EMRAS Theme 2, Working Group 1 - NORM

Report of Meeting #4 ; held in Vienna, 21-25 November, 2005

List of participants:

Richard O'Brien (Chair)	Peter Waggitt (Scientific Secretary)
Jan Horyna	Sergei Sitnikov
Louisa Tsatzi	Virginia Koukouliou
Paul McDonald	Theo Zeevaert
Danyl Pérez Sánchez	Eduardo Quintana
Loren Setlow	Thamir A. Al-Khayat

Model usage

The WG briefly discussed the basic reasons for the work being done, and concluded that the models being assessed and/or developed are intended for use in:

- regulatory assessment;
- environmental impact assessment;
- research.

It was also noted that any models recommended by the group for use in assessing the impact of NORM on human health and the environment need to be:

- easily available;
- easy to use;
- well documented;
- well tested.

NORM Industries

The group briefly reviewed the NORM related industries that have been considered so far. These are summarised in Table 1.

Table 1: A list of industries that generate NORM wastes and residues

Industry	Raw Material	Waste(s) & Residue(s)	Potential use
Mineral extraction	Uranium ore	Waste rock	Construction
	Mineral sands	Waste rock	Construction
	Coal	Waste rock	Construction
	Copper	Waste rock	Construction
	Bauxite	Waste rock	Construction
Mineral processing	Uranium ore	Tailings	Construction
	Mineral sands	Tailings	Construction
	Copper	Tailings	Construction
	Bauxite	Red mud	Soil conditioning
Phosphate industry	Phosphate rock	Phosphogypsum	Soil conditioning, plaster board
Oil & gas	Oil, gas	Formation water, scales, sludges, oily sands	
Generation of electricity from coal	Coal	Fly ash, bottom ash	Land fill, road building, cement extender

Other industries

During this meeting it was agreed that some additional industries and/or processes should be considered by the WG. These are summarised in Table 2.

Table 2: Additional industries that may generate NORM wastes and residues.

Industry	Raw Material	Waste(s)
Water treatment	Waste water, drinking water	Sludges, filters
Paper and pulp industry	Wood pulp, water	Sludges, filters
Paint industry	Rare earths	Sludges, scales
Geothermal power generation	Water/steam	Scales

Other issues

The WG also noted that other issues might require modeling of the impact of NORM in the environment. These are:

- Misuse of NORM (mill tailings, waste rock,…) – building, metal recycling - involving the inappropriate use of contaminated materials under the justification of recycling
- Inadvertent use of NORM - usually resulting from a lack of awareness

Hypothetical Scenarios

The WG has so far considered three hypothetical scenarios:

- Point source
- Area source
- Area source + river

The details of these hypothetical scenarios have been published on the WG web page within the EMRAS web page. Points discussed during the meeting with respect to these hypothetical scenarios were:

- Are there any improvements that could be made to the definitions and specifications of the scenarios?
- What assessments have already been done on the scenarios?
- What assessments still need to be done?
- Are there any other possible scenarios?

Modifications to hypothetical scenarios

Several modifications to the hypothetical scenarios were proposed at the meeting.

1. Radon exhalation rate
   The issue here is whether the radon exhalation rate should be specified as part of the input data for the scenario or calculated by the modeler; the WG noted that it is easier to specify the radon exhalation rate but it is important to ensure that the specified exhalation rate is consistent with the specified concentration of Ra-226 in the waste.
2. Composition of the cover layer
   To simplify the modeling, the WG agreed that the composition of the material covering the waste should be the same as that underlying the waste
3. K_d value for the unsaturated layer beneath the waste
   A K_d value for the underlying material (80% clay + 20% sand) needs to be specified. A value of 10E-8 $cm.sec^{-1}$ was suggested – this may require discussion with the WG revising TRS-364.
4. Range of prediction times
   The range of prediction times should be extended from 1,000 to 10,000 years. While 1,000 years is adequate for most regulatory assessment, the slow movement of radionuclides in soil (leaching) means that in many situations, radionuclide concentrations in groundwater do not increase significantly for several thousand years. Extending the range of prediction times allows a wider range of model predictions to be compared.

5. "Associated workers"
   Doses to "associated workers" involved in disposal of the waste should also be calculated. (e.g. operators of equipment used in NORM transport and activities such as land-spreading, reuse, etc).

Some other points were made during the meeting. These were:

- A clear description of the link between the hypothetical scenarios and real situations is needed.
- The usefulness of the hypothetical scenarios can be enhanced by using real data as inputs and comparing the model predictions with real outcomes.

The importance of hand calculations, particularly for screening, was discussed.
While the natural background can be a problem in many situations involving NORM, because of its high variability and proximity in value to NORM related doses, the presence of the natural background dose allow some simple comparative estimates to be carried out with tables of dose or dose rate coefficients and a hand calculator. These simple calculations may be very useful as a screening tool.

Debugging/Model testing

One session of the meeting was devoted to an examination of the area source hypothetical scenario with the RESRAD 6.3 model, to see if any issues showed up when running the model with the scenario specifications and to check that the values for the different parameters given in the scenario specifications were appropriate. The advantage of doing this with RESRAD is that this model has been extensively tested using real data from a range of real scenarios and the parameter specifications in RESRAD can be accepted with confidence. This testing showed that several parameter values specified in the hypothetical scenario needed to be checked and justified.

Relevance of hypothetical scenarios

An important point that was raised during the meeting concerned the relevance of the hypothetical scenarios to real situations. Table 3 below shows the types of real situations to which the hypothetical scenarios might be applied.

Testing hypothetical scenarios

During the discussion on testing of the hypothetical scenarios, the WG noted that different models may require different input data, because of:

- Different assumptions in different models;
- Different equations or simulation methods in different models;
- Lumping and splitting of parameters in different models

This issue is important because it means that it is very difficult to specify a "standard" scenario. Modelers using different models to test the hypothetical scenarios may have to derive values for some of the parameters required by the particular model being used, either from the parameters given in the scenario specification or from other sources. In either case the modelers have to ensure that the data being used are consistent with the scenario specifications.

Table 3: the relevance of the hypothetical scenarios to real situations

Hypothetical scenario	Real situation	Operating	Legacy
Point source	Power station	Yes	Unlikely
	Ventilation shaft	Yes	Yes
	Mine water discharge	Yes	Yes
Area source	Tailings pile	Yes	Yes
	Waste rock pile	Yes	Yes
	Waste storage	Yes	Yes
	Waste disposal	Yes	Yes
	Resource extraction/processing site	Yes	Yes
Area source + river	Tailings pile	Yes	Yes
	Waste rock pile	Yes	Yes
	Waste storage	Yes	Yes
	Waste disposal	Yes	Yes
	Resource extraction/processing site	Yes	Yes

Hypothetical scenarios - model testing plan

The WG noted that some testing of the point source and area source hypothetical scenarios has already been carried out. The results of the tests will be circulated to WG members as soon as possible, and incorporated into the WG draft report.
The WG agreed to allocate the testing of the hypothetical scenarios as shown in Table 4.

Table 4: Allocation of tasks for testing the hypothetical scenarios.

Scenario	Modeller	Model
point source	Jan Horyna	CAP-88
	Danyl Perez Sanchez	CROM
	Richard O'Brien	CREAM
	Eduardo Quintana	CREAM
	Paul McDonald	CREAM
area source	Theo Zeevaert	DOSDIM + HYDRUS
	Richard O'Brien	RESRAD
	Loren Setlow	Soil screening model
		GENII
	Jan Horyna	PRESTO
		RESRAD
area source+ river	Danyl Perez Sanchez	AMBER

Testing regimes

The WG agreed that there are several types of tests and procedures that need to be carried out in testing the hypothetical scenarios, including:

- Using the same input (source term) data with different models;
- Using the same model with different data and assumptions;
- Using "standard" values for parameters as much as possible, to keep the modeling simple and avoid confusion
- Specifying the input data used for model runs, to allow checking by other modelers.

Model characteristics

The WG briefly discussed the characteristics of the models that have been used, or will be used, by members of the WG in testing the hypothetical scenarios.

- Models such as RESRAD, CREAM, PRESTO, and CROM are deterministic, and the output of the model is determined by the input data and the equations included in the model computer program.
- AMBER is a generalized compartmental model. It is a much more flexible package than the models discussed above, and can be applied to almost any scenario, but the cost of this added flexibility is an increase in complexity in using the model.– AMBER allows both deterministic and probabilistic calculations.
- IMPACT – the WG needs to find out more detail about this package

Other modelers

One feature of this meeting that has not been evident in previous meetings was interaction between different WGs. The NORM WG held combined sessions with the Urban Remediation WG and the Aquatic WG; these sessions examined real scenarios that are of common interest.

The WG noted that there is a need to investigate interaction with groups from other IAEA (NORM related) projects, with a view to obtaining information on such topics as:

- The IMPACT model – this is a model that has been developed in Canada;
- Up to date knowledge of models under development

Real Scenarios

The WG discussed a number of ral scenarios to be developed for model testing purposes.

The Camden scenario

This scenario is based on two neighbouring former gas mantle manufacturing plants in a urban area near a large river. The area has been extensively studied. The source term is relatively complex, as there are several areas where disposal of contaminated material was carried out during the operating life of these facilities. Residential housing was constructed on top of soils containing radioactively contaminated waste. The WG discussed this scenario and decided that further development should include:

- Continuing preparation of data base
- Developing the scenario specifications for modelers;
- Running models (e.g. RESRAD) using average soil concentrations, i.e. simplifying the definition of the source term to allow model testing of the scenario to begin as soon as possible.

The Huelva scenario

This scenario involves a large phosphogypsum disposal site near a river. The WG visited this site during its meeting in Seville in May 2005. This site is also being used by the Aquatic WG as part of one of their scenarios. The WG agreed that the development of this scenario should include:

- Collecting available data and setting up a data base for modeling;
- Developing a model for testing this scenario, using the AMBER package
- Maintaining close links with the staff at the University of Seville, who are involved in developing the scenario for the Aquatic WG.

Other possible scenarios

Other possible scenarios, which might be suitable for this project, were discussed. The most promising of these is a lignite-burning power station site. This will be looked at to see if the available data and site specifications would allow the development of a test scenario.

Draft Report

A first draft of the WG final report was circulated to WG members before the meeting. This draft was intended to provide a focus for the discussions of the WG during the meeting, and highlight any obvious gaps in the work carried out so far.
It is planned to add contributions to this draft report before the next WG meeting, including:

- Model specifications and descriptions;
- Results of hypothetical scenario testing;
- Specification, description and testing of real scenarios (Camden, Huelva);
- Results of real scenario testing.

Examination of the draft report led to several other suggestions for further work that needs to be carried out:

- Other industries that should be considered by the WG;
- Other scenarios that should be considered by the WG;
- Assessments;
- Examination of other models;
- Development of new models;
- Improvement of the Bibliography in the report.

Work Plan

The following work plan was agreed for the next 6 months:

1. **Model testing on hypothetical scenarios**
   This work is to be completed by mid-March 2006, to allow the results to be circulated to WG members before the next meeting, to facilitate discussion of the test results at that meeting, and to allow the results to be incorporated in the draft report;
2. **Testing scenarios with different real data sets**;
   Results to be circulated to WG members for discussion and inclusion in draft report.
3. **Finalise development of real scenarios for discussion at next WG meeting**
4. **Continue the development of the draft report**

Next WG Meeting (April or June, 2006)

The WG discussed several possibilities for the next meeting, using two criteria. Firstly, the site and date of the meeting should allow as many people as possible to attend the meeting. Secondly, the location of the meeting should be convenient for a NORM related site visit.
The possible venues discussed by the WG included:

Italy:	Mestre (phosphogypsum)
	Napoli (phosphogypsum)
Greece:	Athens (lignite power station, phosphogypsum)
Cyprus:	phosphogypsum
South Africa:	Mine tailings
USA:	Florida (phosphogypsum)

The final decision will be made after all interested parties have been consulted.