

ITALIAN SURVEY TO EVALUATE THE AVERAGE EFFECTIVE DOSE EQUIVALENT DUE TO RADON INDOORS

S.Benassai(o), G.Campos Venuti(*), G.Farchi(*), S.Mancioppi(o),
S.Mariotti(*), S. Piermattei(o), S.Risica(*), L.Tommasino(o)

(*) Physics Laboratory, Istituto Superiore di Sanita', Roma, Italy
(o) ENEA-DISP, Roma, Italy

1. Introduction

A more stringent control of the radioactivity either from artificial and natural sources has been requested in Italy by the public opinion after the Chernobyl accident. The competent Authorities and the radiation protection Community are making continuous efforts to fulfill such a request in the most suitable and appropriate ways. The person related environmental monitoring system - existing since the middle fifties - is being improved to face large scale contamination. Environmental monitoring at regional level ("Regione" is an administrative district), is being set up (1).

The control of the radioactivity in the environment was mainly focused on artificial sources; as far as natural radioactivity is concerned no regular surveys were carried out, except in some cases of occupational exposures. Extensive research work was, however, performed to develop suitable radon monitoring devices and the range of radon levels indoors and outdoors have been investigated throughout the country and locally (2,3,4). Considering the radiological relevance of the radon problem (5,6) it was deemed that the exposure of the population due to natural sources of radiation indoors deserves particular attention.

2. Project of the Italian survey on radon indoors.

The knowledge of the average Equilibrium Equivalent Radon concentration existing in dwellings is the first parameter needed to plan whatever action aimed at preventing and/or reducing the exposure to radon. A two step survey has been therefore planned in our country with two different purposes: a) to evaluate the average effective dose equivalent due to radon indoors and b) to identify areas where the radon concentration levels indoors are considerably higher than the average. In these places measurements shall be carried out in a systematic way.

The first step of the survey will permit the evaluation of the average risk associated with radon exposure and the comparison of the radon risk with other sources of domestic risks. In such a way the competent Authorities will be enabled to choose their policy in the field. A comparative study of all the pollutants existing indoors (organic and inorganic compounds, mineral fibres and particles) is, in principle, the correct policy approach. The study should allow to evaluate the social and economical impact due to the indoors pollutants in its entirety. The degree of knowledge in the case of radon is better than in the case of other pollutants, from the point of view either of the detection techniques and of the evaluation of the health effects. Therefore it is considered advisable to limit the survey to the radon indoors.

The second step will allow to select hot spots of radon concentrations and will be the starting point for future actions. The environmental laboratories at regional level will play an important role in this type of survey as far as the measurements are concerned and will operate according to guidelines and procedures established at national level.

3. Statistical criteria to select a sample of dwellings at national level

Keeping in mind the above considerations a sampling technique has been implemented for evaluating the average effective dose equivalent due to radon indoors.

The selection of a sample of dwellings which can be considered representative of the Italian situation is limited by the availability of manpower and economical resources. A sample of 5000 dwellings distributed in about 200 different towns (i.e., the smallest administrative units) was considered a reasonable compromise between cost and representativeness. A two-stage sampling technique is used. The parameters examined to stratify the samples are:

- 1) geolithology of soil, rather well known and showing concentration of natural radioactive materials in a wide range of values;
- 2) building materials, which in some cases play an important role for the radon concentration;
- 3) climate conditions, which influence the way of life indoors;
- 4) floor, where the flat is located in a multifamily house, being the radon concentration indoors dependent on the height from the ground.

The Italian territory is divided into seven areas homogeneous in the respect to the geolithology. The cooperation of the Rome University, Department of Earth Science, is acknowledged in performing such division. Interference between geological areas and the administrative units created operational difficulties preventing the use of geolithology as stratification parameter. Correlations "a posteriori" will be performed between the geolithological areas and the radon indoors concentration. For building materials no satisfactory information exist at national level.

Starting from these considerations, in the first stage the administrative units are chosen and in the second stage the dwellings are singled out. The first stage of the sample is stratified according to a geographycal criterion (five zones are selected) and to the population density (six classes are considered appropriately weighted). In the second stage the strata are chosen according to the age of construction (before 1919; 1919-1945, after 1945) and to the floor where the flat is located (ground floor, first floor, over). The choice of the dwellings within each stratum is at random.

The selection of the sample is made with the help of the Istituto Centrale di Statistica using the data of a general census carried out in 1981.

4. Operational problems

To carry out the survey several economical, political and organizational problems have to be solved. First of all, to avoid undue and dangerous alarm, a public information campaign shall be carried out directed both to the general public and to health and administrative authorities involved. Transparency should be maintained in performing the survey and it is also important to avoid any type of economical speculation - the spread of private firms performing radon measurements do not give any sound contribution to the knowledge of the problem.

The training of the personnel responsible for the distribution of the dosimeters is matter of great importance. No postal distribution is foreseen as the door to door approach is considered having the largest probability of success. The personnel shall be able to satisfy the questions posed by the inhabitants on the scope of the survey, its significance, etc. Particular attention will be required in preparing a questionnaire to be filled when the dosimeters will be distributed. The questionnaire has to contain the information useful to correlate the experimental measurements with those parameters related with the indoor radon concentrations, such as heating system, source of waters, etc. To evaluate the average effective dose equivalent, other information on the inhabitants, their habits, distribution of ages, shall be collected.

5. Experimental set up

A national large survey as that just outlined requires the development of a radon monitor device simple, sensitive, compact and inexpensive. The detector consists of a heat-sealed polyethylene bag enclosing two track etching detectors (cfr.4). The inside of the device is completely transparent and this is particularly important for psychological reasons.

One detector is a piece of LR-115: the tracks can be counted by the spark counter after the chemical etching. The response of the detector saturates at about 3500 Bq/m^3 in 6 months. The other detectors is CR-39 and is used as back up dosimeter. It is chemically etched and can be counted by image analysis or by a microscope. The dosimeters have been extensively used for indoor and outdoor measurements.

TLD-dosimeters will be used to measure gamma ray components. Both the radon and gamma ray dosimeters were calibrated at international level.

Intercomparison exercises will be also planned between the laboratories which will take part into the survey.

6. Conclusion

The experience gained in the preliminary surveys (2, 3) allows to say that the average radon indoor concentrations will range around $20 - 50 \text{ Bq/m}^3$, of the same order of magnitude of those detec-

ted in other European Community Countries. Nevertheless there are sound reasons to presume there will be locations where these levels can be exceeded by an order of magnitude.

It is clear that before undertaking whatever action, the extent of the problem shall be evaluated with a certain degree of confidence. It is also clear that the principles given by ICRP in its Publication n.39 for limiting the exposure of the general public should followed; as far as the possible actions are concerned, the distinction between existing and future housing is of paramount importance. Attempts should be made to set up a range of action levels in the first case and of upper bounds in the second one. In order to prevent confusion and negative effects on the public opinion it should be avoided that at least in the European Community countries different limits be set in Member States.

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