Conference or Workshop Item

Beresford, N.A.; **Barnett, C.L.**; **Howard, D.C.**; Toner, M.; Dale, P.; Jenkinson, S.. 2011

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[Lecture] In: *Radioecology & Environmental Radioactivity - Environment & Nuclear Renaissance, Hamilton, Ontario, Canada, 19-24 June 2011*. Hamilton, Ontario, McMaster University

SCREENING LEVEL ASSESSMENT OF RELEASES FROM OIL AND GAS PLATFORMS ON MARINE NATURA 2000 SITES

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1. INTRODUCTION

In the United Kingdom the European Commission Wild Birds and Habitats Directives have been implemented by the Conservation (Natural Habitats) Regulations 1994 creating designations of Special Protection Area (SPA) and Special Area of Conservation (SAC) respectively; together these form part of Europe's Natura 2000 set of protected habitats. The Conservation (Natural Habitats) Regulations have been interpreted, in the UK, as requiring an evaluation of the potential impact of authorised discharges of radioactive substances on these Natura 2000 sites.

The process of assessing authorised releases in Scotland has recently begun. All authorised discharges from non-nuclear sites to the marine environment have been identified. A large proportion of the authorisations in Scotland are for oil and gas platforms, predominantly discharging ^{226}Ra and ^{228}Ra in 'produced waters'.

This paper describes screening level assessments of releases from marine oil and gas platforms conducted for off-shore Natura 2000 sites.

2. METHODOLOGY

2.1 Marine platforms and Natura 200 sites assessed

The location and characteristics of a total of 94 authorisations to discharge radionuclides from marine oil and gas platforms in Scottish waters were identified. The spatial distribution and character of SPAs and SACs in British waters were obtained from the Joint Nature Conservancy Council (http://jncc.defra.gov.uk/protectedsites/SACselection/gis_data/terms_conditions.asp). The shortest distance from each discharge to the nearest Natura 2000 site was estimated using a geographical information system, this identified a total of six Natura 2000 sites.

For this initial evaluation three Natura 2000 sites, the Scanner Pockmark, Braemar Pockmarks and Ythan Estuary, Sands of Forvie and Meikle Loch (hereafter referred to as Ythan Estuary) were selected for assessment of platform discharges. Scanner Pockmark was identified as the Natura 2000 site closest to a total of 53 authorisations, whilst Braemar Pockmarks and Ythan Estuary were identified for 15 and 3 authorisations respectively. The Scanner Pockmark and Braemar Pockmarks are both designated as UK offshore SACs whilst the Ythan Estuary is a Scottish coastal SPA.

The radionuclides listed on the authorisations were ^{226}Ra, ^{228}Ra, ^{238}U, ^{131}I, ^{82}Br, ^{60}Co, ^{14}C, ^{3}H and a category termed *Groups of two or more radionuclides.* An approach to assessing the 'Groups of two or more radionuclides' was required. The majority of authorisations included ^{226}Ra and ^{228}Ra and authorisations which included these radionuclides rarely included the Groups of two or more radionuclides category. Therefore, a pragmatic decision was taken to assume that the Groups of two or more radionuclides category was comprised of equal activities of ^{226}Ra and ^{228}Ra. Note ^{131}I, ^{82}Br, ^{60}Co, ^{14}C, ^{3}H are used by the oil and gas industry to trace the movement of other materials in pipe work (IAEA 2003).

2.2 Dispersion modelling

To provide estimates for the contributions of each authorisation to the concentrations of radionuclides in water at the Natura 2000 sites the WAT model developed by the Centre for Environment, Fisheries and Aquaculture Science (Cefas) was used. A description of the WAT model can be found in Round (1998).

The WAT model calculates the concentration of a radionuclide(s) at a specified distance from the release point, based on a number of sediment and hydrographic parameters, and the release rate of the radionuclide(s). A basic assumption of the model is that the point of interest (i.e. that at which the nuclide concentration is required) lies in the direction of the residual tidal velocity from the release point. This is unlikely to have been the case for more than a few platforms at any one Natura 2000 site assessed in this report. However, given that the tidal residuals could change with time, and that platform releases could theoretically be concentrated at a time at which the residual velocity was toward the relevant Natura site, it was assumed that this condition held. Therefore, the derived activity concentrations are likely to be maximised, other parameters being equal, as the release is assumed to flows toward the Natura 2000 site. This conservative approach is appropriate for a screening level assessment. A value of 1 m^2 s^{-1} was assumed for the diffusion coefficient; this is at the lower end of recommended values for UK waters and was used to provide a conservative estimate.

The platforms and Natura 2000 sites are in relatively deep water (compared with power station outfalls). Depths from 80 – 150 m were typical. Activity concentrations are inversely proportional to mean water depth, and so a mean water depth of 80 m was assumed to continue the conservative scenario theme. For the Ythan Estuary assessments, a mean depth of 30 m was assumed, as the Natura 2000 site is in considerably shallower waters (although the platforms are still in an area with a water depth of >100 m).

With these above parameter choices, the WAT model was run with the individual platform release data and distances to Natura sites included. For each Natura 2000 site the radionuclide activity concentrations resulting fromeach platform considered were then summed to give the total radionuclide activity concentration for that Natura 2000 site (Table 1).

2.3 Screening level assessment

2.3.1 The ERICA Tool

Tier 1 of the ERICA Tool (Brown et al. 2008) was used to conduct the screening level assessment. The Tool includes a generic marine ecosystem in which the following reference organisms are considered: wading bird; benthic fish; benthic mollusc; crustacean; macroalgae; mammal; pelagic fish; phytoplankton; polychaete worm; reptile; sea anemones or true coral; vascular plant; zooplankton. One of the criteria for the selection of the reference organism was that they encompassed all European protected species. The only user inputs required for Tier 1 assessments are radionuclide activity concentrations in media (i.e. in this case the predicted water concentrations presented in Table 1). The input media concentrations are compared to pre-calculated environmental media concentration limits (EMCLs), defined as the activity concentration in the selected media (soil or air in terrestrial environments, water or sediment in aquatic environments) that would result in a dose-rate to the most exposed reference organism equal to that of the

selected screening dose-rate. To determine the default EMCL values in the ERICA Tool (see Brown et al 2008):

- internal and external DCC values estimated for simplified geometries to represent each reference organism were used, together with default radiation weighting factors of 10 for alpha radiation, 3 for low energy beta and 1 for (high energy) beta and gamma radiation;
- habitat assumptions were selected to maximise likely exposure (e.g. the geometry representative of a benthic fish was assumed to spend 100 % of time at the sediment-water interface);
- probability distributions associated with the default transfer parameters and sediment-water distribution coefficient (K_d) databases were used to determine 5th percentile EMCL values (which are the values used in the Tool).

Table 1. Total radionuclide activity concentrations in water at the three assessed Natura 2000 sites as estimated from authorised discharge activities using the WAT model.

	Scanner Pockmark	Braemar Pockmarks	Ythan Estuary
	Bq L^{-1}		
^{3}H	n/a	1.14E-1	n/a
^{14}C	n/a	6.81E-3	n/a
^{60}Co	6.80E-8	n/a	n/a
^{82}Br	3.14E-19	3.82E-12	n/a
^{131}I	n/a	6.16E-10	n/a
^{226}Ra	6.00E-3	2.53E-4	9.54E-5
^{228}Ra	5.96E-3	2.51E-4	9.33E-5
^{238}U	n/a	1.25E-8	n/a

n/a – no authorisations for this assessment list this radionuclide

The outputs of the initial screening tier are risk quotients (RQ) which are the ratio of input media concentration to the EMCL for the most limiting organism. Only one RQ per radionuclide is reported and the most exposed (or limiting) reference organism for any given assessment may vary between radionuclides. An overall RQ value representing the sum of the RQs for the radionuclides included within a given assessment is also recorded. The default dose rate used as the screening dose rate in the ERICA Tool for all organisms is 10 µGy h^{-1}

2.3.2 Application of the ERICA Tool

Of the radionuclides requiring consideration in this assessment, ^{226}Ra, ^{228}Ra, ^{238}U, ^{131}I, ^{60}Co, ^{14}C, ^{3}H are default radionuclides within the ERICA Tool. For each radionuclide the total water concentrations were input to Tier 1 (i.e. the screening level) of the ERICA Tool to estimate risk quotients for each radionuclide. A screening dose rate of 10 µGy h^{-1} was used for all organisms (see (Garnier Laplace *et al*., (2008) for derivation).

Bromine-82 is not a default radionuclide and hence cannot be considered (within the Tool) in a Tier 1 assessment. However, ^{82}Br can be added and dose conversion coefficients generated. To determine a water EMCL value for bromine a sediment-water k_d and concentration ratios (CR) between the wholebody of

marine organisms and water were required. Neither IAEA (2004) or the forthcoming IAEA handbook (Howard et al. 2011) which will provide radionuclide CR values for wildlife have data for Br in the marine environment. Data are available for some organisms from the Baltic Sea (Engdahl et al. 2006; Kumblad & Bradshaw 2008) and are used in the forthcoming IAEA handbook to provide values for the Estuarine ecosystem. These data have been used here together with guidance presented in Beresford et al. (2008) on deriving CR values when data for a given radionuclide-organism are missing (see Table.2). A k_d value was of 1.8 L kg^{-1} was derived from the average sea water concentrations and sediment data for the North Sea summarised in Coughtrey et al. (1983). Assuming an activity concentration of 1 Bq ^{82}Br L^{-1} in seawater the probabilistic modelling functionality of Tier 3 of the ERICA Tool was then used to derive the 95^{th} percentile total dose rates for each of the reference organisms. The lowest predicted dose rate for any of the reference organisms was taken to be the EMCL, this was 1460 Bq L^{-1} with 'Sea anemones or true corals – colony' being identified as the limiting organism.

Table 2. Bromine CR values for marine organism used to derive a water EMCL value.

ERICA Reference Organism	CR value mean±SD	Notes
Bird	0.17	Assumes fish value
Benthic fish	0.17±0.082	Kumblad & Bradshaw 2008
Benthic mollusc	1.4±1.0	Kumblad & Bradshaw 2008
Crustacean	6.6	Assumes zooplankton value
Macroalgae	2.5±1.2	Kumblad & Bradshaw 2008; Engdahl et al. 2006
Mammal Pelagic	0.17	Assumes fish value
fish	0.17±0.082	Kumblad & Bradshaw 2008
Phytoplankton	1.6	Kumblad & Bradshaw 2008
Polychaete worm	6.6	Assumes zooplankton value
Reptile	0.17	Assumes fish value
Sea anemones or true corals - polyp	6.6	Assumes zooplankton value
Sea anemones or true corals - colony	6.6	Assumes zooplankton value
Vascular plant	2.0±0.49	Engdahl et al. 2006
Zooplankton	6.6	Kumblad & Bradshaw 2008

The predicted water concentrations form Table 1 for all radionuclides other than ^{82}Br were input into Tier 1 of the ERICA Tool to determine RQs; the RQ for ^{82}Br was derived outside of the Tool as the ratio of the predicted water concentration to the derived EMCL value.

3 RESULTS & DISCUSSION

The estimated RQ values for each of the three Natura 2000 sites are presented in Table 3. The combined releases from all of platforms included in the assessment of each of the three Natura 2000 sites result in a RQ value of <1. For all three site ^{226}Ra contributes the majority of the summed RQ value. The highest RQ estimated for Scanner Pockmark (0.25) is dominated by the ^{226}Ra authorisations predominantly from one platform which contributes approximately 90 % of the predicted ^{226}Ra activity concentration in water at this Natura 2000 site.

Table 3. Estimated RQ values for the three Natura 2000 sites as a consequence of releases from marine platforms.

Radionuclide	RQ	Limiting Reference Organism
Scanner Pockmark		
Co-60	8.7E-6	Polychaete worm
Ra-226	2.5E-1	Sea anemones or true corals - colony
Ra-228	2.0E-3	Polychaete worm
Br-82	2.2E-22	Sea anemones or true corals - colony
Summed RQ	**2.5E-1**	
Braemar Pockmarks		
Ra-226	1.0E-2	Sea anemones or true corals - colony
Ra-228	8.3E-5	Polychaete worm
H-3	3.2E-7	Phytoplankton
C-14	1.1E-3	(Wading) bird, Reptile
I-131	9.7E-11	Macroalgae
U-238	5.0E-8	Sea anemones or true corals - polyp
Br-82	2.6E-15	Sea anemones or true corals - colony
Summed RQ	**1.2E-2**	
Ythan Estuary		
Ra-226	3.9E-3	Sea anemones or true corals - colony
Ra-228	3.1E-5	Polychaete worm
Summed RQ	**4.0E-3**	

Conservatism in these assessments largely resulted from the application of 5th percentile EMCL values, the assumption that all releases flow towards the Natura 2000 site being assessed, and the summing of all release at a single point in each Natura 2000 site. A potential lack of conservatism may be that only releases from platforms for which these sites were identified as being the closest Natura 2000 site were considered. However, we are confident that overall the approach should result in a conservative assessment.

As publication of a handbook presenting wildlife transfer parameters for wildlife by the IAEA (Howard et al. 2011) is expected relatively soon it is prudent to consider if CR values presented in the handbook

would have any impact on this assessment. Acknowledging that the parameter values have not yet been published, those values in the draft as submitted to the IAEA for publication will not result in a different conclusion being drawn for this assessment (Howard et al. 2011).

The screening level assessments described here indicate that there is negligible risk to the three Natura 2000 sites from releases of radioactive substances from marine oil and gas platforms.

ACKNOWLEDGEMENTS

The work described here was funded by the Scottish Environment Protection Agency.

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