

**ENVIRONMENTAL SENSITIVITIES
EMRAS WORKING GROUP 8
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**COASTAL MARINE REGIONS
PRELIMINARY RESULTS**

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1. Preliminary scenarios

A single deposition of 1000 Bq/m² for radionuclides ¹³⁷Cs, ⁹⁰Sr, ¹³¹I and ²³⁹Pu and for all marine regions has been chosen for this exercise.

Radionuclide concentrations have been calculated to sea water (unfiltered and filtered), fish, molluscs, crustaceans and seaweeds.

Radiation doses have been calculated to adult, to 10-year old and one-year old children during the 1st year, 2nd year and 10th year after releases of radionuclides.

2. Coastal regions

The marine regions chosen for the present calculations are shown in Table 1 and Figure 1.

Table1. The coastal regions.

Name	Volume, m³	Depth, m	Surface area, m²
Irish Sea: Cumbrian Waters	3,80E+10	2,80E+01	1,36E+09
English Channel: Lyme Bay	2,01E+11	3,95E+01	5,09E+09
North Sea: Norwegian Current Surface	9,20E+12	1,56E+02	5,90E+10
Skagerrak	6,78E+12	2,10E+02	3,23E+10
Baltic Sea: Gulf of Riga	4,05E+11	2,30E+01	1,76E+10
Kara Sea: Ob Bay	3,19E+11	1,10E+01	2,90E+10

The regions were chosen with regards to different seas and conditions. All regions are used for the seafood production. Present calculations of doses to man were provided for all regions on the basis of habit data for radiological assessment (Smith & Jones, 2003).

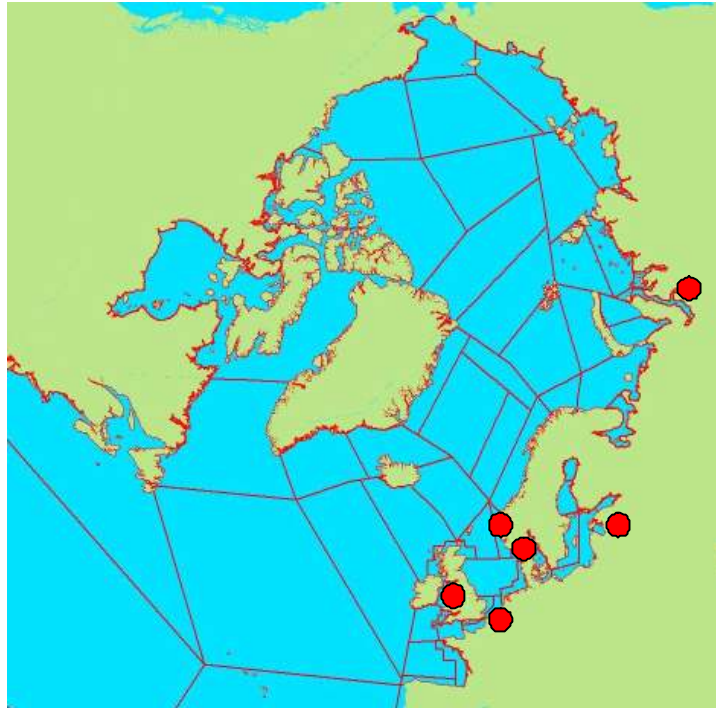


Figure 1. The coastal regions.

3. Brief description of the NRPA box model

The box model developed at NRPA uses a modified approach for compartmental modelling (Iosjpe et al., 2002) which allows for dispersion of radionuclides over time. The box structures for surface, mid-depth and deep water layers have been developed based on description of polar, Atlantic and deep waters in the Arctic Ocean and the Northern Seas and site-specific information for the boxes (Karcher and Harms, 2000) generated from the 3D hydrodynamic model NAOSIM. The volume of the three water layers in each box has been calculated using detailed bathymetry together with a GIS. The box model includes the processes of advection of radioactivity between compartments, sedimentation, diffusion of radioactivity through pore water in sediments, resuspension, particle mixing including mixing due to bioturbation and a burial process of radioactivity in deep sediment layers. Radioactive decay is calculated for all compartments. The contamination of marine organisms is further calculated from the radionuclide concentrations in filtered seawater in the different water regions. Doses to man are calculated on the basis from seafood consumptions.

Table 2 shows the range between parameters *SSL* (suspended sediment load) and *SR* (the mass sedimentation rate) for the chosen marine regions

Table2. The *SSL* (suspended sediment load) and *SR* (the mass sedimentation rate) parameters.

Name	SSL t/m ³	SR, t/m ² /y
Irish Sea: Cumbrian Waters	1,0E-05	6,0E-03
English Channel: Lyme Bay	3,0E-06	1,0E-04
North Sea: Norwegian Current		
Surface	6,6E-06	1,0E-04
Skagerrak	1,0E-06	5,0E-03
Baltic Sea: Gulf of Riga	1,0E-06	5,0E-04
Kara Sea: Ob Bay	5,0E-05	1,0E-03

Table 3 shows the range the sediment concentration factor (k_d) for the chosen radionuclides (IAEA, 2004).

Table 3. Sediment concentration factor (k_d)

Radionuclide	k_d
Cs-137	4000
Sr-90	8
I-131	70
Pu-239	10000

Assumptions about seafood consumption are shown in Table 4 based on Smith & Jones (2003) investigations.

Table 4. Seafood consumption for different age groups (kg per year).

	Group 1 (adult)	Group 2 (child)	Group 3 (infant)
Fish	51	10.2	2.5
Crustacean	17	2.25	0
Molluscs	14	3.5	0
Seaweeds	5	0	0

Dose coefficients for ingestion intake are shown in Table 5.

Table 5. Dose coefficients (Sv/Bq) (ICRP, 1996)

	Cs-137	Sr-90	I-131	Pu-239
1-year	1.20E-08	7.30E-08	1.80E-07	4.20E-07
10-year	1.00E-08	6.00E-08	5.20E-08	2.70E-07
Adult	1.30E-08	2.80E-08	2.20E-08	2.50E-07

Concentration factors for seafood for actual radionuclides are shown in Table 6.

Table 6. Concentration factors (IAEA, 2004)

	Cs-137	Sr-90	I-131	Pu-239
Fish	1E+2	3E+0	9E+0	1E+2
Crustacean	5E+1	5E+0	3E+0	2E+2
Molluscs	6E+1	1E+1	1E+1	3E+3
Seaweeds	5E+1	1E+1	1E+4	4E+3

4. Brief description of the results.

Figures 2-5 show the dose impact from seafood to adult persons for different radionuclides. Calculation correspond to single deposition to the Cumbrian Waters (the Irish Sea)

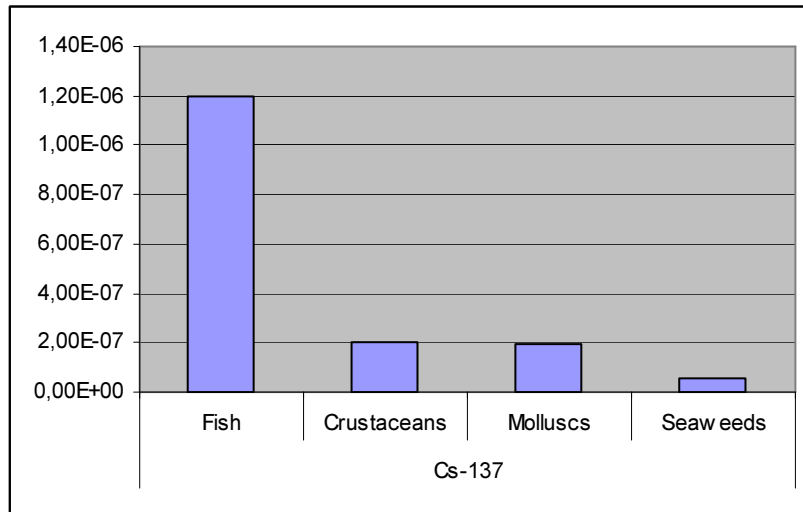


Figure 2. Dose impact from seafood for ^{137}Cs , Sv/y

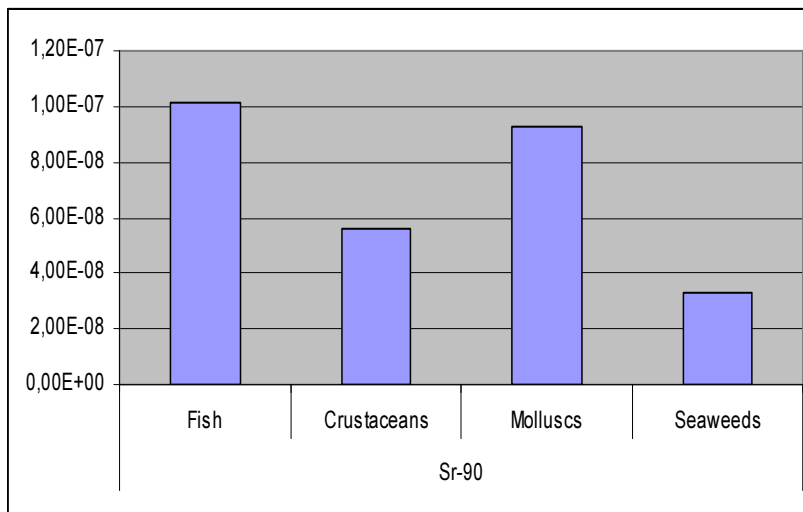


Figure 3. Dose impact from seafood for ^{90}Sr , Sv/y

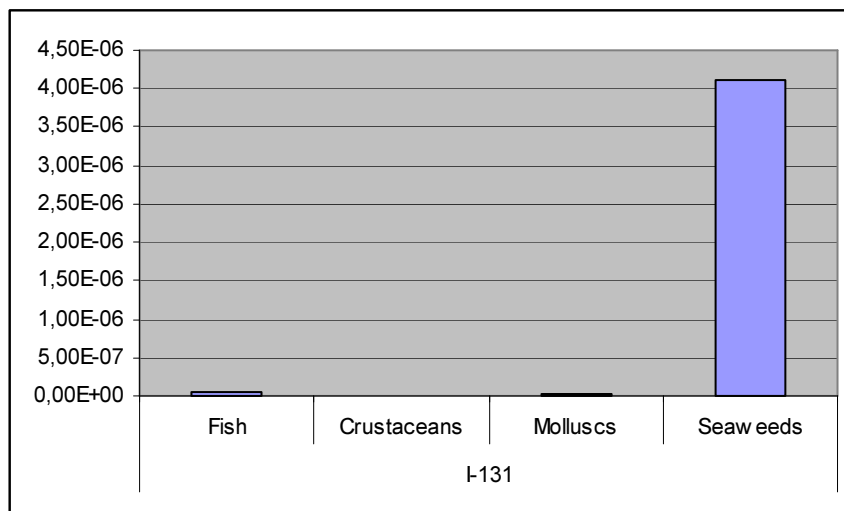


Figure 4. Dose impact from seafood for ^{131}I , Sv/y

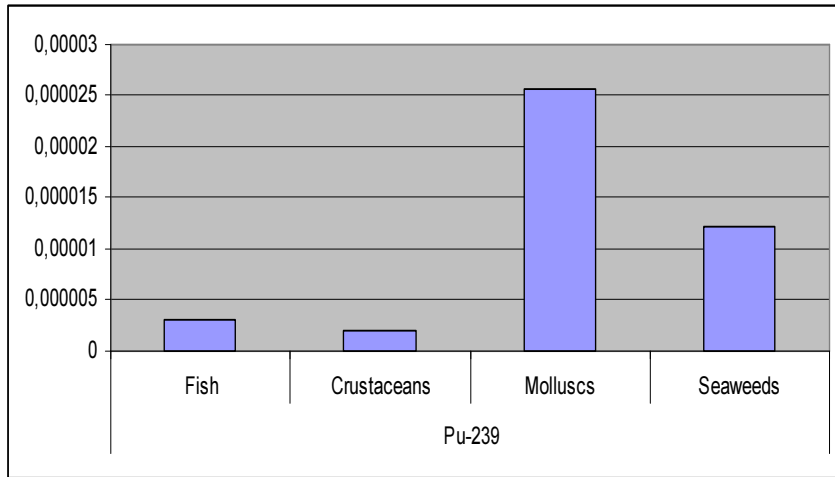


Figure 5. Dose impact from seafood for ^{239}Pu , Sv/y

Figures 6-9 shows doses some doses for adults during the first, second and tenth year after deposition for different radionuclides and marine regions.

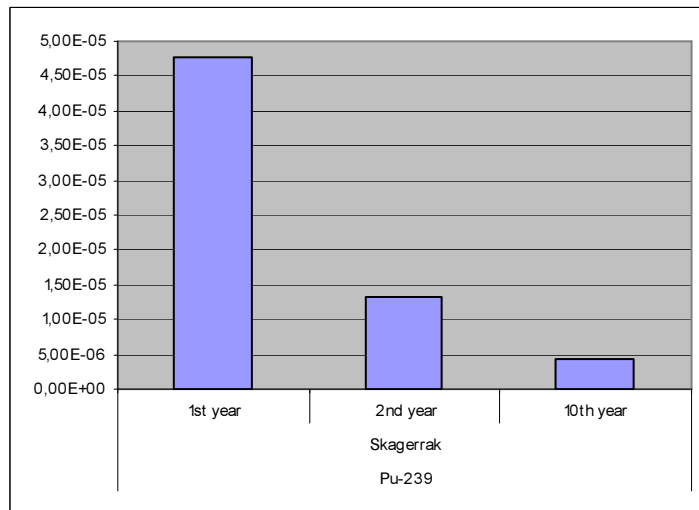


Figure 6. Doses from impact of ^{239}Pu into Skagerrak for adult for different years.

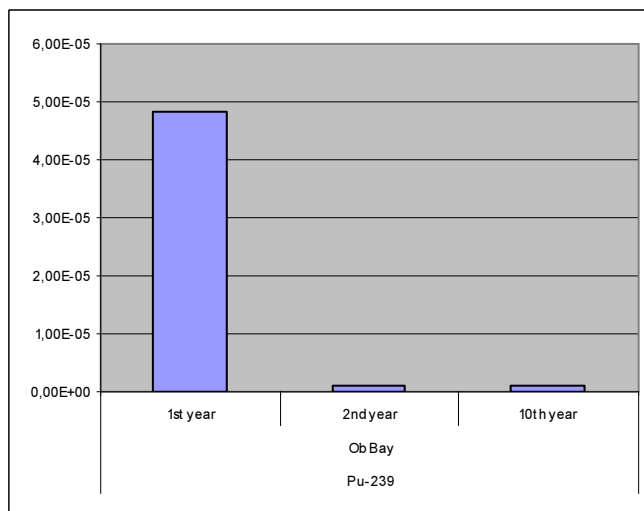


Figure 7. Doses from impact of ^{239}Pu into the Ob Bay for adult for different years.

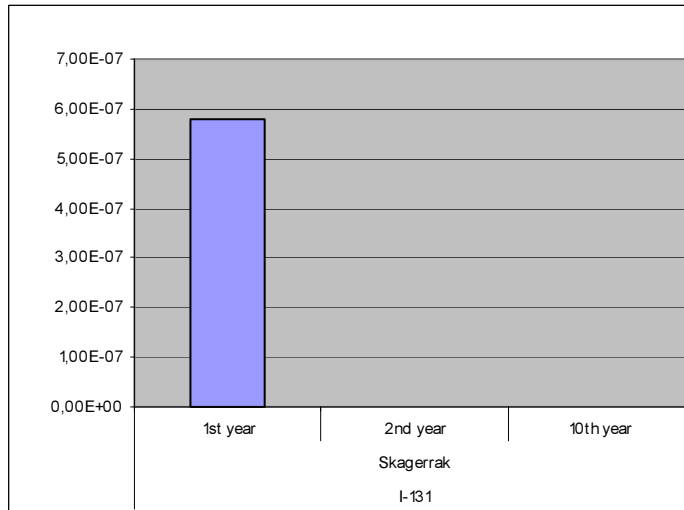


Figure 8. Doses from impact of ^{131}I into Skagerrak for adult for different years.

Figure 9 compares doses to adult and children (10 and 1 year old) for different radionuclides (Cumbrian Waters, first year after deposition).

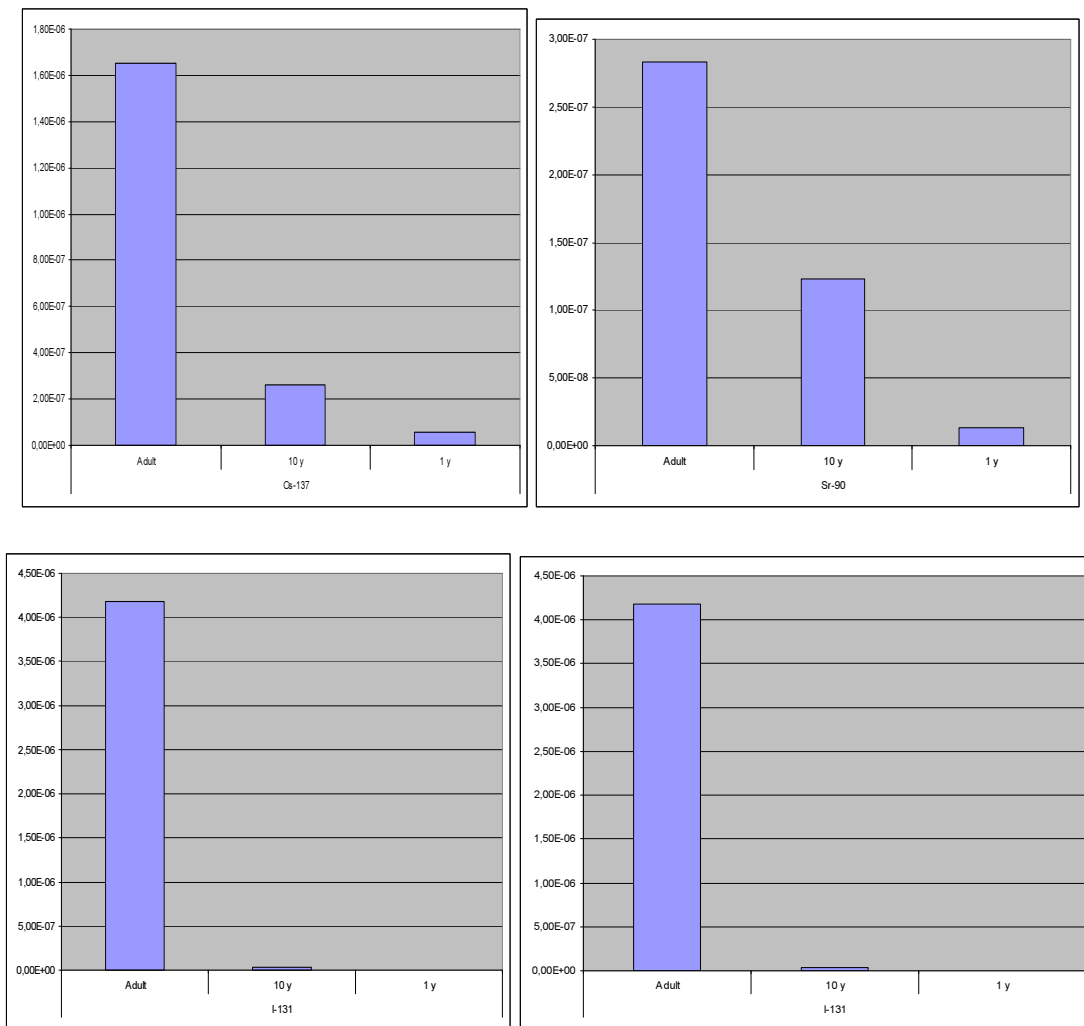


Figure 9. Doses comparison for different age groups.

Impact of radionuclides to different age groups is shown in Figures 10-12.

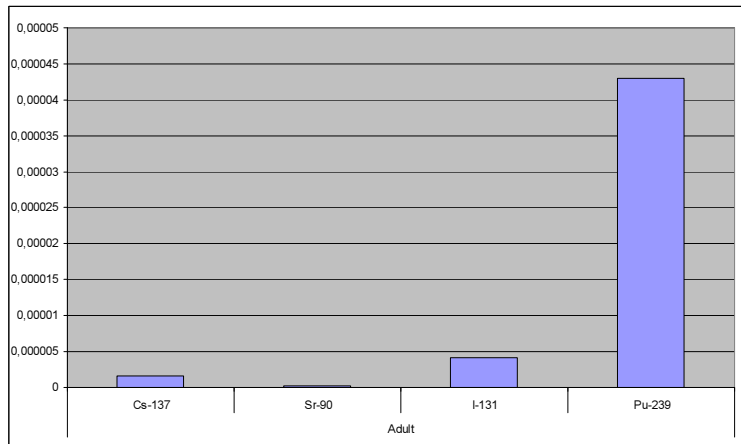


Figure 10. Radionuclides impact to adult

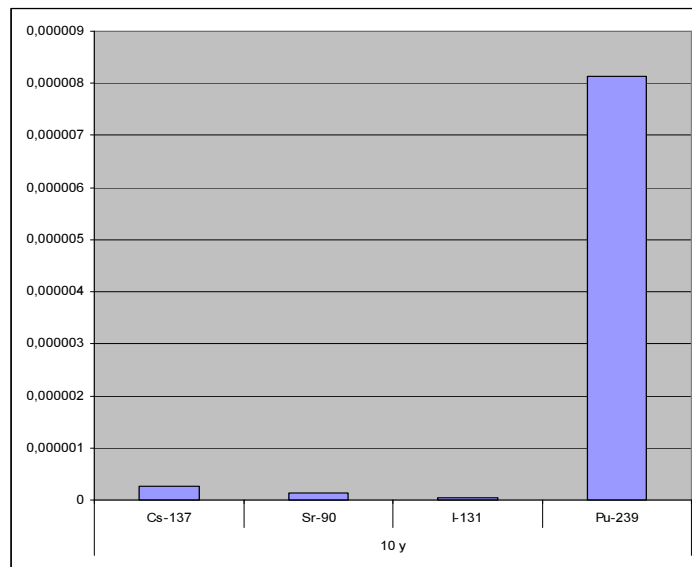


Figure 11. Radionuclides impact to 10-year old

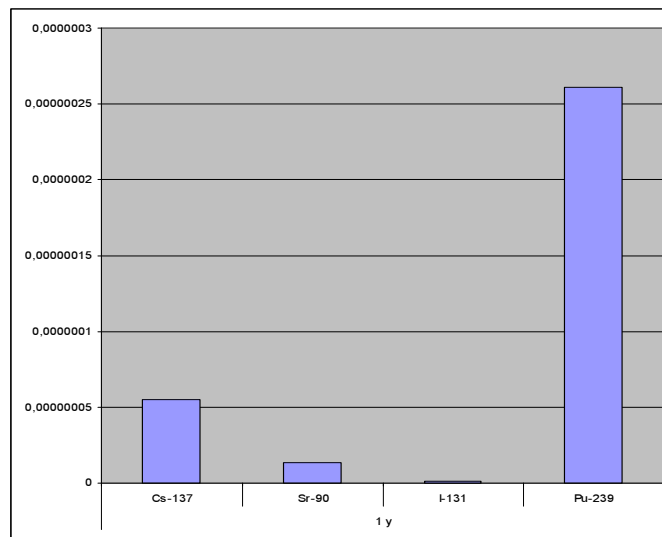


Figure 12. Radionuclides impact to 1-year old

Results for dose calculations during the first year are shown in Table 7.

Table 7. Doses to man during the first year, Sv/y.

	Cs-137			Sr-90			I-131			Pu-239		
	Adult	10 y	1 y	Adult	10 y	1 y	Adult	10 y	1 y	Adult	10 y	1 y
Irish Sea: Cumbrian Waters	1.65E-6	2.60E-7	5.52E-8	2.83E-7	1.23E-7	1.32E-8	4.2E-6	3.79E-8	1.47E-9	4.30E-5	8.1E-6	2.61E-7
English Channel: Lyme Bay	9.45E-7	1.49E-7	7.62E-9	1.32E-7	5.72E-8	6.13E-9	2.9E-6	2.40E-8	9.27E-10	6.75E-5	1.3E-5	4.10E-7
North Sea: Norwegian Current Surface	6.16E-7	9.70E-8	2.06E-8	8.72E-8	3.79E-8	4.07E-9	7.6E-7	7.20E-9	2.80E-10	1.23E-5	2.3E-6	7.49E-8
Skagerrak	8.77E-7	1.38E-7	2.93E-8	1.28E-7	5.55E-8	5.95E-9	5.8E-7	6.45E-9	2.53E-10	4.76E-5	9.0E-6	2.89E-7
Baltic Sea: Gulf of Riga	2.58E-6	4.06E-7	8.62E-8	4.22E-7	1.84E-7	1.98E-8	5.1E-6	4.54E-8	1.76E-9		1.8E-5	5.67E-7
Kara Sea: Ob Bay	2.86E-6	4.51E-7	9.57E-8	5.09E-7	2.21E-7	2.37E-8	1.1E-5	9.07E-8	5.27E-8	4.83E-5	9.1E-6	2.93E-7

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