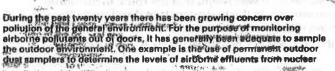
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Assessment of dose from indoor pollutants

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installations. It is difficult to imagine how levels of such pollutarits would not be appreciably lower lifefore; continuous index monitoring of them has therefore, and peen deemed necessary.

It was inevitable, electures, that attention would eventually turn towards pollution indoors since this is where persons spend most of their times indoor pollution the now a topic in its own right and is being considered by such as dies at the Royal Commission on Environmental Pollution and the membranet Commission of Radiological Protection. A miniber of instrumental conferences with also manned which will be devoted entirely to this topic.

Concern has been increased by a more general awareness that pollutents produced indepers tend to linger indoors. Some of the commonly-mentioned pollutents are formaldefive from chilpboard, exides of nitrogen and cerbon from cooking, sincke from clearettes, and redon. The "Saye it" competer of the 1970s emphasised the financial benefits of conserving energy, and this has led to reduced ventilation release the many homes and offices with consequent enhancement of levels of indoor pollutents.

It is simply not adequate just to take grab samples of airborne pollutants indoors to estimate the integrated exposure from them! exposure depends on the levels that exist during the period of occupancy. The ideal arrangement would be to determine personal exposures with some form of personal monitor, but such air angements are generally impracticable or unworkable.

Assessment of exposure to indoor pollutants must therefore involve measurements of the environment, but additional data will then be needed to relete the measured rebuits firsome Way to numer dose. The assessment of one such pollutant, redon, is being undertaken in this memor.

In the national survey of natural radiation indoors in the home," the long-term average concentrations of fadon are being measured by passive detectorals avolutions in the home; the living area and badrants. The concentration of the radion gas is largely determined by the ventilation rate, which in the large of the radion gas is largely determined by the ventilation rate, which in the large of the determined by the values of a number of parameters peculiar to each house any room and the preferences of the occupants with regard to yondow and door-opening, and the use of open lines at its also determined by the guitdoor radion concentration and strice this varies dispinally, by the period of day, when the room is recorded. At any given time, it is further influenced by the prevailing atmospheric conditions. The concentration of the decay broducts of radion, which is the parameter of real interest, is, of course, superiod on the state of equilibrium of the dacky products that place out at the course superiods.

The occupants is determined by their occupants in the read of decay product acrosol. The breathing rate is determined by the scrivities of the occupants, and the characteristics of the acrosol are once again influenced by the ventilation rate. Since the ventilation rate and occupancy

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habits seem to be such important factors in assessing exposure to any indoor pollutant, and not only radon, they are discussed in the remainder the comment of the same of the same of this paper. the second of the property of the property of the

ort. The Marie Last Ventilation rate

Some information on window-opening habits is available from the works with the of Brundrett(2). The number of open windows is strongly influenced by the weather, with external moisture being the strongest influence in winter, ... and mean temperature in summer, It was found that the room in the home most likely to have an open window is the badroom, that dwellings where with the the housewife is at home are more likely to have at least one open window; ""......" and that houses with larger families are also more likely to have a window trends in dialet in our or well afrance & countries? open.

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Relatively little data are available on personal habits with respect to the opening of internal doors. A pilot study by the Building Research Establishment(3) revealed that about 34% of the persons in the sample usually kept their living room, bathroom and second and third bedroom doors open. Some 50% usually kept their main bedroom doors open. Answers by members of Board staff to questions on this topic are the street A summarised in Table 1. The values given are averages for summer and suggestion winter. There is a noticeable decrease in the percentage of obeh windows in the percentage of obeh windows and internal doors during the night: a miss to see the miss from made in your

It is very difficult to discover what persons habits are with regard to the average opening and closing of windows and internal doors. Respondents tend to relate their answers either to their actions on the day of the inquiry (termed the availability heuristic by social researchers) or to their actions in hot or cold weather, leaving the researcher to decide which is the norm. An attempt has been made to overcome this difficulty in the questionnaire now in the being used in the Board's national survey of indoor natural radiation(11). 10 238 Participants are being asked to describe their habits during the 24 hours continued immediately prior to completing the questionnaire. The 24 hours have been announce the cert stables on a granulation

Window and internal door opening habits in 130 dwellings we wastered

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| Room | 14,51 | Windows P | | Internal doors | |
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| Bedroom | 131. 1. | | orth tieran | 63, | 42, |

sub-divided into three categories: yesterday morning and afternoon, yesterday evening, last night. This breakdown is also used to discover the type of heating used in the home during the same period. Since the issue of the questionnaire to 2000 households is extended over more than twelve months, this method should produce a good indication of national habits; and enable an estimate to be made of the prevailing ventilation rate and of the radon decay product concentrations.

Occupancy habits

To date, a value of 90% indoor occupancy has been used in various calculations of radiation exposure in the United Kingdom; this figure derives from the work on weapons fallout in the 1950s⁽⁴⁾. The United Nations Scientific Committee on the Effects of Atomic Radiation⁽⁵⁾ uses a value of 80% for the worldwide average percentage of time spent indoors. Neither source breaks down its overall value into the time spent indoors in the home and the time spent in other indoor places such as offices, factories, shops and schools. Such a distinction would be necessary if the indoor pollution levels were substantially different between such places.

A study of available survey data was undertaken to derive more detailed occupancy factors and this is being published elsewhere⁽⁶⁾. Information was obtained for the whole population and for certain groups in the population, such as housewives and retired persons, who spend more time than usual in the home. On average, the inhabitants of the United Kingdom spend 75% of their time indoors at home with a further 15% spent in other indoor locations, thus confirming the earlier overall estimate. Total occupancy of the home varies more between weekdays and weekends than between winter and summer.

Individual patterns of occupancy within the home and the related activities are, of course, dependent on factors such as sex, age and family composition. On average, however, persons spend 41% of their time indoors sleeping or resting, 19% on leisure activities, and 15% on other activities. It is, of course, reasonable to assume that the time spent sleeping or resting mainly occurs in the bedroom. Leisure activities (watching television and feading) are likely to take place in the living area, and the remaining time indoors is spent in various locations throughout the house. Occupancy of each room also varies with the time of day. The living area and bedroom are no doubt intermittently occupied throughout the day but they are likely to become the main occupied rooms during the evening and night.

Conclusions

These refined estimates of occupancy, with subsequent data on variables affecting the ventilation rate, will be used to refine the present estimate of exposure to radon decay products⁽⁷⁾ when the complete results from the national survey of indoor exposure become available⁽¹⁾. Such information should have wider applicability in radiation protection, for instance, in

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assessing the potential impact of accidental releases to the atmosphere in the nuclear power industry. It may also have wider applicability to indoor pollutants in general.

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