Note of Meeting
Dalgety Bay Risk Assessment Group

DATE: 16 March 2009

TIME: 11.00

LOCATION: Surgeons Hall, Edinburgh

SEPA		**HPA**		**FSA**		**MoD/Contractors**	
George Hunter (GH) (Chairman)	x	Joanne Brown (JB)	x	Will Munro (WM)	x	Ron Brown (RB) (DSTL)	x
Paul Dale (PD)	x	John Burton (JBu)	x			Iain Robertson (IR) (Defence Estates)	x
Ian Robertson (IR – SEPA)	x					Phil Kruse (PK) (Entec)	x
Mark Toner (MT)	x						

Note: An 'x' indicates attendance at the meeting
APOLOGIES: Fife Council

Agenda
0. Agreement to Agenda
1. Introductions
2. Roles & Responsibilities
3. Aims & Objectives of this meeting
4. Risk Assessment for Dalgety Bay
5. Recommendations for Work
6. Date of Next Meeting

0.0	**Agreement to Agenda**	
	The suggested agenda was agreed at the meeting, with modification that item three would be taken before item two.	
1.0	**Introductions**	
	GH welcomed everybody to the meeting and opened the meeting.	
3.0	**Aims & Objectives**	
	GH outlined that this group had been formed at the request of the Dalgety Bay Forum (DBF) to take forward the process of developing a risk assessment at Dalgety Bay which the MoD had indicated it wished to undertake. GH noted that this group did not replicate the representation of the DBF but included those agencies which had statutory responsibilities for public health protection, either directly or indirectly. IR said that scope of the work considered by the group could become wider and consider reviewing the work of the MoD at Dalgety Bay. Following some discussion of the role of the Group it was agreed that the current remit of the group was focused on the need to undertake a full risk assessment at Dalgety Bay and to make technical input on the proposed work by the MoD.	

2.0	**Roles and Responsibilities**	
	WM outlined that the FSA role is to assess the risk to members of the public through exposure by the food chain pathway. RB asked what information the FSA would need to fulfil this responsibility and suggested that such information could be obtained during the planned MoD work. RB said that the aim of the proposed work by the MoD is to provide all the information needed to allow all agencies to fulfil their responsibilities and thus negate the need for any further work. The Group welcomed this approach and agreed that this would prevent prolonging the issue. JBu said that HPA Scotland provide advice to NHS Fife on the risks to the public for Dalgety Bay. JB stated that the role of the HPA in England and Wales is similar to that of the Scottish NHS Local Health Boards, in Scotland, Health Protection (Scotland) does not have responsibility for radioactive issues and seeks its advice from HPA-RPD. The Group considered whether it should consider non-radioactive contamination at Dalgety Bay such as the suspected asbestos. PD suggested that as this was the responsibility of the local council rather than SEPA and that the council were not present, SEPA could contact the Council to determine if any conventional contaminated land assessment had been undertaken. In the absence of any information on conventional contamination it was agreed that the current remit of the group will be limited to radioactive contamination, although IR stated that this should not prevent us (MoD) from looking at other contaminants. RB said that he was present to advise Defence Estates of the radiation aspects with respect to the onsite work and the risk assessment. PD said that SEPA has a role in protection and enhancement of Scotland's environment, more specifically SEPA has statutory duties to assess Special Sites under Radioactive Contaminated Land Regulations.	
Action 1	**Consider contact with Fife Council for non-RS assessment**	**SEPA**
4.0	**Risk Assessment for Dalgety Bay**	
	PD produced a brief presentation on SEPA's view of what the key data requirements are to undertake an appropriate risk assessment at Dalgety Bay. IR suggested that the focus of the work should not be on the risk assessment. As an alternative PD suggested that focus of the work could be entitled 'technical advice and risk assessment'. JB stated that this would address both the prospective risks and hazards and could help establish an end-point. IR said that due to the dynamics of the site he doesn't believe that this issue can ever be 'signed-off'.	

	PD said that the risk assessment is a management tool to help determine what action – if any, is required. JB said it was important to establish timescales for each stage of the work so that the public/DBF can be kept updated. GH did not believe that the full work required to perform a risk assessment could be completed within a year, but we should keep the DBF and public informed of progress. RB accepted this and also noted that further local constraints on this work, such as when monitoring can be undertaken will be determined by the activities of the Sailing Club.	
4.1	**SEPA Presentation**	
	Slide 2 - PD stated that both static and dynamic data is needed for a risk assessment. Static data such as hazard need only to be assessed once whilst dynamic data such as habits may change. WM said that this approach is a very flexible method. Slide 3 - PD said that only very basic experiments had been undertaken on the potential solubility, he suggested that a true representation of GI fluids was needed to determine the true solubility. PK asked if it could be assumed that the current data are valid. PD said that this would only be the case if the current data were representative of the population, which is an assumption. PD advised that particle characterisation is essential to be able to update the risk assessment – and highlighted the data available for Dounreay particles, when a new particle is recovered it can be assessed quickly to determine if the situation is changing. RB agreed with the discussions, but advised that funding this work may be an issue and that the costs must be considered against the benefits of any work. PD acknowledged RB's concerns, and stated that an assessment could be undertaken on the max/min/mean/median values but we would need to be aware of the variance in approach in each study. RB said he hoped that the previous studies were scientifically robust. PD said he could not support this as none of the studies he was aware of represented the true GI fluid and the impact of enzymes present in the stomach could have a significant impact on the dissolution of a particle. RB asked PD to provide the costs of the Dounreay GI study. PD will check on the commercially confidentiality of the work and provide if possible.	
Action 2	**PD to provide costs for GI study**	**SEPA**
	RB stated his concerns over the SEPA data on Radium and daughter activity. The 2006 study suggested that the radium was at 90% equilibrium with daughters and 2008 suggested 60% equilibrium. These values are not normally seen and his staff, who have over 75 years combined experience, suggest that sample storage for up to 2 weeks could have lead to a build up of the daughter products. PD highlighted this as a reason to ensure further collection of data – also, he was aware that the samples collected in 2006/2008 had not	

	been stored for 2 weeks prior to analysis. Slide 4 – PD indicated that the particles need to be characterised on a population basis. RB stated that MoD analysts are not particularly keen to work with these samples due to concerns over dose rates from high-activity samples. RB also advised that cost was an issue.	
	Slide 5 – PD discussed what monitoring data are needed to inform a risk assessment. This includes confidence of detection so that the total number of particles can be calculated. PD stated that he had no knowledge of the proposed Entec system, however, if it is a NaI detector system care, will be needed to interpret a particle from background. PK advised that the system is similar to Groundhog, with NaI detectors linked to GPS. PD commented that information is needed on the system to determine the capabilities. PK enquired to the desired end point for the works, to which PD replied that the requirement is to provide data to determine the population of particles and the probability of encounter. RB did not consider that the requirement to quantify the capability of the monitoring system was essential, as it cannot capture the experience of the operator. RB said that if an operator cannot find a particle, then that is the probability of encounter. PD refuted this and said that if the monitor is not capable of detecting a particle it does not mean that it is not present. WM said that the situation could change with each tide and the population source and movement is to determine the chance of encounter. PD said that the field monitoring capability must be known to determine if particles are missed on the first pass, but could be found on later passes. RB asked 'what is the health concern of what is not detected' and stated that it does not take much radium to get high doses for ingestion. PD said that the risks from deeply buried particles can be treated separately as they are not 'available' for encounter – this is similar to the situation on the coastal path. With regard to the health concerns, PD said that the monitoring system must be able to confidently detect radium which is available to give a potential exposure and of a level to give a significant dose. RB said that he was concerned that a monitoring system may only be capable of detecting 1% of the population of particles. GH said that, if that were the case then, common sense would dictate that such as system should not be used. Slide 6 – PD stated that robust analysis of particle characteristics is essential to undertake the assessment. The orientation of particles during counting is important as experience has shown that the activity can be concentrated on a small point on a large lump of clinker. Slide 7 – PD advised that a risk of encounter assessment could be undertaken using a modified version of the Dounreay risk assessment model. This approach has been peer reviewed by many	

	groups, including COMARE and DPAG. PD commented that NDAWG have a sub-group on heterogeneous contamination that would be able to review the work at Dalgety Bay. He also noted that COMARE could be asked for its views on the work. The group discussed the longevity of the contamination. PK stated that over the past 50 years that similar levels of contamination had been found at Dalgety Bay. PD stated that this is not the case. Different reports showed large variation in particle numbers and SEPA's 2006 study identified small particles of waste, when we were expecting to find large lumps of clinker.	
5	**Recommendations for Work**	
	GH noted that MoD have raised concerns over the assumptions used in the SEPA report. RB stated that MoD has concerns in the following areas: • the role of alpha-radiation; • the value of skin-thickness (considering particle unevenness, adherence of moisture/sweat/sand) • 200 µm value for inhalation, HPA documents state that only 50 µm particles would stay in the air to be available for inhalation; • the issue of self-shielding • assessments based on continuous 'worst-case' scenario GH noted that all of these issues had been discussed at length in the report which had used assumptions in areas where no data were available. However, the values used for the assumptions were chosen carefully and not random numbers. PK raised concerns over assessments based on probability. JB advised that all of the HPA Dounreay assessment can be taken back to the raw data to allow transparency for any assessment. PD stated that the 2008 report was not a risk assessment. The 2008 report was prepared to give the regulatory arm of SEPA the basis with which to undertake a decision on radioactive contaminated land. RB indicated that BGS could do scanning electron microscopy to determine if radium is on the outside or inside the particle. The group also discussed methods to determine skin dose rates, such as mounting a particle on top of a TLD or undertaking alpha-spec followed by grinding the particle and counting again. IR stated that the MoD work programme will not be taken further than previously communicated to SEPA and the DBF. PD advised that this meeting has raised several points of what is required and that there is broad consensus to this. PD stated that we need to see how these requirements are contained within the MoD Work Programme. IR said that the membrane work is progressing and will take time to monitor any trends. The Headland survey and coastal path resurvey will be done, and the possibility of monitoring underneath the membrane if required.	

	IR stated that MoD aim to report during November or December (unsure as to specific dates detailed in the plan). IR advised that beach users will dictate when the work can be done. JB suggested pulling together a matrix of data requirements vs what information we already have and what MoD can provide from the planned current programme. This will identify gaps and can be used to rate the desirability and uncertainty of each item. RB enquired as to the reason for the risk assessment and stated that he had been reviewing Monty Charles's work – could the particles be classed as significant, relevant and minor on the basis of hazard and probability of encounter? PD said that the classification system used for Dounreay Particles is based on hazard, not probability and at this stage insufficient information is available to draw comparisons with the Dounreay particles. RB said that it was clear that some issues needed to be addressed, but he was not sure who would do this and how crucial the data were to the bigger picture. GH said that it was clear that particle characterisation was required. RB said that he would need to find laboratories to do this work. IR advised that we will need to 'apportion tasks' as the MoD already have a detailed work programme and that the preference was not to undertake further surveys. PD said that an appropriate monitoring and recovery programme may give the regulator reassurance that further actions are not necessary at the current time. IR said that MoD are not going to gather information on the physical properties and asked who is best placed to take this forward. GH asked IR to explain what he meant by 'apportion tasks'. Did this mean who in DBRAG or organisations? IR affirmed that MoD will only undertake the work detailed in their plan. PD asked if MoD would undertake work to address all the 'desirable' data, such as physical size. IR stated that some particles may be sent to DSTL. PK advised that MoD will monitor, recover and undertake some analysis, but the detail of the DSTL work is unknown. (RB was out of the room and returned shortly after). RB stated that MoD would be willing to gather habits data, but it is dependent on budgets. IR stated that in the spirit of partnership working, other groups could take an action to find money from their respective organisations and SEPA could validate their assumptions. GH disagreed and noted that it had already been stated by MoD that MoD's Chief Scientific Advisor requires sound science, and the information currently planned to be obtained is not sufficient for a risk assessment. GH advised that this forum is not here to discuss financial issues; it is solely a scientific forum. GH stated that habits data is essential, but given the longevity of the contamination we should also consider potential future pathways. It is crucial to have the characteristics of the contamination in order to assess the viability of any pathway.	

	PD and JB advised that the data needs outlined are the bare minimum of data that would be required for an assessment, PD highlighted the data available at Dounreay is many times greater. PK stated that it was demanding perfection, to which GH replied that we are responding to MoD concerns over uncertainties in the assessment. It was agreed that a matrix of information needs would be developed and attached to the draft minutes of the meeting. RB said he would like to offer to provide all the data requirements, but indicated that it is not in his power to do so. PD offered a SEPA letter of support to RB. GH said that the absence of a commitment to provide the information needed for a robust risk assessment was not a desirable outcome of the meeting, but due to time constraints the meeting had to close. GH continued that we will need to meet soon, otherwise we will have to report to the DBF that we have failed. WM reminded the Group that FSA requirements to assess the food chain risk included both particulate and and diffuse pollution pathways. GH summarised his position that he is not convinced, at the moment, that the group will be able to deliver its function. IR said that the matrix was a good way to start. JB asked if videoconference or teleconference would be possibility for next meeting. IR requested that the slides from the presentation are included in the minutes. Next meeting – early August. Matrix – by 1 month.	

Toner, Mark

From: Toner, Mark

Sent: 05 October 2009 15:00

To: Hunter, George; Dale, Paul; Robertson, Ian; Tilly, Byron; 'Ron Brown DSTL MoD'; 'Iain Robertson DE MOD'; 'Joanne Brown'; 'John Burton'; 'Will.Munro@foodstandards.gsi.gov.uk'

Subject: Dalgety Bay Risk Assessment Group - SEPA's response to Defence Estates Comments

Attachments: DBRAG 1 Final 290509.doc; Matrix 290509.doc; DBRAG PD Presentation.PDF; dbriskassgrp0909annxa.pdf; dbriskasstgrp0909.pdf; SEPA Response to DE Oct 2009.pdf

Tracking:

Recipient	Delivery
Hunter, George	Delivered: 05/10/2009 15:00
Dale, Paul	Delivered: 05/10/2009 15:00
Robertson, Ian	Delivered: 05/10/2009 15:00
Tilly, Byron	Delivered: 05/10/2009 15:00
'Ron Brown DSTL MoD'	
'Iain Robertson DE MOD'	
'Joanne Brown'	
'John Burton'	
'Will.Munro@foodstandards.gsi.gov.uk'	

Dear all,

Following my earlier email (below), we have now received commentary on the DE approach to progressing the risk assessment which is attached together with George Hunter's response to the issues raised. For ease of reference I have also attached a copy of the draft minutes with FSA and HPA comments incorporated.

Kind regards,

Mark Toner
Secretary, Dalgety Bay Risk Assessment Group.

From: Toner, Mark
Sent: 29 May 2009 14:54
To: Toner, Mark; Dale, Paul; Hunter, George; 'Iain Robertson DE MOD'; 'Joanne Brown'; 'John Burton'; Robertson, Ian; 'Ron Brown DSTL MoD'; 'Will Munro'
Subject: Dalgety Bay Risk Assessment Group - Final Minutes/Matrix

Dear all,

Dalgety Bay Risk Assessment Group

Thank you for your comments on the matrix and the minutes. I have made the suggested changes and attach a final version for your records. Please note that to date, no comments have been received from the Ministry of Defence.

SEPA will be in touch in the near future regarding future meetings of this group.

Kind regards,

Mark

Radioactive Substances Policy Unit
SEPA

Data Requirements Matrix
Dalgety Bay Risk Assessment Group

April, 2009.

Matrix of data to determine requirements for risk assessment at Dalgety Bay, Fife	Essential	Desirable	Not Essential (For Risk Assessment Purposes)
Physical Properties			
- Size/dimensions	√		
- Volume		√	
- Mass	√		
- Density	√		
- Hydrodynamic Equiv.		√	√
- Aerodynamic Equiv.	√		
- Solubility (G.I tract)	√		
- Friability	√		
- Physical state on recovery & contamination of surrounding sediment	√		
Radiological properties			
- Ra and daughters	√		
- dose rates (skin, eye and GI tract)	√		
Particle populations			
- Likely ranges of chemical form and sizes	√		
- Population data with parameters	√		
- Outliers	√		
Monitoring data			
- Monitoring performance	√		
- Number recovered/locations	√		
- Number not recovered (not detected)	√		
- Verification of capability	√		
- Area coverage (detailed and consistent)	√		

- Electronic data capture to determine performance/coverage/allow interrogation	√		
- LoD must detect contamination of potential consideration in risk assessment with confidence (incl inhalation)	√		
- Monthly changes / seasonal trends	√		
Analysis			
- Care needed when determining activity – large variations if orientation changed	√		
- Possible issues of electro static charge			√
- Solubility – in vivo and in vetro to confirm data to represent the population range	√		
- Friability experimentation	√		
- Homogenous contamination – determine if small particles	√		
Risk of encounter			
- Suggest use Dounreay model:	√		
- Habits data (seasonal) – suggest 4 surveys	√		
- Consideration of future habits (longevity)	√		
- Size distribution of sediment	√		
Diffuse Pollution			
- Characterisation of hazard	√		

MINISTRY OF DEFENCE

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George Hunter
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Scottish Environmental Protection Agency
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Erskine Court
Castle Business Park
STIRLING FK9 4TR

Ref. ROS/FFE/ESM/005

9 Sept 2009

Dear George

DALGETY BAY RISK ASSESSEMNT GROUP

This letter sets out MOD's position on some issues arising from the March 2009 meeting. It is suggested that this letter should be circulated to members with a view to setting a date and agenda for a further meeting.

The depth and outcome of discussions at the meeting on 16 March 2009 seem disappointing in as much as the minutes record statements with very differing levels of supporting justification providing little indication of the position of the group. In addition to which some attendees do not feel that the draft minutes accurately reflect the statements made. Furthermore, although encouraging that there was broad agreement on aspects such as the need for representative sampling, it was disappointing that there was no discussion on how this could be achieved.

In order to provide focus and structure to a future meeting of the Risk Assessment Group prior circulation of the detailed arguments and suggestions are attached at Annex A.

The expectations of the group members at present do not appear to be aligned. MOD's perception is that the purpose of the group is to agree on the most appropriate scientific and technical assessment using authoritative based information. This must be a relevant assessment of risks based on the available evidence, in order to determine whether on the balance of probabilities significant harm is being caused. Given that cost is a consideration of both the contaminated land regime and consistent with the International Commission on Radiological Protection's view that social and economic factors should be considered when devising radiation safety systems., it should also be considered by the group.

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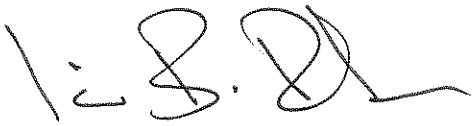
I trust that members of the group will see the second meeting as an opportunity to make a difference in this area by focusing on reaching a scientifically robust agreement on the most appropriate means and method to assessing the risks posed and assumptions to be made within the cost constraints outlined.

Yours sincerely



Iain B Robertson
Sr Estate Advisor (Ops Policy & Environment)
Land Management Services

Annex A

DALGETY BAY RISK ASSESSMENT
MOD POSITION ON TECHNICAL ISSUES

Item 1 Depth for calculation of skin dose and self-shielding effects

Issue

MOD understand that normal practice is to assess skin dose at a depth of 70 μm rather than the 40 μm used in SEPA's most recent report. This is very important because the use of 40 μm leads to doses about 100 times greater[1] than those obtained using 70 μm. This arises from the dose contribution made by alpha radiation at skin thicknesses below about 65 μm.

MOD have sought advice from the Health Protection Agency and University of Birmingham[2] and a copy of their reply is attached. Their advice is that "the most appropriate assessment of skin dose from radioactive particles is as an average over an area of 1 cm^2 at a depth of 70 μm. Higher values of dose at shallower depths into the epidermis need very careful assessment and will not relate to ED values and dose limits set for 1 cm^2 and a depth of 70 μm. Analyses of the effect of different assumptions regarding skin thickness and the shallow depth-doses from non-penetrating radiations require expert judgement on a case-by-case basis."

MOD position

As a Department of State, MOD receives vote funding for expenditure on national defence. Other Departments receive funding for research into radiation-related health and environmental effects and for establishing standards for protecting the UK population and environment against radiation risks. Other considerations are that radium has not been used exclusively for defence purposes and that there appear to be no other occasions on which UK regulators have advocated the use of anything other than a depth of 70 μm for calculation of the skin dose from radium luminising material. MOD appreciate that future developments might impact on this topic.

If the alpha dose to the skin is of importance, it would seem reasonable for mitigating factors such as surface irregularity, adherent sand and the effects of sweat or other moisture to receive some attention.

Proposed future action

MOD do not consider it appropriate for them to allocate public funds to the calculation of skin dose at anything other than a depth of 70 μm. However MOD are prepared to reconsider this in the light of emerging scientific knowledge and welcome comment from other members of the Dalgety Bay Forum or Risk Assessment Group.

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[1] Charles, MW, Skin dose from Ra-226 contamination: Dose estimation & comments, University of Birmingham, Edgbaston, Birmingham B15 2TT, UK, 2 November 2008

[2] Harrison JD and Charles MW, Calculation of the skin dose received by members of the public who may be exposed to radium contamination, Health Protection Agency Centre for Radiation Chemical and Environmental Hazards, Radiation Protection Division, Dose Assessment Department, Chilton, Didcot, Oxon, OX11 0RQ UK, 9 June 2009

Item 2 Extent of equilibrium of decay products

Issue

Any emanation of radon-222 will reduce the concentration of decay products and hence the radiation dose from any given activity of radium luminising material. The activities of decay products reported most recently are anomalous in terms of previous surveys and experience with similar material at other sites as they suggest an unusually high degree of equilibrium. It is suggested that the sample storage conditions prevented egress of radon that would have dispersed had the material remained in the natural environment and that the time between sampling and analysis was sufficient for an appreciable approach to decay product equilibrium. With regard to this topic, the relevance of the in-situ gamma spectrometry in SEPA's 2008 report is unclear as this seems most likely to be providing information on conditions in the bedrock and the sand produced from it. The activity concentrations reported from the in-situ work are certainly typical of naturally occurring material.

Plots of the activities of radium-226 and lead-214 in the analysis data reported by SEPA for 2006 and 2008 are shown in Figure X below. The gradients give a percentage equilibrium of about 50% and 90% for 2006 and 2008 respectively. It is evident that 3 results from 2006 (comprising about 10% of the total) are very similar to the 2008 data. This could be due to analysis of these samples being delayed or to the sample matrix preventing egress of radon. At the very least an allowance for a lower value of equilibrium in the vast majority of samples seems appropriate.

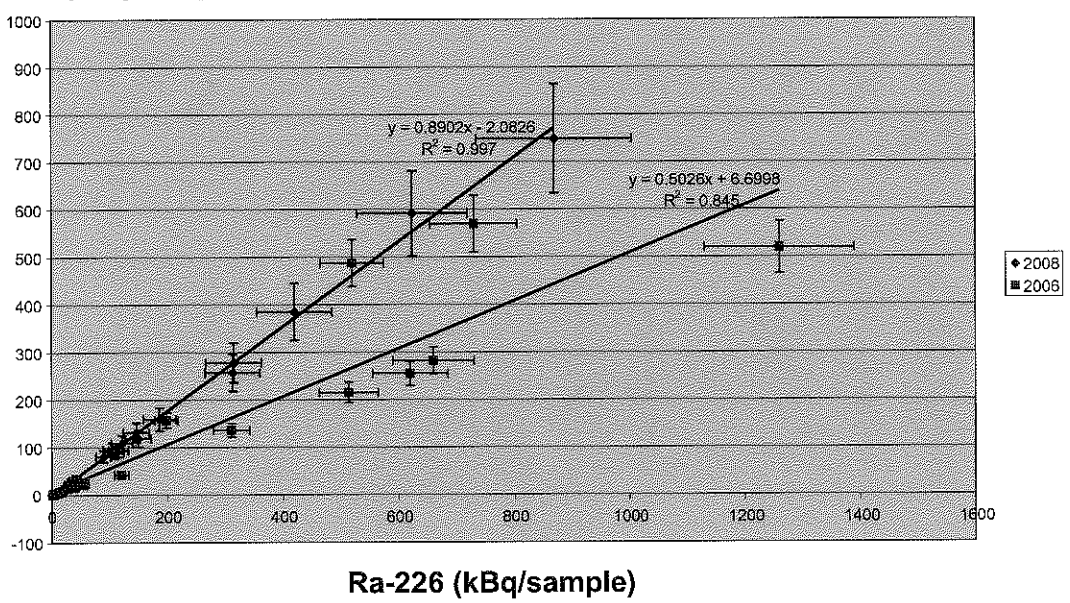

Figure X Radium-226 and lead-214 activities in samples collected in 2006 and 2008 as analysed by gamma spectrometry

MOD position

The balance of evidence suggests that it is highly unlikely that levels of decay product equilibrium will approach 100% in the natural environment and that there is widespread low level homogeneous contamination at Dalgety Bay. With regard to decay product equilibrium, the situation appears well-suited to the method of dealing with uncertainties described above. Inputs of 50% and 90% equilibrium for central and worst-case estimates are proposed.

Proposed future action

MOD would be interested to learn of any related views, experience or expertise amongst other members of the Dalgety Bay Forum or Risk Assessment Group.

Item 3 Context of results

Issue

There has been speculation over the extent to which conditions at Dalgety Bay might change with time. Inhomogeneous contamination within a particle coupled with particle friability has been suggested as possible source of smaller and much higher specific activity particles. Recent reports consider inhalation whereas past reports did not. Conversely, it has been suggested that, in the short term, particles on the beach can be considered to be in a state of equilibrium and that, over the longer term, the numbers of particles and the total activity will reduce due to environmental mixing, given no major change in beach conditions. The implication being that risks are more likely to reduce rather than increase over time and that absence of a particular particle size during repeated surveys indicates that that type of particle cannot exist on the beach.

With regard to inhalation, it is important to distinguish between the risks from particles with aerodynamic diameters of the order of a few micrometers and those with diameters of a few tens of micrometers. The smaller particles have the capability to reach the deepest parts of the lung and an average bulk activity concentration, calculated from the total activity and weight of a sample in which the contamination is not separated from surrounding soil, is used as a basis for assessing inhalation risk. Larger particles become trapped in the extra-thoracic airways and the risk is more usually assessed by reference to particle activity. Unfortunately the distinction between these two scenarios has not always been clear in reports dealing with Dalgety Bay.

Past assessments of inhalation risks do not appear to have allowed for the fact that only particles with an aerodynamic diameter less than 50 μm will remain airborne for significant periods and that HPA have stated that it is only particles less than 10 μm that are important for inhalation for radiation protection purposes. It is noted that there is limited data on particles at Dalgety Bay with dimensions lower than one millimetre and that the sampling techniques used to date provide little or no information on in-situ conditions.

MOD position

To avoid nugatory work and expedite an outcome acceptable to all parties, the detailed scope of any future risk assessment needs to be established before any further work occurs. There is a particular need for clarity in respect of inhalation risks, the time periods over which assessments are required and whether recent surveys represent equilibrium conditions with regard to risk of encounter and particle size and activity.

Air sampling can be undertaken during future intrusive works for relatively little additional cost and this seems likely to produce additional relevant data. Some useful information in-situ conditions may be obtained by collection of undisturbed samples. Autoradiography and scanning electron microscopy may give useful information on the activity distribution within or on a particle.

Proposed future action

MOD would be interested to learn of the views of other members of the Dalgety Bay Forum or Risk Assessment Group. Views are welcomed on the benefit of carrying out air sampling and continuing to collect at least a proportion of undisturbed samples during future site works.

Item 5 Depth for calculation of skin dose and self-shielding effects

Issue

MOD understand that normal practice is to assess skin dose at a depth of 70 μm rather than the 40 μm used in SEPA's most recent report. This is very important because the use of 40 μm leads to doses about 100 times greater[3] than those obtained using 70 μm. This arises from the dose contribution made by alpha radiation at skin thicknesses below about 65 μm.

MOD have sought advice from the Health Protection Agency and University of Birmingham[4] and a copy of their reply is attached. Their advice is that "the most appropriate assessment of skin dose from radioactive particles is as an average over an area of 1 cm^2 at a depth of 70 μm. Higher values of dose at shallower depths into the epidermis need very careful assessment and will not relate to ED values and dose limits set for 1 cm^2 and a depth of 70 μm. Analyses of the effect of different assumptions regarding skin thickness and the shallow depth-doses from non-penetrating radiations require expert judgement on a case-by-case basis."

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If the alpha dose to the skin is of importance, it would seem reasonable for mitigating factors such as surface irregularity, adherent sand and the effects of sweat or other moisture to receive some attention.

Proposed future action

MOD do not consider it appropriate for them to allocate public funds to the calculation of skin dose at anything other than a depth of 70 μm. However MOD are prepared to reconsider this in the light of emerging scientific knowledge and welcome comment from other members of the Dalgety Bay Forum or Risk Assessment Group.

Item 7 Benchmark values for risk assessments

Issue

The particles found at Dalgety Bay constitute a population with a mean, medium and maximum value for each parameter assessed. Figure Y has been prepared by ENTEC[5] and shows the activity distribution of particles collected in the 2006 and 2008 surveys. The arithmetic mean for the 2008 data was 102 kBq and the median 25.5 kBq. The 2006 RWE data have a mean of 62 kBq and a median of 13 kBq, while the alternative HPA analysis produced a mean of 225 kBq and

[3] Charles, MW, Skin dose from Ra-226 contamination: Dose estimation & comments, University of Birmingham, Edgbaston, Birmingham B15 2TT, UK, 2 November 2008

[4] Harrison JD and Charles MW, Calculation of the skin dose received by members of the public who may be exposed to radium contamination, Health Protection Agency Centre for Radiation Chemical and Environmental Hazards, Radiation Protection Division, Dose Assessment Department, Chilton, Didcot, Oxon, OX11 0RQ UK, 9 June 2009

[5] Kruse P, Dalgety Bay Dose Assessment Review, Draft Technical Note, ENTEC UK Ltd, 2009

a median of 29.2 kBq. There is also clearly a higher frequency of lower as opposed to higher activity items.

Similar issues relate to gut solubility. SEPA's 2009 report noted that gut solubility ranged from less that 1% to 7% and that values up to 15% has been suggested elsewhere. A figure of 4% was used for dose assessment purposes although a mean of 1.39% and a median of 0.25% were suggested by the 2008 survey.

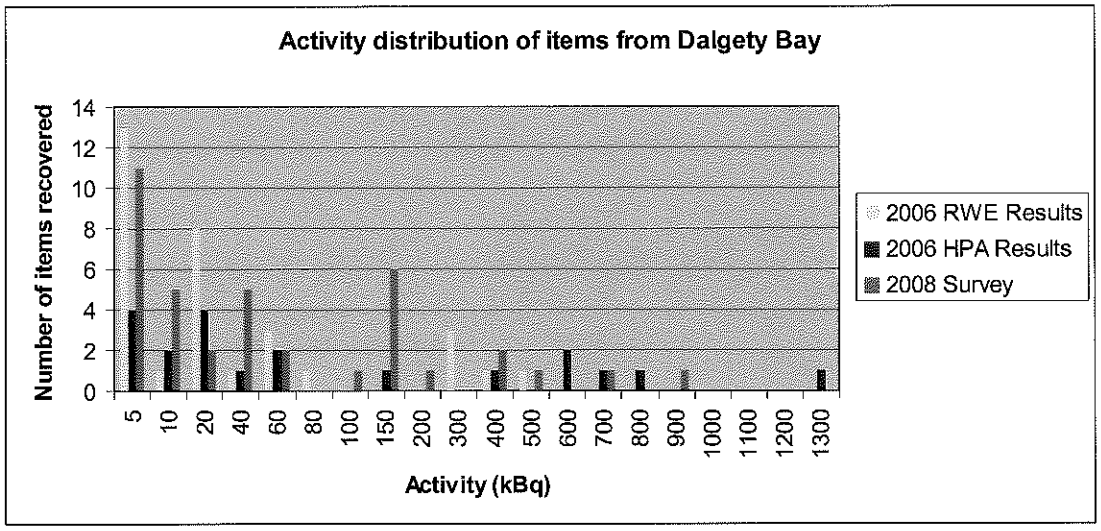

Figure 2. Activity distribution of items recovered during 2006 and 2008

MOD position

A common approach in deciding what values of activity and encounter frequency to use in any further risk assessment would simplify technical discussions and enhance public understanding. Similar considerations apply to consideration of the depth at which items are found. It is noted that the Dounreay Particle Advisory Group methodology[6] corrected for this but SEPA's 2008 assessment was based on the assumption that all particles would be within the top 10 cm of sand.

Proposed future action

MOD would be interested to learn of the views of other members of the Dalgety Bay Forum or Risk Assessment Group.

Item 8 Particle solubility

Issue

ICRP Type M solubility was assumed for the calculation of inhalation doses in SEPA's 2009 report. This is a reasonable first-order approximation, since, by comparison with other ICRP default solubility categories, it may overestimate the risk by a factor of 6 and is unlikely to underestimate the risk by more than a factor of about 2. A similar approximation was made in respect of gut solubility where a benchmark figure of 4% was used for values that ranged from less that 1% to 7%. This is linked to the wider issue of methodologies for combining uncertainties mentioned as Item 2 above.

[6] Dounreay Particle Advisory Group, Third Report, Scottish Environment Protection Agency, 2006

MOD position

It seems that it would be helpful to know the cost and/or benefit of reducing the uncertainty in each or all parameters.

Proposed future action

MOD would be interested to learn of the views of other members of the Dalgety Bay Forum or Risk Assessment Group.

Item 1 Representative sampling

Issue

MOD believe there is general agreement on the need for representative sampling but no process to assure that the type, quantity, and quality of data will be appropriate for the intended application and that this will result in decisions that are scientifically sound and legally defensible. This increases the risk of committing resources to data collection efforts that do not support a defensible decision.

Background

The Data Quality Objectives (DQO) Process is a strategic planning tool that provides a systematic procedure for defining the criteria that a data collection design should satisfy, including when to collect samples, where to collect samples, the tolerable level of decision error for the study, and how many samples to collect, balancing risk and cost in an acceptable manner. It is understood that the process is recognised by the US Environmental Protection Agency and the UK Environment Agency.

MOD position

Future surveys, sampling and research should be based on application of the DQO or some similar process. In deciding what additional information is needed, account should be taken of what is already known – i.e. the last two SEPA surveys[7,8] provide information on the physical dimensions, weights and radium-226 activities of about 65 samples. The question as to what more is needed and why seems legitimate.

Proposed future action

MOD would be interested to learn of any related views, experience or expertise amongst other members of the Dalgety Bay Forum or Risk Assessment Group. Should a process such as DQO be deemed appropriate then there needs to be agreement on the level of confidence required from such a process with consideration to the cost.

[7] Radium Contamination at Dalgety Bay Fife, Probabilistic and Hazard Assessment: A Screening Assessment, Scottish Environment Protection Agency, May 2006

[8] Dale P, Dalgety Bay Radium Contamination, Preliminary assessment produced by Scottish Environment Protection Agency (SEPA) Environmental and Strategy Directorate, Scottish Environment Protection Agency, January 2009

SEPA
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If telephoning ask for:
George Hunter

2nd October 2009

Dear Iain,

Dalgety Bay Risk Assessment Group

Following your letter dated 9th September 2009, I have considered the issues you have raised and have responded to these following the numbering in your original letter in Appendix 1. However, I consider that it is important to recall that the SEPA's reports on Dalgety Bay radium contamination (2006 and 2009), were undertaken to provide information on whether further work was needed (2006 report) and if the criteria for radioactive contaminated land were met (2009 report). Both of these reports recommended that a risk assessment should be undertaken. Neither of these reports could be considered as a 'risk assessment' as they were written for the objectives indicated above, i.e. to determine whether further work was needed (SEPA 2006) or to determine the potential committed dose or skin dose rate (for comparison with the criteria set in the guidance relating to the radioactive contaminated land regulations), rather than to quantify the risks to human health. SEPA considers that a suitable risk assessment must include a consideration of the potential committed effective doses and in the case of the risk assessment to the skin, agrees with Harrison and Charles that "*the effect of different assumptions regarding skin thickness… require expert judgement*". I also note that Harrison and Charles have offered "*further advice on the interpretation of skin doses on the basis of measurement data – ideally including depth-dose and radiation quality data".* As you are aware we hope that current SEPA work on this would go some way to providing that data such that a suitably informed expert judgement can be made regarding risks (rather than simply dose rates) to different skin thicknesses.

As a result of the recommendation for a risk assessment to be undertaken in both 2006 and 2009 SEPA reports, at a Dalgety Bay Forum meeting it was decided to form a Risk Assessment Group to provide guidance on how this could be undertaken and the data requirements for such a risk assessment. I believe that the matrix of data needs produced following the first meeting of this group provides a good indication of the data required in order to carry out a risk assessment and should form the basis of any discussions at a future meeting. If we can agree this matrix we will have made significant progress and any future meeting should allow sufficient time for detailed discussions for this to take place.

I believe that it is clear that the group has been established to ensure that an appropriate risk assessment is carried out. However, it is essential that consideration is given to the data required to carry out a competent risk assessment before it is begun. This is an essential first task of the group. If in considering the data requirements it is found that further data are needed to carry out a

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competent risk assessment then this should clearly be provided in a cost effective and timely manner.

I agree that for progress to be made it is essential that the expectations of the group members be aligned. It is our expectation that the group has been convened to agree a scientifically robust and appropriate means and method to assess the risks posed and that your reference to devising radiation safety systems and indeed the contaminated land regime is somewhat misplaced.

The ICRP has made it clear that the factors to be used in risk estimates are not necessarily the same as those used in developing their advice on radiological protection systems (e.g. Harrison, J. Rad Prot 29 (2009) pp 335-349). We should therefore in carrying out a risk assessment ensure that it is robust. Harrison and Charles' letter of 9th June provides useful advice in a succinct letter of around one page in length which is welcomed. However, I believe that any parts of that advice need to be read in context. It appears to me that your letter indicates a fundamental mis-understanding of the relationship between factors used in developing general radiological protection regimes and their relevance, if any, in carrying out appropriate scientific risk assessments on a case-by-case basis as indicated by Harrison and Charles' letter of 9th June.

A number of the issues you have raised in Annex A of your letter are addressed in some detail in the attached Appendix. I would be grateful for your comments on this response to your letter before convening a second meeting of the risk assessment group. I believe that this would be a more productive use of time than convening a meeting of the group before you have had an opportunity to consider and respond. We are happy for your communications and our reply to be circulated more widely and consequently we are copying this letter and your letter to the working group members and Byron Tilly.

Yours sincerely,

George Hunter
Chairman,
Dalgety Bay Risk Assessment Group

Cc: Byron Tilly, SEPA
Dalgety Bay Risk Assessment Group

Appendix 1

Comments on Annex A

I consider that the MoD's position outlined in Annex A requires a significant number of assumptions to be made for which there is little or no scientific basis at present. I believe that the risk assessment approach used at Sandside for fuel particles should be followed at Dalgety Bay which would provide sufficient information to determine an appropriate management strategy for the contamination.

I would also like to note that SEPA consider that for an appropriate risk assessment, information must be gathered on those items outlined in the matrix attached to the minutes of the Dalgety Bay risk assessment group.

Item 1.

It is normal practice to assess skin dose at 70 microns for practices where dose limits apply which allows like for like comparisons to be drawn for skin doses where the limit is 50mSv per year. Clearly, at Dalgety Bay the contamination is an existing situation and dose limits for derived for practices do not apply. Advice relating to a skin depth of 70 microns relates directly to ICRP and an assumed skin depth for an adult which we would recommend is used. However, at Dalgety Bay, children are also known to be present, I do not think that children or adults with thinner skins than the 70 micron value should be ignored in any risk assessment on the basis that the doses are "about 100 times greater".

Having now viewed the reference of Harrison and Charles indicated in your letter, SEPA has noted that the letter refers to experiments undertaken on the role of beta energies, clearly the emissions for radium particles include gamma, beta and alpha radiation. Thus, there is a need to consider the effect of alpha radiation on the skin. In SEPA's 2009 report it was shown that for skin depths of 70 micron the contribution from alpha radiation is effectively zero, however for depths of less than 60 micron there is a potential contribution from alpha emissions and as stated in your letter at skin depths less than this value the doses could be "100 times greater".

I also note that the Harrison and Charles letter also states that (*for beta emitters only*) "However, analyses of the results of a large number of experimental studies of the effects of a range of beta emitters on pig skin (Charles and Harrison, 2007) have shown that when doses are averaged over an area of 1 cm^2 at a depth of 70 μm, the ED_{10} and ED_{50} values for acute ulceration vary by only a factor of two across a wide range of beta energies. ED_{10} and ED_{50} values calculated for shallower depths are substantially greater". ICRP Reference man assumes values for an adult skin depth of 70 micron, and for infants/children of 45-50 micron. Thus, we consider that "*substantially greater doses*" to ICRP reference man criteria for children means that this requires further investigation. I would also draw your attention to the statement in the report that *"On this basis, ICRP recommend dose limits, calculated over the most exposed 1 cm^2, of 500 mSv for workers and 50 mSv for members of the public (ICRP, 1991, 2007)"*. Clearly, doses to members of the public who are unfortunate enough to encounter a particle on the skin could, potentially, receive a skin dose far in excess of these values even for skin thickness of 70 micron. As indicated above, doses to ICRP's criteria for children stated in reference man will be "*substantially greater*".

As MoD is aware, Dalgety Bay is the first site within the UK which has been assessed under the radioactive contaminated land regulations, which were brought in to address existing situations of radioactive contamination which had previously been outwith the duties of the environment agencies. The SEPA 2009 report set out to determine the potential committed dose or skin dose rate (for comparison with the criteria set in the guidance relating to the radioactive contaminated

land regulations), rather than to quantify the risks to human health. It is notable that the guidance is silent on skin depth and the effect of this is discussed in the 2009 report. In its 2009 report SEPA used ICRP reference man for skin thickness'.

In 2008, the University of Birmingham ran a model for SEPA to derive potential skin doses from Dalgety Bay particles which showed that doses to thinner skins could be significant which was reported in SEPA's preliminary report. Work has continued in this area to determine the dose rate from a number of the Dalgety Bay particles at a range of skin depths. I understand that SEPA hope to report the results of this work later in the year, which would hopefully provide some of the data which was indicated by Harrison and Charles to be valuable in considering the effects on the skin in their letter of 9th June.

Overall, I believe that everybody hopes that the doses from the radioactive contamination at Dalgety Bay are low for both skin and ingestion pathways. However, we do not consider that people with thinner skins should be afforded a lower level of protection than those with thicker skins without a robust justification.

I would confirm (again) that self shielding etc should be considered in any risk assessment as it was in SEPA's 2009 report, and I hope that SEPA's current work will provide some quantitative data to assess this factor.

Item 2.
The loss of radon-222 could reduce the concentration of decay products within Dalgety Bay particles and thus result in a lower potential committed dose than if the decay products were in full equilibrium. However, the loss of radon could also mean that there is a pathway for external exposure of the skin to radiation from radon daughters which should also be included in any risk assessment.

The Dalgety Bay particles were analysed by the HPA lab in Glasgow and will be analysed again in the near future to verify that initial analyses. The nature of the contamination may mean that a diverse range of contamination has been detected some of which are relatively sealed and allow the build up of daughters and some of which may not be as well sealed and allow the escape of radon-222.

The 2009 SEPA report considered the varied nature of the particles detected at Dalgety Bay and as a result assessed each particle on an individual basis. In situations where the population is poorly characterised, it is not appropriate to make generalisations or assumptions about the particles when specific information can be gathered. In this case it is not appropriate to make assumptions on the equilibrium levels of the particles when this is easily quantifiable for each point source and seems a wholly unnecessary assumption. If DE does not choose to collect this data, the use of a value of 50% equilibrium as a central estimate would be an unjustifiable assumption.

Issue 3.
The SEPA reports in 2006 and 2009 do not report any information to support the assumption regarding any future level of contamination in the bay which is why the screening report produced in 2006 and the 2009 radioactive contaminated land report recommended a full risk assessment. It would appear to SEPA that the MoD is making a substantial assumption for future levels of contamination.

For inhalation, the 2006 report assumed that the particles were too large to be inhaled. The 2009 radioactive contaminated land report suggested further work in any risk assessment could be

undertaken ... "*if this pathway needs to be considered*". SEPA also requested specific advice from HPA on this matter. The resultant advice from the HPA is clearly stated in the 2009 report with the statement about depth in the lung. If MoD have any concerns about this, I would suggest that you raise it directly with the originator i.e. HPA. Thus, I consider that both the 2006 and 2009 reports have been clear on the issue of inhalation of radioactive particles.

Item 5.
This appears to be a repeat of item 1. There also appears to be no item 4 or 6.

Item 7.
The field data collected by RWE in 2006 was shown to be inaccurate through laboratory analysis. Thus, it would be inappropriate to base any risk assessment on this or other field data, unless accuracy could be demonstrably improved. The particles show a skewed activity distribution and thus it would be normal practice to transform the data to an approximately normal distribution before undertaking any statistical analysis.

In 2008, SEPA used real particle solubility for each particle, thus, it did not as stated use "*a figure of 4%*" nor did SEPA use a "*mean of 1.39*" or a "*median of 0.25%*". Using such assumptions with no robust basis would be a substantial assumption which could not be supported at this time. Clearly, following the approach suggested by DE would not represent a realistic dose assessment.

In its 2009 report SEPA also noted that using HCl only approximated the solubility of a particle. SEPA reiterated that for a risk assessment the true gut conditions need to be replicated as was undertaken at Dounreay.

In terms of probability of contact, in 2008 SEPA did assume that all of the particles detected on the beach were in the top 10 cm of sand, SEPA could have corrected the data for the capabilities of the groundhog system, for example, by correcting for the particles which statistically the groundhog system would have missed. This would have had the effect of increasing the assessed probability of contact. However, the 2009 report was not a risk assessment, thus this factor was not included. I recommend that any risk assessment should include this factor which would be consistent with other risk assessments being undertaken in the UK.

Item 8.
As indicated in item 7 in 2008, SEPA used real particle solubility for each particle, SEPA did not as stated use "a figure of 4%" nor did we use a "mean of 1.39" or a "median of 0.25%". If SEPA had used a benchmark of 4% for all point sources this could have lead to a significant over-estimation of the committed effective doses.

Item 1. (This number is repeated in your annex)
In order to inform any risk assessment for particles, it is essential to determine the activities and radioactive hazard that such particles pose. The 2006 and 2008 datasets have shown a range of activities, thus, any generalisations on the radionuclide properties for the particles subsequently recovered, would create a significant area of uncertainty in any resultant risk assessment and given the relative ease of analysis and comparatively low cost would be unwarranted.