



SUMMARY OF SUBMISSIONS AND RESPONSES

Title of Document: Radiation Protection of the Environment, Safety Guide

Period of public comment: 8 weeks, ending 7th November

Please note that the text of the Safety Guide has been heavily edited in the final review, including the removal of Annexes A & B from the main document. As such, the majority of the comments have been accepted and should be compared to both the ‘Public Comments’ version and the final published version of the Guide.

It is intended to provide online supplementary material on the ARPANSA website (where the digital version of the Guide is kept) comprising of;

- Material from the former Annexes A & B,
- Case studies and assessments, which may be submitted and built into a library over time.

#	SUBMITTER	COMMENT	RESPONSE
1	Department of Environmental Regulation (WA)	<p>Section 3.7, page 14: Under the ‘Selecting environmental reference values’ section, the following statement is made: “The possible combination of small effects on biological endpoints should also be considered.”</p> <p>Further clarification on this statement would be helpful to assist in interpreting its application. For example, does this statement mean that the cumulative effects on populations of smaller-scale changes to multiple biological endpoints should be considered? To what degree should these ‘small effects’ be evaluated and, in doing so, how can the inherent uncertainties of looking at small effects, and the multiplication of uncertainties when considering cumulative effects, be accounted for? Guidance on preferred approaches that should be used to minimise uncertainties (e.g. in the form of an annex to the main document) would assist in interpreting this statement.</p>	<p>Comment accepted. Sentence deleted.</p> <p>The inherent uncertainties and variabilities are unknown. The paragraph refers to dose rate level – this does not imply knowledge of a dose-response relationship and hence speculation as to combination of effects is not realistically feasible.</p> <p>Standard techniques of error analysis should be used to minimise uncertainties.</p>

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2		<p>Section 4.3, page 18: Under the scenario building section, the following statement is made: “Where long half-life radionuclides are included in the source term, a long-term assessment (i.e. tens of thousands of years for long-lived radionuclides) of radionuclide transfer should be considered.”</p> <p>In the Western Australian setting, DER considers that the majority, if not all, of the settings where environmental radiological assessments will be required will involve long half-life radionuclides. Further guidance on long-term assessments is vital to ensure that some consistency is achieved in timescales considered, approach for considering environmental change (e.g. climatic changes or fluctuations) and expectations around when long-term (i.e. tens of thousands of years) assessments should be conducted.</p>	<p>Comment accepted.</p> <p>After a practice is finalised (i.e. after closure) exposure of the environment moves into an existing exposure situation. It would be appropriate for timescales considered for assessment to be aligned to those applied to people. As such, appropriate guidance should be provided in the upcoming Existing Exposure Code.</p>
3		<p>Annex B, page 34: DER proposes that the guidance on the evaluation area (section B1) be extended to include a buffer zone adjacent to contamination or potential contamination area. In the setting of a mine site, for example, the habitat areas may not necessarily overlay the contamination areas, instead being adjacent to the contamination site. If so, consideration should be given as to whether the buffer zones are species specific (to allow for differences in species range) yet standardised across different assessments.</p>	<p>Comment Rejected.</p> <p>The use of buffer zones is considered to be a regulatory management approach and is not essential for environmental monitoring.</p> <p>This Annex will now be included in supplementary online material.</p>
4		<p>Glossary, page 52: The definition of environment as given in the glossary is specific and limited: “The areas outside of sites under direct human control.”</p> <p>A wider definition that represents the processes as well as the physical location may be preferable (e.g. Environment means living things their physical, biological and social surroundings and interactions between all of these – taken from the Environment Protection Act 1986 WA).</p>	<p>Accepted</p> <p>Definition expanded.</p>

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5		In addition to assessment considerations, it would be helpful for the document to add discussion on recommended frequency of assessment review for ongoing operations.	Partially Accepted. Frequency is dependent upon significant changes to operation that affect dose rates to flora and fauna. A lack of significant change indicates no further work is required.
6	Thomas Kim - Department of Mines and Petroleum (WA)	The review of this document showed that it is quite fragmented and does not flow or keep with one theme. An attempt has been made to replicate international work to make it fit Australia.	The final review and reshape of the Safety Guide has attempted to address this comment.
7		<p>Rather than identify specific comments line for line, I will provide these general comments:</p> <p>I suggest removing the term “harmful” in the context of “harmful effects of ionising radiation.” I pose the question, is it harmful? There is enough quantified and peer reviewed research on the subject that would suggest that low doses can actually improve viability of species. Current studies of species and the F1 and F2 progeny actually demonstrated negative correlation from test specimens collected from the vicinity of Fukushima¹. Additionally, 10µGy/hr above background is extremely conservative when considering chronic absorbed dose rates. Radiation effects have been studied for over 75 years with more recent research suggesting that chronic doses are insignificant in nature and concern arises from large acute doses in the range of 2.5Gy/day.² The concept of positive stimulation of the immune system has been studied and is well documented in journals worldwide.</p> <ol style="list-style-type: none"> 1. The biological impacts of the Fukushima nuclear accident on the pale grass blue butterfly. Atsuki Hiyama, Chiyo Nohara, Seira Kinjo, Wataru Taira, Shinichi Gima, Akira Tanahara & Joji M. Otaki. 2. Low Dose Research Program, US Department of Energy, Antone Brookes. 	<p>Rejected.</p> <p>The document follows the current approach of the ICRP which is endorsed by the IAEA and UNSCEAR.</p>

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8		Excluding contaminated environments from this scope is not realistic. Management of contamination as a source of radiation exposure needs to be included. Australia in general is very poor at including contamination with any measurement regime.	Clarification. Contaminated environments are existing exposure situations, which are actually included within the scope of the Safety Guide. The Guide does not address human radiation protection.
9		The discussion on determining radiological effects on the environment appears to be purely theoretical, based on creating a risk assessment and discussing potential outcomes. I believe in defining “data quality objectives (DQO)” and then designing a robust sampling plan to actually MEASURE the uptake and effects.	Clarification. The focus is on radiation assessment of the environment, as recommended by the ICRP.
10		The concept of DQO is not mentioned anywhere. How do you know the sampling to determine effects is adequate or answering the question you set out to answer? No mention of what is considered statistically valid to ensure confidence in the outcome of any study.	Clarification. The sampling methodologies discussed are in support of assessments (see Comment 9) – not intended to define the dose-response relationship for each species. The Annex on monitoring will now be included in supplementary online material.
11		I did not see any reference to conducting bio-assay of flora or fauna to determine species specific ranges for bioaccumulation of isotopes. This would aid in more accurately defining the reference species. I would question whether this is an area for directly referencing the flow-on effects of bio-magnification in conjunction with bio-accumulation as they are typically linked and higher order organisms are typically what we eat?	Rejected. Testing is not required to determine radiation exposure to species – reference species are selected according to consideration of all species’ habits/behaviours. The comment is relevant to human health and outside the scope of this Guide.
12		Sources of radioactivity are treated generically. Variable such as solubility and form of the isotope are not discussed. Other factors such as comparison with other contaminants in the environment need to be addressed. Again, there is existing research showing relationships between certain isotopes and other contaminants, including metals and	Clarification. In the absence of comprehensive knowledge of the physiological behaviour of radionuclides in flora and fauna sources of radioactivity are treated generically.

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		chemicals. When combined, the behaviour may change with an effect in either direction. Some natural matrices actually conduct ion exchange which can bind the isotope and change how it interacts with flora and fauna.	
13		<p>ARPANSA should consider that there are other arid environments in the world with significant research.^{3,4} While existing data is focussed on Northern Hemisphere work and there are substantial difference exist between the commonly perceived regions of study and proposed Australian projects. There does however exist data from Northern Hemisphere arid regions with substantial historical records that is lesser known but still comparable and relevant to Australian areas. It is recommended that before an approach “from the drawing board” is taken, a more thorough literature search and review is conducted by operators with a less ‘privileged’ view of Australian flora and fauna.</p> <p>3. Idaho National Laboratory annual site environmental reports. 2004 through 2013, www.gsseser.com</p> <p>4. US Department of Energy order, DOE O 450.1, protection of the Environment.</p>	<p>Accepted.</p> <p>Any data available that is relevant to the Australian environment should be incorporated into an assessment. This can reduce the need for biological sampling.</p> <p>Advice in Section has been modified to reflect this.</p>
14		<p>In summary, the draft document is a discussion tool and does not really tell you how to do anything. Australia does have data for known sites that can be drawn from.⁵ Establishing a bio-assay program and a monitoring program would help build a foundation to better understand the effect of radiation on the environment in Australia.</p> <p>5. The Arid Recovery Centre, http://www.aridrecovery.org.au.</p>	<p>Clarification.</p> <p>The Safety Guide provides a framework for radiation practices to assess potential impact on the environment and to allow these practices to demonstrate to regulatory authorities that the environment is adequately protected. It is not intended to provide advice on determining biological effects.</p>
15	Jim Hondros	It is not clear what the overall purpose of this document is. It is currently a collection of general statements about	Accepted.

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		<p>environmental radiation and some suggested methods. It should either be a framework document (which outlines objectives and aims and who should do it) and/or a comprehensive list ways to do the assessments. At the moment it seems to be neither.</p> <p>Provide an indication of what the document is aiming to achieve</p>	<p>Further clarification of objectives provided in final review.</p> <p>See Comment 14 for further clarification.</p>
16		<p>There is a lot of confusion in industry and with regulators about environmental impacts of radiation. This document should aim to make it all very clear and lay out a clear framework without being overly complex. As it stands, the document seems to make the issue more confusing.</p> <p>Provide clear examples on what “an assessment” would look like and what level of impact would be acceptable.</p>	<p>Accepted.</p> <p>While the Guide aims to be applicable in all situations, some case study examples will be included in an Online Annex.</p>
17		<p>The ideas of; environmental impact, environmental dose and radionuclide concentrations are used almost interchangeably, which adds to the confusion (in an already confusing area).</p> <p>Be more precise with terminology in the text.</p>	<p>Accepted.</p> <p>Some of these mean different things. Incidence of “Environmental Dose” have been removed. A review of terminology to ensure consistency has been undertaken for the final review.</p>
18		<p>The main user of the guide is likely to be the minerals industry, where a number of assessments have already been done. However, none of this work is referenced.</p> <p>It should also be noted that new operations are already being conditioned on impacts to “non human biota” rather than environmental impacts. So, standardised guidance is important.</p> <p>The main user of the guide is likely to be the minerals industry, where a number of assessments have already been done. However, none of this work is referenced.</p>	<p>Partially Accepted.</p> <p>This Guide applies to all practices where wildlife may be affected by radionuclides associated with the practice.</p> <p>Examples will be included in an additional online Annex (see Comment 16).</p>

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		It should also be noted that new operations are already being conditioned on impacts to “non human biota” rather than environmental impacts. So, standardised guidance is important.	
19	Jim Hondros (continued)	Lines 69 and 74. Should refer to an “acceptable” level of impact (rather than negligible). Consider editing words	Clarification. Footnote added to clarify that this does not mean zero radiation dose to flora and fauna.
20		Lines 177 – 181. Does this imply that plants and animals may need to be shielded?	Accepted. Sentence deleted.
21		Line 182. Internal dose (as a standardised measure of impact) to a plant or animal seems to be a difficult concept without exposure response data. See point above about being precise in the language used in the document	Accepted. This Safety Guide is not addressing biological modelling of internalized radionuclides. Words reviewed.
22		Section 3.4 (from line 235). This section is overly complex. Provide more guidance on how to practically apply some of the theory in this section (for example through case studies or examples)	Accepted. These concepts are complex but necessary. The section has been reduced and simplified in the final review. More practical guidance with examples will be included in an additional Online Annex.
23		Line 236/237. These lines state; “If known, activity concentrations in plants and animals can be used directly in subsequent doserate calculations.” This is not entirely correct. Dose rates require knowledge on the exposure-response of a species. Be more precise with language	Clarification. Dose rate referred to is in Gy per unit time. Such is not intended to imply a dose-response relationship and does not require knowledge of same. Note that dosimetry for flora/fauna is calculated in absorbed dose rate and is not reflective of biological outcomes in the way that Sieverts are for human health

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			<p>considerations.</p> <p>The Section wording has been altered in the final review.</p>
24		<p>Lines 309 to 317. This section outlines the basis of an exemption level or criteria that can be practically used. This should be more prominent in the guide to ensure that unnecessary assessments are not being done.</p> <p>Consider establishing exemption criteria for assessments base on this section</p>	<p>Rejected.</p> <p>The determination of an exemption criteria is outside of the scope of a Safety Guide. This should be addressed in the NDRP.</p>
25		<p>Section starting at line 1421. This defines the scope of who should do this. This section should be in the front of the document. It is also inconsistent with section 4.2.</p> <p>Ensure consistency and put at beginning of the document</p>	<p>Accepted.</p> <p>Annex C has been brought into the main document in the final review.</p>
26		<p>Line 1458 and 1464. These lines indicate that industries with NORM may be required to conduct assessments.</p> <p>Many of these industries need a lot of guidance and it is important to make sure that any response is warranted (ie; that a real risk exists).</p> <p>Ensure that all industries are able to comment. Note that some of these industry groups may not even know that the safety guide exists.</p>	<p>Clarification.</p> <p>Minerals Council consulted, incorporating all of these industries.</p>
27		<p>Annex B. This section on environmental sampling is included to “support environmental dose assessment” (title of Annex B).</p> <p>This is a useful set of information, but gives the impression that it is necessary to do “environmental dose assessments”, which is incorrect.</p>	<p>Accepted.</p> <p>Environmental sampling in the context given is in support of Environmental Dose Assessment (e.g. in determining site-specific CR or K_D values).</p> <p>See Comment 23.</p>

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		<p>The sampling is useful to characterise the environment, but does not give dose information because you need exposure information and then some sort of exposure/response information for doses.</p> <p>The environmental sampling is useful for identifying changes in radionuclide concentrations, but not for flora and fauna dose assessment.</p> <p>Delete annex B and create separate guidance document on environmental radiation sampling and monitoring.</p>	<p>Annex B will be removed from the Safety Guide but will be included in online supplementary material. A paragraph has been added to clarify the purpose of field sampling in this context.</p>
28	Minerals Council of Australia (MCA)	<p>Guide title and purpose</p> <p>The MCA considers that the current title of the safety guide – “Radiation protection of the Environment” suggests a broader application than is intended. The term “environment” generally includes all humans as well as other non-specific attributes such as visual and heritage aspects. In this instance, the guide specifically focuses on the non-human biota and should be recognised as such.</p> <p>In addition, the terms ‘wildlife’, ‘fauna and flora’ and ‘plants and animals’ are all used interchangeably throughout the Guide.</p> <p><i>Recommendation:</i></p> <p><input type="checkbox"/> The MCA recommends the title of the Guide be amended to more appropriately reflect the intended application.</p> <p><input type="checkbox"/> The MCA recommends using the term ‘Non-human biota’ (NHB) throughout the Guide to avoid any confusion with respect to the intended scope of the Guide.</p>	<p>Clarification/Partially Accepted.</p> <p>The title of the Guide has been Accepted at RHC Committee level. The language in the Scope has been tightened to clarify that humans are not considered to be part of the ‘environment’ in the context of the Guide.</p> <p>The term ‘wildlife’ is used throughout the Safety Guide, and is consistent with those used for International best practice by ICRP, IAEA and others.</p> <p>The Glossary has been updated to include non-human biota & flora and fauna within the definition of wildlife.</p>
29		<p>Consistency with the Radiation Protection Systems for Humans</p> <p>The MCA notes that the Guide does not specify how and when the guide should be utilised and how it aligns with current regulatory requirements and management systems</p>	<p>Clarification</p> <p>The document is not a regulatory instrument, nor is it intended to be. It provides guidance to how practices can demonstrate to their regulatory authority that they have</p>

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		<p>in place for the protection of humans. Specifically, there is no recognition of the well-established concepts of exemption and exclusion which would be of genuine benefit for industries where there is negligible radiological risk. These concepts are essential to prevent the misdirection of resources to areas of negligible risk and should therefore be included in the national approach.</p> <p><i>Recommendation:</i></p> <p>The MCA recommends that:</p> <ul style="list-style-type: none"> <input type="checkbox"/> The scope and purpose of the Guide be clarified in the forward to the document; <input type="checkbox"/> the concepts of exemption and exclusion be incorporated into the Guide; and <input type="checkbox"/> ARPANSA commit to amending the National Directory to adequately cover the approach to the environment in a consistent manner to that used for protection of humans. 	<p>considered environmental protection and that the environment can be shown (relatively) to be adequately protected.</p> <p>Concepts of exemption and exclusion are outside the scope of this Safety Guide (see Comment 24). Policy for implementation and use of this document is expected to be addressed via the NDRP.</p>
30		<p>Reference organisms</p> <p>When the International Commission on Radiation Protection (ICRP) introduced the concept of protection of the non-human biota, it suggested that generic approximate models of representative animals and plants (RAPs) should be used, and proposed 12 standard RAPS. The MCA notes that as Annex A is currently written in the Guide, it appears to set aside the international norm of the proxies suggested by the ICRP and encourages the creation of new reference organisms, which is contrary to the intent of the authors of the system.</p> <p><i>Recommendation:</i></p> <p>The circumstances under which new reference organisms are required should be the exception rather than the rule, and should be science based, clearly defined and subject to expert review to ensure that they meet the requirements for being representative organic models.</p>	<p>Rejected.</p> <p>The 12 specific RAPs are mostly not relevant to Australian biota. The work of Doering (2010) showed that the ERICA integrated approach can be used in an Australian context. The use of reference organisms is a cornerstone of this approach.</p>

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31		<p>Environmental Sampling and Research The appendices to the Guide provide advice on environmental sampling methodologies. While the MCA recognises the value in providing some general advice, there is a possible implication that sampling is necessary for an assessment of impacts. It should be acknowledged that sampling does not provide a measure of dose impacts and it would therefore be inappropriate for this condition to be incorporated into any project approval conditions. The MCA does not support the promotion of, and advice on, environmental fauna sampling as provided by the Guide. Sampling should only be required when modelling of the radiation levels and or pathways present a high probability of risk to a species based on reference animals. The MCA is aware of some regulators requiring sampling when radiation levels are extremely low and such sampling is not justified.</p> <p>MCA concern stems from three factors.</p> <p>I. Unnecessary sampling represents significant cost to the operator, (and cost to the regulator) possible risk to the species, and may not be justified by any realistic assessment of risk to a species. In most temperate climates and probably all semi-arid and arid terrestrial environments it is impossible to take samples of, for example, reptile or mammals at sufficient numbers to make a representative sample without having a potentially severe impact on the local population.</p> <p>II. Many of the arid and semi-arid species are listed as conservation significant by State and Federal agencies and it would be illegal to catch and sample these species.</p> <p>III. All jurisdictions require sampling to be conducted by trained and licenced biologists and botanists and typically</p>	<p>Accepted.</p> <p>This is not a regulatory document and is intended to provide advice as to how practices can demonstrate compliance with jurisdictional legal requirements to protect the environment as contained within radiation protection legislation.</p> <p>See Comment 27 for modifications in wording regarding sampling and the inclusion of Annex B in online material.</p> <p>Noted.</p>

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		<p>require practitioners to be licenced with the appropriate authority.</p> <p>The Guide also suggests the need for potentially extensive research to provide more site-specific, or species-specific data, without any context that allows readers to recognise that the whole system is based on approximations at almost every step (RAPS are not real animals or plants, they are geometric representations that may be much larger or smaller than the plants or animals they represent).</p> <p><i>Recommendation:</i></p> <p>The MCA recommends that the detailed description of sampling be removed from this safety guide as it is potentially misleading.</p> <p>The MCA acknowledges that targeted research may be undertaken by ARPANSA or the Supervising Scientist Division to add reference organisms and reference levels for Australian arid and tropical species knowledge to national and international databases. However, the MCA does not support sampling or research by companies where it is not warranted, exposes real plants or animals to real harm to prevent a potential risk, and exposes small companies to additional environmental assessment costs that produce no nett benefit to the environment or to regulators.</p>	<p>Accepted.</p> <p>If it can be demonstrated that the doses are acceptably low using the geometric model of the reference organism then further specific sampling/research is not required.</p> <p>Partially Accepted. Material will be included online. See Comment 27.</p> <p>Agree in part.</p> <p>The Safety Guide is not intended nor designed to force industry to undertake fundamental research. Environmental sampling can be performed by qualified staff under appropriate licences.</p>
32		<p>The tiered/graded approach to assessment</p> <p>The most crucial elements of this Guide is the discussion on the approach to the use of screening levels and undertaking an assessment, and the diagram and discussion on a tiered, graded or risk based approach to assessment. This section of the Guide assists regulators in determining how to apply and appropriate risk based approach to assessment and the related effort required to provide assurance that impacts are being properly</p>	<p>Accepted.</p> <p>Clarification.</p> <p>The document provides guidance. Specific policy decisions will need to be made by regulators and it is expected that jurisdictions will follow the NDRP in this regard.</p>

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		<p>managed to mitigate potential impacts on the non-human biota.</p> <p><i>Recommendation:</i></p> <p>The MCA recommends this section should be brought forward in the Guide before the discussion presented in Section 3, in recognition of its importance in framing the methodological approach to regulators.</p>	<p>Accepted.</p> <p>Material on graded approach has been given increased prominence in the final review.</p>
33		<p>Levels below Regulatory Concern</p> <p>While the Guide attempts to provide guidance via the “screening level” as to what situations or radiation levels could be considered to be below regulatory concern, significant ambiguity remains and can lead to confusion. The MCA notes the following:</p> <p>I. Lines 318 and 319 state that levels below 10 µGy/h can be considered to be below concern;</p> <p>II. Figure 3 implies the same;</p> <p>III. Figure 6 implies that even levels below 10 µGy/h need to be justified;</p> <p>V. Various references to “screening level” throughout the text do not clearly state what it means in terms of action. As the Guide is intended to be used as a framework for regulators, it should be clear about a below concern level. Alternatively, the Guide should define the environmental conditions and radiation levels that could be used to establish such a level.</p> <p><i>Recommendation:</i></p> <p>The MCA recommends that the Guide states clearly that 10 µGy/h is below regulatory concern, and that no further action is required below this level. This will give projects clarity over levels above which impact on NHB must be managed, and the public confidence that below a certain level, the NHB is protected by default. Such an approach is also consistent with current international practice.</p>	<p>Accepted.</p> <p>“Justification” replaced with “No further actions required” in Figure 6.</p> <p>Descriptive text modified throughout Section 3 in final reviewed version, including revision of terms to describe and apply;</p> <ul style="list-style-type: none"> • Reference levels, and • Screening values.

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34		<p>Prescriptive Regulation Section 4.2 defines the four triggers for requiring a non-human biota assessment, of which only one, the fourth, relates to environmental risk. The paragraph starting with line 461 prescribes uranium mining as requiring assessment, rather than relying on line 466 which covers all projects that may present a genuine risk. <i>Recommendation:</i> The MCA recommends outcome based regulation, rather than prescriptive regulation, and that triggers for requiring an NHB assessment should relate to environmental risk, not prescribed industries or activities.</p>	<p>Accepted.</p> <p>The text has been heavily modified in the final review, including the removal of the first three dot-points and a focus on relative risk.</p>
35		<p>Provide case study to illustrate Section 3.2 From line 155 in Section 3.2, various exposure scenarios are set out. The MCA considers that the concepts within these exposure scenarios may provide more useful guidance to regulators were they explained by using examples, case studies or scenarios. <i>Recommendation:</i> The MCA recommends the Guide include examples, case studies and scenarios to help explain various exposures.</p>	<p>Accepted.</p> <p>An online Annex with examples will be provided.</p>
36	Phil Crouch	<p>General Comments I had looked forward to this Guide but overall I found it disappointing. Environmental Radiation is new, and I hoped to find a clear-cut description of exactly what is required, and particularly guidance on the “Australianization” of current models, which are based mainly on Northern Hemisphere conditions. Instead I found it very confusing, and found little assistance on these matters. And some areas seemed to imply massively greater efforts than are required by internationally accepted tools such as ERICA.</p> <p>Confusion came in two main areas. Firstly, a “graded”</p>	<p>Accepted.</p>

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		<p>approach is recommended in the Guide. This approach is strongly supported, and would be expected to begin with an assessment based on generic “reference organisms”, using very conservative parameters. Only if this initial assessment indicated that there may be populations at risk would there be a need to move to an assessment based on the organisms that are actually present in the area under consideration.</p> <p>There is no clear-cut statement of these steps, indeed there is considerable confusion, with some parts of the document apparently requiring biota surveys and radiological monitoring in all cases. This is an enormous increase in complexity and seems completely out of step with the several times repeated mantra “as simple as possible”. (In parenthesis it would appear that a Commonwealth agency (unnamed) has advised the WA Government that assessments for mine closure should [always] “be conducted using local data and particularly local reference species. This will require the collection of local sample material.” Is this in fact Commonwealth policy? If it is, then it has serious ramifications, which need to be discussed in this Guide).</p> <p>The second area of confusion comes from the terms reference/representative organisms. This is related to the above concern. In some areas “reference” seems to refer to generic species etc, and “representative” to those actually present in the area, but this is by no means consistent. The definitions are of little assistance for example “RAPs (Reference Animals and Plants) – A suite of organisms recommended as models by the ICRP as Reference Animals and Plants ...” – seemingly a completely circular definition.</p>	<p>This is the intention of the Guide.</p> <p>Accepted.</p> <p>The final review of the Safety Guide has simplified wording and clarified aspects of the graded approach.</p> <p>The amendment to (the former) Figure 6 and proposed footnote should help to delineate effort.</p> <p>Additions have been made to Annex B to clarify the purpose of monitoring (i.e. in support of assessment). Monitoring is not required in all cases.</p> <p>The material in Annex B has been removed from the Safety Guide main document and will be included in online supplementary material.</p> <p>Accepted.</p> <p>Terminology will be double-checked to ensure internal consistency. The Safety Guide includes reference to ICRP and the ERICA integrated approach.</p> <p>Glossary to updated in final review.</p>

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		<p>The concept is of course tightly bound up with the difficulties that arise in applying assessment tools based on Northern Hemisphere circumstances to Australia. There is an obvious pressing need to have appropriate Australian data for use in assessments, and I looked forward to finding such information in this guide. Alas there is none, apart from the advice on the dimensions of “ellipsoids”, which in my experience has little effect on dose, and the bizarre inclusion of buffalo and fox.</p> <p>The Guide includes advice on sampling of biota. It must be assumed that it is included in anticipation that it will be a common element of a radiological environmental assessment. There is no doubt worthy advice on general sampling techniques, although a good deal of it appears rather simplistic (“Care should be taken in dissecting samples to avoid cross-contamination”). But in other areas it is not. Consider the last two sentences of the Annex “If the model used to estimate exposure of animals that consume earthworms does not include a term for soil ingestion, this bias is not critical. However, if a soil ingestion term occurs in the model, the use of undepurated worms will result in some double counting of the amount of soil consumed and will overestimate exposure.” There are sweeping implications here. It implies that a model (detailed enough to consider soil intake) is to be developed for [each?] potentially earthworm eating species, the quantity of earthworms consumed is to be assessed, radionuclide transfer factors from ingested earthworms to the organism are to be determined etc etc. And of course if this must done for earthworms, then it should also be done for all the other food sources (plant and animal) that each of the reference</p>	<p>Accepted.</p> <p>Reference will be made to local data sources such as the wildlife transfer database.</p> <p>Feral animals are not the objects of protection and buffalo and fox should be removed. Their CR data may be useful as surrogates for natives, however.</p> <p>Clarification.</p> <p>The Safety Guide has been designed to ensure protection of the environment while suitably limiting the possibility that specific biota sampling will be commonly required.</p> <p>Refer also to Comment 23.</p> <p>Detailed materials on monitoring (Annex B) will now be included in online supplementary material rather than in the main Safety Guide document.</p>

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		<p>(or representative) organisms consume. The amount of work involved is staggering. As an example, extensive radiological monitoring of the Alligator Rivers environment has been undertaken for decades, but this level of information, where it exists at all, exists for only a very few species. If such investigations were to be a regular requirement of environmental impact studies, they are likely to be exorbitantly expensive, and take decades.</p> <p>I don't believe that the authors can expect that detailed sampling and radionuclide analysis is to be an essential component of every (or even most) impact studies. The "as simple as possible" guiding principle would surely, in the majority of cases require no more than an assessment using a tool such as ERICA, and generic (preferably Australian) data. But if sampling is required, there is no specific radiological guidance in the Guide. Under what conditions is sampling required? What organisms should be sampled? How many individual organisms need to be sampled to give adequate coverage? What needs to be done to allow for seasonal or other temporal effects? What monitoring of the substrate (soil, water etc) is needed in order to determine environmental concentration factors? Indeed, is the concentration factor model adequate, or is some sort of food-chain model required (as seems implied from the earthworm case)?</p> <p>So overall the Guide leaves me more confused than I was before reading it, and with a strong foreboding that it will lead to requirements for very large programs requiring large expenditures of time and resources.</p> <p>What is needed is a simple, clear exposition of what the Guide envisages as the "graded approach" to</p>	<p>Accepted.</p> <p>See Comment 23 and the revised Figure 6.</p> <p>Clarification of the purpose of sampling in Annex B (as online supplementary information) and rewording in final review addresses this.</p> <p>Accepted.</p>

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		environmental radiological assessment. The present document does not provide this.	The graded approach clarified further as part of the final review.
36		<p>Line 81 “All of these [that is mortality, morbidity etc] should be considered when applying appropriate protection strategies for wildlife.”</p> <p>This should be “developing appropriate protection strategies. That is these “endpoints” are relevant to the planning process, but not to “applying” or implementing the strategies that have been developed.</p>	<p>Accepted.</p> <p>“Applying” replaced by “developing”.</p>
37		<p>Line 118 “The framework incorporates conceptual and numerical models (‘reference organisms’) for assessing exposure-dose”</p> <p>This is a rather odd. Clearly “conceptual and numerical models” are not “organisms” reference or not. The models go further than the “organisms”. Does it mean something like “conceptual and numerical models for assessing exposure-dose ... to “reference organisms” ... ?</p>	<p>Accepted.</p> <p>Line 119 has been amended to reflect that the numerical model is representative of organisms.</p> <p>All definitions have been reviewed in final proofing.</p>
38		<p>Line 166 “What is the geographical context (i.e. an area of 2m2 around a discharge point or an entire County or State)”</p> <p>It is difficult imagining a situation where an environmental assessment would be made on an area of 2m2. “Counties” are not universal, and vary widely in area, and again it is difficult to imagine a situation where whole states had to be assessed. Suggest just leaving it as “What is the geographical area which needs to be considered in the assessment”.</p>	<p>Accepted.</p> <p>Line 169 amended – “i.e.” replaced with “e.g.”.</p> <p>Repetitive material has been removed as part of the final review.</p>
39		<p>Line 177 “For humans, the three main issues that determine</p>	Accepted

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		<p>external dose from exposure to radioactive materials are time, distance and shielding. These issues also pertain to environmental dose.”</p> <p>I don’t see any benefit in trying to draw this parallel between radiation protection in humans, and exposure to the environment. Firstly, as it stands it is not generally correct: the source characteristics (activity, radiation type, energy etc) are at least as important as time distance, shielding. Secondly, “shielding” in this context is rarely relevant to the environmental case. I am sure the important concept – time spent in the contaminated environment – can be better expressed without bringing in this extraneous pseudo-parallel.</p>	<p>Sentence deleted. See Comment 20.</p> <p>Text removed during final review.</p>
40		<p>Line 181 “Internal dose will depend on how (and in what form) radionuclides enter the organism.” This is only part of the story. Retention, excretion etc are at least as important.</p>	<p>Accepted.</p> <p>Sentence re-worked.</p>
41		<p>Line 192 “Reference organisms.”</p> <p>I would like to make a number of comments on “Reference organisms” and the way they are used in this document. I will make some comments here, but I will come back to them in other contexts.</p> <p>This “definition” is at serious variance to other authoritative definitions eg ICRP 108</p> <p>Reference animal or plant A hypothetical entity, with the assumed basic biological characteristics of a particular type of animal or plant, as described to the generality of the taxonomic level of</p>	<p>Accepted in part</p> <p>Section edited during final review. Definitions tightened.</p>

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		<p>family, with defined anatomical, physiological, and life-history properties, that can be used for the purposes of relating exposure to dose, and dose to effects, for that type of living organism.</p> <p>Thus a “reference organism” is not a “hypothetical representation” of an organism.</p> <p>The footnote I find even more confusing: “Various compatible terms are used to describe the conceptual and numerical model used to describe an organism type, or Representative Organism (see Section 3.3 and Annex A.2). These include ‘Reference Animals and Plants’ (RAP) (ICRP, 2009) and the ERICA Integrated Approach use of ‘Reference Organisms’ (Larsson, 2008; Howard and Larsson, 2008). The latter tem is generally used in this Guide.” Now this to me means that the terms “Representative Organism” and “Reference Organism” are effectively interchangeable, and the use of one or the other is just a matter of preference. But this is not what is done in the document: for instance Figure 2 (Line 210) clearly attempts to distinguish the two terms (and I believe, incorrectly).</p> <p>Figure 2 has its own problems too. A “Representative organism” cannot be “typical of a contaminated environment – that is ridiculous, an organism is not an environment. It might be typical of one type of organism found in the contaminated environment. And a “Reference organism” is not a “numerical approximation”. Both of these are category errors: the latter error is made in many places and seems to arise from confusion between the “organism” and a method of calculating its dose (“numerical approximation”). As another example, line 200 says “Reference organisms are not real or living organisms</p>	<p>Accepted</p> <p>This was a typographical error. “Representative” should have been replaced with “Reference”.</p> <p>Section heavily edited in final review.</p> <p>Accepted.</p> <p>Figure 2 edited.</p> <p>Partially Accepted.</p> <p>The definition quoted above from ICRP108 describes a RAP</p>

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		<p>themselves. They are instead simplified conceptual and numerical models for estimating ... doses of selected representative organisms". This is certainly not the inference from ICRP 108. Reference plants and animals are described as organisms not as models. Of course they are generalised: the Reference Deer "is taken to have the characteristics of a large woodland deer ..." but they are none the less organisms. Various approximations may then be used to derive doses, and then these doses estimates may be applied to different species of deer (or other "large terrestrial mammals" such as antelope, or even kangaroos). But the reference organisms are not "models".</p>	<p>as 'a hypothetical entity'. This is not a real organism. The final review includes a review of definitions with a focus on the ERICA integrated approach.</p>
42		<p>Line 192 "Reference Organisms are hypothetical representations of plants and animals that are simplified (to ellipsoids) for the purposes of determining dose and effects parameters." The "ellipsoids" have nothing at all to do with "effects parameters". The use of ellipsoids and the modelling of size and shape of organisms are discussed at some length in the document (notably Annex A) but in fact "size" has little effect on dose (see later).</p>	<p>Accepted. Definition edited in final review.</p>
43		<p>Line 234 "If known, activity concentrations in plants and animals can be used directly in subsequent dose-rate calculations" While true, the fact is that in very few cases (certainly in no cases during EIS assessment and the like) will such concentrations be available or even obtainable. See next comment.</p>	<p>Accepted. Words altered in final review.</p>
44		<p>Line 241 "it is essential to have an appropriate organism-to-media concentration ratio"</p>	<p>Accepted. Comments 43 & 44 have been addressed by amending the description during the final review.</p>

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		See previous comment – there is a minor contradiction here – if you have the organism concentrations you don't need the CR, so it is not "essential"	
45		<p>Line 258 "These values may have been derived previously during efforts to assess human dose via the consumption of particular foods, such as meat or milk."</p> <p>This is worded clumsily, and "milk" is not a tissue. Suggest "These values may be available from studies to assess doses to humans from consumption of foods such as meat or grain". But I think it is dangerous to imply any link between dose assessments to humans (eg "bush foods") and environmental assessment.</p>	<p>Accepted in part.</p> <p>The implication is that milk is a food, not a tissue. The sentence indicates that data may be obtained from studies conducted for doses to humans.</p> <p>The section has been removed in final review as relevant information is included in the online supplementary material.</p>
46		<p>Line 293 "consider an as-complex-as-necessary but as-simple-as-possible approach"</p> <p>This is a truism, but it doesn't help much. There is scope for endless debate on what is too complex or too simple. The next paragraph should explain this, but it doesn't really do this. See next comment.</p>	<p>Noted.</p> <p>Refer next comment.</p>
47		<p>Line 295 "To reflect this, the protection of wildlife should be addressed using a tiered (or graded) approach"</p> <p>This should be a central part of the whole document, outlining how a graded approach should be used to "minimise unnecessary work". But effectively it only talks about "screening (dose) levels" and associated matters. They are of course very important, but what is missing is a clear discussion of the graded approach, that is</p> <ul style="list-style-type: none"> • An initial study using "reference organisms", conservative screening levels etc. <p>If this results in all organisms having negligible risks, then</p>	<p>Accepted.</p> <p>Tiered approach given more focus during final review of document. Step-by-step process is included.</p>

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		<p>that should be the end of the assessment.</p> <ul style="list-style-type: none"> • If (and only if) the initial study indicates that some organisms may be at risk, then further studies may be needed. These may include flora and fauna surveys (of the groups potentially at risk), review of effect data etc. <p>This needs to be spelled out as a clear step-by-step process, showing what is needed at each stage.</p>	
48		<p>Line 313 “If more realistic assumptions are made, potentially supported by site specific data, the dose rate criterion may have to be reconsidered,”</p> <p>I cannot understand this. There are two broad concepts in play: the methods of estimating doses, and the dose rate criterion. The dose rate criterion is set on the basis of doses or dose rates that may cause environmental harm. Appropriate margins of conservatism are included (see for example the quite extensive discussion on the determination of 10µGy/h in ERICA). Quite separately to this, dose rates are calculated. If for example a dose rate of 5µGy/h is calculated, but a conservative confidence interval of a factor of 3 is assumed, the correct procedure is to recognise that the dose rate may be as high as 15µGy/h: it is not to then decide that the dose rate criterion should be reduced from 10µGy/h to 3.3µGy/h. It is quite analogous to the human exposure situation: if an uncertainty in the dose to individuals is identified, then this (higher) possible dose is compared with the limits: the limit is not reduced!</p>	<p>Accepted.</p> <p>Amendments made text in final review. The former Figure 6 has been edited to clearly indicate the concepts of the graded approach.</p>
49		<p>Line 324 “Finally, it is important to note that screening levels should not be applied as regulatory limits but, rather, as levels beyond which further investigations are highly recommended.”</p>	<p>Accepted.</p> <p>Text revised in final review.</p>

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		<p>The first part is absolutely correct: but what of the second part – “highly recommended”? Are there circumstances where further investigations are not required when screening levels are exceeded?</p>	
50		<p>Line 371 “There is unlikely to be any effect at the population level if there are no deleterious effects in any of the individuals of that population. Therefore environmental reference values should be selected commensurate with the minimum dose rate level at which radiation induced biological effects in individuals occur.”</p> <p>The first sentence is something of a tautology: clearly there can’t be <i>any</i> population effects if <i>no</i> individuals are affected. The more important problem here is that the whole NHB assessment process is (or should be) based entirely on populations, not individuals. You can easily imagine situations where individuals have significantly increased risks, but there is no discernable change in the viability of the population as a whole. For instance would the viability of the human population be at risk if the cancer rate were doubled? I very much doubt it! The dose rate criterion should be set on the basis of <i>population effects</i>.</p>	<p>Accepted.</p> <p>The protection from individual effects (and hence population protection) can be used as a starting point for Environmental Reference Values, but the overall aim is to protect the population.</p> <p>Text revised in final review.</p>
51		<p>Line 449 “The practice is a ‘nuclear action’ under the Environment Protection and Biodiversity Conservation (EPBC) Act 1999.” This requirement selects just one piece of Commonwealth legislation for special mention. Other pieces of commonwealth or State legislation may have statutory requirements for environmental radiation assessment. The dot point should be more general eg “required by Commonwealth or State</p>	<p>Accepted.</p> <p>Reference to EPBC removed (see Comment 35).</p>

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		legislation”	
52		<p>Line 482 “A baseline value for natural background should be established. Environmental radiological assessment focuses on dose rates to wildlife additional to natural background.”</p> <p>In general the value for natural background is only required when an assessment is being made on an existing exposure situation, and the relevant dose rates are determined from monitoring. Then it is important to know background so that the incremental dose rate can be obtained by subtraction. But in the very common case of assessments on proposed operations, the potential impacts are determined from dispersion models or similar, and knowledge of the natural background, either generally or in detail is not required.</p>	<p>Accepted in part.</p> <p>A background measurement is not required for an assessment of a planned situation. It is good practice, however, and useful for verifying future impacts.</p> <p>A footnote has been added to lines 485 & 486 to describe this.</p> <p>It should be noted that background levels are useful in demonstrating the effects of an emergency or planned situation with respect to monitoring data and remediation.</p>
53		<p>Line 497 “As defined in Section 3.3, Representative Organisms should be determined via surveys of the affected area. Consideration should be given to relevant organisms or habitats that may be difficult to sample. These can be represented at the assessment stage through use of Reference Organism data (numerical approximations).”</p> <p>This again muddies the distinction between initial assessments that are made on the basis of “reference organisms”, with later assessments, made in response to an initial indication that some organisms may be at risk, and which may be made on the organisms actually present. It is <i>not</i> necessary to determine the actual organisms present (“Representative Organisms”?) in the initial assessment. The paragraph also uses the odd structure “Reference Organism data (numerical approximations)”. What additional information is meant to be conveyed by including</p>	<p>Partially Accepted</p> <p>The Section that is quoted refers to the construction of the scenario. It suggests that the organisms within the area of interest are included in the scenario being built – undergoing the assessment (using any assessment tool) is considered in Section 4.4 (which is retained as A.4).</p> <p>Terminologies used have been updated in the final review.</p> <p>Accepted</p> <p>Remove the phrase “numerical approximations” from line 503.</p>

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		<p>the words “numerical approximations”?</p> <p>The wording here is very difficult (for example the second sentence – does this mean that you should give more or less attention to “organisms or habitats that may be difficult to sample”?) But more importantly the whole section seems to be inconsistent with the approach in ICRP, the ERICA model etc. In those, an initial assessment is carried out on <i>Reference Organisms</i>. If this assessment indicates that there is no significant risk, then that is the end of the process. The inbuilt conservatism in parameters and reference levels is designed to ensure that there is no reason to go further. Thus if the Reference Organism “Reptile” is protected, there is no need to do a survey to determine exactly what reptiles are present. The Guideline envisages (in fact directs) that representative organisms in the environment first be determined, then an assessment be done on <i>these</i> organisms. This is particularly pointless given the paucity of data on individual species available and likely to be available in the foreseeable future. For example assume a fauna survey is done and determines that red, black, brown and green snakes are important in the environment, but that the only useful radiological data available is for a generic “snake”. What has been achieved apart from a massive amount of additional work? Or does it imply that sampling and further radiological studies need to be done on <i>each</i> of these species?</p> <p>This inconsistency is amplified in Annex A eg Line 797 ff. where detailed instructions for determining the Representative Organisms are given. Of course it is perfectly reasonable to use <i>generic</i> site specific information in carrying out the assessment: for instance using kangaroos instead of deer, or using desert or</p>	<p>Accepted in part.</p> <p>As above, the intention of this Section is to build the scenario being considered in order for assessments to be undertaken with any appropriate tool. It is not the intention that a complex survey is performed before a screening assessment is applied.</p> <p>A paragraph reflecting the comment has been included.</p> <p>Note. This document is a Safety Guide – it should not include directive language.</p>

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		<p>tropical transfer factors (if available) in preference to (predominantly) cool temperate zone factors as in ICRP or ERICA, and this should in fact be encouraged wherever relevant data is available. But then again in line 797 “In evaluating doses to biota at a site, it is usually impractical to calculate dose for each of the numerous diverse plants and animals that may inhabit, or use the site”. USUALLY impractical???</p> <p>Can you give an example where it might be even potentially possible? And in that case which of the “numerous diverse plants and animals” should have their doses calculated?</p> <p>Determining, via surveys, site specific Representative Organisms and their radiological parameters, when a generic assessment based on Reference Organisms indicates that there is a minimal risk, is a very large increase in effort for no discernible benefit.</p>	<p>Accepted. Language modified to remove “usually”. Annex A will be retained in online supplementary material.</p> <p>Accepted. That is not the intention of the guidance. Paragraph added at beginning of Annex A – it should not apply to screening assessments.</p>
54		<p>Line523 “In rare cases, consideration can also be given to the redundancy of the exposed habitat in relation to the broader regional context ...”</p> <p>I do not believe that this situation is “rare” at all! It is in fact very common. In the non-radiological case the total destruction of species in the area of say the stockpiles or tailings facilities of a mining operation is inevitable, and is accepted providing that these areas are not in any way unique, and that there is an extensive “reservoir” of unaffected environment that preserves the environmental features of the region. It should be the same for radiological effects: it is of little overall consequence to the general environment if a relatively small area surrounding an operation is affected radiologically, provided that a large</p>	<p>Accepted. “In rare cases” removed.</p>

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		surrounding area is unaffected. This is a most important point.	
55		<p>Line 539 “These two tools have been tested in various inter-comparison exercises to look at model-model differences introduced by user assumptions”</p> <p>This is left hanging, and amplification would be very useful. What is the result of these inter-comparisons? Which tool is most appropriate for use in Australia generally, and for particular Australian situations?</p>	<p>Accepted.</p> <p>Reference to Doering (2010) included for Australian context.</p>
56		<p>Line 560 “Where the screening has failed, a more complex assessment (where site-specific data is applied)”</p> <p>Firstly, it is not “screening” that has failed: screening has succeeded in identifying a potential problem. But the more important comment on this section is that it again confuses the reference/representative dichotomy. The implication is that no site specific data need be used in the initial assessment – quite correctly in my opinion. But this does not seem to be the implication of other sections of this document.</p>	<p>Accepted and Noted.</p> <p>Language tightened.</p> <p>Even if no site-specific data is included, data relevant to the situation being screened should be included where possible.</p> <p>Consistency check conducted on advice for the use of site-specific or generic data during screening.</p>
57		<p>Line 565 “Populations and ecosystems are normally the overall objects of protection (rather than aiming to protect at the individual plant or animal level).”</p> <p>As discussed above, the NHB assessment is (or should be) all about populations and ecosystems, and not about individuals. The only possible case where effects on individuals should be considered is in the case of very rare or endangered species where loss of single individuals may have serious implications. But it is very unlikely that in such</p>	<p>Accepted and Noted.</p> <p>The protection of populations and ecosystems is also described in Section 2.</p> <p>The statement has been tightened by removing “normally”.</p>

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		<p>a case radiological considerations would be dominant (and indeed the sampling of that species for radiological purposes may be damaging). This statement needs to be expanded.</p>	
58		<p>Line 729 “As defined in Section 3.1, Reference Organisms are hypothetical representations of plants and animals that are typically simplified (to ellipsoids) for the purposes of determining dose and effects parameters. One of their key practical purposes is to provide input information (mass, size dimensions, etc.) into the detailed dosimetric modelling necessary to calculate dose.”</p> <p>There are a number of points I would like to make here (some of which I have made elsewhere).</p> <ol style="list-style-type: none"> 1. This “definition” is completely at odds with the definition given in the glossary and in eg ICRP 108. 2. In more authoritative use (eg ICRP 108), the Reference plants and animals are not “simplified” but “generalised” – that is for example a generic “duck” is used to represent a range of waterbirds. 3. Any “simplification” (to ellipsoids or otherwise) has no relation at all to “effects parameters”. 	<p>Accepted in part</p> <p>Modifications made to description of Reference Organisms in final review (see comment 41).</p> <p>Glossary updated.</p>
59		<p>Line 763 “Guidance on reference organism geometry”</p> <p>A good deal of space is given to organism dimensions, but in fact the size of the organism is often (possibly usually) of very little significance to the dose. As an example, the ERICA tool has been used to calculate the dose to user defined “deer” with masses of 2kg and 200kg exposed to the U series radionuclides (in equilibrium). The total dose in these two cases only differs by a few percent, for a factor of 100 change in mass.</p>	<p>Partially accepted.</p> <p>Size and mass is one factor that can affect the dose rate, and is a common input into dose assessment models as the comment indicates. The more influential factors that need to be considered are the Concentration Ratio and exposure (behaviour) data.</p> <p>Text altered in final review.</p>

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60		<p>Line 796 “Reference Organism Geometry Table 3”</p> <p>I find it absolutely astounding that this table lists water buffalo and red fox as “some Australian organisms” for which default dimensions can be used. It is incomprehensible that data for vermin should be included here. It seems that the document has completely missed the point: this whole process is about “protection of the biological diversity of wildlife living in their natural environment” (Scope line 35). To even hint that the guideline is to be applied to protection of introduced species, particularly vermin, seems to be a complete aberration.</p>	<p>Accepted.</p> <p>This oversight will be corrected (see Comment 53).</p>
61		<p>Line 798 “it is usually impractical to calculate dose for each of the numerous diverse plants and animals that may inhabit, or use the site.”</p> <p>Something of an understatement. It is surely always impractical to assess all of the organisms.</p>	<p>Accepted</p> <p>“Usually” removed (see Comment 53). Annex A removed from the Safety Guide and included in online supplementary information.</p>
62		<p>Line 805 “all affected organisms should be considered,”</p> <p>Presumably this means potentially affected, but even then it is an impossibility to even “consider” all organisms.</p>	<p>Accepted.</p> <p>The emphasis was intended to be on removing human bias. Sentence revised to replace “affected organisms” with “potentially affected species”.</p> <p>Annex A removed from the Safety Guide and included in online supplementary information.</p>
63		<p>Line 854 “site-specific data should be used where possible. If site-specific sampling cannot be accomplished (on a protected species for example) ...”</p>	<p>Accepted.</p> <p>A generic screening is not always appropriate, as parameters can differ by orders of magnitude. Where site-specific data is not available, data representative of the</p>

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		<p>This seems to be saying that some site specific data collection will always be required, unless there are very extenuating circumstances (eg rare or endangered species). This is not the case. As I have said above in several places the overriding recommendation to have a graded approach to the assessment will mean that in most cases assessment with generic information will be enough to establish that the environment is protected.</p>	<p>region and species should be considered.</p> <p>It is not intended to imply that sampling is required. Wording reviewed and sentence removed.</p>
64		<p>Line 950 “Guidance on field sampling to support environmental dose assessments”</p> <p>I believe that this Annex should be completely removed. There are several reasons for this. Firstly, I believe that it is only in the most extreme circumstances that a sampling program for environmental radiological assessment would be necessary, and even fewer cases where it is likely to provide useful data. Consider the case of Kakadu which has been extensively sampled and tested over more than 3 decades, but it appears that there is still very limited data on organism radionuclide concentrations, transfer factors etc.</p> <p>Secondly, environmental sampling programs are commonly implemented for non-radiological purposes. These would be conducted under their own procedures. It would be counter productive to introduce new guidelines which may conflict with existing ones.</p> <p>What might be of use is advice on any specific radiological requirements that should be included. This may include specific radiological sample collection, storage and analysis requirements. There is nothing of this in the document.</p>	<p>Partially Accepted & Noted.</p> <p>Annex B to include additional advice on usage and interpretation. The annex will be removed from the Safety Guide but will be included in online supplementary information.</p>

#	SUBMITTER	COMMENT	RESPONSE
65	Sharon Paulka	<p>Overall I think the safety guide is well written and covers all of the key issues.</p> <p>As general overall comments:</p> <ol style="list-style-type: none"> 1. I think that the document need to be clearer in areas relating to the use of site specific data and more advanced assessments. Much of the time the document discusses details that would related to higher level assessments but does not make it clear that this would not relate to initial or lower level assessments as per a tiered or graded approach. Rather the document could be interpreted to infer that detailed site specific monitoring and assessments were required for a screening assessment. 2. I think the use of the terms "reference organisms" and "representative organisms" is confusing. While I understand the why an attempt has been made to separate these, and in practice when doing an assessment this is the general process. The use of the terms themselves through the document is quite confusing, possible because they are very similar. I expect that a person that is new to an assessment would not understand this at all. The question is do we need the two separate words, I am not convinced? 3. I am not sure that I agree that these assessments can be applied to emergency situations. I know that this is covered to some extent by ICRP, but these assessments need steady state conditions to work which is not the case for emergency situations. I think that a different method may need to be applied for these cases and consideration should be given to removing them from this safety guide. 	<ol style="list-style-type: none"> 1. Accepted – Working around Annex A and relevant sections to be reviewed. Annex A to be removed from the Guide and included in online supplementary material. 2. Accepted - The use of these terms has been modified for more consistency with the ERICA & ICRP approaches. Section 3 has been heavily modified in final review (also see Comment 41). 3. Partially Accepted – the issues associated with using Steady-State models for emergencies have been revised in the final review, with the shortcomings described in Section 3. The use of dynamic models during an emergency is also considered in the ‘Assessment Context’ Annex. Steady-state models are relevant in the recovery phase (equivalent to an existing situation).
66		<p>Section 2.2, lines 100-101</p> <p>I do not agree that using the dose rate benchmark in this</p>	Accepted.

#	SUBMITTER	COMMENT	RESPONSE
		<p>use of site specific should only be required for these higher level "complex assessments".</p> <p>I think more detail needs to be added to this section to explain what a complex assessment involves (not just a probabilistic Tier 3 level assessment) and it also needs to include the step of comparing dose rates to either effects data or the Environmental Reference Values (as per the flow shown in Figure 1).</p>	<p>this.</p> <p>Accepted</p> <p>The final section of Chapter 3 has been edited to strengthen advice.</p>
69		<p>Line 375-376</p> <p>This sentence is a little out of place, we spend time speaking about population level endpoints and this sentence is about biological effects to individuals. This seems a little confusing.</p>	<p>Accepted.</p> <p>Text revised (see comment 50).</p>
70		<p>Line 382-383</p> <p>I think this sentence should be removed. There is such a small amount of effects data that making the data set smaller data set even smaller through this refinement could end up with erroneous results.</p>	<p>Rejected.</p> <p>Whilst it is true that there is a lack of data, the sentence is written as a guideline in order for assessors to be aware that the situation can affect the data obtained.</p>
71		<p>Section 4.2</p> <p>The dot point provided under lines 447-459 should be reviewed to make it clearer the real reasons for why an assessment should be done. Saying that an assessment is required because a regulator requests it will not help a regulator in determining when they should request one to be done. Likewise for the nuclear action reason. This safety guide should provide guidance to both regulators and operations as to the situations that could present a risk to the environment and thus require an assessment. There are already several examples of regulators requesting or approval conditions being placed on the need for</p>	<p>Noted and Accepted.</p> <p>Section revised. See comment 34.</p>

#	SUBMITTER	COMMENT	RESPONSE
		<p>assessments in situation that clearly present not risk, in fact they are well below what would even be deemed radioactive by the National Directory.</p> <p>I think this is the most important section of this safety guide and serious consideration should be given to "when an assessment should be done". This will make it easier not only for operators but for regulators as well.</p>	
72		<p>Section 4.3 Please consider using standard nomenclature for risk assessment in this section and possibly even referring to the risk assessment standard. These assessments are ecological risk assessment and the first step is to either "set the context" as per the Australian Standard for all risk assessments, or "problem formulation" as per the US EPA guide for ecological risk assessments.</p> <p>Also need to mention in this section the need to develop a conceptual model. The steps for this are described but it is important to mention that one needs to be constructed. This makes sure a proper pathways analysis is completed.</p>	<p>Accepted.</p> <p>Text revised.</p>
73		<p>Line 485 I do not see the reason why a baseline value for natural background is required for this assessment. Yes I agree it is required for other reasons, but not related to these assessments. Remove this first sentence.</p>	<p>Accepted.</p> <p>Sentence remains, but footnote added for clarity. See Comment 52.</p>
74		<p>Line 500-501 Organisms can be determined in many ways, not just surveys. This should be made clear. For many assessments a literature search and threatened species database search is all that is required.</p> <p>This comes back to the general comments on levels of detail for different tiers/grades. A survey of flora and fauna</p>	<p>Accepted</p> <p>500-501 to be expanded to include these words; "For many assessments a literature search and threatened species database search might be all that is required."</p>

#	SUBMITTER	COMMENT	RESPONSE
		would not be required for a tier 1 screening assessment for a small, low activity operation. Alternatively would be needed for a large higher risk operation in a sensitive area. Note this is also relevant to line 814.	Accepted See comment 63 - language revised in final review.
75		Line 513-515 I do not agree that these assessments, using the described methods, are applicable to short-term releases. Remove this sentence	Partially Accepted. Reference to dynamic models for short-term releases is relevant, however the advice has been edited to indicate that overall advice in the Safety Guide might not be relevant for these situations. The description has been revised in Section 3 after the final review.
76		Line 517-518 The statement about conducting assessment out to 10,000 years because of long lived radionuclides should be removed as this is correct. Assessments are conducted for steady state conditions for the duration of operations, and may look at a worst case assessment of cumulative concentrations as a result of several years of operation. But the concentration of radionuclides in the environment would only reduce after the completion of operations so an assessment does not have to be completed for impacts over 10,000 years.	Partially Accepted. These timescales should be considered due to the possibility of eventual mobilisation of radionuclides post-operation (e.g. groundwater, degradation of controls, etc.). The sentence has been edited to reflect this.
77		Line 519 This section seems to be out of order, this is for after the assessment.	Noted, but no change.
78		Line 536 This section only mentions the two tools. I think it is important to note here that your own model or spreadsheet could be developed using the ICRP described methods.	Accepted. Section edited.

#	SUBMITTER	COMMENT	RESPONSE
79		Figure 6 Suggestion to change the last triangle to "comparison with organism effects data"	Partially Accepted. Caption edited to reflect this.
80		Line 563-564 It is not always necessary to use site specific data if the screening assessment has failed. Yes in some circumstances but this is very specific. Again refer to general comments that this does not distinguish between levels of assessment. Rather than just say site specific data, a range of options could be provided like the wildlife transfer database, or the new ARPANSA TR167 etc....	Accepted. Language revised to reflect that more relevant data from literature can be used.
81		Line 786-787 I do not agree that the ellipsoids are Eurocentric, there is a range of animals and plants in Australia and Europe within each of the reference organisms (or RAPs) and only one general ellipsoid is chosen. If you do a review of all the animals and plants in an area and compare them to the reference organism sizes then several of them will match and many will not. This is the same for Europe. Once again the detail required in matching of organisms should be dependent upon the risk of the operation as per a graded approach. I think this sentence should be removed. If some sort of review is required at this level then it should be specific to higher risk operations.	Accepted. Paragraph edited to indicate this should occur only for 'more complex assessments'. Overall description revised in final review. Annex is included in online supplementary material.
82		Table 3 I do not think it is appropriate to have feral animals in this table. There should never be a requirement to assess risk to feral animals that are subject to routine culling.	Accepted. Feral animals removed. See comment 36.
83		Annex A and B in general A qualification needs to be placed at the start of these	Accepted.

#	SUBMITTER	COMMENT	RESPONSE
		annexes to qualify that the majority of this is relevant to more detailed assessments and higher risk operations. Refer general comments	Text added. Annexes A & B removed from Safety Guide and included in online supplementary information.
84		Line 841-844 I do not understand the need for this paragraph	Noted. Paragraph is valid in terms of optimising scientific effort/resources.
85		Line 845-846 Again I do not understand this statement. It is important to assess threatened species and these are usually identified as part of most assessments. It does not mean that samples of them are required. This statement is inferring that to do an assessment sample data from site animals is required. This is definitely NOT the case.	Accepted. Delete statement.
86		Line 847-856 This paragraph is very details and I am not sure is providing any value	Partially accepted. Paragraph reduced for clarification.
87		Line 868 No mention is made in her of the ARPANSA TR167	Accepted Include reference to TRS167 in 'breakout' box.
88		Line 892-899 I agree that there can be substantial differences in CRs for different situations. However the use of CR's themselves is full of assumptions and large errors. Caution should be taken when trying to drill into the small details here when the error bars on the data are significantly greater than the changes within these details. Also the assumptions within the parameter of relating media directly to organism have significant potential errors.	Accepted. The statements referred to are precautionary, however a statement relating to uncertainty has been included.

#	SUBMITTER	COMMENT	RESPONSE
89	Supervising Scientist	In general, the text of the safety guide is convoluted, making it difficult to follow and understand. This unfortunately diminishes the meaning and value of the guidance that is provided. We suggest a thorough editorial review and 'clean-up' of the text to improve readability and the clarity technical advice.	Accepted. The final review has included the removal of repetition and difficult language. The detailed Annexes have been cut back to be included in supplementary material.
90		<p>The parts of this safety guide that relate to screening levels and environmental reference values are generally convoluted, difficult to read and provide no real practical advice. They only tend to invoke confusion and annoyance. Instead of suggesting the use of the ERICA 10 µGy/h screening level and then user-defined environmental reference values for environmental protection, wouldn't it be much simpler to just follow the advice of the ICRP on using reference values based on the DCRLs (see ICRP Publication 124)? Australia follows the advice of the ICRP on dose limits and reference levels for humans; why not follow it for wildlife?</p> <p>We also note that a draft IAEA safety guide on radiation protection of the environment (DS427) is generally consistent with the advice of the ICRP in using reference values based on the DCRLs.</p> <p>If choosing to follow the advice of the ICRP on using reference values based on the DCRLs, then it would be prudent to provide some additional advice in the safety guide on what to do in situations where:</p> <p>1) it is either impractical or impossible to meet the reference values; and</p> <p>2) wildlife are naturally exposed to dose rates above the reference value (e.g. does it make sense to suggest an incremental increase for environmental protection purposes that is less than the natural background level?)</p>	<p>Partially accepted.</p> <p>The Safety Guide includes advice from a number of international sources. This includes the ICRP, IAEA and ERICA integrated approach. This is consistent with Best Practice.</p> <p>The methodology applied was recommended for Australia by Doering (2010).</p> <p>The wording has been heavily edited in final review to clarify intended meaning.</p> <p>The RHC Safety Guide recommends that reference values are consistent with DCRL's, which is consistent with the IAEA advice mentioned.</p> <p>Agreed.</p> <p>Advice has been incorporated into the revision of Section 3.</p> <p>Regulatory policy is outside of the scope of this Safety Guide, however the Background (S1.2) has been modified</p>

#	SUBMITTER	COMMENT	RESPONSE
			to indicate that exposures above and beyond background are considered.
91		Several different terms are used in the safety guide to describe the process of assessing radiation doses to wildlife (e.g. radiological risk assessment, environmental radiological assessment, biota dose assessments, etc). To avoid confusion, a single term should be used and defined in the glossary.	Accepted. These terms have been consolidated where possible in the final review, with definition in Glossary.
92		Use of dynamic models is mentioned several times in the safety guide. It might be useful to describe what a dynamic model is and what information is generally needed to parameterise such models.	Partially Accepted. Additional references included. Dynamic model & Steady-State model to be included in glossary.
93		There is no mention in the safety guide about environmental media concentration limits (EMCLs) or how these could be used in the assessment context. Why not?	Accepted. EMCLs included in 'Assessment Context' Annex.
94		Lines 9-12 The Fundamentals for Protection Against Ionising Radiation (2014) does not include any explicit recommendation for 'demonstrating protection of the environment'; it is implicit at best. The Fundamentals does include environmental exposure as a distinct exposure category (something new that we haven't seen before in Australia's national radiation protection recommendations), perhaps some discussion around this point could be included in the background information of the safety guide.	Accepted. Background revised in final review.
95		Line 11 The Australian system now includes recommendations for demonstrating <u>radiation</u> protection of the environment.	Accepted.
96		Lines 23-25 This sentence seems unnecessary and in some ways duplicates what is said in section 1.3. Suggest deleting it.	Accepted. Sections revised in final review.

#	SUBMITTER	COMMENT	RESPONSE
97		<p>Lines 33-34 “This Safety Guide specifically focuses on environmental radiological protection (i.e. protection of the biological diversity of wildlife living in their natural environment)” A key definition missing from the glossary is biological diversity. Additionally, the definition of wildlife should be amended to make clear that for the purposes of environmental radiological assessment wildlife does not include farmed, feral or domesticated species.</p>	<p>Accepted.</p> <p>Definition of “biological diversity” to be added to the glossary. “Wildlife” definition to be updated to exclude stock, farmed, feral or domesticated species.</p>
98		<p>Lines 33-37 This sentence is long, convoluted, difficult to understand, and in some ways makes no sense at all. Suggest re-wording.</p>	<p>Accepted.</p> <p>Reworded into two sentences. Section revised.</p>
99		<p>Lines 44-48 Is this section necessary? It is generally understood that a safety guide is not a regulatory style document and does not need to be complied with. Suggest deleting.</p>	<p>Partially accepted.</p> <p>The section is consistent with style guidance on the production of RHC documents. Interpretation of the document is important to avoid the Guide being used as a regulatory document, however the sentence has been revised to simplify.</p>
100		<p>Lines 64-65 Is this sentence necessary? Suggest deleting it.</p>	<p>Accepted.</p> <p>Revised in final review.</p>
101		<p>Lines 66-67 Suggest changing the title of this section to: OBJECTIVES OF RADIATION PROTECTION OF THE ENVIRONMENT Adding “from ionising radiation” to the title of this section and to sentences elsewhere in the text is clumsy. It should be made clear from the beginning that use of the word radiation refers to ionising radiation.</p>	<p>Partially accepted.</p> <p>Emphasis on ionising radiation at beginning of the document (Scope) has been strengthened.</p> <p>The name and focus of this section has changed in the final review.</p>
102		<p>Lines 68-74</p>	<p>Accepted.</p>

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		These sentences are convoluted and do not give a clear indication of what the objectives of radiation protection of the environment actually are. Suggest re-wording these sentences into a more clear and coherent form, pointing out that the general protection objective is to ensure the maintenance of robust populations of wild plants and animals. Key word there being 'populations', which does not currently appear in these sentences in the safety guide.	Section re-worded in final review.
103		Lines 75-105 (Section 2.1 and 2.2) Do these sections actually fit within the chapter on 'objectives of radiation protection of the environment'? Would it make more sense to move them into relevant parts of chapter 3 or chapter 4?	Partially Accepted. The section has been heavily edited in the final review, including removing repetition and integrating text.
104		Line 87 "All of these should be considered when applying appropriate protection strategies for <i>wildlife</i> ." This statement is unclear. Some additional detail may be required to explain how each of these biological endpoints should be considered, e.g. are some endpoints more important than others when it comes to protection of populations and should protection strategies be more strongly based on those particular endpoints?	Partially Accepted. The section has been heavily edited in the final review, including removing repetition and integrating text.
105		Lines 89-97 Is this paragraph necessary? Seems it could be deleted without any loss of useful information.	Accepted. Section 2 has been heavily revised in the final review. This paragraph has been removed.
106		Line 111 Replace: through international collaboration With: internationally	Accepted.
107		Line 124 (Figure 1) Suggest including an additional box after environmental radionuclide concentrations called 'exposure scenario' and	Rejected. The figure is not being changed excessively to preserve the

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		then further additional boxes called representative person (public) and representative organism (environment). The exposure scenario and representative organism together describe the interaction of the organism with the contaminated environment. Without this information an assessment of the dose cannot be made.	links to the ICRP approach. Exposure scenario is considered in Section 4.
108		Lines 147-149 Expanding knowledge and merging acquired information into databases does not specifically assist at the regulatory level, but rather assists at the national and international level to collate and make available data which could be used for assessment purposes. Suggest deleting this bullet point.	Accepted. Deleted.
109		Lines 127-151 These sentences should be included as part of section 3.1.	Accepted. These sections have been revised and rearranged in the final review.
110		Lines 152-176 Suggest moving this information into the relevant parts of section 4 as these questions are to do with assessment considerations rather than the framework for protection.	Partially Accepted. Much of this information has been deleted or moved in the final review to reduce repetition.
111		Line 164 "Routine or regular releases into the environment are best assessed as chronic, long-term releases (equilibrium situation)" Why should a routine release (which may be short-term) be assessed as a chronic long-term release? For short term releases the total doses to an organism could be assessed and compared with benchmarks for acute doses provided by UNSCEAR (or ERICA) (see for example Strand et al 2014, Environ Sci Technol Lett 2014, 1, 198-203).	Partially Accepted. The line mentioned has been deleted in the final review to reduce repetition.

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112		Line 175 What is meant by “in situ or in transit”? Please explain.	Partially Accepted The line mentioned has been deleted in the final review to reduce repetition.
113		Lines 177-181 This is an assessment consideration on how an organism might interact with a contaminated environment and should be moved to the relevant part of section 4.	Partially Accepted The lines mentioned has been deleted in the final review to reduce repetition.
114		Lines 182-190 This information is to do with assessment considerations and should be moved to the relevant parts of section 4.	Partially Accepted The line mentioned has been deleted in the final review to reduce repetition.
115		Lines 214-215 What is the purpose of including this statement? Suggest deleting it.	Partially Accepted. This section has been heavily revised in final review.
116		Line 223 Please explain the meaning of: “screening the environment at the ecosystem level”.	Accepted. This section has been heavily revised in final review. The phrase has been deleted.
117		Lines 235-294 (Section 3.4) Integrate this section into the relevant parts of section 4 on assessment considerations.	Partially Accepted. This Section has been heavily revised in final review.
118		Line 245 It should be the concentration ratio for organism-media combinations, not for “those environmental media”.	Accepted.
119		Line 247 the environmental media in which they inhabit.	Accepted.

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120		Line 261 It is unlikely that a CR is available for milk of wildlife species. A clearer definition of 'wildlife' is required.	Accepted. This Section has been heavily revised in final review, milk removed.
121		Line 277 To what soil depth are you talking about for calculating CRs?	Noted. This Section has been heavily revised in final review. The depth on the circumstances - for flora root depth will vary according to the plant type.
122		Lines 295-325 (Section 3.5) Integrate this section into the relevant parts of section 4 on assessment considerations.	Partially Accepted. The final review has restructured the sections, however the section on application of reference levels has remained prominent in the Guide to reflect other comments.
123		Line 297 "as-complex-as-necessary but as-simple-as-possible" Shouldn't this be as simple as possible but as complex as necessary	Accepted.
124		Line 298 What is meant by " <i>unnecessary work</i> " and unnecessary for whom? Perhaps a better way to phrase this would be ' to optimize resources spent on the environmental assessment '	Accepted.
125		Footnote 4 A concentration ratio approach is unlikely to apply to doses from radon and radon progeny in air and this is probably the reason why assessment tools like ERICA are not capable of calculating radon-related doses to wildlife. An allometric approach has been suggested to calculate radon-related doses to wildlife, see Vives i Batlle et al 2012, Science of the Total Environment 427-428, pp 50-59.	Accepted. Modify footnote to include "however, a concentration ratio approach is unlikely to apply".

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126		Lines 300-308 Natural dose rates to the environment can be above 10µGy/h and a discussion on the treatment of species naturally exposed to high dose rates seems warranted.	Rejected. The Safety Guide is concerned with doses due to human action (see Section 1). It is not suggesting that areas where wildlife is exposed to naturally high dose rates should undergo intervention.
127		Line 311 The tier 2 assessment should not simply use less conservative assumptions, but needs to demonstrate that the use of less conservative assumptions is justified.	Accepted Text modified.
128		Line 321-322 Please provide some information on how the optimisation process using environmental reference values actually works.	Partially Accepted. The revision of Section 3 discusses this process, as does the Annex on 'Assessment Context'.
129		Line 323 <i>"As the complexity of the assessment increases, so too do the effort and data requirements."</i> Isn't this just stating the obvious? Suggest deleting.	Accepted.
130		Line 349 (Table 1) IAEA and UNSCEAR values are looking at population effects, ICRP DCRLs give dose rate bands where effects may occur to individuals of that type of Reference Animal or Plant. This should be emphasized in Table 1.	Accepted. Caption edited.
131		Line 349 (Table 1) It needs to be noted (perhaps in a footnote to the table) that the UNSCEAR value of 100 uGy/h for terrestrial organisms applies to the most highly exposed individuals of the population and not to the average exposed individuals of the population.	Accepted. Footnote added to table.
132		Line 373-376 <i>"Therefore environmental reference values should be selected commensurate with the minimum dose rate level"</i>	Accepted. Reworded.

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		<p><i>at which radiation induced biological effects in individuals occur.”</i></p> <p>This contradicts the statement made previously (Line 364) and on subsequent pages (for example Line 426-427). It is about the protection of the environment and not of an individual of a species within the environment. This would imply that as soon as there is a dose rate above the effects level to an individual that the level of effort needs to be increased.</p>	
133		<p>408-434 (Section 3.8) Suggest integrating this section into the relevant parts of section 4 on assessment considerations.</p>	<p>Partially Accepted. Section now stands alone as Section 4.</p>
134		<p>Lines 410-411 <i>“The approach taken to radiological protection of the environment in this safety guide is, by design, conservative.”</i></p> <p>How is it conservative by design? No useful information has been provided in the safety guide on how to build conservatism into the assessment process. Suggest including some guidance on conservative assumptions that could be made within the assessment context (e.g. assuming 100% occupancy of the organism in the contaminated environment, placing the organism in the environmental compartment that would maximise exposure (in-soil instead of on-soil), using maximum or upper percentile values of CR or media activity concentration, etc).</p>	<p>Partially Accepted.</p> <p>The section has been revised as part of the final review. It is anticipated that the proposed online annex of examples will help to clarify some of the more specific guidance issues.</p>
135		<p>Line 418 Why would more realistic base assumptions a priori result in a confirmation that the environment is being protected?</p>	<p>Accepted.</p> <p>The lines (and the Section) have been modified in the final review.</p>
136		<p>Line 436 (Section 4) An additional sub-section on ‘reporting’ should be included to provide guidance on what to include in an assessment</p>	<p>Rejected.</p> <p>Such matters are expected to be discussed/resolved</p>

#	SUBMITTER	COMMENT	RESPONSE
		report and to what level of detail, particularly for those reports that are being submitted to a regulator as part of an approvals process.	between radiation practices and the regulatory body.
137		<p>Line 436 (Section 4) Guidance on data sources and data selection should be included, especially for CRs, since this parameter is likely to have the greatest influence on the assessment result. Guidance on the use of generic versus site specific CR data should be included; when is it acceptable to use generic CR values, are they good enough for assessments in the regulatory context, should an analysis (or discussion) of uncertainties be included if using generic CR data?</p>	<p>Accepted.</p> <p>The revised Section 3 includes guidance on using generic CR data.</p>
138		<p>Line 436 (Section 4) Some cautionary advice on using tiered approaches should be included, especially for tier 1 level assessments where certain assessment tools (e.g. ERICA) do not allow the user to enter any organism information. Are tier 1 assessments good enough to demonstrate radiation protection of the environment in the regulatory context?</p>	<p>Accepted.</p> <p>Tier 1 assessments are probably good enough to demonstrate radiation protection of the environment in the regulatory context, however such matters involving compliance and regulatory policy are outside of the scope of this Safety Guide.</p>
139		<p>Line 436 (Section 4) Some advice on how to deal with doses from radon and progeny should be included since: 1) Commonly used assessment tools (e.g. ERICA) are not capable assessing radon-related doses; and 2) The uranium mining industry is likely to be a major user of this safety guide.</p>	<p>Noted.</p> <p>1) Refer to footnote in Comment 125.</p> <p>2) The Safety Guide is intended to apply to all radiation practices with potential offsite release and, for example, may include Universities and Hospitals that dispose of wastes to sewers.</p>
140		<p>Line 460 Change: Building a scenario To: Exposure scenario</p>	Accepted.
141		<p>Line 473-474 Is it suggested to include a full FEP analysis? Needs clarification.</p>	<p>Rejected.</p> <p>It is not necessary to include all of these for all situations.</p>

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			The degree will vary, as described by: "Scenario building <u>can</u> include a description of;".
142		Line 478-480 Suggest deleting this sentence.	Rejected. The effects of radiation exposure should be considered in the context of other contaminants in order to establish relative risk.
143		Line 483 (Figure 4) Change: Timescales To: Spatial and temporal scales	Partially Accepted. The title remains, however, "spatial extent" has been added to line 487 (Source).
144		Line 486 Natural dose rates to the environment can be above 10uGy/h and a discussion on the treatment of species naturally exposed to high dose rates seems warranted.	See comment 126
145		Line 517 Under what proviso is it recommended to consider "a tens of thousands of years assessment"?	Partially Accepted. See comments 2 & 76. Assessments of these timescales are appropriate in the case where long half-life radionuclides are considered and assumptions are made based on engineering controls lasting for these time periods. Paragraph altered to reflect this.
146		Line 521 What is meant by an "effect of significance, or significance" in the context of risk in general?	Partially Accepted. Line 521 amended to include the term "deleterious".
147		Line 544 Important reference is missing here: (Stark et al.2015. Envpol 196, 201-213)	Accepted. Reference added.
148		Figure 555 (Figure 6) There is no exit from the last feedback loop. What happens if a complex assessment using site- and species-specific data indicates doses to wildlife above the environmental reference value? Is the practice not justified?	Accepted. Regulatory policy on acceptability of assessments which indicate significant questions concerning radiological protection of the environment is a matter for the NDRP

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			and/or specific regulatory bodies. Figure and wording adjusted. Section 3 altered in final review.
149		Line 560 Please provide some examples of ‘conservative assumptions’ that could be applied within the initial screening assessment.	Partially Accepted. The proposed Online Annex featuring examples could include this type of detail.
150		Line 563-566 For a complex (tier 3) assessment, which percentile value of the calculated dose rate should be compared to the environmental reference value for the purposes of demonstrating protection of wildlife populations? Alternatively, what percentage of the exposed population can receive a dose above the environmental reference value and the environmental exposure situation still be considered acceptable?	Noted. The Safety Guide is not a regulatory document. It is a tool to permit practices to consider how they might address potential questions of radiological exposure of the environment. Matters of compliance (yet to be developed) rest with radiation regulators.
151		Line 574-575 Certainly stakeholders need to be engaged during the assessment process, but <i>“at all stages of the assessment”</i> ?	Accepted. Reword, replacing "At all stages of" with "During".
152		Line 576 The level of engagement should be commensurate with the level of community concern.	Noted.
153		Line 576-578 Certainly the consultation process should be open and transparent and be informative for stakeholders, but should it really be the aim to <i>“earn their trust”</i> ?	Accepted. Deleted.
154		Line 585 News and social media are not stakeholders. They are channels used to broadcast information to an audience. It is the audience (i.e. people who watch or subscribe to those channels) that are the potential stakeholders. Suggest deleting.	Accepted. Reworded.
155		Line 600 <i>“...deliberations on environmental impacts should include</i>	Rejected.

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		<p><i>the effects of all possible contaminants and a characterisation of the relative risks that they may pose to populations and ecosystems."</i></p> <p>Advice of this nature seems to be out of scope of the safety guide.</p>	<p>It is true that more specific advice on these effects is outside of the scope of the Safety Guide, however it is important to state that radiation protection of the environment should not be the only aspect considered.</p>
156		<p>Section 4.5</p> <p>An additional stakeholder is Indigenous people and the organisations that represent them and their rights.</p>	<p>Rejected.</p> <p>These groups are included in Public and Community Groups.</p>
157		<p>Line 743</p> <p>The derivation of equations 1 and 2 are unclear (Reference needed). What are the units of the constant 0.00057672? As it stands the DCC has the units Joule, but should be J/Bq.</p>	<p>Accepted.</p> <p>This annex is to be included in online supplementary material (removed from Safety Guide). This includes the relevant Reference.</p>
158		<p>Line 764-767</p> <p>Unclear from this description how DCCs are calculated from computer codes, and why they are under or over protective.</p>	<p>Accepted.</p> <p>Sentence clarified.</p>
159		<p>Line 789</p> <p>How is it suggested to perform effects studies on 'Reference Organisms' (which are not real)?</p>	<p>Accepted.</p> <p>Deleted "Reference".</p>
160		<p>Line 825-826</p> <p>Consideration should also be given to species of cultural significance.</p>	<p>Accepted.</p> <p>Decisions should not be influenced by human bias (see line 811) – i.e. all affected organisms should be considered. For completeness culturally significant species will be added to the list provided.</p>

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161		Line 880 & 882 Reference to ARPANSA technical report 167 (Hirth 2014) missing.	Accepted.
162		Line 920 It is unclear why: <i>“Application of these relationships requires suitable dietary intake values, often also derived allometrically. Obtaining the valid dietary intake values necessary may require extensive effort including site-specific, or laboratory studies”</i> . More explanation needed.	Accepted. This will be addressed in online Annex.
163		Lines 978-982 <i>“in which the boundaries of the evaluation area should fairly consider how flora and fauna may be exposed to contamination as they follow routine habitats habits at a site.”</i>	Accepted. Typographical error.
164		Line 984 What about the biological half-life?	Rejected. This Safety Guide does not address matters of biological modelling of internalised radionuclides.
165		Lines 986-987 Incomplete sentence.	Accepted.
166		Lines 991-992 Why is time averaging going to result in environmental reference values that provide protection of populations?	Clarification. The sentence is in context – dose rates averaged over long time periods apply to the population as a whole rather than to individuals.
167		Line 993 In practice	Accepted.
168		Line 1014 What is considered an <i>“acceptable variation from the mean”</i> ?	Noted. Questions of regulatory interpretation are outside the scope of this Safety Guide.
169		Line 1018 Wouldn't sampling bias introduce a systematic	Noted.

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		uncertainty?	Yes, this was dealt with as per the example cited.
170		Lines 1022-1030 Additional data may reduce uncertainty, but not the variability of concentration ratios. Consequently, additional data may not help. This whole paragraph should be reduced to a couple of sentences, highlighting log-normality and the provision of means and confidence intervals.	Partially Accepted. Material will be reviewed in online Annex.
171		Line 1048 What is meant by “ <i>locations that represent the exposures to the specific biota</i> ”?	Accepted. Sentence deleted.
172		Line 1063 (Figure 8) Green box unclear: Is the task is to ‘Select Sample Size’, of course you will have to ‘determine sample size’. Suggest to rename task: ‘Plan sampling’	Accepted.
173		Line 1091 Reference to IAEA-TECDOC-1415 should be included.	Accepted. Reference added.
174		Line 1134 How will the sampling and analysis of parasites provide data on biota activity concentrations?	Clarification. Parasite sampling may inform knowledge of animal activity concentrations.
175		Lines 1135-1136 “ <i>Also, in cases where population dynamics are considered, it is important to measure the collection efficiency per unit time or effort to facilitate comparisons.</i> ” Unclear what is meant by this statement.	Clarification. Lines 1135-1136 refer to optimisation of sampling efforts. "per unit time or effort" deleted.
176		Line 1140 Has the practicability of sampling invertebrates with a core or grab sampler, and analysing for radionuclides been	Noted. The Safety Guide supplementary material provides advice

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		considered? The mass of sediment dwelling invertebrates of one species required to result in suitable counting statistics for most radionuclides would require a ridiculous amount of sediment to be processed.	on how to sample biota. It is not intended to be the definitive guide for such sampling.
177		Line 1144 Why would the sample mass per sediment area be needed?	Noted. As per comment 176.
178		Lines 1399-1608 (Annex C) Although Annex C talks about radiation protection of the environment in the three exposure situations (i.e. planned, existing and emergency), it gives no indication of how environmental reference values should be applied in each situation to ensure an acceptable level of protection to the environment. Should environmental reference values be applied in the same way or differently across the three exposure situations? ICRP Publication 124 suggests that there are inherent differences in how reference values based on the DCRLs would be applied in each exposure situation. Similar advice is perhaps needed in this safety guide.	Accepted. Definitive advice as to matters of interpretation is planned to be included in each of the respective codes (planned, existing, emergency).
179		Line 1610 (Glossary) Please include a definition of 'stakeholder' in the glossary.	Accepted. Definition provided as per IAEA.
180		Contributors to drafting and review Why is the working group role (e.g. radiation health committee representative, industry representative, specialist scientific member, etc) given for some contributors and not others? In previous RPS documents, only the name and organisational affiliation of the working group members is given, with the chair (or convenor) identified. Why deviate from this?	Noted. The RHC is moving towards a new style of published documents. Edits will be made for consistency.