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*Radon Legislation and
National Guidelines*



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SUMMARY: The International Commission on Radiological Protection (ICRP) and The Council of the European Union have recommended that the Member States to take action against radon in homes and at workplaces. Within the EU project European Research into Radon in Construction Concerted Action, ERRICCA, (Contract ERB F14P-CT96-0064, DG12-WSMN), the Topic Group on Legal and Building Code Impact was designated to study the current radon legislation and give advice regarding future enactment of laws and recommendations. On behalf of the Group, a questionnaire on radon legislation was sent out to nearly all European States and a selection of non-European States. Questions were asked regarding reference levels for dwellings, workplaces and drinking water, and about regulations or recommendations for building materials and city planning. All 15 EU Member States, 17 non-EU European countries and 10 non-European countries responded to the questionnaire. Their answers are considered current as of the end of 1998.

Most European States and many non-European countries have *recommended* reference levels for dwellings and workplaces, and some have guidelines for measures against radon incorporated in their building codes and guidelines for construction techniques. However, only a few countries have *enforced* reference levels or regulations for planning and construction. The reference levels for indoor radon concentration in existing and new dwellings or workplaces are within the range 150-1000 Bq/m³. Sweden is the only country (out of 15 EU Member States) which has *enforced* limits for existing dwellings. Sweden and the UK have both *enforced* levels for new dwellings. 7 non-European countries (out of 17 responding countries) have *enforced* levels for existing dwellings and 9 have them for new dwellings.

At the end of 1998, only Finland, Sweden, the Czech Republic, Romania, Russia and the Slovak Republic had limits for radon in water, although 8 countries were planning to introduce such limits. The present limits are within the range for 50-500 Bq/l public waters and 200-1000 Bq/l for private water supplies. 4 EU Member States and 11 non-EU European countries have reference levels for the concentration of radioactive elements in building materials. 8 European countries have guidelines regarding radon at city planning and 13 have mapped the radon-prone/radon risk areas in their countries.

It is essential to the work against radon and to future reduction of radon concentrations in dwellings and workplaces that the national states issue recommendations, regulations, directives or laws on radon limits and building practices. In order to have a significant effect on the radon situation, the questionnaire responses show that radon reference levels and regulations must be enforced or very little progress is achieved. Extensive measurement and research programs have been carried out in many in countries. Heretofore, only those countries with *enforced* regulations have had successful programs, resulting in remedial actions in more than 10,000 buildings. The only exception is the USA, which concentrated on extensive information media campaigns on radon and the training of large numbers of contractors to perform measurements and remedial measures.

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SAMMANFATTNING: Medlemsstaterna i den Internationella strålskyddskommissionen (ICRP) och EU har av dessa organisationer rekommenderats att vidta åtgärder mot radon i bostäder och på arbetsplatser. Inom EU projektet European Research into Radon in Construction Concerted Action, ERRICCA, (Contract ERB F14P-CT96-0064, DG12-WSMN), har en expertgrupp arbetat med frågor kring lagstiftning och rekommendationer för åtgärder mot radon. För att få in uppgifter om den nuvarande situationen tog gruppen initiativ till en enkät. Denna innehöll bl a frågor om bestämmelser och myndighetsrekommendationer avseende radon i bostäder, på

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arbetsplatser, i vatten och byggnadsmaterial samt frågor kring hur radon beaktats vid byggande och planläggning. Enkäten har besvarats av samtliga 15 EU-stater, 17 andra europeiska länder samt av 10 länder utanför Europa. Uppgifterna avser förhållandena vid slutet av 1998. Statens strålskyddsinstitut har svarat för enkätens utskickning och sammanställningen av svaren.

De flesta europeiska länder och många länder utanför Europa har rekommenderade gränsvärden för radon i bostäder och arbetsplatser och en del har även anvisningar för hur risken för radon skall beaktas vid byggande och planläggning. Dock är det få länder som tillämpar tvingande bestämmelser. Sverige är det enda EU-land som har tvingande gränsvärden för radon i befintliga bostäder. Gränsvärdena för radon i bostäder och på arbetsplatser ligger inom intervallet 150-1000 Bq/m³. Sju länder har rekommenderande eller tvingande gränsvärden för radon i vatten. Dessa ligger för kommunalt vatten inom intervallet 50-500 Bq/l, för enskilt vatten 200-1000 Bq/l. 15 länder har gränsvärden för naturliga radioaktiva ämnen i byggnadsmaterial och 13 har tagit fram radonriskkartor över landet.

Svaren på enkäten visar att det behövs tvingande lagstiftning för att åtgärder mot radonet skall bli vidtagna. Det är endast i de länder där som har tvingande lagstiftning som man åtgärdat mer än 10 000 bostäder. Detta med undantag för USA där goda resultat nåtts genom massiv information och utbildning att ett stort antal entreprenörer för mätning och åtgärder mot radon.



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Swedish Radiation Protection Institute



Radon Legislation and National Guidelines

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1. Introduction

Exposure to radon and radon decay products in the home and at workplace constitutes one of the greatest, perhaps the greatest, risk from ionizing radiation. An estimate of the risk leads to thousands of deaths per year from cancer caused by exposure by radon and especially its decay products. However, radon is a radiation risk, which we can do something about and which can be reduced at reasonable costs, thereby saving many lives. In order to reach such a goal, it is important that national authorities inform the public about the risks related to radon, enact legislation and issue guidelines, which aim toward limiting exposure to radon, and taking measures against radon where the risks are great. The International Commission on Radiological Protection (ICRP), the World Health Organization (WHO) and the International Atomic Energy Agency (IAEA) have repeatedly encouraged countries to create programs on radon. Countries have been encouraged to, among other things, issue advisory levels for radon in homes and workplaces, issue guidelines for locating buildings with radon, check for radon risks prior to starting new construction, and introduce limits for concentrations of natural radioactive elements in building materials. The European Commission issued recommendations in 1990 on advisory levels for radon in residential dwellings (EC 1990). In 1996 the Commission in Council Directive 96/29/ EURATOM for laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation (BSS), gave requirements for monitoring of radon and corrective measures against exposure to radon in the workplace (EC 1997).

A review of what has been accomplished on the radon issue indicates that large scale measures have been taken against radon, principally in countries where considerable effort has been made to spread information and where authorities have included reference levels for radon in their legislation. Examples of countries where these measures have been most successful are the USA, Czech Republic and Sweden.

Information on radon, recommendations, guidelines, directives and legislation on radon were considered within the EU project, European Research into Radon in Construction Concerted Action (ERRICCA) Contract No.: F14P-CT96-0064 (DG12-WSMN). Questions concerning legislation and official directives were treated concurrently by a special ERRICCA Topic Group, Legal/Building Code Impact. Legislation and strong official recommendations on radon questions have proven to be a key factor in intensifying the work on radon. For the purposes of informing and updating EU Member States and other countries on how various countries treat radon in legislation and guidelines, ERRICCA took the initiative of sending out a questionnaire to all EU Member States, most other European countries and selected non-European countries. One objective of the questionnaire was to stimulate, through examples, ideas on how radon issues can be treated in health and building codes, etc. The report before us presents an account of the various responses given by countries to the questions and gives a good picture of how far along the world's countries have come toward including radon in their legislation and official directives/guidelines at the end of 1998.

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2. Recommendations by the International Commission on Radiological Protection, ICRP, and The European Commission concerning protection from indoor radon

The first indications that radon and radon daughter products could constitute a risk to human health came in the 1920s. Lorensen and Ludvig (1924), as well as Behounek (1927), proposed

that the radioactive gas radon could be a determinant factor in increased mortality associated with the pulmonary diseases observed among mine workers since the 1500s (Agricola 1556).

The first guidelines for protection against radon covered occupational exposure. In 1941, the United States Advisory Committee on X-ray and Radium Protection set 10^{-8} $\mu\text{Ci}/\text{cm}^3$ ($370 \text{ Bq}/\text{m}^3$ EER¹) as the value of maximum permissible concentration (MPC) for occupational exposure (40hr/week) to ²²²Rn, including its daughter products (National Bureau of Standards, 1941). In 1953, the International Commission on Radiological Protection (ICRP) gave an MPC value of 10^{-7} $\mu\text{Ci}/\text{cm}^3$ ($3700 \text{ Bq}/\text{m}^3$ EER) for continuous exposure (168/hr week) (ICRP 1953). In 1959, it was time for new levels. The ICRP recommended the following MPC values for radon gas in the workplace: for 40 hr/week, $3 \cdot 10^{-7}$ $\mu\text{Ci}/\text{cm}^3$ ($11,100 \text{ Bq}/\text{m}^3$) and for 168 hr/week, 10^{-7} $\mu\text{Ci}/\text{cm}^3$ ($3700 \text{ Bq}/\text{m}^3$) (ICRP 2, 1959).

The connection between radon in mines and lung cancer in mine workers was established in the late 1950s through the aid of epidemiological studies of increased mortality due to lung cancer among mine workers in American, Czechoslovakian and Canadian uranium mines (Archer 1962, Wagoner et al. 1965, Sevc et. al 1976, Chovil 1981). These miner workers had worked in environments where the radon concentration in the mine air was at tens of thousands to millions of Bq/m^3 .

Once it was clear that radon in mining environments contributes to the increased frequency of lung cancer in mine workers, new proposals were made to limit the risk of exposure to radon. In 1976, the ICRP recommended that the following operational levels and rules should be put into practice: “a. Access to inactive mine areas should as a rule be controlled unless the equilibrium equivalent ²²²Rn concentration (EER) is less than 30 pCi/l ($1,110 \text{ Bq}/\text{m}^3$ EER). b. The use of filtering respirators approved for protection against radon daughters should be satisfactory in areas with EER concentrations up to 300 pCi/l ($11,100 \text{ Bq}/\text{m}^3$ EER). In areas with EER concentrations between 300 pCi/l and 3000 pCi/l ($111,000 \text{ Bq}/\text{m}^3$ EER) the use of respirators should be combined with a reduction of working-time. c. Parts of the mine with EER concentrations higher than 3000 pCi/l ($111,000 \text{ Bq}/\text{m}^3$ EER) should be marked with a sign indicating the radon hazard (ICRP 24, 1976)”.

In 1985, the ICRP recommended that a mine worker’s Annual Limit on Intake (ALI) of radon decay products (EER) should be $3.6 \cdot 10^6 \text{ Bq h m}^{-3}$, which corresponds to an average EER concentration of $1800 \text{ Bq}/\text{m}^3$ for the period of 2000 work hours per year (ICRP 47, 1985).

The awareness of radon in homes as a potential radiation risk has grown and over the years, international organizations have sharpened radon requirements and lowered the recommended limits. In 1977, the ICRP wrote that their “recommended limits are intended as guides for planning, and thus primarily apply to man made practice.. Man-made modifications or the environment and man’s activities can increase the ‘normal’ exposure to natural radiation. Even living in a house is often sufficient to increase the radiation exposure because restricted ventilation tends to lead to an accumulation of radioactive gases and their decay products...” (ICRP 26, 1977).

In 1983, the ICRP concluded in Principles for Limiting Exposure of the Public to Natural Sources of Radiation that “Almost all exposures to natural sources of radiation are controllable to some extent.... Controllability must therefore be a major factor in any system of dose limitation.... There is a clear difference between *existing* exposure situations, where any action would have to be remedial, and *future* situations, which can be subject to limitation and control at the stages of decision and planning.... It would not be helpful to suggest a generally applicable value of an action level, even one limited to the specific case of radon in houses. However, if

¹ EER, the Equilibrium Equivalent Concentration of Radon, of a non-equilibrium mixture of short-lived radon daughters in air, is that activity concentration of radon in radioactive equilibrium with its short-lived daughters which has the same potential α -energy concentration as the actual non-equilibrium mixture.

the remedial action is fairly simple, an action level for EER concentration in the region of 200 Bq/m³ (annual effective dose equivalent of about 20 mSv) might be considered.... It is recommended that competent national authorities establish *investigation levels* to separate exposures that require investigation from those that do not.... In order to establish an appropriate upper bound for exposure from radon indoors, some indication of reference levels of risk would be helpful.... The Commission believes that a reasonable upper bound for the EER concentration is of the order of 100 Bq/m³ and that, in many countries, a value of this magnitude would prevent radon from becoming a dominating source of risk in dwellings..." (ICRP 39, 1983).

In 1990, the ICRP reconsidered the radon question and presented these and other recommendations:

- Occupational exposure: "Only radon in workplaces and work with materials containing natural radionuclides can reasonably be regarded as the responsibility of the operating management.... The Commission recommends that exposure to radon and the handling of materials containing traces of natural radionuclides should be regarded as excluded from occupational exposure and treated separately, unless the relevant regulatory agency has ruled otherwise, either in defined geographical areas or for defined practices. To provide some practical guidance, the Commission recommends that there should be a requirement to include exposures to natural sources as parts of occupational exposure only in the following cases: a. Operations in workplaces where the regulatory has declared that radon needs attention and has identified the relevant workplaces.... b. Operations with and storage of materials not usually regarded as radioactive, but which contain significant traces of natural radionuclides and which have been identified by regulatory agency."
- Radon in dwellings. Situations in which remedial action may be required: "Radon in dwellings needs special attention because both the individual and the collective dose from radon are higher than those from almost any other source.... The Commission recommend in Publication 39 (1984) the use of action levels to help in deciding when to require or advise remedial action in existing dwellings.... For owner-occupied dwellings, general guidance may be adequate.... but in countries with substantial numbers of rented dwellings, it may be desirable to establish firm national action levels...."
- New dwellings: "Guides or codes for the construction of new dwellings in selected areas can be established so that it is highly probable that they will result in exposures in these dwellings below some chosen reference level..." (ICRP 60, 1991).

In 1990, the Commission of the European Communities presented recommendations for the protection of the public from exposure to indoor radon. The main recommendations follow here:

- Existing buildings: "A reference level for consideration of remedial action.... may be taken as an annual average radon gas concentration of 400 Bq/m³. The urgency of remedial action take account of the extent to which this reference level is exceeded...."
- Future constructions: "A design level be used to aid the relevant authorities in establishing regulations, standards, or codes of construction practices for circumstances under which the design level might otherwise be exceeded. The design level may be taken as an annual average radon gas concentration of 200 Bq/m³...."
- Measurements: "Radiation protection decisions should in general be based on the annual-averaged measurements of radon gas using integrating techniques. The competent authorities should ensure that the quality and reliability of measurements are adequate."
- Planning: "Criteria be developed for identifying regions, sites and building characteristics likely to be associated with high radon levels..." (EC 1990).

The 1993 ICRP Publication 65, Protection against Radon-222 at Home and at Work, is entirely devoted to radon. The commission presents a series of recommendations for action levels in existing dwellings, new dwellings and workplaces, as well as for identifying radon-prone areas, and applying remedial and preventive measures.

Regarding action levels for intervention in dwellings, the ICRP writes: “It seems clear that some remedial measures against radon in dwellings are almost always justified above a continued annual effective dose of 10 milliSievert (mSv). For simple remedial measures, a somewhat lower figure could be considered, but a reduction by a factor five or ten would reduce the action level to a value below the dose from natural background sources. The choice of action level for annual effective dose is thus limited to the range of about 3-10 mSv. The Commission recommends that the action level should be set at this range by the appropriate authorities. The corresponding rounded value of radon concentration is about 200-600 Bq/m³, with an annual occupancy of 7000 hours and an equilibrium factor of 0.4. Continuous domestic exposure at average concentrations of 200 Bq/m³ and 600 Bq/m³ would imply annual exposures of 3 mSv respectively 10 mSv...” (ICRP 65, 1993).

Concerning workplaces where intervention is required, the ICRP writes in ICRP 65: “Workers who are not regarded as being occupationally exposed to radiation are usually treated as members of the public. It is then logical to adopt an action level for intervention in workplaces at the same level of effective dose as the action level for dwellings. The action level for intervention in workplaces can be most easily derived from the range of action levels by multiplying by 7000/2000 (the ratio of occupancy) and by 3.88/5.06 (the ratio of the dose conversion coefficients). The resulting range (rounded) is 500-1500 Bq/m³. When selecting action levels for dwellings and workplaces, authorities should choose values that are similarly located within the two ranges.... Some workplaces are also used by members of the public. If the public occupancy is low, e.g. in offices, libraries and theaters, these workplaces need no special treatment. If the occupancy is high, e.g. in hospitals, residential institutions and schools, the premises should be treated as dwellings for the purpose of setting an action level for remedial measures...” (ICRP 65, 1993).

In 1996, the European Commission issued Basic Safety Standards (BSS) for the health of workers and the general public against the danger arising from ionizing radiation. The BSS deals with protection against ionizing radiation from artificial and natural radiation sources and contains demands for limits for workers and members of the general public. The BSS also treats work activities involving the presence of natural radiation sources which may lead to a significant increase in exposure for workers or members of the public and which cannot be disregarded, from a radiation perspective. The BSS does not deal with exposure to radon in dwellings (EC 1996).

Title VII of the BSS directive is on radon. It stipulates that each EU Member State shall ensure the identification of “work activities where workers and, where appropriate, members of the public are exposed to thoron or radon daughters or gamma radiation (Article 40).... For each work activity declared by them to be of concern, the Member States shall require the setting-up of appropriate means for monitoring exposure and as necessary the implementation of corrective measures to reduce exposure...” (Article 41) (EC 1996).

Because exposures of this nature had not been explicitly dealt with before, the EU Commission directed a Group of EU Experts on Radiation Protection, established under the terms of Article 31 of the EURATOM Treaty, to provide guidance on the implementation of Title VII of the BSS. The Group of Experts presented a series of recommendations in their report Radiation Protection 88 (EC 1997). On the whole, these recommendations follow the guidelines set up by the ICRP in Publication 65.

The recommendations made by the EU Group of Experts are in this report summarized in the introductions to the various subsections of Chapter 5, Regulations and guidelines of the nations.

The first federal regulations concerning actions against radon in dwellings were enacted by the USA in 1979 and applied to houses built on reclaimed land in the Florida phosphate mining districts (EPA 79) and to dwellings constructed on tailings in uranium mining areas in Colorado (EPA 80). An Action level of 2 pCi/l EER (74 Bq/m³ EER) was set for the Florida dwellings and 200 Bq/m³ EER for the buildings on the tailings.

In Sweden, after the Swedish Radiation Protection Institute discovered considerably elevated radon concentrations in homes built on alum shale bedrock with high uranium concentrations, the Swedish Radon Commission was appointed in 1979. One of this commission's first acts was to propose limits for radon in residential dwellings and new buildings. In 1980, the following compulsory limits were issued: existing dwellings, 400 Bq/m³ EER, new construction, 70 Bq/m³ EER. These were later revised and as of 1994, expressed as annual radon gas concentration. For existing dwellings, including workplaces (excepting mines), the compulsory limit for the radon gas concentration is 400 Bq/m³. For new construction the limit is 200 Bq/m³.

Several of the responding countries now have advisory reference levels. Very few countries apply enforced reference levels, action levels or limits. See Chapter 5 for the international responses and Appendices 1, 2 and 3 for the comments to the questionnaire regarding legislation, directives recommendations and guidelines.

3. Terminology

The regulations and guidelines applied in the various responding countries utilize different terms. Some examples of these terms follow:

Action levels - above which measures should be taken, e.g. remedial measures to reduce radon risks in dwellings and workplaces

Intervention levels - provide a basis for urgent remediation decisions

Investigation levels - above which the cause or implications of the results should be examined

Exemption levels - below which a source or an environmental situation is exempted from regulatory control, usually because the strength of the source is too low to be considered harmful

Limits - maximum allowable concentrations of a substance, e.g. the concentration of natural radioactive nuclides in building materials, or radon gas in drinking water.

Both the questionnaire and this report will replace the several terms above with one term, *Reference level*. This term is recommended in 1990 Recommendations of the ICRP, ICRP 60, quote: "It is often helpful in the management of operations to establish values of measured quantities above some specified action or decision should be taken. These values are generally called reference levels. They include recording levels, above which a result should be recorded, lower values being ignored, investigation levels, above which the cause or the implications of the results should be examined, and intervention levels, above which some remedial action should be considered." (ICPR 60, 1991).

The reference levels applied to radon by authorities in many of the responding countries are more or less strongly recommended reference levels. These have been given the designation *advisory reference levels* in the questionnaire and this report. When reference levels are stated by laws and official directives and have a binding legal nature, with corresponding penalties, they have been given the designation *enforced reference levels*. Regarding other requirements

connected to the radon question, for example building materials and construction requirements, the terms *advisory* and *enforced* have been used there as well.

Many of the limits and recommendations are the same in many countries, but there are countries using limits and recommendations which diverge greatly from those applied by the majority of countries, and many countries lack recommendations regarding radon all together. The attitude toward the radon question reflects conditions in the individual countries. In countries where the radon problem is greater, like in Sweden, Finland, Switzerland, the Czech Republic, the Slovak Republic and the United Kingdom (UK), the radon question has received significantly more interest and reference levels and remedial measures have been given in official directives or legislated by the governments.

4. The Questionnaire

For the purposes of gathering information on how the radon question is dealt with in legislation, and government directives and recommendations within Europe, a questionnaire was sent out in December of 1997 (Appendices 1, 2, 3). The questionnaire was distributed via e-mail to all European countries and a few selected countries outside of Europe, including the USA, Australia, Canada and Japan. In total, the questionnaire was distributed to 57 countries and was answered by 42 countries (Table 4.1). The majority of the recipient countries have responded. Early in 1998, non-responding countries were contacted again and in the fall, completed questionnaires were sent to the countries, which had replied, in order to give them the opportunity to update and edit their responses for inaccuracies. Consequently, information from responding countries is considered current at the end of 1998.

Table 4.1. Countries responding to the questionnaire

EU Member States	Non-EU European countries	Non-European countries
Austria	Albania	Canada
Belgium	Belarus	USA
Denmark	Croatia	Mexico
Finland	Czech Republic	
France	Estonia	Zimbabwe
Germany	Hungary	
Greece	Latvia	Israel
Ireland	Lithuania	Syria
Italy	Norway	
Luxembourg	Poland	Japan
The Netherlands	Rumania	Hong Kong
Portugal	The Russian Federation	
Spain	Slovak Republic	Australia
Sweden	Slovenia	New Zealand
United Kingdom	Switzerland	
	Turkey	
	Fed. Repub. of Yugoslavia	

The questionnaire inquired about radon reference levels for existing vs. planned residences and work places, limits for drinking water and radioactive elements in building materials, directives regarding preventive radon planning and construction, as well as grants for remedial radon measures. In addition, the questionnaire asked which government agencies issue directives and give recommendations pertaining to radon, and what was the legal status of the limits, laws and directives. For each subset of questions, space was allowed for comments. The questionnaire contained a total of 47 questions.

The questionnaire was sent to the agency in charge of radon issues in each country. Among the respondents were ministers, government agencies and state institutions, resulting in answers which may be of varying status in the different countries.

The replies from the various countries, including comments, have been compiled in three appendices: EU Member States (Appendix 1); Non-EU European Countries, (Appendix 2), Non-European Countries (Appendix 3).

A few countries, which haven't come particularly far in dealing with the radon question, chose to respond to the questionnaire by letter. Their replies have been entered into the compilation of questionnaires (Appendices 1, 2, 3).

5. Regulations and guidelines of the nations. Answers and comments on the questionnaire

This section presents a compilation of the various questions and comments from the questionnaire. Each subset of questions is presented individually.

5.1. RADON IN DWELLINGS (QUESTIONS 1-6, 8-12)

5.1.1. Reference levels for existing and new dwellings (questions 1-4)

Of the EU Member States that answered the questionnaire (15 countries), ten have reference levels for action against radon gas in existing dwellings and five countries do not have any reference levels (Table 5.1.1.1). Sweden is the only country, which applies an enforced action level, 400 Bq/m³. Of the non-EU European countries responding to the questionnaire (17 countries), seven have enforced and five have advisory reference levels, while five have no reference levels for radon (Table 5.1.1.2). In the latter group, Hungary is planning to introduce reference levels. All responding countries with current radon reference levels for dwellings apply the same reference levels to all residences, independent of ownership: private, government, cooperative or rental; with the exception of Luxembourg which only has reference levels for privately owned homes.

The range of the reference levels in use is 150-1000 Bq/m³. For existing dwellings a reference level of 400 Bq/m³ is applied by the EU Member States of Austria, Denmark, Greece and Sweden, as well as the non-EU European countries of Belarus, Estonia, Lithuania, Norway, Poland, Russia, Slovak Republic and Yugoslavia. Ireland and the UK have an advisory reference level of 200 Bq/m³, and Luxembourg has an advisory reference level of 150 Bq/m³ (Figure 5.1.1.1 and 5.1.1.3).

Table 5.1.1.1. Dwellings, radon reference levels (Bq/m³), EU Member States.

Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, UK (15 countries total)					
Dwellings – existing			Dwellings - new		
Enforced	Advisory	None	Enforced	Advisory	None
1	9 (3)	5	2	8	5

Number in parentheses () = countries with one higher enforced level/one higher advisory level and one lower advisory level.

Range: Existing dwellings enforced 200-1000 Bq/m³, advisory 150-1000 Bq/m³
 New dwellings enforced 200-1000 Bq/m³, advisory 150-400 Bq/m³

Table 5.1.1.2. Dwellings, radon reference levels (Bq/m³), Non-EU European Countries.

Albania, Belarus, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Norway, Poland, Romania, Russia, Slovak Republic, Slovenia, Switzerland, Turkey, Yugoslavia (17 countries total)					
Dwellings - existing			Dwellings – new		
Enforced	Advisory	None	Enforced	Advisory	None
7	5 (4)	5	9	3 (1)	5

Number in parentheses () = countries with one higher enforced level/one higher advisory level and lower advisory levels.

Range: Existing dwellings enforced 200-1000 Bq/m³, advisory 150-1000 Bq/m³
 New dwellings enforced 200-1000 Bq/m³, advisory 150-400 Bq/m³

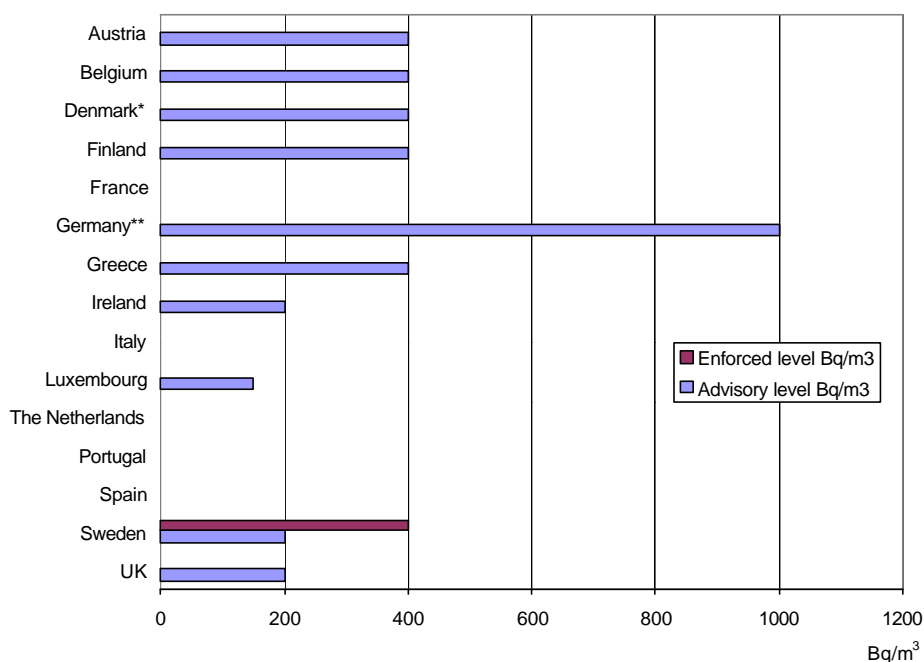


Figure 5.1.1.1. Existing Dwellings. Reference levels for radon gas. EU Member States.

(Denmark* has two advisory levels, 200 Bq/m³ for simple remedial measures, 400 Bq/m³ for more costly measures. Germany** for existing dwellings has two advisory levels; 1,000 Bq/m³ and 250 Bq/m³.)

Several countries have two reference levels, an upper level with requirements for remedial measures or strong recommendations, and a lower level that applies to dwellings where the radon concentration can be reduced by simple and less expensive remedial measures. For example, Germany has an upper advisory mitigation reference level of 1000 Bq/m³, and a recommended reference level of 250 Bq/m³. Switzerland has an enforced reference level of 1000 Bq/m³, and an advisory level of 400 Bq/m³ for both existing and new dwellings. Sweden has an enforced upper reference level of 400 Bq/m³ and a recommended level of 200 Bq/m³ for existing dwellings, the latter also applies to new constructions.

The Slovak Republic and the Czech Republic have reference levels expressed as radon progeny concentrations for existing dwellings and new construction. The Slovak Republic has one enforced upper reference level of 200 EEC Bq/m³ for existing dwellings. The Czech Republic uses four advisory reference levels for recommended mitigation: "200-300 EEC Bq/m³ simple miti-

gation, e.g. increased ventilation; 300-600 EEC Bq/m³ more expensive mitigation; 600-2000 EEC Bq/m³ sophisticated remedial measures; >2000 EEC Bq/m³ people stay excluded”.

Most countries apply lower radon reference levels to planned construction than they do to existing dwellings. Of the EU Member States, for new dwellings, two states have enforced reference levels of 200 Bq/m³ (UK and Sweden), eight have advisory levels and five have no reference levels (Figure 5.1.1.2). Of the non-EU European countries poled, nine have enforced reference levels, three have advisory levels and five have no reference levels (Figure 5.1.1.4). Most counties apply a reference level of 200 Bq/m³, but Latvia has a enforced reference level of 300 Bq/m³, and Switzerland has an enforced reference level of 1000 Bq/m³, as well as an advisory level of 400 Bq/m³.

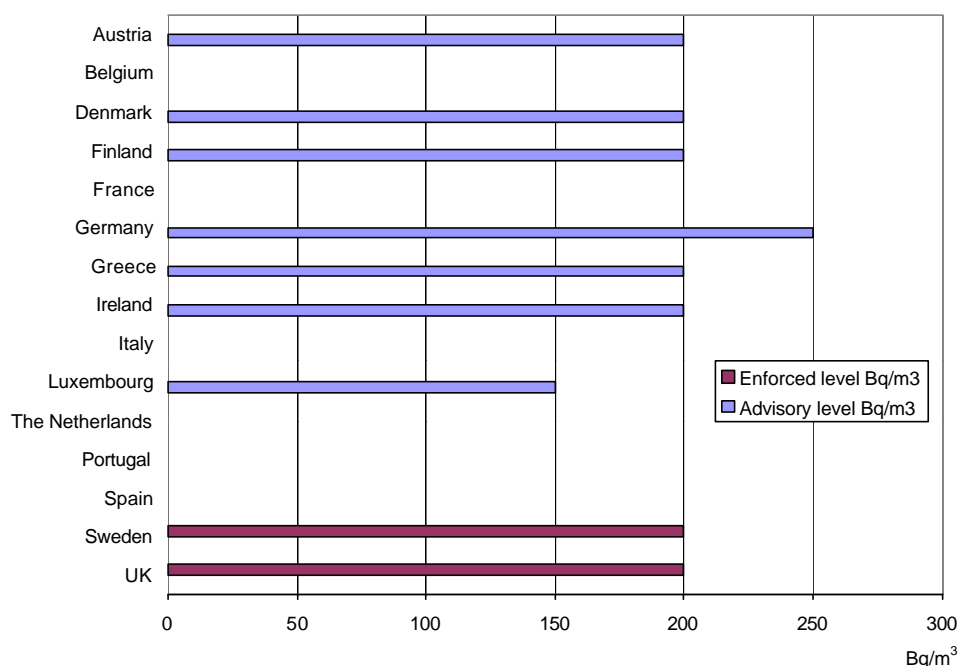


Figure 5.1.1.2. New dwellings. Reference levels for radon gas. EU Member States.

Of the non-European countries responding to the questionnaire, Australia, Canada, Israel, Syria and the USA have advisory reference levels for radon gas. The reference levels apply universally to all homes, regardless of ownership: private, government, cooperative, or rental. The levels are the same for both existing and new dwellings: in the USA, 150 Bq/m³; in Australia, Israel and Syria, 200 Bq/m³; in Canada, 800 Bq/m³. The Radon Council in Japan is in the process of adapting ICRP 60 and recommending reference levels for radon gas in dwellings.

5.1.2. Implementation and supervision (question 5)

Among the EU Member States, most governments or the relevant ministries implement legislation and recommendations regarding radon in dwellings, as well as supervise compliance with ordinances and recommendations. In Finland and Sweden, local municipal authorities have the responsibility for supervision and in the UK, it is the district authorities.

Among the non-EU European countries, implementation and supervision are generally performed by government authorities; in seven countries, supervision is the responsibility of the institutions for radiation protection. In Norway, the local municipal authorities supervise radon regulations. The radon program in the US is largely voluntary and in Canada, natural radioactivity is a public health issue over which the provincial governments have jurisdiction.

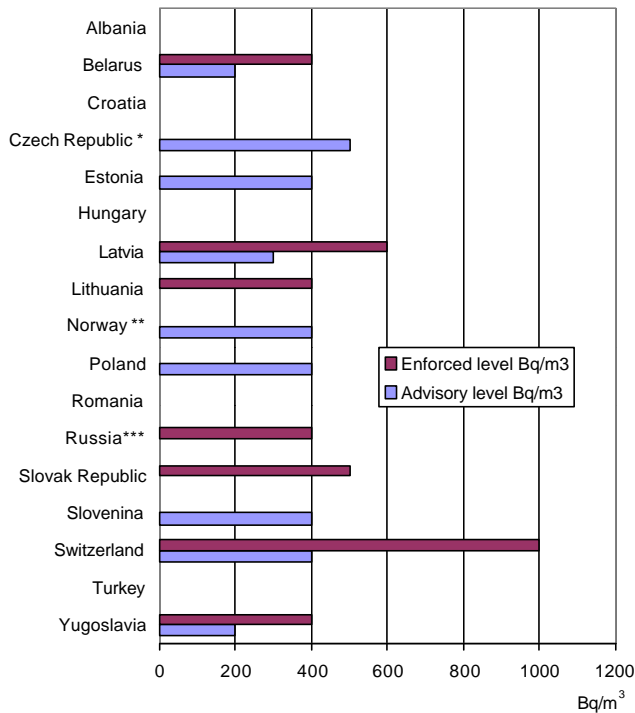


Figure 5.1.1.3. Existing dwellings. Reference levels for radon gas.

Non-EU European countries. (The Czech Republic* and the Slovak Republic have reference levels set as radon progeny activity concentration, EEC. In the Figure the EEC concentrations are given as radon gas concentration, a F-factor of 0.4 is applied for the recalculation. The Czech Republic* has 4 advisory levels for mitigation; 200-300 EEC Bq/m³ simple mitigation, 300-600 EEC Bq/m³ more expensive mitigation, 600-2000 EEC sophisticated remedial measures and >2,000 EEC Bq/m³ people stay excluded. Norway** has two advisory levels, 200-400 simple and inexpensive measures are recommended, >400 Bq/m³ expensive measures are justified. Russia*** has two enforced levels for mitigation; >200 Bq/m³ simple mitigation, >400 upper action level.)

5.1.3. Financing remedial measures (questions 9-12)

The homeowners bear all costs for remedial measures taken in most countries. However, in six EU Member States and five non-EU European countries, private homeowners may receive some assistance with remedial costs. This assistance takes the form of grants, subsidies or tax reductions. For example, the Swedish government subsidizes up to 50 % of remedial costs, max. 1,700 EUR. Ireland has grants that cover 50 % of remedial costs, max. 800 EUR. Norway subsidizes 50 % of the costs, max. 1,800 EUR; if the costs are higher than 3,600 EUR, state granted loans are available for costs up to 7,200 EUR. Switzerland uses the tax reduction. In Germany the Federal Land Saxony generally subsidizes 30 % of mitigation costs if the indoor radon concentration exceeds 1000 Bq/m³ on average. For buildings belonging to the regional administrative bodies (kindergartens, schools e.g.) up to 80 % of the costs can be subsidized.

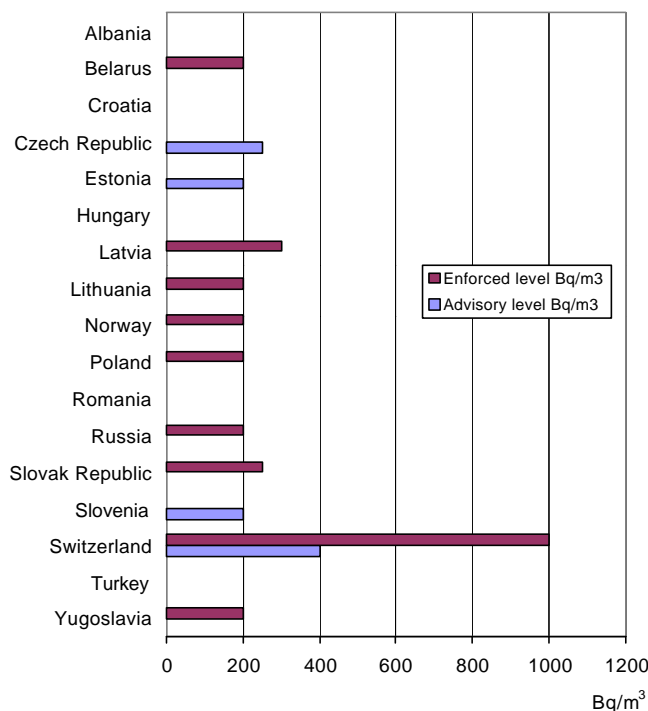


Figure 5.1.1.4. New dwellings. Reference levels for radon gas. Non-EU European countries. (The Czech Republic and the Slovak Republic have reference levels set as radon progeny activity concentration, EEC. In the Figure the EEC concentrations are given as radon gas concentration, a F-factor of 0.4 is applied for the recalculation.)

5.2. WORKPLACES (QUESTIONS 13-18)

In *Radiation Protection 88*, the EU Group of Experts gives recommendations for radon action levels for workplaces in the European Union. They recommended that action levels “should be set in the range 500-1000 Bq/m³ time averaged radon gas concentration. This is based on occupational exposure of 2000 hours per year and an equilibrium factor (F-factor) of about 0.4. National Authorities may also select an action level below the specified range if they judge this desirable and will not lead to an impracticable radon program. For workplaces with high occupancy (e.g., residential homes, schools, some hospitals) it may be appropriate to adjust the action level to reflect the increased occupancy. If radon concentrations are found to be below the action level then there is no requirement for future action other than re-testing if concentrations are marginal or substantial changes are made in the construction or use of the building.... If the concentrations are above the action levels and occupancy is not very low then remedial action to reduce the radon level should be required.... Records of monitoring radon exposures of workers should be kept....” (EC 1997).

5.2.1. Reference levels for radon gas at workplaces (questions 13-16)

Of the EU Member States responding to the questionnaire (15 countries), seven countries have reference levels for radon at all workplaces (Table 5.2.1.1, Figure 5.2.1.1, 5.2.1.2, 5.2.1.3 and 5.2.1.4). France will have reference levels for radon in schools and municipally owned workplaces. Reference levels in Denmark, Finland, Sweden and the UK are enforced and will be so in France, as well. Of the non-EU European countries (17), seven have reference levels for all workplaces, five have no reference levels and four plan to introduce reference levels. Estonia is planning to implement workplace reference levels in the near future.

The range of radon levels implemented by all responding countries is 200-3,000 Bq/m³. Countries have differing views on which reference levels should be applied and have often implemented different reference levels for different types of workplaces.

Table 5.2.1.1. Workplaces. Radon reference levels (Bq/m³), European countries.

EU Member States														
Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, UK (15 countries)														
Schools		Day care homes		Offices private		Industry State-owned		Offices Municipal		Other		Underground (not mines)		
Enf	Adv	Enf	Adv	Enf	Adv	Enf	Adv	Enf	Adv	Enf	Adv	Enf	Adv	
Existing work-places	5	3(1)	4	3	4	3	4	3	5	3(1)	4	3	5	2
New workplaces	5	3(1)	4	3	4	3	4	3	5	3(1)	4	3	3	2

Non-EU European Countries														
Albania, Belarus, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Norway, Poland, Romania, Russia, Slovak Republic, Slovenia, Switzerland, Turkey, Yugoslavia (17 countries)														
Schools		Day care homes		Offices private		Industry State-owned		Offices Municipal		Other		Underground (not mines)		
Enf	Adv	Enf	Adv	Enf	Adv	Enf	Adv	Enf	Adv	Enf	Adv	Enf	Adv	
Existing work-places	5	4(1)	4	5(1)	5	5(1)	5	5(1)	4	5(1)	4	5(1)	5	2
New workplaces	7	3(1)	6	3(1)	6	3(1)	6	3(1)	5	3(1)	5	3(1)	5	1

7 EU Member States and 10 non-EU European countries lack reference levels for all existing and new workplaces.

Number in parentheses () = countries with one higher enforced level and one lower advisory level.

Range: Existing workplaces enforced 400-1000 Bq/m³ advisory 150-1000 Bq/m³
 New workplaces enforced 200-3000 Bq/m³ advisory 200-1000 Bq/m³

Among the EU Member States, Austria, Denmark, Finland, Greece and Sweden (5 states) apply the same reference level to both existing workplaces and existing dwellings, 400 Bq/m³. Of these states, Austria, Greece and Sweden apply a lower level to new workplaces, 200 Bq/m³.

Most countries use the same reference level for all types of workplaces, but in Ireland, the advisory reference level for schools is 150 Bq/m³, and for other workplaces it is 200 Bq/m³.

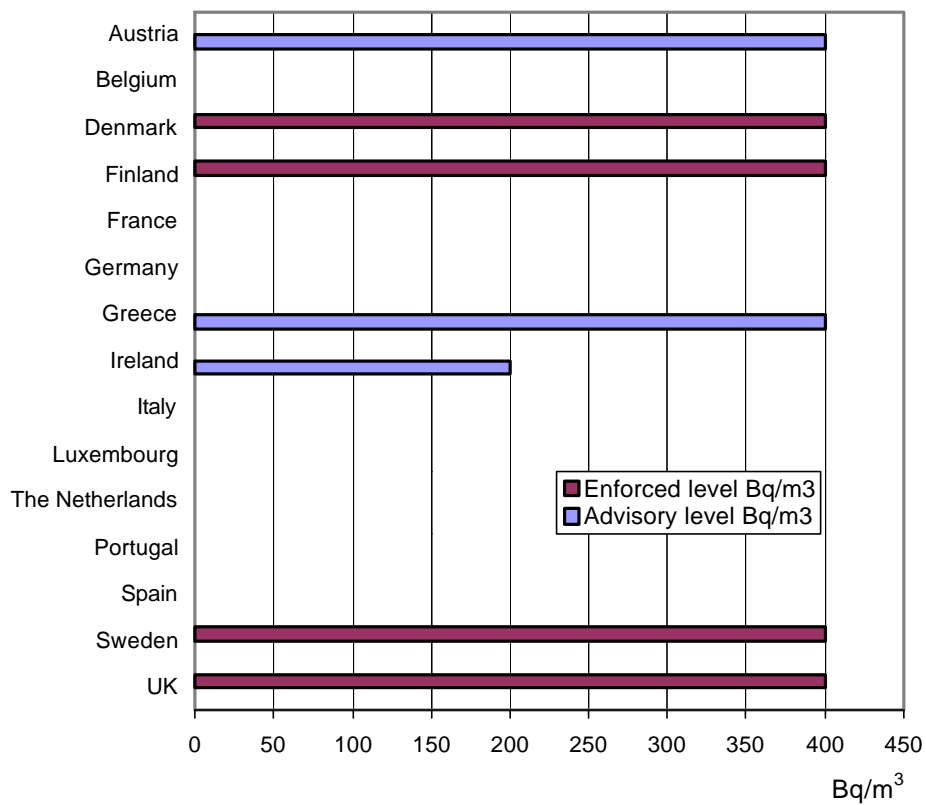


Figure 5.2.1.1. Existing workplaces, offices and industrial premises. Reference levels for radon gas. EU Member States.

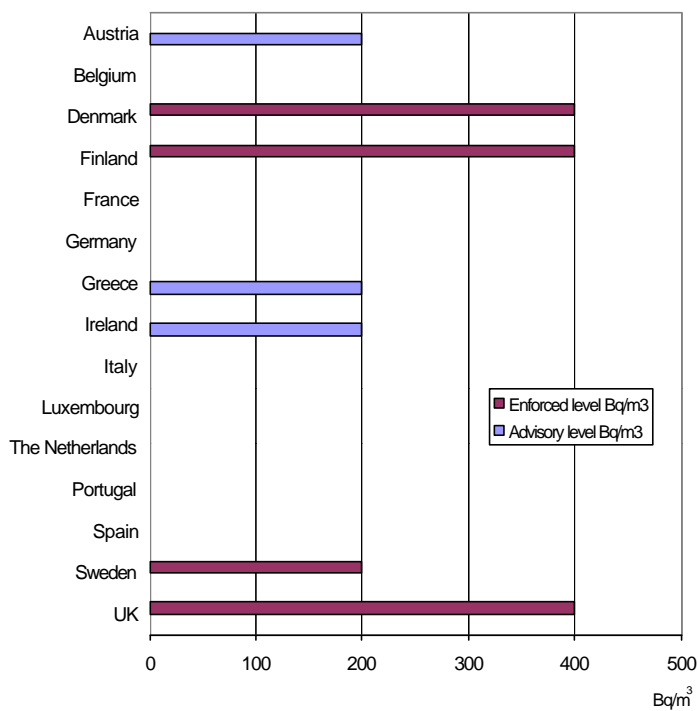


Figure 5.2.1.2. New workplaces, offices and industrial premises. Reference levels for radon gas. EU Member States.

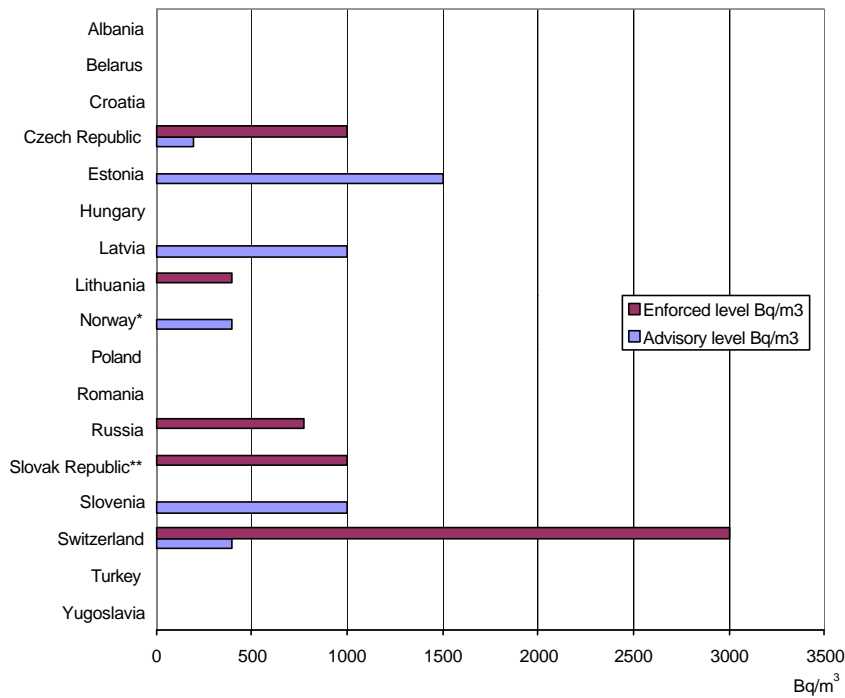


Figure 5.2.1.3. Existing workplaces, offices and industrial premises. Reference levels for radon gas. Non EU European countries. (Norway* has two advisory levels, 200 Bq/m³ simple and inexpensive measures, 400 Bq/m³ more expensive measures. The Slovak Republic** has two enforced levels, 500 Bq/m³ and 1,000 Bq/m³. The lower levels applies to situations when the work hours exceeded 1,000 h/y, the higher is a decision level above which the workplace is regarded as a workplace with ionizing source.)

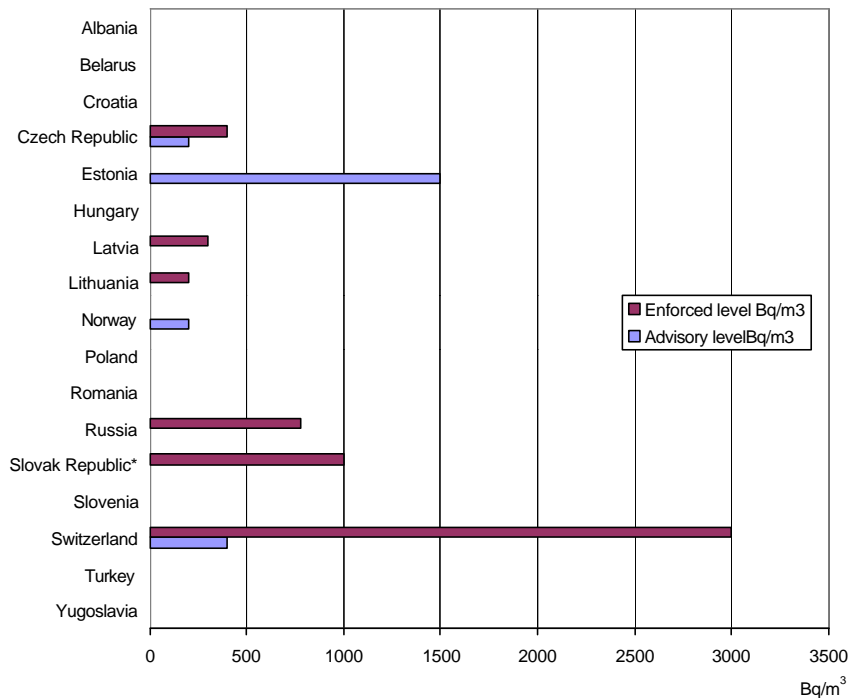


Figure 5.2.1.4. New workplaces, offices and industrial premises. Reference levels for radon gas. Non-EU European countries. (The Slovak Republic* has two enforced levels, 250 Bq/m³ and 1,000 Bq/m³. The lower levels applies to situations when the work hours exceeded 1,000 h/y, the higher is a decision level above which the workplace is regarded as a workplace with ionizing source.)

The non-EU European countries reference levels diverge much more than do those of the EU Member States. For example, Switzerland applies one enforced upper limit, 1,000 Bq/m³, for existing and new schools, day care homes, and municipally owned offices, while applying another limit to private workplaces, 3,000 Bq/m³. Switzerland also has one advisory level, 400 Bq/m³, for all types of existing and new workplaces. The Czech Republic applies both an enforced reference level, 1,000 Bq/m³, and a general guidance level, 200 Bq/m³ EEC, to all types of workplaces; for new workplaces the enforced reference level is 200 Bq/m³ EEC and the advisory level is 100 Bq/m³ EEC. Norway has two advisory reference levels for existing workplaces: 200-400 Bq/m³ for simple and inexpensive remedial measures; 400 Bq/m³ for more expensive measures. Russia has an enforced level 310 EER Bq/m³. The Slovak Republic has two separate enforced reference levels, one for existing workplaces, 500-1,000 Bq/m³, and one for new workplaces, 250-1,000 Bq/m³. The lower value applies to situations when the time individuals spend in the building exceeds 1,000 hours, and the higher level is a decision level above which the workplace is regarded as a workplace with ionizing radiation source.

Outside of Europe, Australia, Israel and Syria have either enforced or advisory reference levels for all workplaces. Israel has one enforced reference level, 200 Bq/m³, for schools and day care homes and one advisory reference level, 400 Bq/m³, for all other workplaces. For new schools and day care homes, Israel applies an advisory reference level of 40 Bq/m³, whereas the level for other new workplaces is 200 Bq/m³.

The USA has one national reference level, which is applied, to schools, 150 Bq/m³, and which is an enforced reference level supervised at the state level. Other US legislation covering radon in the workplace is enacted and supervised at the state and local levels. Generally, only mitigation in schools is financed with public funds. Canada has a reference level for government-owned new industrial properties, 800 Bq/m³, but otherwise there are no national reference levels for workplaces.

5.2.2. Implementation and supervision (question 17 and 19)

Within the EU, most governments or relevant ministries implement the legislation and recommendations for radon in workplaces, as well as supervise compliance with radon ordinances and recommendations. In Denmark and Finland, the National Radiation Protection Institutes are the competent authorities and also have responsibility for supervising implementation. In Sweden, the National Board of Occupational Safety and Health implements the regulations, whereas local municipal offices perform the actual supervision for Occupational Safety and Health. In the UK, the responsibility for enforcement is divided between the Health and Safety Executive for large buildings and local authorities for small buildings.

Among the non-EU European countries, most governments implement the legislation and recommendations, as well as supervise the implementation. In Switzerland, the Swiss National Accident Insurance Organization (Suva) supervises implementation. In the USA, the Environmental Protection Agency (EPA) has the overall responsibility of following the radon issue, informing the public about radon and promoting remedial radon measures. According to the Canadian Labor Code, no employee, other than an atomic radiation worker as defined in the Atomic Energy Control Regulations, shall be exposed in the course of any year to a concentration of radon that on average, over a year, is higher than 800 Bq/m³. This regulation applies to places of business that come under the jurisdiction of the Federal Canada Labor Code.

5.2.3. Protocols for measurement in workplaces (question 18)

Among the EU Member States, France, Finland, Germany and Ireland have protocols for the measurement of radon in workplaces. The non-EU European countries of Norway, Slovak Republic and Yugoslavia, as well as the non-European countries of Israel and Syria also have such protocols. Two EU Member States and three non-EU European countries plan to publish protocols.

5.3. DRINKING WATER (QUESTIONS 20-27)

The risks associated with radon and other radioactive elements occurring naturally in water have increased in relevance in recent years. This is due to the attention directed toward the very high radiation doses which infants and young children can receive due to consumption of water containing radon and radon decay products (Kendall et al 1988, UNSCEAR 1993, Swedjemark 1997). At the end of 1998, the EU Article 31 Group of EU Experts on Radiation Protection, at the direction of the EU Committee on Water Intended for Human Consumption, examined the risks connected with radioactive elements in water. The Group of EU Experts on Radiation concluded that the reference level of effective dose presented in the 1993 WHO proposal, 0.1 mSv/y, would indeed be an appropriate indicator parameter. However, both the EU Experts on Radiation and WHO think that knowledge regarding the risks associated with radon and radon decay products is still limited and therefore, the dose due to radiation from these elements should not be included in the reference level.

The European Union Council adopted the proposal presented by the Article 31 group and decided that the indicative parameter for the total indicative dose of radioactivity present in water intended for human consumption shall be 0.10 mSv/year. This value excludes the dose received from tritium, potassium-40, radon and radon decay products. The indicative parameter value applies to water supplies serving more than 50 persons (Council Directive 98/83/EC of 3 November 1998: on the quality of water intended for human consumption). The Council instructed the Article 31 Group to submit proposals for indicator parameters and for monitoring programs within 12 months of the date 5.12.98. The EU Council also directed the EU Article 31 Group of experts to further investigate the risks of radon and radon decay products in drinking water and give recommendations for reference levels.

In the USA, at the request of the EPA, the National Research Council appointed a multidisciplinary committee to conduct a study and to report on the health risks associated with exposure to radon in drinking water. The committee gave their report at the end of 1998 (National Research Council 1998). The committee recommended that the value of the Alternative Maximum Contaminant Level (AMCL) for the average ambient radon concentration in drinking water be set at 150 Bq/l, and that public water supplies with levels in excess of the AMCL must be mitigated to at least the AMCL. (Water supplies serving 25 people or more are considered to be public water supplies.)

Table 5.3.1.1. Drinking water. Radon protection standards (question 20).

EU Member States			Non-EU European Countries		
Yes	No	We shall	Yes	No	We shall
2	12	3	3 (1)	13	4
Finland		Austria	Czech Republic		Latvia
Sweden		Germany	Russia		Slovenia
		Greece	Slovak Republic		Turkey
			(Norway)		Yugoslavia
			Romania		

Number and name in parentheses () = advisory level

Range: Public waters 50-500 Bq/l

Private waters 120-1000 Bq/l

5.3.1. Reference levels (question 21)

By the end of 1998, only seven countries had reference levels for radon in drinking water and seven other countries had plans to introduce such levels (Table 5.3.1.1).

The seven countries with reference levels are the Czech Republic, Finland, Norway, Romania, Russia, the Slovak Republic and Sweden (Figure 5.3.1.1). There is a good reason why these particular countries have introduced reference levels for radon in water. To a large extent, these countries receive their water supplies from wells drilled into crystalline bedrock, often granites with enhanced uranium content. In each of these countries, there are several thousand wells containing water with radon concentration levels above 1,000 Bq/l, and several wells with levels greater than 20,000 Bq/l have been found. In Sweden, for example, there are 200,000 wells used as water supplies for residents and 45 % of these have radon concentrations above 100 Bq/l and 10,000 have more than 1,000 Bq/l.

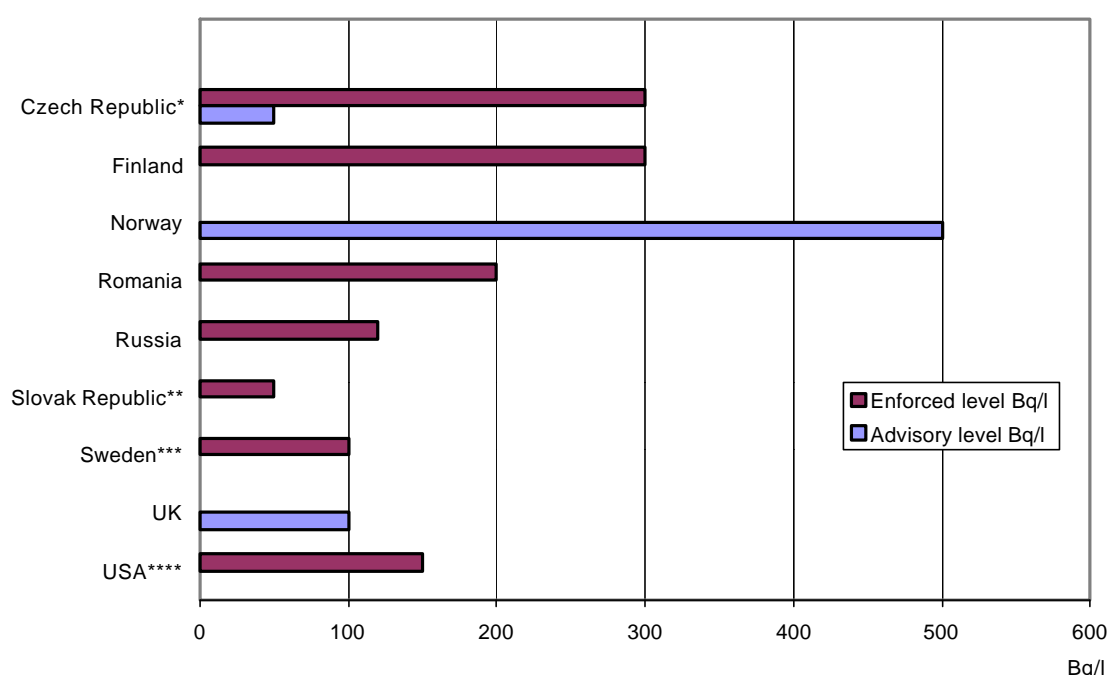


Figure 5.3.1.1. Public drinking water. Countries that have reference levels for radon. (The Czech Republic* for private waters besides the enforced level also has two advisory levels 200 Bq/l and 1,000 Bq/l. The Slovak Republic** for private waters has an advisory level 200 Bq/l and an enforced level 1,000 Bq/l. Sweden*** for public waters has two enforced levels, 100 Bq/l at which the owners have to take measures, and 1,000 Bq/l at which the delivery of water is not allowed. For private waters these levels are advisory. USA****, suggested reference level for public waters.)

Of the countries with reference levels, the Czech Republic has one enforced level, 300 Bq/l, and one advisory level, 50 Bq/l, for public water, while private homeowners have two advisory levels, 1000 Bq/l and 200 Bq/l, corresponding to different remedial measures. Finland has one enforced level for public waters, 300 Bq/m³, and Norway has one advisory level, 500 Bq/l. Russia has an enforced level, 120 Bq/l, for all drinking waters, irrespective of patterns of ownership. The Slovak Republic has one advisory level for all drinking water, 50 Bq/m³, and one enforced level, 1000 Bq/l. Sweden applies two limits, >100 Bq/l is designated as fit for consumption with reservations, and >1000 Bq/l is designated as unfit for human consumption. The Swedish limits are compulsory for all public water supplies and advisory for private homeowner drinking water.

5.3.2. Implementation and supervision (question 22)

In countries, which have regulations for drinking water, the national governments are responsible for implementation of radon regulations and in most cases, for supervising the implementation. In Sweden, the local municipal authorities are responsible for supervising implementation.

5.3.3. Mapping of areas with waters at risk of radon contamination (questions 23-24)

Areas with high uranium content in the bedrock commonly exhibit high radon concentrations in ground water. One way to prevent radon rich waters from being used as drinking water is to conduct special checks for radon in such areas, as do Spain, Slovenia and the Slovak Republic.

Sweden and Norway have classified the radon risk in ground waters for different parts of their countries.

5.3.4. Protocols for the analysis of radon in drinking water (question 26)

Six countries have protocols for the analysis of radon in drinking water: Austria, Luxembourg, Sweden, Portugal, Czech Republic and Slovak Republic.

5.4. BUILDING MATERIALS (QUESTIONS 28-36)

On the topic of building materials, the ICRP writes in ICRP 65, Protection against Radon-222 at Home and at Work "In some circumstances, elevated radon concentrations could be caused by the use of ground fill or building materials with elevated radium-226 content. As such materials can be readily detected by the gamma-ray emission, consideration should be given to identifying them and preventing or limiting their use" (ICRP 65, 1993).

There is not much written on requirements for protection to radiation in the EU Council Directive 89/106/EEC of 21 December 1988 relating to construction products (EC 1988). Radiation in construction materials is only taken up in Annex 1, "Essential Requirements" where it states that "The products must be suitable for construction works and fit for their intended use", and under section 3. "Hygiene, health the environment" where it states that "The construction work must be designed and built in such a way that it will not be a threat to the hygiene or health of the occupants or neighbors, in particular as a result of any of the following:- the emission of dangerous radiation .."

The working group EU Article 31 Group of Experts on Radiation Protection writes in Radiation Protection 88: "Building materials are not usually a dominant source of radon. Nevertheless, it may be found that high levels of ^{226}Ra or other natural radionuclides in some materials should be avoided" (EC1997).

By order of the European Commission the Finnish Center for Radiation and Nuclear Safety (STUK) has made a study about natural radioactivity of building materials and in industrial by-products used as raw materials in building material industry (Mustonen et. al 1997). STUK suggests, "that the European Community could have a common approach regarding natural radioactivity in building materials. The proposal is that, for protection of members of the public, the same dose criterion could be applied to radioactivity of building materials as to practices with radiation, i.e. 1 mSv per year as an effective dose. However this annual dose shall not be regarded as a dose limit, but as a reference level above which a specific assessment of the use of material and exposure to radiation should be presented. Radon exhaling from building materials into indoor air should further meet the requirement for new houses presented in the separate recommendation from the European Commission, i.e. radon concentration should not exceed 200 Bq/m^3 in indoor air" (EC1990). STUK also propose the introduction of an activity index used to assess the safety requirement of building materials. The proposed activity index is $I = (C_{\text{Th}}/200 + C_{\text{Ra}}/300 + C_{\text{K}}/3000)$ where C_{Th} , C_{Ra} and C_{K} are the activity concentrations of ^{232}Th , ^{226}Ra and ^{40}K in the main construction materials of a house, expressed in Bq/kg, and w is a weighting factor to be applied for materials used in minor amounts. If the value of the activity

index exceeds 1, it is required to show specifically the safety requirement will be met, and the indoor radon concentration of 200 Bq/m³ due to the use of the material will not be exceeded. The EU Article 31 Group of Experts on Radiation Protection has in March 1999 decided to publish the STUK report as Radiation Protection No. 95.

Judging by the responses to the questionnaire, the legislation has made most progress in the area of building material. Among the EU Member States, three countries have enforced reference levels and among the other European countries, eight apply enforced reference levels.

Table 5.4.1.1. Building materials - Reference levels for radioactive elements. European countries (question 29).

EU Member States			Non-EU European Countries		
Yes	No	We shall	Yes	No	We shall
4 Austria Finland Germany* Luxembourg	11		11 Belarus Czech Republic Latvia Lithuania Norway Poland Romania Russia Slovak Republic Slovenia Yugoslavia	6	2 Estonia Turkey

* in the New Federal Lands (former GDR).

Table 5.4.1.2. Building materials - Legal status of radon reference levels. European countries (question 30).

EU Member States			Non-EU European Countries		
Enforced	Advisory	None at present	Enforced	Advisory	None at present
3 Finland Germany Luxembourg	1 Austria	11	9 Belarus Czech Republic Latvia Lithuania Poland Romania Russia Slovak Republic Slovenia	1 (1) Norway (Czech Republic)	7

Number of countries with reference levels for: radioactive elements 14, total gamma radiation 3, beta radiation 2, radon exhalation 1 (question 32).

5.4.1. Radon reference levels (questions 28-32)

Austria and Luxembourg are the two EU Members States with protection standards for radon in building materials (question 28). Outside the EU, the following countries apply such standards: Czech Republic, Lithuania, Norway, Poland, Romania, Slovak Republic, Israel and USA.

However, more countries have various reference levels for the contents of radioactive elements in or radon flux from building materials (question 29). Four EU Member States, Austria, Finland, Germany and Luxembourg have this type of reference level, as do eleven non-EU European countries, Estonia and Turkey are planning to introduce them. Of the countries outside Europe responding to the questionnaire, Israel has such levels.

In most of the responding countries with some sort of reference levels, the levels are enforced (question 30). Only in Norway are the reference levels advisory. In most cases, the state authorities are solely responsible for implementation and supervision. However, in Finland, Belarus, Latvia and Poland, responsibility for supervision is shared between the state authorities and construction companies.

Most countries with reference levels for radioactive elements in building materials apply activity indices or maximum permissible/recommended concentrations (question 36). Some countries have responded that they have one reference level for Radium-226 and other countries have reference levels for each of the following radioactive elements: Radium-226, Thorium-232 and Potassium-40. The indices are generally different for the different countries. Here are some examples:

Austria applies the following advisory activity index:

$${}^{40}\text{K}/10,000 + A({}^{226}\text{Ra})/1000 \cdot (1 + 0.15 \cdot \Sigma \cdot \text{density} \cdot \text{thickness}) + A({}^{232}\text{Th}/600) = <1.$$

Austria also has an advisory reference level for Beta radiation. Beta radiation is recommended to be $<1 \text{ Bq/cm}^2$. (A = activity concentration, Bq/kg)".

Finland has a "maximum permitted indoor dose due to gamma radiation from building materials, 1 mSv/year. This level corresponds to the following activity index, where the value of the activity index is 1 or less: $C(\text{Th})/200 + C(\text{Ra})/300 + C(\text{K})/3000 = <1$. (C = activity concentration, Bq/kg)".

Latvia has the following enforced regulations: "1) for residential buildings, internal materials: $(A_{\text{Ra}} + A_{\text{Th}})/170$ less or equal to 1 and activity of ${}^{40}\text{K}$ shall not exceed 1500 Bq/kg; 2) for industrial buildings, residential houses, external materials and roads within towns and cities $(A_{\text{Ra}} + A_{\text{Th}})/250 < 1$ and activity of ${}^{40}\text{K}$ shall not exceed 2000 Bq/kg; 3) for industrial buildings external materials and roads outside populated areas $(A_{\text{Ra}} + A_{\text{Th}})/300 < 1$ and activity of ${}^{40}\text{K}$ shall not exceed 2500 Bq/kg".

Lithuania has regulations that "materials used shall cope with the formula for Activity in Building Materials; $A_{\text{Ra}}/300 + A_{\text{Th}}/200 + A_{\text{K}}/3000 = <1$ for all building materials, $A_{\text{Ra}}/700 + A_{\text{Th}}/500 + A_{\text{K}}/8000 + A_{\text{Cs}}/2000 = <1$ for building materials used outside (streets, roads, etc.), $A_{\text{Ra}}/2000 + A_{\text{Th}}/1500 + A_{\text{K}}/20000 + A_{\text{Cs}}/5000 = <1$ for landscaping (they should be covered with building materials with lower extent of radionuclides)".

Norway has advisory reference levels for the contents of radioactive elements in building materials. ${}^{226}\text{Ra}/300 \text{ Bq/kg} + {}^{232}\text{Th}/200 + {}^{40}\text{K}/3000 \text{ Bq/kg} < 1$. ${}^{226}\text{Ra} < 200 \text{ Bq/kg}$.

Poland, "the enforced permissible levels are determined by the following formula: $0.0027 C_{\text{Ra}} + 0.0043 C_{\text{Th}} + 0.0027 C_{\text{K}} < 1$. C in Bq/kg. $C_{\text{Ra}} < 185$ ".

Russia: "Materials used shall cope with the following formula for Activity Concentration of radioactive elements in building materials: $A_{\text{eff}} = A_{\text{Ra}} + 1.31A_{\text{Th}} + A_{\text{K}}$. The limits (A_{eff}) are 370 Bq/kg for new buildings, 740 Bq/kg for industrial constructions and roads in towns and villages, and 2.8 kBq/kg for roads outside occupied areas". (Radiation Safety Standards NRB-96.)

Slovak Republic, "use of building materials with higher radium content can be permitted if it has negligible mass fraction, and unless $C_{\text{Ra}} + 1.25 C_{\text{Th}} + 0.086 C_{\text{K}} < 370 \text{ Bq/kg}$ ".

Republic of Slovenia, "the enforced reference levels are expressed as: Gamma-activity index, $C_{Ra}/400 + C_{Th}/300 + C_K/5000 + C_{artif}/4000 < 1$. C in Bq/kg. Gamma radiation $< 0.50 \mu\text{Gy/h}$. Beta radiation $< 40 \text{ Bq/dm}^2$."

Germany, "the enforced reference level for radium-226 in equilibrium with decay products is 200 Bq/kg".

Luxembourg, "the reference levels for radioactive elements are for ^{40}K : 5000 Bq/kg, ^{232}Th : 250 Bq/kg and ^{226}Ra : 350 Bq/kg".

Czech Republic has the following reference levels for radium-226 in building materials (Bq/kg). "Enforced level: 150-200 Bq/kg for materials in buildings where people could stay more than 1000 h/year (depending on the type of material); 1000 Bq/kg for materials in other buildings. *Advisory level*: 80-120 Bq/kg in buildings where people normally stay more than 1000 h/year; 300-500 Bq/kg for materials in other buildings".

Sweden has chosen a different approach toward regulation of radiation in new buildings. There are no special regulations for the permissible concentrations of radioactive elements in building materials. Instead, in Sweden, this ordinance has the legal Functional Requirements for emissions in new buildings. According to the Swedish Building Code, the highest permissible radon activity concentration in a newly built room where people stay longer than just temporarily is 200 Bq/m^3 , and gamma radiation is $0.5 \mu\text{Sv/h}$. In order to fulfill these Functional Requirements, adequate consideration must be given to all sources of radon and gamma radiation: the ground, building materials and water.

The Nordic countries have common regulations for Eco-labeling (the Swan label) for building boards. The following requirement applies: $C_K/3000 + C_{Ra}/300 + C_{Th}/200 = < 1.0$. There is also a requirement to use the radium index: $C_{Ra} / 100 = \leq 1.0$. There is an ongoing effort to require Swan labeling of concrete as well.

Of the non-European countries responding to the questionnaire, only **Israel** has reference levels for radioactive elements in building materials: ^{226}Ra 50 Bq/kg; ^{232}Th 50 Bq/kg; ^{40}K 500 Bq/kg; gamma radiation 0.7 mSv/y ; radon exhalation $1 \text{ Bq m}^{-2} \text{ h}$. **Japan** has no regulations for building materials. However, the Japanese gypsum board industry is aware of the radon problem. They are trying to reduce radon exhalation from gypsum boards by selecting low radium phosphate gypsum for the production of phosphate and mixing it with natural gypsum in gypsum board production.

5.4.2. Checkups for building materials (question 33)

Within the EU, Austria, Luxembourg and Germany perform special checkups for building material. Among the non-EU countries, inspections are much more common, with seven performing such checks. Among these, the Czech Republic and Poland have extensive programs for control of building materials.

5.4.3. Protocols for the investigation of radioactivity in building materials (question 35).

Austria and Luxembourg have special protocols for the investigation of radioactivity in building materials, as do the Czech Republic, Slovak Republic, Lithuania, Poland, Slovenia, Yugoslavia and Israel.

5.5. RADON IN THE PLANNING STAGE AND AT CONSTRUCTION (QUESTIONS 37-46)

In ICRP 65, Protection against Radon-222 at Home and at Work, ICRP, gives the following advice regarding new construction: "The aims in imposing restrictions on the constructions of new dwellings in radon-prone areas are to keep the radon concentration in the finished building as low as can reasonably be achieved.... These aims are best achieved by issuing guidance on construction practices.... When new buildings are to be erected in a radon-prone area it will be advisable to modify the design of the foundation to prevent elevated radon levels.... For pre-

ventive work, construction codes should be devised that will consistently achieve low concentrations in the completed buildings” (ICRP 65,1993).

The working group of EU Article 31 Group of Experts on Radiation Protection writes in Radiation Protection 88: “Although not explicitly mentioned in the BSS, Title VII, it would be sensible to consider preventing high radon levels in new workplaces rather than taking remedial measures after they have been built. It is simple and cheap to incorporate measures to reduce radon levels at the time that the building is being constructed” (EC 1997).

5.5.1. Construction requirements for prevention of radon in new buildings (question 37-40)

Five EU Member States have regulations and guidelines for construction requirements to prevent radon in new buildings: Denmark, Finland, Ireland, Sweden and the UK (Table 5.4.1.1). In the future, Austria, Germany and Greece are also planning to introduce such regulations. Most countries with requirements have enforced radon prevention regulations which are specified in the national Building Codes (Table 5.4.1.2). The national authorities and local municipal authorities usually share in supervising implementation of the regulations. In Sweden, the future owner has complete and full responsibility to ensure that the radon concentration in the completed building does not exceed 200 Bq/m³, the enforced reference level for new buildings.

Table 5.5.1.1. Regulation guidelines for construction requirements (question 37)

EU Member States			Non-EU European Countries		
Yes	No	We shall	Yes	No	We shall
5 Denmark Finland Ireland Sweden UK	10	3 Austria Germany Greece	4 Czech Republic Latvia Slovak Republic Norway	12	1 Switzerland

Table 5.5.1.2. Legal status of regulations (question 38)

EU Member States			Non-EU European Countries		
Enforced	Advisory	None at present	Enforced	Advisory	None at present
4 Denmark Ireland Sweden*	1 Finland	10	3 Czech Republic Latvia Slovak Republic	2 Norway	12

In Sweden*, this ordinance has the legal status of Functional Requirement and stipulates that the radon concentration shall not be greater than 200 Bq/m³ in a room where people stay longer than just temporarily.

Of the non-EU European countries, the Czech Republic, Slovak Republic and Latvia have enforced radon regulations for new buildings and Norway has advisory regulations. Switzerland is planning to introduce such requirements. Responsibility for implementation and supervision is shared between the state and local authorities, and construction companies, in three of these countries. In the Czech Republic, preventive radon protection measures must be executed when a building site is not located in a low radon risk area. Local building authorities are the supervisors (Czech Atomic Act, July 1998).

Outside Europe, Canada has guidelines for radon published by the Canadian Mortgage and Housing Cooperation and the Canadian public health authorities. In the USA, building codes are developed by membership consensus organizations that continually have hearings to update their documents. States and other jurisdictions base their local building codes on these documents. The States and other jurisdictions pass the codes into law and then enforce them through a permit and inspection system. There are also Model Standards and Techniques for the Control of Radon in New Residential Buildings published by the EPA in 1994, which are used as a basis for US construction guidelines.

5.5.2. Regulations and guidelines for radon in the planning stage (questions 41-42)

In ICRP 65, Protection against Radon-222 at home and at Work, ICRP writes: “In the Commission’s view, there is a merit in defining radon-prone areas in which concentration of radon is likely to be higher than typical of the country as a whole” (ICRP 65,1993).

Radiation Protection 88 gives the following advice: “National Authorities should delimit localities within radon prone areas or elsewhere within which appropriate radon preventive measures should be included in the construction of new workplaces. These should ensure that radon levels in new workplaces are as low as reasonably achievable and that further measures can easily be introduced if necessary” (EC 1997).

Table 5.5.2.1. Guidelines for radon in the planning stage. European countries (question 41)

EU Member States			Non-EU European Countries		
Yes	No	We shall	Yes	No	We shall
3	7	3	4	13	1
Denmark		Austria	Czech Republic		Slovenia
Finland		Germany	Norway		
Ireland		UK	Slovak Republic		
Sweden					

The following countries have regulations or guidelines for radon prevention in the general and the detailed planning stages, eg. for areas for which construction permits are applied for domestic buildings, offices and factories: Denmark, Finland, Ireland, Sweden, Czech Republic, Norway, and the Slovak Republic. The UK, Austria and Germany are planning to introduce such regulations/guidelines. Denmark and Ireland have enforced radon regulations and the other countries have guidelines.

Outside Europe, Israel and the USA have regulations/guidelines for radon prevention at the planing stage and Syria is planning to introduce such. Three of the 50 states in the US have regulations mandated by law, as do about 40 counties, cities, and towns. However, most of the US does not have mandated regulations/guidelines.

In Ireland, Sweden, Czech Republic, Slovak Republic and Israel, the regulations/guidelines require an investigation of the radon risk situation at construction sites before building is permitted (question 44).

5.5.3. Mapping radon risk areas (questions 45-46)

Most of the EU Member States, as well as many other countries, have executed radon risk maps to show the potential risk of radon emanating from the ground (Table 5.5.3.1). Usually, the surveyed areas are given risk designations dependent upon ambient radon conditions: high, normal and low risk areas. In some countries, e.g. UK, Norway, Czech Republic, and USA, the maps are executed in small scale and cover the entire country. Other countries, e.g. Sweden and Finland, produce radon risk maps using the scale 1:50,000 or larger, covering a municipality/district or part of one. Most often, production of the radon risk map is the responsibility of the Geological Survey of the country and is executed at the request of the Ministry of the Environment.

Table 5.5.3.1. Countries, which have mapped/surveyed their radon prone areas/radon risk areas. European countries. (question 45)

EU Member States			Non-EU European Countries		
Yes	No	We shall	Yes	No	We shall
10 Austria Belgium Finland France Ireland Germany Portugal Spain Sweden UK	3	2 Denmark Greece	4 Czech Republic Norway Slovak Republic Switzerland.	12	1 Yugoslavia

In Sweden, the local municipal authorities are responsible for mapping and surveying radon risk areas. Most municipalities have radon risk maps executed using the scale 1:50,000 or larger. The US radon potential map designates each of the 3141 counties in the US as having high, medium or low radon potential. Americans consider the map to be a helpful tool for use in targeting resources to the most radon-prone areas.

5.6. SHOULD THERE BE COMMON REFERENCE LEVELS WITHIN EU? (QUESTIONS 7-8)

Question 7 asked: Should there be common reference levels within EU? (Table 5.6.1). This question was meant for the EU Member States. Most of them answered Yes to this question. Two countries Denmark and Luxembourg answered No, and France, the Netherlands and UK didn't answer. No comments were made on this question. Apparently there is a majority of EU Member States perceive a benefit from having common reference levels within the EU. Perhaps

having common reference levels would make it easier to get the various governments to accept programs aimed at decreasing the risk due to radon.

Twelve of the non-EU European countries, mainly EU candidates, answered question 7. Eleven of the twelve answered *Yes*. Perhaps they reason that common EU reference levels for radon would serve to promote the work against radon in their own countries.

Of the non-European countries Israel answered *Yes*. The US EPA gave the following answer: "We would like to see a common level only if the level was at, below, or very near the U.S. action level of 4 pCi/L (148 Bq/m³). Otherwise, it is more helpful to have individual countries in the EU with different action levels above and below the U.S. level. Opponents of radon action in the U.S. often cite higher action levels of other countries as a reason not to take action in the U.S. about radon problems".

Table 5.6.1. Should there be common reference levels within EU? (Question 7)

EU Member States			Non-EU-European countries		
Yes	No	No answer	Yes	No	No answer
10	2	3	12	1	7
Austria	Denmark	Belgium	Belarus	Romania	Albania
Finland	Luxembourg	France	Czech Republic		Croatia
Germany		The Netherlands	Estonia		Hungary
Ireland		UK	Lithuania		Latvia
Italy			Poland		Norway
Portugal			Russia		
Spain			Slovak Republic		Japan
Sweden			Slovenia		Syria
			Switzerland		
			Turkey		
			Yugoslavia		
			Israel (U.S.A.)		

Conclusions

The responses to the questionnaire disclosed that many countries have programs to reduce health risks associated with radon and that many countries are in the process of introducing similar programs. Nevertheless, it has still taken the majority of countries a considerable time for the responsible authorities to include requirements for action levels and remedial measures in their legislation and guidelines. At this point, more than 20 years have passed since the first compulsory limits for radon in dwellings were introduced in Sweden and for buildings on uranium-rich ground in mining areas in the USA.

In order to actually reach the goal of vigorously diminishing radon dependent deaths, it is evident to the ERRICCA Topic Group on legal and building code impact (before *author*) that in countries where radon constitutes a public health problem, it is necessary to enact compulsory regulations into the legislation. Not until then will the risks associated with radon be taken seriously by local authorities, construction companies, materials manufactures and the general public. It appears to the Group (before *author*) that it is particularly important that regulations for protection against radon be legislated into planning and building codes, so that radon concentrations in new buildings will be kept to acceptably low levels in the future.

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Appendices:

1. THE QUESTIONNAIRE. EU MEMBER STATES. ANSWERS AND COMMENTS
2. THE QUESTIONNAIRE. NON-EU EUROPEAN COUNTRIES. ANSWERS AND COMMENTS
3. THE QUESTIONNAIRE. NON EUROPEAN COUNTRIES. ANSWERS AND COMMENTS

Swedish Radiation Protection Institute. SE- 171 16 Stockholm, Sweden
QUESTIONNAIRE ON RADON-LEGISLATION IN DIFFERENT COUNTRIES

Answers from: Austria (AT), Belgium (BE), Denmark (DK), Finland (FI), France (FR), Germany (DE), Greece (GR), Ireland (IE), Italy (IT), Luxembourg (LU), the Netherlands (NL), Portugal (PT), Spain (ES), Sweden (SE) and United Kingdom (UK). (15 EU Member States)

Please give your answers by writing in the space provided following the question number. You can use your own space, if you need to. But remember to correspond your answer to the correct question-number.

Feel free to send us only the answers, if you find it more convenient for you!

1. DWELLINGS (Existing & New)

No	Questions	Answers									
		Private Homes		State/Municipality owned		Cooperative owned		Rented		Other what?	
1	Does your country have a reference level for radon for:	Yes 10	No 5	Yes 10	No 5	Yes 10	No 5	Yes 10	No 5		
2	Which reference levels for radon are applied in existing dwellings at present, Bq/m ³ (radon gas)? (a) Enforced	400 ***SE		400 ***SE		400 ***SE		400 ***SE			
	(b) Advisory	400 AT 400 BE 200/400 *DK 400 FI 250/1000 **DE 400 GR 200 IE 150 LU 200 ***SE 200 UK		400 AT 400 BE 200/400 *DK 400 FI 250/1000 **DE 400 GR 200 IE - LU 200 ***SE 200 UK		400 AT 400 BE 200/400 *DK 400 FI 250/1000 **DE 400 GR 200 IE - LU 200 ***SE 200 UK		400 AT 400 BE 200/400 *DK 400 FI 250/1000 **DE 400 GR 200 IE -LU 200 ***SE 200 UK			
3	Which reference levels for radon are applied in new dwellings at present? Bq/m ³ (radon gas)? (a) Enforced	200 SE 200 UK		200 SE 200 UK		200 SE 200 UK		200 SE 200 UK			
	(b) Advisory	200 AT 200 DK 200 FI 250 DE 200 GR 200 IE 150 LU		200 AT 200 DK 200 FI 250 DE 200 GR 200 IE - LU		200 AT 200 DK 200 FI 250 DE 200 GR 200 IE - LU		200 AT 200 DK 200 FI 250 DE 200 GR 200 IE - LU			
	(c) None at present	BE, FR, IT, NL, PT, ES,		BE, FR, IT, LU, NL, PT, ES		BE, FR, IT, LU, NL, PT, ES		BE, FR, IT, LU, NL, PT, ES			
4	Comments: * Denmark has two advisory levels, 200 Bq/m ³ for simple remedial measures, 400 Bq/m ³ for more costly measures. France : Regulations, which are to be issued by the ministries of Health and Housing, will not include dwellings. ** Germany for existing dwellings has two advisory levels; 1000 Bq/m ³ mitigation level, 250 Bq/m ³ recommended level. Greece follows the Euratom 90/143 Recommendation. Ireland : Building Regulations 1997. Technical guidance document *** Sweden for existing dwellings has one enforced level 400 Bq/m ³ and one recommended level 200 Bq/m ³ .										

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QUESTIONNAIRE ON RADON-LEGISLATION IN DIFFERENT COUNTRIES

5	Who implements/supervises radon regulations/guidelines in Dwellings?	Private Homes		State/Municipality owned		Cooperative owned		Rented		Other what?			
	Government/Ministry/Board/Department	Yes 7	No 7	Yes 7	No 7	Yes 7	No 7	Yes 7	No 7				
	District	2		2		2		2					
	Municipality	2		2		2		2					
	Institution	1		1		1		1					
	Other:												
6	<p><i>Comments:</i> Austria Recommendation of the Austrian Radiation Protection Commission, July 1992 (general for buildings). Finland: The municipalities authorities are responsible to do radon measurements in dwellings and to identify the radon prone/risk areas in cooperation with the Finnish Centre for Radiation and Nuclear Safety (STUK). This is based on direction given by the Ministry of Health France: Regulations, which are to be issued by the ministries of Health and Housing, will not include dwellings. Germany: Recommendation issued by the German Commission on Radiological Protection; no supervision. Greece: The Government Board responsible for the implementation /supervision of the radon regulation/guidelines is the Greek Atomic Energy Commission. Sweden: The regulations on existing dwellings are given out by the National Board of Health and Welfare, on new dwellings by the National Board of Housing, Building and Planning.</p>												
7	Should there be common reference levels for radon within EU?	Yes 9		No 2		No answers 3							
8	<p><i>Your comments:</i> Yes: Austria, Finland, Germany, Greece, Ireland, Italy, Portugal, Spain, Sweden. No: Denmark, Luxembourg. No answers from: Belgium, The Netherlands, UK.. France: The levels of the Euratom recommendation appear in discussions but not in the official French documents.</p>												
9	Is your remedial measure financed by (more than one answer is possible):	Grants		Subsidies		Tax reduction		Other		None		Planned	
		4		2		1		1		9		1	
10	<p><i>Comments:</i> Austria Only few buildings were mitigated at the moment in the frame of pilot studies partly financed by public funds. Denmark: No finances are at present given to radon remedial measures. Finland: The municipal health authorities administer the finances appropriated by the Ministry of Health. Germany: Grants are used only in the federal land Saxony. Subsidies and credits are applied for special projects Ireland: Grants, 50 % of the cost of remediation, max IR £ 800. Sweden: Subsidies, 50 % of the costs, max SEK 15,000. UK: Local governments has the power to award grants to help the poorest home owners with the costs of remedial work.</p>												
11	Who administers the finances for remedial measures?	Grants		Subsidies		Tax reduction		Other		None		Planned	
	Government/Ministry/Board/Department	4										1	
	State	1											
	Institution												
	Municipality	1		1									
	<p><i>Other, what:</i> Germany: Kreditanstalt für Wiederaufbau (until 1998 in the new federal lands)</p>												

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12	<p><i>Comments:</i> Austria Only few buildings (>10) were mitigated at the moment in Austria in the frame of pilot studies partly financed by public funds. Denmark: No finances or supports are at present given to radon remedial measures. Finland: The municipal health authorities administer the finances appropriated by the Ministry of Environment. Ireland: Grants aid is administered by the department of Public Enterprise. Luxembourg: In 1979 the Government created a legal framework of premiums and subsidies granted to house owners for the renovation of their dwellings. At that time, this financial support aimed the amelioration of the heating systems, the sanitary and electric installations, the roofing, the replacement of windows etc. In 1994 the decision was taken to extend this legal frame work also on remedial measures undertaken by house owners wishing to improve the sanitary conditions by reducing radon in their homes. Portugal: Remedial actions are not implemented, at present. Sweden: The National Board of Housing, Building & Planning has the responsibility for the administration of the subsidies.</p>
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QUESTIONNAIRE ON RADON-LEGISLATION IN DIFFERENT COUNTRIES

2. WORKPLACES

Answers from: **Austria (AT), Belgium (BE), Denmark (DK), Finland (FI), France (FR), Germany (DE), Greece (GR), Ireland (IE), Italy (IT), Luxembourg (LU), the Netherlands (NL), Portugal (PT), Spain (ES), Sweden (SE) and United Kingdom (UK).** (15 EU Member States.)

No	Question	Answers							
		Yes	No	We shall					
13	Do you have standards of Radon Protection in all Workplaces?	8 AT, DK, FI, (FR), GR, IE, SE, UK	6 BE, DE, IT, LU, NL, PT, ES,	2 (FR) ES					
14	Please write down the reference level you use for EXISTING workplaces? Bq/m^3 (radon gas) (a) <i>Enforced</i>	Schools	Day care homes	Private industry-offices	State-owned industry offices	Municipality owned offices	Other offices	Misc. underground workplaces except mines	
		- *AT 400 DK 400 FI 1000 **FR 400 SE 400 UK	- *AT 400 DK 400 FI 400 SE 400 UK	*AT 400 DK 400 FI 400 SE 400 UK	*AT 400 DK 400 FI 400 SE 400 UK	*AT 400 DK 400 FI 1000 **FR 400 SE 400 UK	*AT 400 DK 400 FI 400 SE 400 UK	*AT 400 DK 400 FI 3000 ***DE 400 SE	
		(b) <i>Advisory</i>	400 AT 400 **FR 400 GR 150 IE	400 AT 400 GR 200 IE	400 AT 400 GR 200 IE	400 AT 400 GR 200 IE	400 AT 400 **FR 400 GR 200 IE	400 AT 400 GR 200 IE	400 GR 200 IE
15	Please write down the level of reference you use for NEW workplaces? Bq/m^3 (radon gas) (a) <i>Enforced</i>	400 DK 400 FI 1000 **FR 200 SE 400 UK	400 DK 400 FI 200 SE 400 UK	400 DK 400 FI 200 SE 400 UK	400 DK 400 FI 200 SE 400 UK	400 DK 400 FI 1000 **FR 200 SE 400 UK	400 DK 400 FI 200 SE 400 UK	400 DK 400 FI 200 SE	
		(b) <i>Advisory</i>	200 AT 400 **FR 200 GR 150 IE	200 AT 200 GR 200 IE	200 AT 200 GR 200 IE	200 AT 200 GR 200 IE	200 AT 400 **FR 200 GR 200 IE	200 AT 200 GR 200 IE	200 GR 200 IE
		(c) <i>None at present</i>	6 DE, IT, LU, NL, PT, ES	7 FR, DE, IT, LU, NL, PT, ES	7 FR, DE, IT, LU, NL, PT, ES	7 FR, DE, IT, LU, NL, PT, ES	6 DE, IT, LU, NL, PT, ES	7 FR, DE, IT, LU, NL, PT, ES	9 AT, FR, DE, IT, LU, NL, PT, ES, UK
16	Please, describe any different classification standards you have: * Austria: The enforced level for workplaces is 370 Bq/m^3 (168 h) or 1110 Bq/m^3 (40 h). It does <u>not</u> include the <u>natural</u> Radon background. Finland: Work is classified as radiation work if the effective dose at work is higher than 2.5 mSv/year. When classified as radiation work the maximum concentration is 3,200 Bq/m^3 (20 mSv, regular working hours). ** France: Planned levels. Not <u>all</u> workplaces have the same standards concerning radon. The levels 1000 and 400 Bq/m^3 will apply only to workplaces which are buildings open to the public (especially schools); these buildings are usually State-owned and municipality offices. When the workplace is classified as radiation work (for instance, underground workplaces or industry plants where radioactive materials containing radium are handled) radiation protection regulations apply and dose limits must be respected. For common offices, regulations are planned in accordance with Euratom directive 96/29 which suggests to take regulations in case of significant increase in exposure due to natural radiation sources among which there is radon. *** Germany: Standards only for caves, waterworks, spas in the new federal lands. For miscellaneous underground workplaces, except mines the enforced limit is $40 MeV/cm^3$, which is about 3,000 Bq/m^3 . The regulation (act) from the former German Democratic Republic (DDR) is still in power for the territory of the new federal lands until the amended Radiation Protection Ordinance is being issued. Ireland: Building Regulations 1997. Technical guidance document.								

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QUESTIONNAIRE ON RADON-LEGISLATION IN DIFFERENT COUNTRIES

17	<i>Who implements/supervises radon regulations in Workplaces?</i>	<i>Schools</i>	<i>Day care homes</i>	<i>Private industry-offices</i>	<i>State-owned industry offices</i>	<i>Municipality owned offices</i>	<i>Other offices</i>	<i>Misc. underground workplaces except mines</i>
	<i>A. Government/Ministry/Board/ Department</i>	8	6	6	6	6	6	5
	<i>B. Municipality</i>	2	1	1	1	2	1	1
	<i>C. District</i>							
	<i>D. Institution</i>	2	2	2	2	2	2	2
	<i>E. Other</i>							
18	<i>Do you have protocols for the measurement of radon in Workplaces:</i>	<i>Yes</i>	<i>No</i>	<i>We shall</i>				
		5 FR, FI, DE, IE	10	1 GR, SE				
19	<p><i>Please write your comments & the authority(ies) who promulgated the regulations/guidelines:</i> Denmark: National Institute of Radiation Hygiene. Finland: The instruction known as Radiation Safety Act Guides is given by The Finnish Centre for Radiation and Nuclear Safety (STUK). STUK is the competent authority. The specifications on methods and instruments have been issued by STUK, the instruments must be accepted by STUK. France: Protocols for the measurements exist both for dwellings and state-owned buildings; by extension they can apply to workplaces where radon is "geographical". These protocols have been issued by the French association of standardization (AFNOR) which is under the jurisdiction of the Ministry of Industry. Germany: Limits and protocols for the new federal lands only. Greece: Greek Atomic Energy Commission is responsible for radon regulations and guidelines. Ireland: Department of Environment /Radiological Protection Institute of Ireland. Sweden: The National Board of Occupational Safety and Health. UK: The legislation provides limits on exposure to radon decay products over a working day. The Health and Safety Executive (HSE), which implements the law, has adopted a practical Action level of 400 Bq/m³ measured over a month or more. The responsibility for enforcement is divided between the HSE for large buildings and local authorities for small ones. The regulations are being revised and reference levels for different types of workplace have not yet been established.</p>							

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QUESTIONNAIRE ON RADON-LEGISLATION IN DIFFERENT COUNTRIES

3. DRINKING WATER

No	Questions	Answers			
		Yes	No	We shall	
20	Do you have radon protection standard for drinking water?	2 FI, SE	13	3 AT, DE, GR	
21	Please write down the reference level for radon your regulations specify, Bq/l: (a) Enforced	<i>Public waters</i>	<i>Private waters</i>	<i>Home owner's waters</i>	<i>Other</i>
		300 FI 100 SE	1000 SE		
		(b) <i>Advisory</i>	100 UK*		1000 SE
	(c) <i>None at Present</i>	12	13	13	13
22	Who implements/supervises radon regulations for drinking water?				
	A. <i>Government/Ministry/Board/Department</i>	4	3	3	3
	B. <i>Municipality</i>	2	1	1	
	C. <i>District</i>				
	D. <i>Institution</i>				
	E. <i>Other</i>				
23	Do you make special checkups for water sources in uranium rich surroundings ?	Yes	No	We shall	
		1 ES	13	1	
24	Have you classified the radon risks of the water-resource zones in your country? (Say: High/Sporadic/Low)	1 SE (1) DK	12	2 AT, FI	
25	If you have your own classifications please name :				
26	Do you have protocols for the analysis of radon in Drinking Water:	4 AT, LU SE, PT	10		
27	Please write your comments & authority(yes) that promulgated the regulations: Austria: Internal protocols of different testing laboratories. Finland: The instructions known as Radiation Safety Guides are given by STUK, the work is based on Radiation Act given in 1991. An activity index have been given. $I = C(\text{alfa})/\text{Bq/l} + C(\text{beta})/\text{Bq/l} + C(\text{Rn})/300 \text{ Bq/l}$. The safety requirement is met if the activity index is 1 or less. Extensive mapping has been carried out, many high risk areas are known. Luxembourg: Although radon in water is not subject of any regulation, controls are carried out. Spain: A guide has been issued for the radiological control of drinking water. Rn-222 was excluded, based on WHO recommendations. Sweden: The regulations have been issued by the National Food Administration. (Drinking water directions, SLV FS 1997:2). The municipalities are responsible for supervising, Subsidies for measures to reduce the radon concentration of up to SEK 5,000 for private water supplies if the radon concentration is > 1000 Bq/l. Subsidies with no upper level for public municipality owned water works if the radon concentration is > 100 Bq/l. UK*: has a semi-formal guideline of 100 Bq/l.				

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4. BUILDING MATERIALS

No	Questions	Answers				
		Yes	No	We shall		
28	Do you have radon protection standards for building materials?	2 AT, LU	13			
29	Have you reference levels for: Contents of Radioactive Elements, Gamma Radiation, Beta Radiation & Radon Exhalation/Radon Flux?	4 AT, FI, DE, LU	11			
30	Status of reference levels?	<i>Enforced</i>	<i>Advisory</i>	<i>None at present</i>		
		3 ¹⁾ FI, DE, LU	1 ²⁾ AT	11		
31	Who implements/supervises radon regulations for building materials?	Government/Ministry/Board/Department	Municipality	District	Construction companies	Other?
		³⁾ FI, ⁴⁾ DE, ⁵⁾ LU			³⁾ FI	AT (Austrian Standard Institute)
32	Please write down the reference levels your regulations/guidelines specify for	Contents of radioactive elements	Gamma radiation	Beta radiation	Radon exhalation/ radon flux	
		⁶⁾ AT, ⁷⁾ FI, ⁸⁾ GE, ⁹⁾ LU	SE	¹⁰⁾ AT	²⁾ AT	
33	Do you make special checkups for building materials to be used for public buildings?	<i>Yes</i>	<i>No</i>	<i>We shall</i>		
		2 AT (volunt.), LU, DE	13			
34	Do you have your own classifications ?	2 LU, DE	13		If yes, name	
35	Do you have protocols for the investigation of radioactivity in Building Materials ?	2 AT, LU	13			
36	<p>Please write your comments & the authority(yes) who promulgated the regulations/guidelines:</p> <p>Austria: ²⁾Reference level (ÖNORM S5200/1.April 1996). ⁶⁾Activity index: $A^{40}\text{K}/10,000 + A^{226}\text{Ra}/1000 \cdot (1 + 0.15 \cdot \Sigma \text{ density} \cdot \text{thickness}) + A^{232}\text{Th}/600 < 1$. ¹⁰⁾Beta radiation: $< 1 \text{ Bq/cm}^2$.</p> <p>Finland: ¹⁾Content of radioactive elements as regards gamma radiation. ³⁾The instructions known as Radiation Safety Guides are given by STUK, the work is based on Radiation Safety Act given in 1991. STUK is the competent authority. If it is discovered or there is a reason to suspect that the radioactivity in the materials is liable to cause doses greater than presented in the guide concerning the radioactivity of construction materials, the responsible party is required to investigate the radiation exposure caused by the practice as directed in the Radiation Act. ⁷⁾Activity index I corresponds to 1mSv/y. $I = C(\text{Th})/200 + C(\text{Ra})/300 + C(\text{K})/3000 < 1$, where the concentrations of Thorium-232, Radium-226 and Potassium-40 are given in Bq/kg. Germany: ⁴⁾In the new federal lands according to the "Haldenanordnung" still in power (from the former GDR-law). ⁸⁾200 Bq/kg ²²⁶Ra in equilibrium with decay products. Luxembourg: ⁵⁾The guidelines are given by the Direction de la Santé. ⁹⁾⁴⁰K: 5000, ²³²Th: 250, ²²⁶Ra: 350 Bq/kg. Sweden: In Sweden, there are no special regulations for building materials. Sweden has Functional Requirements for new buildings. In rooms where people stay longer time than temporarily the highest permissible radon concentration is 200 Bq/m³ and gamma radiation 0.5 μSv/h. In order to fulfill these Functional Requirements, adequate consideration must be given all sources of radon and gamma radiation: the ground, building materials and water. The Nordic countries have common regulations for Eco-labeling (the Swan label) for boards used in buildings. The following demand applies: $C_{\text{K}}/3000 + C_{\text{Ra}}/300 + C_{\text{Th}}/200 < 1.0$. There is also a requirement for radium index: $C_{\text{Ra}} < 1.0$. In the formulas are C_{K}, C_{Ra} and C_{Th} are expressed as concentrations of Potassium-40, Radium-226 and Thorium-232 in becquerel per kilogram (Bq/kg) of the material. 1% Potassium is equivalent to 310 Bq/kg Potassium-40. 1 ppm Uranium is equivalent to 12.3 Bq/kg of Radium-226 and 1 ppm Thorium to 4.0 Bq/kg of Thorium-232. There is an ongoing effort to include the Swan labeling for concrete as well.</p>					

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5. PLANNING, CONSTRUCTION

No	Questions	Answers				
		Yes	No	We shall		
37	Do you have regulations guidelines for construction requirements to prevent radon in new buildings?	5 DK, FI, IE, SE, UK	10	3 AT, DE, GE		
38	What is the status of these regulations/guidelines?	Enforced	Advisory	None at present		
		4 DK, IE, *SE, UK	1 FI	9		
39	Who is responsible for their implementations/ supervision ?	Government/Ministry/Board/Department	Municipality	District	Construction companies	Other?
		4 AT, DK, FI, IE	3 FI, IE, SE	2 AT, UK		1 SE
40	Please write your comments & the authority(yes) that promulgated the regulations/guidelines: Denmark: Ministry of Housing (Danish Building Code): Build airtight against the ground. Finland: The radon limit for existing and new buildings has been issued in the building code. No special regulations for new buildings. A guide has been issued by the Ministry of Environment: Guide for planning and construction of radon safe slab-on-grade foundation. Other guides have been published by the Helsinki University of Technology. France: Radon levels are to be set up for both existing and new buildings open to the public, but there are no specific guidelines planned concerning constructions. Ireland: Department of Environment has overall responsibility but law is applied locally through the Building Control system administered by the Local Authority. Under the Building Regulations all new buildings are required by law to have a radon sump fitted during construction. Building Regulations 1997. Technical guidance document, Section 2: Dangerous substances. Germany: A regulation is under elaboration by a working party in portfolio of the ministries of the federal lands, guided by the German Institution for Construction Technology. Sweden: *The National Board of Housing, Building & Planning (Boverkets byggregler, BFS 1993:57, 6:223). The ordinance has a status of Functional Requirements and imply that the radon-activity concentration should not be more than 200 Bq/m ³ in a room where people stay for a time longer than just temporary. Guide, the Radon Book (BFR). UK: Department of the Environment, Transport and the Regions (DETR). Guides for remediation and construction (BRE).					
41	Are there regulations/guidelines for the protection of radon in general & detailed planning as in construction permits for: domestic buildings, offices and factories ?	Yes	No	Are in plan		
		4 DK, FI, IE, SE	8	3 AT, DE, UK		
42	Name the authority that promulgated the regulations/guidelines? Ireland: Department of Environment: Building Regulations 1997. Technical guidance document. Section 2. Dangerous substances. Germany: German Institution for Construction Technology. Sweden: The National Board of Building & Planning. UK: For domestic buildings, Department of Environment.					
43	What is the status of the regulations/guidelines?	Enforced	Advisory	None at present		
		2 DK, IE	2 FI, SE	11		
44	Do the regulations/guidelines imply/signify a requirement for examining the presence of radon in construction sites for new buildings?	Yes	No	We shall		
		2 IE, SE	11	2 AT, DE		
45	Have you mapped/surveyed the radon prone/risk areas in your country?	10 AT, BE, *FI, FR, IE, **DE, PT, ES, SE, UK	3	2 DK, GR		

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46	<p><i>Please write your comments & the authority(yes) that promulgated the regulations/guidelines:</i> Finland: *STUK has carried out a very extensive work in cooperation with municipal authorities in order to survey the radon prone/risk areas. We have issued many publications concerning this work and also the Radon Atlas of Finland. Report STUK-A148, November 1997. France: The Institute for Protection and Nuclear Safety (IPSN) is responsible for the national survey of measurements in cooperation with the decentralized service of the ministry of Health. As far as now over 10,000 dwellings have been tested, showing departments at risk. Germany: Recommendations: German Commission on Radiological Protection, Instructions: German Institution for Construction Technology, Law: Federal and Land Ministries. **Partially. Sweden: The National Board Of Housing Building & Planning (Boverkets konstuktions regler, BFS 1993:58, 4:22). The local authorities are responsible for mapping & surveying the radon prone/risk areas. Most municipalities have Radon Risk Maps in the scale 1:50,000 or larger. UK: Department of the Environment, Transport and the Regions (DETR).</p>
47	<p><i>Feel free to give an overall comment or your concluding remarks..</i></p>

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Answers from: Albania (AL), Belarus (BY), Croatia (HR), Czech Republic (CZ), Estonia (EE), Hungary (HU), Latvia (LV), Lithuania (LT), Norway (NO), Poland (PL), Romania (RO), Russia (RU), Slovak Republic (SK), Republic of Slovenia (SI), Switzerland (CH), Turkey (TR), Yugoslavia (YU).

(17 non-EU European countries that has answered the questionnaire.)

Please give your answers by writing in the space provided following the question number. You can use your own space, if you need to. But remember to correspond your answer to the correct question-number. Feel free to send us only the answers, if you find it more convenient for you!

1. DWELLINGS (Existing & New)

No	Questions	Answers										
		Private homes		State/Municipality owned		Cooperative owned		Rented		Other what?		
1	Does your country have a <i>reference level</i> for radon for:	Yes 12	No 5	Yes 12	No 5	Yes 12	No 5	Yes 12	No 5			
2	Which reference levels for radon are applied in <i>existing</i> dwellings at present, Bq/m ³ (radon gas)? (a) <i>Enforced</i>	400 *BY 600 ***LV 400 LT 200/400 RU***** 200 EEC SK 1000 *****CH 400 *****YU		400 *BY 600 ***LV 400 LT 200/400 RU***** 200 EEC SK 1000 *****CH 400 *****YU		400 *BY 600 ***LV 400 LT 200/400 RU***** 200 EEC SK 1000 *****CH 400 *****YU		400 *BY 600 ***LV 400 LT 200/400 RU***** 200 EEC SK 1000 *****CH 400 *****YU				
	(b) <i>Advisory</i>	200 *BY 200 EEC *CZ 400 EE 300 ***LV 200/400 ****NO 400 PL 400 SI 400 *****CH 200 *****YU		200 *BY 200 EEC **CZ 400 EE 300 ***LV 200/400 ****NO 400 PL 400 SI 400 *****CH 200 *****YU		200 *BY 200 EEC **CZ 400 EE 300 ***LV 200/400 ****NO 400 PL 400 SI 400 *****CH 200 *****YU		200 *BY 200 EEC **CZ 400 EE 300 ***LV 200/400 ****NO 400 PL 400 SI 400 *****CH 200 *****YU				
3	Which <i>reference levels</i> for radon are applied in <i>new</i> dwellings at present? Bq/m ³ (radon gas)? (a) <i>Enforced</i>	200 BY 300 LV 200 LT 200 NO 200 PL 100 EEC RU***** 100 EEC SK 1000 *****CH 200 *****YU		200 BY 300 LV 200 LT 200 NO 200 PL 100 EEC RU***** 100 EEC SK 1000 *****CH 200 *****YU		200 BY 300 LV 200 LT 200 NO 200 PL 100 EEC RU***** 100 EEC SK 1000 *****CH 200 *****YU		200 BY 300 LV 200 LT 200 NO 200 PL 100 EEC RU***** 100 EEC SK 1000 *****CH 200 *****YU				
	(b) <i>Advisory</i>	100 EEC *CZ 200 EE 200 SI 400 *****CH		100 EEC *CZ 200 EE 200 SI 400 *****CH		100 EEC *CZ 200 EE 200 SI 400 *****CH		100 EEC *CZ 200 EE 200 SI 400 *****CH				
	(c) <i>None at present</i>	AL, HR, HU, RO, TR		AL, HR, HU, RO, TR		AL, HR, HU, RO, TR		AL, HR, HU, RO, TR				

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4	<p><i>Comments:</i> *Belarus for existing dwellings has two levels; 400 Bq/m³ enforced level, 200 Bq/m³ advisory level. **Czech Republic for existing dwellings has 4 advisory levels for recommended mitigation ; 200-300 EEC Bq/m³ simple mitigation e.g. increased ventilation, 300-600 EEC Bq/m³ more expensive mitigation, 600-2000 EEC Bq/m³ sophisticated remedial measures, > 2000 EEC Bq/m³ people stay excluded. Hungary is planning to have the following advisory levels; existing dwellings 600 Bq/m³, new dwellings 400 Bq/m³. ***Latvia for all types of existing dwellings has two levels, enforced level 600 Bq/m³, advisory level 300 Bq/m³. ****Norway has two advisory levels; 200-400 Bq/m³ simple and inexpensive measures are recommended, >400 Bq/m³ expensive measures are justified. ***** Russia has two enforced levels for mitigation, >200 Rn Bq/m³ Rn - simple mitigation e.g. increased ventilation, >400 Bq/m³ - if it is not possible to decrease radon activity in the dwelling lower than 400 Rn Bq/m³, the question about population removal (with their agreement and changing of the intent of the building or its demolition is settled. Limit for new dwellings is: ARneqv + 4.6 ATneqv < 100 Bq/m³, where ARneqv is the annual average equivalent equilibrium volumetric activity concentration of radon and thoron gases respectively *****Switzerland has one enforced level of 1000 Bq/m³ and one advisory of 400 Bq/m³ for existing and new dwellings. *****Yugoslavia for existing dwellings has two levels; 400 Bq/m³ enforced level, 200 Bq/m³ advisory level.</p>													
5	<p><i>Who implements/supervises radon regulations/guidelines in Dwellings?</i></p>		<p><i>Private homes</i></p>		<p><i>State/Municipality owned</i></p>		<p><i>Cooperative owned</i></p>		<p><i>Rented</i></p>		<p><i>Other what?</i></p>			
	<p><i>Government/Ministry/Board/Department</i></p>		<p>Yes 15</p>	<p>No 2</p>	<p>Yes 14</p>	<p>No 3</p>	<p>Yes 14</p>	<p>No 3</p>	<p>Yes 14</p>	<p>No 3</p>				
	<p><i>District</i></p>													
	<p><i>Municipality</i></p>		<p>1</p>		<p>1</p>		<p>1</p>		<p>1</p>					
	<p><i>Institution</i></p>		<p>7</p>		<p>7</p>		<p>7</p>		<p>7</p>					
	<p><i>Other:</i></p>													
6	<p><i>Comments:</i> Belarus. Radon monitoring is conducted by the sanitary - epidemiological services of Ministry of Health. Czech Republic: The regulations are given out by "Atomic Act" and Decree No. 184/1997. For new dwellings the reference levels are used now as advisory levels (the decision of Ministry for Regional Development responsible for Municipal Building Offices), but negotiations was started to return this reference level as enforced (amendment of the new Building Act). Estonia: There is no Radon Regulation enforced in Estonia, the data given are from the draft of a corresponding regulation. Latvia: The regulations are issued by the cabinet of Ministers (1997 gada MK noteikumi Nr. 297 -Regulations on Protections Against Ionizing Radiation). Lithuania: Regulated by the Basic Radiation Protection Standards HN73-1997. Poland: National Atomic Agency Agency. Russia: Regulated by the Radiation Safety Standards NRB-96: Hygienic Standards GN 26.1.054-96. Slovak Republic: The Ministry of Health and the State Health Institutes are regulatory authority and supervisory bodies respectively. Republic of Slovenia: The recommendations are given out by the Commission for Radiation Protection, constituted by the Ministry of Health. Switzerland: The Swiss Federal Office of Public Health (SFOPH) coordinates all Radon-activities.</p>													
7	<p><i>Should there be common reference levels for radon within EU?</i></p>		<p><i>Yes</i></p>		<p><i>No</i></p>		<p><i>No answers</i></p>							
			<p>11</p>		<p>1</p>		<p>5</p>							
8	<p><i>Your comments:</i> Yes: Belarus, Czech Republic, Estonia, Lithuania, Poland, Russia, Slovak Republic, Republic of Slovenia, Switzerland, Turkey and Yugoslavia. No: Romania. No answers from: Albania, Croatia, Hungary, Latvia and Norway.</p>													
9	<p><i>Is your remedial measure financed by:</i></p>		<p><i>Grants</i></p>		<p><i>Subsidies</i></p>		<p><i>Tax reduction</i></p>		<p><i>Other</i></p>		<p><i>None</i></p>		<p><i>Planned</i></p>	
			<p>1</p>		<p>2</p>		<p>2</p>		<p>1</p>		<p>11</p>		<p>2</p>	

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10	<i>Comments</i>				Belarus. State budget		Norway 50% max. 15,000 NOK
11	<i>Who administers the finances for remedial measures?</i>						
	<i>Government/Ministry/Board/Department</i>	3	3	1	1	1	1
	<i>State</i>	1					
	<i>Institution</i>						
	<i>Municipality</i>	1	1				
	<i>Other, what.</i>						
12	<p><i>Comments:</i> Belarus: Financing is small. There is no national program of radon monitoring. Czech Republic: The Ministry of Finance, the Ministry of environment and the district officers are responsible for the administration of the grants according to government resolution No.709/1193. The state grants and subsidies correspond to EEC advisory levels. Norway: Subsidies, 50 % of the costs, max. NKR 15,000. If the costs are higher than NKR 30,000 State granted loans up to NKR 60,000. Slovak Republic: In case of new buildings the soil measurements and subsequent countermeasures are financed by investors. Republic of Slovenia: In houses and apartments owners take care about remedial measures and payment. In schools and kindergartens government pays (Ministry of Health and other Ministries). Switzerland: Tax reduction, different situations in different cantons. Turkey: There has been no need for remedial measures up to now, because no elevated radon concentration has been measured.</p>						

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2. WORKPLACES

No	Question	Answers from: Albania (AL), Belarus (BY), Croatia (HR), Czech Republic (CZ), Estonia (EE), Hungary (HU), Latvia (LV), Lithuania (LT), Norway (NO), Poland (PL), Romania (RO), Russia (RU), Slovak Republic (SK), Republic of Slovenia (SI), Switzerland (CH), Turkey (TR), Yugoslavia (YU). (17 non-EU European countries that has answered the questionnaire.)						
13	Do you have standards of Radon Protection in all Workplaces?	Yes 7 CZ, EE, LV, LT, NO, CH, SK	No 6 BY, HR, RO, RU, SI, TR	We shall 4 AL, HU, PL, YU				
14	Please write down the reference level you use for EXISTING workplaces? Bq/m ³ (radon gas) (a) Enforced	Schools	Day care homes	Private industry-offices	State-owned industry offices	Municipality-owned offices	Other offices	Misc. underground workplaces except mines
		1000 CZ 400 LT 500/1000*SK 400 SI 1000** CH	1000 CZ 400 LT 500/1000*SK 1000**CH	1000 CZ 400 LT 310 EEC RU 500/1000*SK 3000**CH	1000 CZ 400 LT 310 EEC RU 500/1000*SK 3000**CH	1000 CZ 400 LT 500/1000*SK 1000** CH	1000 CZ 400 LT 500/1000*SK 1000** CH	1000 CZ 1000 NO 1000 LT 1000 *SK 3000**CH
	(b) Advisory	200 EEC CZ 1500 EE 1000 LV 200/400 NO 400** CH	200 EEC CZ 1500 EE 1000 LV 200/400 NO 400 SI 400 **CH	200 EEC CZ 1500 EE 1000 LV 200/400 NO 1000 SI 400 **CH	200 EEC CZ 1500 EE 1000 LV 200/400 NO 1000 SI 400 **CH	200 EEC CZ 1500 EE 1000 LV 200/400 NO 1000 SI 400**CH	200 EEC CZ 1500 EE 1000 LV 200/400 NO 1000 SI 400**CH	200 EEC CZ 1000 LV 20 mSv/a SI tourist caves
15	Please write down the level of reference you use for NEW workplaces? Bq/m ³ (radon gas) (a) Enforced	200 EEC CZ 300 LV 200 LT 100 EEC RU 250/1000*SK 200 SI 1000** CH	200 EEC CZ 300 LV 200 LT 100 EEC RU 250/1000*SK 1000** CH	200 EEC CZ 300 LV 200 LT 310 EEC RU 250/1000*SK 3000** CH	200 EEC CZ 300 LV 200 LT 310 EEC RU 250/1000*SK 3000** CH	200 EEC CZ 300 LV 200 LT 100 EEC RU 250/1000*SK 1000** CH	200 EEC CZ 300 LV 200 LT 100 EEC RU 250/1000*SK 1000** CH	200 EEC CZ 300 LV 1000 LT 1000*SK 3000** CH
		(b) Advisory	100 EEC CZ 1500 EE 200 NO 400** CH	100 EEC CZ 1500 EE 200 NO 400** CH	100 EEC CZ 1500 EE 200 NO 400 **CH	100 EEC CZ 1500 EE 200 NO 400 **CH	100 EEC CZ 1500 EE 200 NO 400** CH	100 EEC CZ 1500 EE 200 NO 400** CH
		(c) None at present	7	8	8	8	8	9
16	Please, describe any different classification standards you have: Czech Republic for existing workplaces has one enforced level, 1000 Bq/m ³ radon gas, and one general guidance level, 200 Bq/m ³ EEC. If the radon gas concentration exceeds 1000 Bq/m ³ , regulation depends on individual human exposures (occupational time). In connections with the new Czech Building Act there were performed a change in the Atomic Act: In cases of existing buildings of "public concern" where the Radon level is higher than the action levels, the remedial measure can be enforced by the local building office. Norway has two advisory levels for existing workplaces, 200-400 Bq/m ³ simple and inexpensive measures, >400 Bq/m ³ more expensive measures are justified. Russia Limit for new industrial workplaces is 310 Bq/m ³ , as long as the time individuals spend in the building is 2000 hours per year. Limit for new public buildings is: ARneqv + 4.6 ATneqv < 100 Bq/m ³ , where ARneqv is the annual average equivalent equilibrium volumetric activity concentration of radon and thoron gases respectively. Slovak Republic has two levels for existing and new workplaces. The lower value applies to situations when the time all individuals spend in the building exceeds 1000 hours, the higher level is a decision level above which the workplace is regarded as a workplace with ionizing radiation source. Switzerland has one enforced level and one advisory level for existing and new workplaces.							

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17	Who implements/supervises radon regulations in Workplaces?	Schools	Day care homes	Private industry-offices	State-owned industry offices	Municipality-owned offices	Other offices	Misc. underground workplaces except mines
	A. Government/Ministry/Board/ Department	7	7	7	8	7	6	7
	B. Municipality							
	C. District	1	1		1	1		
	D. Institution	1	1	1	1	2	1	2
	E. Other							
18	Do you have protocols for the measurment of radon in Workplaces:		Yes	No	We shall			
			3 NO, SK, YU	14	3 CZ LV, SI			
19	Please write your comments & the authority(ies) who promulgated the regulations/guidelines: Belarus: National Comitty for Radiation Protection, State Committee for Atomic Supervision in Industry, Ministry of Health. Czech Reublic. State Office for Nuclear Safety (the are 7 Regional Centers). Estonina: The data given are from the draft of Radon Regulations, it is not yet officiallay enforced. Latvia: In the regulations are not given who shall implement the radon regulations in workplaces. Russia: Gossansanepidnadzor (State Committee on the Sanitary-Epidemiological Supervision) has issued the Radiation Safety Standards NRB-96. Slovak Republic: See question 6. Republic of Slovenia: Governmental and other institutions working in the field promulgate the regulations/guidelines. Switzerland: SFOPH promulgates and the Swiss National Accident Insurance Organization (Suva) supervises.							

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3. DRINKING WATER

No	Questions	Answers			
		Yes	No	We shall	
20	Do you have radon protection standard for drinking water?	4 CZ, NO, RU, SK	13	4 LV, SI, TR, YU	
21	Please write down the reference level for radon your regulations specify, Bq/l: (a) Enforced	Public Waters	Private waters	Home owner's waters	Other
		300*CZ 120 RU 50**SK 300 RO	120 RU 1000**SK K 300 RO	120 RU 1000**SK 300 RO	120 RU 50**SK
	(b) Advisory	50*CZ 500 NO	500 NO 50**SK	200/1000 *CZ 500 NO 50**SK	50**SK
	(c) None at Present				
22	Who implements/supervises radon regulations for drinking water?				
	A. Government/Ministry/Board/Department	6	5	6	
	B. Municipality	1	1	1	
	C. District				
	D. Institution				
	E. Other				
23	Do you make special checkups for water sources in uranium rich surroundings ?	Yes 2 SK, SI	No 15	We shall 1	
24	Have you classified the radon risks of the water-resource zones in your country? (Say: High/Sporadic/Low)	1 NO	16	2	
25	If you have your own classifications please name:				
26	Do you have protocols for the analysis of radon in Drinking Water:	2 CZ, SK	15	2	
27	Please write your comments & authority(yes) that promulgated the regulations: *Czech Republic has two advisory levels for private waters which corresponds to different remedial measures. Latvia is planning to introduce the following levels: Public waters 100 Bq/l, private and home owners waters 1000 Bq/l. Russia: Gossanepidnadzor has the responsibility for supervision. **Slovak Republic has one enforced limit for public waters, 50 Bq/l. For private waters is the advisory limit 50 Bq/l. The use of private waters with higher radon content can be permitted unless higher than 1000 Bq/l.				

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4. BUILDING MATERIALS

No	Questions	Answers							
		Yes		No		We shall			
28	Do you have radon protection standards for building materials?	6 CZ, LT, NO, PL, RO, SK		11 AL, BY, HR, HU, EE, LV, RU, SI, CH, TR, YU		2 EE, TR			
29	Have you reference levels for: Contents of Radioactive Elements, Gamma Radiation, Beta Radiation & Radon Exhalation/Radon Flux?	11 BY, CZ, LV, LT, NO, PL, RU, RO, SK, SI, YU		6 AL, HR, EE, HU, CH, TR		2 EE, TR			
30	Status of reference levels?	Enforced		Advisory		None at present			
		9 BY, CZ, LV, LT, PO, RO, RU, SK, SI		1 (1 CZ), NO		7 AL, HR, EE, HU, CH, TR, YU			
31	Who implements/supervises radon regulations for building materials?	Government/Ministry/Board/Department		Municipality		District		Construction companies	Other?
		9 CZ, LV, LT, NO, PO, RO, RU, SK, YU						3 BY, LV, PO	1
32	Please write down the reference levels your regulations/guidelines specify for	Contents of radioactive elements		Gamma radiation		Beta radiation		Radon exhalation/radon flux	
		Yes 10 BY, CH, LV, LT, NO, PO, RO, RU, SK, SI	No 7	Yes 2 LT, PO	No 15	Yes	No 17	Yes	No 17
33	Do you make special checkups for building materials to be used for public buildings?	Yes		No		We shall			
		7 CZ, LT, PO, RO, SK, SI, YU		10 AL, BY, CH, EE, HU, LV, NO, RU, CH, TR		1 LV			
34	Do you have your own classifications ?	4 CZ, LT, PO, RU		13 AL, BY, CH, EE, LV, NO, RO, SK, SI, CH, TR, YU				If yes, name	
35	Do you have protocols for the investigation of radioactivity in Building Materials?	6 CZ, LT, PO, SK, SI, YU		11 AL, BY, CH, EE, LV, NO, HU, RO, RU, CH, TR		1 LV			

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36	<p><i>Please write your comments & the authority(ies) who promulgated the regulations/guidelines:</i></p> <p>Czech Republic: State Office for Nuclear Safety (Act No. 18/97, Atomic Act" and Decree No. 184/97). <u>Reference levels</u> (^{226}Ra Bq/kg) for building materials: <u>Enforced levels</u>; materials for buildings where people could stay more than 1000 h/y - 150-200 Bq/kg (according to the type of material), materials for other buildings - 1000 Bq/kg, <u>Advisory levels</u>; where people stay more than 1000 h/y - 80-120 Bq/kg, materials for other buildings - 300-500 Bq/kg.</p> <p>Estonia is planning to introduce a gamma-activity index, <1. Latvia has the following regulations: 1) for living building internal material: $(A_{\text{Ra}} + A_{\text{Th}})/170$ less or equal to 1 and Activity of ^{40}K does not exceed 1500 Bq/kg; 2) for industrial buildings, living houses external and roads within towns and cities $(A_{\text{Ra}} + A_{\text{Th}})/250 < 1$ and Activity of ^{40}K does not exceed 2000 Bq/kg; 3) for industrial buildings external and similar and roads outside populated areas $(A_{\text{Ra}} + A_{\text{Th}})/300 < 1$ and Activity of ^{40}K does not exceed 2500 Bq/kg. Lithuania has regulations that materials used shall cope with the formula for Activity in Building Materials; $A_{\text{Ra}}/300 + A_{\text{Th}}/200 + A_{\text{K}}/3000 = <1$ for all building materials, $A_{\text{Ra}}/700 + A_{\text{Th}}/500 + A_{\text{K}}/8000 + A_{\text{Cs}}/2000 = <1$ for building materials used outside (streets, roads, etc.), $A_{\text{Ra}}/2000 + A_{\text{Th}}/1500 + A_{\text{K}}/20000 + A_{\text{Cs}}/5000 = <1$ for landscaping (they should be covered with building materials with lower extent of radionuclides). Norway: has advisory limits for contents of radioactive elements in building materials. $^{226}\text{Ra}/300 \text{ Bq/kg} + ^{232}\text{Th}/200 + ^{40}\text{K}/3000 \text{ Bq/kg} < 1$. $^{226}\text{Ra} < 200 \text{ Bq/kg}$. Poland: the permissible levels are determined by the following formula $0.0027 C_{\text{Ra}} + 0.0043 C_{\text{Th}} + 0.0027 C_{\text{K}} < 1$. C in Bq/kg. $C_{\text{Ra}} < 185$. Russia: Goscomsanepidnadszor issues the regulations, Radiation Safety Standards NRB-96. Building materials shall cope with the formula for activity concentration of building materials: $A_{\text{ff}} = A_{\text{Ra}} + 1.31 A_{\text{Th}} + 0.085 A_{\text{K}}$. Where A_{Ra} is the activity concentration of ^{226}Ra, A_{Th} of ^{232}Th and A_{K} of ^{40}K in Bq/kg. The limits are for new buildings 370 Bq/kg, for industrial constructions, roads in towns and villages 740 Bq/kg, for roads outside occupied areas 2.8 kBq/kg. Slovak Republic: the use of building materials with higher radium content can be permitted if it has negligible mass fraction, and unless $C_{\text{Ra}} + 1.25 C_{\text{Th}} + 0.086 C_{\text{K}} > 370 \text{ Bq/kg}$. Republic of Slovenia: the limits are expressed as: Gamma-activity index, $C_{\text{Ra}}/400 + C_{\text{Th}}/300 + C_{\text{K}}/5000 + C_{\text{artif}}/4000 < 1$. C in Bq/kg.</p>
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5. PLANNING, CONSTRUCTION

No	Questions	Answers				
		Yes	No	We shall		
37	Do you have regulations guidelines for construction requirements to prevent radon in new buildings?	4 CZ, LV, NO, SK	12 AL, BY, HR, EE, HU, LT, PO, RO, SI, CH, TR, YU	1 CH		
38	What is the status of these regulations/guidelines?	Enforced	Advisory	None at present		
		3 CZ, LV, SK	1 NO	12 AL, BY, HR, EE, HU, LT, PO, RO, SI, CH, TR, YU		
39	Who is responsible for their implementations/ supervision ?	Govern- ment/Ministry/Board/ Department	Municipality	District	Construction Companies	Other?
		5	2 (1)	1 (1)	3 (1)	
40	Please write your comments & the authority(yes) that promulgated the regulations/guidelines: Belarus: Ministry of Health. Czech Republic. Act No 18/97. Atomic Act and Decree No 184/97. National standard CSN 730601: Protection of buildings against radon from the soil. There are guidance levels for: 1) Radon risk classification of foundation soils (preventive measures. 2) Radon concentration in new building, EEC = 100 Bq/m ³ . In connections with the new Czech Building Act (July 1998) there were performed a change in the Atomic Act: Preventive radon protection measures must be carried out, if the building site is not at a low radon risk area. Local building offices are the supervisors. (Low risk area is defined by decree 184/98 and based on measurements of radon in soil gas and soil permeability.) Latvia: In the regulations (see question 6) it is written that all involved parties are responsible for keeping the 300 Bq/m ³ limit. Slovak Republic: See question 6.					
41	Are there regulations/guidelines for the protection of radon in general & detailed planning as in construction permits for: domestic buildings, offices and factories ?	Yes	No	Are in plan		
		3 CZ, NO, SK	13 AL, BY, HR, EE, HU, LV, LT, PO, RO, SI, CH, TR, YU	1 SI		
42	Name the authority that promulgated the regulations/guidelines? Czech Republic: State Office for Nuclear Safety, Local building Offices. Norway: Statens bygningstekniske etat och Norges byggforskningsinstitut. Slovak Republic: Guidelines promulgated by the Ministry of Building.					
43	What is the status of the regulations/guidelines?	Enforced	Advisory	None at present		
			3 CZ, NO, SK	13 AL, BY, HR, EE, HU, LT, PO, RO, SI, CH, TR, YU		
44	Do the regulations/guidelines imply/signify a requirement for examining the presence of radon in construction sites for new buildings?	Yes	No	We shall		
		2 CZ, SK	14 AL, BY, HR, EE, HU, LV, LT, NO, PO, RO, SI, CH, TR, YU	1 YU		
45	Have you mapped/surveyed the radon prone/risk areas in your country?	4 CZ, NO, SK, CH	12 AL, BY, HR, EE, HU, LV, LT, PO, RO, SI, TR, YU	1 YU		
46	Please write your comments & the authority(yes) that promulgated the regulations/guidelines: Czech Republic: State Office for Nuclear Safety, Ministry for Regional Development, Local Building Offices. Latvia. According to State Municipality Order the Radiation and Nuclear Safety Inspectorate, Health Centers and certified institutions are responsible for findings and investigations of potentially hazardous areas.					
47	Feel free to give an overall comment or your concluding remarks:					

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QUESTIONNAIRE ON RADON-LEGISLATION IN DIFFERENT COUNTRIES

Answers from: Australia (AU), Canada (CA), Israel (IL), Japan (JP), Syria (SY), U.S.A. (US)

Please give your answers by writing in the space provided following the question number. You can use your own space, if you need to. But remember to correspond your answer to the correct question-number.

Feel free to send us only the answers, if you find it more convenient for you!

1. DWELLINGS (Existing & New)

No	Questions	Answers									
		Private Homes		State/Municipality owned		Cooperative owned		Rented		Other what?	
		Yes AU, CA, IL, SY, US	No JP	Yes AU, CA, IL, SY, US	No JP	Yes AU, CA, IL, SY, US	No JP	Yes AU, CA, IL, SY, US	No JP	Y es	N o
1	Does your country have a reference level for radon for:										
2	Which reference levels for radon are applied in existing dwellings at present, Bq/m ³ (radon gas)? (a) Enforced	200 IL		200 IL		200 IL		200 IL			
	(b) Advisory	200 AU 800 CA 200 IL 200 SY 150 US		200 AU 800 CA 200 IL 200 SY 150 US		200 AU 800 CA 200 IL 200 SY 150 US		200 AU 800 CA 200 IL 200 SY 150 US			
3	Which reference levels for radon are applied in new dwellings at present? Bq/m ³ (radon gas)? (a) Enforced	200 IL		200 IL		200 IL		200 IL			
	(b) Advisory	200 AU 800 CA IL 200 SY 150 US		200 AU 800 CA IL 200 SY 150 US		200 AU 800 CA IL 200 SY 150 US		200 AU 800 CA IL 200 SY 150 US			
	(c) None at present										
4	<p>Comments: Australia: Single 200 Bq/m³ action level applicable to all Australian dwellings. Canada, guidelines: It is recommended that remedial measures be taken when the level of radon in a home is found to exceed 800 Bq/m³ as the annual average concentration in the normal living area. Because there is some risk at any level of exposure, home-owners may wish to reduce levels of radon as low as practicable. Approved by the Federal and Provincial Deputy Ministers of Health, December 1988. Japan: Radiation council in Japan is now in the progress of adapting ICRP 60. They are discussing reference levels for radon. U.S.A.: The U.S. Environmental Protection Agency suggests that any building 4 pCi/L (148 Bq/m³) or above be mitigated. This level is the same for homes, schools, workplaces, etc. There is no mandatory language, except at the State level for schools. Some states mandate just testing, others mandate the mitigation of classrooms with 4 pCi/L or above. In reality, enforcement of these regulations is lax. Funds are usually not sufficient.</p>										

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5	<i>Who implements/supervises radon regulations/guidelines in Dwellings?</i>	<i>Private Homes</i>		<i>State/Municipality owned</i>		<i>Cooperative owned</i>		<i>Rented</i>		<i>Other what?</i>
	<i>Government/Ministry/Board/Department</i>	<i>Yes</i> AU, CA, IL, SY	<i>No</i>	<i>Yes</i> AU, CA, IL, Y	<i>No</i>	<i>Yes</i> AU, CA, IL, SY	<i>No</i>	<i>Yes</i> AU, CA, IL, SY	<i>No</i>	
	<i>District</i>									
	<i>Municipality</i>									
	<i>Institution</i>									
	<i>Other:</i>									
6	<p><i>Comments:</i> Australia Guidelines are National/Federal. Implementation is State responsibility. Canada: Jurisdiction for natural radioactivity is a health responsibility of provincial governments. Syria: The regulations given out by the Atomic Energy Commission. Department of Radiation Protection. U.S.A.: Testing and mitigation of private homes is all voluntary in the U.S. Municipalities/States/Cities/Towns/Counties may have programs, which advocate testing/mitigation of homes, but no laws exist mandating such action. Individual Cities/States may have laws urging the disclosure of radon levels at the time of a sale of a home or even the testing of a home at the time of sale, but no mitigation is mandated. The radon program in the U.S. is considered to be largely voluntary.</p>									
7	<i>Should there be common reference levels for radon within EU?</i>	<i>Yes</i> IL		<i>No</i> JP, SY						
8	<p><i>Your comments:</i> Japan: Common reference levels could not be set up if we consider the economical aspects of implementation. Syria Only through IAEA regulations. U.S.A.: We would like to see a common level only if the level was at, below, or very near the U.S. action level of 4 pCi/L (148 Bq/m³). Otherwise, it is more helpful to have individual counties in the EU with different action levels above and below the U.S. level. Opponents of radon action in the U.S. often cite higher action levels of other countries as a reason not to take action in the U.S. about radon problems.</p>									
9	<i>Is your remedial measure financed by (more than one answer is possible):</i>	<i>Grants</i>	<i>Subsidies</i>	<i>Tax reduction</i>	<i>Other</i>	<i>None</i>	<i>Planned</i>			
		US ¹⁾	IL			AU, CA, SY, US ²⁾				
10	<p><i>Comments:</i> ¹⁾U.S.A.: A few demonstration projects have been given grants, such as poor housing on Indian tribal lands. ²⁾ Except schools</p>									
11	<i>Who administers the finances for remedial measures?</i>	<i>Grants</i>		<i>Subsidies</i>	<i>Tax reduction</i>	<i>Other</i>	<i>None</i>	<i>Planned</i>		
	<i>Government/Ministry/Board/Department</i>									
	<i>State</i>									
	<i>Institution</i>									
	<i>Municipality</i>			IL						
	<i>Other, what:</i>									

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12	<i>Comments:</i> Australia Minimal number of homes exceed action levels so remediation not presently an issue. Canada: Remedial measures are the responsibility of the property owner. There are no financial programs or subsidies for mitigation of radon levels in dwellings. U.S.A.: Except for school buildings, almost all mitigation is privately financed in the U.S.
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2. WORKPLACES

Answers from: **Australia (AU) Canada (CA), Israel (IL), Japan (JP), Syria (SY), U.S.A. (US)**

No	Question	Answers						
		Yes	No	We shall				
13	Do you have standards of Radon Protection in all Workplaces?	AU	CA, IL, JP, SY, US	SY				
14	Please write down the reference level you use for EXISTING workplaces? Bq/m ³ (radon gas) (a) Enforced	Schools	Day care homes	Private industry-offices	State-owned industry offices	Municipality owned offices	Other offices	Misc. under-ground workplaces except mines
		200 IL 150 US	200 IL			400 IL		
	(b) Advisory	1000 AU 200 SY*	1000 AU 200 SY*	1000 AU 400 IL 200 SY*	1000 AU 400 IL 200 SY*	1000 AU 200 SY*	1000 AU 400 IL 200 SY*	1000 AU
15	Please write down the level of reference you use for NEW workplaces? Bq/m ³ (radon gas) (a) Enforced				800 CA			
		(b) Advisory	1000 AU 40 IL 200 SY*	1000 AU 40 IL 200 SY*	1000 AU 200 IL 200 SY*	1000 AU 200 IL 200 SY*	1000 AU 200 SY*	1000 AU
	(c) None at present							
16	Please, describe any different classification standards you have: Australia Value is action level for intervention or application of radiation monitoring program.							
17	Who implements/supervises radon regulations in Workplaces?	Schools	Day care homes	Private industry-offices	State-owned industry offices	Municipality owned offices	Other offices	Misc. under-ground workplaces except mines
	A. Government/Ministry/Board/ Department	AU, CA, IL, SY	AU, CA, IL, SY	AU, CA, IL, SY	AU, CA, IL, SY	AU, CA, IL, SY	AU, CA, IL, SY	AU, CA, IL
	B. Municipality							
	C. District							
	D. Institution							
	E. Other							
18	Do you have protocols for the measurement of radon in Workplaces:	Yes	No	We shall				
		IL, SY	CA, JP					

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19	<i>Please write your comments & the authority(ies) who promulgated the regulations/guidelines:</i> Australia: State Government responsible for regulation of workplace exposure to radiation. Canada: Canada Labour Code. 26/6/96 Canada Gazette Part ii, Vol., 130, No. 13p. 2014. Registration SOR/96-294, 13 June 1996. Canada Labor Code, Canada. Occupational Safety and Health Regulations, amendment: 10.26 (4). No employee, other than an atomic radiation worker as defined in the Atomic Energy control Regulations, shall be exposed in the course of any year to a concentration of radon that on average, over a year, is higher than 800 Bq/m ³ . This regulation applies to place of business that comes under the jurisdiction of the federal Canada Labour Code. Syria: Atomic Energy Commission of Syria (planned levels).
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3. DRINKING WATER

No	Questions	Answers			
		Yes	No	We shall	
20	Do you have radon protection standard for drinking water?		AU, CA, IL, JP, SY, US	SY, US	
21	Please write down the reference level for radon your regulations specify, Bq/l: (a) Enforced	Public waters	Private Waters	Home owner's waters	Other
	(b) Advisory				
	(c) None at Present	CA, IL	CA, IL	IL	
22	Who implements/supervises radon regulations for drinking water?				
	A. Government/Ministry/Board/Department	IL	IL		
	B. Municipality				
	C. District				
	D. Institution				
	E. Other				
23	Do you make special checkups for water sources in uranium rich surroundings ?	Yes	No	We shall	
			AU, CA, IL, JP		
24	Have you classified the radon risks of the water-resource zones in your country? (Say: High/Sporadic/Low)		AU, CA, IL, JP, SY		
25	If you have your own classifications please name:		CA, IL, JP		
26	Do you have protocols for the analysis of radon in Drinking Water:		CA, IL, JP, SY		
27	Please write your comments & authority(yes) that promulgated the regulations: Canada: Guidelines for radionuclides in drinking water are published in "Guidelines for Canadian Drinking Water Quality" Sixth Edition, Health Canada publication. 96-EHD-1996. There is no guideline for radon in water. Syria: Atomic Energy Commission of Syria.				

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4. BUILDING MATERIALS

No	Questions	Answers							
		Yes	No	We shall					
28	Do you have radon protection standards for building materials?	IL, US	AU, CA, JP, SY						
29	Have you reference levels for: Contents of Radioactive Elements, Gamma Radiation, Beta Radiation & Radon Exhalation/Radon Flux?	IL	AU, JP, SY						
30	Status of reference levels?	Enforced	Advisory	None at present					
		IL							
31	Who implements/supervises radon regulations for building materials?	Government/ Ministry/Board/Department	Municipality	District	Construction Companies	Other?			
		IL							
32	Please write down the reference levels your regulations/guidelines specify for	Contents of radioactive elements		Gamma radiation		Beta radiation		Radon exhalation/ radon flux	
		Yes IL	No CA	Yes IL	No CA	Yes	No CA, IL	Yes IL	No CA
33	Do you make special checkups for building materials to be used for public buildings?	Yes	No	We shall					
		IL	AU, CA, JP, SY						
34	Do you have your own classifications ?	IL	AU, CA, JP, SY		If yes, name				
35	Do you have protocols for the investigation of radioactivity in Building Materials ?	IL	AU, CA, JP, SY						
36	Please write your comments & the authority(yes) who promulgated the regulations/guidelines: Israel : Limits for radioactive elements in building materials. ²²⁶ Ra 50 Bq/kg, ²³² Th 50 Bq/kg, ⁴⁰ K 500 Bq/kg, for gamma radiation 0.7 mSv/y, radon exhalation 1 Bq m ⁻² h. We need urgently a calibration system for radon exhalation from building materials. Japan : In Japan, there is no regulation for building materials. However, gypsum board industry is aware of the radon problems. They have tried to reduce radon exhalation from gypsum boards by selecting low radium content phosphate gypsum for the production of phosphate and mixing with natural gypsum in the process of board production.								

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5. PLANNING, CONSTRUCTION

No	Questions	Answers				
		Yes	No	We shall		
37	Do you have regulations guidelines for construction requirements to prevent radon in new buildings?	IL, US	AU, CA ¹⁾ , JP, SY	SY		
38	What is the status of these regulations/guidelines?	Enforced	Advisory	None at present		
		US	CA, IL, US	SY		
39	Who is responsible for their implementations/ supervision ?	Government/Ministry/Board/Department	Municipality	District	Construction companies	Other?
		IL, SY, US	US			CA
40	Please write your comments & the authority(yes) that promulgated the regulations/guidelines: Canada: Remedial guidelines published by Canada Mortgage and Housing Cooperation/Health Canada in the publication entitled "Radon. A guide for Canadian homeowners", 1997. Japan: Until recently Japan had a regulation that each house should have a crawl space to prevent moisture problems. However, the regulation is not valid now and more over private wooden house can have basement now. This may create radon problems in the future. Syria: Atomic Energy Commission of Syria. U.S.A.: In the U.S., building codes are developed by membership consensus organizations that continually have hearings to update their documents. States and other jurisdictions base their local building codes on these documents. The States and other jurisdictions make the codes the law and then enforce them through a permitting/inspection process. There are also <u>Model Standards and Techniques for the Control of Radon In New Residential Buildings</u> , published by the EPA in 1994, which are used as a basis for construction guidelines.					
41	Are there regulations/guidelines for the protection of radon in general & detailed planning as in construction permits for: domestic buildings, offices and factories?	Yes	No	Are in plan		
		IL, US	AU, CA, JP, SY	SY		
42	Name the authority that promulgated the regulations/guidelines? Israel: Ministry of Environment, Radiation Safety Division. U.S.A.: Three of 50 States have such laws, along with about 40 other cities/counties/towns. Most of the U.S. does not have such regulations/guidelines mandated					
43	What is the status of the regulations/guidelines?	Enforced	Advisory	None at present		
				CA, SY		
44	Do the regulations/guidelines imply/signify a requirement for examining the presence of radon in construction sites for new buildings?	Yes	No	We shall		
		IL	AU, CA, SY, US	SY		
45	Have you mapped/surveyed the radon prone/risk areas in your country?	AU, IL, JP, US	CA			
46	Please write your comments & the authority(yes) that promulgated the regulations/guidelines: Israel: Ministry of Environment, Radiation Safety Division. Japan: We carried out nation wide surveys twice in Japan. The first one was for about 7,000 houses and the second one for 940 houses. No radon prone area was found. Only .4 percent of the measured houses have radon concentrations more than 150 Bq/m ³ . Syria: Atomic Energy Commission of Syria. U.S.A.: There is no testing requirement for new residential buildings, if the construction follows the guidelines. It is up to the homeowner to test the home for radon to make sure the construction process worked to reduce the radon in the home. If not, it is up to the homeowner to decide whether or not to mitigate, and the homeowner must finance the mitigation. We have an excellent map, which designates each of our 3141 counties in the U.S. at high, medium or low radon potential. This is a helpful tool for us to target our resources to the most radon-prone areas.					

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47	<i>Feel free to give an overall comment or your concluding remarks:</i> Israel: The building materials as Radon Source is the most complicated problem to be solved. U.S.A.: With the recent release of the National Academy of Sciences' BEIR VI report, which concluded that 15,000-22,000 deaths are radon-induced, we may be able to promote the promulgation of more regulations about radon at the local/State level. However, the political climate right now probably precludes federal regulations.
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SSI-rapporter 1999

SSI reports 1999

99:01 Publikationer 1998

Statens strålskyddsinstitut

99:02 SSI:s projekt avseende avveckling av kärntekniska anläggningar – en förstudie

Avdelningen för avfall och miljö, Avdelningen för personal- och patientstrålskydd, Administrativa staben. Henrik Efraimsson, Hans Ehdwall, Thommy Godås, Peter Hofvander, John-Christer Lindhé, Juha Lumpus, Ingemar Lund, Lars Malmqvist, Erik Welleman 50 SEK

99:03 Föreskrifter om skydd av människors hälsa och miljön vid slutligt omhändertagande av använt kärnbränsle och kärnavfall -bakgrund och kommentarer

Avdelningen för avfall och miljö

99:04 Calibration in Medical Diagnostic Beams at the Swedish Secondary Standard Dosimetry Laboratory

Avdelningen för miljöövervakning och mätning. Jan-Erik Kyllönen and Jan-Erik Grindborg 30 SEK

99:05 Long-term funding and faithfulness to the original goal

Department of Waste and Environmental Protection Gabriella Sjögren

99:06 Personalstrålskydd inom kärnkraftindustrin

Avdelningen för personal- och patientstrålskydd Ann-Christin Hägg, Thommy Godås, Lars Malmquist, Peter Hovander, Ingemar Lund och Erik Welleman 50 SEK

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