



World Health Organization

Report of the 2nd meeting of the
WHO International Radon Project

WHO Headquarters
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WHO would like to thank the rapporteurs of the plenary sessions and the individual working groups for their effort in preparing these minutes.

Background

Radon (Rn) and its progeny is a major contributor to the ionizing radiation dose received by the world population. Negative health effects of radon have been noted for many decades. Initially investigations were limited to underground miners exposed to high concentrations of radon in their occupational environment. More recently, efforts to directly investigate the association between indoor radon and lung cancer have provided convincing evidence of negative health effects of radon even at the levels found in buildings. Radon is recognized as the second most important cause of lung cancer after smoking.

Many countries have established indoor radon programmes that aim at assessing indoor radon levels and support mitigation of houses to lower radon levels. However, the public uptake of radon prevention advice and actions has not always been satisfactory.

In order to reduce radon risk, it is important that national authorities have methods and tools based on scientific evidence and sound public health policy. To support member states in their activities targeting radon, the International Radon Project of the World Health Organization was established in 2005.

This report summarizes the presentations and discussions during the second annual meeting of the IRP project, held in Geneva 13-15 March 2006. It also gives an overview of the project structure and provides a planning basis for the next project phase.

Welcome (Maria Neira, Michael Repacholi)

Maria Neira, Dir PHE and Michael Repacholi, Coordinator RAD

On behalf of the Director General of WHO, Maria Neira welcomed all participants to the 2nd meeting of the International Radon Project. She pointed out the new strategy of her department, now called Public Health and Environment (PHE), where prevention of environmentally caused diseases will play a central role. Dr. Neira described the importance of the international collaboration in this effort. She shortly highlighted the scientific basics of radon in homes and the need for accessible and clear information and for preventive action in reducing radon levels. Michael Repacholi also warmly welcomed the participants and gave an short overview of the agenda which was subsequently adopted. He summarized the main objectives of the second meeting as

- review the progress achieved by the working groups so far
- develop specific outlines for the draft documents to be produced by the project
- decide on the further communication strategy of the project
- discuss and decide on new project activities and areas, e.g. on education and training

Opening speech by Susanne Weber Mosdorf, ADG

Due to other commitments, Assistant Director General Ms Weber-Mosdorf gave an opening speech at the evening reception. After expressing her gratitude to the large number of experts attending this meeting, the ADG pointed out that the overall goal of the WHO International Radon Project is to assess and reduce the disease burden caused by radon. To this end, it is important that national authorities have methods and tools based on solid scientific evidence and sound public health policy. Much work in this respect has been done in individual countries. The WHO project is actively involved in bringing this work together and proceeding towards developing international guidance to limit exposure to radon and advise on effective prevention and mitigating measures.

The range of radon risk reduction actions is broad and currently include legislative as well as voluntary approaches in many countries. Collaboration across sectors, in particular with the building industry, as well as risk communication and integrated public health policy development is necessary. WHO, as the leading international organization in health is happy to work with all the partners to achieve a comprehensive yet flexible approach to radon risk reduction, based on the best available scientific evidence.

According to the ADG the working group structure adopted for this project allows all participants to provide input and shape the project in a cooperative fashion. It also demands, however, a high level of commitment and willingness to take over tasks and responsibilities. Ms Weber-Mosdorf expressed her belief that participants were ready to take on this responsibility and would work jointly with WHO to achieve the goals of the radon project.

Session 1 Status of the International Radon Project

Chair: Michael Repacholi

Review of IRP project status (Hajo Zeeb)

Hajo Zeeb (IRP co-ordinator, WHO RAD) gave an overview of the project status after the first year of operations. He pointed out that through the IRP, WHO and its member states should succeed in putting radon on the environmental health agenda in countries where this has not been the case so far, and in strengthening local and national radon-related activities in countries with ongoing radon programmes. In 2005, the main objectives of the IRP project were identified as

1. Identify effective strategies for reducing the health impact of radon
2. Promote sound policy options, prevention and mitigation programmes to national authorities
3. Raise public and political awareness about the consequences of exposure to radon
4. Raise the awareness of financial institutions supplying home mortgages to the potential impact of elevated radon levels on property values.
5. Monitor and periodically review mitigation measures to ensure their effectiveness
6. Estimate the global health impact of exposure to residential radon and so allow resources to be allocated effectively to mitigate the health impact of radon
7. Create a global database (including maps) of residential radon exposure

In a critical assessment, not all these objectives actually lend themselves to being achieved through work of WHO (see discussion below).

In terms of activities in year 1, five IRP working groups and the co-ordination team were established during 2005. Other activities included finalizing the 1st meeting report publication, the production and dissemination of a WHO radon fact sheet, two press releases and a press conference on radon as well as a

project newsletter and project flyer. The website of the project was updated continuously.

Early 2006 the project secretariat and the working groups developed and circulated a radon survey, an initiative first started by David Fenton (Ireland). The survey was done in two steps, with a very short survey to all WHO member states and an extended survey to those countries with existing programmes. First results were collated and distributed as a basis for the working group meetings during this conference. This work will be continued further and the detailed questionnaire sent to all countries with existing programmes (work ongoing).

Hajo Zeeb also discussed the planned scientific outputs of the IRP and suggested to focus on a small number of comprehensive publications (See Session 5).

In terms of membership, there was substantial interest in the project especially after the press releases in June and July 2005. Partners from more than 30 countries are currently registered in the project, with many new partners from Eastern European countries. The co-ordinator also established contact with India and Myanmar as well Ecuador and Peru. Unfortunately, not all partners and interested parties could attend the Geneva meeting.

Finally, the presenter pointed out the very limited project budget, currently involving funds from the UK and US only. Especially in order to include partners from low- and middle income countries and to swiftly proceed with the scientific work in the project, additional funds are urgently needed.

Reports from working groups

Chairs of the IRP working groups then shortly introduced their respective groups and gave an overview of past and planned activities. The presentations were followed by short discussions

WG 1 Risk assessment (Sarah Darby)

The working group has been discussing methodological approaches to the burden of disease assessment. Several partners of the IRP working group are also involved in the ongoing world pooling of radon case-control studies

Discussion

There was a short discussion about the methodology to be used. Several models are available, including the established methodology WHO uses for global burden of disease assessments. Jan Zielinski pointed out that the two important issues - smoking and mapping of radon levels - would be discussed at length during the meeting. The EIP unit of WHO will need to get involved in these discussions to make sure the method used for the radon project is compatible with WHO. Also EIP help will be useful for dealing with the uncertainty in estimate of average Rn concentrations and the problem of what can be done when countries have no data.

Sarah Darby (UK) wondered whether all necessary radon information is already available. If there are any sources that have not yet been tapped, this should be a priority.

WG2 Exposure guidelines (David Fenton)

The working groups' composition (see Annex) and the tasks for the group were discussed. One of the main activities so far has been the identification of existing radon action levels in different countries. The survey mentioned above was introduced in some detail.

Discussion

The issue of setting RN guidance levels was at the centre of the following discussion.

The Chair pointed out that the question of WHO guidance on Rn is important. He noted that there was a question as to whether the WHO IRP should be producing guidance levels at all.

Hans-Erich Wichmann (Germany) and others noted that it might be difficult to have one guideline for all areas. It might be worth looking at the concept of having several guidelines, taking into account that for some countries radon is not a top priority. The Chair described WHO's experience in working with countries to establish guidelines.

Dan Krewski (Canada) encouraged the WHO to set a guideline – looking at the diversity of Rn levels there is much uncertainty and misunderstanding of the situation. The WHO could exercise leadership here.

Maria Neira (WHO) underlined her hopes that WHO guidelines could be used in practice. She felt a need to demonstrate that there are inexpensive measurements that can be taken to assess radon levels and eventually reduce risk. Guidelines should separate the two situations a) new buildings and b) existing buildings.

With respect to the target areas for radon interventions, Sarah Darby (UK) showed that the majority of deaths occurs in low Rn homes – 90% of deaths happen at less than 100Bq/m³ average exposure over 30 years. Most of these deaths occur among smokers.

WG3 Cost effectiveness (Alastair Gray)

The working group has started to discuss the existing approaches to assess cost-effectiveness of radon mitigation. There is an active search for publications, and a question in this regard was also included in the WHO radon survey.

Discussion

The Chair noted that the group is looking at a framework of how cost benefit analysis practically can be done– this would need to be on national level.

David Fenton (Ireland) asked whether the group would be looking at the cost of a lung cancer death. The group plans to do this, since in order to identify costs for each country such data have to be put into the economic appraisal

Hans-Erich Wichmann (Germany) stated that it might be more cost effective to have programmes for smoking reduction rather than Rn reduction. He asked for a general decision on how far the WHO IRP should touch on smoking. Other discussants also focussed on the question of smoking versus radon reduction and the economic issues related to this issue.

Francesco Bochicchio (Italy) discussed two different types of cost analysis. Firstly - looking at the Rn issue - he wondered whether a cost analysis could help decide which exposure level (to start mitigation) to choose. Secondly comparisons for different actions for the same health effect - e.g. stop smoking – could be done separately.

Concerning smoking and radon, Alastair Gray (UK) said that it is not a question of either smoking cessation or Rn reduction. The group would establish cost benefit of all issues on the group's list and work down the list, also being aware that smoking cessation is not effective for all smokers. Rn remediation may also have a place in the cost effectiveness list. The IRP would not have to show that Rn remediation is more cost effective than stopping people from smoking. He said it is likely to be cost effective for new buildings. Likewise, it may be cost effective to identify high Rn houses – but this may be expensive.

WG 4 Measurement and mitigation (Bill Field)

The measurement and mitigation group has the largest number of members. Bill Field introduced the working group list server at the University of Iowa and summarized the tasks of the working group which range from the review of radon measurement devices and mitigation practices to quality assurance and control as well as training and education issues.

Discussion

The discussion touched on various issues. Hans Landfermann (Germany) noted that there is the practical problem of having quick testing methods for Rn levels and asked the group to provide a recommendation.

Sarah Darby (UK) noted the need for interaction between different working groups to find out what kind of information or input the groups might want from each other.

Margot Tirmarche (France) encouraged the IRP to also take a look at most recent publications on uranium miners that include time dependency and show that the risk drops with time since exposure. This demonstrates how important it is to understand how Rn risk works. She commented that the tobacco impact is important for all lung carcinogens; however, the public and authorities did not postpone action on asbestos until they fully understood the smoking / asbestos interaction.

WG 5 Risk communication (James McLaughlin)

James McLaughlin (Ireland) described the scope of the working groups' activities that includes clarifying the objectives of radon risk communication, identify target audiences and existing perceptions of radon risk. Other issues include combined risk statements on radon and smoking, the choice of communication channels and training and education in risk communication.

Discussion

The Chair summarized the recent WHO press release on Rn and asked about the success of the January 2006 Rn action month in the US.

Phil Jalbert (USA) described it as moderately successful, but focus group testing shows that after 15 years public understanding has eroded. A sustained investment in the radon message would have been necessary.

Hans Landfermann (Germany) postulated that the success of efforts by WHO would be linked to continuous and visible radon advocacy and awareness raising. He described the need for continuous public information on dangers of Rn. If people are informed, then governments will follow. The Chair noted that such actions should be leading to measurable impacts (e.g. lives saved), so that one could define what impact will be achieved if actions as recommend were taken.

James McLaughlin (Ireland) reminded the participants that most deaths occur at low Rn, but regulatory agencies focused on high Rn. Thus persuading governments to change building regulations would be important. The target audience should be building technologists in government agencies.

Phil Jalbert (USA) agreed and said that getting the government to do right thing was effective in the US and also had a positive effect on the private sector – leading by example.

Josef Thomas (Czech Republic) reported the same experience from the Czech republic. He argued that not the whole population but rather governments should be targets for risk communication. 2% of houses are having high RN indoor levels, and 2% of families build new houses, so only these 4% only would need to be aware.

Francesco Bochicchio (Italy) concluded that the target population can be different depending on the message. For example, the medical profession should be informed on interaction between Rn and smoking, but governments needed information for changes in building codes. Radon communication will need to connect the target audience with the appropriate message

On the issue of schools and potentially high levels of radon levels James McLaughlin pointed out that Ireland had a major campaign in schools to reduce Rn levels. The EU directive of 400Bq/m³ can be applied to schools, and increased awareness of radon in schools will be helpful to increase public awareness overall.

David Fenton (Ireland) mentioned that the Irish government addressed Rn in schools in 1990s. This actually started a Rn measurement industry and hence a Rn remediation industry in Ireland.

James McLaughlin (Ireland) agreed and pointed out that Rn awareness in Ireland increased due to courts proceedings against companies that have refused to have Rn levels measured.

Margot Tirmarche (France) described that France focused on public buildings. She said that it is efficient to communicate with parents via the concept of risk at school. However, there is no evidence that exposure at low ages increases lung cancer risk. She also noted the problem of convincing relevant bodies that there is a linear relation of risk with Rn levels - especially in France.

Jon Miles (UK) said that in the UK effective communication is delivered as part of a package from the local government. It contains information about risk, how to get measurements done and what local firm to go to for remedial work.

IAEA's activities (Ches Mason, IAEA)

WHO and IAEA both have activities in the radon field and have decided to collaborate in the respective projects. Ches Mason from IAEA gave an overview of IAEA interests and activities concerning radon. He pointed out the role of IAEA in relation to UNSCEAR and ICRP and described the different publication types IAEA uses. Currently the review of the 1996 Basic Safety Standards is ongoing. This is relevant to radon. As in the 1996 edition radon action levels will be included in the revised BSS. Ches Mason indicated that most likely separate action levels for workplaces (1000 Bq/m³) and for homes (200-600Bq/m³) will be retained, but the actual values still depend on the ICRP recommendations. There is a discussion whether tables of conversion coefficients for radon and thoron progeny need updating, and whether these should be shifted to technical documentation.

IAEA is also working on a draft document (DSS 400 - Safety Guide on protection of the public against exposure from natural sources). WHO has been involved in the first expert meeting. The guide will include advice on action levels as well as on identifying radon-prone areas, measurement, and mitigation techniques. The potential for overlap between WHO and IAEA publications is evident, but in practice it seems that the level of detail expected in the WHO publications will be higher. The DSS 400 will also include recommendations on building material. It is envisaged as a joint IAEA - WHO publication and may serve as a vehicle for joint guidance on radon in homes and workplaces.

Discussion

There was some concern among participants about duplication of efforts. One participant asked about the reasoning behind a separate IAEA paper in addition to the WHO project.

Ches Mason answered that both activities began independently. For IAEA it was important to fill an empty slot in the safety guides series. Now it would be the joint task to make sure that the various publications complement each other.

Regarding Bill Field's question what would be the best mechanism for collaboration, Ches Mason suggested that there should be close communication, e.g. through country representatives. IAEA would also consider identifying experts from the WHO project who could be invited to IAEA.

The Chair concluded that WHO and IAEA need more information about each other's programmes. WHO / IAEA would talk over the next few days to give a clearer idea of who is doing what.

On action levels Francesco Bochicchio (Italy) noted that the IAEA approach gives most attention to high Rn levels. He wondered whether this was related to thinking that levels beneath action levels are considered safe? Recent epidemiological studies, however, give new information about low Rn risk.

Ches Mason answered that there is no presumption that there is a level below which risk is negligible. However, for making suggestions for a regulatory framework levels would be given. There would always be an element of judgment in establishing what level would be, also a balance of costs and benefits is necessary. The Basic Safety Standards (BSS) are actually silent on what to do at lower levels

Radon mapping surveys in Europe (Gregoire Dubois, EC)

Gregoire Dubois introduced the Joint Research Centre (JRC) and the Radioactivity Environmental Monitoring (REM) group based at Ispra/Italy. He provided an overview of the steps the JRC has taken towards a European Atlas of Natural Radiation to which radon is the most important contributor. 30 European countries have replied to a radon mapping questionnaire and the answers compiled in a recently published report (EUR 21892 EN, EC. *An overview of radon surveys in Europe*. 168 pp. Dubois G., 2005). He then described the main challenges in harmonizing radon surveys across Europe, for example the differences in measurement and mapping strategies, the question of which variables to use for a joint map etc.. The presenter pointed out that preparing radon maps is by no means a trivial exercise and needs to be taken very seriously.

Discussion

The discussion revolved around the need to produce maps given the major difficulties associated with their production.

Jan Zielinski (Canada) commented that the Canadian group has started a world map of country level Rn, using reported average values.

Several participants mentioned that care should be taken with maps and the compilation of data from different countries. These maps are by no means

harmonised and the methods vary. Maps should not be used for decision making until the data are analysed in a similar way.

Gregoire Dubois (EC) pointed out that the diversity of measurements illustrates the need to have a transparent and common way to produce a map. These maps are just showing diversity, and there is a need to identify end users and uses.

Margot Tirmarche (France) argued that maps are not really comparable from one country to another. She wondered who can do the work of harmonization, and whether it is really worthwhile doing this.

Hans Landfermann (Germany) said that in Germany the government is trying to develop a new Rn protection law and maps give very good guidance for this. However, one must have a map that is consistent in data.

Francesco Bochicchio (Italy) discussed the purpose of maps. Members of the public may think that if they live in a certain area this is "their" value – but there is much variation in each region, and this should be kept in mind when communicating with the public. Data collection is a good starting point – but there is a need to think about the purpose in advance.

Hans-Erich Wichmann (Germany) reported that in Germany a lot of work was needed to harmonise data. There is no easy way of producing maps properly, a reasonable team of people and 3 years or more of time should be available.

Sarah Darby (UK) referred to the question what end users would like to see. For the risk assessment group a map showing outdoor radiation levels would be very useful, because outdoor Rn levels give lower bound to indoor levels. Also for the global disease burden calculations, mean Rn concentration in each country would be very useful. She voiced concern that there is little discussion of sampling strategy of Rn measurements. Large numbers of Rn measurements have been taken in the past, and it is unlikely that there will budget for more. Thus knowledge of the sampling strategy to interpret existing data to estimate mean Rn levels is necessary. Also a representative estimate of the upper tail would be useful (although this may be unrealistic).

Gregoire Dubois (Italy) answered that for the EC survey the degree of bias in sampling was asked in the questionnaire.

Jing Chen (Canada) stated that Health Canada has been working on a revision of radon guidelines since 2003. The new proposed guideline will be put on a website for consultation soon. The new guideline contains one action level for all buildings 200Bq/m³ (current 800 Bq/m³). This is applied to all houses and buildings including schools / hospitals / workplaces etc..

Session 2 IRP working group agenda

Chair Hajo Zeeb

Since most working groups had already discussed their group meeting agenda during the morning presentation, the afternoon session was started with a critical discussion of the seven IRP project objectives.

Critical review of WHO IRP objectives (Hajo Zeeb)

The original IRP objectives were

1. Identify effective strategies for reducing the health impact of radon
2. Promote sound policy options, prevention and mitigation programmes to national authorities
3. Raise public and political awareness about the consequences of exposure to radon
4. Raise the awareness of financial institutions supplying home mortgages to the potential impact of elevated radon levels on property values.
5. Monitor and periodically review mitigation measures to ensure their effectiveness
6. Estimate the global health impact of exposure to residential radon and so allow resources to be allocated effectively to mitigate the health impact of radon
7. Create a global database (including maps) of residential radon exposure

The presenter pointed out that while progress had been made on several of these objectives, in particular objective 4, 5 and 7 appeared rather difficult and partly not appropriate for the WHO IRP. Hajo Zeeb argued that objective 4 on raising awareness among financial institutions could be seen as a sub-objective of 3. and currently no working group was actively involved in work on this objective. Objective 5. was seen as a task for national or local authorities, and all the project could do would be to provide guidance on how such monitoring and review should actually be organized. Objective 7 was also seen as critical since a number of other institutions are involved in similar activities and the development and maintenance of a high-quality global database would be an enormous task consuming major resources. On a more limited scale the IRP would collect all data necessary for a burden of disease assessment, this, however, would not be the same as database development and maintenance.

Discussion on:

Objective 4: raise awareness of financial institutions supplying home mortgages to the potential impact of elevated Rn levels on property values

Philip Jalbert (USA) noted that in the US there had been an attempt to look at financial institutions. It was unclear whether the mortgage lending community is willing to consider a link between radon and home value, they are mainly concerned with property conditions. However, mortgage lenders have taken steps to help inform mortgage applicants of risk.

Jon Miles (UK) said that in England and Wales, the solicitor asks a set of questions about the house to be bought and a question about Rn has been added.

James McLaughlin (Ireland) argued that the WHO IRP should examine different target audiences, and not neglect financial institutions.

Objective 5: to monitor and periodically review mitigation measures to ensure their effectiveness

Hans Landfermann (Germany) found that this would not typically be a task of this project and felt it not necessary to be included in the framework of the WHO IRP

Sarah Darby (UK) was not convinced by this. She stated that the most effective way of reducing Rn is to ensure new buildings have basic Rn protection measures. It would be important to discuss how to ensure that these measures are applied in practice.

Margot Tirmarche (France) said that when recommending how to measure Rn, it is necessary to verify each 10 years if the new level after mitigation is still achieved. In France this would be the best procedure

Hajo Zeeb (WHO) argued that the objective is important but not necessarily the responsibility of this project.

Bill Angell (USA) supported this saying that it is an issue of fundamental importance to know the effectiveness of mitigation strategies. It should not necessarily be for WHO to do field measurements or other assessments, but the issue needs to be addressed by the IRP.

General Discussion on both objectives listed above

David Fenton (Ireland) pointed out that in the survey only 5 countries answered yes to the question whether Rn information is required on house purchase. On the 2nd objective (monitoring and review) – WHO can only advise.

Anssi Auvinen (Finland) said that the objective 4 was not general enough to be on list of overall objectives. The objective 5 on monitoring and review also should not be the responsibility of WHO or this group, but WHO could identify good practice.

Matti Hakama (Finland) commented on effectiveness stating that in this context an action is effective if it results in reduction of mortality. He warned that there is

not sufficient information, so he advised against using something that promises too much.

Hannu Arvela (Finland) said that objective 4 (financial institutions) would be an issue if price of mitigation is low or moderate, but there are areas where prices will be higher.

As a summary of this discussion, the following four objectives for the IRP were suggested by Hajo Zeeb:

1. Identify effective strategies for reducing the health impact of radon
2. Promote sound policy options, prevention and mitigation programmes (incl. monitoring & evaluation of programmes)
3. Raise public, political and economical awareness about the consequences of exposure to radon (incl. financial institutions as target group)
4. Estimate the global health impact of exposure to residential radon using available data on radon worldwide

Comments on objective 7 : Create a global database (incl. maps) of residential Rn exposure

Jan Zielinski (Canada) said that for Global Burden of disease calculations a Rn mean value and variation for each country were needed. A world map with these numbers would be a good start. The quality of the estimates is an issue. Such a map would be possible for Europe, but perhaps not for all countries. His group in Canada is also increasing collaboration with partners in South America. Maps were useful as a front end to a radon data base.

Francesco Bochicchio (Italy) suggested separating Rn maps from the Rn exposure information since their use is different. Rn exposure information would be needed for the Global Burden of Disease calculation. For that it would be important to do a critical review of existing data. He defined maps as a tool for Rn (regional) policy and a tool to identify where to do measurements. He was critical of the chance to harmonise such maps.

Hans-Erich Wichmann (Germany) pointed out that one should think about the purpose of maps before working on them. Just producing maps would not be helpful, one needs to be systematic about it.

Hans Landfermann (Germany) felt it helpful if WHO could make recommendation for a minimal data set .

Gregoire Dubois (EC) stated that the first step would be to define the variable – what measure of Rn will be used.

On this issue, Hans-Erich Wichmann suggested to use annual averages leaving out basement measurements, hotspots etc..

Mikhail Zhukovsky (Russian Federation) noted that in large countries, to use one point/average value poses a problem. There is a need to define the level of detail.

In Russia it would be difficult to use one point only. Also a protocol for measurements would need to be put in place.

Hajo Zeeb (WHO) summarised:

Creating a global map is beyond the resources of this project. However, the project will need average data for the Global Burden of Disease assessment. These – prepared properly and transparently – could be used as basis of a global data base. The objective thus should be to produce a global data base (and not focus on a global map).

Sessions 2 & 4 Working group meeting

Over the next 1.5 days the meeting split up in 5 working groups. Summaries of the working group results are presented together with the plenary discussion comments and questions during Session 5 on day 3 (15.03.06) of the IRP meeting.

Working group 1 Risk assessment (Chairs Sarah Darby and Jan Zielinski)

Rapporteurs: A Offer, P McGale, M Smith, S Darby

Discussion participants: Anssi Auvinen, Juan Miguel Barros Dios, Francesco Bochicchio, Olivier Catelinois, Doug Chambers, Sarah Darby, Bill Field, Matti Hakama, Lothar Kreienbrock, Michaela Kreuzer, Dan Krewski, Paul McGale, Suzanne Menzler, Alison Offer, Annette Prüss-Üstün, Alberto Ruano Ravina, Margaret Smith, Margot Tirmarche, Lene Veiga, Hans-Erich Wichmann, Mikhail Zhukovsky, Jan Zielinski.

Presentations made to the group:

Sarah Darby: Calculating the Numbers of Deaths Due to Radon

Jan Zielinski: WHO Methodology on Calculating Attributable Risk

Lothar Kreienbrock/Suzanne Menzler: Numbers of Deaths Attributable to Radon in Germany

Mikhail Zhukovsky: Modelling Radon-Related Risk

Sarah Darby: Radon and Smoking*

Jan Zielinski: World mapping of residential radon*

Olivier Catelinois: Risks attributable to radon in France

Margot Tirmarche: Risks from radon in miners

Jan Zielinski: Population Attributable Risks for Residential Radon

*These presentations to the joint meeting of all working groups (See Session 4)

Summary of Working group discussion

1. Information on radon concentrations

Doug Chambers is assembling data on radon concentrations in different countries for UNSCEAR. It is expected that these will be published early in 2007, but it may be possible for some of those involved in the WHO Risk Assessment Working Group to see them somewhat earlier than this.

A number of other individuals are also in the process of assembling data on radon concentrations in different countries, including Gregoire Dubois and Hajo Zeeb (WHO survey). For some countries they may have data that would be useful directly. For other countries they may have contacts who may help in providing additional data.

In many countries radon concentrations tend to have been measured preferentially in high radon areas. However, for the WHO project, it is important to try and obtain population-weighted representative averages for each country, wherever possible.

Francesco Bochicchio agreed to take the lead on behalf of the group in assembling the radon concentrations for use in the burden of disease calculations. He will work with Jan Zielinski and Doug Chambers from the Working Group, and others if appropriate.

Francesco will aim to produce an interim summary for the group by the beginning of October 2006.

2. Calculation of the burden of disease due to radon

Calculations will assume that the risk of lung cancer from residential radon is 16% per 100 Bq/m³, i.e. the risk seen in the European analysis of residential radon studies, and that the risk does not depend on age or sex. These assumptions will be revised after the results of the World Pooling become available, if necessary.

As far as possible the calculation will distinguish between potentially avoidable deaths, and those caused by radon at outdoor concentrations, which are not avoidable.

It would be appropriate to consider the potential impact of different policy options, e.g. the potential impact of building regulations which would be likely to halve the radon concentration in new buildings and also the potential impact of remediation measures in existing buildings with high concentrations.

The method, assumptions, risk estimates and data sources need to be agreed with WHO prior to carrying out the main calculations.

It may be convenient to present results in terms of the 14 WHO regions. This can be particularly useful when data are too uncertain to present results for individual countries.

The final outcome is expected to be both a WHO report and a paper submitted to a peer-reviewed journal. There is also a WHO methodological series, which might possibly be appropriate.

Sarah Darby and Paul McGale will take the lead in performing the calculations.

Provisional Timetable WG 1

1 Oct 2006 Interim summary of available radon concentrations

Lead: Francesco Bochicchio, assisted by Doug Chambers

31 Dec
2006

Provisional GBD calculation:

- risk estimate based on European pooling
- description of methodology for WHO approval
- evaluation of maximum possible impact of various radon policies
- (reducing mean concentration, mitigation in homes above action level)
- sensitivity analysis (mortality rates in lifelong non-smokers, BEIR VI)
- individual countries where data permit (i.e. most European, US, Canada, some others), WHO regions elsewhere

Lead: Paul McGale and Sarah Darby

~Oct 2007 Revised radon concentration data

~Dec 2007 Revised GBD calculation

Plenary discussion of WG 1 summary:

The discussion focused on the issues of data availability and quality.

Anssi Auvinen (Finland) asked whether corrected radon data (*corrected for uncertainty in exposure assessment*) and respective lower and upper CIs would be used.

Sarah Darby (UK) responded that the WG will be presenting both RR observed and RR corrected. Information on methodology how to go from observed to corrected values will be provided.

Anssi Auvinen (Finland) pointed out the problem of biased radon data in some countries. Surveys had not been done population based or only in radon-prone areas, and were not representative. Should these be left out for GBD ?

Francesco Boccicchio (Italy) explained how data from the UNSCEAR report could be used. The basic idea would be to collect information that is available and to check if data are of acceptable quality. If this remains unclear, then relevant persons in the country will be contacted.

Matti Hakama (Finland) pointed to the role of smoking. A small difference in smoking has a major impact on the risk of lung cancer before and after a radon intervention. He suggested to develop a study design to assess this issue.

Sarah Darby (UK) warned that the impact of a radon intervention might be difficult to evaluate using risk differences pre-post intervention.

Anssi Auvinen (Finland) suggested to perform a calculation how many cigarettes smoked corresponds to radon in Bq/m³.

With regard to maps. Jan Zielinski (Canada) stated that the WG had limited resources. Some graphical outputs, details of which could be decided later, might be produced only for risk communication.

Margot Tirmarche (France) recommended to not only use published BEIR VI miner data, but also more recent miner data. She noted the different time windows of exposure in miner and residential studies: the risk estimates from residential case-control studies are reflecting 30 years of exposure, the miner data lifelong exposure. However, according to the WG chair, additional miner data can be used in the next step, not this time.

All available information, including further data from the WHO radon survey should be compiled by late September 2006.

Working group 2 Exposure guidelines (Chair and rapporteur David Fenton)

Discussion participants: Gregoire Dubois, Eckhard Ettenhuber, David Fenton, Ches Mason, Georges Piller, Ann-Louis Soderman, Zuoyuan Wang, Hidenori Yonehara, Hajo Zeeb

The efforts of the WG focussed on reviewing questions 2 to 8 of the returned questionnaires. These questions contained the information sought by the WG. The purpose of the review was to make recommendations to WHO based on the replies. The review looked at the answers under the following general headings.

1. Action Levels – that is a radon concentration above which remediation should be considered
2. Prevention – methods of reducing the average level of radon in the future
3. Finance
4. Buying and selling of homes
5. Radon and smoking

1. Action Levels

Most countries who have adopted an Action Level seemed to have followed ICRP recommendation and set an Action Level within the range 200 Bq/m³ – 600 Bq/m³. 60% of respondents choose 400 Bq/m³ while 30% choose 200 Bq/m³.

The risk from radon increases significantly above around 100 Bq/m³. The risk is 25 times higher for smokers when compared to non smokers. The majority of countries who responded choose 400 Bq/m³ as their Action Level. To take account of these facts the WG agreed that WHO should consider recommending Action Levels within the range 100 to 400 Bq/m³. It is however noted that Action Levels are set by individual countries based on circumstances in that country.

The criteria on which member states could choose an appropriate Action Level from within this range should be considered at future meetings of the IRP. Having said this, the criteria should be meaningful to the health of the population of the country and appropriate to national priorities.

Some countries who responded did not have a radon programme or radon policies in place. The WG recommends to WHO that such countries consider introducing appropriate policies.

2. Prevention

The WG recognised that setting an Action Level alone is not sufficient. Introduction of building regulations or building codes requiring radon prevention in new buildings is also necessary. Proper implementation of the building

regulations should ensure that radon levels in new homes are well below the Action Level and will help reduce the risks to the population.

In some countries where such regulations are in place studies have shown that regulations have a positive effect. The WG therefore recommends to WHO that member states introduce building regulations for radon prevention and devise means to help ensure that these regulations are effective.

3. Finance

The WG noted that in a minority of countries a state grant is offered towards the cost of radon remediation. In the vast majority of countries it is the householder who must pay for the remediation. The WG offered no specific recommendation. In any case the WG noted that the provision of grants did not substantially increase the rate of radon remediation (experience from Austria and Germany).

4. Buying and Selling of homes

The WG noted that the majority of states did not require radon to be considered in the buying and selling of homes. Nonetheless the WG felt that such a measure would be a way of finding homes above the Action Level. Therefore the WG recommends to WHO that consideration of radon should be included in the buying and selling of homes in member states. This should be done preferably through regulation but could also be done through increasing public awareness.

5. Radon and Smoking

The WG agreed that this was an important issue with relevance to the entire project. However the WG did think that for smokers the advice should be to reduce radon concentrations and to stop smoking.

Plenary discussion of WG 2 summary

The issue of action levels was intensively discussed after the presentation.

Bill Field (USA) asked if the time of measuring, type of detector, duration of measurement had been considered by the group in reviewing action levels and if any recommendation would be given.

David Fenton (Ireland) answered that the group had not discussed this but probably would not be able to make a recommendation.

Anssi Auvinen (Finland) discussed the high risk approach and the population approach to prevention. He argued that for radon a population approach is well justified, which would mean giving priority to building codes rather than to action levels for high-radon homes. The WG felt that both approaches are needed.

James McLaughlin (Ireland) mentioned that for the buying/selling process, quick measurements are necessary since decisions are often taken very fast. In the overall price some money for measurements could be reserved.

Alastair Gray (UK) pointed out that before recommendations for action levels are given, cost/effectiveness assessments should be made and used for information.

On the question of different action levels for new and existing buildings, the group's current proposal was to have only one action level for all buildings.

Sarah Darby (UK) reiterated that to ensure radon concentration are below a prescribed action level would be the first step. In order to achieve larger population health gains, radon levels should be brought down further, and it could be very cheap to do more. This, however, depends on the countries.

Phil Jalbert (USA) reported the US experience with new construction, building codes, and radon resistant housing. There are no compulsory regulations, so it is important to educate the building community. The US now have 15 years experience. He estimated that half of the radon mitigation installations were installed incorrectly.

Jing Chen (Canada) pointed out that the requirement of test-radon in buying and selling of homes is a successful practice in the US. However, it is hard to implement the same strategy in many poor countries where houses almost never are put into the market.

Working group 3 Cost effectiveness (Chairs Alastair Gray and Terje Strand)

Rapporteur Alastair Gray

Discussion participants: Terje Strand, Ilona Makelainen, Josef Thomas, Ladislav Tomasek, Alastair Gray

The objectives of the WG were discussed as follows

1) To set out a general framework of economic evaluation and its relevance to radon actions:

- cost benefit analysis
- cost effectiveness analysis
- a) Explain perspective and explain why radon evaluation has to be comprehensive
 - for example, energy saving or damp reduction effects of remediation
- b) Explain concept of time horizon in economic evaluation and why this has to be long in radon remediation/prevention
- c) Cover prevention and remediation

The framework will explain that a country-specific economic evaluation will require evidence on

l) Costs:

- radon surveys & measurement, identification of affected homes, prevention and remediation (including maintenance/running costs)

II) Effectiveness:

- could be intermediate outcomes: affected building identified, radon reduction
- preferably health outcomes: lung cancer cases averted, deaths averted, life years gained, quality adjusted life years gained

These can then be combined in a cost-effectiveness calculation – net cost per additional unit of effect

- could be used to compare
 - different radon actions
 - different ways of preventing lung cancer
 - different health interventions
- or can be placed in a cost-benefit framework

Handling uncertainty is likely to be important, especially in relation to radon effects.

Alastair Gray agreed to take responsibility for this in the first instance, by producing an outline draft.

2) Undertake a review of published and unpublished economic studies relating to radon

- cost studies
- cost-benefit analyses
- cost-effectiveness analyses

This could involve a questionnaire, also results from Q19 in the WHO questionnaire, which resulted in a number of publications being identified and reported to Hajo Zeeb.

Terje Strand agreed to take responsibility for this in the first instance.

3) Develop a cost-effectiveness model that can be used to evaluate different radon policies in different countries

- prevention - actions focused on new buildings and significant reconstruction of existing buildings
- remediation of existing homes affected by radon. Includes different action levels, different remediation techniques
- Produce example evaluations from different countries

Software:

- European Commission Radon Software
- Other existing models

Alastair Gray agreed in the first instance to circulate a spreadsheet-based model that has been developed for use in the UK, for sub-group members to evaluate and possibly use to produce example evaluations based on parameter inputs for their own countries.

4) Make use of work coming from other IRP working groups:

- risk assessment, exposure guidelines, measurement and mitigation, risk communications

5) Make input to work of other WGs:

- e.g. on costs and cost-effectiveness of different measurement strategies and remediation techniques

Communication to other groups

1) The WG aims to provide a cost-effectiveness model – a tool – that can be used in different countries, and to assess policy recommendations from this project.

2) The WG would like different WGs to help discover what information is available in different countries, thus to help design this tool.

3) The WG hopes that other groups may take account of their work on cost-effectiveness when making recommendations:

- recommendations on actions (action levels, mitigation strategies etc)
- recommendations on information collection (e.g. costs of measurement and mitigation, radon surveys)

Questions and points for discussion with other WG:

a) Risk assessment WG:

- Information from risk models
- Advice on preferred model
 - will WG be able to look at a cost-effectiveness model?
- Average level and distribution of radon?
- Information from GBD
- Deaths attributable to radon
- Lung cancer rates/deaths

- Prevalence of smoking by age/sex?
- General mortality – life table or age-specific deaths?

b) WHO Exposure guidelines WG:

- Does this WG plan to make specific recommendations on action levels?
- .. on target levels?
- .. on building codes?
- If so, WG3 would hope cost-effectiveness might play a part.

c) Measurement and mitigation WG:

- Will the group be looking at effectiveness of different mitigation methods?
- In new buildings as well as existing?
- Will the group look at evidence on cost of different methods?
- Will they be looking at maintenance/running costs and expected lifetime of techniques?

d) Risk communication WG:

- Will the group be looking at factors influencing whether people agree to have homes tested, to take remediation action?
- Policies to improve willingness to take action?

Plenary discussion of WG3 summary

Phil Jalbert (USA) reported that in a US benefit-cost analysis, radon scored favourable compared to other programmes, being rated second best. Such assessments obviously can be very useful to obtain programme resources

Alastair Gray (UK) pointed out that the economic analyses could not be done for all countries. The group would focus on giving examples of cost - benefit analyses from different countries and circumstances. The small size of the group would also influence the amount of work that could be done.

Anssi Auvinen (Finland) added that Dan Krewski and colleagues compared cost-effectiveness of different action levels. The key result of this analysis was that an action level of 200 Bq/m³ was the most cost effective compared to other options.

Working group 4 Measurement and Mitigation (Chairs Bill Field and Bill Angell)

Rapporteur Dan Steck

Radon Measurement Summary (Session I and III)

Goal for measurement portion of the joint Working Group session: Create and review an outline for a draft report

Discussion points:

1. Are there any additions to the list of detectors in the questionnaire results?
NONE
2. What kinds of tests are done in your country and who performs them?

Nation	Activity
Bulgaria	Alpha-Track Detectors (ATD) mostly applied in suspect areas for 2 to 6 months; government and institutes; no mitigation; no commercial detectors
Canada	Low Rn awareness means little testing; Charcoal (CC) from commercial companies (~9) Current guideline calls for normal living area for a year; Ongoing mini-survey with EPERMS
China	Short-term(ST) = EPERM follow-up if high; some charcoal (CC); Institutes do testing; ATD <3 months(called short-term); ATD >3 months (called long-term),consider seasonal correction (short-term; a specification is completed with monitoring drawn from US EPA technology documents
Finland	STUK requires use of integrating device for official Rn measurements must be done during heating season. STUK sells 95% of ATDs used in Finland.
Germany	ATD for 3 months usually; measurements are carried out by government services and a few private services; usually two detectors per site in living rooms. No regulation on measurement in house; measurements by the government for survey and regulative purposes; individual home assessments for home owners/users by private services
Japan	Makrofol in German detector used in 80's survey. New detector (Rn-Tn) used in 90's by government and institutions. Little public measurement.
Luxemburg	ATDs for 3 months; government supplied to homeowners for living and bedroom exposures. Little public interest in radon testing.
Poland	University-based research with variety of detectors; not much radon found so focus is on workers in mines; no commercial activity
Romania	Early measurements in U mines but results unavailable; limited surveys with ATDs no commercial detectors

Russia	Two organizations make measurements; State Ministries of Health (mostly short-term for radiation health “approval” of buildings and Universities/Institutes for research. Measurements by Health Ministries not widespread; mostly around Moscow and not useful for determining exposure. Universities use ATDs (LR115 based) and occasionally charcoal and RnP grab samples. Some radon soil flux for site assessment near Moscow and St. Petersburg but not in country. No sound evidence that site evaluation is helpful. There are few radon researchers (~10) and 3 laboratories in St. Petersburg (Meteorology?), Moscow and Urals Institute. No national agreement on standards.
Spain	Radon testing is regional; few tests done mostly by universities; CR-39 ATDs with a few scintillation cell samples early
Switzerland	<ul style="list-style-type: none"> - ATD and EPERM now; 3 months normal (1 month minimum usually in winter, 3 months are recommended).- - Some Picorad (LS CC) early (current project to determine the reliability of measurements with Picorad-detectors compared to the 3 months measurements). - 13 companies on the accredited service list; they are subject to annual QA testing. - The radon map was finished in 2004 (measurement in 60'000 houses). Now extensive survey to find all the houses over 1000 Bq/m3 in the high risk area. In winter 2005/2006: measurement in 20'000 houses in Switzerland (estimation).
UK	3 mo. ATD and 14 day ATD for real estate transactions; most detectors supplied by government but some companies and some CC. Usually measure both living and bed rooms
US	Mostly ST CCs for real estate transactions; EPA proficiency programmes was privatized; many companies and market driven

3. Who is routinely measuring radon in water? UK, Spain, Switzerland, Luxemburg, Germany, Finland, China (observation earthquake)
4. Who still uses charcoal for short-term measurements?
 - US, Canada (frequent)
 - China (frequent, new building measurement)
 - Japan (occasionally)
5. Who routinely measures for radon progeny?
 - Poland
 - Romania
 - Russia (Urals)
 - China (sometime)

6. Who is measuring for thoron?
 - Japan; intensive research and measurement to assure radon results are thoron free; also cooperative work in China
 - China (research and survey), cooperation with Germany
7. What techniques are used for radon in water?
 - Liquid scintillation (most nations)
 - Gamma spectroscopy (medium and/or high resolution)
 - i. Finland
 - ii. Russia
 - Emanation
 - Bubbling and condensation
8. Where do individuals calibrate or inter-compare?
 - NRPB (UK)
 - PTB (Germany)
 - Paul Scherrer Institut (PSI) (Switzerland)
 - National chambers=> need a comprehensive list; start with Andy George's old list; make a subcommittee to develop new list
 - NURL (China)
9. Who uses active monitors for radon and/or radon progeny (RnP)?
 - Germany: Tracerlab and SARAD developed electronic RnP devices now available on the market
 - Bulgaria: RnP monitor using CR39
 - Canada (Health Canada): Pylon equipments, SARAD devices
 - Switzerland: Alpha guard (ionization) for Rn
 - Russia: ionization detector
 - China: RAD7, Alpha guard, RTM2100
 - Japan: Alpha guard and RAD7
 - UK: Alpha guard and Thomson Nielsen WL Meter used for workplace measurements
 - Luxembourg: Alphaguard
 - Some discussion of new cheap CRMs (Safety Siren/RAMON) "electronic radon monitor"
10. What detector failures have you encountered in field applications?

- Dates/ exposure information
- Failure to deploy

11. What are the requirements for commercial detector companies?

- Switzerland: QA programmes and results are reported to government
- Requirements of the measuring system (similar as DIN 25706-1) to be on the list:
 - Exposition time over 1 month possible
 - Minimum detectable exposition: < 50 kBqh/m³
 - Maximally detectable exposition: > 3`000 kBqh/m³
 - Measurement accuracy (1σ-error by 200 kBqh/m³): < 30%
 - Reproducibility (dispersion): < 15%
 - Linearity in the measuring range: < 25%
- The accredited services of measurement are subject to annual QA testing. Requirements to pass the test:
$$\sqrt{B^2 + S^2} \leq 20\%$$

B: Deviation from the reference value in %
S: Standard deviation in %
- Communication of the measurement results in Bq/m³. Calculation of the annual mean:
$$A_0 = A_m \frac{\bar{N}_{Wi} + N_{So}}{1.12 \cdot N_{Wi} + 0.88 \cdot N_{So}}$$

Am: Radon concentration in Bq/m³
Nwi: Exposition time from October to March (winter)
Nso: Exposition time from April to September (summer)
- Russia: official certification needed for radiation measurements
- Poland: companies are tested by accredited labs
- Germany: only workplace measurements need to meet certain requirements comprising QA and participation in inter-comparisons; for measurements in houses these requirements have the status of recommendations for good practice
- Finland: companies need to be certified by NRPB or STUK
- China: official accredited labs
- UK: Validation scheme for companies offering passive radon detectors

12. What recommendations would you make for improving QA?

- Detector results need to be reported with an uncertainty attached
- Traceability to standard
- calling administration branch standard or guideline

13. What QC practices are used now?

- US(BF): 10% duplicates, 5% spikes, 3 to 8% blanks
- Bulgaria:
- Poland: calibration through NRPB
- Switzerland: duplicates and spikes (see topic 11)
- Luxembourg: don't usually do duplicates but do 10 to 20% blanks; PTB calibrated
- Russia: no duplicates but experience shows 15-20% reproducibility
- Spain: use duplicates, blanks, and control charts. Calibrated in Barcelona.
- Finland: spikes every 20 films, duplicates in lab since experience shows that's equivalent to duplicates in the field. Blanks used too.
- UK: twice a year QA/QC exercise. Each sheet of material is sampled at 6% for blanks, 6% for spikes; a no more than 10% variability acceptance criterion for the sheet. Uses a service for blind spikes. Finds duplicates in lab same as in houses. Distribution blanks studied.
- Japan: calibrated at PTB in Germany, compare with NRPB
- China: national comparison; COV must be lower than 20%, normally around 13%
- Germany: dual programmes; internal and external. Internal=control charts and extensive exposure calibrations. External= must have a QA plan and participate in comparison exposures.
- Bulgaria: lab spikes show COV ~10%. Compare with Czech and Belgium show difference of ~15%.

14. What factors affect the Rn detector results?

- China: Thoron in some conditions; reported survey results, variety of season or altitude
- Japan: presented research on thoron effect on RADTRAKs, thoron spatial distribution from source, and new thoron-radon discrimination detector. Need to measure thoron in order to ensure (or correct) radon measurement in thoron's presence.

[Bill Field suggests making a list of the detectors used in the epidemiological studies and what may we know about their thoron sensitivity. Need to make recommendation about reducing thoron effects for preferred measurement methods that the group might recommend].

15. What devices should be used in mass surveys?

- Integrating devices
- ATD (Switzerland)

16. What are the shortest term measurements that are acceptable?

- UK: allows 14 day measurements under unusual circumstances
- US: proper decision protocols need to be found if short-term tests are to be used at all. This may need country-by-country or regional studies.
- China: 2-day measurement under limited ventilation conditions and closed window
- Switzerland: 1 month

Radon Mitigation Summary (Session II and IV)

Goals for mitigation portion of the joint Working Group session: Create and review an outline for a draft report reflecting the following:

1. Identify the variation in radon sources and transportation mechanisms in the various countries presenting at the session as well as peer-reviewed, guidance, and literature describing these variations.
2. Identify the variation in mitigation strategies in the various countries presenting at the session as well as peer-reviewed, guidance, and literature describing these variations.
3. Identify the variation in prevention strategies in the various countries presenting at the session as well as peer-reviewed, guidance, and literature describing these variations.

Sources and transport mechanisms

- Emanation of radon from buildings materials have been a concern in
 - China (mixed scrap building material, soil brick)
 - Hong Kong (in high rise residential buildings built with concrete)
 - Italy

- Sweden (in high rise residential buildings built with concrete as well as low-rise houses built with light weight concrete block)
- United States (rarely)

- Well water transport of radon reported to be a concern only in the United States
- Thoron interference is a concern in China, Hungary, Japan and Russia
 - in China, thoron concerns are focused especially in houses built with soil-based materials, such as traditional raw earth buildings (cave dwellings) , as well as high natural radiation background areas.
 - in Russia, thoron concerns are related to some plaster used in certain regions of the country
- The possibility that earlier residential epidemiological studies in thoron rich regions may have suffered thoron interference needs further study to see if the thoron influenced risk estimates.

Mitigation and prevention report summaries by country

- Bulgaria
 - needs to move ahead with mitigation experiments
 - recommends ventilation of indoor spaces (opening windows)
- Canada
 - Canada Mortgage and Housing Corporation has lead responsibility on mitigation and prevention guidance (contact Don Fugler)
- China
 - mitigation techniques include only space ventilation
 - new construction enforceable guidance for residential buildings and enforceable guidance for (emanation from?) building materials

[Discussion: ^{226}Ra content limitation is 200Bq/kg-1 in China building materials standard, the relation in ^{226}Ra content and radon exhalation rate for autoclaved aerated concrete and new type wall material need to be studied]

- Finland
 - radon mitigation has been practised in Finland since the mid-1980s
 - published mitigation and new construction guides
 - the residential guide is currently under revision

- recommends referencing European Radon Research and Industry Collaboration Concerted Action 2 (ERRICCA - 2) residential mitigation and prevention case studies and reports
- also has provided presentations on mitigation and prevention as well as a 1993 Indoor Air paper
- Germany
 - mitigation recommendations published in a handbook
 - mitigation techniques include sealing, ventilation and airing of indoor spaces (particularly cellars or basement rooms)), as well as active soil depressurization
 - had a research, demonstration, and mitigation training house in a high radon area
 - no professional service for mitigation available, training of architects and house constructors is under way
- Japan
 - mitigation techniques include exhaust ventilation of a school
- Luxembourg
 - Nobody does mitigation but guidance document for householders exists
 - recommends ventilation of indoor spaces (opening windows)
- Poland
 - recommends ventilation of indoor spaces (opening windows)
- Romania
 - recommends ventilation of indoor spaces (opening windows)
- Russia
 - mitigation and prevention recommendations exist for existing and new buildings in Moscow
 - prevention guidance encourages limiting openings to the soil
 - a book is available with mitigation guidance drawn from the EU and US recommendations
 - very little mitigation expertise in Russia
 - sometimes high radon buildings are destroyed as a mitigation measure
- Spain
 - seeking funding to build an experimental house

- Switzerland
 - has mitigated homes since 1987
 - goal to mitigate all houses with radon concentrations $>1000 \text{ Bq/m}^3$ by 2014
 - mitigation techniques include active soil depressurization, ventilation, overpressure in the building (preferred in high radon homes)
 - radon resistant new construction used and consists of pipes under slabs and then testing is recommended
 - CD with radon documentation provided to W. Angell
 - Handbook is available
- United Kingdom
 - existing buildings
 - mitigation techniques principally include active soil depressurization, increased ventilation under suspended floors, and positive ventilation of houses but may include improved house ventilation or sealing techniques.
 - radon resistant new construction:
 - radon prevention requirements are for regions with known radon problems as identified on maps.
 - in areas with 3 – 10% of homes above the UK Action Level, new homes must include 'basic radon protection': a radon-proof barrier across the whole area of the building, sealed at service penetrations.
 - in areas with $> 10\%$ of homes above the UK Action Level, new homes must include 'full radon protection': in addition to the basic protection, means of ventilation under the floor, such as a suspended concrete floor or a radon sump.
 - written mitigation guides available
 - Building Research Establishment has delivered radon mitigation training
- United States
 - virtually all residential mitigation uses active soil depressurization
 - the historic voluntary guidance has been the US EPA's
 - Henschel, D.B. (1993) *Radon Reduction for Existing Detached Houses: Technical Guidance [Third Edition] for Active Soil Depressurization*, U.S. Environmental Protection Agency, Research Triangle Park, NC
 - U.S. Environmental Protection Agency (1994) *Radon Mitigation Standards* US EPA, Washington, DC

- scheduled to be retired this year
 - ASTM 2121-03 is an alternate
 - American Association of Radon Scientists (AARST) is finalizing a radon mitigation standard
- radon resistant new residential construction primarily relies on passive soil depressurization and a membrane under the ground-contacted portions of the foundation
- the historic voluntary guidance has been the US EPA's Radon Resistant New Construction (RRNC) documents
 - ASTM 1465 on RRNC is currently undergoing review
 - Appendix F of the *International Residential Code* reflects US EPA's RRNC recommendations
- radon mitigation in mechanically ventilated schools may involve ventilation changes and/or active soil depressurization
- voluntary guidance for radon resistant construction of schools has been issued by US EPA

The Mitigation Working Group needs to make further contacts with:

- Ireland
- Norway
- Sweden

The Mitigation Working Group Chair, William Angell (U.S.) has started a critical review of the scientific peer-reviewed literature as well as guidance literature on mitigation and prevention. He also announced plans to visit WG member countries to meet with leading academic researchers, government officials, and private contractors doing mitigation and prevention work.

The following individuals have expressed interest in contributing to the Mitigation Working Group

- William Angell, USA
- Hannu Arvela, Finland
- Marielle Lecomte, Luxemburg
- Winfried Meyer, Germany
- Qui Shou Kany, Nanhua University, China (unclear whether nominated)
- Georges-Andre Roserens, Switzerland
- Chris Scivyer, Building Research Establishment, UK

Other members identified in October 25, 2005 WHO list:

F. Bochicchio, Italy, D. Chase, US, I. Chell, UK, G. Fisher, US, J. Jankowski, Poland, P. Jenkins, US, D. Pressyanov, Bulgaria, W. Ringer, Austria. L. Quindos, Spain, B. Shang, China, T. Strand, Norway, S. Tokonami, Japan, W. Zhuo, China.

Plenary discussion of WG 4 summary

Bill Field (US) commented that the group would need to get together either physically or electronically to edit a draft of their document in the next 6 - 9 months. The group may want to explore funding available through a grant to get together in North America after a first draft is ready. Elluminate, an e-conferencing tool through the University of Iowa, could allow the group to work together from their respective home bases.

Hajo Zeeb (WHO) stated that the group should keep in mind their task which is to write a document that makes recommendations to the national authorities rather than a deeply technical or an instruction manual for homeowners. The chapter does not need to exceed ten of pages for radon measurement and ten pages for mitigation.

The chairs will start the drafts of the chapter with input from the working group. A sub working group needs to be formed to focus just on the calibration guidelines and availability of chambers.

Hans Landfermann (Germany) asked if it is intended to give advice on short term measurements. As a start no exact measurement might be needed, but a general indication if Rn levels are above/below AL

Bill Field answered that this it is hard to determine exposure from short-term measurements, therefore both short-term and long-term measurements would be needed.

Georges Piller (Switzerland) added that information on feasibility of short-term measurements will be provided soon through a Swiss project.

Working group 5 Risk communication (Chair James McLaughlin)

Rapporteur Sandor Horvath

Discussion participants: Manfred Helming, Sandor Horvath (Co-Chair/Rapporteur), Philip Jalbert, Virginia Koukoulidou, Hans Landfermann, James Mc Laughlin, Georges Piller, Andre Poffijn, Luis Quindos, Ann-Louis Soderman, Quanfu Sun, Pavel Szerbin

A number of members of the above list were not able to be present for the full discussion time of the group as they also participated in discussions in other work groups. In addition due to their respective positions and duties as Chair and Co-Chair of other work groups two members of the work group (David Fenton and Terje Strand) were unable to attend the formal discussions. In spite of this during the meeting in Geneva their opinions were sought and obtained on a number of aspects of risk communication by the Chair (James Mc Laughlin).

Summary of Meeting

The discussions of the group mainly focused on the following topics :

- a) Identification of target audiences
- b) Evaluation of existing radon risk perceptions
- c) Core messages on Radon risk and on the smoking issue
- d) Communication Strategies
- e) Training
- f) Proposals to the WHO IRP

a) Identification of target audiences

The discussions led to making a distinction between two types of target groups. The first group, called the Direct Category, are those whose actions (either by physical means or regulatory/financial instruments) could directly result in radon reduction in existing or future houses.

The second group, called the Indirect Category, are those whose actions (either by decision-making or by highlighting the radon problem) would help to increase and improve public awareness/ perception thereby helping to encourage radon prevention and reduction in communities. While it was realized that some target audiences may in different situation be seen to be in either or both categories nevertheless this dual categorization is useful to the planning of communication strategies. The list of target audiences, which should not be considered as exhaustive, in the two categories now follows :

Direct Category of Target Audiences

- Persons building or modifying their own dwelling
- Householders

- Tenants
- Architects, Engineers, Designer
- Constructors, construction companies
- Financial institutions
- Real estate companies
- Local authorities
- Water supply companies

Indirect Category of Target Audiences

- Governmental and political decision makers
- Financial institutions
- Architects and Engineers
- Legal advisors, lawyers
- Medical persons, pharmacists
- Teachers
- Media
- Do-it-yourself stores
- Professional associations of above mentioned target groups

b) Evaluation of existing radon risk perceptions

The group discussions on this topic led to a strong recommendation that surveys of knowledge of radon in each chosen target audience should be carried out before and after a communication campaign.

The main objectives of such surveys will be to find out what is the extent and origin of their knowledge about radon, with regard to:

- a) the origin and pathways of radon
- b) the health effects of radon
- c) means to protect from radon

The ultimate goal of such surveys is to evaluate the effect of a communication campaign and to improve it.

c) Core Messages on radon risk and on the smoking issue

A number of examples of radon risk communication message from different countries were discussed. Of particular value to this discussion topic was the information and insight given to the group by Dr Philip Jalbert based on the extensive experience in this field of the US EPA. In other examples discussed it was also noted that there was much commonality between the radon messages in different countries and after discussion it was agreed that to be effective radon

risk communications should be focused on three main core messages as follows :

- Core message (1): "indoor radon is the most important cause for lung cancer after smoking"
- Core message (2): "radon is a radioactive gas in your house: measure it!"
- Core message (3): "you can protect yourself from radon"

It was also considered most important that the messages should be adapted to the individual target groups. The importance of using a credible/respected sender (for instance WHO) and appropriate channels was also emphasized. In the case of dealing with the "smoking issue" it was agreed that care should be taken in formulating messages linked to tobacco such as by :

- a) In the case of simple communication messages avoid giving separate quantitative messages for smokers and non-smokers. Such quantitative information should of course be used in more targeted communication messages.
- b) Concentrate on comprehensive and simple information regarding the radon risk in the context of smoking

Example:

- "whether you are a smoker or not: a high radon concentration significantly increases your lung cancer risk"

d) Communication strategies

The complex question of how effective communication strategies should be designed and implemented gave rise to much discussion from which the following observations emerged:

- The chosen strategy will depend on:
 - a) the actual situation in a country (extent of the problem, legislation, recommendations, action level, budget and resources, etc.)
 - b) the overall objective of the radon programme (for examples is it to reduce the average or only high radon concentrations?)
 - c) the communication objective
 - d) the set time frame
- Possible strategies that may be adopted are :
 - direct approach to people building or modifying a house
 - disseminate information through the media
 - repeat information at appropriate intervals of time
 - use of credible intermediate target groups
 - convince decision makers
- The actual communication means to be used will depend on the chosen strategy examples of which are :

- roadshows
- direct mailing
- helpline, hotline
- construction exhibitions
- dosimeter point of sale
- media
- measurement campaigns
- workshops, conferences, training courses,
- WHO communication channels (radon day etc.)?

e) Training

An important aspect of radon risk communication will be the development of training strategies. This was considered of particular importance to countries who at present do not have any or only a very rudimentary radon programme. As WHO IRP is intended to be a “global” project training will be a major requirement to establish it on a “global” basis. The following is a list produced by the group of topics relevant to the training need :

- Production of training and teaching materials by WHO
- Organise „train the trainers“ courses or workshops.
- Production of educational materials for schools
- Appoint an ambassador for radon (a star architect or a media personality with a well known environmental or health protection concern)
- Set indicators for each objective and activity (percentage population increase in knowledge of radon, number of measurements, number of houses remediated, number of contacts by phone or mail, number of hits on Rn programme homepage, number of articles, tv reports etc.)
- Check the extent to which the set objectives have been achieved
- Be patient in achieving the goals....

f) Proposals to the WHO IRP

At the end of the group discussions it was decided that the following proposals should be submitted to the management and secretariat of the WHO IRP :

- WHO should officially inform **all** member state governments about the WHO International Radon Project
- WHO should recommend to member states that funding should be made available to national experts in the IRP who so far have not received any funding to enable them to attend the IRP meetings. This is an important issue for those experts who come from the university sector as distinct from those in the direct employment of a government

agency. In the case of the latter once permission to attend is granted the funding is usually made available.

Plenary discussion of WG 5 summary:

Smoking and radon - if and how to combine communication on these two risks was a major topic for discussion.

Anssi Auvinen (Finland) asked why one should avoid messages on smoking in the framework of radon risk communication? The public could set own priorities, and should note that radon is not the only risk. He supported the use of absolute risk information that is different for smokers and non-smokers

Jim McLaughlin (Ireland) argued that the public can not do own risk assessment. For different target audiences different messages were needed. For the public he recommended using simple messages speaking only about radon and not in combination with smoking) while for professionals radon and smoking could be combined.

Francesco Bocchichio (Italy) said that all target groups should obtain a qualitative idea of risk (a comparison with other daily life risks)

Matti Hakama (Finland) added that for non-smokers the lung cancer risk is small. However, radon programmes might not receive funding if they say this.

Margot Tirmarche (France) said that there are certain clear messages: roughly 10% of lung cancers could be due to radon; for individuals with high exposure risk is doubling, and the relative risk is independent of smoking status. She added that smokers often are not interested in risk messages anyway since they are aware of the smoking risk and continue in spite.

David Fenton (Ireland) reminded the group that if smoking would not exist, lung cancer would be a rare disease. For the risk communication it is important to think of practical situations: what should you say at a telephone helpline? Some guidance how one could assist the person to answer the phone would be very helpful.

Jing Chen (Canada) said that for public decision makers comparisons of radon risks with other risks are useful (e.g. traffic accidents, etc..). The radon risk would be higher than most, and comparison should not only be made with smoking.

Phil Jalbert (USA) pointed out the difference between radon risks which are involuntary, and other risks that people face voluntary. Risk should be put in perspective to allow choices. For the Helpline in the US, the staff is receiving periodical training.

Sarah Darby (UK) responded to an earlier comment saying that lung cancer would not be all that rare without smoking. The cumulative risk increases from 4 per 1000 to 8 per 1000 for non-smokers.

Hans Landfermann (Germany) noted that in Germany 99% of the population don't know what radon is, or that it is dangerous. Thus the first step is information about radon.

Georges Piller (Switzerland) discussed the risk comparisons and argued that stakeholders have less understanding of this than the public. Looking at such risk comparisons, an argument could be that children should get the same level of protection from natural radiation as nuclear power plant workers receive concerning artificial radiation.

To this, Lene Veiga (Brazil) replied that natural radiation is not an easy topic for risk communication with the public. She was concerned that one of the main issues is the question of how to avoid radon phobia in risk communication.

Jim McLaughlin (Ireland) noted that the WG had decided not to include the word "natural" in their recommendations. Natural gas is used for heating, and radon gas - even though natural - is quite distinct from this.

Evaluation and coordination group (Chair Hajo Zeeb)

Rapporteur: Hajo Zeeb

Discussion participants: Anssi Auvinen, Gregoire Dubois, Philip Jalbert, Hans-Erich Wichmann, Hajo Zeeb

The evaluation and co-ordination group met twice during the IRP meeting. The main topics of discussion were:

Terms of reference for this group:

The evaluation and co-ordination group agreed to see itself as a critical body that

- overviews the work of the project and the individual working groups
- ensures that objectives are feasible and can be met
- ensures that individual working groups remain committed and contribute to overall aims and objectives of the WHO IRP

It does not consider its task to develop guidelines for the evaluation of radon programmes at large. Issues related to evaluation of programmes will need to be addressed in the relevant working groups and should be part of the final document(s).

Discussion of IRP objectives

The group sees the following interconnected goals relevant for the radon project:

- Ultimate objective: reduce radon -related ill health effects
- Intermediate objective: reduce radon exposure, to be achieved through the development of measurement and mitigation guidelines, respective policy documents and scientific appraisal of alternative actions.

Overall, major tasks for the IRP include:

- Information collection and dissemination
- Development and dissemination of recommendations
- Promotion of good practices with regard to radon

Members of the group then joined other working groups to observe and contribute.

At the second meeting on day 2 the evaluation group initially assessed the progress made in the working groups, which in general was judged to be good.

Other issues discussed were:

Radon mapping in the framework of the project

It was recognized that radon mapping is an issue that cannot be adequately addressed in the WHO IRP. However, links should be maintained and developed to the projects focussing on mapping (e.g. EU JRC activities)

Potential threats to the project

The issue of overlap with IAEA activities following the presentation by Ches Mason was discussed and seen as potentially problematic. The WHO IRP team will enter into a written agreement with IAEA to ensure good collaboration and avoidance of duplication of efforts. It was generally felt that the WHO project might be more specific and detailed in several areas, and might cover issues not included by the IAEA guide under development (i.e. cost - effectiveness). However, this remains to be followed up and discussed with IAEA colleagues. The already established link between the agencies was noted. The issue of co-sponsoring the respective outputs should be clarified as soon as possible.

Time lines

The time schedule for the IRP activities requires rather intense progress by the working groups in the coming year. This was regarded as one major threat to the project success. Intense communication and motivation to fulfil tasks will be needed. It was recognised that the WG chairs carry particular responsibility for this

A full SWOT (strengths, weaknesses, opportunities, threats) analysis could be done by the WHO secretariat in due course.

Session 3 Joint meeting of working groups

Chair Anssi Auvinen

Smoking and Radon (Sarah Darby)

Sarah Darby presented data from the European pooling study. She pointed out that while the cases were mostly smokers, the controls were mainly non-smokers. There was, however, a positive association between radon levels and smoking prevalence among controls, with the lowest smoking prevalence (39%) in the group below 100 Bq/m³ of measured indoor radon. The % increase in lung cancer risk per 100 Bq/m³ increased with finer stratification for smoking, indicating the potential for residual confounding by smoking if not properly controlled. The presenter then explained the final analysis results in more details and also displayed the relative risk for smoking irrespective of radon, which was increased up to 40-fold in heavy current smokers as compared to lifelong non-smokers.

Against the lung cancer risk of life-long non-smokers that increases very gradually with increasing radon concentrations, there is a steep risk increase in current smokers and recent ex-smokers with increasing radon concentrations, highlighting the fact that most radon-related lung cancers occur among smokers.

There are marked differences in lung cancer mortality trends across countries. While UK men have enjoyed a marked rate reduction since about 1960 (age-dependent), countries such as France and more dramatically Hungary see high and increasing lung cancer mortality rates among men. From a lower level, rates among women have been increasing in most countries. Mortality estimates for non-smokers still largely depend on the CPS I and II studies from the US, but there are also some direct estimates from the UK. While cumulative lung cancer deaths risk at age 75 essentially remained stable among non-smokers between 1950 and 1990, there are marked cumulative risk increases between 1950 and 1990 for ex and current smokers, indicating the very strong effect of smoking as well as the variability of lung cancer risk over time.

To nevertheless try and estimate the different contributions to lung cancer mortality from radon and smoking, data from a Europe-wide study were presented. The aim of this study is to present, for each European country, an estimate of the number of lung cancer deaths caused each year by residential radon alone, and by residential radon in conjunction with cigarette smoking. After a detailed presentation of the methodology for this study, results indicated that about 1.3% of all lung cancers are caused by radon alone, with a further 6.9% of the more than 270,000 lung cancer deaths jointly caused by radon and smoking. More than 75% of the radon-associated deaths would occur at mean concentrations below 100 Bq/m³, which is the level found in more than 90% of homes. These data vary somewhat according to the set of countries included but no major differences were seen between EU25, all of Europe or OECD countries.

Plenary discussion:

The short discussion covered issues of data availability. Sufficient data e.g. on moving from measured to usual Rn levels will not be available for all countries, and for some no data at all. This will have implications for the GBD assessment. Another approach could be to look at the burden from the perspective of life expectancy of individuals in countries involved.

World mapping of residential radon (Jan Zielinski)

The presenter observed that to estimate the global disease burden due to radon the information about geographical distribution of radon levels is needed. To estimate the disease burden for a country, one needs to apply the relationship between exposure and response to the exposure distribution in the country's population. The development of the world map of radon levels would be very useful for the GBD project. Data for world mapping can be obtained from various sources: 1) data on radon concentrations in different countries for UNSCEAR assembled from literature by Doug Chambers; 2) data from the IRP radon survey collected by Hajo Zeeb; 3) data from European radon mapping study (Gregoire Dubois, <http://radonmapping.jrc.it/>); 4) and new data generated under the proposed South American Radon Mapping Initiative (RW Field, LS Quindos, D Steck, L Veiga, J Zielinski).

Different resolution of available data (from individual geocoded measurements to region/country averages) presents a significant challenge. The presenter proposed several possible approaches to designs of the map using as example a radon map of Canada generated by integrating historical radon data from various radon surveys in Canada.

Plenary discussion:

Again the plenum discussed questions related to GBD.

Dan Krewski (Canada) asked whether population-weighted measurements could be used in GBD calculations.

Sarah Darby (UK) responded that this is possible but the problem may be that radon measures may mostly be made in populations with high average radon indoor levels.

Francesco Bochicchio (Italy) noted that it is important to evaluate the number of measurements required for mapping.

The Chair noted that many radon measures are available. The group needs to sort out most representative measures of radon for the respective purposes. Similarly, some minimum criteria for mapping measurements should be defined. However, if there are minimum criteria it must be made clear what to do for countries where the data do not meet these minimum criteria.

Dan Krewski (Canada) said that there is the possibility of correcting data rather than excluding it, and Bill Field added that with the occupancy data available for some regions exposure estimates could be supported.

Session 5 IRP - the way forward

Co-chairs Hajo Zeeb and Michael Repacholi

Future project directions and activities (Hajo Zeeb)

The presenter summarized the scope work of the WHO IRP secretariat and discussed ways to improve the collaboration and timeliness of working group activities. Due to shortage of funds, much communication has to be done electronically or by phone and less by personal meetings. Hajo Zeeb described the system of electronic net meetings which could be a way to meet and discuss more frequently. Bill Field expanded on this and informed the participants about the system used successfully at the University of Iowa (WHO is connected with this project).

The effectiveness of collaboration in the project can be improved by clearer agreements on group objectives - as achieved in this meeting - , on deadlines, responsibilities and communications. Smaller group meetings should be considered, either in person or via internet.

IRP outputs

In terms of expected IRP outputs, the presenter noted that initially a fair number of different reports or handbooks were planned. He then argued for a focus on two main report outputs:

- **A global burden of disease from radon report**
- **A WHO Radon handbook.**

The first product would be the product mainly from group 1, with inputs from several other groups. The target group for this GBD assessment includes the scientific community, national and international authorities.

The WHO Radon handbook would include chapters (or modules) on exposure guidelines, measurement, mitigation, cost-effectiveness and radon risk communication, as well as a background chapter. National and local authorities and perhaps legislators would be the main target group here. Both reports should be available via the internet. Publishing the handbook modules individually is an option, depending on the time schedule that the working groups follow.

Fact sheets and media releases will accompany the launch of these products, another fact sheet on specific issues (e.g. radon and smoking) should also be developed in the coming months.

Concerning training and educational materials, several options including adopting existing material from national sources were discussed.

New activities

WHO was asked to participate and support the US national radon month in January 2006. WHO produced a media note at the time but also considered taking up the idea of a radon action day or month. The presenter asked the group whether they thought such an activity - a global radon day - appeared feasible.

With a view to training activities, the presenter argued that these issues would be incorporated into the WHO handbook and dealt with separately by existing working groups.

The WHO radon survey will be continued and the extended survey sent to all those countries with existing radon activities.

The WHO project will continue to seek the collaboration with other international organizations, most notably the IAEA, UNSCEAR and ICRP. Good links exist and will be extended in the future.

Project timeline

The original project timeline was 2005 - 2007, i.e. 3 years. The work started more intensely in mid 2005, so that the project has actually run for just under year so far. An updated time plan was proposed:

- 12/2006: 1st draft of modules for handbook
- 12/2006: GBD 1st draft
- 01-04/2007: Internal review of modules
- March 2007: 3rd IRP meeting
- 06/2007: Final draft of handbook modules
- 06/2007: GBD 2nd draft
- 12/2007: WHO handbook published
- GBD final draft ready by end 2007, preparations for publication

Budget

The IRP budget problems were then highlighted. There is some financial support available from the UK and the US EPA, but beyond that no other country has pledged any extra-budgetary support for the WHO IRP in spite of intense fund-raising attempts.

All partners were once again asked to support fundraising for the project. As an activity outside the regular WHO budget, basically all work that the Organization

does in this field needs to be funded through additional contributions and funds. What can be done with the present funding is rather limited, and particularly the inclusion of partners from middle and low income countries is difficult to achieve when very limited meeting are available.

Next meeting

The BfS in Munich, Germany has kindly agreed to host the 2007 meeting. The BfS is a newly appointed WHO Collaborating Center for Ionizing and Non-Ionizing Radiation and Health. After recent discussions with the BfS, the meeting dates are March 13-15, 2007. The global pooling group is expected to meet on Monday, March 12, 2007.

Annex

1. Agenda

Day 1, March 13 (Monday) Morning

Session 1. Status of the WHO International Radon Project

Chair: M. Repacholi

09:00-09:30 Opening session

Salle A Welcome by M.Neira, Dir PHE; M.Repacholi, PHE/RAD

Adoption of the agenda, Introduction of participants, Selection of rapporteurs

09:30-10:30 IRP Project – Introduction of new IRP project partners

Salle A Review of current project status and past working group activities (short input by all G chairs)

H. Zeeb, PHE/RAD & WG chairs

10:30-11:00 **Coffee break (Salle A)**

11:00-12:00 Continued: review of activities and current project status

Update on new developments in individual countries/regions

Basic Safety Standards (C.Mason, IAEA)

12:00-12:20 The European Radon Mapping project - short overview

G. Dubois (EU-JRC)

12:20-12.30 Summary of morning session

12:30-13:30 **Lunch**

Day 1, Afternoon

Session 2. IRP Working group agenda

Chair: H.Zeeb

13:30-14:30 Introducing the WG - specific agenda for at this meeting (all WG chairs)

- Risk assessment
- Exposure guidelines
- Measurement - Mitigation
- Cost effectiveness
- Risk communication
- Coordination & Evaluation

14:30-15:30 *Split up into working groups (for rooms see separate list)*

Working groups to take up their work

15:30-15:45 **Coffee break (Salle A)**

15:45-17:15 Working groups continued

18:00-20:00 **Welcome reception (WHO, main cafeteria)**

Opening address by Susanne Weber-Mosdorf, Ass. Dir General WHO/SDE

Day 2, March 14 (Tuesday) Morning

Session 3. Meeting of individual working groups

9:00-10:30 [See Agenda for WG meetings]

10:30-11:00 **Coffee break (Salle A)**

11:00-12:30 **Chair: A. Auvinen**

Joint meeting of Working Groups (Salle A)

Topics:

- Radon and smoking; risk communication
- GBD methodology

12:30-13:30 **Lunch**

Day 2, March 14 (Tuesday) Afternoon

Session 4. Meeting of individual working groups (continued)

13:30-15:30 [See Agenda for WG meetings]

15:30-15:45 **Coffee break (Salle A)**

15:45-17:15 WG meeting cont.

Day 3, March 15 (Wednesday) Morning

Session 5. IRP - the way forward

Chair: H.Zeeb, M.Repacholi

09:00-10:30 Feedback from Working groups (15 min each)

Matters arising from reports

10:30-11:00 **Coffee break (Salle A)**

11:00-12:30 Future project directions and activities (H.Zeeb)

- How can the WHO effectively support working groups?
- eMeeting as an option
- IRP products – what outputs we expect and in which form?
- Promoting WHO IRP and national radon programmes
- New activities
- Review of overall work plan, budget and timetables

12:30-13:30 **Lunch**

Day 3, March 15 (Wednesday) Afternoon

Summary Session 6

Chairs: M. Repacholi, H.Zeeb

13:30-15:00 Discussions & Summary

Setting deadlines, next meeting date and venue, close

2. List of meeting participants

Dr William J. ANGELL, USA

Dr Hannu ARVELA, Finland

Dr Anssi AUVINEN, Finland

Dr Juan Miguel BARROS DIOS, Spain

Dr Thomas BECK, Germany

Dr Shang BING, People's Republic of China

Dr Francesco BOCHICCHIO, Italy

Dr Olivier CATELINOIS, France

Dr Douglas B. CHAMBERS, Canada

Dr Ian CHELL, United Kingdom

Dr Jing CHEN, Canada

Dr Constantin COSMA, Romania

Dr Sarah C. DARBY, United Kingdom

Dr Gregoire DUBOIS, European Commission

Dr Eckhard ETTENHUBER, Germany

Dr David FENTON, Republic of Ireland

Dr R. William FIELD, USA

Dr Alastair GRAY, United Kingdom

Martha GRUSON, Switzerland

Dr Matti HAKAMA, Finland

Dr Manfred HELMING, Germany

Sándor HORVATH, Switzerland

Dr Philip P. JALBERT, USA

Dr Jerzy JANOWSKI, Poland

Dr Antoine KIES, Luxembourg

Dr Virginia KOUKOULIOU, Greece

Dr Lothar KREIENBROCK, Germany

Dr Michaela KREUZER, Germany
Dr. Daniel KREWSKI, Canada
Dr Hans-Henning LANDFERMANN, Germany
Dr Marielle LECOMTE, Luxembourg
Dr Ilona MAKELAINEN, Finland
Dr Ches MASON, IAEA
Dr Paul McGALE, United Kingdom
Dr James P. McLAUGHLIN, Republic of Ireland
Dr Susanne MENZLER, Germany
Dr Winfried MEYER, Germany
Dr Jon MILES, United Kingdom
Dr Alison OFFER, United Kingdom
Dr Georges PILLER, Switzerland
Dr André POFFIN, Belgium
Dr Dobromir PRESSYANOV, Bulgaria
Dr Luis Santiago QUINDOS, Spain
Dr Alberto Ruano RAVINA, Spain
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Dr Margaret SMITH, United Kingdom
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Dr Terje STRAND, Norway
Dr Quanfu SUN, People's Republic of China
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Dr Ladislav TOMASEK, Czech Republic

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Dr Lene VEIGA, Brazil

Dr Zuoyuan WANG, People's Republic of China

Dr H.-Erich WICHMANN, Germany

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Dr Hidenori YONEHARA, Japan

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