgments recorded during the Task 7 workshop were utilized to evaluate the RROs based on effectiveness to reduce frequency and severity on the accident types.

Table ES.4 Summary of Overall Rank for each RRO

RRO No.	RRO Name	Description of RRO Evaluated	Overall Rank
1	**Enhance Vessel Monitoring Program**		
1a	Satellite tracking plus AIS	Increase areas coverage, increase number of vessels covered, implement an alarm system; integration of all monitors	1
2	**Establish Vessel Tracking System (VTS) in Unimak and Akutan Passes**		
2a	Manned VTS/direct communication with vessels	Meets IMO procedures and standards; new equipment, personnel, integration of systems	16
2b	Traffic separation scheme in Unimak Pass	Voluntary; mark lanes on nautical chart to control traffic direction	10
3	**Increase Rescue Tug Capability**		
3a	Dedicated rescue tug(s)	Open sea capability, always available	12
3b	Non-dedicated rescue tug	Open sea capability, similar capability to dedicated tug but with cost-sharing, variable availability	14
3c	Seasonal, dedicated tug	Open sea capability, similar capability to dedicated tug but only available seasonally (Oct 1 through May 30)	9
3d	Tugs of Opportunity Program	Tug regardless of size but available to respond; implement a program	3
4	**Increase Emergency Towing System (ETS) Capabilities**		
4a	Expand shore-based ETS	There is an ETS system in Dutch Harbor; expanding system in Dutch Harbor to other locations (e.g., add one in Adak and one in location to be determined); provide greater coverage	2
4b	Require emergency towing arrangements on deep draft vessels	For vessels not in innocent passage	6
5	**Enhanced USCG Capabilities**		
5a	Enhance towing capabilities on cutters	See Tugs of Opportunity	10

RRO No.	RRO Name	Description of RRO Evaluated	Overall Rank
5b	Increase number of USCG cutters		16
6	**Establish Restricted Areas**		
	Identify certain areas (to be defined) that should be avoided to reduce environmental or socioeconomic consequences/impacts		
6a	IMO PSSA/ATB/SA	Measure does not reduce spill severity once it occurs but there is a benefit to reduce severity due to preventing the accident from happening	3
7	**Increase Spill Response Capability**		
7a	Ocean-rated OSRO/PRAC - Open Ocean	No response capability except an Oil Spill Response Organization (OSRO) with only inland capability; this measure assumes Open Ocean	15
7b	Near-shore-rated OSRO/PRAC		13
7c	Increase salvage and firefighting capability via regulations	New regulations go into effect in Feb 2011 for tank vessels; includes tugs, marine salvagers available, increase capability of lightering; ensure the regulations adequately address and are tailored for the Aleutian Islands. Salvage and marine firefighting regulations (subpart I) would apply	8
8	**Bolster Area Contingency Plans**		
8c	Develop more geographic response strategies	Tail end of causal chain; enables a minimizing of impacts with prompt and proper response	7
9	**Raise Liability Limits and Civil Penalties**		
9b	Increase State civil penalties	Intent to encourage better operations of vessel and vessel company	5

Accident Scenarios 2 and 16 resulted in the highest risk scenarios according the risk matrix, which represents collision and drift grounding accident types (respectively). Both these scenarios scored highest in terms of severity and within the second highest frequency of occurrence category. Thus, RRO categories most effective at reducing risks associated with these scenarios based on the RRO evaluation process conducted for this study include:

- Enhance Vessel Monitoring Program
- Establish VTS in Unimak and Akutan Pass
- Increase Rescue Tug Capability
- Increase Spill Response Capability

It should be noted that the RRO evaluation process is a Decision Support Tool, not a Decision-Making Tool. The prioritization of RROs for implementation (the next AIRA task) involves making choices of the relative importance of the RRO effectiveness, cost, and practicality. It may also take into account factors outside the scope of this risk assessment, such as additional stakeholder input and human fatality risk.

1.0 INTRODUCTION

The Aleutian Islands Risk Assessment (AIRA) program was created to produce a comprehensive evaluation of the risk of vessel accidents and spills in the Aleutian Islands (www.aleutiansriskassessment.com). The risk assessment is being conducted in two Phases, Phase A – Preliminary Risk Assessment (PRA) (semi-quantitative assessment, current phase) and Phase B – Focused Risk Assessment.

This document, Phase A - Risk Reduction Options (RROs) Evaluation Report, was prepared by the Risk Analysis Team on behalf of the AIRA Management Team, which consists of the National Fish and Wildlife Federation, United States Coast Guard (USCG), and the Alaska Department of Environmental Conservation (ADEC). The report summarizes information initially developed and evaluated during the Task 6 (September 2010) and Task 7 (October 2010) Workshops with members of the Advisory Panel (AP), Management Team (MT), and Facilitation Team.

1.1 SCOPE AND OBJECTIVES

This report covers the scope of work for Tasks 6 and 7 as presented in the AIRA Request For Proposal and the Risk Analysis Team's proposal. The process for completing the Task 6 and 7 scope of work is described in more detail in Section 1.2.

It should be noted that one element of the Task 7 scope, assessment of the potential unintended consequences of the RROs, was not evaluated to any depth. During the Task 7 workshop, the information for this type of assessment was limited and the AP and MT members chose to focus on the other primary elements of evaluating the RROs.

The objectives of RRO Evaluation Report are to 1) provide a review of the work completed to date; 2) document the process from the Task 6 Workshop held September 21-22, 2010, and the Task 7 Workshop held October 12-15, 2010; and 3) summarize the results of the accident scenario ranking and RRO evaluation and ranking process.

Based on this information, this report provides a qualitative analysis of potential high-risk scenarios that could take place in the Aleutian Islands

area, ranking the accident scenarios, documenting the development of the list of RROs, and describing the evaluation and ranking of the RROs.

1.2 RRO EVALUATION PROCESS

The specific elements of Tasks 6 and 7 are described in this section. It should be noted that the evaluation process was determined by the framework of the Phase A Preliminary Risk Assessment Program, which utilized workshop formats by convening experts and stakeholders representing various disciplines and organizations from the Advisory Panel and public participation.

Task 6 consists of the following elements:

- A workshop discussion with participation of the Management Team, Advisory Panel, Risk Analysis Team and facilitators;
- Developing consequence scores for each scenario;
- Assigning frequency categories;
- Mapping Scenarios to Risk Matrix; and
- Ranking of accident scenarios by level of risk.

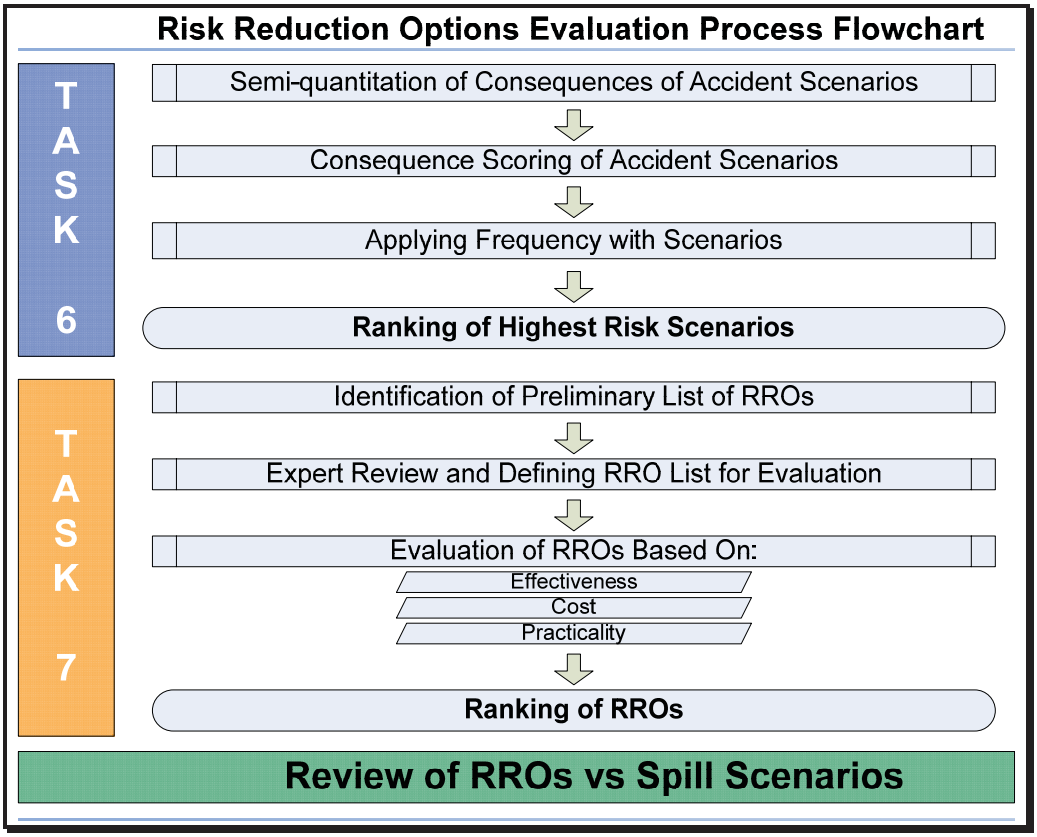
These elements of Task 6 are discussed and results presented in Section 2.0.

Task 7 consists of the following elements:

- A workshop discussion with participation of the Management Team, Advisory Panel, Risk Analysis Team and facilitators;
- Refinement of the list of RROs to be evaluated and definitions of each RRO evaluated;
- Development of the initial evaluation approach for the RROs; and
- An evaluation of the RROs based on ease of implementation, costs, and effectiveness.

Following the ranking of the accident scenarios and RROs, the RROs were reviewed for effectiveness of the scenarios. A flowchart describing the above RRO evaluation process, as requested by the MT, is presented in Figure 1.1.

Figure 1.1 RRO Evaluation Process Flowchart



1.3 *PROJECT STATUS*

The Phase A scope of work consists of the following eight tasks:

- Task 1 - Marine Traffic Study
- Task 2 – Baseline Spill Study
- Task 3 – Characterizing Spills from the Highest-Risk Accidents
- Task 4 – Consequence Analysis
- Task 5 – Accident Scenario and Causality Study
- Task 6 – Qualitative Assessment of Risk Reduction Options
- Task 7 – Evaluation of Risk Reduction Options
- Task 8 – Prioritization of Risk Reduction Options

Tasks in this report

The final reports associated with Tasks 1 and 2 were submitted on 3 September 2010 (ERM/DNV 2010a, 2010b and 2010c). The Consequence

Analysis Report (covering Tasks 3 and 4) and the Task 5 Accident Scenario and Causality Study Report were submitted in July 2011.

The results of the Consequence Analysis Report and the Task 5 Accident Scenario and Casualty Study Report were used in preparation of Tasks 6 and 7 to rank accident scenarios and evaluate and rank RROs. Risk, in terms of spill risk, impact risk and receptor risk, is determined based on estimated frequencies of occurrence for each scenario identified and assessed in this report.

The final step in the Phase A PRA is to utilize the information from the evaluation and ranking of the RROs to prioritize the implementation of the RROs. Following the Tasks 6 and 7 workshops, the Risk Analysis Team provided a draft recommended approach to prioritization of the RROs to the MT. In March 2011, the MT and AP convened a meeting to discuss the evaluation RROs and prioritize the RROs. A final summary and review of the Phase A PRA Program will be prepared by the MT.

1.4 DEFINITION OF TERMS

For purposes of consistency and clarity, this section provides definitions for terms used in this report. In some cases, specific definitions are delineated for terms that may have another meaning in a different context.

Spill Risk – is the expected mass or volume of material released per year. For this study, it is derived from the Marine Accident Risk Calculation System (MARCS).

Impact Risk – is evaluated by combining spill risk with a spill trajectory model. It describes the magnitude of the environment affected by the spill using data on spill size, spill rate, and weather.

Receptor Risk – is the combination of impact risk overlaid with the environmental receptors (and their sensitivity) in the impact zone at the given time of year.

2.0 HIGHEST RISK SCENARIOS

Task 1 and Task 2 performed a system-wide vessel traffic and spill risk analysis of the Aleutian Islands study area as defined in the contract scope (ERM/DNV 2010a, 2011b, and 2010c). These risk results were used as the basis to identify a number of higher spill risk locations and spill scenarios. This work was performed under Task 3.

Based on the work completed under Task 3, 16 hypothetical spill scenarios were selected for further analysis as part of Task 4. The consequence analysis involved modeling the hypothetical spill scenarios to evaluate the relative impact on the environment of spill size, types of hazardous substance spilled, and spill location. Thus, the consequence analysis provided a qualitative assessment of the potential resource damages and socioeconomic impacts of an example mix of spill events.

This report presents the methodology and ranking of the hypothetical spill scenarios based on the findings of the potential impacts presented in the Consequence Analysis Report.

2.1 RANKING THE ACCIDENT SCENARIOS

This section describes the methodology and process for developing consequence scores for each accident scenario and the frequency categories. These criteria are for purposes of ranking the scenarios and accidents by level of risk.

2.1.1 Approach for Ranking of Accident Scenarios

An approach was developed to obtain a single consequence score for each scenario for purposes of mapping to the risk matrix. The following discussion explains the methodology applied to conduct the preliminary and qualitative evaluation for ranking the spill scenarios based on the potential impacts presented in the Consequence Analysis Report. The resulting Spill Scenario Consequence Scoring/Ranking Matrix, provided in Appendix A, provides a way to compare the potential impacts of an oil spill for all receptor/resource categories relative to each scenario. However, the primary purpose for developing Consequence Scores for each scenario is for mapping to the risk matrix.

Ranking of the consequences (impacts) of the spill scenarios was conducted using a weighting summation technique to express a consistent comparative rating of the scenarios based on environmental, physical, and socioeconomic categories. The method includes numeric representations of the magnitude of potential impact of the characteristic (in terms of area impacted), probability of impact (in terms of percent from probability from spill model) and the relative importance (i.e., sensitivity) of each category.

The consequence ranking summation model is composed of 1) Sensitivity Factors (SF) to express the magnitude of potential impact to the receptor group being evaluated; 2) the mean value of the highest impact probability band (% Prob) obtained from spill model overlays; and 3) Total Area (TA) of potential impact (i.e., area of overlap between spill impact and receptors). In addition to the above inputs, a Socioeconomic Factor (SEF) based on relative importance of resource vulnerability and an Oil Type Factor (OTF) to account for persistent oil versus non-persistent oil was used in the ranking process.

A Consequence Score was obtained for each scenario by multiplying the summation of the TA, the SF, and the mean value of the highest impact probability band (% Prob) of each receptor/resource group by the SEF and OTF. The receptor/resource Consequence Scores were then summed for each scenario to obtain the Total Consequence Score. Thus for each receptor group, a rating is derived by application of sensitivity factors, probability of impact and total area, socioeconomic factor, and oil type as follows:

$$\text{Total Consequence Score} = \sum (TA * SF * \% \text{ Prob.}) * SEF * OTF$$

Where,

- SFs are assigned a range of value from "1" (limited potential or severity of impact) to "5" (high potential or severity of impact) as presented in the Consequence Analysis Report;
- % Prob are scenario-specific probabilities based on the spill modeling results and receptor group areas, which were determined from available mapping sources (see Section 4 of Consequence Analysis Report);
- Total Area (TA) (or number of points, e.g. bird nesting sites, SSL haul outs, etc.) in the highest impact probability band was determined for each category and sensitivity factor and used to populate the matrix;

- SEF is the Socioeconomic Factor applied to each scenario based on a qualitative evaluation of the socioeconomic resources potentially impacted; and
- OTF is the Oil Type Factor based on whether the spilled substance in the spill scenario was persistent oil (assigned value of 10) or non-persistent oil (assigned value of 1).

The above describes the general approach and method for evaluation of the 16 scenarios. The following discussion addresses the specifics of the ranking method. This high-level and qualitative screening was conducted to rank the scenarios for purposes of completing the overall Risk Matrix for Task 6.

Sensitivity Factor (SF)

For the initial screening and comparison of the 16 scenarios, six basic selection categories were considered, as summarized below. These categories are described in more detail in the Consequence Analysis Report (ERM/DNV 2011). The sensitivity factors are summarized in Table 2.1 below.

Table 2.1 Description of Sensitivity Factors for Each Category

Receptor Groups	Description	Low Sensitivity (1)	High Sensitivity (5)
Habitat: Littoral	Typically, oil causes more damage in low energy coastal areas where weathering is slower and oil can become entrapped in sediment, i.e., bays and marshes, versus more rapid weathering associated with more energetic environments (e.g., exposed rocky shores reduces exposure to oil).	A ranking of 1 represents shorelines that are *least sensitive* to oil and includes steep, exposed rocky shores	A ranking of 5 represents shorelines *most* sensitive to oil (e.g., protected, vegetated wetlands such as saltwater marshes). Oil in these areas will remain longer.
Habitat: Sub-littoral	Aleutian Islands Archipelago supports a diverse subtidal benthic community.	Very high energy habitat, widespread	Extremely sheltered areas with rare diverse faunal and floral communities. Endangered Species Act (ESA)-listed species
Seabirds	Seabirds (i.e., auks, gulls and water fowl) are highly sensitive to oil spills primarily during critical periods (e.g., breeding and migration).	Species affected are not present in large numbers	ESA-listed species
Mammals	Aleutian Islands provide suitable breeding habitat for visitors and resident species of marine mammal (e.g., Steller sea lions, sea otters, and northern fur seals).	No specific importance to marine mammals	ESA-listed species
Fish	Oil spill will generally not affect adult pelagic or demersal fish, but may affect spawning, nursery areas, and shallow-water shell fisheries. There are spawning and nursery areas of numerous species of economic importance within the Aleutian Islands.	Transient species; no or limited economic importance	Intertidal/ subtidal areas; National Marine Fisheries Service-designated "Savings Area"
Socio-economic	Includes fisheries, subsistence, recreation and tourism.	No specific socio-economic activity	Resources are of National Value; economies and communities are totally reliant.

Total Area (TA)

As described in the Consequence Analysis Report, the surface oiling probability, maximum subsurface (water column) concentration, and sediment concentration modeled for each scenario were used to evaluate area of impact for each receptor. Exposure expressed in terms of surface water oiling and shoreline oiling was used to provide an indicator of impact on seabirds and mammals by estimating total area of intersection between spill plots and receptor location maps. To provide an indicator of impact on fish and invertebrates, the subsurface concentration in the water column and the area of bottom sediment contamination affected above thresholds of concern was used from the stochastic model. Again, the estimated area of potential impact was estimated by overlaying fish receptor maps with spill plots. For the Spill Scenario Consequence Scoring/Ranking Matrix (Appendix A), the total areas of potential impact within each probability band were summed for each receptor. This results in total areas estimated (in acres) for each receptor given each probability band of the spill model.

Percent Probability of Impact (% Prob.)

As explained above, the total areas for each receptor group (at each sensitivity level) were estimated for each probability band in 10% increments from the stochastic modeling. The% Prob value is the median from highest probability range modeled to occur for each receptor group. For example, if the highest potential for impact within for a given receptor is within the probability range of 20-30%, then the % Prob value equals 0.25.

Oil Type Factor

During the Task 6 workshops (AIRA AP Meeting, Ranking of High Risk Scenarios and Qualitative Assessment of RROs, Anchorage, AK, September 20-21, 2010), the Advisory Panel members recommended applying an OTF to account for greater impacts associated with different oil types. Those scenarios that consisted of persistent oil type spill were given a factor of 10, whereas the non-persistent oil scenarios were given a factor of 1. These were derived through discussion and consensus.

Socioeconomic Factor

The assessment of socioeconomic receptors was undertaken by reviewing available literature sources and identifying the following:

- Power stations industrial abstraction
- Communities/Subsistence use areas
- Cultural heritage sites
- Tourism and recreation
- Fisheries resource

The sensitivity of the receptor was graded according to the scheme summarized above and in the Consequence Analysis Report.

The location of the resource was plotted on ArcMap GIS and the overlaid with the 1% probability envelope derived from the stochastic modeling. A conservative assumption was made that were there was a receptor present within this envelope, then unacceptable effects would occur. For receptors that covered a large area, e.g., fisheries resources, the proportion and relative value of the area over which oiling may occur was taken into account.

The sensitivity scores for each scenario and receptor type were tabulated. For multispecies fisheries, the overall socioeconomic sensitivity to each scenario was represented by the highest sensitivity score of all fish species for each scenario. These were then all summed to obtain one socioeconomic factor for each scenario (see Appendix A).

2.1.2 Results of Total Consequence Score

The rating for each category is summed to obtain the total weighted rating for a scenario to directly compare to the corresponding ratings of other scenarios. The Total Consequence Score represents a comparative value of the potential consequences associated with each example spill scenario. The result of the process is that scenarios with higher total weighted rating are considered to represent greater potential impacts to receptors/resources evaluated. Table 2.2 presents the summary of the ranked scenarios from 1 (the highest score) to 16 (the lowest score).

Table 2.2 Summary of Total Consequence Scores

Scenario ID	Description/Location	Total Conseq. Score	Rank
2	Bulk carrier, vessel collision North of Unimak Pass, Bunker C spill	34	1
16	Bulk carrier, drift grounding North of Urilia Bay, Bunker C spill	24	2
3	Crude Oil tanker, vessel collision North of Unimak Pass, Crude Oil spill	22	3
8	Crude Oil tanker, drift grounding off Sanak Island, Crude Oil spill	19	4
12	Crude Oil tanker, drift grounding Holtz Bay on Attu Island, Crude Oil spill	14	5
1	Container ship, vessel collision North of Unimak Pass, Bunker C spill	13	6
15	Container ship, drift grounding South of Amlia Island, Bunker C spill	10	7
10	Container ship, drift grounding Holtz Bay on Attu Island, Bunker C spill	10	8
4	Product tanker, vessel collision North of Unimak Pass, Diesel spill	10	9
7	Bulk carrier, drift grounding off Sanak Island, Bunker C spill	6	10
11	Bulk carrier, drift grounding Holtz Bay on Attu Island, Bunker C spill	6	11
6	Container ship, drift grounding off Sanak Island, Bunker C spill	5	12
13	Product tanker, drift grounding Holtz Bay on Attu Island, Diesel spill	0.8	13
14	Tank barge, powered grounding North of Adak, Diesel spill	0.8	14
5	Tank barge, vessel collision North of Unimak Pass, Diesel spill	0.8	15
9	Tank barge, drift grounding off Sanak Island, Diesel spill	0.4	16

Appendix A provides the spreadsheet of the Spill Scenario Consequence Scoring/Ranking Matrix. Each cell in the Spill Scenario Consequence Matrix was populated with the total area from the highest impact probability band for every scenario and receptor.

2.1.3 Determination of Frequencies

Risk has two components: frequency and consequence. The previous section concluded with a summary of the consequence scores and ranking for each of the accident scenarios.

Each of the 16 scenarios was then reviewed to identify a relevant frequency to assign to it, which when finished, completes the two components needed to estimate their risk. The scenarios are a sampling of the types of events that are likely to be a greatest concern, and so are worthwhile to look at from a risk perspective.

The MARCS output from the Task 2 analysis, provides key insights into the frequencies associated with the events selected for consequence modeling during the Task 3 Risk Matrix webinars. The Task 2 output was reviewed to identify a relevant frequency category for the spill type. For instance, *Container Ship spill of Bunker C fuel from a vessel collision* (Scenario 1) had a frequency category of "D" based on the MARCS output (ERM/DNV 2010b). See Table 2.3 for Definitions of the Frequency Categories.

Table 2.3 Definitions of Frequency Categories in the Study Risk Matrix

Risk Matrix Frequency Category	Definition	Working Definition (Frequency of Occurrence/year)
A	Improbable	>10-7 - Occurs once in more than 10 million years
B	Unlikely	10-5 – 10-7 - Occurs between once every 100 thousand years to once every 10 million years
C	Remote	10-3 – 10-5 - Occurs between once every thousand years to once every hundred thousand years
D	Less Probable	10-1 – 10-3 - Occurs between once every 10 years to once every thousand years
E	Probable	10-1 – 10 - Occurs more than once every 10 years

It was decided early in the study that the study area would not be divided into sub-regions for purposes of MARCS modeling. As a result, the frequency information available from the model represents the frequency of such a spill scenario associated with that ship/material/size combination, *anywhere in the study area*, and not location specific. So for Scenario 1, the frequency information is not specific to the area north of Unimak Pass. This is an important aspect to consider later when reviewing the results of the scenarios mapped to the risk matrix.

Each scenario was reviewed, in turn, and its relevant frequency category identified. Each category has an associated range of frequencies it represents. This analysis chose to apply the median or middle value from the relevant range to each of the scenarios, the results of which are shown in Table 2.4. The median frequency values in Table 2.4 are calculated as the average based on the working definitions in Table 2.3.

Table 2.4 Summary of Relative Frequencies for Study Area

Scenario ID	Description/Location	Frequency Matrix Category	Median Frequency Value for that Frequency Category
1	Container ship, vessel collision North of Unimak Pass, Bunker C spill	D	0.01
2	Bulk carrier, vessel collision North of Unimak Pass, Bunker C spill	D	0.01
3	Crude Oil tanker, vessel collision North of Unimak Pass, Crude Oil spill	C	0.0001
4	Product tanker, vessel collision North of Unimak Pass, Diesel spill	C	0.0001
5	Tank barge, vessel collision North of Unimak Pass, Diesel spill	D	0.01
6	Container ship, drift grounding off Sanak Island, Bunker C spill	D	0.01
7	Bulk carrier, drift grounding off Sanak Island, Bunker C spill	D	0.01
8	Crude Oil tanker, drift grounding off Sanak Island, Crude Oil spill	D	0.01
9	Tank barge, drift grounding off Sanak Island, Diesel spill	E	1
10	Container ship, drift grounding Holtz Bay on Attu Island, Bunker C spill	D	0.01
11	Bulk carrier, drift grounding Holtz Bay on Attu Island, Bunker C spill	D	0.01
12	Crude Oil tanker, drift grounding Holtz Bay on Attu Island, Crude Oil spill	C	0.0001
13	Product tanker, drift grounding Holtz Bay on Attu Island, Diesel spill	D	0.01
14	Tank barge, powered grounding North of Adak, Diesel spill	B	0.000001
15	Container ship, drift grounding South of Amlia Island, Bunker C spill	D	0.01
16	Bulk carrier, drift grounding North of Urilia Bay, Bunker C spill	D	0.01

2.2 *RESULTS OF RANKING SPILL SCENARIOS*

Once the consequences and frequencies were estimated for each of the scenarios, the risks could be mapped back into the risk matrix (Figure 2.1). The risk matrix itself was modified to allow the Total Consequence Score for each scenario to directly correlate to a matrix column. That is, the column definitions were determined by placing the largest total score, which was 34, into the highest of the five columns, then dividing into five partitions. In addition, the red-to-green matrix coloring has been removed because the study has not adopted any risk criteria by which to judge whether risks are tolerable or intolerable. Darker yellow cells represent greater risk than the lighter yellow cells. Figure 2.1 shows the 16 scenarios mapped into the risk matrix.

Based on the risk matrix mapping, the scenarios posing the greatest risk are:

- Scenario 2 – Bulk carrier, vessel collision North of Unimak Pass, Bunker C spill
- Scenario 16 – Bulk carrier, drift grounding North of Urilia Bay, Bunker C spill
- Scenario 8 – Crude Oil tanker, drift grounding off Sanak Island, Crude Oil spill

Figure 2.1 Spill Scenario Ranking Mapped to Risk Matrix

Frequency of Occurrence/ Likelihood (events/year)	Total Consequence Score (severity)				
	0 to <6	6 to <12	12 to <18	18 to <24	24 +
E Probable	Scenario 9				
D Less Probable	Scenario 6 Scenario 5 Scenario 13	Scenario 15 Scenario 10 Scenario 11 Scenario 7	Scenario 1	Scenario 8	Scenario 2 Scenario 16
C Remote		Scenario 4	Scenario 12	Scenario 3	
B Unlikely	Scenario 14				
A Improbable					

High Risk

Low Risk

It is best **not** to analyze these risk results in a way that implies they are quantitative, because truly this has been a semi-quantitative exercise. The results are based on a mixture of quantitative and qualitative inputs (with quantitative intermediate processing such as modeling).

In addition, the uncertainty associated with both the frequency and consequence estimates (individually) is likely plus or minus a matrix category. That is not to say this is a valueless exercise, but rather, that use of the results should be limited to provision of guidance to the decision-making process.

It would not be appropriate to rely exclusively on the matrix mapping to determine which RROs should be implemented. Additional inputs such as effectiveness, affordability, and practicality should weigh heavily in the decision process.

3.0 DEVELOPMENT OF RRO LIST

This section provides a description of the process used for selecting the RROs to be evaluated and summarizes the final list of RROs agreed upon during the AIRA AP Task 7 RRO Evaluation workshops in October 2010. Information provided in Sections 3.1, 3.2 and 3.3 were provided and authored by the Facilitation Team.

3.1 ORIGIN FOR RRO LIST

In 2006, the USCG and ADEC sponsored a Ports and Waterways Safety Assessment (PAWSA) Workshop for the Aleutian Islands. The workshop was attended by 20 participants representing waterway users, regulatory authorities, and stakeholders (i.e., organizations with an interest in the safe and efficient use of the Aleutian Islands for commercial and recreational purposes). Based on extensive discussions during the workshop, concentrations of risks were noted by the participants in three locations: Dutch Harbor, Unimak Pass, and North of Akun Island. The participants judged that additional risk reduction actions were needed. Table 3.1 below summarizes the information from the PAWSA and is ordered from highest to lowest possible risk improvement based on the Waterway Risk Model (PAWSA 2006).

Table 3.1 PAWSA Risk Improvement List

Risk Factor	General Strategy	Specific Action
Small Craft Quality	Rules & Procedures	License boat operators
Petroleum Discharge	Coordination/Planning	Update Subarea Contingency Plan-Logistics Section
Water Movement	Navigation/Hydrographic Info	Enhanced vessel reporting system; Wind/water circulation study
Aquatic Resources	Coordination/Planning	Develop additional Geographic Response Strategies
Bottom Type	Navigation/Hydrographic Info	Update charts and Coast Pilot

Risk Factor	General Strategy	Specific Action
Winds	Navigation/Hydrographic Info	Install more wind sensors in Passes
Visibility Restrictions	Navigation/Hydrographic Info	Require Automatic Identification System (AIS) on all commercial vessels >26 feet
Hazardous Materials Release	Coordination/Planning	USCG receive all dangerous cargo manifests
Environmental	Coordination/Planning	Include biological releases (non-indigenous species) in Subarea Contingency Plan
Mobility	Coordination/Planning	Better coordination during response
Commercial Fishing Vessel Quality	Rules & Procedures	Mandatory inspections for F/V >26 feet
Deep Draft Vessel Quality	Active Traffic Management	Establish vessel tracking information system for Unimak Pass
Shallow Draft Vessel Quality	Rules & Procedures	Require double hulls on all tank barges. Put look ahead sonar on all cruise vessels
Health and Safety	Coordination/Planning	Continue emergency response drills and planning

In 2007, the State of Alaska and the USCG asked the National Academies to examine the available data and develop an appropriate framework that includes the most scientifically rigorous approach possible for a comprehensive risk assessment, and to design the assessment with a logical sequence of building blocks so that it could be conducted in discrete steps.

To conduct this study, the Transportation Research Board (TRB) within the National Academy of Sciences empanelled the Committee for Risk of Vessel Accidents and Spills in the Aleutian Islands: A Study to Design a Comprehensive Assessment (Committee). The Committee met three times. During a multiday meeting (October 29–November 2, 2007) in

Alaska with a site visit to Dutch Harbor, the Committee heard from stakeholders and reviewed available data pertinent to its charge. Stakeholders discussed specific hazards presented by Aleutian shipping operations and a range of possible mitigation measures they believed should be considered for implementation. The Committee developed an initial list of mitigation measures that were grouped within a number of general categories. The list includes all ideas presented to the Committee, which were not vetted or prioritized. Table 3.2 represents the list of risk mitigation measures found in the Committee's final report (TRB 2008).

Table 3.2 Initial Risk Mitigation Measure List

Risk Mitigation Option	Category	Description
Waterway Mgmt & Traffic Control	Prevention	Enhance or expand vessel tracking and communication systems (a volunteer vessel traffic information system for Unimak Pass or a mandatory traffic management scheme)
	Prevention	Expand the existing AIS network to encompass a larger region (southern route)
	Prevention	Build and operate more AIS receiver stations throughout the Aleutians and possibly along the southern route by using weather buoys for mounting
	Prevention	Enhance and optimize the aids to navigation currently in place throughout the Aleutians
	Prevention	Implement traffic separation scheme in and/or near Unimak Pass and greater Aleutians
	Prevention	Implement speed restrictions in shipping lanes
	Prevention	Establish restrictions for certain sensitive areas of operation
	Prevention	Implement long-range vessel tracking, and use it to identify potential problems
	Prevention	Enhance requirements for voyage planning and safety features for vessels calling at US and Canadian ports and transiting Aleutians
	Prevention	Update charts and Coast Pilots; improve weather forecasting
	Prevention	Implement long-range vessel tracking and use to identify potential problems
Inspection & Enforcement	Prevention	Increase inspection and enforcement of safety requirements on vessels calling a US and Canadian ports and transiting the Aleutians
Emergency	Prevention	Station adequate salvage and lightering equipment and

Risk Mitigation Option	Category	Description
Operations and Procedures		capabilities at key locations
	Prevention	Provide standby rescue tugs to respond to vessels in distress (large enough for prevailing conditions and ships in trade)
	Prevention	Enhance tug of opportunity network
Emergency Operations and Procedures	Prevention	Station a multi-purpose vessel in Dutch Harbor with rescue tug capabilities but other uses (research) to help pay the cost
		Provide escort tugs for certain vessels and conditions in Unimak Pass
		Enhance and expand USCG response capabilities for vessels in distress (added teams, rescue vessels and helicopters), located at Dutch Harbor
		Implement storm and severe weather rules for Unimak Pass and Greater Aleutians
		Require pollution/response plans for all large vessels transiting sensitive areas similar to requirements for vessels calling at Alaska ports
		Require all large vessels to have tow packages
		Expand upon emergency towing equipment currently implemented in Dutch Harbor
Emergency Operations and Procedures	Prevention	Identify a network of places of refuge and develop refuge plans for their use
		Establish an incident and near-miss reporting system with safeguards for mariners
Vessel Personnel and Pilotage	Prevention	Expand pilotage areas and pilot services to Unimak Pass and other possible locations
		Enhance requirements for vessel safety equipment and training and enforce existing requirements
Vessel Enhancements	Prevention	Require redundant steering and propulsion for tankers
		Require redundant steering and propulsion for tugs towing tank barges
		Require redundant steering and propulsion for all vessels
		Require double hull protection for fuel tanks
		Require double hull protection of cargo tanks and tank barges
		Raise liability limits
Response Improvements	Response	Station adequate salvage and lightering equipment and

Risk Mitigation Option	Category	Description
		capabilities at key locations
	Response	Finalize USCG salvage and firefighting requirements
		Enhance oil spill response capabilities and training
		Conduct emergency training and salvage drills

3.2 AIRA PHASE A RRO LIST

During the AIRA Advisory Panel Task 6 Workshop (September 2010), the AIRA Team members reviewed the Committee's list as a starting point for determining if the measures currently applied have already been implemented or if additional measures need to be added to the list. This vetting process resulted in the development of another list, which includes many of the measures from the Committee list.

3.2.1 Selection of the RROs

As stated above, the RRO list was further reviewed and developed through the expert judgment of the AIRA AP and consulted stakeholders. The RROs identified for evaluation are shown in Table 3.3.

Table 3.3 Risk Reduction Options Selected for Evaluation in Phase A

RRO #	RRO Description	Comment
1	**Enhance Vessel Monitoring Program**	
1a	Satellite tracking + AIS	Evaluated
1b	Long-range identification and tracking	Not evaluated as considered not effective at breaking causal chain
2	**Establish VTS in Unimak and Akutan Passes**	
2a	Manned Vessel Traffic System (VTS)/direct communication with vessels	Evaluated
2b	Traffic separation scheme in Unimak Pass	Evaluated
2c	Speed restrictions	Not evaluated as not enforceable
3	**Increase Rescue Tug Capability**	
3a	Dedicated rescue tug(s)	Evaluated

RRO #	RRO Description	Comment
3b	Non-dedicated rescue tug	Evaluated
3c	Seasonal, dedicated tug	Evaluated
3d	Tugs of Opportunity Program	Evaluated
4	**Increase Towing Capabilities**	
4a	Expand shore-based Emergency Towing System (ETS)	Evaluated
4b	Require emergency towing arrangements on deep draft vessels	Evaluated
5	**Enhanced USCG Capabilities**	
5a	Enhance towing capacity on USCG cutters	Evaluated
5b	Increase number of USCG cutters	Evaluated
5c	Increase inspections	Not evaluated
5d	Split Captain of the Port (COTP zones)	Not evaluated
6	**Establish Restricted Areas**	
6a	IMO PSSA/ATB/SA	Evaluated
7	**Increase Spill Response Capability**	
7a	Ocean-rated Oil Spill Removal Organization (OSRO) / Primary Response Action Contractor (PRAC) - Open Ocean	Evaluated
7b	Near-shore rated OSRO/PRAC	Evaluated
7c	Increase salvage and firefighting cap thru regulations	Evaluated
7d	Local community response agreements	Not evaluated
7e	Phase out Oil Pollution Act of 1990 (OPA 90) alternative compliance	Not evaluated
8	**Bolster Area Contingency Plans**	
8a	Establish requirements for vessels in innocent passage	Not evaluated
8b	Set area standards for vessels with Vessel Response Plans (VRP) calling at US ports	Not evaluated
8c	Develop more geographic response strategies	Evaluated
8d	Potential places of refuge planning	Not evaluated
8e	Storm and severe weather rules	Not evaluated
9	**Raise Liability Limits and Civil Penalties**	
9a	Increase liability and civil penalties	Not evaluated
9b	Increase State civil penalties	Evaluated

Note: The deadline for double-hull tank barges under OPA 90 is 2015; therefore, single-hull was not considered to be an issue in the study region.

3.2.2 *Descriptions of RROs*

The descriptions of the RROs as defined during the workshop for each RRO are summarized in Table 3.4. Table 3.4 is as recorded at the workshop; however, it includes some edits to improve the clarity of the description. These definitions were the basis of the evaluation process discussed in Section 4.0.

Detailed background and descriptions for each mitigation measure selected for evaluation were developed by the Facilitation Team, and are provided in Appendix B. This information is also posted on the AIRA website.

Table 3.4 Description of RROs as Recorded at the Workshop (Risk Team Summary)

RRO No.	RRO	Description of RRO as Recorded at the Workshop
1	**Enhance Vessel Monitoring Program**	
1a	Satellite tracking plus AIS	Increase areas coverage, increase number of vessels covered, implement an alarm system; integration of all monitors
1b	Long-range ID and tracking (LRIT)	Enhance ability to identify and monitor vessel movements and communicate with vessels engaged in questionable situation and provide alarm notification to USCG and State and response vessels
2	**Establish Vessel Tracking System (VTS) in Unimak and Akutan Passes**	
2a	Manned VTS/Direct Communication with Vessels	Meets IMO procedures and standards; new equipment, personnel, integration of systems
2b	Traffic Separation Scheme in Unimak Pass	Voluntary; mark lanes on nautical chart to control traffic direction
2c	Speed Restrictions	Dropped because low benefits, high unintended consequences, difficult to implement
3	**Increase Rescue Tug Capability**	
3a	Dedicated rescue tug(s)	Open sea capability, always available
3b	Non-dedicated rescue tug	Open sea capability, similar capability to dedicated tug but with cost-sharing, variable availability

RRO No.	RRO	Description of RRO as Recorded at the Workshop
3c	Seasonal, dedicated tug	Open sea capability, similar capability to dedicated tug but only available seasonally (Oct 1 thru May 30)
3d	Tugs of Opportunity Program	Tug regardless of size but available to respond; implement a program
4	**Increase Emergency Towing System (ETS) Capabilities**	
4a	Expand shore-based ETS	There is an ETS system in Dutch Harbor; expanding system in Dutch Harbor to other locations (e.g., add one in Adak and one in location to be determined); provide greater coverage
4b	Require emergency towing arrangements on deep draft vessels	For vessels not in innocent passage
5	**Enhanced USCG Capabilities**	
5a	Enhance towing capabilities on cutters	See Tugs of Opportunity
5b	Increase number of USCG cutters	
5c	Increase inspections	Not evaluated because there is no practical way to reduce risk further from the current inspection program
5d	Split Captain of the Port (COTP) zones	Currently 3 zones - change or add Unalaska as COTP city to theoretically reduce response time; RRO is very high up in causal chain and within institutional organization/management, which is difficult to evaluate
6	**Establish Restricted Areas**	
	Identify certain areas (to be defined) that should be avoided to reduce environmental or socioeconomic consequences/impacts	
6a	IMO PSSA/ATB/SA	Measure does not reduce spill severity once it occurs but there is a benefit to reduce severity due to preventing the accident from happening
6b	Seasonal Routing	No formal mechanism for implementation; further consideration deferred
7	**Increase Spill Response Capability**	
7a	Ocean-rated OSRO/PRAC - Open	No response capability except an Oil Spill Response Organization (OSRO) with only inland capability; this

RRO No.	RRO	Description of RRO as Recorded at the Workshop
	Ocean	measure assumes Open Ocean
7b	Near-shore rated OSRO/PRAC	
7c	Increase Salvage and Firefighting Capability via Regulations	New regulations go into effect in Feb 2011 for tank vessels; includes tugs, marine salvagers available, increase capability of lightering; ensure the regulations adequately address and are tailored for the Aleutian Islands. Salvage and marine firefighting regulations (subpart I) would apply
7d	Local Community Response Agreements	Not considered further because part of the existing baseline; no delta in risk reduction effectiveness
7e	Phase Out OPA 90 Alternative Compliance	The OPA 90 Alternative Compliance should NOT be phased out at this time; therefore, not an option.
8	**Bolster Area Contingency Plans**	
8a	Establish requirements for vessels in innocent passage	Not likely to be implementable; therefore not evaluated further
8b	Set area standards for vessels with VRP calling at US ports	Use local contingency plans to set standards; is a mechanism thus not evaluated further
8c	Develop more geographic response strategies	Tail end of causal chain; enables a minimizing of impacts with prompt and proper response
8d	Potential places of refuge planning	Already exists; baseline condition, no need to evaluate
8e	Storm and severe weather rules	Stay the course; part of existing baseline condition; not evaluated further
8f	High-Frequency radar surface current monitoring	Way of tracking oil and where it might go/trajectory; shore-based; assume transportable units set up as needed to monitor currents to help understand where spill might go; a tool in the toolbox; not enough information/knowledge of system to evaluate further
8g	Require more training and drills	New Vessel Response Plan (VRP) regulations require additional training; part of baseline condition and not evaluated further at this time
9	**Raise Liability Limits and Civil Penalties**	

RRO No.	RRO	Description of RRO as Recorded at the Workshop
9a	Increase liability and civil penalties	Cost of penalties is relatively low compared to response; but need limits within reason to obtain insurance; if raised too high insurance companies won't insure and may increase number of uninsured vessels; the General Accounting Office report states that OPA requires review of insurance
9b	Increase State civil penalties	Intent to encourage better operations of vessel and vessel company

3.3 RROs NOT EVALUATED FURTHER

During the AIRA AP Task 6 and Task 7 workshops conducted in Anchorage, Alaska, the Advisory Panel and Management Team discussed and evaluated 27 RROs. Of these risk reduction options, 13 were considered and set aside. The following provides a brief summary of the reason for setting aside each of the options.

***Speed Restrictions**:* The AP determined that this RRO would be difficult to implement considering the amount and various types of vessels transiting in and through the region. The Panel concluded there was a low benefit and would result in a high-unintended consequence if pursued.

***Seasonal Routing**:* The AP concluded that there is no formal mechanism for implementing seasonal routing throughout the study area and further consideration was deferred.

***Increase Coast Guard Vessel Inspections*:** The USCG currently has a vessel inspection program that has been implemented in Alaska and the United States. The AP concluded to not evaluate this RRO because there is no practical way to reduce risk further from the current inspection program.

Split Western Alaska Captain-of-the-Port (COTP) Zone: Currently three COTP zones exist in Alaska. The three zones are Southeast Alaska, Western Alaska, and Prince William Sound. The COPT and their representatives enforce within their respective areas port safety and security and marine environmental protection regulations. The Western COTP zone is the largest of the three and includes Cook Inlet, Kodiak, Aleutian Islands, Bristol Bay, the Northwest Arctic, and North Slope. There are three Marine Safety Detachment offices within the Western Alaska COTP zone, located in Kenai, Kodiak, and Unalaska. The AP

discussed the need to create an additional COTP within the Western Alaska zone, thus reducing the area of responsibility for one Captain. It was suggested to change and/or add Unalaska as a COTP city with the intent to decrease or reduce the response times currently stipulated in the federal Marine Firefighting, Salvage and Emergency Lightering rules. The AP concluded that this RRO was very high on the causal chain within the institutional organization/management (USCG) would be difficult to implement or evaluate.

State of Alaska Local Response Agreements: The Community Spill Response Program administered by the ADEC Prevention and Emergency Response Program began in the early 1990s. The State recognized the importance of local involvement and has worked with communities to provide for coordinated and effective responses, and to expand the network of resources available to protect human health and the environment from the risks associated with oil and hazardous substance spills. The AP did not consider this RRO primarily because it is an existing program. They encourage local communities without Community Response Agreements to contact the ADEC and work towards establishing agreements with the goal of expanding local capabilities and increasing response coordination.

Phase Out OPA 90 Alternate Compliance: This RRO was added to the AP's list during the September meeting based on public input. Oil spill prevention programs, contingency planning, and preparedness have undergone significant enhancements and changes since the passage of OPA 90. Due to these changes, the Alaska Petroleum Distributors and Transporters, an ad-hoc group of non-persistent Alaska fuel barge operators, have worked with the state and federal regulatory agencies to implement prevention measures and achieve a level of spill prevention and response agreeable to all parties. This agreement is referred to as an "alternate compliance agreement" and it was originally established in 1998 after a series of workshops. The agreement was modified in 2002. An Alaska non-persistent tank barge operator may voluntarily elect to subscribe to the alternate compliance agreement as opposed to meeting full compliance with OPA 90 in Alaska. The AP concluded that the alternate compliance agreement should not be eliminated due to the unintended consequences placed on commercial operators. Eliminating this option would result in a decrease of operators and a significant increase in the cost of fuel distributed in rural Alaska because of the cost of full compliance with OPA 90.

Establish Requirements for Vessels in Innocent Passage: The AP recognized early during discussions that implementing domestic management measures on vessels in innocent passage would be difficult. As the Advisory Panel discussion evolved, members began to better understand how International Maritime Organization (IMO) worked and the Panel discussed management measures that are applicable to vessels in innocent passage. Although, the AP did not pursue domestic management measures aimed at innocent passage vessels, they recommended that the US seek IMO approval of Particularly Sensitive Sea Areas (PSSAs) and associated protected measures.

Set Area Standards for Vessels with Vessel Response Plan's calling at US Ports: The AP recommended that, rather than attempting to set area standards for vessels required to have a federal vessel response plan, examine using the local or area contingency plan as a means of establishing standards.

Potential Places of Refuge: Establishing Potential Places of Refuge in the Aleutian Island region was first suggested in 2006 during the Ports and Waterways Safety Assessment for the Aleutian Islands. The ADEC funded the Aleutian Subarea Potential Places of Refuge (PPOR) Workgroup and the project was completed in September 2007. Ten zones were established within the region and maps developed depicting PPORs. Although the PPOR process does not need to be reexamined, the AP recommends examining the infrastructure (i.e., emergency anchoring or mooring buoys) need for those locations identified as PPORs. See recommendations for Bolstering Area Contingency Plans.

Increase Training and Drills: Training and drills are required under OPA 90 and state law and will be expanded and required under the salvage and firefighting rules. Part of the baseline for every new requirement or regulation has a training requirement and component for compliance. Therefore, the AP did not consider examining this RRO further.

Storm and Severe Weather Rules: Since the mid-1990s, the City of Unalaska, Alaska Marine Pilots, USCG, and local maritime industry have negotiated and established storm and weather rules for the Port of Dutch Harbor. These rules are reviewed annually and adjusted accordingly based on incidents or observations. The AP concluded that the existing process is working fine and no further evaluation of this RRO was necessary.

***High-Frequency (HF) Radar Surface Monitoring Currents**:* This RRO was added during the September meeting at the recommendation of an AP member. Ocean researchers use HF radar to measure surface current velocity fields near the coastline. An HF radar system can measure surface currents averaged over 15 minutes as far offshore as 50 miles. The AP concluded that HF radar is not a RRO, but rather a tool that could be used during or after a spill to track and map oil transported by nearshore currents. HF radar is certainly considered a tool in the oil spill response kit.

***Increase Federal Liability and Civil Penalties**:* The AP concluded that the cost of penalties is relatively low compared to the cost of response. The liability limits need to be reasonable in order for operators to obtain insurance. If raised too high, insurance companies will not insure and this may increase the number of uninsured vessels. The General Accounting Office report states that OPA requires review of the insurance limits every 3 years, but this has not been done since 1990. Essentially, the federal government needs to comply with OPA 90 by reviewing insurance limits every 3 years and implementing the necessary adjustments.

***Manned Vessel Tracking System**:* Due to the volume of traffic passing through the Unimak and Akutan passes, there was initial interest from some of the AIRA AP members to consider establishing a manned Vessel Tracking Service (VTS). Based on subsequent discussions, the AP and MT recommend reserving this RRO from further consideration for the following reasons:

- Under current federal law, the USCG is the only entity authorized to establish a VTS. The VTS would need to meet IMO procedures and standards.
- An in-depth study would be required to determine whether the USCG VTS is the best choice over an expanded and upgraded AIS or a Vessel Traffic Monitoring System.
- Regulatory changes would be needed to establish the control zone and to mandate who must participate, possibly involving submittal to the IMO for review, approval and adoption.
- The cost to purchase VTS equipment and increase the number of personnel to implement a VTS in Dutch Harbor would be substantially higher than the USCG's other 12 VTSs.
- Establishing and maintaining radar and communications equipment in the remote and hostile environment would not be easy or economical. All mountaintop access is by helicopter only.

- There is little technical support in Dutch Harbor for such an enterprise and would have to be developed.
- There is currently no public notice by the USCG to establish a formal, manned VTS for Unimak Pass.

4.0 RRO EVALUATION

This section describes the process used to evaluate the RROs, the categories and scores utilized for the evaluation, and the results of the RRO evaluation process.

4.1 OBJECTIVES OF APPLYING RROs

The objective of most risk assessments is to identify potential RROs and, for each RRO, determine if it should be implemented. There are four main considerations that determine the decision to implement:

- Is the RRO effective at reducing risk?
- Is the RRO affordable?
- Is the RRO practicable?
- Does the estimated risk support the implementation of additional RROs?

This report describes how each identified RRO was evaluated for effectiveness, cost, and practicality using an expert judgment-based process.

4.2 METHOD

The RRO evaluation was discussed via an expert judgment process during the Task 7 workshop (Anchorage 12-15 October 2010). This section describes the expert judgment process and describes how the accident causal chain is applied to the evaluation of the RROs.

4.2.1 Workshop Process

The attendees of the workshop and days they participated are shown in Table 4.1.

Table 4.1 Attendees at the AIRA Task 6 RRO Evaluation Workshop, October 2010

First	Last	Organization	Role	12 Oct	13 Oct	14 Oct	15 Oct
David	Arzt	Marine Pilot	Advisory Panel	x	x	x	x
Jay	Calkins	USCG	Federal Agency	x			
Berg	Catherine	Resource Manager	Advisory Panel			x	x
Rose	Cox	Public / Media	Public Attendee	x			
Gary	Folley	ADEC/SPAR	Management Team	x	x	x	x
Tim	Fowler	DNV	Risk Analysis Team	x	x	x	x
LCDR Mike	Franklin	USCG	Management Team	x	x	x	x
Tom	Gemmell	Fisheries	Advisory Panel	x	x		
Amy	Gilson	Nuka Research	Facilitation Team	x	x	x	x
David	Gregory	Subsistence	Advisory Panel	x	x	x	x
Layla	Hughes	NGO - Environmental	Advisory Panel	x	x	x	x
Larry	Iwamoto	ADEC	State Agency Attendee	x			
Colleen	Keane	Public/Pacific Environment	Public Attendee	x			x
Karol	Kolehmainen	NGO – Local	Advisory Panel	x	x	x	x
Tom	Lakosh	Public	Public Attendee	x			
Denny	Lassux	Public / US Fish & Wildlife Service	Federal Agency				x
Gene	Makarin	Mariner, Containerships	Advisory Panel	x	x	x	x
Shirley	Marquardt	Local Government	Advisory Panel	x	x	x	x
Ed	Page	Marine, General	Advisory Panel	x	x	x	x
Bob	Pawlowski	Public / Legislature	State Legislator Attendee	x			
Leslie	Pearson	Pearson Consulting, LLC	Facilitation Team	x	x	x	x
Tim	Robertson	Nuka Research	Facilitation Team	x	x	x	x

First	Last	Organization	Role	12 Oct	13 Oct	14 Oct	15 Oct
Michael	Ruiz	Public / Penco	Public Attendee	x			x
CAPT Adam	Shaw	USCG	Management Team	x	x	x	x
Whit	Sheard	NGO - Environmental	Advisory Panel	x	x	x	x
Laura	Tesch	ERM	Risk Analysis Team	x	x	x	x
Bob	Umbdenstock	Marine Salvor	Advisory Panel	x	x	x	x
John	Whitney	NOAA	Federal Agency	x	x	x	x
Jeff	Williams	Resource Manager	Advisory Panel	x	x		
Jay	Wright	National Fish and Wildlife Foundation	Management Team	x	x	x	x

The workshop was facilitated by the Risk Analysis Team. After introductions and definitions, the main meeting process involved the following:

- Selection of an RRO for evaluation.
- Discussion and agreement on how the RRO creates a barrier in the accident causal chain.
- Discussion and agreement of the degree to which the RRO will reduce the frequency of each of the five accident types modeled in Tasks 1 and 2 (collision, structural failure or foundering while underway, fire or explosion while underway, powered grounding, and drift grounding).
- Discussion and agreement of the degree to which the RRO will reduce the severity of each of the five accident types modeled in Tasks 1 and 2.
- Discussion and agreement on the extent of the geographical coverage of the RRO compared to the size of the study area.
- Discussion and agreement on the proportion of the year affected by the RRO compared to the size of the study area.
- Discussion and agreement of the capital and operating costs of the RRO, and who bears the cost.
- Discussion and agreement of the practicality of the RRO.

Time at the end of the workshop was used to review the initial outputs of the evaluation to provide a reality check on the workshop results obtained. Finally, the workshop attendees were requested to provide feedback on the workshop organization and process.

4.2.2 *Elaboration of Accident Causal Chain*

It is possible to consider that an accident is the result of a chain of preceding events or conditions that combine together to result in an accident. For example, a ship that suffers a main engine failure results in a drifting ship, but a drift grounding occurs only when engine failure occurs close to land and the wind or currents force the ship onto the grounding line. Similarly, only if the ship grounds on rocks and the laden tanks are punctured will a spill occur. Risk analysts refer to these circumstances as causal chains. Figure 4.1 shows the basic structure of a marine accident causal chain.

Figure 4.1 Marine Accident Causal Chain

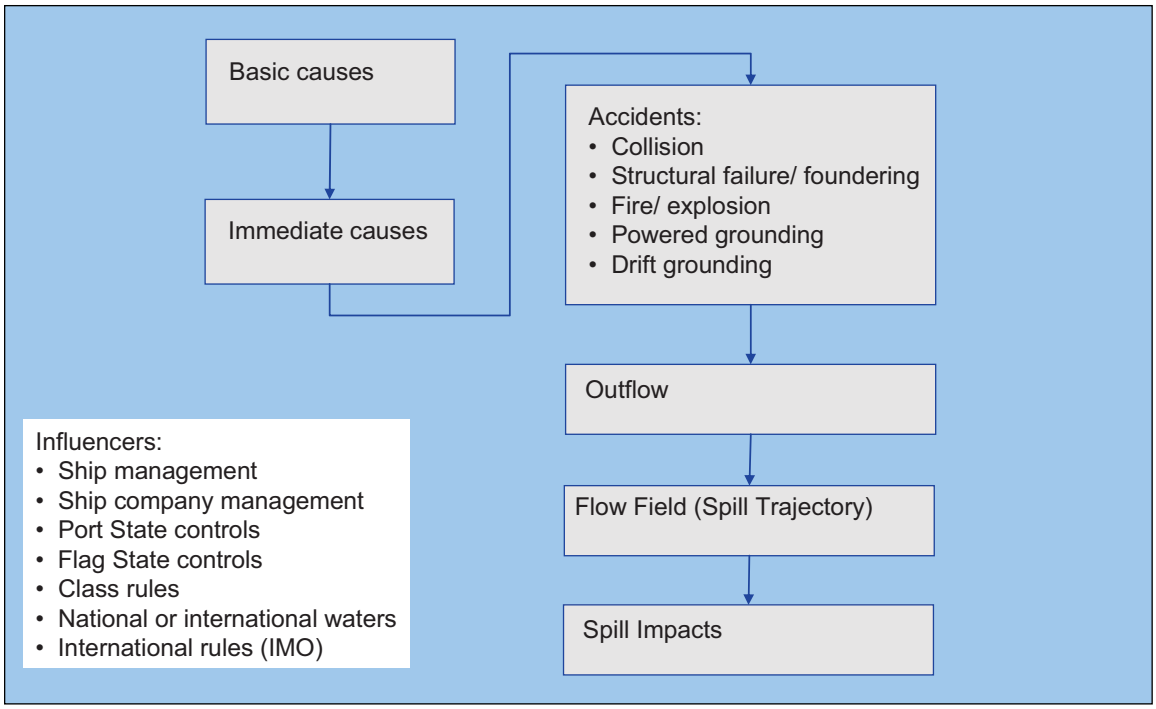


Figure 4.1 indicates that accidents arise from immediate causes (e.g., human error) which in turn arise from basic causes (e.g., poor training). Basic causes are usually related to organization and management issues. Similarly a cargo or fuel spill leads to an affected flow field and then to

impacts by the inclusion of environmental receptors. The main organizations that can influence risk are also shown.

Figure 4.2 shows the main immediate causes that contribute to each type of marine accident considered.

Figure 4.2 Summary of Immediate Causes

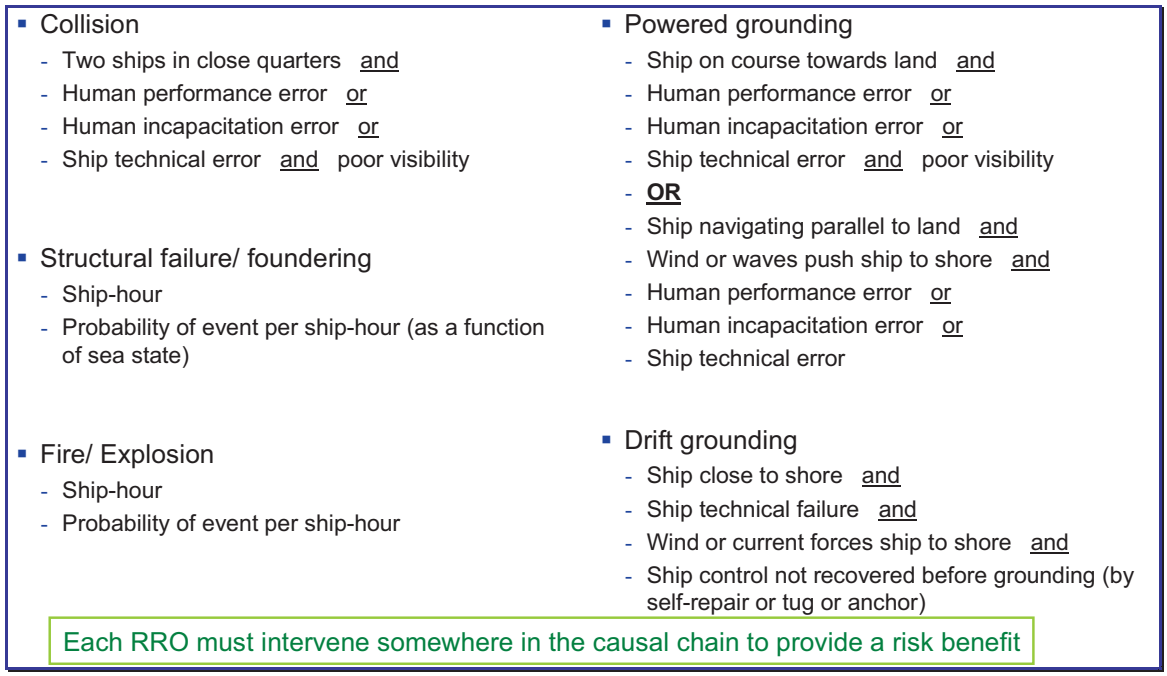


Figure 4.2 also emphasizes again that each RRO must intervene in the causal chain to provide a risk reduction benefit.

4.3 *CATEGORIES AND SCORES*

The categories used to evaluate and rank the RROs are effectiveness, cost and practicality. The factors or significant inputs associated with each category are described below. A qualitative scoring system was developed to capture a broad range of possibilities within each category. Each category used a simple scoring mechanism ranging from 1 to 3 or 0 to 3 to capture the low and high ranges. The specific scoring systems developed and used for each category are discussed in the subsequent sections.

Table 4.2 Evaluation Factors

Factors that determine if an RRO is effective at reducing risk include if:	The RRO might reduce the frequency of a specific accident type (e.g., a tug might prevent a drifting ship from grounding). The RRO might reduce the frequency of several accident types (e.g., options aimed at improving crew competence should reduce most or all accident types). The RRO might prevent a spill from occurring if an accident happens (e.g., double-hulled tank barges will prevent the spill of cargo in some accidents). The RRO might reduce the severity of the consequence of a spill (e.g., by ensuring that ships are routed away from certain areas at certain times of the year to protect migratory species).
The factors that influence the cost of an RRO include:	The capital cost of the RRO. The annual operating cost of the RRO. Who bears the capital and operating cost directly, and who ultimately pays the cost after cost recovery. Typical cost bearers are the shipping industry, one or more ports, the State of Alaska and/ or the federal government.
The factors that influence the practicability of an RRO include:	Which party can implement the RRO? Some RROs can be implemented by local decision; others require international agreement. Typical implementers are similar to typical cost-bearers, namely the shipping industry, one or more ports, the State of Alaska, the federal government and/ or the IMO. How long will it take to implement the RRO (what is the lead time during which the system operates without the full risk-reducing benefit of the RRO)? How easy is it to implement or enforce the RRO?

This report does not consider if the estimated risk supports the implementation of additional RROs (out of scope of the work). As an aside, one possible outcome of a risk assessment could be that the risk levels in the system are already either low in absolute terms or are low relative to the difficulty (e.g., cost or practicality) of implementing further RROs. In this situation, the risk assessment could validly conclude that the implementation of further RROs is not justified.

The prioritization of RROs for implementation involves making choices of the relative importance of RRO effectiveness, cost, and practicality. It should also take into account factors outside the scope of this risk assessment, such as the effect of the RRO on human fatality risk. The prioritization of the RROs is part of Task 8 and is outside of the scope of this report.

4.3.1 Effectiveness

There are three main factors that influence the effectiveness of an RRO at reducing risk within the study area:

- The size proportion of the study area that is affected by the RRO. For example, a single emergency towing vessel cannot provide an effective risk reduction benefit across the entire study area. The scoring system for this factor is shown in Table 4.3.
- The time proportion relative to a year that is affected by the RRO. For example, an emergency towing vessel that is chartered only for the winter cannot provide a risk reduction benefit during the summer. The scoring system for this factor is shown in Table 4.4.
- The technical effectiveness of the RRO, in terms of how the RRO affects the frequency of each accident type and how it affects the severity of each accident type. The scoring system for this factor is shown in Table 4.5.

Table 4.3 Scoring System Used to Assess the Size Proportion Affected by the RRO

Score	Fraction of AIRA study area covered
1	<33%
2	33% to 67%
3	>67%

Table 4.4 Scoring System Used to Assess the Time Proportion Affected by the RRO

Score	Fraction of time RRO applies
1	<33%
2	33% to 67%
3	>67%

Table 4.5 Scoring System Used to Assess Risk Reduction Effectiveness of the RRO

Score	Effect	Description
0	No effect	Uncertain/no mechanism to affect causal chain from basic causes to resource impacts
1	Minor effect	Minor mechanism to affect causal chain from basic causes to resource impacts
2	Moderate effect	Moderate mechanism to affect causal chain from basic causes to resource impacts
3	Strong effect	Strong mechanism to affect causal chain from basic causes to resource impacts

The raw results of the expert judgment evaluation of effectiveness are given in Table 4.6. Only evaluated RROs are shown.

Table 4.6 Raw Results - Expert Judgment Evaluation of RRO Effectiveness (evaluated)

RRO #	RRO Name	Area (Table 4.3)	Time (Table 4.4)	Accident Frequency (Table 4.5)					Spill Severity (Table 4.5)				
				Collision	Structural failure	Fire/ Explosion	Powered Grounding	Drift Grounding	Collision	Structural Failure	Fire/ Explosion	Powered Grounding	Drift Grounding
1a	Satellite tracking + AIS	2	3	0	0	0	3	3	2	2	2	2	2
2a	Manned VTS/Direct Communications with Vessels	1	3	3	0	0	3	1	2	2	2	2	2
2b	Traffic Separation Scheme in U. Pass	1	3	3	0	0	0	0	0	0	0	0	0
3a	Dedicated rescue tug(s)	2	3	0	0	0	0	3	2	2	2	1	2
3b	Non-dedicated rescue tug	2	2	0	0	0	0	3	2	2	2	1	2
3c	Seasonal, dedicated tug	2	2	0	0	0	0	3	2	2	2	1	2
3d	Tugs of opportunity program	3	3	0	0	0	0	1	1	1	1	1	1
4a	Expand shore-based ETS	3	3	0	0	0	0	2	2	2	2	1	1
4b	Require emergency towing arrangements on deep draft vessels	3	3	0	0	0	0	3	2	2	2	1	1
5a	Enhance towing cap on cutters	2	3	0	0	0	0	1	1	1	1	1	1
5b	Increase number of cutters	2	2	0	0	0	0	1	1	1	1	1	1

RRO #	RRO Name	Area (Table 4.3)	Time (Table 4.4)	Accident Frequency (Table 4.5)					Spill Severity (Table 4.5)				
				Collision	Structural failure	Fire/ Explosion	Powered Grounding	Drift Grounding	Collision	Structural Failure	Fire/ Explosion	Powered Grounding	Drift Grounding
6a	IMO PSSA and associated measures (e.g. ATBA)	2	3	0	0	0	2	2	2	2	2	2	2
7a	Ocean rated OSRO/PRAC - Open Ocean	3	3	0	0	0	0	0	1	1	1	0	0
7b	Near-shore rated OSRO/PRAC	3	3	0	0	0	0	0	2	2	2	2	2
7c	Increase salvage & firefighting cap through regulations	2	3	0	0	0	0	1	3	3	3	3	3
8c	Develop more geographic response strategies	3	3	0	0	0	0	0	1	1	1	1	1
9b	Increase State civil penalties	3	3	1	1	1	1	1	0	0	0	0	0

The overall effectiveness of each RRO was calculated using the "accident frequency with spill" results and the "probability of spill given an accident" results obtained from Tasks 1 and 2 as shown in Table 4.7.

Table 4.7 Accident Frequency and Spill Probability Results from Tasks 1 & 2

Accident Type	Accident Frequency per year	Accident with Spill Frequency per year	Probability of Spill given an Accident
Collision	0.173	0.062	0.36
Structural failure	0.105	0.034	0.32
Fire/ Explosion	0.107	0.033	0.31
Powered Grounding	4.541	0.707	0.16
Drift Grounding	3.741	0.603	0.16
Total	**8.667**	**1.439**	**1.31**

The results were calculated as follows:

- The effectiveness of the RRO at reducing accident frequency, calculated as:

  = (Area score) x (Time score) x Σi (accident frequency with spill from Table 4.7)i x (accident frequency reduction score)i

Where the summation runs over the five accident types.

- The effectiveness of the RRO at reducing accident severity, calculated as:

  = (Area score) x (Time score) x Σi (spill probability from Table 4.7)i x (accident probability reduction score)i

Where the summation runs over the five accident types.

- The effectiveness of the RRO at reducing accident risk, calculated as

  = (effectiveness of the RRO at reducing accident frequency) + (effectiveness of the RRO at reducing accident severity)

That is, the sum of the first two results.

These results are shown in Table 4.8 in terms of both the above results and how the results rank internally. Only evaluated RROs are shown.

Table 4.8 Results of Expert Judgment Evaluation of RRO Effectiveness

RRO #	RRO Name	Low rank is good Effectiveness - Frequency	Rank	Low rank is good Effectiveness - Severity	Rank	Low rank is good Effectiveness	Rank
1a	Satellite tracking + AIS	23.58	1	15.67	5	39.24	1
2a	Manned VTS/Direct Comm w Vessels	8.73	7	7.83	13	16.56	11
2b	Traffic Separation Scheme in U. Pass	0.56	14	0.00	16	0.56	17
3a	Dedicated rescue tug(s)	10.85	5	14.73	7	25.58	6
3b	Non-dedicated rescue tug	7.23	8	9.82	10	17.05	9
3c	Seasonal, dedicated tug	7.23	8	9.82	10	17.05	9
3d	Tugs of opportunity program	5.43	10	11.75	8	17.17	8
4a	Expand shore-based ETS	10.85	5	20.65	3	31.50	3
4b	Require emergency towing arrangements on deep draft vessels	16.28	2	20.65	3	36.92	2
5a	Enhance towing cap on Cutters	3.62	11	7.83	13	11.45	14
5b	Increase number of cutters	2.41	13	5.22	15	7.63	16
6a	IMO PSSA and associated measures (e.g. ATBA)	15.72	3	15.67	5	31.38	4
7a	Ocean rated OSRO/PRAC - Open Ocean	0.00	15	8.90	12	8.90	15
7b	Nearshore rated OSRO/PRAC	0.00	15	23.50	1	23.50	7
7c	Increase Salvage& Firefighting Cap thru Regs	3.62	11	23.50	2	27.11	5
8c	Develop more geographic response strategies (GRS)	0.00	15	11.75	8	11.75	13
9b	Increase State civil penalties	12.95	4	0.00	16	12.95	12

Table 4.8 shows that:

- Satellite tracking and AIS (RRO 1a) was evaluated as the most effective RRO at reducing accident frequency. This was because:
  - It provides wide area coverage and full time coverage.
  - It was evaluated as strongly effective (Table 4.6) for reducing the accident frequency of both drift grounding and powered grounding accident types (drift and powered groundings are the dominant accident types in the Aleutian Islands study area) by providing early warning of hazardous situations.
- Near-shore-rated OSRO/PRAC (RRO 7b) was evaluated as the most effective RRO at reducing accident severity. This was because:
  - It provides wide area coverage and full time coverage.
  - It was evaluated as moderately effective (Table 4.6) for reducing the accident severity of all accident types by providing near shore spill response capability.
- Satellite tracking and AIS (RRO 1a) was evaluated as the most effective RRO at reducing spill accident risk. This was because:
  - It is effective at reducing accident frequency.
  - Rapid and accurate knowledge of where an accident has occurred promotes effective spill response and spill impact mitigation.

Note that even if cost and practicality is excluded from a prioritization process, it is still necessary for the responsible parties (those that decide

what RROs should be implemented) to make judgments (choices) regarding what they are aiming to achieve by the implementation of RROs. Example choices include aiming for: reduction of total spill risk, reduction of spill risk of higher severity accidents, reduction of frequency of all accidents, etc. The role of the risk assessment team is to facilitate this process by defining options, not to make the judgments themselves.

Finally, these risk reduction effectiveness results are driven by expert judgment only. Expert judgment is a completely valid and recognized approach to assessing risk, but it must also be recognized that opinions expressed in expert judgment solicitation processes reflect the expertise, experiences, and personal positions of the experts consulted.

An alternative method of evaluating RRO effectiveness would be to evaluate each RRO in terms of the effect it would have on the risk model input parameters by:

- Recalculating the risk using the risk model (see Task 1/2), and then
- Comparing the new risk results to the base-case results to determine the absolute and percentage effectiveness of either RRO individually and, if required, in combination.

These alternative calculations, however, are outside of the Phase A scope of work.

4.3.2 Cost

In general, RROs will have both capital (initial purchase) and annual operating costs. These costs may be initially paid by different stakeholders, and may ultimately be re-charged to different stakeholders again. Capital and operating costs may be paid by different stakeholders. Table 4.9 shows the scoring system used for costs.

Table 4.9 Scoring System Used to Assess the Cost of the RRO

Score	Title	Capital Cost	Operating Cost per Year
1	Minor cost	Up to 1,000,000USD	Up to 1,000,000USD
2	Moderate cost	Between 1,000,000 and 10,000,000USD	Between 1,000,000 and 10,000,000USD
3	High cost	Greater than 10,000,000USD	Greater than 10,000,000USD

The stakeholders which might bear the costs of RROs considered during the workshop were:

- The shipping industry;
- One or more ports (e.g., Dutch Harbor);
- The State of Alaska (e.g., ADEC); and/ or
- The federal government (e.g., USCG).

The mechanisms whereby costs could be allocated and recovered were not considered during the workshop. The raw results of the expert judgment evaluation of RRO cost are given in Table 4.10. Only evaluated RROs are shown.

Table 4.10 Raw Results of Expert Judgment Evaluation of RRO Cost

RRO	RRO Description	Capital Cost (CapEx)					Operating Cost (OpEx)				
		Industry	Port	State	Federal	Not-Specified	Industry	Port	State	Federal	Not-Specified
1a	Satellite tracking + AIS					1					1
2a	Manned VTS/Direct Comm w Vessels				3					2	
2b	Traffic Separation Scheme in U. Pass				1						0
3a	Dedicated rescue tug(s)					3					2
3d	Tugs of opportunity program					1					1
4a	Expand shore-based ETS					1					1
4b	Require emergency towing arrangements on deep draft vessels	2					2				
5a	Enhance towing cap on cutters				2					1	
5b	Increase number of cutters				3					2	
6a	IMO PSSA/ATB/SA				1	IMO ?	1				
7a	Ocean-rated OSRO/PRAC - Open Ocean	3					2				
7c	Near-shore rated OSRO/PRAC	3					2				
7d	Increase salvage & firefighting cap through regs	2					1				

8c	Develop more geographic response strategies					1					1
9b	Increase State civil penalties			0			1		0		

The total cost of an RRO was calculated as follows:

Total RRO cost = Σi (expert judgment weighting factor) x (cost factor from Table 4.9)

Where the summation runs over capital and operating costs borne by all parties (10 elements in all). The expert judgment weighting factors were assumed to be 1.0. The effect of this assumption is that recurring operating costs have equal weight with the one-off capital costs. This assumption may need to be modified.

The results are shown in Table 4.11 in terms of both the above results and how the results rank internally. Only evaluated RROs are shown.

Table 4.11 Results of Expert Judgment Evaluation of RRO Cost

RRO No.	RRO Description	Low Rank is Good	
		Cost	Rank
1a	Satellite tracking + AIS	2	3
2a	Manned VTS/Direct Comm w Vessels	5	12
2b	Traffic Separation Scheme in U. Pass	1	1
3a	Dedicated rescue tug(s)	5	12
3b	Non-dedicated rescue tug	5	12
3c	Seasonal. Dedicated tug	3	8
3d	Tugs of opportunity program	2	3
4a	Expand shore-based ETS	2	3
4b	Require emergency towing arrangements on deep draft vessels	4	11
5a	Enhance towing cap on cutters	3	8
5b	Increase number of cutters	5	12
6a	IMO PSSA/ATB/SA	2	3
7a	Ocean-rated OSRO/PRAC – Open Ocean	5	12
7b	Near-shore-rated OSRO/PRAC	5	12
7c	Increase salvage & firefighting cap through regs	3	8

8c	Develop more geographic response strategies	2	3
9b	Increase State civil penalties	1	1

The RRO evaluation based on cost indicated the following:

- RRO 2b - Traffic Separation Scheme in Unimak Pass and 9b - Increased State Civil Penalties are ranked as 1 (lowest cost); and
- RRO 1a - Satellite tracking and AIS and 8c - Develop more geographic response strategies are ranked as 3.

4.3.3 Practicality

Different RROs have different levels of practicality. This was discussed at the workshop in the following terms:

- Who implements the RRO? Example of potential RRO implementers are:
  - The shipping industry (if the RRO is not mandated then implementation is likely to be partial).
  - One or more ports (such as Dutch Harbor).
  - The State (such as ADEC).
  - Federal government (such as USCG).
  - International agreement (such as through IMO).
- What is the likely lead time for implementation? (how quickly is the risk reduction benefit achieved?); see Table 4.12.
- How easy is the RRO to implement or enforce? For example, a RRO could be easy to enact in legislation but difficult to enforce in practice and hence have reduced risk reduction benefit; see Table 4.13.
- Are there any unintended consequences of the RRO? (Note, this factor was not evaluated in detail during the workshop).

Table 4.12 Scoring System Used to Assess the Implementation Lead Time of the RRO

Score	Lead Time	Lead Time Description
1	Short	<1 year
2	Moderate	1 to 3 years
3	Long	> 3 years

Table 4.13 Scoring System Used to Assess the Ease of Implementation of the RRO

Score	Ease of Enforcement or Implementation
1	Easy
2	Moderate
3	Difficult

The raw results of the expert judgment evaluation of effectiveness are given in Table 4.14. Only evaluated RROs are shown.

Table 4.14 Raw Results of Expert Judgment Evaluation of RRO Practicality

RRO	RRO Description	Who Implements					Lead Time	Ease	Unintended Effects
		Industry	Port	State	Federal	NS			
1a	Satellite tracking + AIS	x		x	x		1	1	
2a	Manned VTS/Direct Comm w Vessels				x	IMO	3	3	
2b	Traffic Separation Scheme in U. Pass				x	IMO	3	1	
3a	Dedicated rescue tug(s)		x	x	x		2	3	
3d	Tugs of opportunity	x				x	1	1	

RRO	RRO Description	Who Implements					Lead Time	Ease	Unintended Effects
		Industry	Port	State	Federal	NS			
	program								
4a	Expand shore-based ETS	x		x	x		1	1	
4b	Require emergency towing arrange-ments on deep draft vessels	x			x	IMO	3		APC is less time as opposed to regulation which is longer
5a	Enhance towing cap on cutters				x		2	1	
5b	Increase number of cutters				x		2	3	
6a	IMO PSSA/ATB/ SA	x			x	IMO	2	1	
7a	Ocean-rated OSRO/PRA C - Open Ocean				x		3	2	May divert resources from more effective RROs?
7c	Near-shore rated OSRO/PRA C			x	x		3	2	
7d	Increase salvage & firefighting cap through regs				x		2	2	
8c	Develop more geographic response strategies	x		x	x		2	1	
9b	Increase State civil penalties			x			1	1	Is this possible?

The overall practicality of an RRO was calculated as follows:

- Overall RRO practicality =

  (lead time expert judgment weighting factor) x (lead time factor from Table 4.12) + (ease expert judgment weighting factor) x (ease factor from Table 4.13)

Both the expert judgment weighting factors were assumed to be 1.0.

These results are shown in Table 4.15 in terms of both the above results and how the results rank internally. The easiest RROs to implement have the lowest practicality score and are ranked 1. Only evaluated RROs are shown.

Table 4.15 Results of Expert Judgment Evaluation of RRO Practicality

RRO	RRO Description	Low Rank is Good	
		Practicality	Rank
1a	Satellite tracking + AIS	2	1
2a	Manned VTS/Direct Comm w Vessels	6	17
2b	Traffic Separation Scheme in U. Pass	4	9
3a	Dedicated rescue tug(s)	5	12
3b	Non-dedicated rescue tug	5	12
3c	Seasonal. Dedicated tug	4	9
3d	Tugs of opportunity program	2	1
4a	Expand shore-based ETS	2	1
4b	Require emergency towing arrangements on deep draft vessels	3	5
5a	Enhance towing cap on cutters	3	5
5b	Increase number of cutters	5	12
6a	IMO PSSA/ATB/SA	3	5
7a	Ocean-rated OSRO/PRAC – Open Ocean	5	12
7b	Near-shore rated OSRO/PRAC	5	12
7c	Increase Salvage and Firefighting Cap through Regs	4	9
8c	Develop more geographic response strategies	3	5

9b	Increase State civil penalties	2	1

As indicated in the table above, the RROs that rank the highest for practicality are:

- RRO 1a - Satellite tracking and AIS;
- RRO 3d - Tugs of opportunity program;
- RRO 4a - Expand shore-based ETS; and
- RRO 9b - Increased State Civil Penalties.

4.4 *COST-BENEFIT ANALYSIS*

The results presented above evaluated the risk reduction effectiveness, cost, and practicality on the basis of an expert judgment solicitation process conducted during the Task 7 workshop held in October 2010. Examination of the results indicates that no one RRO is evaluated as best for effectiveness, cost, and practicality. That is, there is no RRO identified by this analysis that is clearly the best.

Risk assessments often perform a cost benefit analysis to identify the best RROs to implement (which option gives the "biggest bang for the buck"). The work reported here is based on an expert judgment process, so the results presented below will need to be verified by additional data and analysis, but are provided to give an indication of which RROs might be the best candidates for implementation.

Table 4.16 is the list of RROs sorted on the RRO effectiveness divided by the RRO cost. The RRO with the highest effectiveness per cost is the most cost-effective.

Table 4.16 Cost Benefit Results Based on Expert Judgment Workshop Outputs

RRO #	RRO Name	Effectiveness : Cost
1a	Satellite tracking + AIS	19.6
4a	Expand shore-based ETS	15.7
6a	IMO PSSA and associated measures (e.g., ATBA)	15.7
9b	Increase State civil penalties	12.9
4b	Require emergency towing arrangements on deep draft vessels	9.2

RRO #	RRO Name	Effectiveness : Cost
7c	Increase salvage & firefighting cap through regs	9.0
3d	Tugs of Opportunity Program	8.6
8c	Develop more geographic response strategies	5.9
3c	Seasonal, dedicated tug	5.7
3a	Dedicated rescue tug(s)	5.1
7b	Near-shore rated OSRO/PRAC	4.7
5a	Enhance towing cap on Cutters	3.8
3b	Non-dedicated rescue tug	3.4
2a	Manned VTS/direct communication with vessels	3.3
7a	Ocean-rated OSRO/PRAC - Open Ocean	1.8
5b	Increase number of cutters	1.5
2b	Traffic separation scheme in U. Pass	0.6

Table 4.16 indicates, on the basis of the information and assumptions described in this report, that enhanced satellite tracking and AIS (1a) is the most cost-effective RRO.

Figure 4.3 shows the effectiveness (large is most effective at reducing risk), cost (small is low cost) and practicality (small is easy to implement) plotted on a single graph.

Figure 4.3 Composite Plot of RRO Effectiveness, Cost, and Practicality

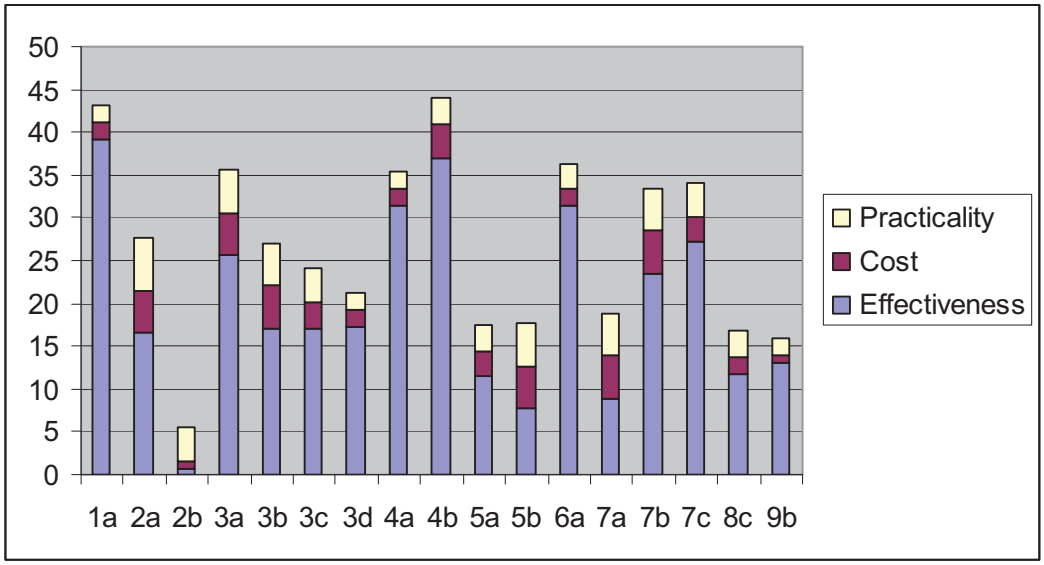


Figure 4.3 shows that:

- The most effective RROs have the largest blue bars.
- The least cost RROs have the smallest red bars.
- The easiest to implement RROs have the smallest yellow bars.

From Figure 4.3, different prioritization strategies are immediately apparent, such as:

- Most effective RRO at reducing risk (highest blue bar) – RRO #1a.
- Least expensive RRO (lowest red bar) – RRO #s 2b and 9b.
- Most practical RRO (lowest yellow bar) – RRO #s1a, 3d, 4a and 9b.
- Most cost effective (highest blue: red ratio) – RRO #1a.
- Cheapest and easiest ("Low hanging fruit," lowest red and lowest yellow bar) – RRO#9b.

The primary evaluation of the effectiveness of the RROs was performed during the Task 7 Workshop held in Anchorage in October 2010 as described above. Nevertheless, it is valuable to consider how each RRO might affect the 16 spill scenarios identified and evaluated as part of Tasks 3, 4 and 5 (see Consequence Analysis Report and Task 5 Accident Scenario and Causality Study Report). It is important to note that the 16 spill scenarios are example scenarios and not representative scenarios. In fact, the 16 spill scenarios were selected as reasonable worst-case scenarios, so they are clearly higher risk (and higher severity) than a typical or average spill scenario in the Aleutian Islands study area.

The outputs from the Task 7 Workshop are used to evaluate the effect of the RROs on each of the 16 accident scenarios. Expert judgments as presented in Table 4.6 are used to complete this qualitative evaluation. Based on these results, the RROs were evaluated based on effectiveness to break the causal chain of the severity or frequency associated with each accident scenario and its accident type. For example, if the RRO is a traffic separation scheme, then it won't be effective for a scenario caused by a powered grounding. Each scenario is summarized by accident type below.

Effect of RROs on Collision-type Accident Scenarios (Scenarios 1 through 5)

Scenarios 1, 2, 3, and 5 all arise due to collisions on the northern side of Unimak Pass in summer. The scenarios are distinguished by their spill size and the type of oil spilled (bunker fuel oil, bunker fuel oil, crude oil and diesel for Scenarios 1, 2, 3 and 5, respectively). Accident Scenario 4 arises due to collision on the north side of Unimak Pass in winter with a spill of diesel.

Effect of RROs on Drift Grounding-type Accident Scenarios (Scenarios 6 through 13, 15, and 16)

Scenarios 6 through 9 all arise due to drift grounding off Sanak Island in summer. The scenarios are distinguished by their spill size and the type of oil spilled (bunker fuel oil, bunker fuel oil, crude oil, and diesel for Scenarios 6, 7, 8, and 9, respectively).

Scenarios 10 through 13 all arise due to drift grounding in Holtz Bay on Attu Island. The scenarios are distinguished by their spill size, the type of oil spilled, and the season (winter and bunker fuel oil, summer and bunker fuel oil, spring and crude oil and spring and diesel for Scenarios 10, 11, 12, and 13, respectively).

Scenario 15 is a drift grounding in South of Amlia Island resulting in a spill of bunker oil in summer. Scenario 16 is a drift grounding in North of Urilia Bay resulting in a spill of bunker oil in spring.

Effect of RROs on Powered Grounding-type Accident Scenarios (Scenario 14)

Accident Scenario 14 is a powered grounding to the north of Adak, resulting in a spill of diesel in summer.

The effectiveness of the RROs for frequency and severity for each scenario based on accident type are summarized in Table 5.1.

Table 5.1 Summary of RRO Effectiveness on Accident Scenarios [1]

RRO	RRO Name	Accident Scenarios 1-5 (Collision Accidents) [2]	Accident Scenarios 6-12, 15, 16 (Drift Grounding Accidents)	Accident Scenario 14 (Powered Grounding Accident)
1a	Satellite tracking + AIS	Does not affect the frequency of collision accidents but it was judged to have a moderate reduction in severity due to the ability of the responsible parties to quickly identify where the accident occurred, thus enabling a more effective response.	Provides a strong reduction in the frequency of drift grounding accidents because it enables the early identification of a drifting ship and hence swift response; judged to provide a moderate reduction in severity due to the ability of the responsible parties to quickly identify where the accident occurred, thus enabling a more effective response.	Provides a strong reduction in the frequency of powered grounding accidents because it enables the early identification of a drifting ship and hence swift response; judged to provide a moderate reduction in severity due to the ability of the responsible parties to quickly identify where the accident occurred, thus enabling a more effective response.
2a	Manned VTS/direct communication with vessels	Strongly reduces the frequency of collision accidents by providing external vigilance to help prevent the collision. In addition, it was judged to have a moderate reduction in severity due to the ability of the responsible parties to quickly identify where the accident occurred, thus enabling a more effective response.	Weakly reduces the frequency of drift grounding accidents by providing early identification of a drifting ship; judged to have a moderate reduction in severity due to the ability of the responsible parties to quickly identify where the accident occurred, thus enabling a more effective response. Note it is questionable if any VTS would provide coverage as far out as Sanak Island.	Provides a strong reduction in the frequency of powered grounding accidents because it enables the early identification of a drifting ship and hence swift response; judged to provide a moderate reduction in severity due to the ability of the responsible parties to quickly identify where the accident occurred, thus enabling a more effective response
2b	Traffic separation scheme in Unimak Pass	Strongly reduces the frequency of collision accidents by providing traffic separation to help prevent the collision, but it was judged to provide no reduction in severity due to the absence of shore-based support.	No effect on either the frequency or the severity of drift grounding accidents.	No effect on either the frequency or the severity of powered grounding accidents.
3a	Dedicated rescue tug(s)	Does not affect the frequency of collision accidents; judged to provide a moderate reduction in severity due to the near-immediate response capability provided	Strongly reduce the frequency of drift grounding accidents due to the ability of the tug to take control of the drifting ship; judged to provide a moderate	No effect on the frequency of powered grounding accidents; judged to provide a weak reduction in severity.

RRO	RRO Name	Accident Scenarios 1-5 (Collision Accidents) [2]	Accident Scenarios 6-12, 15, 16 (Drift Grounding Accidents)	Accident Scenario 14 (Powered Grounding Accident)
		by the tug.	reduction in severity due to the near-immediate response capability provided by the tug.	
3b	Non-dedicated rescue tug	Does not affect the frequency of collision accidents and does not affect the severity of accidents because the tug is assumed to be absent in summer.	Strongly reduce the frequency of drift grounding accidents due to the ability of the tug to take control of the drifting ship; judged to provide a moderate reduction in severity due to the near-immediate response capability provided by the tug.	
3c	Seasonal, dedicated tug	Does not affect the frequency of collision accidents and does not affect the severity of accidents because the tug is assumed to be absent in summer.	Does not affect the frequency of collision accidents and does not affect the severity of accidents for Scenarios 6-9, 11 and 15 because the tug is assumed to be absent in summer.	No effect on the frequency of powered grounding accidents; judged to provide a weak reduction in severity.
3d	Tugs of Opportunity Program	Does not affect the frequency of collision accidents but it was judged to provide a weak reduction in severity due to the near-immediate response capability provided by the tug, though the response capability will be less effective than for a dedicated tug.	Provides a weak reduction in frequency of drift grounding accidents due to the partial coverage provided; judged to provide a weak reduction in severity due to the near-immediate response capability provided by the tug, through the response capability will be less effective than for a dedicated tug.	No effect on the frequency of powered grounding accidents; judged to provide a weak reduction in severity.
4a	Expand shore-based ETS	Does not affect the frequency of collision accidents but it was judged to provide a moderate reduction in accident severity due to the enhanced capability of taking control of a ship that starts to drift due to collision.	Provides a moderate reduction to the frequency of drift grounding accidents due to the enhanced ability for available ships to take control of a drifting ship; judged to provide a weak reduction in accident severity due to the enhanced capability of taking control of a ship that starts to drift.	No effect on the frequency of powered grounding accidents; judged to provide a weak reduction in severity.
4b	Require emergency	RRO does not affect the frequency of collision accidents but it was judged to	Provides a strong reduction to the frequency of drift grounding accidents	No effect on the frequency of powered grounding accidents; judged to provide

RRO	RRO Name	Accident Scenarios 1-5 (Collision Accidents) [2]	Accident Scenarios 6-12, 15, 16 (Drift Grounding Accidents)	Accident Scenario 14 (Powered Grounding Accident)
	towing arrangements on deep draft vessels	provide a moderate reduction in accident severity due to the enhanced capability of taking control of a ship that starts to drift due to collision.	due to the enhanced ability for available ships to take control of a drifting ship and the fact that the towing package is matched to the ship size; judged to provide a weak reduction in accident severity due to the enhanced capability of taking control of a ship that starts to drift.	a weak reduction in severity.
5a	Enhance towing cap on cutters	Does not affect the frequency of collision accidents but it was judged to provide a weak reduction in severity due to providing some capability of taking control of a ship that starts to drift due to collision.	Provides a weak reduction to the frequency of drift grounding accidents due to the enhanced availability of tow equipped vessels; judged to provide a weak reduction in accident severity due to the enhanced capability of taking control of a ship that starts to drift.	No effect on the frequency of powered grounding accidents; judged to provide a weak reduction in severity.
5b	Increase number of cutters	Does not affect the frequency of collision accidents but it was judged to provide a weak reduction in severity due to providing some capability of taking control of a ship that starts to drift due to collision.	Provides a weak reduction to the frequency of drift grounding accidents due to the enhanced availability of tow equipped vessels; judged to provide a weak reduction in accident severity due to the enhanced capability of taking control of a ship that starts to drift.	No effect on the frequency of powered grounding accidents; judged to provide a weak reduction in severity.
6a	IMO PSSA and associated measures (e.g., ATBA)	Does not affect the frequency of collision accidents but it was judged to provide a moderate reduction in severity due to its effect of routing ships away from the most environmentally sensitive areas.	Provides a moderate reduction of the frequency of drift grounding due to routing vessels away from the shoreline; judged to provide a moderate reduction in severity due to its effect of routing ships away from the most environmentally sensitive areas.	Provides a moderate reduction of the frequency of powered grounding due to routing vessels away from the shoreline; judged to provide a moderate reduction in severity due to its effect of routing ships away from the most environmentally sensitive areas.
7a	Ocean-rated OSRO/PRAC - Open Ocean	Does not affect the frequency of collision accidents but was judged to provide a weak reduction in severity due to its providing an open ocean spill response	Does not affect the frequency or severity of drift grounding accidents.	Does not affect the frequency or severity of powered grounding accidents.

RRO	RRO Name	Accident Scenarios 1-5 (Collision Accidents) [2]	Accident Scenarios 6-12, 15, 16 (Drift Grounding Accidents)	Accident Scenario 14 (Powered Grounding Accident)
		capability.		
7b	Near-shore-rated OSRO/PRAC	Does not affect the frequency of collision accidents; judged to provide a moderate reduction in severity due to its providing a near shore spill response capability.	Does not affect the frequency of drift grounding accidents; judged to provide a moderate reduction in severity due to its providing a near shore spill response capability.	No affect on the frequency of powered grounding accidents; judged to provide a moderate reduction in severity due to its providing a near shore spill response capability.
7c	Increase salvage & firefighting cap through regs	Does not affect the frequency of collision accidents but it was judged to provide a strong reduction in severity due to its providing a specialist state-of-the art spill response capability.	Provides a weak reduction to the frequency of drift grounding accidents but it was judged to provide a strong reduction in severity due to its providing a specialist state-of-the art spill response capability.	No affect on the frequency of powered grounding accidents; judged to provide a strong reduction in severity due to its providing a specialist state-of-the art spill response capability.
8c	Develop more geographic response strategies	Does not affect the frequency of collision accidents but it was judged to provide a weak reduction in severity due to its providing some enhancement of spill response capability.	Does not affect the frequency of drift grounding accidents but it was judged to provide a weak reduction in severity due to its providing some enhancement of spill response capability.	Does not affect the frequency of powered grounding accidents but it was judged to provide a weak reduction in severity.
9b	Increase State civil penalties	Provides a weak reduction of frequency of collision accidents due to crew and shipping companies taking more care to avoid penalties; however, judged to not provide any reduction in accident severity.	Provides a weak reduction of frequency of drift grounding accidents due to crew and shipping companies taking more care to avoid penalties; however, judged to not provide any reduction in accident severity.	Provides a weak reduction of frequency of powered grounding accidents due to crew and shipping companies taking more care to avoid penalties; however, judged to not provide any reduction in accident severity

Notes:

1. Evaluation summarized based on RRO effectiveness recorded in Table 4.6. Expert judgments recorded as 0 = no affect; 1 = weak reduction; 2 = moderate reduction; and 3 = strong reduction.

2. Accident Scenario 4 - This scenario arises due to collisions on the north side of Unimak pass in winter with a spill of diesel. All RROs are evaluated as identical for Scenarios 1, 2, 3 and 5 except for 3b and 3c. RRO does not affect the frequency of collision accidents but it was judged to provide a moderate reduction in severity due to the near-immediate response capability provided by the tug (assumed present in winter).

6.0 RRO EVALUATION SUMMARY

This RRO Evaluation Report provides a qualitative analysis of potential high-risk accident scenarios selected for the Aleutian Islands area and describes the development, evaluation, and ranking of the RROs. The results herein are interdependmet on the studies completed previously:

- Spill Scenarios selected through stakeholder engagement and studies conducted during Tasks 1, 2, and 3 (ERM/DNV 2010a, 2010b, and 2010c);
- The consequence and causality analysis conducted during Tasks 4 and 5 (ERM/DNV 2011a and 2011b); and
- A process to score and rank the accident scenarios developed as part of Task 6 (see Section 2).

Risk has two components: consequence (severity) and frequency. Thus, each of the 16 accident scenarios was evaluated and assigned consequence scores and relevant frequency of occurrences to estimate its relative risk (see Section 2).

Ranking of the consequences of the spill scenarios was conducted using a weighting summation technique to express a consistent comparative rating of the scenarios based on environmental, physical, and socioeconomic categories. The method includes numeric representations of the magnitude of potential impact of the characteristic (in terms of area impacted), probability of impact (in terms of percent from probability from spill model) and the relative importance (i.e., sensitivity) of each category.

The rating for each of the categories was summed to obtain the total weighted rating for a scenario to directly compare to the corresponding ratings of other scenarios. The resulting Total Consequence Score represents a comparative value of the potential consequences associated with each example spill scenario. The result of the process is that scenarios with higher total weighted rating are considered to represent greater potential impacts. The five accident scenarios representing the highest risk for potential impacts (severity) are summarized below.

Top five scenarios with highest Total Consequence Scores (beginning with highest score)

Scenario 2	Bulk carrier, vessel collision North of Unimak Pass, Bunker C spill of 15,000 barrels (bbl)
Scenario 16	Bulk carrier, drift grounding North of Urilia Bay, Bunker C spill of 15,000 bbl
Scenario 3	Crude Oil tanker, vessel collision North of Unimak Pass, Crude Oil spill of 400,000 bbl
Scenario 8	Crude Oil tanker, drift grounding off Sanak Island, Crude Oil spill of 400,000 bbl
Scenario 12	Crude Oil tanker, drift grounding Holtz Bay on Attu Island, Crude Oil spill of 400,000 bbl

Frequencies for five categories, ranging from improbable (least likelihood) to probable (more likely), were assigned based on Task 2 analysis and MARCS output results (ERM/DNV 2010b). Each category has an associated range of frequencies it represents. This analysis chose to apply the median or middle value from the relevant range to each of the scenarios. It should be noted that the frequency information available from the model represents the frequency of the given spill scenarios (vessel, material, spill size combination) *anywhere* in the study area, and as such, is not specific to each spill location.

Once the consequences and frequencies were estimated for each of the scenarios, the risks could be mapped back into the risk matrix. Based on the matrix mapping, the scenarios posing the greatest risk are summarized below.

Scenario No.	**Description**	**Spill Load Rate (MT/hour)**
Scenario 16	Bulk carrier, drift grounding North of Urilia Bay, Bunker C spill of 15,000 bbl	100
Scenario 2	Bulk carrier, vessel collision North of Unimak Pass, 15,000 bbl Bunker C spill	100
Scenario 8	Crude Oil tanker, drift grounding off Sanak Island, Crude Oil spill of 400,000 bbl	19,210 -1st hr 171.5 - next 48 hrs

It is best **not** to analyze these risk results in a way that implies they are quantitative, because this truly has been a semi-quantitative exercise. The results are based on a mixture of semi-quantitative and qualitative inputs (with quantitative intermediate processing such as modeling).

In addition, the uncertainty associated with both the frequency and consequence estimates (individually) is likely plus or minus a matrix category. That is not to say this is a valueless exercise, but rather, that use of the results should be limited to provision of guidance to the decision-making process.

The next step of the evaluation process involved reviewing the RRO list and evaluating the RROs based on effectiveness, cost, and practicality (see Sections 3 and 4). The list of RROs evaluated as part of the Phase A PRA during the Task 7 Workshop is summarized in Table 6.1 below.

Table 6.1 RROs Evaluated During Task 7 Workshop

RRO No.	RRO Name	Description of RRO Evaluated
1	**Enhance Vessel Monitoring Program**	
1a	Satellite tracking plus AIS	Increase areas coverage, increase number of vessels covered, implement an alarm system; integration of all monitors
2	**Establish Vessel Tracking System (VTS) in Unimak and Akutan Passes**	
2a	Manned VTS/Direct Communication with Vessels	Meets IMO procedures and standards; new equipment, personnel, integration of systems
2b	Traffic Separation Scheme in Unimak Pass	Voluntary; mark lanes on nautical chart to control traffic direction
3	**Increase Rescue Tug Capability**	
3a	Dedicated rescue tug(s)	Open sea capability, always available
3b	Non-dedicated rescue tug	Open sea capability, similar capability to dedicated tug but with cost-sharing, variable availability
3c	Seasonal, dedicated tug	Open sea capability, similar capability to dedicated tug but only available seasonally (Oct 1 through May 30)
3d	Tugs of opportunity program	Tug regardless of size but available to respond; implement a program

RRO No.	RRO Name	Description of RRO Evaluated
4	**Increase Emergency Towing System (ETS) Capabilities**	
4a	Expand shore-based ETS	There is an ETS system in Dutch Harbor; expanding system in Dutch Harbor to other locations (e.g., add one in Adak and one in location to be determined); provide greater coverage
4b	Require emergency towing arrangements on deep draft vessels	For vessels not in innocent passage
5	**Enhanced USCG Capabilities**	
5a	Enhance towing capabilities on cutters	See tug of opportunity
5b	Increase number of USCG cutters	
6	**Establish Restricted Areas**	
	Identify certain areas (to be defined) that should be avoided to reduce environmental or socioeconomic consequences/impacts	
6a	IMO PSSA/ATB/SA	Measure does not reduce spill severity once it occurs but there is a benefit to reduce severity due to preventing the accident from happening
7	**Increase Spill Response Capability**	
7a	Ocean-rated OSRO/PRAC - Open Ocean	No response capability except an Oil Spill Response Organization (OSRO) with only inland capability; this measure assumes Open Ocean
7b	Near-shore rated OSRO/PRAC	
7c	Increase Salvage and Firefighting Capability via Regulations	New regulations go into effect in Feb 2011 for tank vessels; includes tugs, marine salvagers available, increase capability of lightering; ensure the regulations adequately address and are tailored for the Aleutian Islands. Salvage and marine firefighting regulations (subpart I) would apply
8	**Bolster Area Contingency Plans**	
8c	Develop more geographic response strategies	Tail end of causal chain; enables a minimizing of impacts with prompt and proper response
9	**Raise Liability Limits and Civil Penalties**	

RRO No.	RRO Name	Description of RRO Evaluated
9b	Increase State civil penalties	Intent to encourage better operations of vessel and vessel company

The factors or significant inputs and qualitative scoring system developed to capture a broad range of possibilities associated with each category are described in Section 4. The categories used to evaluate and rank the RROs are effectiveness, cost, and practicality.

The RROs ranked highest for effectiveness are as follows:

- Satellite Tracking and AIS (RRO 1a) was evaluated as the most effective RRO at reducing accident frequency.
- Near-Shore Rated OSRO/PRAC (RRO 7b) was evaluated as the most effective RRO at reducing accident severity.
- Satellite Tracking and AIS (RRO 1a) was evaluated as the most effective RRO at reducing spill accident risk (severity and frequency).

The RROs ranked highest based on cost are as follows:

- Traffic Separation Scheme in Unimak Pass (RRO 2b);
- Increased State Civil Penalties (RRO 9b);
- Satellite Tracking and AIS (RRO 1a);
- Tugs of Opportunity Program (RRO 3d);
- Expand Shore-based ETS (RRO 4a);
- IMO PSSA and Associated Measures (RRO 6a); and
- Develop more geographic response strategies (RRO 8c).

The RROs ranked highest based on practicality are as follows:

- Satellite Tracking and AIS (RRO 1a); and
- Increased State Civil Penalties (RRO 9b);
- Tugs of Opportunity Program (RRO 3d); and
- Expand Shore-based ETS (RRO 4a).

Table 6.2 provides a summary of the RRO ranked scores for effectiveness, costs, practicality, and overall rank. Based on overall rank, the top five RROs are:

1. Satellite Tracking and AIS (RRO 1a) ;
2. Expand Shore-based ETS (RRO 4a) ;
3. Tugs of Opportunity Program (RRO 3d) ;
3. IMO PSSA and Associated Measures (RRO 6a); and
5. Increased State Civil Penalties (RRO 9b).

Table 6.2 Summary of Ranked Scores for each RRO

RRO #	RRO Name	Effectiveness	Cost	Practicality	Overall Rank
1a	Satellite tracking + AIS	1	3	1	1
2a	Manned VTS/Direct Comm w Vessels	11	12	17	16
2b	Traffic Separation Scheme in U. Pass	17	1	9	10
3a	Dedicated rescue tug(s)	6	12	12	12
3b	Non-dedicated rescue tug	9	12	12	14
3c	Seasonal, dedicated tug	9	8	9	9
3d	Tugs of opportunity program	8	3	1	3
4a	Expand shore-based ETS	3	3	1	2
4b	Require emergency towing arrangements on deep draft vessels	2	11	5	6
5a	Enhance towing cap on Cutters	14	8	5	10
5b	Increase number of cutters	16	12	12	16
6a	IMO PSSA and associated measures (e.g. ATBA)	4	3	5	3
7a	Ocean rated OSRO/PRAC - Open Ocean	15	12	12	15
7b	Nearshore rated OSRO/PRAC	7	12	12	13
7c	Increase Salvage& Firefighting Cap thru Regs	5	8	9	8
8c	Develop more geographic response strategies (GRS)	13	3	5	7
9b	Increase State civil penalties	12	1	1	5

Based on the qualitative cost-benefit analysis, the following observations were found:

Most effective RRO at reducing risk (frequency and severity)	RRO 1a	Satellite tracking and AIS
	RRO 4b	Require emergency towing arrangements on deep draft vessels
	RRO 4a	Expand shore-based ETS
	RRO 6a	IMO PSSA and associated measures (e.g., ATBA)
Least expensive RRO	RRO 2b	Traffic separation scheme in Unimak Pass
	RRO 9b	Increased State civil penalties

Most practical RRO	RRO 1a	Satellite tracking and AIS
	RRO 3d	Tugs of Opportunity Program
	RRO 4a	Expand shore-based ETS
	RRO 9b	Increased State civil penalties
Most cost effective	RRO 1a	Satellite tracking and AIS
Cheapest and easiest	RRO 9b	Increased State civil penalties

Examination of the results indicates that no one RRO is evaluated as best for effectiveness, cost, and practicality. That is, there is no RRO identified by this analysis that is clearly the best.

An evaluation of RRO effectiveness on the accident scenarios is presented in Section 5.0. The expert judgments recorded during the Task 7 workshop were utilized to evaluate the RROs based on effectiveness to reduce frequency and severity on the accident types. General observations from this review are summarized below.

The RROs most effective for Scenarios 1 through 5, which are collision-type accidents, include:

- Manned VTS/Direct Communication with Vessels (2a) and Traffic Separation Scheme in Unimak Pass (2b) at reducing frequency; and
- Increase Salvage & Firefighting Cap through Regulations (7c) at reducing severity.

The RROs most effective for Scenarios 6 through 13, 15, and 16, which are drift grounding-type accidents, include:

- Satellite Tracking and AIS (1a), Dedicated Rescue tug(s) (3a), Non-Dedicated Rescue Tug (3b), Seasonal, Dedicated Tug (3c), and Require Emergency Towing Arrangements on Deep Draft vessels (4b) at reducing frequency; and
- Increase Salvage & Firefighting Cap through Regulations (7c) at reducing severity.

The RROs most effective for Scenario 14, which is a powered grounding-type accident, include:

- Satellite Tracking and AIS (1a) and Manned VTS/Direct Communication with Vessels (2a) at reducing frequency; and
- Increase Salvage & Firefighting Cap through Regulations (7c) at reducing severity.

Accident Scenarios 2 and 16 resulted in the highest risk scenarios according to the risk matrix, which represents a collision and drift grounding accident type, respectively. Both these scenarios scored highest in terms of severity and within the second highest frequency of occurrence category. Thus, RRO categories most effective at reducing risks associated with these scenarios based on the RRO evaluation process conducted for this study include:

- Enhance Vessel Monitoring Program;
- Establish VTS in Unimak and Akutan Pass;
- Increase Rescue Tug Capability; and
- Increase Spill Response Capability.

It should be noted that the RRO evaluation process is a Decision Support Tool, not a Decision-Making Tool. The prioritization of RROs for implementation (next task) involves making choices of the relative importance of the RRO effectiveness, cost, and practicality. It may also take into account factors outside the scope of this risk assessment, such as additional stakeholder input and human fatality risk.

7.0 REFERENCES

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Appendix A
Spill Scenario Consequence Scoring/Ranking Matrix

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Table B-1
Preliminary Spill Scenario Consequence Scoring/Ranking Matrix
Risk Reduction Options Evaluation Report
AIRA Phase A Preliminary Risk Assessment

No.	Resource Categories	Location	North Unimak Pass														
		Scenario	1 - Bunker C			2 - Bunker C			3 - Crude Oil			4 - Diesel			5 - Diesel		
		SF [a]	%Prob [b]	TA [c]	Total Score	%Prob [b]	TA	Total Rating	%Prob [b]	TA	Total Rating	%Prob [b]	TA	Total Rating	%Prob [b]	TA	Total Rating
1	**Habitat: Littoral Resources (indicator receptors)**																
1A	Exposed rocky shores	1			-			-			-			-			-
1B	Course grained sands; fine to medium grained sands	2	0.95	3	6	0.95	94	178	0.95	2,402	4,563	0.95	185	351	0.85	17	30
1C	Gravel beaches (all types); Mixed gravel/sand; riprap	3	0.85	3	9	0.95	33	94	0.95	181	517	0.95	92	262	0.85	9	24
1D	Exposed tidal flats	4	0.85	6	20	0.55	7	15	0.95	7	26	0.95	53	203	0.75	21	62
1E	Sheltered tidal flats; vegetated, wetlands, marshes	5			-			-			-	0.95	100	474			-
2	**Habitat: SubLittoral Resource (indicator receptors)**													-			-
2A	Barren sand or exposed rocky shore	1			-			-			-			-			-
2B	Exposed rock and boulders with common species	2			-			-			-			-			-
2C	Shallow kelp habitat	3			-			-			-			-			-
2D	Eelgrass; Sheltered rocky shore	4	0.95	3300	12,540	0.95	5,011	19,043	0.95	15,766	59,912	0.95	15,034	57,128	0.95	244	929
2E	Salt-water marshes; lagoons; sheltered tidal flats	5	0.15	109	82	0.05	184	46	0.05	436	109	0.45	12	27	0.05	35	9
3	**Birds (indicator receptors)**													-			-
3A	Low population or species with low specific sensitivity	1			-			-			-			-			-
3B	Spp. not fully depend on sea; gulls	2	0.35	3667	2,567	0.05	43,146	9,521	0.15	9,778	2,933	0.65	489	636	0.25	10,144	5,072
3C	Spp. depend most of year on sea; water fowl	3	0.95	3300	9,405	0.95	5,011	110	0.95	15,766	44,934	0.95	15,034	42,846	0.95	244	697
3D	Highly dependent; migratory; auks, divers	4	0.35	3667	5,133	0.15	244	24	0.15	9,778	5,867	0.65	489	1,271	0.25	10,144	10,144
3E	ESA-listed; eiders	5	0.85	7	30	0.85	7	30	0.15	9,778	7,333	0.95	7	33	0.75	8	30
4	**Mammals (indicator receptors)**													-			-
4A	Low population or species with low specific sensitivity	1			-			-			-			-			-
4B	Non-gregarious breeders; Cetacean spp. (e.g. sperm whales)	2			-			-			-			-			-
4C	Gregarious breeding colonies; resident cetacean, e.g. some killer whales or blue whales	3	0.85	6	15	0.85	2	5	0.95	181	517	0.95	3	9	0.75	4	9
4D	Important marine spp.; dependent on fur; e.g. Pacific walrus, gray whales, habor seals.	4	0.85	2	7	0.85	1	3	0.95	7	26	0.85	1	3	0.75	1	3
4E	ESA-listed; stellar sea lions, sea otters	5	0.95	10145	48,188	0.95	35,934	170,689	0.95	6	29	0.95	100,103	475,489	0.95	5,378	25,544
5	**Fish (indicator receptors) [d]**																
5A	Transient species found at depths > 200 m	1			-			-			-			-			-
5B	Transient species found at depths > 100 m	2			-			-			-			-			-
5C	Mature Groundfish (flatfish, rockfish). Adults of pelagic species (e.g. Pacific cod, pollock, Atka mackerel).	3			-			-	0.55	0.02	0.03			-	0.64	888	1,705
5D	Eggs, larvae, juveniles of ground fish; Mature salmon, herring, and crab.	4			-			-	0.95	9.16	35			-	0.64	980	2,509
5E	Eggs, larvae, juveniles of any species of salmon, crab, and herring; Adult Chinook salmon (NMFS Savings Areas), summer herring (NMFS Savings Areas).	5			-			-	0.95	9.16	44			-	0.64	120	384
	Total Value for DIRECT Impacts to Receptors (acres)				**78,002**			**199,758**			**126,843**			**578,734**			**47,150**
6	**Socio-Economic**																
	No specific SE activity	1			3			3			3			3			3
	Resource common; short-term recovery expected; Pelagic fishing areas	2			5			5			5			5			5
	Alternative resource not feasible; recovery 6 mo - 1yr; crab fishery, tourism, offshore fish processing	3			1			1			1			1			1
	Resource high value; recovery > 1yr; subsistence fishing or hunting; CDQ; commercial fishing (state or federal)	4			3			3			3			3			3
	National value; impacts difficult to mitigate; local community fisheries or shore-based processing	5			5			5			5			5			5
	Socio-Economic Factor				**17**			**17**			**17**			**17**			**17**
	Oil Type Factor				**10**			**10**			**10**			**1**			**1**
	Total Consequence Score (unitless) [e]				**13**			**34**			**22**			**10**			**0.8**
	Relative Rank				**6**			**1**			**3**			**9**			**15**

a SF= Sensivity Factor, expression of the magnitude of impacts based on rating between 1 and 5; 1 = low potential for impacts; 5 = highly sensitive

b %Prob = Percent Probability of Impact (highest average from probability ranges); e.g, if highest potential impact is within probability range of 20-30%, then value equals 0.25.

c TA = total area of potential impact in acres (i.e., area of intersection/overlap of at leat 1% probability of spill area with receptor/resource area)

d No shellfish impacts (greater than threshold value) in Scenarios 1,2, 4, 6, 7, 10, 11, 13, 14, 15, and 16.

e total score for each scenario divided by 10^6 to represent relative score thus is unitless

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Table B-1
Preliminary Spill Scenario Consequence Scoring/Ranking Matrix
Risk Reduction Options Evaluation Report
AIRA Phase A Preliminary Risk Assessment

No.	Resource Categories	Location	Sanak Island											
		Scenario	6 - Bunker C			7 - Crude Oil			8 - Bunker C			9 - Diesel		
		SF [a]	%Prob [b]	TA	Total Rating	%Prob [b]	TA	Total Rating	%Prob [b]	TA	Total Rating	%Prob [b]	TA [c]	Total Rating
1	**Habitat: Littoral Resources (indicator receptors)**													
1A	Exposed rocky shores	1			-			-			-			-
1B	Course grained sands; fine to medium grained sands	2	0.95	84	159	0.95	137	260	0.95	822	1,562	0.95	62	117
1C	Gravel beaches (all types); Mixed gravel/sand; riprap	3	0.15	4,378	1,970			-			-	0.15	195	88
1D	Exposed tidal flats	4	0.95	10	37	0.95	20	77	0.95	30	113	0.95	5	19
1E	Sheltered tidal flats; vegetated, wetlands, marshes	5	0.05	885	221	0.35	148	260	0.25	24	30	0.25	43	54
2	**Habitat: SubLittoral Resource (indicator receptors)**													
2A	Barren sand or exposed rocky shore	1			-			-			-			-
2B	Exposed rock and boulders with common species	2			-			-			-			-
2C	Shallow kelp habitat	3			-			-			-			-
2D	Eelgrass; Sheltered rocky shore	4	0.95	4,008	15,232	0.95	5,587	21,231	0.95	11,174	42,462	0.95	2,672	10,154
2E	Salt-water marshes; lagoons; sheltered tidal flats	5	0.95	2	8	0.95	7	32	0.95	10	48	0.85	8	32
3	**Birds (indicator receptors)**													
3A	Low population or species with low specific sensitivity	1			-			-			-			-
3B	Spp. not fully depend on sea; gulls	2			-			-			-			-
3C	Spp. depend most of year on sea; water fowl	3	0.95	4,008	11,424	0.95	5,587	15,923	0.95	11,174	31,847	0.95	2,672	7,616
3D	Highly dependent; migratory; auks, divers	4			-			-			-			-
3E	ESA-listed; eiders	5	0.15	13	10	0.15	2	2	0.05	1	0	0.15	8	6
4	**Mammals (indicator receptors)**													
4A	Low population or species with low specific sensitivity	1			-			-			-			-
4B	Non-gregarious breeders; Cetacean spp. (e.g. sperm whales)	2			-			-			-			-
4C	Gregarious breeding colonies; resident cetacean, e.g. some killer whales or blue whales	3	0.95	1	3	0.95	2	6	0.95	2	6	0.95	1	3
4D	Important marine spp.; dependent on fur; e.g. Pacific walrus, gray whales, habor seals.	4	0.95	1	4	0.95	2	8	0.95	2	8	0.95	1	4
4E	ESA-listed; stellar sea lions, sea otters	5	0.95	4,008	19,040	0.95	5,587	26,539	0.95	10	48	0.95	2,672	12,693
5	**Fish (indicator receptors) [d]**													
5A	Transient species found at depths > 200 m	1			-			-			-			-
5B	Transient species found at depths > 100 m	2			-			-			-			-
5C	Mature Groundfish (flatfish, rockfish). Adults of pelagic species (e.g. Pacific cod, pollock, Atka mackerel).	3			-			-	0.46	8080	11,150	0.39	596	697
5D	Eggs, larvae, juveniles of ground fish; Mature salmon, herring, and crab.	4			-			-	0.46	25,334	46,615	0.39	1002	1,563
5E	Eggs, larvae, juveniles of any species of salmon, crab, and herring; Adult Chinook salmon (NMFS Savings Areas), summer herring (NMFS Savings Areas).	5			-			-	0.46	6174	14,200	0.39	0.0001	0.0003
	Total Value for DIRECT Impacts to Receptors (acres)				**48,108**			**64,338**			**148,089**			**33,045**
6	**Socio-Economic**													
	No specific SE activity	1			1			1			1			1
	Resource common; short-term recovery expected; Pelagic fishing areas	2			5			5			5			5
	Alternative resource not feasible; recovery 6 mo - 1yr; crab fishery, tourism, offshore fish processing	3			1			1			1			1
	Resource high value; recovery > 1yr; subsistence fishing or hunting; CDQ; commercial fishing (state or federal)	4			1			1			3			3
	National value; impacts difficult to mitigate; local community fisheries or shore-based processing	5			3			2			3			3
	Socio-Economic Factor				**11**			**10**			**13**			**13**
	Oil Type Factor				**10**			**10**			**10**			**1**
	Total Consequence Score (unitless) [e]				**5**			**6**			**19**			**0.4**
	Relative Rank				**12**			**10**			**4**			**16**

a SF= Sensivity Factor, expression of the magnitude of impacts based on rating between 1 and 5; 1 = low potential for impacts; 5 = highly sensitive

b %Prob = Percent Probability of Impact (highest average from probability ranges); e.g, if highest potential impact is within probability range of 20-30%, then value equals 0.25.

c TA = total area of potential impact in acres (i.e., area of intersection/overlap of at leat 1% probability of spill area with receptor/resource area)

d No shellfish impacts (greater than threshold value) in Scenarios 1,2, 4, 6, 7, 10, 11, 13, 14, 15, and 16.

e total score for each scenario divided by 10^6 to represent relative score thus is unitless

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Table B-1
Preliminary Spill Scenario Consequence Scoring/Ranking Matrix
Risk Reduction Options Evaluation Report
AIRA Phase A Preliminary Risk Assessment

No.	Resource Categories	Location	Holtz Bay Attu Island											
		Scenario	10 - Bunker C			11 -Bunker C			12 - Crude Oil			13 - Diesel		
		SF [a]	%Prob [b]	TA [c]	Total Score	%Prob [b]	TA [c]	Total Score	%Prob [b]	TA [c]	Total Score	%Prob [b]	TA [c]	Total Score
1	**Habitat: Littoral Resources (indicator receptors)**													
1A	Exposed rocky shores	1	0.15	7.00	1.05	0.95	5	5	0.95	4	4	0.95	12	11
1B	Course grained sands; fine to medium grained sands	2			-			-			-			-
1C	Gravel beaches (all types); Mixed gravel/sand; riprap	3			-			-			-			-
1D	Exposed tidal flats	4			-			-			-			-
1E	Sheltered tidal flats; vegetated, wetlands, marshes	5			-			-			-			-
2	**Habitat: SubLittoral Resource (indicator receptors)**													
2A	Barren sand or exposed rocky shore	1	0.95	28	27	0.95	6	6	0.95	2	2	0.95	22	21
2B	Exposed rock and boulders with common species	2			-			-			-			-
2C	Shallow kelp habitat	3			-			-			-			-
2D	Eelgrass; Sheltered rocky shore	4			-			-			-			-
2E	Salt-water marshes; lagoons; sheltered tidal flats	5			-			-			-			-
3	**Birds (indicator receptors)**													
3A	Low population or species with low specific sensitivity	1			-			-			-			-
3B	Spp. not fully depend on sea; gulls	2			-			-			-			-
3C	Spp. depend most of year on sea; water fowl	3	0.95	4,029	11,482	0.95	244	696	0.95	2,808	8,003	0.95	2,808	8,003
3D	Highly dependent; migratory; auks, divers	4			-			-			-			-
3E	ESA-listed; eiders	5			-	0.95	1	5	0.95	2	10	0.95	3	14
4	**Mammals (indicator receptors)**													
4A	Low population or species with low specific sensitivity	1			-			-			-			-
4B	Non-gregarious breeders; Cetacean spp. (e.g. sperm whales)	2	0.95	35,283	67,038	0.95	28,324	53,816	0.95	35,283	67,038	0.95	35,283	67,038
4C	Gregarious breeding colonies; resident cetacean, e.g. some killer whales or blue whales	3	0.85	1	3	0.95	1	3	0.95	1	3	0.95	1	3
4D	Important marine spp.; dependent on fur; e.g. Pacific walrus, gray whales, habor seals.	4	0.85	4,517	15,359	0.95	2,442	9,279	0.95	4,151	15,774	0.95	4,151	15,774
4E	ESA-listed; stellar sea lions, sea otters	5	0.95	6,349	30,156	0.95	3,174	15,078	0.95	2,320	11,018	0.95	5,860	27,836
5	**Fish (indicator receptors) [d]**													
5A	Transient species found at depths > 200 m	1			-			-			-			-
5B	Transient species found at depths > 100 m	2			-			-			-			-
5C	Mature Groundfish (flatfish, rockfish). Adults of pelagic species (e.g. Pacific cod, pollock, Atka mackerel).	3			-			-	0.65	9,657	18,831			-
5D	Eggs, larvae, juveniles of ground fish; Mature salmon, herring, and crab.	4			-			-	0.65	19,297	50,172			-
5E	Eggs, larvae, juveniles of any species of salmon, crab, and herring; Adult Chinook salmon (NMFS Savings Areas), summer herring (NMFS Savings Areas).	5			-			-			-			-
	Total Value for DIRECT Impacts to Receptors (acres)				**124,066**			**78,887**			**170,855**			**118,700**
6	**Socio-Economic**													
	No specific SE activity	1			1			1			1			1
	Resource common; short-term recovery expected; Pelagic fishing areas	2			1			1			1			1
	Alternative resource not feasible; recovery 6 mo - 1yr; crab fishery, tourism, offshore fish processing	3			1			1			1			1
	Resource high value; recovery > 1yr; subsistence fishing or hunting; CDQ; commercial fishing (state or federal)	4			1			1			1			1
	National value; impacts difficult to mitigate; local community fisheries or shore-based processing	5			4			4			4			3
	Socio-Economic Factor				**8**			**8**			**8**			**7**
	Oil Type Factor				**10**			**10**			**10**			**1**
	Total Consequence Score (unitless) [e]				**9.9**			**6.3**			**13.7**			**0.8**
	Relative Rank				**8**			**11**			**5**			**13**

a SF= Sensivity Factor, expression of the magnitude of impacts based on rating between 1 and 5; 1 = low potential for impacts; 5 = highly sensitive

b %Prob = Percent Probability of Impact (highest average from probability ranges); e.g, if highest potential impact is within probability range of 20-30%, then value equals 0.25.

c TA = total area of potential impact in acres (i.e., area of intersection/overlap of at leat 1% probability of spill area with receptor/resource area)

d No shellfish impacts (greater than threshold value) in Scenarios 1,2, 4, 6, 7, 10, 11, 13, 14, 15, and 16.

e total score for each scenario divided by 10^6 to represent relative score thus is unitless

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Table B-1
Preliminary Spill Scenario Consequence Scoring/Ranking Matrix
Risk Reduction Options Evaluation Report
AIRA Phase A Preliminary Risk Assessment

No.	Resource Categories	Location	Adak Island			Amlia Island			Urilia Bay		
		Scenario	14 - Diesel			15 - Bunker C			16 - Bunker C		
		SF [a]	%Prob [b]	TA [c]	Total Score	%Prob [b]	TA [c]	Total Score	%Prob [b]	TA [c]	Total Score
1	**Habitat: Littoral Resources (indicator receptors)**										
1A	Exposed rocky shores	1	0.95	143	136	0.95	23	22			-
1B	Course grained sands; fine to medium grained sands	2			-			-	0.95	2,799	5,319
1C	Gravel beaches (all types); Mixed gravel/sand; riprap	3			-			-	0.95	425	1,212
1D	Exposed tidal flats	4			-			-	0.95	1,149	4,364
1E	Sheltered tidal flats; vegetated, wetlands, marshes	5			-			-	0.95	4,390	20,854
2	**Habitat: SubLittoral Resource (indicator receptors)**										
2A	Barren sand or exposed rocky shore	1	0.95	76	72	0.95	42	40			-
2B	Exposed rock and boulders with common species	2			-			-			-
2C	Shallow kelp habitat	3			-			-			-
2D	Eelgrass; Sheltered rocky shore	4			-			-	0.95	15,484	58,839
2E	Salt-water marshes; lagoons; sheltered tidal flats	5			-			-	0.95	3,132	14,876
3	**Birds (indicator receptors)**										
3A	Low population or species with low specific sensitivity	1			-			-			-
3B	Spp. not fully depend on sea; gulls	2			-			-			-
3C	Spp. depend most of year on sea; water fowl	3			-	0.25	366	274	0.95	15,484	44,129
3D	Highly dependent; migratory; auks, divers	4			-			-			-
3E	ESA-listed; eiders	5	0.95	2	10	0.95	1	5	0.65	2	7
4	**Mammals (indicator receptors)**										
4A	Low population or species with low specific sensitivity	1			-			-			-
4B	Non-gregarious breeders; Cetacean spp. (e.g. sperm whales)	2	0.95	13,470	25,592	0.95	47,418	90,094			-
4C	Gregarious breeding colonies; resident cetacean, e.g. some killer whales or blue whales	3	0.95	2	6	0.95	7	20	0.05	5121	768
4D	Important marine spp.; dependent on fur; e.g. Pacific walrus, gray whales, habor seals.	4	0.75	10557	31,671	0.95	122	464	0.65	1	3
4E	ESA-listed; stellar sea lions, sea otters	5	0.65	1,456	4,733	0.95	1,950	9,264	0.95	32,187	152,888
5	**Fish (indicator receptors) [d]**										
5A	Transient species found at depths > 200 m	1			-			-			-
5B	Transient species found at depths > 100 m	2			-			-			-
5C	Mature Groundfish (flatfish, rockfish). Adults of pelagic species (e.g. Pacific cod, pollock, Atka mackerel).	3	0.56	99	166			-			-
5D	Eggs, larvae, juveniles of ground fish; Mature salmon, herring, and crab.	4	0.56	163	365			-			-
5E	Eggs, larvae, juveniles of any species of salmon, crab, and herring; Adult Chinook salmon (NMFS Savings Areas), summer herring (NMFS Savings Areas).	5			-			-			-
	Total Value for DIRECT Impacts to Receptors (acres)				**62,750**			**100,182**			**303,258**
6	**Socio-Economic**										
	No specific SE activity	1			1			1			1
	Resource common; short-term recovery expected; Pelagic fishing areas	2			5			5			1
	Alternative resource not feasible; recovery 6 mo - 1yr; crab fishery, tourism, offshore fish processing	3			1			1			1
	Resource high value; recovery > 1yr; subsistence fishing or hunting; CDQ; commercial fishing (state or federal)	4			3			1	0	0	1
	National value; impacts difficult to mitigate; local community fisheries or shore-based processing	5			3			2	0	0	4
	Socio-Economic Factor				**13**			**10**			**8**
	Oil Type Factor				**1**			**10**			**10**
	Total Consequence Score (unitless) [e]				**0.8**			**10**			**24**
	Relative Rank				**14**			**7**			**2**

a SF= Sensivity Factor, expression of the magnitude of impacts based on rating between 1 and 5; 1 = low potential for impacts; 5 = highly sensitive

b %Prob = Percent Probability of Impact (highest average from probability ranges); e.g, if highest potential impact is within probability range of 20-30%, then value equals 0.25.

c TA = total area of potential impact in acres (i.e., area of intersection/overlap of at leat 1% probability of spill area with receptor/resource area)

d No shellfish impacts (greater than threshold value) in Scenarios 1,2, 4, 6, 7, 10, 11, 13, 14, 15, and 16.

e total score for each scenario divided by 10^6 to represent relative score thus is unitless

Appendix B
Background and Descriptions of Risk Reduction Options (as provided by Facilitation Team)

Bolster Area Contingency Planning

Background

The National Oil and Hazardous Substances Pollution Contingency Plan (National Contingency Plan or NCP),[1] which is part of the Clean Water Act, establishes the organizational structure and procedures for preparing for and responding to discharges of oil and releases of hazardous substances, pollutants, and contaminants. Under the NCP, there are three levels of contingency planning: the NCP which establishes the national response organization; Regional Contingency Plans (RCP) which establish regional response organization; and Area Contingency Plans which establish response organizations and set contingency planning standards for defined Areas within each Region.[2] Area Committees (AC) are responsible for development of Area Contingency Plans (ACP).[3]

Alaska is somewhat unique in that the State is both a Region and an Area. The Alaska Federal/State Preparedness Plan for Response to Oil & Hazardous Substance Discharges/Releases (Unified Plan) serves as the Regional Contingency Plan for the Alaska Region. The Unified Plan, supplemented by 10 Subarea Plans, serves as the ACP for the Alaska Area. Federal regulations direct that the Area Contingency Plans must address both spill prevention and response such that they "shall be adequate to remove a worst case discharge under Sec. 300.324, and to mitigate or prevent a substantial threat of such a discharge, from a vessel, offshore facility, or onshore facility operating in or near the area." [4]

Federal regulations require that ACPs describe in detail the responsibilities preventing or mitigating the threat of a discharge and cleaning up a discharge for owners and operators of vessels and facilities as well as federal, state and local agencies. The ACPs are also required to describe how contingency plans prepared by owners and operators of vessels and facilities operating in the Area must integrate into the spill prevention and response planning system established in the ACP.[5]

Owners and operators of tank vessels carrying oil as cargo and non-tank vessels over 400 gross tons carrying fuel oil for propulsion are required to develop a U.S. Coast Guard- approved Vessel Response Plan (VRP) for their operations in U.S. waters.[6] The VRP must include a geographic-specific appendix for each Captain of the Port (COTP) zone through which the vessel will transit. VRPs are required by federal regulation to be consistent with the ACPs in effect 6 months prior to the submission date for the VRP.[7] The evaluation criteria for VRP state that response resources identified in the plan must meet limitations stated in the applicable ACP.[8]

Foreign-flagged vessels engaged in innocent passage are exempted from the VRP requirements;[9] however, the ACP regulations require that the Area Contingency Plan identify sufficient

[1] 40 CFR Part 300
[2] 40 CFR Part 300 Sec. 210.
[3] 40 CFR Part 300 Sec. 205.
[4] 40 CFR Part 300 Sec. 210(c).
[5] 40 CFR Part 300 Sec. 210(c)(3).
[6] 33 CFR Part 155.
[7] 33 CFR Part 155 Sec. 1030(h).
[8] 33 CFR Part 155 Sec. 1050(a)(2)
[9] 33 CFR Part 155 Sec. 1015.

equipment, resources, and planning to respond to spill risks from any operations in the Area.[10] Since vessels engaged in innocent passage may be operating without a VRP, the ACP becomes the default response plan for spills from vessels not subject to U.S. oil spill planning regulations.

Operators of tank vessels and non-tank vessels that operate or transfer oil in state waters are required to prepare Oil Discharge Prevention and Contingency Plans (ODPCP).[11] These plans are submitted to the Alaska Department of Environmental Conservation (ADEC) for review and approval under relevant state regulations.[12] Alaska Statutes require that ODPCPs are consistent with the state regional and master plans, which include the Unified Plan and applicable Subarea Contingency Plans.[13]

The Aleutian Islands are part of the Aleutians Subarea and part of the Western Alaska Captain of the Port Zone. Therefore, vessels operating in the Aleutian Islands that are required under federal regulation to develop VRPs[14] must ensure that the VRPs are consistent with the Unified Plan and Subarea Plan for the Aleutians, as well as with any operating measures put in place by the Captain of the Port of Western Alaska. ODPCPs prepared by vessel owners and operators under State statutes and regulations must also be consistent with the Unified Plan and Subarea Plans.

[10] 40 CFR Part 300 Sec. 210,

[11] AS 46.04.030.

[12] 18 AAC 75.425, 445 and 455

[13] AS 46.04.200 and AS 46.04.210.

[14] Note that vessels engaged in innocent passage – foreign flagged-vessels not calling on U.S. ports or transferring or lightering oil in U.S. waters – are exempted from VRP requirements.

Establishing Restricted Areas: IMO Particularly Sensitive Sea Areas with Associated Protective Measures

Description & Background

A Particularly Sensitive Sea Area (PSSA) is an area that needs special protection through action by the International Maritime Organization (IMO) because of its significance for recognized ecological, socio-economic, or scientific attributes where such attributes may be vulnerable to damage by international shipping activities. An application for PSSA designation should contain a proposal for an associated protective measure or measures aimed at preventing, reducing or eliminating the threat or identified vulnerability. Associated protective measures for PSSAs are limited to actions that are to be, or have been, approved and adopted by IMO, for example, a routing system such as an area to be avoided.

IMO guidelines provide advice to IMO Member Governments in the formulation and submission of applications for the designation of PSSAs to ensure that in the process, all interests - those of the coastal State, flag State, and the environmental and shipping communities - are thoroughly considered on the basis of relevant scientific, technical, economic, and environmental information regarding the area at risk of damage from international shipping activities. The guidelines update resolution A.927 (22) *Guidelines for the Designation of Special Areas under MARPOL 73/78 and Guidelines for the Identification and Designation of Particularly Sensitive Sea Areas.*

A PSSA can be protected by ships routing measures – such as an area to be avoided: an area within defined limits in which either navigation is particularly hazardous or it is exceptionally important to avoid casualties and which should be avoided by all ships, or by certain classes of ships. Two PSSA's have been established in the United States—the Northwestern Hawaiian Islands Marine National Monument and the Florida Keys. The IMO has adopted certain Areas to be Avoided and mandatory Ship Reporting System for the Northern Hawaiian Islands PSSA. Likewise, the Florida Keys' PSSA includes Areas to be Avoided and established three non-anchoring areas within the 3,000 square nautical mile zone.

Areas within the Aleutian Island region have been identified by the Federal government (Marine Protection Areas, Alaska Maritime Refuge and Stellar Sea Lion Critical Habitat), State of Alaska (Most Environmentally Sensitive Areas) and East Aleutian Borough as having designations for special significance such as, subsistence use, areas suitable for study and understanding history and pre-history, important habitat areas, areas suitable for commercial fishing and seafood processing facilities, and natural hazards.

A Particularly Sensitive Sea Area (PSSA) is an area that needs special protection through action by the International Maritime Organization (IMO) because of its significance for recognized ecological, socio-economic, or scientific attributes where such attributes may be vulnerable to damage by international shipping activities. Potential impacts to vessel routing will needs to be considered, and whether vessels are being placed at a higher risk by establishing areas to be avoided. Non- government organizations or state governments through the US Coast Guard, the US Representative to the IMO, who makes the final decision, can initiate a PSSA.

The application and approval process for obtaining a PSSA designation can take up to a year or more. PSSA's can be applied to large areas and all vessels transiting the area.

Increase Rescue Tug Capability for the North Pacific Great Circle Route

Description & Background

In 2004, there were four resident tugs in the study area and all located at Dutch Harbor.[15] These four tugs have sufficient horsepower and sea-keeping ability to potentially respond as a rescue/assist tug for a ship in distress. Additionally, there are about 200 voyages of other tugs through the region each year by tugs in trade and these transient tugs range from 1,200 to 7,000 horsepower.[16] Tugs in trade typically have a barge in tow, which hampers their ability to respond to calls for emergency assistance. There has not been a study conducted that specifically examines tug capabilities and operational/response expectations based on weather conditions typically experienced in the Bering Sea and Gulf of Alaska. Recognizing this limitation, additional information is needed to determine what type of program could or should be implemented for the Aleutian Island region.

Securing funding for a Rescue Tug will prove to be the greatest challenge. Some associated issues that may need to be addressed are:

1. Funding by the shippers, like the Washington State Neah Bay Tug. Since the great majority of vessels transiting the Great Circle Route are foreign flagged vessels in innocent passage, fund seeking might best be pursued through, IMO, local, state, federal and international regulatory changes that create a framework for some kind of fee structure.
2. The Jones Act (The Merchant Marine Act of 1920) Section 27, referred to as the Jones Act, deals with cabotage (coastal shipping), and requires that all shipments (including salvage) between US ports be carried in US flagged ships, built in, owned by and crewed by US citizens. Therefore, vessels being considered for use should be able to comply. This may reduce the number of available vessels for consideration.
3. Salvage Laws. Maritime law distinguishes between contract salvage and true salvage. A vessel contractually obligated to respond cannot expect a salvage award other than as specified under the payment terms agreed in advance (contract salvage). Traditionally, a vessel that voluntarily responds and succeeds in removing another vessel from "maritime peril" (true salvage) can expect remuneration for those services. Depending on the risk involved, the successful volunteer may realize an award equal to a significant percentage of the residual value of the rescued vessel, its bunker, and its cargo. This was given as one of the reasons the captain of the *M/V Selendang Ayu* delayed allowing rescue operations until it was too late.

   In the USA, OPA 90 requires that every vessel's response plan include provisions to activate the services of a tug if needed or so directed by the Federal On-Scene Coordinator (USCG). The UK system includes a statutory requirement that the casualty vessel accept and pay for services from a dedicated tug kept in position by public funding and called out by the government overseer. Wherever transiting vessels pay an

[15] Vessel Traffic in the Aleutians Subarea: Updated Report to the Alaska Department of Environmental Conservation. Nuka Research & Planning Group and Cape International, Inc., September 20, 2006.
[16] Vessel Traffic in the Aleutians Subarea: Updated Report to the Alaska Department of Environmental Conservation. Nuka Research & Planning Group and Cape International, Inc., September 20, 2006.

annual or per trip fee to keep a dedicated tug on standby contract, that tug cannot respond on commercial terms other than those incorporated in the agreement.

The size of the study area and the lack of infrastructure along the Aleutian Island Chain likely make building and maintaining an effective response structure cost prohibitive. Therefore, reliance would be on prevention measures that can be effective in the study area.

Increase Salvage and Spill Response Capability in the Aleutians

Background

One candidate for mitigating the consequence of an oil spill in the Aleutian Islands is to increase the capability to respond to marine oil spills in the region. The amount and type of salvage and oil spill response equipment required in the region is under the jurisdiction of two agencies the USCG and ADEC. In State waters ADEC requires tank vessels, tank barges, and nontank vessels to have an approved oil discharge prevention and contingency plan (C-plan) that meets state planning standards for discharge removal.[17] In State and Federal waters tank vessels (includes barges) and nontank vessels must have an approved vessel response plan (VRP).[18] Vessels in innocent passage do not require a vessel response plan, but will likely have a Shipboard Oil Pollution Emergency Plan (SOPEP). The Area Contingency Plan covers spill response for vessels in innocent passage.

It is not known how many vessels are required to carry these plans, but with the exception of the vessels carrying only SOPEP plans, each vessel must have access to equipment and personnel necessary to execute the C-plan and/or VRP for their vessel. In general terms this means contracting with a State Primary Response action Contractor (PRAC) or a Federal Oil Spill Removal Organization (OSRO) to meet the oil spill planning standards for the vessel.[19] OSRO are approved for specific operating environments: River/Canal, Inland, Offshore, Nearshore, and Great Lakes based on their response capability. Planning standards differ between vessels and state/federal regulations, but generally the planholder must be able to stop the discharge, lighter un-spilled oil from damaged tanks, observe and monitor the oil slick, contain and skim the oil from the water, and prevent oil from reaching wildlife and sensitive areas. The biggest response planning standards that apply to vessels trading in the Aleutians, are for oil tankers carrying persistent oil (1 trip per month with a maximum of 26.8 million gallons cargo), but the planning standards for tank barges (5 trips per month with a maximum of 6.3 million gallons cargo) and large container ships (160 trips per month with a maximum of 2.2 million gallons of fuel) are also substantial.[20]

The actual oil spill response capability in the Aleutians is a small fraction of the spill response capability in other areas with similar vessel traffic. For example there is not a single dedicated spill response vessel in the entire sub-area nor is there an OSRO that is classified to respond in neither the Open Ocean, Offshore, nor Nearshore operating environments. Outside of ports and harbors, there is no resident oil spill response capability in the Aleutians to respond to the 185 transits per month reported from the Vessel Traffic Study. The reasons for this apparent inequity in response capability are not clear, but mostly due to exceptions being granted to the regulatory requirements through the alternative planning criteria process.

Recently the USCG implemented new Salvage and Marine Firefighting requirements for tank vessels that are required to carry VRP[21]. Similar requirements will be extended to non-tank vessels in the near future. These regulations establish specific planning requirements for vessels operating within fifty miles of the nearest COTP city. Vessels operating in the Aleutians would

[17] 18 AAC 75.400
[18] 33 CFR Part 155
[19] USCG. 2008. Guidelines for the U.S. Coast Guard Oil Spill Removal Classification
[20] Estimates taken from Phase A Vessel Traffic Study
[21] 33 CFR Part 155.4030

not have to meet these specific requirements, because the entire Aleutian subarea is more than fifty miles from Anchorage, Alaska, which is the COTP for this area.

Another consideration is the response gap in the Aleutians. A response gap is the percentage of time that the environmental conditions (wind, sea state, visibility, currents, etc.) exceed the limitation of the response system. No response gap analysis has been conducted for the Aleutians, but experience has shown that there are substantial periods of time when a marine spill response would not be possible no matter what the oil spill response capability.

Evaluate and Determine Whether to Increase State Civil Penalties

Background

Liability for the unlawful discharge of oil into public waters and the public's right to be compensated for resulting environmental and natural resource damages has been addressed in statute at both the federal and state levels. Statutes typically hold responsible parties strictly liable for environmental and natural resource damages as determined through a damage assessment process. The State of Alaska's oil spill liability and compensation scheme doesn't necessarily follow the more traditional approach in that compensable environmental and natural resource damages determined through the use of various economic valuation techniques. Alaska rarely attempts to establish actual damages. Instead, while maintaining the strict liability component, Alaska pursues compensation for all natural resources and environmental damage through civil penalties, which are assessed on each gallon of oil spilled[22]. The amount of the fine varies depending on the type of oil spilled and the sensitivity of the receiving environment[23].

In 1977, the Alaska Department of Environmental Conservation and the Department of Law having primary responsibilities of responding to and prosecuting oil pollution cases in Alaska were tasked with drafting an approach and structure for assessing civil penalties for oil pollution. In order to protect the environment of the state, the civil penalties imposed were intended to provide a meaningful incentive and be set high enough to induce those potentially subject to them to perform their oil handling operations in as safe a manner as possible. Civil penalties were not intended to be punitive.

Alaska's civil penalties approach is based upon the following premise and intent:

- All oil discharges will cause environmental and natural resource harm
- For that portion of the damage, which is readily identifiable and quantifiable, existing legal remedies provide an adequate means of recovery
- A substantial portion of the damage caused by oil pollution cannot be determined with certainty
- The public should be compensated for those damages, which are not readily identifiable and quantifiable
- The scheme is intended to pre-determine the loss from oil pollution, which is not readily identifiable and/or quantifiable through the use of civil penalties based on objective criteria of the characteristics of the oil and the sensitivity of the receiving environment
- Provide an meaningful incentive to safe operations by setting out the consequences of the unlawful act in advance in an effort to prevent the discharge of oil before it occurs
- Intended to both compensate the public for damages and to provide an incentive for safe operations.

Alaska Statute (AS) 46.03.758, Civil Penalties for Discharge of Oil was enacted into law in May 1977 and established a fixed civil penalty scheme. Penalties were established for the following categories of receiving environments and may not exceed:

[22] Alaska Statute 46.03.758(b)
[23] Alaska Statute 46.03.758(d)

- $10.00 per gallons of oil to an anadromous stream or other freshwater environment with significant aquatic resources;
- $2.50 per gallon of oil to an estuarine, intertidal or confined saltwater environment
- $1.00 per gallon of oil to an unconfined saltwater environment, public lands or freshwater environment without significant aquatic resources.

The regulations created a range of penalties varying according to the toxicity, degradability and dispersal characteristics of oil, and the sensitivity and productivity of the receiving environment. The statute provides for the assessed penalty to be multiplied by a factor of five (5) if the discharge is caused by gross negligence or an intentional act by the discharger, or if the courts found the discharger did not take reasonable measures to contain and cleanup the discharged oil[24].

Alaska statute 46.03.758(f) allows for the deduction for the gallons of oil cleaned up. The original House Bill (HB) 173, when introduced did not allow for the amount of oil cleaned up to be deducted in the penalty base. Industry lobbyists argued that by not allowing a deduction provided a disincentive for speedy and efficient action to limit the impact of the discharge and to recover the spilled oil. Industry agreed that the burden of proof for estimating the amount of oil removed be at the courts discretion.

Oil spills of 18,000 gallons or less is exempt form the provisions of the civil penalty statute. In 1977, the legislature felt that penalties imposed by AS 46.03.758 would be punitive to small operators in rural Alaska. Minor adjustments were made to the civil penalty schedule in 1992 and 2003.

[24] AS 46.03.758(b)(2)

Enhanced Towing Capabilities

Description & Background

A proposed mitigation measure to reduce risk is to enhance the shore-based Emergency Towing System (ETS) project initially implemented by the City of Unalaska and Alaska Department of Environmental Conservation (ADEC), and also require towlines to be carried on all deep draft vessels transiting the Aleutian Island region. Following the near grounding of the *M/V Salica Frigo o*n March 9, 2007 the Mayor of Unalaska convened a Disabled Vessel workgroup to address the possibility of future groundings and to discuss local emergency response solutions. This initial meeting prompted the ETS workgroup; whose goal was to develop emergency towing capabilities for disabled vessels in the Aleutian Subarea using locally available tugboats in conjunction with ETS equipment stationed in Unalaska. Based on the Aleutian Subarea vessel traffic, the ETS workgroup implemented two ETS in order to serve a wider range of vessels. The City of Unalaska purchased a system suitable for vessels up to 50,000 DWT and the ADEC purchased a system capable of towing vessels greater than 50,000 DWT; both systems are stored in Unalaska. The ETS consists of a lightweight towline, a messenger line to assist in deploying the towline, a line-launcher, a lighted buoy, and chaffing gear. These components may be configured to deploy to a disabled ship from the stern of a tugboat or airdropped to the ship's deck via helicopter.

Since 2007, the project continues to expand and annual exercises/training have been held in Unalaska. An ETS manual has was updated in 2008 and the ADEC has purchased and stored a 10 inch (> 50,000 DWT) ETS at the USCG Air Station Kodiak. In 2010, ADEC received additional funds, which will allow them to purchase two more 10-inch ETS packages. Tentative plans are to stage one system at USCG Air Station Sitka and the other at U.S. Navy Supervisor of Salvage warehouse at Fort Richardson, Alaska for forward deployment to a potential vessel in distress.

The International Maritime Organization (IMO) established a requirement in May 1994 that all tankers of not less than 20,000 DWT be fitted with emergency towing arrangements (aft and steer), which was adopted into the Safety of Life at Sea, 1974 (SOLAS). In May 2008, IMO passed resolution MSC.256(84) amending SOLAS and requiring emergency towing procedures on all passenger ships by January 1, 2010; cargo ships constructed on or after January 1, 2010; and cargo ships constructed before January 1, 2010 by January 1, 2012.

Under the federal regulations the U.S. Coast Guard requires emergency towing capability and procedures for oil tankers (33 CFR 155.235) and emergency control systems for tank barges (33 CFR 155.230). The proposed rules for Nontank vessels (400 gross tons and greater) scheduled to be promulgated in April 2011 do not specifically require emergency towing equipment onboard the vessel but states that if an operator has emergency towing equipment the procedures and arrangements for emergency towing including rigging and operations shall be described in their response plan.

The proposed mitigation measure is intended to ensure vessels transiting the Aleutian Island region are equipment, trained and prepared in the use of emergency towing equipment. In general, all vessels regardless of size and cargo should be required to have emergency towing equipment onboard and the crew trained on the use of the equipment. Regulatory changes would be necessary to require that all vessels transiting the Aleutian Island region to have emergency towing equipment and procedures. Current International and federal emergency towing equipment and procedure requirements are based on the vessel size and cargo type (petroleum/chemical carriers). Recognizing that not all vessel types and sizes are covered under

the regulations, additional emergency towing systems may need to be staged in the Aleutian Island region. The number, location and size of the systems needed have not been identified.

Establish a Traffic Separation Scheme in Unimak Pass

Description & Background

There are two shipping safety fairways in Alaska—Hinchinbrook Entrance in Prince William Sound and Unimak Pass. A shipping fairway is defined in 33 CFR 166.105(a) as a lane or corridor in which no artificial island or fixed structure, whether temporary or permanent, will be permitted. Aids to navigation approved by the USCG may be established in a fairway. Coast Pilot 9 recommends to mariners that vessels should approach Unimak Pass through the prescribed Unimak Pass Shipping Safety Fairway. The Unimak Pass Safety Fairway is composed of an E-W fairway with a connecting N-S fairway in the W section. (See 166.100 through 166.110 and 166.400, chapter 2, for limits and regulations.) Navigation rules, specifically Rule 9 for Narrow Channels apply to the Unimak Pass shipping fairway. Currently no traffic separation scheme exists for Unimak Pass.

Enhanced U. S. Coast Guard Capabilities: Towing Capabilities on Cutters

Background

The U.S. Coast Guard (USCG) has served under four Cabinet Secretaries: Treasury, Department of Defense or U.S. Navy during time of war, Transportation and currently Homeland Security. With each change more areas of responsibility were added while few were eliminated. The Coast Guard is a maritime, military, multi-mission service unique among the military branches for having a maritime law enforcement mission with jurisdiction in both domestic and international waters. The Coast Guard mission in Alaska is to serve and safeguard the public, protect the environment and its resources, and defend the Nation's interest in the Alaska maritime region.

Coast Guard vessels such as Buoy Tenders, 110 patrol boats and three cutters operate throughout Alaska waters. The three Coast Guard cutters assigned to Alaska are the *Alex Haley*, *Acushnet* and *Munro*. The *Alex Haley* and the *Munro* are home ported in Kodiak, and the *Acushnet* is home ported in Ketchikan. All three patrol the Bering Sea and the Aleutians performing fisheries enforcement and search and rescue. The *Alex Haley* and the *Acushnet* both began life as US Navy Rescue and Salvage vessels. The *Alex Haley* was built in 1967 and was re-fitted and commissioned in the USCG in 1999. The *Acushnet* was built in 1942 and is the sole remaining WWII vintage vessel in the USCG Fleet. The towing winch was removed when each cutter was re-fitted for duty in the Coast Guard but there propulsion had not been altered. The *Munro* is a relatively new High Endurance Cutter, outfitted for a Homeland Security role and can be re-assigned out of the Alaska Region as other USCG responsibilities take priority.

Each cutter has towing capability, equipment and trained crew. Although the towing winches were removed from the *Alex Haley* and *Acushnet*, they do having towing bits and the *Munro* has a mooring bit. In addition, each vessel carries a hawser, messenger line and line-throwing gun. The crews train twice per year and when on patrol and activated respond to vessels in distress. Refresher training is conducted with the US Navy every two-years. The important presence and towing capability of Coast Guard vessels or "Vessels-of-Opportunity" have proven to be valuable during incidents by arresting the drift of a vessel until larger commercial assets can reach the scene. In 2004, the *Alex Haley* performed a 41-hour tow of the M/V *Selendang Ayu* a 593-foot, 46,000-ton bulk freighter. The Alex Haley used a 1,000-foot, 8-inch towing hawser to slow the freighters drift towards Unalaska Island. When the tug *Sidney Foss* arrived on-scene the *Alex Haley* was stood down while the *Sidney Foss* prepared a tow. The *Alex Haley* remained on scene to provide assistance.[25]

Maintain and improving US Coast Guard towing capabilities in the Bering Sea is imperative for mitigating the risk of drift groundings. Currently, the *Acushnet* is scheduled to be decommissioned and there is no replacement, thus reducing patrol coverage in the Bering Sea. Replacing the *Acushnet* with a vessel similar to the *Alex Haley* will maintain and potentially increase ship time and coverage. The towing equipment onboard the cutters need to be evaluated and potentially upgraded to modern standards.

[25] http://www.ntsb.gov/publictn/2006/MAB0601.htm

Enhance Vessel Monitoring and Reporting Program

Description & Background

Automatic Identification System (AIS)

On December 31, 2004 the International Maritime Organization (IMO) required that all ships above 300 gross tons on the high seas be equipped with Automatic Identification System (AIS) Equipment. This technology is akin to aircraft transponders and comprised of a VHF/FM based transponder that transmits the vessels GPS acquired position to other vessels and to terrestrial receiving stations where they exist. The regulation requires a ship's name, position, course, speed, destination and other data, based on the nature of the cargo and the voyage, be transmitted continuously in real time. This allows all vessels within the range of the transponder to see the progress and course of other AIS equipped vessels to aid collision avoidance. The information can be displayed onboard on a minimum keyboard display (MKD) or a vessel's navigation plotter. Each AIS equipped vessel in the area displayed as a character on the screen along with the other information noted above. The Marine Exchange of Alaska has installed and operates all AIS receivers in Alaska outside of Prince William Sound with the U.S. Coast Guard and State of Alaska accessing the system. The Marine Exchange currently has a total of 80 sites in Alaska, with six AIS receivers along the Aleutian chain from Akutan to Adak.

The AIS network operated by the Marine Exchange of Alaska simply receives vessel data and disseminates it to authorized users. The Coast Guard's National Automatic Identification System (NAIS) network, where established in some regions of continental U.S. and Prince William Sound is a two way, send and receive AIS network, allowing the Coast Guard to directly send data to a vessel via AIS.

Long Range Identification and Tracking System

In addition to IMO requiring the tracking of vessels via AIS, in 2007 IMO implemented the Long Range Identification and Tracking System (LRIT) initiative intended to provide port and coastal states information on vessels operating in or near their coasts in light of emerging security concerns. Unlike AIS which broadcasts in the open substantial amounts of information on a vessel several times a minute via VHF communications, LRIT is a satellite based system that simply sends a vessels serial number and location 4 times a day over a secure network. The information may be acquired by authorized coastal and flag states for a fee. As a 20 knot vessel would cover 120 nautical miles between position reports, LRIT does not provide the granularity of data needed to address safety and environmental concerns. LRIT information is not available to the general public and would be inappropriate for a search and rescue vessel tracking option.

Voluntary Vessel Monitoring

In addition to LRIT, many vessels are tracked by other satellite systems to aid safety and efficiency as per company policy (Alaska Marine Highway System, Alaska Marine Lines, Northland Services, etc.) or to satisfy fishing regulations, i.e. VMS (Vessel Monitoring System). The types of satellite transponders and their polling/reporting rates vary from every 30 minutes to a few times a day. In most cases vessels automatically send reports every three hours with the operating cost of such systems averaging a $1-$3 dollars a day with the equipment ranging from $500 to $2,500. In addition to AIS, the Marine Exchange of Alaska also installs and disseminates satellite transponders and its vessel tracking system receives and processes satellite position reports along with AIS reports. Thus vessels, such as the Alaska Marine Highway System ferries, operating outside the range of AIS receiving sites are still tracked when also equipped with a satellite transponder.

Maritime Insurance Clause associated with Vessel Tracking in the Bering Sea

In addition to international and federal vessel monitoring and tracking requirements, insurers for maritime commerce worldwide such as Lloyds of London have specific requirements for vessels passing through Unimak Pass. The Bering Sea Transit Clause (b) of their standards reads:

> "Notwithstanding anything contained in this insurance to the contrary, it is hereby agreed that when on through voyage to or from the Far East, the insured vessel may navigate the Bering Sea provided that:
>
> 1. The vessel has onboard the appropriate Hydrographic Charts corrected up to date,
> 2. Entry is made through the Unimak Pass and exit west of Buldir Island or vice versa and
> 3. The vessel is equipped and properly fitted with marine radar, a satellite navigator, a sonic depth sounding apparatus, radio direction finder and gyro compass, all fully operational and manned by qualified personnel. (Alternatively the vessel may enter or leave through the Amchitka, Amukta or Attu passes, but only when equipped and properly fitted with marine radar, a satellite navigator, sonic depth sounding apparatus, radio direction finder, gyro compass and a weather facsimile recorder, all fully operational and manned by qualified personnel).
>
> Insurance hereunder permits the insured vessel to use the Bering Sea, entering through Unimak Pass and leaving west of Buldir Island or vice versa, on through voyages to the Far East, provide the vessel is equipped with the marine radar and GPS and also sonic depth sounding apparatus and GMDSS/radio direction finder."

It is unlikely that the entire study area could or should be covered by AIS. Presently, there are two AIS receivers at Adak at the Port and at some elevation, Dutch Harbor (sea level and mountain top) in two locations and Akutan in two locations, mid mountain and sea level. The Marine Exchange of Alaska is planning on installing two new sites the summer of 2011 in Nikolski and Atka. The following locations are considered critical to the success of the system and could be in operation within a year after funding is secured:

- Attu Island,
- Shemya,
- Adak mountaintop (an abandoned White Alice site),
- Akutan mountaintop and;
- Nikolski mountaintop (also an abandoned White Alice site).

Appendix C
RRO Evaluation Spreadsheet from Task 7 Workshop

DRAFT

RRO EVALUATION And RANKING
WORKING SPREADSHEET
AIRA Phase A Peliminary Risk Assessment

DRAFT

Risk Reduction Option Effectiveness Evaluation

Equal weight factors	1	1	1	1	1	1	1	1	1	1	1
Accident Frequency Results (MARCS)	0.06181	0.03401	0.0328	0.7071	0.6028	0.358111	0.324523	0.30597	0.155715	0.161133	
AIRA Phase A Frequency weighting factor	0.06181	0.03401	0.0328	0.7071	0.6028	0.358111	0.324523	0.30597	0.155715	0.161133	
Expert weighting factor	1	1	1	1	1	1	1	1	1	1	

Area = Fraction of AIRA study area covered by RRO 1 < 33% 2 = 33-67% 3 = >67%

Time = Fraction of time RRO applies 1 < 33% 2 = 33-67% 3 = >67%

Risk Reduction Option Scoring

Weighting 1 1 1

Pink shaded cells must not be edited!

RRO #	RRO Name	Area	Time	Accident Frequency: Collision	Accident Frequency: Structural failure	Accident Frequency: Fire/ Explosion	Accident Frequency: Powered Grounding	Accident Frequency: Drift Grounding	Spill Severity: Collision	Spill Severity: Structural failure	Spill Severity: Fire/ Explosion	Spill Severity: Powered Grounding	Spill Severity: Drift Grounding	Low rank is good Effectiveness - Frequency	Rank	Low rank is good Effectiveness - Severity	Rank	Low rank is good **Overall Effectiveness**	Rank	Low rank is good **Cost**	Rank	Low rank is good **Practicality**	Rank	**Overall**	Rank
1	Enhance Vessel Monitoring Program			0	0	0	0	0	0	0	0	0	0												
1a	Satellite tracking + AIS	2	3	0	0	0	3	3	2	2	2	2	2	23.58	1	15.67	5	39.24	1	2	3	2	1	5	1
2	Establish VTS in Unimak and Akutan Pass			0	0	0	0	0	0	0	0	0	0												
2a	Manned VTS/Direct Comm w Vessels	1	3	3	0	0	3	1	2	2	2	2	2	8.73	7	7.83	13	16.56	11	5	12	6	17	40	16
2b	Traffic Separation Scheme in U. Pass	1	3	3	0	0	0	0	0	0	0	0	0	0.56	14	0.00	16	0.56	17	1	1	4	9	27	10
2c	Speed Restrictions			0	0	0	0	0	0	0	0	0	0												
3	Increase Rescue Tug Capability			0	0	0	0	0	0	0	0	0	0												
3a	Dedicated rescue tug(s)	2	3	0	0	0	0	3	2	2	2	1	2	10.85	5	14.73	7	25.58	6	5	12	5	12	30	12
3b	Non-dedicated rescue tug	2	2	0	0	0	0	3	2	2	2	1	2	7.23	8	9.82	10	17.05	9	5	12	5	12	33	14
3c	Seasonal, dedicated tug	2	2	0	0	0	0	3	2	2	2	1	2	7.23	8	9.82	10	17.05	9	3	8	4	9	26	9
3d	Tugs of opportunity program	3	3	0	0	0	0	1	1	1	1	1	1	5.43	10	11.75	8	17.17	8	2	3	2	1	12	3
4	Increase Towing Capabilities			0	0	0	0	0	0	0	0	0	0												
4a	Expand shore-based ETS	3	3	0	0	0	0	2	2	2	2	1	1	10.85	5	20.65	3	31.50	3	2	3	2	1	7	2
4b	Require emergency towing arrangements on deep draf	3	3	0	0	0	0	3	2	2	2	1	1	16.28	2	20.65	3	36.92	2	4	11	3	5	18	6
5	Enhanced USCG Capabilities			0	0	0	0	0	0	0	0	0	0												
5a	Enhance towing cap on Cutters	2	3	0	0	0	0	1	1	1	1	1	1	3.62	11	7.83	13	11.45	14	3	8	3	5	27	10
5b	Increase number of cutters	2	2	0	0	0	0	1	1	1	1	1	1	2.41	13	5.22	15	7.63	16	5	12	5	12	40	16
5c	Increase inspections			0	0	0	0	0	0	0	0	0	0												
5d	Split COTP zones			0	0	0	0	0	0	0	0	0	0												
6	Establish Restricted Areas			0	0	0	0	0	0	0	0	0	0												
6a	IMO PSSA and associated measures (e.g. ATBA)	2	3	0	0	0	2	2	2	2	2	2	2	15.72	3	15.67	5	31.38	4	2	3	3	5	12	3
6b	Seasonal Routing			0	0	0	0	0	0	0	0	0	0												
7	Increase Spill Response Capability			0	0	0	0	0	0	0	0	0	0												
7a	Ocean rated OSRO/PRAC - Open Ocean	3	3	0	0	0	0	0	1	1	1	0	0	0.00	15	8.90	12	8.90	15	5	12	5	12	39	15
7b	Nearshore rated OSRO/PRAC	3	3	0	0	0	0	0	2	2	2	2	2	0.00	15	23.50	1	23.50	7	5	12	5	12	31	13
7c	Amend Salvage& Firefighting standards to apply to DH	2	3	0	0	0	0	1	3	3	3	3	3	3.62	11	23.50	2	27.11	5	3	8	4	9	22	8
7d	Local Community Response agreements			0	0	0	0	0	0	0	0	0	0												
7e	Phase out OPA90 Alternative Compliance			0	0	0	0	0	0	0	0	0	0												
8	Bolster Area Contigency Plans			0	0	0	0	0	0	0	0	0	0												
8a	Establish requirements for vessels in innocent passage			0	0	0	0	0	0	0	0	0	0												
8b	Set area standards for vessels with VRP calling at US ports			0	0	0	0	0	0	0	0	0	0												
8c	Develop more geographic response strategies (GRS)	3	3	0	0	0	0	0	1	1	1	1	1	0.00	15	11.75	8	11.75	13	2	3	3	5	21	7
8d	Potential places of refuge planning			0	0	0	0	0	0	0	0	0	0												
8e	Storm and severe weather rules			0	0	0	0	0	0	0	0	0	0												
8f	HF radar surface current monitoring			0	0	0	0	0	0	0	0	0	0					0.00	18						
9a	Increase liability & civil penalties			0	0	0	0	0	0	0	0	0	0												
9b	Increase State civil penalties	3	3	1	1	1	1	1	0	0	0	0	0	12.95	4	0.00	16	12.95	12	1	1	2	1	14	5

Risk Reduction Option Cost

Expert weighting factor	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

(1 means no factor applied)

RRO #	RRO Name	Capital Cost (CapEx): Industry	Port	State	Federal	NS	Operating Cost (OpEx): Industry	Port	State	Federal	NS	Evaluation
1	Enhance Vessel Monitoring Program											0
1a	Satellite tracking + AIS	0	0	0	0	1	0	0	0	0	1	2
2	Establish VTS in Unimak and Akutan Pass											0
2a	Manned VTS/Direct Comm w Vessels	0	0	0	3	0	0	0	0	2	0	5
2b	Traffic Separation Scheme in U. Pass	0	0	0	1	0	0	0	0	0	0	1
2c	Speed Restrictions											0
3	Increase Rescue Tug Capability											0
3a	Dedicated rescue tug(s)	0	0	0	0	3	0	0	0	0	2	5
3b	Non-dedicated rescue tug	0	0	0	0	3	0	0	0	0	2	5
3c	Seasonal, dedicated tug	0	0	0	0	1	0	0	0	0	2	3
3d	Tugs of opportunity program	0	0	0	0	1	0	0	0	0	1	2
4	Increase Towing Capabilities											0
4a	Expand shore-based ETS	0	0	0	0	1	0	0	0	0	1	2
4b	Require emergency towing arrangements on deep draf	2	0	0	0	0	2	0	0	0	0	4
5	Enhanced USCG Capabilities											0
5a	Enhance towing cap on Cutters	0	0	0	2	0	0	0	0	1	0	3
5b	Increase number of cutters	0	0	0	3	0	0	0	0	2	0	5
5c	Increase inspections											0
5d	Split COTP zones											0
6	Establish Restricted Areas											0

6a	IMO PSSA/ATB/SA						1	1					2
6b	Seasonal Routing												0
7	Increase Spill Response Capability												0
7a	Ocean rated OSRO/PRAC - Open Ocean		3	0	0	0	0	2	0	0	0	0	5
7b	Nearshore rated OSRO/PRAC		3	0	0	0	0	2	0	0	0	0	5
7c	Increase Salvage& Firefighting Cap thru Regs		2	0	0	0	0	1	0	0	0	0	3
7d	Local Community Response agreements												0
7e	Phase out OPA90 ALternative Compliance												0
8	Bolster Area Contigency Plans												0
8a	Establish requirements for vessels in innocent passage												0
8b	Set area standards for vessels with VRP calling at US ports												0
8c	Develop more geographic response strategies (GRS)		0	0	0	0	1	0	0	0	0	1	2
8d	Potential places of refuge planning												0
8e	Storm and severe weather rules												0
8f	HF radar surface current monitoring												0
9a	Increase liability & civil penalties												0
9b	Increase State civil penalties		0	0	0	0	0	1	0	0	0	0	1

Risk Reduction Option Practicality

Expert weighting factor	1.0	1.0	1.0

RRO #	RRO Name	Who Implements					Lead Time	Ease of Implementation	Evaluation
		Industry	Port	State	Federal	NS			
1	Enhance Vessel Monitoring Program								0
1a	Satellite tracking + AIS	x	0	x	x	0	1	1	2
2	Establish VTS in Unimak and Akutan Pass								0
2a	Manned VTS/Direct Comm w Vessels	0	0	0	x	IMO	3	3	6
2b	Traffic Separation Scheme in U. Pass	0	0	0	x	IMO	3	1	4
2c	Speed Restrictions								0
3	Increase Rescue Tug Capability								0
3a	Dedicated rescue tug(s)	0	x	x	x	0	2	3	5
3b	Non-dedicated rescue tug	0	0	0	0	0	2	3	5
3c	Seasonal, dedicated tug	0	0	0	0	0	2	2	4
3d	Tugs of opportunity program	x	0	0	0	x	1	1	2
4	Increase Towing Capabilities								0
4a	Expand shore-based ETS	x	0	x	x	0	1	1	2
4b	Require emergency towing arrangements on deep draf	x	0	0	x	IMO	3	0	3
5	Enhanced USCG Capabilities								0
5a	Enhance towing cap on Cutters	0	0	0	x	0	2	1	3
5b	Increase number of cutters	0	0	0	x	0	2	3	5
5c	Increase inspections								0
5d	Split COTP zones								0
6	Establish Restricted Areas								0
6a	IMO PSSA/ATB/SA	x			x	IMO	2	1	3
6b	Seasonal Routing								0
7	Increase Spill Response Capability								0
7a	Ocean rated OSRO/PRAC - Open Ocean	0	0	0	x	0	3	2	5
7b	Nearshore rated OSRO/PRAC	0	0	x	x	0	3	2	5
7c	Increase Salvage& Firefighting Cap thru Regs	0	0	x		0	2	2	4
7d	Local Community Response agreements								0
7e	Phase out OPA90 ALternative Compliance								0
8	Bolster Area Contigency Plans								0
8a	Establish requirements for vessels in innocent passage								0
8b	Set area standards for vessels with VRP calling at US ports								0
8c	Develop more geographic response strategies (GRS)	x	0	x	x	0	2	1	3
8d	Potential places of refuge planning								0
8e	Storm and severe weather rules								0
8f	HF radar surface current monitoring								0
9a	Increase liability & civil penalties								0
9b	Increase State civil penalties	0	0	x	0	0	1	1	2