ALEUTIAN ISLANDS RISK ASSESSMENT PHASE B

Tug Location Study

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References

1. *Aleutian Islands Risk Assessment – Phase B Work Plan*, Nuka Research & Planning Group, LLC and Pearson Consulting, LLC, 29 November 2012.
2. *Best Available Technology*, The Glosten Associates, Inc., File No. 12127.02, Report No. 12127.02.1-2c, Rev. -, 20 September 2013.
3. *Purpose Designed Emergency Towing Vessel*, The Glosten Associates, Inc., File No. 12127.02, Report No. 12127.02.1-2c, Rev. -, 8 November 2013.
4. *Minimum Required Tug*, The Glosten Associates, Inc., File No. 12127.02, Report No. 12127.02.1-2b, Rev. A, 14 January 2013.
5. *Development of Frigate Designs with good Seakeeping Characteristics*, Thomas Eefsen, Frans van Walree, Daniele Peri, Peter van Terwisga, Hans Otto Kristensen, Roberto Dattola, and Marcel Visser, 9th Symposium on Practical Design of Ships and Other Floating Structures, 2004.
6. *The Sea is Never Calm – Design with Respect to Overall Performance*, Ingvar Rask and Sven Jacobsson, SSPA Highlights, 48/2009.
7. *Guidelines for Marine Transportations 0030/ND*, Nobel-Denton Towing Policy Board, 15 April 2009.

Introduction

The Aleutian Islands Risk Assessment Phase 2 Work Plan (Reference 1) requires a study of tug location and number based on tug performance. This study uses the tugs identified in References 2 and 3 and looks at combinations of numbers and speed to evaluate their effectiveness in a range of conditions. The study compares the regions of the study area where the stricken vessel would drift to shore before one of the tugs could arrive and perform a rescue.

Weather

The evaluation of the location and number of tugs was run for a range of conditions that might be found in the Aleutians. The conditions are from Reference 4 and are summarized in Table 1.

Table 1 Wind and Sea conditions.

Significant Wave Height (ft)	5	10	15	20	25	30
Modal Wave Period (s)	7.94	9.44	10.94	12.44	13.94	14.80
Mean Wind Speed (kt)	14	20	25	30	35	41

Stricken Vessels

Actual vessels were selected to match the requirements of the work plan. The vessel particulars are taken from Reference 4 and summarized below in Table 2.

Table 2 Stricken Vessel Particulars.

	Tanker	Container Ship
Type	NASCO 675,930 BBL	HHI 7,500 TEU Class
Name	*Overseas Ohio*	*Hong Kong Express*
Length Overall (m)	272(est.)	320
Length Between Perpendiculars (m)	261	304
Beam (m)	32.2	42.8
Deadweight(MT)	90,000	82,800
Design Draft (m)	15	13
Depth (m)	18(est.)	24.5
Block Coefficient	0.82	0.65(est.)

Towing Vessels

Three towing vessels are used in this study. Reference 2 identified the *Alert* as the best available domestic towing vessel for this task, and the *Barentshav* as the best available foreign towing vessel. Reference 3 gives details of the Purpose Designed Towing Vessel developed for this task. The purpose designed towing vessel is included to evaluate the added value of tug speed in an emergency response system. Details of the three vessels are shown in Table 3.

Table 3 Towing Vessels – Main Particulars

	Alert	Barentshav	Purpose Designed Towing Vessel
Length, Overall	140 ft	305 ft	350 ft
Length, Waterline	130 ft	270 ft	350 ft
Breadth	42 ft	54 ft	40 ft
Depth, Main Deck	20 ft	28 ft	23.5 ft
Draft	16 ft	19 ft	12.5 ft
Displacement	1,534 LT	3,251 LT	3,100 LT
Propulsion BHP	10,192 hp	8,660 hp	71,370 hp
Propulsion Type	Z-drives	fixed prop with thrusters	water jets with thruster
Bollard Pull	136 MT	110 MT	110 MT
Crew Capacity	16 persons	40 persons	16 persons
Fuel Capacity	129,500 gal	238,100 gal	236,000 gal
Max Speed	16 kt	20 kt	34 kt
2013 Construction Cost	$30.3M	$65.1M	$86.8M

Drift Speeds

The speed at which the stricken vessels drift is related to the weather condition. The methods in Reference 4 were used to calculate drift speeds by assuming the force in the hull traveling through the water at an angle was balanced by the forces produced by the wind and waves. A drift angle was used that balanced the moments produced by all the forces. The drift speeds in Table 4 were calculated for the range of weather conditions for both the tanker and the container ship.

Table 4 Drift Speeds

		Tanker	Container Ship
wave height (ft)	wind speed (kt)	drifting speed (kt)	drifting speed (kt)
0	0	0.0	0.0
5	14	1.2	1.7
10	20	1.7	2.3
15	25	2.2	2.7
20	30	2.6	3.2
25	35	3.0	3.7
30	41	3.5	4.2

Speed Reduction

The travel time of the towing vessel is based on its top speed in calm water and its ability to maintain that speed in higher sea states. The top speed is typically well known, while the speed reduction in waves is estimated based on tests of other vessels, judgment, and experience. The speed reduction values used in this study have different sources for the different vessels. The *Alert* values are based on the Nobel-Denton towing manual, Reference 7 modified by the experience of Alaska tugboat operators. The *Barentshav* values are taken from Reference 6, which are for a larger but bluffer car-carrier; however, they are judged to be descriptive in the absence of real data. The purpose-designed vessel is specifically designed to maintain its speed in rough seas. The first portion of its curve is scaled from values in Reference 5 for Axe-bowed frigates. The latter part of the curve is tapered to meet the same speed as the *Barentshav* in 30' waves. The values for speed factor and the resulting speed are presented in Table 5 and Figure 1.

Table 5 Speed Reductions

	Alert		Barentshav		Purpose Designed Tug	
wave height (ft)	Speed Factor	Speed (kt)	Speed Factor	Speed (kt)	Speed Factor	Speed (kt)
0	1.00	16.00	1.00	20.00	1.00	34.00
5	1.00	16.00	0.98	19.60	0.99	33.66
10	0.94	14.95	0.91	18.20	0.96	32.64
15	0.74	11.85	0.82	16.40	0.92	31.28
20	0.46	7.38	0.70	14.00	0.77	26.18
25	0.13	2.00	0.59	11.80	0.53	18.02
30	0.00	0.00	0.47	9.40	0.30	10.20

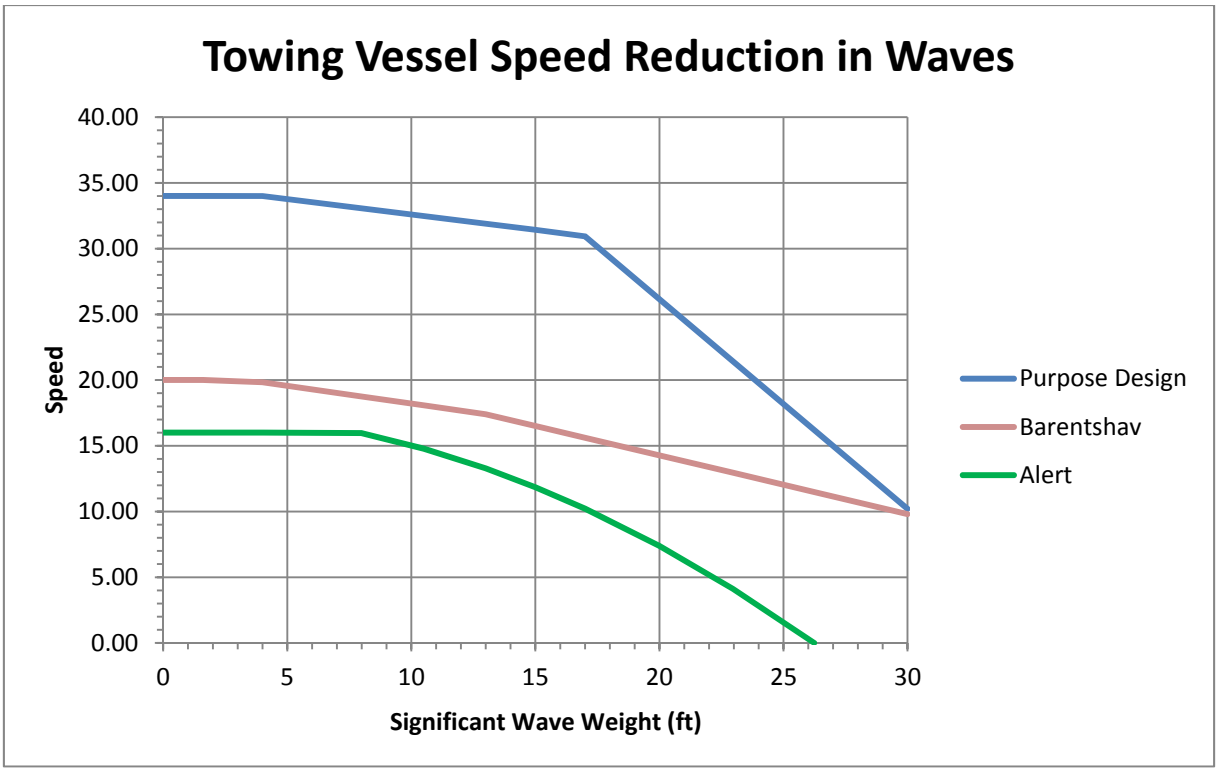

Figure 1 Speed Reduction in Waves

Towing Vessel Ports

The Aleutian Islands have a limited number of ports suitable for basing the emergency towing vessels. It was assumed that the vessel would be largely self-supporting with its own living quarters and the ability to carry enough stores and fuel for at least three to six months. Crew transfers, health, and morale, along with the need to receive spare parts, dictated a port with an airport, a secure anchorage, and some pier access. The only ports that meet these requirements are Dutch Harbor and Adak.

Drift Distances

The drift distances were calculated assuming a worst case scenario, where the vessel drifts directly towards a hazard during the time that the towing vessel proceeds at maximum speed for the conditions in order to intercept the drifting vessel before it reaches the hazard. The travel time of the towing vessel multiplied by the drifting speed equals the drift distance for the given conditions. If the stricken vessel is closer to the hazard than the calculated drift distance, then the towing vessel cannot arrive in time.

The drift distances are calculated for each weather condition, for each towing vessel, for each stricken vessel, and for each towing vessel port. The results are presented in Appendix A.

Risk Area Calculation

Aggregate Risk Area

The drift distance can be thought of as a radius around the hazard defining an area where the towing vessel is not effective. The aggregate area is the sum of the areas surrounding each scenario site identified in the work plan (Reference 1).

Net Risk Area

Since there is a fixed relationship between the drift distance and the speed of the towing vessel for a given vessel and conditions, the radius will vary linearly with the distance from the towing vessel port to the scenario location. A plot of these radiuses along the Aleutian chain produces a curved conical area with a rounded end at the most distant scenario location. The sum of the two conical areas on either side, east and west of the towing vessel home port, represents the net risk area. The net area is a roughly the total area within the Aleutian Islands study area in which the towing vessel cannot rescue the stricken vessel in time.

The net risk area for a single case is shown in Figure 3. The aggregate risk area is the sum of the areas within the circles.

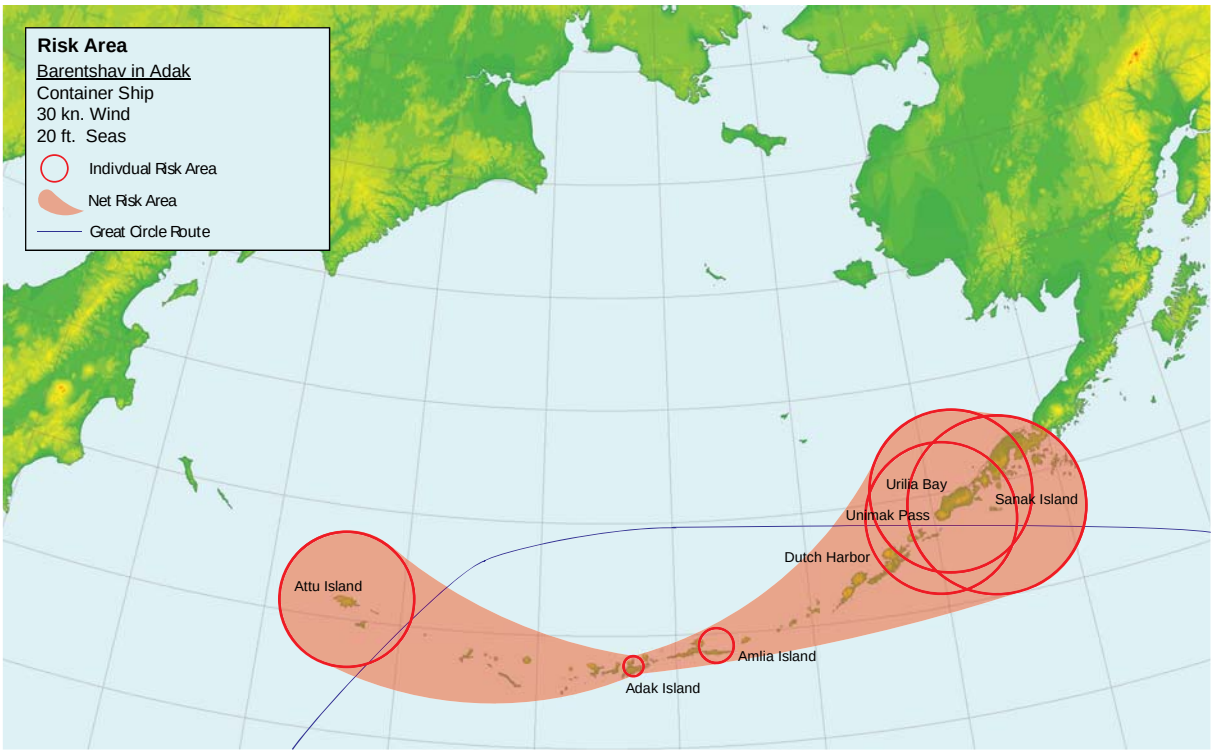

Figure 2 Risk Areas - *Barentshav* Class Tug in Adak

When there are two towing vessels stationed in different ports, the net areas for two ports are combined as shown in Figure 3.

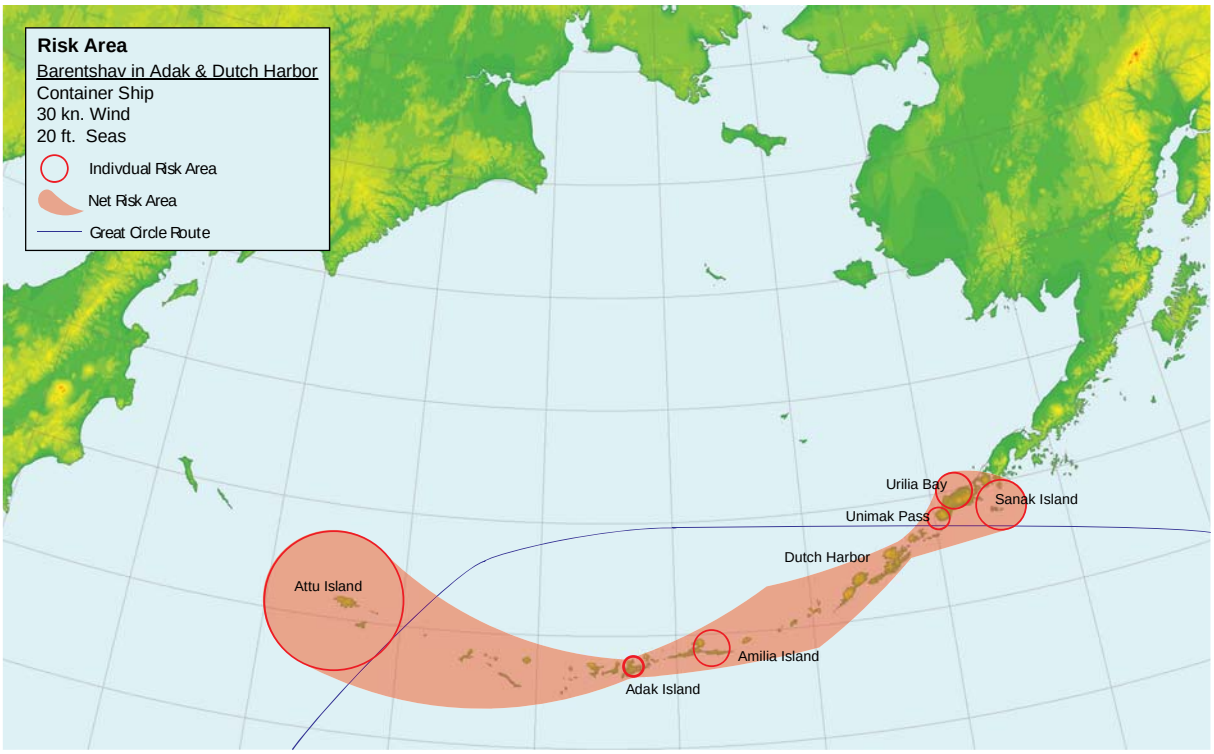

Figure 3 Risk Areas - *Barentshav* Class Tug in Adak and Dutch Harbor

The entire calculation assumes steady, worst case conditions. The wind speed and direction, and the wave height and direction travel on the bearing to the hazard, all remain constant. In reality, the conditions would remain steady for only a short time. The longer the travel time for the towing vessel, the more likely the conditions are to change. This would result in a longer, non-linear track for the stricken vessel as it drifts toward the hazard. The resulting areas for the slower, more distant towing vessels look worse than they actually may be. No attempt was made in this study to account for this bias in favor of the faster towing vessels.

The aggregate and net risk areas are calculated for each weather condition, for each towing vessel, for each stricken vessel, and for each towing vessel port. The results are presented in Appendix B.

Figures 4 through 8 complete the selection of cases for 20' seas and 30 knots of wind.

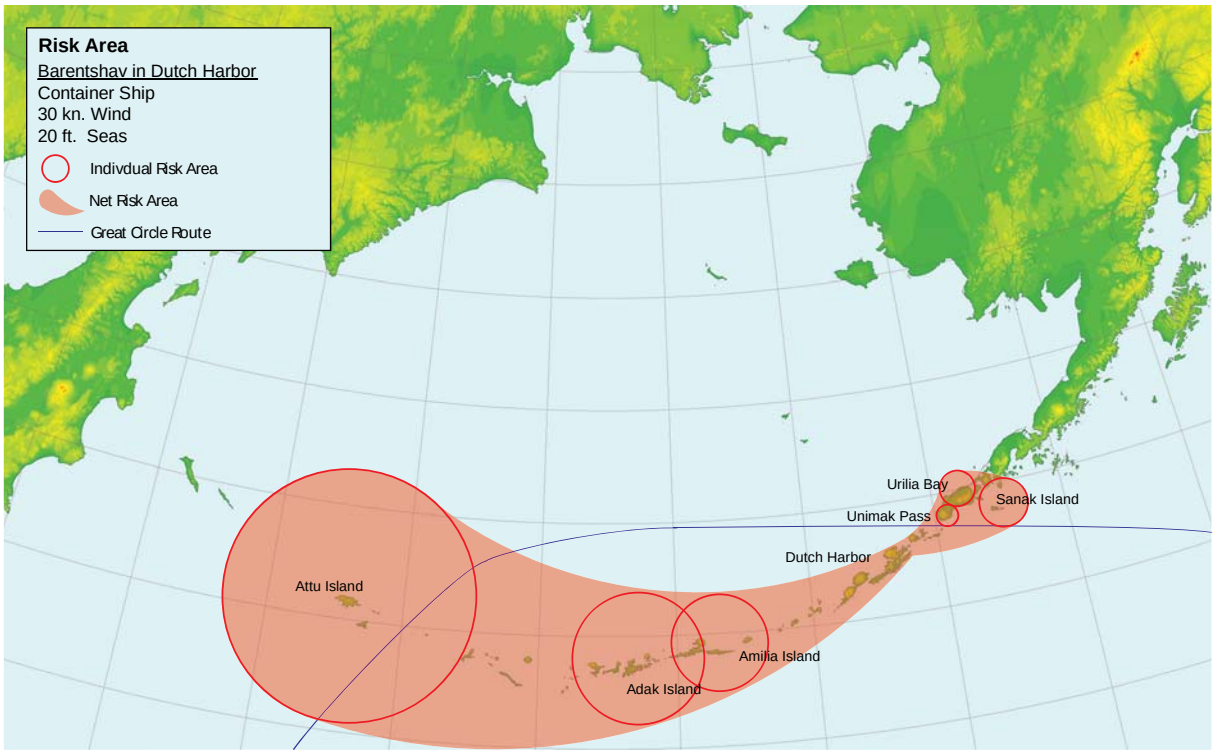

Figure 4 **Risk Areas - *Barentshav* Class Tug in Dutch Harbor**

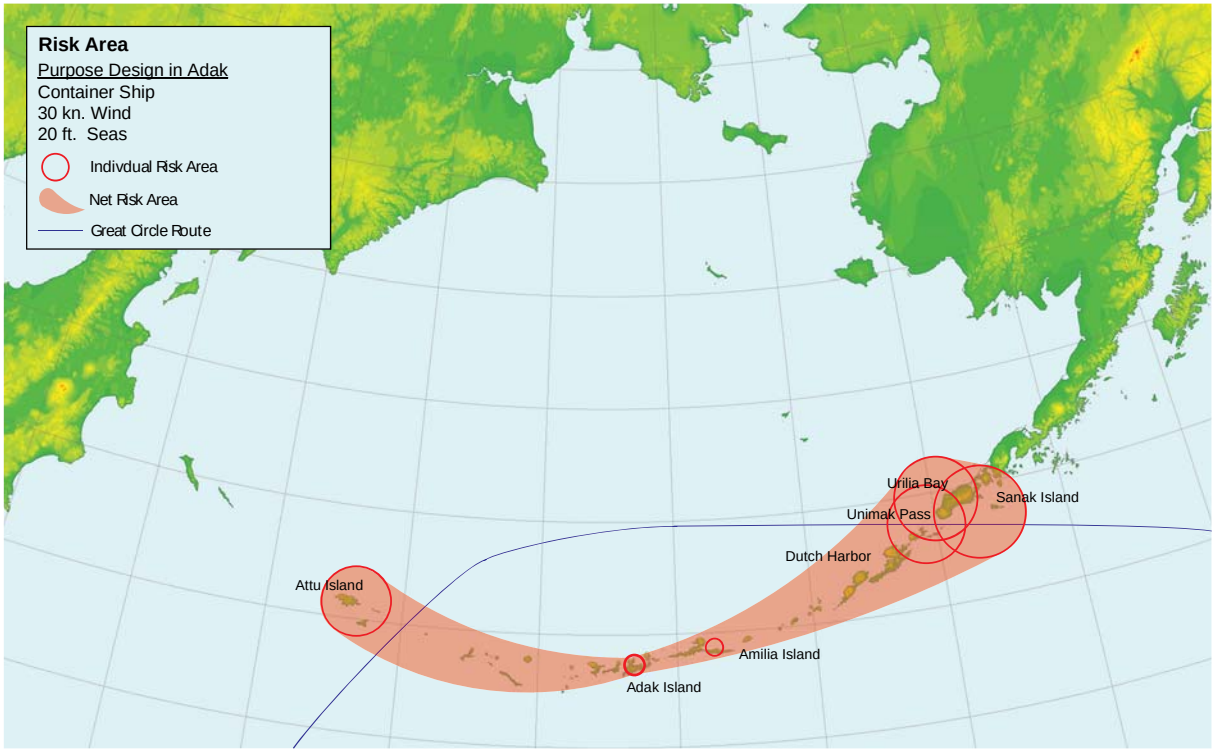

Figure 5 **Risk Areas - Purpose Design Towing Vessel in Adak**

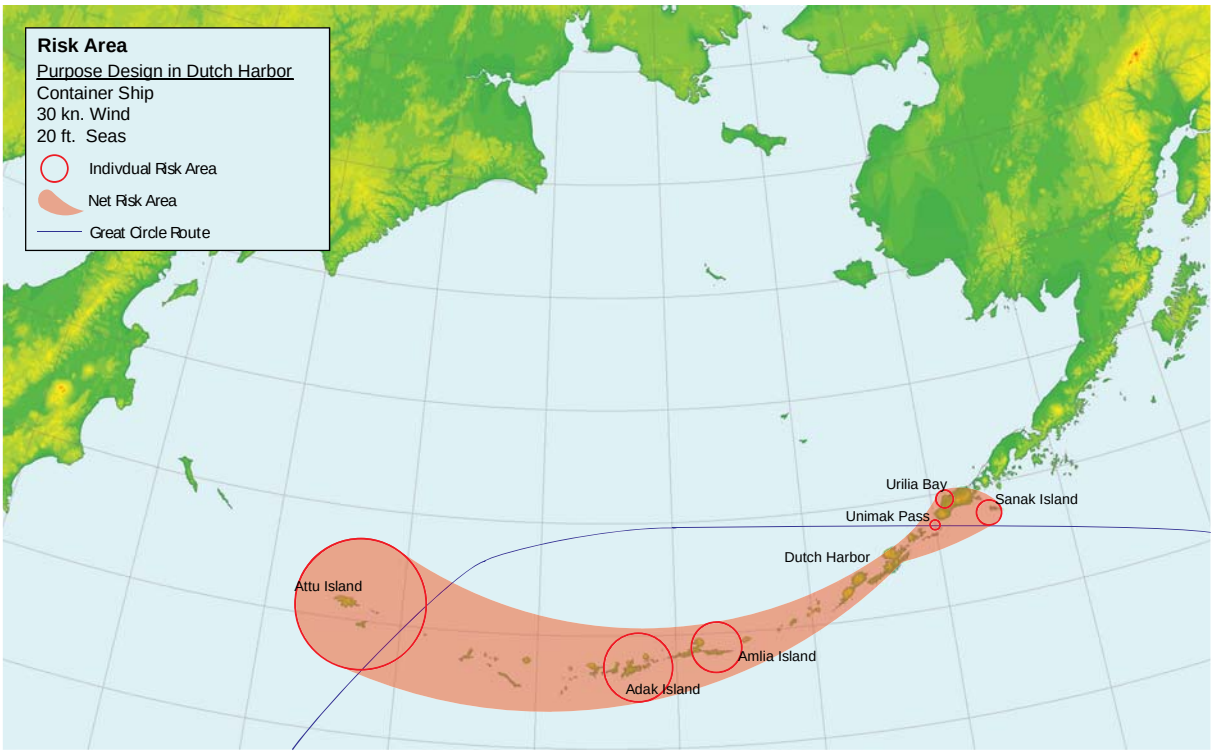

Figure 6 Risk Areas - Purpose Design Towing Vessel in Dutch Harbor

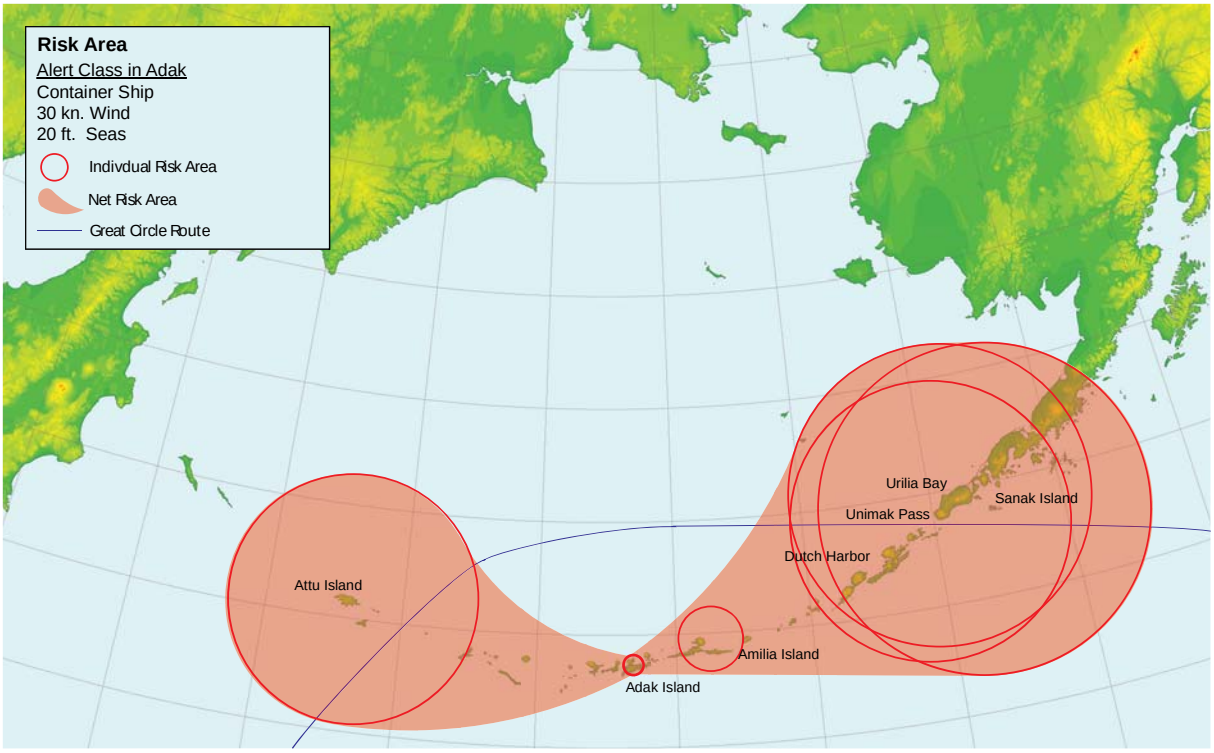

Figure 7 Risk Areas - *Alert* Class Tug in Adak

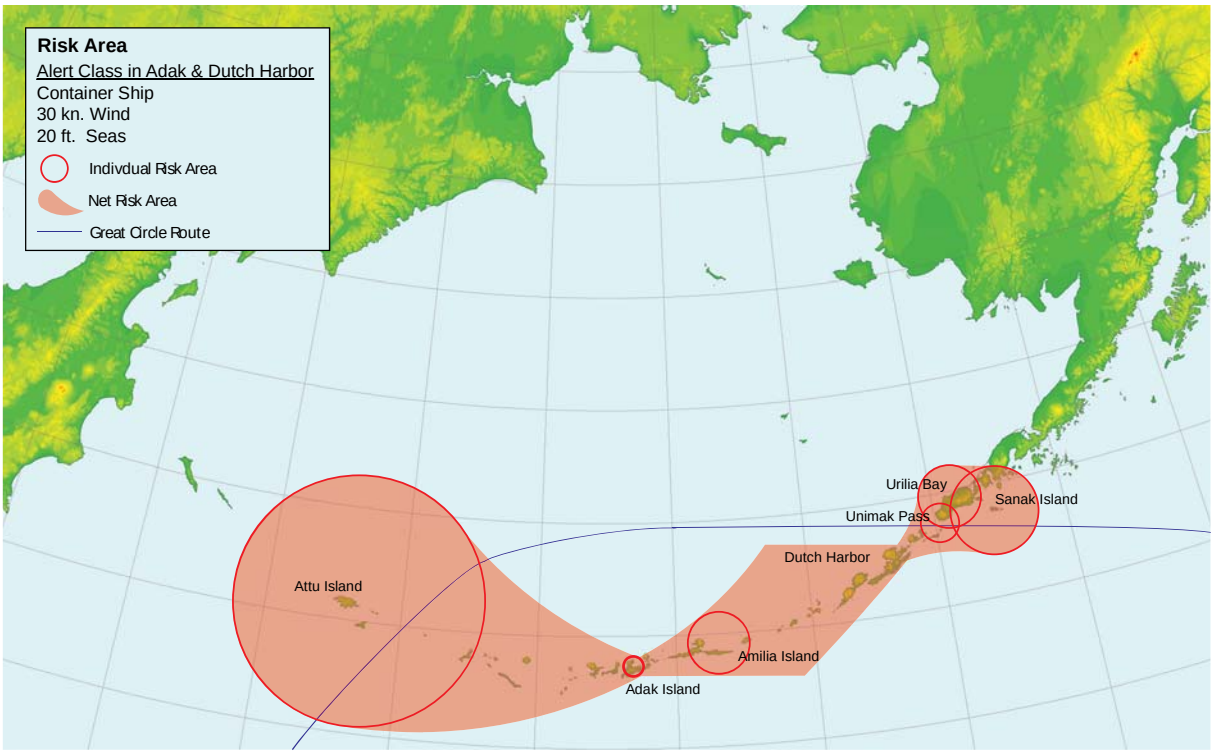

Figure 8 Risk Areas - *Alert* Class Tugs in Adak and Dutch Harbor

Results

Plots of the net and aggregate risk areas for 20' and 10' waves are shown in Figures 10 through 13.

For higher seas, the aggregate areas are greater than the net areas. For the lower seas, the trend is reversed. This is due to the areas overlapping for the higher sea states.

The net risk areas for the single tug in Dutch Harbor are greater than the aggregate areas. For tugs in Adak the aggregate risk areas are larger than the net areas. This is due to the distribution of scenario locations with the majority of sites near Dutch Harbor.

The aggregate area calculation is an attempt to evaluate the towing vessel response to incidents at the specific scenario sites specified in the work plan. The net area calculation is an attempt to treat the entire Aleutian Island chain as equally important. If only the scenario sites matter to a decision, then the home port closest to those sites, Dutch Harbor, will be the best choice. If the entire Aleutian chain is of equal importance, then the port closest to the center of the chain will give the best results.

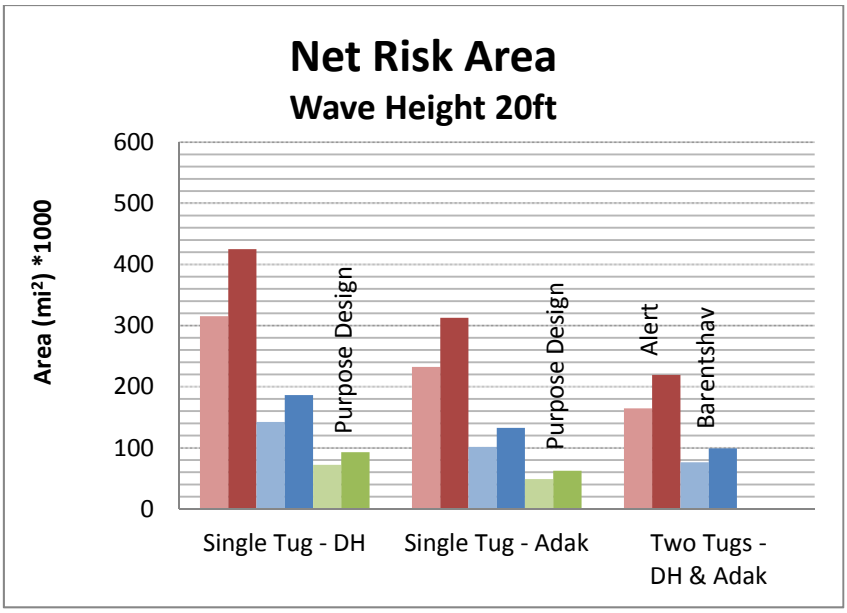

Figure 10 **Net Risk Area Comparisons – 20' Waves**

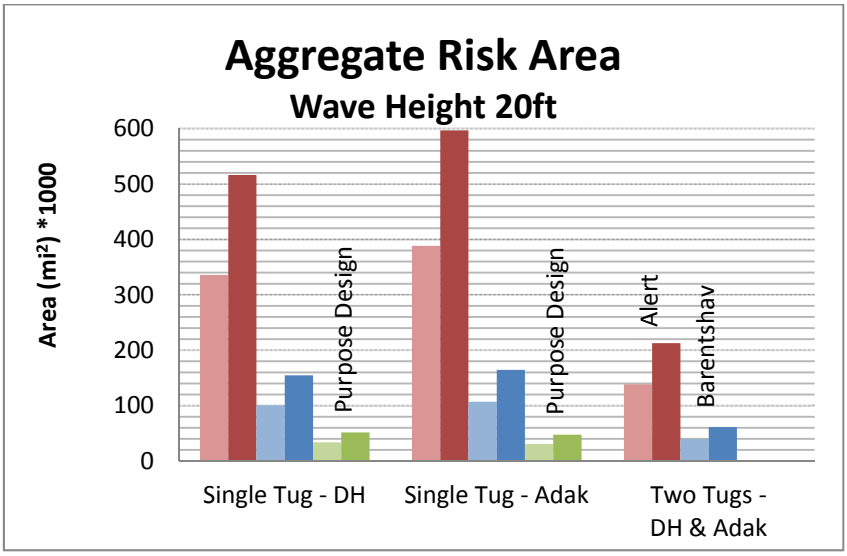

Figure 11 **Aggregate Risk Area Comparisons – 20' Waves**

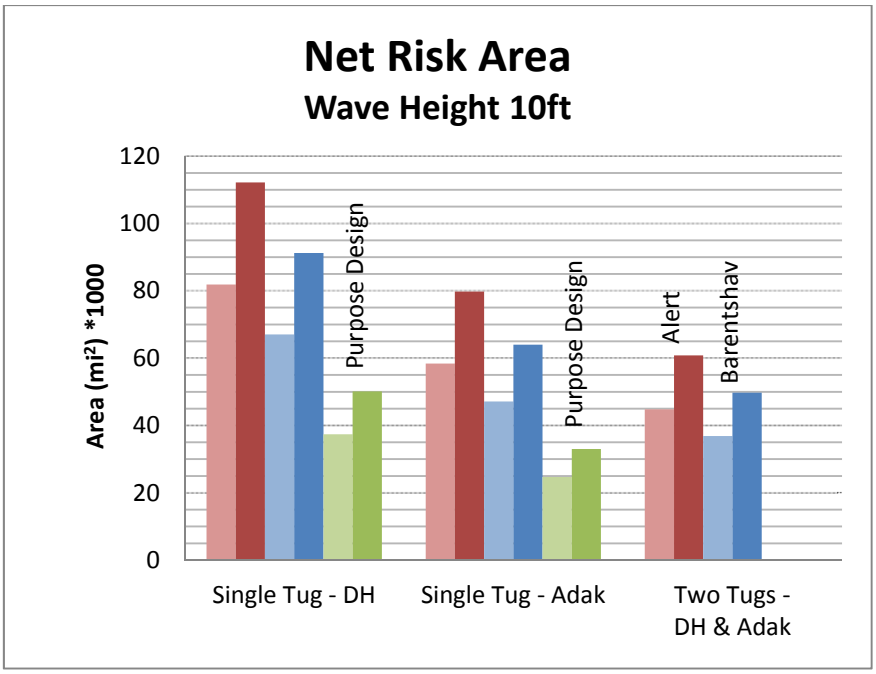

Figure 12 **Net Risk Area Comparisons – 10' Waves**

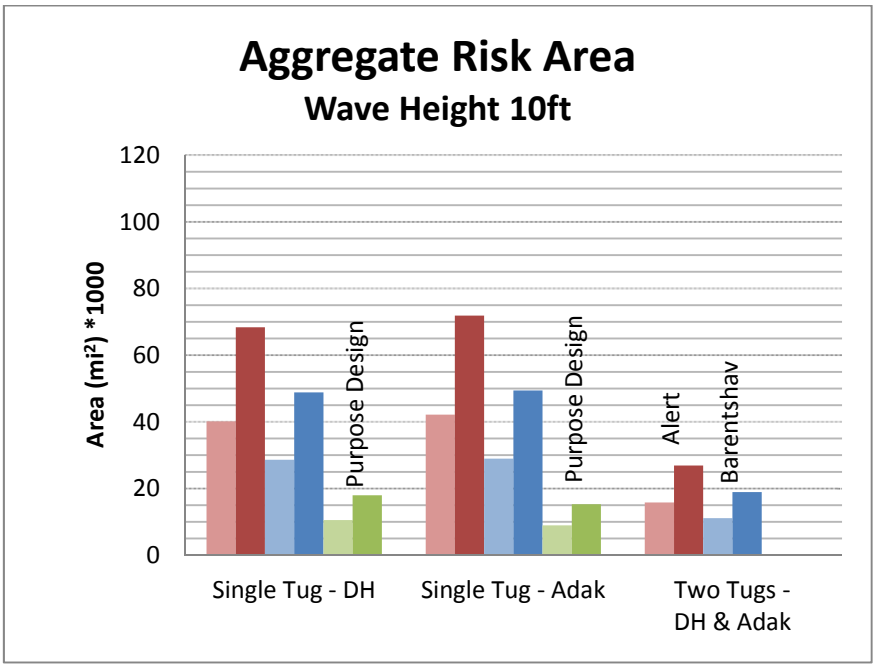

Figure 13 **Aggregate Risk Area Comparisons – 10' Waves**

The final observation is that a single-purpose designed towing vessel is more effective (less ineffective) than any alternatives with one or two tugs for all conditions.

Conclusions

The drifting speeds for a container ship and a tanker were calculated for the range of conditions. The speed of three towing vessels was calculated for the same conditions. For

each distance between home ports and incident sites, the travel time was found and the corresponding drift distance was calculated. These distances were used to calculate net and aggregate risk areas as a basis of comparison. Different combinations of home ports, number, and type of towing vessels were compared.

In terms of risk area, it is clear that the purposed designed towing vessel has the advantage. Two towing vessels of the *Barentshav* design are required to equal the same performance. Stationing the towing vessel in Adak rather than Dutch Harbor generally produces smaller risk areas.

Further Analysis

A factor to represent the wandering of a vessel's drift track should be found and applied to the risk area calculations. It will have the effect of making vessel drift speeds effectively slower and the risk areas will decrease more for slower tugs than faster ones.

Other technologies for slowing the drift speed of the ships, such as air-dropped parachute sea anchors, could be evaluated.

It is not clear that the size of the risk area is the only criteria to evaluate. In a further study, it is recommended that typical shipping routes, as determined by Phase A of the risk assessment, be overlaid on the area plots. With an integration of the intersection of the tracks and risk areas, weighted by the shipping and weather frequencies will produce an objective measure of the towing vessel effectiveness. This measure may be combined with the cost numbers to identify the best solution.

Appendix A Stricken Vessel Drift Distances

Adak to Attu		Alert						Barentshav						Purpose Designed Rescue Tug					
394 Nmi		speed =	16	Tanker		Container Ship		speed =	20	Tanker		Container Ship		speed =	34	Tanker		Container Ship	
wave height (ft)	wind speed (kt)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)
0	0	1.00	25	0.0	1	0.4	10	1.00	20	0.0	1	0.4	8	1.00	12	0.0	0	0.4	5
5	14	1.00	25	1.2	30	1.7	42	0.98	20	1.2	25	1.7	34	0.99	12	1.2	14	1.7	20
10	20	0.94	26	1.7	45	2.3	59	0.91	22	1.7	38	2.3	49	0.96	12	1.7	21	2.3	27
15	25	0.74	33	2.2	72	2.7	91	0.82	24	2.2	52	2.7	66	0.92	13	2.2	27	2.7	34
20	30	0.46	53	2.6	138	3.2	171	0.70	28	2.6	72	3.2	90	0.77	15	2.6	39	3.2	48
25	35	0.13	197	3.0	592	3.7	722	0.59	34	3.0	101	3.7	123	0.53	22	3.0	65	3.7	79
30	41	0.13	197	3.5	692	4.2	833	0.47	42	3.5	146	4.2	176	0.30	39	3.5	136	4.2	163

Adak to DH		Alert						Barentshav						Purpose Designed Rescue Tug					
383 Nmi		speed =	16	Tanker		Container Ship		speed =	20	Tanker		Container Ship		speed =	34	Tanker		Container Ship	
wave height (ft)	wind speed (kt)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)
0	0	1.00	24	0.0	1	0.4	9	1.00	19	0.0	1	0.4	8	1.00	11	0.0	0	0.4	4
5	14	1.00	24	1.2	29	1.7	41	0.98	20	1.2	24	1.7	33	0.99	11	1.2	14	1.7	19
10	20	0.94	25	1.7	44	2.3	58	0.91	21	1.7	37	2.3	48	0.96	12	1.7	20	2.3	27
15	25	0.74	32	2.2	70	2.7	88	0.82	23	2.2	51	2.7	64	0.92	12	2.2	26	2.7	33
20	30	0.46	52	2.6	134	3.2	166	0.70	27	2.6	70	3.2	87	0.77	15	2.6	38	3.2	47
25	35	0.13	192	3.0	575	3.7	702	0.59	33	3.0	98	3.7	119	0.53	21	3.0	63	3.7	77
30	41	0.13	192	3.5	672	4.2	810	0.47	40	3.5	142	4.2	171	0.30	38	3.5	132	4.2	159

Adak to Amilia		Alert						Barentshav						Purpose Designed Rescue Tug					
102 Nmi		speed =	16	Tanker		Container Ship		speed =	20	Tanker		Container Ship		speed =	34	Tanker		Container Ship	
wave height (ft)	wind speed (kt)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)
0	0	1.00	6	0.0	0	0.4	3	1.00	5	0.0	0	0.4	2	1.00	3	0.0	0	0.4	1
5	14	1.00	6	1.2	8	1.7	11	0.98	5	1.2	6	1.7	9	0.99	3	1.2	4	1.7	5
10	20	0.94	7	1.7	12	2.3	15	0.91	6	1.7	10	2.3	13	0.96	3	1.7	5	2.3	7
15	25	0.74	9	2.2	19	2.7	24	0.82	6	2.2	13	2.7	17	0.92	3	2.2	7	2.7	9
20	30	0.46	14	2.6	36	3.2	44	0.70	7	2.6	19	3.2	23	0.77	4	2.6	10	3.2	12
25	35	0.13	51	3.0	153	3.7	187	0.59	9	3.0	26	3.7	32	0.53	6	3.0	17	3.7	21
30	41	0.13	51	3.5	179	4.2	216	0.47	11	3.5	38	4.2	46	0.30	10	3.5	35	4.2	42

Adak to Unimak Pass		Alert						Barentshav						Purpose Designed Rescue Tug					
443 Nmi		speed =	16	Tanker		Container Ship		speed =	20	Tanker		Container Ship		speed =	34	Tanker		Container Ship	
wave height (ft)	wind speed (kt)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)
0	0	1.00	28	0.0	1	0.4	11	1.00	22	0.0	1	0.4	9	1.00	13	0.0	1	0.4	5
5	14	1.00	28	1.2	34	1.7	47	0.98	23	1.2	28	1.7	39	0.99	13	1.2	16	1.7	22
10	20	0.94	29	1.7	51	2.3	67	0.91	24	1.7	42	2.3	55	0.96	14	1.7	24	2.3	31
15	25	0.74	37	2.2	81	2.7	102	0.82	27	2.2	58	2.7	74	0.92	14	2.2	30	2.7	39
20	30	0.46	60	2.6	155	3.2	192	0.70	32	2.6	81	3.2	101	0.77	17	2.6	44	3.2	54
25	35	0.13	222	3.0	665	3.7	812	0.59	38	3.0	113	3.7	138	0.53	24	3.0	73	3.7	89
30	41	0.13	222	3.5	778	4.2	936	0.47	47	3.5	164	4.2	198	0.30	43	3.5	152	4.2	184

Adak to Urilia Bay		Alert						Barentshav						Purpose Designed Rescue Tug					
477 Nmi		speed =	16	Tanker		Container Ship		speed =	20	Tanker		Container Ship		speed =	34	Tanker		Container Ship	
wave height (ft)	wind speed (kt)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)
0	0	1.00	30	0.0	1	0.4	12	1.00	24	0.0	1	0.4	9	1.00	14	0.0	1	0.4	6
5	14	1.00	30	1.2	37	1.7	51	0.98	24	1.2	30	1.7	42	0.99	14	1.2	17	1.7	24
10	20	0.94	32	1.7	55	2.3	72	0.91	26	1.7	46	2.3	60	0.96	15	1.7	25	2.3	33
15	25	0.74	40	2.2	87	2.7	110	0.82	29	2.2	63	2.7	80	0.92	15	2.2	33	2.7	41
20	30	0.46	65	2.6	167	3.2	207	0.70	34	2.6	88	3.2	109	0.77	18	2.6	47	3.2	58
25	35	0.13	239	3.0	716	3.7	875	0.59	41	3.0	122	3.7	149	0.53	26	3.0	79	3.7	96
30	41	0.13	239	3.5	837	4.2	1008	0.47	50	3.5	177	4.2	213	0.30	47	3.5	164	4.2	198

Adak to Sanak Reef		Alert						Barentshav						Purpose Designed Rescue Tug					
523 Nmi		speed =	16	Tanker		Container Ship		speed =	20	Tanker		Container Ship		speed =	34	Tanker		Container Ship	
wave height (ft)	wind speed (kt)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)
0	0	1.00	33	0.0	1	0.4	13	1.00	26	0.0	1	0.4	10	1.00	15	0.0	1	0.4	6
5	14	1.00	33	1.2	40	1.7	56	0.98	27	1.2	33	1.7	46	0.99	15	1.2	19	1.7	26
10	20	0.94	35	1.7	60	2.3	79	0.91	29	1.7	50	2.3	65	0.96	16	1.7	28	2.3	36
15	25	0.74	44	2.2	95	2.7	121	0.82	32	2.2	69	2.7	87	0.92	17	2.2	36	2.7	45
20	30	0.46	71	2.6	183	3.2	227	0.70	37	2.6	96	3.2	119	0.77	20	2.6	52	3.2	64
25	35	0.13	262	3.0	785	3.7	959	0.59	44	3.0	134	3.7	163	0.53	29	3.0	86	3.7	105
30	41	0.13	262	3.5	918	4.2	1106	0.47	55	3.5	194	4.2	233	0.30	51	3.5	180	4.2	217

DH to Attu		Alert						Barentshav						Purpose Designed Rescue Tug					
732 Nmi		speed =	16	Tanker		Container Ship		speed =	20	Tanker		Container Ship		speed =	34	Tanker		Container Ship	
wave height (ft)	wind speed (kt)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)
0	0	1.00	49	0.0	2	0.4	19	1.00	40	0.0	2	0.4	16	1.00	25	0.0	1	0.4	10
5	14	1.00	49	1.2	60	1.7	83	0.98	40	1.2	50	1.7	69	0.99	25	1.2	30	1.7	42
10	20	0.94	52	1.7	90	2.3	117	0.91	43	1.7	75	2.3	98	0.96	25	1.7	44	2.3	58
15	25	0.74	65	2.2	140	2.7	177	0.82	48	2.2	103	2.7	131	0.92	26	2.2	57	2.7	72
20	30	0.46	102	2.6	264	3.2	327	0.70	55	2.6	142	3.2	176	0.77	31	2.6	80	3.2	99
25	35	0.13	369	3.0	1108	3.7	1353	0.59	65	3.0	196	3.7	239	0.53	43	3.0	130	3.7	159
30	41	0.13	369	3.5	1296	4.2	1560	0.47	80	3.5	282	4.2	339	0.30	75	3.5	262	4.2	316

DH to Adak		Alert						Barentshav						Purpose Designed Rescue Tug					
383 Nmi		speed =	16	Tanker		Container Ship		speed =	20	Tanker		Container Ship		speed =	34	Tanker		Container Ship	
wave height (ft)	wind speed (kt)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)
0	0	1.00	27	0.0	1	0.4	11	1.00	22	0.0	1	0.4	9	1.00	14	0.0	1	0.4	6
5	14	1.00	27	1.2	33	1.7	46	0.98	23	1.2	28	1.7	39	0.99	14	1.2	18	1.7	24
10	20	0.94	28	1.7	49	2.3	64	0.91	24	1.7	42	2.3	55	0.96	15	1.7	26	2.3	33
15	25	0.74	35	2.2	76	2.7	96	0.82	26	2.2	57	2.7	72	0.92	15	2.2	33	2.7	41
20	30	0.46	55	2.6	142	3.2	176	0.70	30	2.6	78	3.2	97	0.77	18	2.6	46	3.2	56
25	35	0.13	195	3.0	584	3.7	713	0.59	36	3.0	107	3.7	130	0.53	24	3.0	72	3.7	88
30	41	0.13	195	3.5	683	4.2	822	0.47	43	3.5	153	4.2	184	0.30	41	3.5	142	4.2	171

DH to Amilia		Alert						Barentshav						Purpose Designed Rescue Tug					
283 Nmi		speed =	16	Tanker		Container Ship		speed =	20	Tanker		Container Ship		speed =	34	Tanker		Container Ship	
wave height (ft)	wind speed (kt)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)
0	0	1.00	21	0.0	1	0.4	8	1.00	17	0.0	1	0.4	7	1.00	11	0.0	0	0.4	4
5	14	1.00	21	1.2	25	1.7	35	0.98	17	1.2	21	1.7	30	0.99	11	1.2	14	1.7	19
10	20	0.94	22	1.7	38	2.3	49	0.91	19	1.7	32	2.3	42	0.96	12	1.7	20	2.3	26
15	25	0.74	27	2.2	58	2.7	73	0.82	20	2.2	44	2.7	56	0.92	12	2.2	26	2.7	33
20	30	0.46	41	2.6	107	3.2	132	0.70	23	2.6	60	3.2	74	0.77	14	2.6	36	3.2	44
25	35	0.13	145	3.0	434	3.7	530	0.59	27	3.0	81	3.7	99	0.53	19	3.0	56	3.7	68
30	41	0.13	145	3.5	507	4.2	611	0.47	33	3.5	115	4.2	139	0.30	31	3.5	108	4.2	130

DH to Unimak Pass		Alert						Barentshav						Purpose Designed Rescue Tug					
60 Nmi		speed =	16	Tanker		Container Ship		speed =	20	Tanker		Container Ship		speed =	34	Tanker		Container Ship	
wave height (ft)	wind speed (kt)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)
0	0	1.00	7	0.0	0	0.4	3	1.00	6	0.0	0	0.4	2	1.00	5	0.0	0	0.4	2
5	14	1.00	7	1.2	8	1.7	11	0.98	6	1.2	7	1.7	10	0.99	5	1.2	6	1.7	8
10	20	0.94	7	1.7	12	2.3	16	0.91	6	1.7	11	2.3	14	0.96	5	1.7	8	2.3	11
15	25	0.74	8	2.2	17	2.7	22	0.82	7	2.2	14	2.7	18	0.92	5	2.2	11	2.7	13
20	30	0.46	11	2.6	29	3.2	36	0.70	7	2.6	19	3.2	23	0.77	5	2.6	14	3.2	17
25	35	0.13	33	3.0	99	3.7	121	0.59	8	3.0	24	3.7	30	0.53	6	3.0	19	3.7	23
30	41	0.13	33	3.5	116	4.2	140	0.47	9	3.5	33	4.2	39	0.30	9	3.5	31	4.2	38

DH to Urilia Bay		Alert						Barentshav						Purpose Designed Rescue Tug					
100 Nmi		speed =	16	Tanker		Container Ship		speed =	20	Tanker		Container Ship		speed =	34	Tanker		Container Ship	
wave height (ft)	wind speed (kt)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)
0	0	1.00	9	0.0	0	0.4	4	1.00	8	0.0	0	0.4	3	1.00	6	0.0	0	0.4	2
5	14	1.00	9	1.2	11	1.7	16	0.98	8	1.2	10	1.7	14	0.99	6	1.2	7	1.7	10
10	20	0.94	10	1.7	17	2.3	22	0.91	9	1.7	15	2.3	19	0.96	6	1.7	11	2.3	14
15	25	0.74	11	2.2	25	2.7	31	0.82	9	2.2	20	2.7	25	0.92	6	2.2	13	2.7	17
20	30	0.46	17	2.6	43	3.2	53	0.70	10	2.6	26	3.2	32	0.77	7	2.6	18	3.2	22
25	35	0.13	53	3.0	159	3.7	194	0.59	12	3.0	35	3.7	42	0.53	9	3.0	26	3.7	31
30	41	0.13	53	3.5	186	4.2	224	0.47	14	3.5	48	4.2	57	0.30	13	3.5	45	4.2	54

DH to Sanak Reef		Alert						Barentshav						Purpose Designed Rescue Tug					
139 Nmi		speed =	16	Tanker		Container Ship		speed =	20	Tanker		Container Ship		speed =	34	Tanker		Container Ship	
wave height (ft)	wind speed (kt)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)	speed factor	travel time (hours)	drifting speed (kt)	drift dist (Nmi)	drifting speed (kt)	drift dist (Nmi)
0	0	1.00	12	0.0	0	0.4	5	1.00	10	0.0	0	0.4	4	1.00	7	0.0	0	0.4	3
5	14	1.00	12	1.2	14	1.7	20	0.98	10	1.2	12	1.7	17	0.99	7	1.2	9	1.7	12
10	20	0.94	12	1.7	21	2.3	28	0.91	11	1.7	18	2.3	24	0.96	7	1.7	13	2.3	16
15	25	0.74	15	2.2	32	2.7	40	0.82	12	2.2	25	2.7	31	0.92	7	2.2	16	2.7	20
20	30	0.46	22	2.6	56	3.2	70	0.70	13	2.6	33	3.2	41	0.77	8	2.6	21	3.2	27
25	35	0.13	73	3.0	218	3.7	266	0.59	15	3.0	45	3.7	54	0.53	11	3.0	32	3.7	39
30	41	0.13	73	3.5	255	4.2	307	0.47	18	3.5	62	4.2	75	0.30	17	3.5	58	4.2	70

Appendix B Risk Area Calculations

NET AREAS

Adak to Attu 394 Nmi		*Alert*		*Barentshav*		*Purpose Designed Tug*	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height (ft)	wind speed (kt)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	413	3973	330	3154	194	1833
5	14	13336	19288	10717	15397	5961	8449
10	20	21138	28888	17068	23170	8948	11957
15	25	36349	48750	24743	32762	11804	15334
20	30	84159	113216	36731	47984	17688	22636
25	35	783012	1104204	55545	72100	32302	41231
30	41	1023991	1417729	91068	117896	82297	106195

Adak to DH 383 Nmi		*Alert*		*Barentshav*		*Purpose Designed Tug*	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height (ft)	wind speed (kt)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	402	3858	321	3064	189	1781
5	14	12925	18675	10391	14917	5785	8196
10	20	20460	27931	16531	22420	8680	11591
15	25	35115	47038	23937	31663	11443	14855
20	30	81000	108810	35482	46301	17130	21905
25	35	746227	1051133	53563	69444	31220	39810
30	41	975008	1348578	87616	113286	79216	102094

Adak to Amilia 102 Nmi		*Alert*		*Barentshav*		*Purpose Designed Tug*	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height (ft)	wind speed (kt)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	107	1000	85	798	50	468
5	14	3177	4463	2590	3630	1481	2068
10	20	4850	6419	3991	5270	2184	2870
15	25	7859	10134	5590	7174	2835	3616
20	30	16061	20507	7931	9997	4124	5160
25	35	97204	128609	11329	14118	7086	8771
30	41	120914	157976	17146	21198	15765	19459

Adak to Unimak Pass 443 Nmi		*Alert*		*Barentshav*		*Purpose Designed Tug*	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height (ft)	wind speed (kt)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	465	4487	371	3560	218	2065
5	14	15195	22073	12184	17572	6747	9586
10	20	24220	33253	19502	26583	10158	13609
15	25	42000	56626	28415	37789	13433	17498
20	30	98799	133711	42448	55719	20220	25961
25	35	957284	1356136	64677	84381	37250	47746
30	41	1256420	1746405	107080	139353	96570	125256

Adak to Urilia Bay 477 Nmi		*Alert*		*Barentshav*		*Purpose Designed Tug*	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height (ft)	wind speed (kt)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	501	4847	400	3843	235	2227
5	14	16511	24056	13220	19114	7298	10387
10	20	26418	36382	21232	29020	11009	14776
15	25	46069	62326	31039	41401	14584	19033
20	30	109501	148767	46565	61316	22020	28334
25	35	1088204	1545845	71302	93333	40805	52446
30	41	1431359	1994273	118800	155126	106999	139244

Adak to Sanak Reef 523 Nmi		*Alert*		*Barentshav*		*Purpose Designed Tug*	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height (ft)	wind speed (kt)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	728	7000	582	5558	342	3229
5	14	23499	33986	18883	27130	10503	14887
10	20	37246	50901	30074	40826	15767	21069
15	25	64048	85899	43598	57728	20799	27018
20	30	148290	199488	64720	84548	31167	39884
25	35	1379682	1945630	97872	127042	56917	72650
30	41	1804293	2498068	160464	207735	145010	187117

AREAS

Adak to Attu 394 Nmi		*Alert*		*Barentshav*		*Purpose Designed Tug*	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height	wind speed	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	3	296	2	189	1	66
5	14	2867	5526	1925	3711	643	1240
10	20	6482	11047	4457	7595	1380	2352
15	25	16168	25922	8499	13627	2298	3684
20	30	59695	91759	16446	25280	4747	7296
25	35	1099787	1639204	31805	47404	13311	19840
30	41	1502948	2179168	67032	97191	57753	83738

Adak to DH 383 Nmi		*Alert*		*Barentshav*		*Purpose Designed Tug*	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height	wind speed	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	3	280	2	179	1	62
5	14	2709	5222	1819	3507	608	1172
10	20	6125	10439	4211	7177	1304	2223
15	25	15278	24495	8031	12876	2171	3481
20	30	56409	86707	15541	23888	4485	6894
25	35	1039235	1548953	30053	44794	12578	18748
30	41	1420199	2059187	63341	91840	54574	79128

Adak to Amilia 102 Nmi		*Alert*		*Barentshav*		*Purpose Designed Tug*	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height	wind speed	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	0	20	0	13	0	4
5	14	192	370	129	249	43	83
10	20	434	740	299	509	93	158
15	25	1084	1737	570	913	154	247
20	30	4001	6150	1102	1694	318	489
25	35	73708	109860	2132	3177	892	1330
30	41	100728	146049	4493	6514	3871	5612

Adak to Unimak Pass 443 Nmi		*Alert*		*Barentshav*		*Purpose Designed Tug*	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height	wind speed	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	4	374	3	240	1	83
5	14	3625	6986	2434	4692	813	1568
10	20	8195	13966	5634	9602	1745	2974
15	25	20440	32771	10745	17227	2905	4657
20	30	75467	116002	20792	31959	6001	9224
25	35	1390349	2072278	40207	59928	16828	25082
30	41	1900024	2754899	84741	122869	73012	105862

Adak to Urilia Bay 477 Nmi		*Alert*		*Barentshav*		*Purpose Designed Tug*	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height	wind speed	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	5	434	3	278	1	96
5	14	4202	8100	2822	5439	943	1818
10	20	9501	16192	6532	11132	2023	3448
15	25	23698	37994	12458	19973	3368	5399
20	30	87496	134491	24105	37053	6957	10694
25	35	1611955	2402577	46616	69480	19510	29080
30	41	2202867	3194000	98248	142453	84649	122735

Adak to Sanak Reef 523 Nmi		*Alert*		*Barentshav*		*Purpose Designed Tug*	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height	wind speed	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	6	522	4	334	1	116
5	14	5052	9737	3393	6539	1134	2185
10	20	11422	19465	7853	13383	2432	4145
15	25	28489	45675	14976	24011	4048	6491
20	30	105185	161682	28979	44544	8364	12856
25	35	1937848	2888311	56040	83527	23455	34959
30	41	2648225	3839738	118111	171253	101763	147549

NET AREAS

DH to Attu 732 Nmi		Alert		Barentshav		Purpose Designed Tug	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height (ft)	wind speed (kt)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	1520	14647	1233	11810	763	7225
5	14	49397	71608	40238	57952	23597	33536
10	20	78193	107106	63908	86969	35375	47401
15	25	132980	178720	92173	122339	46569	60668
20	30	302479	407527	135812	177819	68571	88000
25	35	2740539	3865971	203738	264995	121643	155660
30	41	3584889	4964730	331202	429496	300284	388172

DH to Adak 383 Nmi		Alert		Barentshav		Purpose Designed Tug	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height (ft)	wind speed (kt)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	838	7950	689	6511	443	4166
5	14	25906	36891	21519	30527	13364	18815
10	20	39958	53690	33356	44640	19751	26194
15	25	64907	85261	46858	61054	25667	33068
20	30	135310	177141	66726	85574	36581	46321
25	35	963632	1320975	96113	122172	61121	76833
30	41	1232397	1664019	148193	187426	136010	171596

DH to Amilia 283 Nmi		Alert		Barentshav		Purpose Designed Tug	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height (ft)	wind speed (kt)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	643	6074	533	5021	352	3299
5	14	19590	27742	16434	23206	10525	14777
10	20	29940	39982	25246	33609	15474	20458
15	25	47741	62230	35103	45465	20010	25692
20	30	96044	124398	49309	62799	28101	35434
25	35	613539	828809	69875	88105	45705	57116
30	41	775685	1033405	105449	132120	97293	121650

DH to Unimak Pass 60 Nmi		Alert		Barentshav		Purpose Designed Tug	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height (ft)	wind speed (kt)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	210	1959	186	1740	148	1380
5	14	6169	8623	5541	7740	4343	6059
10	20	9103	11976	8195	10773	6256	8211
15	25	13210	16887	10861	13862	7928	10098
20	30	22329	28070	14285	17875	10293	12848
25	35	87980	111571	18741	23131	14414	17749
30	41	105898	132699	25681	31338	24351	29698

DH to Urilia Bay 100 Nmi		Alert		Barentshav		Purpose Designed Tug	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height (ft)	wind speed (kt)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	287	2690	248	2324	184	1723
5	14	8509	11922	7449	10426	5437	7594
10	20	12688	16739	11149	14691	7877	10352
15	25	19023	24409	15009	19209	10041	12809
20	30	34144	43185	20179	25337	13375	16727
25	35	156321	201576	27163	33668	19713	24342
30	41	190605	242882	38408	47124	36073	44217

DH to Sanak Reef 139 Nmi		Alert		Barentshav		Purpose Designed Tug	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height (ft)	wind speed (kt)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	69	674	59	569	42	401
5	14	2316	3389	1968	2862	1333	1915
10	20	3659	5058	3107	4271	2000	2711
15	25	6004	8137	4418	5920	2629	3464
20	30	12827	17388	6362	8405	3705	4809
25	35	104744	147957	9298	12190	6050	7820
30	41	137161	190177	14678	19162	13464	17528

INDIVIDUAL AREAS

DH to Attu 732 Nmi		Alert		Barentshav		Purpose Designed Tug	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height (ft)	wind speed (kt)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	13	1160	9	766	3	294
5	14	11237	21659	7752	14942	2878	5548
10	20	25218	42978	17755	30259	6122	10434
15	25	61359	98375	33398	53546	10106	16202
20	30	218694	336160	63494	97598	20085	30872
25	35	3858593	5751132	120617	179776	53048	79066
30	41	5273079	7645589	249681	362019	216365	313714

DH to Adak 383 Nmi		Alert		Barentshav		Purpose Designed Tug	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height (ft)	wind speed (kt)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	4	354	3	240	1	99
5	14	3431	6613	2418	4661	972	1874
10	20	7654	13044	5493	9362	2055	3503
15	25	18246	29252	10219	16384	3372	5406
20	30	63115	97015	19150	29436	6511	10009
25	35	1072051	1597864	35846	53427	16416	24467
30	41	1465044	2124210	73087	105971	63645	92280

DH to Amilia 283 Nmi		Alert		Barentshav		Purpose Designed Tug	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height (ft)	wind speed (kt)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	2	209	2	144	1	63
5	14	2024	3900	1447	2789	612	1180
10	20	4496	7662	3269	5571	1289	2197
15	25	10569	16944	6036	9677	2107	3378
20	30	35802	55032	11201	17217	3995	6141
25	35	591714	881934	20755	30935	9769	14561
30	41	808625	1172449	41875	60716	36590	53053

DH to Unimak Pass 60 Nmi		Alert		Barentshav		Purpose Designed Tug	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height (ft)	wind speed (kt)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	0	22	0	18	0	11
5	14	215	415	174	336	108	208
10	20	462	787	376	641	221	377
15	25	951	1524	651	1043	352	565
20	30	2594	3987	1106	1699	586	901
25	35	30861	45997	1860	2772	1125	1677
30	41	42173	61149	3375	4894	3054	4429

DH to Urilia Bay 100 Nmi		Alert		Barentshav		Purpose Designed Tug	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height (ft)	wind speed (kt)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	0	42	0	31	0	17
5	14	405	780	312	601	168	324
10	20	880	1499	685	1167	348	593
15	25	1914	3068	1216	1950	559	896
20	30	5735	8816	2141	3291	974	1497
25	35	79603	118646	3750	5589	2048	3052
30	41	108784	157728	7120	10324	6346	9202

DH to Sanak Reef 139 Nmi		Alert		Barentshav		Purpose Designed Tug	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height (ft)	wind speed (kt)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	1	67	1	48	0	25
5	14	646	1245	484	933	239	461
10	20	1416	2413	1074	1831	499	850
15	25	3173	5087	1936	3103	806	1292
20	30	9983	15346	3477	5344	1446	2223
25	35	148954	222012	6223	9275	3212	4787
30	41	203558	295144	12102	17547	10702	15518

NET AREAS

Net Areas Dutch Harbor		*Alert*		*Barentshav*		*Purpose Designed Tug*	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height (ft)	wind speed (kt)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	1589	15321	1292	12379	805	7626
5	14	51713	74997	42205	60815	24930	35451
10	20	81852	112165	67015	91240	37375	50112
15	25	138984	186857	96592	128259	49197	64133
20	30	315307	424915	142174	186224	72276	92809
25	35	2845283	4013928	213036	277185	127694	163479
30	41	3722050	5154907	345880	448657	313748	405700

Net Areas Dutch & Adak		*Alert*		*Barentshav*		*Purpose Designed Tug*	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height (ft)	wind speed (kt)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	901	8621	734	6979	458	4316
5	14	28605	41123	23444	33523	13976	19772
10	20	44776	60791	36853	49761	20824	27765
15	25	74807	99518	52590	69210	27266	35331
20	30	164642	219174	76456	99176	39684	50605
25	35	1369571	1912649	112900	145377	68913	87467
30	41	1777350	2439916	179843	230771	163767	209521

Net Areas Adak		*Alert*		*Barentshav*		*Purpose Designed Tug*	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height (ft)	wind speed (kt)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	1140.957	10972.52	912.0088	8712.603	535.74258	5061.68646
5	14	36835.11	53273.9	29599.61	42527.47	16463.078	23335.2296
10	20	58384.12	79788.3	47141.67	63996.12	24715.644	33025.5176
15	25	100397.8	134649.8	68340.98	90489.69	32603.007	42351.4519
20	30	232449.6	312703.6	101450.5	132532	48855.079	62519.8458
25	35	2162694	3049834	153417.1	199141.7	89219.719	113880.379
30	41	2828284	3915798	251532	325631.2	227307.31	293311.966

AGGREGATE AREAS

Aggregate Areas Dutch Harbor		*Alert*		*Barentshav*		*Purpose Designed Tug*	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height (ft)	wind speed (kt)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	21	1854	14	1246	6	509
5	14	17957	34612	12588	24263	4978	9595
10	20	40125	68383	28652	48830	10535	17954
15	25	96211	154251	53456	85704	17301	27738
20	30	335923	516356	100569	154586	33597	51643
25	35	5781775	8617586	189050	281774	85617	127611
30	41	7901263	11456268	387240	561471	336703	488195

Aggregate Areas Dutch & Adak		*Alert*		*Barentshav*		*Purpose Designed Tug*	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height (ft)	wind speed (kt)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	8	726	6	478	2	185
5	14	7034	13559	4844	9337	1810	3489
10	20	15799	26925	11101	18919	3845	6552
15	25	38568	61834	20903	33513	6339	10164
20	30	138418	212765	39813	61197	12556	19300
25	35	2472148	3684672	75822	113011	33166	49434
30	41	3378390	4898425	157463	228310	136301	197626

Aggregate Areas Adak		*Alert*		*Barentshav*		*Purpose Designed Tug*	
		Tanker	Container	Tanker	Container	Tanker	Container
wave height (ft)	wind speed (kt)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)	Area (Nmi^2)
0	0	22.27442	1925.342	14.25563	1232.219	4.932744	426.3734
5	14	18647.57	35942.31	12522.51	24136.54	4185.0522	8066.4907
10	20	42159.44	71849.84	28984.85	49397.18	8976.5813	15298.259
15	25	105156.5	168593.5	55278.85	88626.51	14943.585	23958.491
20	30	388252.2	596791.5	106965.4	164419	30871.376	47453.113
25	35	7152882	10661185	206853	308309	86575.013	129037.81
30	41	9774991	14173041	435966.9	632120.9	375621.18	544623.95