Agreement on a Methodology for Deriving Environmental Assessment Criteria and their application

(OSPAR Agreement: 2016-07) [1]

Source: RSC 22/17/01, Annex 8

Introduction

1. This agreement sets out the methodology for deriving criteria for the radiological environmental assessment of concentrations of radioactive substances in the marine environment of the OSPAR maritime area by OSPAR Contracting Parties. The agreement also describes how the criteria should be applied.

2. The practical aspects of the methodology should be reviewed and updated where necessary by 2028.

Methodology

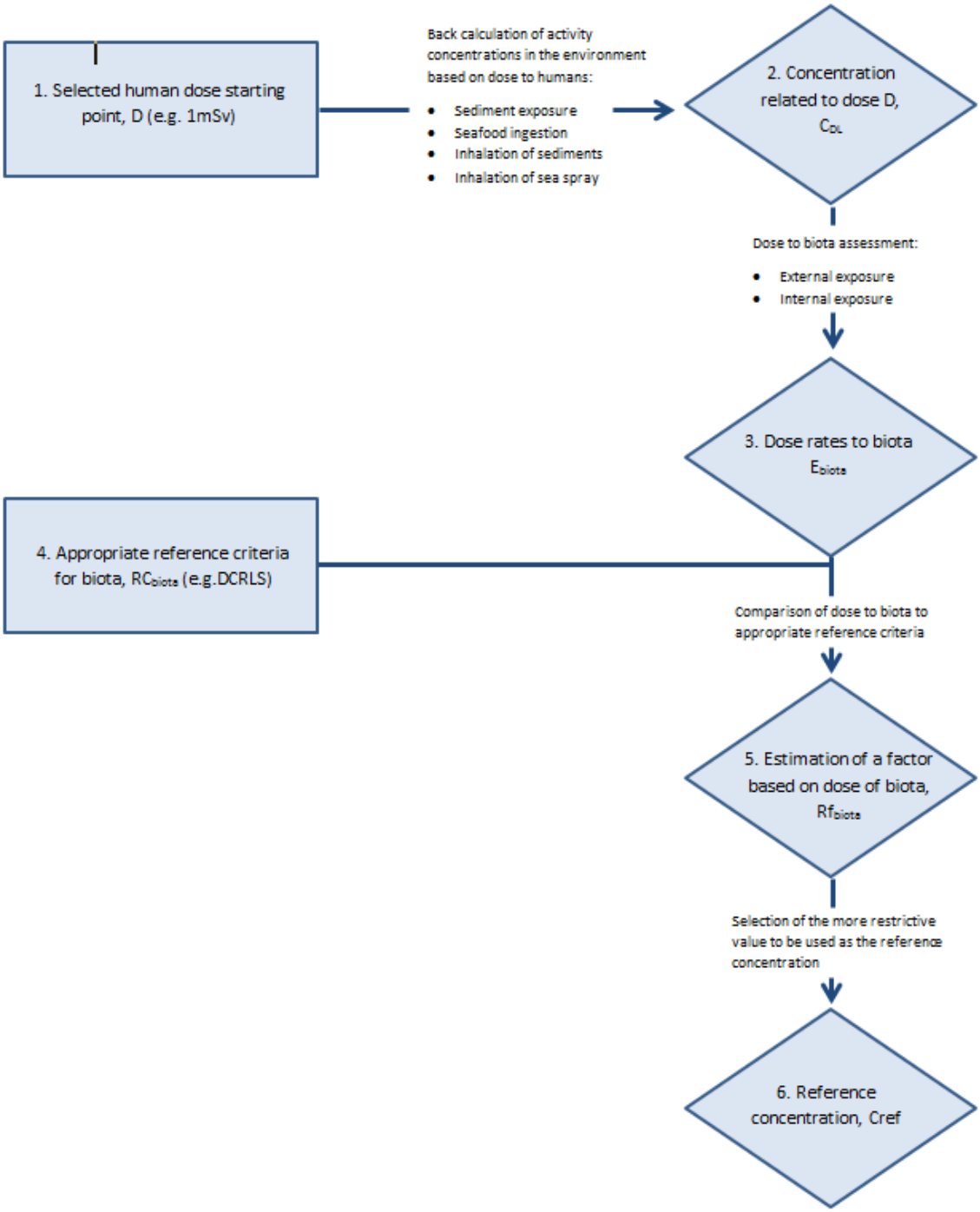
3. The methodology developed by the International Atomic Energy Agency (IAEA) for deriving the environmental assessment criteria (EAC) is set out in Reference 1 ("the IAEA Methodology") and attached at Annex 1. The principles of the IAEA Methodology were agreed by the OSPAR Radioactive Substances Committee in 2013 subject to further testing and demonstration (see 'Application' below).

4. The scheme used in the IAEA Methodology to assess the radiological impact on humans and non-humans in an integrated manner is summarised in Figure 1.

[1] English only. Update 2022

Figure 1: Scheme used by the IAEA to derive reference concentrations

(taken from Reference 1)



5. In summary, the criteria are in the form of reference activity concentrations in filtered seawater (Cref) which equate to whichever is the lower of the concentrations that would give rise to:

a. an annual radiation dose of 1 millisievert (mSv) to humans; or

b. a radiation dose rate at the lower bound of the relevant Derived Consideration Reference Level (DCRL) as defined by the International Commission on Radiological Protection for key marine Reference Animals and Plants.

6. The EAC for the OSPAR indicator radionuclides are given in Table 1.

Table 1: Environmental Assessment Criteria for OSPAR Indicator Radionuclides

OSPAR Indicator Radionuclide	Cref (Bq/l, filtered seawater)
H-3	5.60E+05
Tc-99	1.80E+01
Cs-137	4.50E+00
Pu-239/240	2.80E-02
Ra-226	2.60E-02
Ra-228	6.70E-02
Po-210	1.10E-04
Pb-210	8.80E-04

Application

7. The OSPAR Radioactive Substances Committee tasked an Intersessional Correspondence Group (ICG-EAC) in 2013 and 2014 with the testing and practical demonstration of the IAEA Methodology. The testing and demonstration carried out by the ICG-EAC is described in References 2 and 3, and attached as Annexes 2 and 3.

8. In the light of further consideration, the OSPAR Radioactive Substances Committee has agreed to apply the IAEA Methodology as follows.

9. The EAC in Table 1 may be used for screening purposes, as part of a suite of assessment tools, provided it is made clear that the screening assessment is applicable to OSPAR indicator radionuclides only.

10. Care should be taken when selecting the regional monitoring data for assessment. In particular, the demonstration (see Reference 3) showed that there is the potential for artificially high 'Limits of Detection' (e.g. where they have been set on cost rather than quality grounds) to exceed EAC.

11. Derived environmental concentration values (e.g. assessment values or modelled values) for radionuclides shall be considered individually, and compared to 100th of the Cref value for that radionuclide.

12. If the derived value is less than 100th of the relevant Cref value it may be concluded that the environmental concentration of that radionuclide would result in an annual dose that would be below the environmental reference levels and the trivial annual dose of 10 µSv and therefore would not result in a significant radiological impact to humans or the marine environment.

13. If the environmental concentration is greater than 100th of the relevant Cref value, OSPAR Contracting Parties may wish to consider confirming the radiological impact by reviewing their

national monitoring and assessment programme and any national dose assessments of the region in question.

14. Where activity concentrations reported as less than the minimum detectable activity (MDA) are used to derive environmental concentration values that are to be compared with 100th of the relevant Cref value, care must be used as to the impact of such values, particularly if any individual MDA values are greater than 100th of the relevant Cref value.

15. The use of this assessment methodology for OSPAR indicators does not replace the need for a more detailed and specific radiological assessment if the total doses to humans or biota at a specific location from a wider range of radionuclides are required.

References

1. IAEA (2013) Definition of Radiological Environmental Assessment Criteria for the OSPAR Convention: A Proposal by the IAEA for consideration by the RSC - IAEA Contribution to RSC 2013. Ref. RSC 13/7/1 (Note: a minor clarification in the text was produced by IAEA in 2016 and approved by RSC 2016).

2. RSC (2014) Report on the application of the "Definition of Radiological Environmental Assessment Criteria for the OSPAR Convention: A Proposal by the IAEA for consideration by the RSC". ICG-EAC report to RSC 2014. Ref. RSC 14/4/1.

3. RSC (2016). Final report on the demonstration of the proposed IAEA method for Environmental Assessment Criteria. Ref. RSC 16/4/1 (Annex 2).

4. RSC (2014). RSC 2014 Summary Record, Annex 6. Table 5: Sum of Risk Quotients (SRQ) Categories for application at OSPAR regional level.

ANNEXES

Annex 1 - IAEA (2013) Definition of Radiological Environmental Assessment Criteria for the OSPAR Convention: A Proposal by the IAEA for consideration by the RSC - IAEA Contribution to the Meeting of the OSPAR Radioactive Substances Committee (RSC) 2013. Ref. RSC 13/7/1.

Annex 2 - RSC (2014) Report on the application of the "Definition of Radiological Environmental Assessment Criteria for the OSPAR Convention: A Proposal by the IAEA for consideration by the RSC". ICG-EAC report to RSC 2014. Ref. 14/4/1.

Annex 3 - RSC (2016) . Final report on the demonstration of the proposed IAEA method for Environmental Assessment Criteria. Summary of RSC 15/3/1. Ref. RSC 16/4/1 (Annex 2).

Final report on the demonstration of the proposed IAEA methodology for deriving Environmental Assessment Criteria

1 Introduction

1. The strategic objective of the OSPAR North-East Atlantic Environment Strategy with regard to radioactive substances is to prevent pollution of the OSPAR maritime area from ionising radiation through progressive and substantial reductions of discharges, emissions and losses of radioactive substances, with the ultimate aim of concentrations in the environment near background values for naturally occurring radioactive substances and close to zero for artificial radioactive substances. In achieving this objective the following issues should, inter alia, be taken into account:

i) Radiological impacts on man and biota;

ii) Legitimate uses of the sea;

iii) Technical feasibility.

2. The Radioactive Substances Strategy will be implemented progressively by making every endeavour, through appropriate actions and measures to ensure that by the year 2020 discharges, emissions and losses of radioactive substances are reduced to levels where the additional concentrations in the marine environment above historic levels, resulting from such discharges, emissions and losses, are close to zero.

3. The OSPAR Radioactive Substances Committee (RSC) set up an Intersessional Correspondence Group (ICG) on Environmental Assessment Criteria (ICG-EAC) to assess the potential application of such criteria in OSPAR assessments.

4. The derivation of environmental assessment criteria (EAC) for OSPAR purposes follows a methodology proposed by the International Atomic Energy Agency (IAEA) (IAEA (2011)). The methodology was refined and tested using a case study based on Region 6 (Irish Sea-Sellafield)[2] following an IAEA/OSPAR workshop (IAEA 2013). In 2013, RSC endorsed the principles of the methodology and following further testing by the ICG-EAC in 2014, RSC 2015 agreed to recommend the use of EAC in future OSPAR assessments as part of a suite of assessments tools.

2 Environmental Assessment Criteria

5. The IAEA methodology is used to calculate reference radioactivity concentrations in seawater that correspond to reference levels of radiation exposure of humans and wildlife and the most restrictive concentration taken as the EAC. The reference levels of radiation exposure used to derive the reference concentrations were the established dose limit for humans of 1mSv/y (IAEA (2014)) and the lower bound of the appropriate range of the International Commission on Radiological Protection's (ICRP) Derived Consideration Reference Levels (DCRLs) (ICRP 2008) for the Reference Animals and Plants (RAPs). In the majority of cases the reference concentrations derived on the basis of human exposure were the most restrictive.

3 Demonstration of the Methodology

[2] *Data on environmental concentrations are reported to OSPAR for 15 monitoring areas that generally represent subdivisions of the five designated regions of the OSPAR maritime area. See Figure 1.*

6. In 2014, ICG-EAC examined a number of issues raised by RSC regarding the practical application of the methodology in the OSPAR context. This report summarises and updates the progress report of the demonstration of the methodology tabled at RSC 2015 (RSC (2015)), in light of the comments made at RSC 2015 and further comments from the ICG-EAC.

3.1 Demonstration of EAC for OSPAR monitoring regions

7. The Environmental Assessment Criteria (EAC) were compared to the measured concentrations of OSPAR indicator radionuclides for each of the OSPAR monitoring regions shown in Figure 1.

3.2 Monitoring data issues

8. The assumption of equilibrium between sediment and seawater concentrations, spatial averaging issues and the variation in the datasets underpinning the derivation of the EACs were considered.

9. Using three selected regions, i.e. Region 1 (Wider Atlantic, Bay of Biscay/Golfe de Gascogne, Iberian Waters and the Western Approaches), Region 4 (Irish Sea, Republic of Ireland) and Region 6 (Irish Sea, Sellafield), spatial and temporal averaging of OSPAR data was considered to determine the variability of concentrations and how these compared with the EAC.

10. A short literature review of the role of historical discharges and environmental sinks in contributing to seawater concentrations of radionuclides was conducted. The remobilisation of radionuclides from contaminated sediments is well documented and has been the subject of many studies in areas within, for example, Region 6 (Irish Sea, Sellafield) and these were the focus of the review.

3.3 Relative impacts of the OSPAR indicator radionuclides

11. To investigate the relative impact of OSPAR indicator radionuclides when compared with the longer list of radionuclides which may be detected in the OSPAR regions, estimates of dose rates to biota for the measured OSPAR radionuclides and monitoring data from the Radioactivity in Food and the Environment (RIFE) report (Environment Agency et al (2014)) were compared. For this purpose the ERICA tool (Brown et al (2008)) was used, which is compatible with the ICRP methodology (ICRP 2008) used by IAEA to define the EAC. Region 6 (Irish Sea, Sellafield) was used for the comparison as it has a relatively large dataset. The percentage contribution of the OSPAR radionuclides to the total dose from the wider set of radionuclides was assessed for the years 2008 to 2012. A review of the contribution of OSPAR indicator radionuclides to doses to humans in the vicinity of Sellafield was also carried out.

3.4 Sensitivity and uncertainty

12. A particular area of sensitivity in the assessments of doses to non-human species is the concentration ratio representing the equilibrium ratio of radionuclide concentration in the tissue of organism to that in its external environment. A limited exercise was carried out to explore the probability distributions attached to concentration ratios and their effect on the calculated dose rates.

Region 1. Wider Atlantic
Region 2. Cap de la Hague Channel
Region 3. Channel East
Region 4. Irish Sea (Rep. of Ireland)
Region 5. Irish Sea (Northern Ireland)
Region 6. Irish Sea (Sellafield)
Region 7. Scottish waters (Dounreay)
Region 8. North Sea South (Belgian and Dutch coast)
Region 9. German Bight
Region 10. North Sea (NW, SE and Central)
Region 11. North Sea (Skagerrak)
Region 12. Kattegat
Region 13. Norwegian Coastal Current
Region 14. Barents Sea
Region 15. Norwegian, Greenland Seas and Icelandic waters

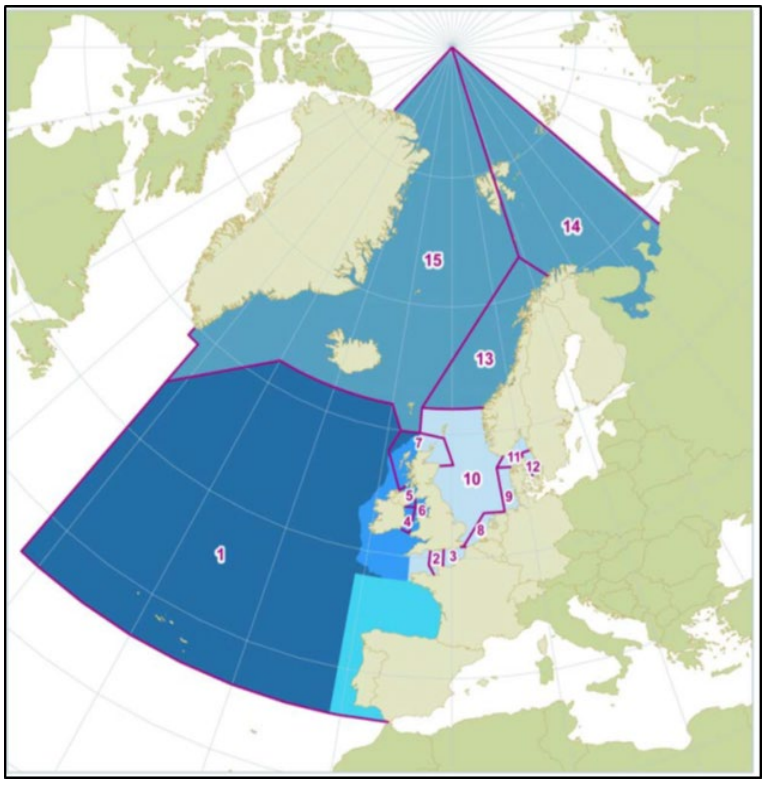


Figure 1: The OSPAR monitoring regions for RSC purposes

4 Summary of results

13. This section summarises the key results and conclusions.

4.1 Demonstration of EAC for OSPAR monitoring regions and data issues

14. The OSPAR Monitoring Agreement specifies that monitoring of eight indicator radionuclides (Cs-137, Pu-239/240, H-3, Tc-99, Ra-226, Ra-228, Po-210 and Pb-210) in seawater and biota should be carried out where possible. The OSPAR Monitoring dataset is comprehensive, however this work demonstrated that a full comparison of seawater concentrations against the EAC was not possible for all indicator radionuclides for all years in all regions. For the majority of regions, data were available for the four artificial radionuclides but were not always available for the whole of the 5 year period studied (2008-2012). The number of data entries per radionuclide for each region varied greatly as did the proportion of limit of detection (LoD) values which varied between 0 and 100% of the seawater concentrations.

15. The EAC values were not exceeded by measurements of artificial radionuclides in any region over the 5 year period studied. However, the quoted LoD for Pu-239/240 in 2009-2011 in Region 8 exceeded the EAC.

16. There were a few cases where the LoD (or in three cases the actual measurement) of naturally occurring radionuclides exceeded the EAC (i.e. radium isotopes in Region 8 for the years 2010-2012 and Po-210 in regions 14 and 15 for the year 2012). However, this does not include the subtraction of natural background levels which could account for all, or a significant fraction, of the measured concentrations.

17. The comparison for the years 2008-2012 therefore indicates that the activity concentrations of radionuclides in the OSPAR monitoring regions are already low and below any levels of potential risk to humans or wildlife. This is consistent with the general conclusions from the Third Periodic Evaluation in 2009 (OSPAR (2009)).

18. As mentioned above, some of the quoted LoDs were higher than the EAC, this may be where LoDs have been determined principally on cost rather than analytical grounds. OSPAR may wish to consider whether it needs to address the issue of high LoDs when comparing with the EAC. OSPAR may also wish to consider how to draw final conclusions regarding impact given that a comparison of the EAC with monitoring data was not possible for all years and regions.

Remobilisation

19. Radionuclides are known to move between contaminant sinks as a result of different chemical, biological and physical mechanisms. There are a number of well understood environmental processes that determine the rate and extent of this remobilisation including chemical re-dissolution and sediment transport that will influence the activity concentrations of radionuclides in seawater.

20. Remobilisation of radionuclides from the Irish Sea 'mud patch' and intertidal locations is particularly well documented and for some of the OSPAR indicator radionuclides this may become a significant contributor to activity concentrations in seawater.

21. Given the significant reductions in discharges from Sellafield since the 70s and 80s, it is reasonable to infer that contaminant sinks of radioactivity, through radionuclide remobilisation, are likely to become an important factor in any future variation seen in radioactivity concentrations in media such as seawater.

22. Region 6 includes the Sellafield and other nuclear licensed sites as well as the now decommissioned phosphoric acid manufacturing plant at Whitehaven in Cumbria. The Whitehaven plant was a significant anthropogenic source of naturally occurring radionuclides (uranium, thorium and their daughter products) into the Irish Sea. Peaks in authorised discharges from Sellafield occurred in the mid1970s but since then regulatory pressure and the commissioning of a number of effluent treatment facilities at Sellafield has resulted in a dramatic reduction in discharges. Therefore future levels of radioactivity in seawater are likely to be dominated by remobilisation of the radionuclides already within the environment rather than ongoing discharges.

23. Because of the potential contributions to measured concentrations from the remobilisation of radionuclides discharged in the past it is clear that if the EAC are exceeded in some regions it may not

be due to current discharges and further work may be required in these cases to determine the attribution of the measured concentrations.

4.2 Relative impact of OSPAR radionuclide indicators

24. The relative contribution from the OSPAR indicator radionuclides to the radiological impact on humans was considered using the latest published dose assessment based on measurements for region 6 in the UK's Radioactivity in Food and Environment (RIFE) report for 2013 (Environment Agency et al (2014)).

25. The total dose to the representative group of humans published in the RIFE report for 2013 (Environment Agency et al (2014)) for all pathways and sources in the marine environment in the vicinity of the Sellafield site was 40 Sv from artificial radionuclides (including external radiation). The principal contributing radionuclides were iodine-129 (32%), carbon-14 (10%) and caesium-137 (7%). The contributions from americium-241 (7%) and plutonium-239/240 (3%) were smaller. The contribution to total dose from external exposure was 33%.

26. This information on the breakdown of dose by radionuclide indicates that I-129, C-14 and Am-241 (non OSPAR indicator radionuclides), contributed 49% to the total dose from artificial radionuclides in 2013.

27. With the addition of the dose from naturally occurring radionuclides, assumed to be from past discharges from the decommissioned phosphoric acid plant at Whitehaven, of 21 Sv the highest total dose near Sellafield assessed for 2013 in RIFE was 61 Sv. The contributions of OSPAR indicator radionuclides to this total, which includes naturals, were Po-210 (33%), Cs-137 (5%) and Pu-239 (2%) giving 40% in total.

28. This task confirmed (at least for a specific coastal area within Region 6) that, in the case of human exposure, the OSPAR indicator radionuclides may contribute a significant proportion (approximately 40% in this case) of the total radiological impact when compared with the impact from all measured radionuclides.

29. The demonstration broadly indicated that the OSPAR indicator radionuclides may contribute a smaller fraction of the total dose rate to non-human organisms i.e. less than 10%, when using measurements of activity concentrations from the Irish Sea. However, it should be noted that this is based on measurements taken close to the shore rather than those representative of regional data, and on default parameters in the ERICA tool that, in some cases, use derived rather than measured Concentration Ratios.

30. In the light of these results the ICG-EAC concluded that there is no need to modify the table of 'OSPAR Assessment' categories proposed at RSC 2014. However, If the 'sum of risk quotients' (SRQ, a unit less ratio) is calculated it should include all or as many OSPAR indicator radionuclides as possible and the OSPAR radiological status categorised according to the table of categories. The methodology is primarily intended to give an indication of the radiological impact of the OSPAR indicator radionuclides and whether a more comprehensive assessment is necessary (i.e. a screening tool). It should be made clear that the use of OSPAR indicators and the table of categories does not replace the need for a more detailed and specific radiological assessment if the total doses to humans or wildlife within a particular monitoring region from a wider range of radionuclides are required.

31. With the above in above in mind the ICG-EAC suggests that if the SRQ is greater than 1 then a more detailed and specific radiological assessment should be considered. If the SRQ is in the region of 0.1-1 then OSPAR Contracting Parties may wish to consider confirming the satisfactory status by reviewing their monitoring programme, and including additional radionuclides in the assessment if adequate monitoring data exist, especially as the SRQ value approaches 1.

4.3 Wildlife assessment parameters - sensitivity and uncertainty

32. All radiological impact assessments are associated with uncertainty. The EAC methodology is a generic tool which provides reference levels for OSPAR screening purposes. To account for these uncertainties, the data and assumptions used in the EAC methodology are therefore conservative.

33. In common with other radiological impact assessments the results of non-human dose assessments are sensitive to a range of input parameters. An important example is the concentration ratio (CR) for radionuclides in the tissues of organisms relative to their surrounding environment. To illustrate the uncertainty that may arise from the variability of CRs in deriving the EAC, a limited exercise was conducted using the ERICA Tool (Brown et al (2008)).

34. In summary, there are examples of where the CRs quoted in the literature vary by several orders of magnitude which would cause similar variation in EAC. Whether this variation has the potential to make biota exposure more limiting (in effect changing the EAC based on human exposure to EAC based on biota exposure) may be a subject for future evaluation when the practical aspects of the EAC methodology are reviewed, and updated where necessary, by 2020 when new data on the biota CRs, for example, will be available from ongoing research projects.

5 Conclusions

35. The OSPAR Monitoring Agreement specifies that monitoring of eight indicator radionuclides in seawater and biota should be carried out where possible. The OSPAR Monitoring dataset is comprehensive, however this demonstration showed that a full comparison of seawater concentrations against the EACs was not possible for all indicator radionuclides for all years studied in all regions.

36. Comparison of the sub-set of the OSPAR dataset for 2008-2012 demonstrates, as expected, that the radionuclide activity concentrations in the OSPAR monitoring regions are generally already low and below levels of potential risk to humans or wildlife.

37. OSPAR may wish to consider further whether, and how, to deal with the issue of high LODs when reporting against the EAC and also how to draw final conclusions on impact given that a comparison of the EAC with monitoring data was not possible in every case.

38. The spatial and temporal averaging of the OSPAR monitoring data in Regions 1 (Wider Atlantic, Bay of Biscay/Golfe de Gascogne, Iberian Waters and the Western Approaches), 4 (Irish Sea, Republic of Ireland) and 6 (Irish Sea, Sellafield) showed that the seawater concentrations were generally in decline with little variation. Apart from only two cases (Pu-239/240 in Region 6 in the early 2000s) seawater concentrations did not exceed the EAC.

39. It is well documented that environmental sinks of radionuclides from past discharges can act as ongoing sources for radionuclides in the water column. The position in Region 6 with respect to environmental sinks such as intertidal sediments and the Sellafield mud patch was briefly reviewed. It is clear that remobilisation of the radionuclides is occurring in this region and that any reported OSPAR data will include radionuclides that are currently discharged and those that have been remobilised from the accumulation in bottom sediments from past discharges.

40. Published dose assessments for parts of Region 6 indicate that the relative impact on humans of the OSPAR indicator radionuclides was less than 50% of the total dose determined near Sellafield in 2013. However this used local rather than regional measurements which are applicable to the OSPAR framework.

41. In common with other types of radiological assessment concentration ratio (CR) values are known to be one of a number of important influences on the results of dose assessments for biota. The uncertainty associated with this key parameter has been briefly considered.

42. In general the findings highlight that care is needed when interpreting the meaning of any EAC assessments for OSPAR.

43. Our findings reinforce the earlier recommendation to RSC that the practical aspects of EAC methodology (e.g. input data) should be reviewed and updated where necessary by 2020.

6 Recommendations

44. Overall this work has demonstrated that the EAC can be applied successfully as a screening tool for assessing monitoring data from the OSPAR regions. On the whole, the results were as expected and the findings provide confidence in the application of the EAC for OSPAR assessments of radiological status. The findings highlight the need to take care when interpreting the results, to note the appropriate caveats and to provide clear information on the derivation of the OSPAR monitoring data.

45. Based on the findings above, RSC 2015 recommended that the EAC, accompanied with the appropriate caveats, could be used in future OSPAR assessments as part of a suite of tools.

7 References

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