Measurement of Radon in the Workplace and Estimation of the Risk of Lung Cancer

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Personal Details
After finishing my Diploma in Applied Science I decided to continue my studies by enrolling in the Physics & Physics Technology Degree course. My academic interests are mainly in areas such as renewable power systems and environmental science. Next year I am hoping to take a year out to be a volunteer in either South America or India and on my return complete my studies in Newcastle University. My hobbies include travelling, swimming, football, films and camping.

Project Summary
My final year project focused on the measurement of radon concentrations and the assessment of the risk posed by exposure to radon in the workplace. The basic idea of the project was that 50 radon detectors were placed in the Mid Western and Southern Health Boards by a final year Environmental health student.

The detectors were then returned to the Radiological Protection Institute of Ireland (RPII) and the radon concentrations calculated using Electronic Imaging Techniques. The concentrations calculated by the RPII were then compared to those obtained using manual counting techniques carried out in the School of Physics Laboratory at DIT (see figure 1).

The manual counting of the concentrations provided several insights into the process involved in radon detection using the CR-39 detector. One key observation was that the raw experimental data follows a Poisson distribution as seen in figure 2. This allowed for the calculation of the uncertainties present in the measurements obtained using the manual system. The results of the manual counting were then compared to the results obtained using the automatic system. The results shown in figure 3 indicate that the results are in good agreement.

Most radon measurement laboratories typically quote uncertainties in their measurements that are in excess of those calculated using the manual system. These lead to the overall conclusion that the major uncertainties present in radon measurements are not due to the counting procedures used in the processing of detectors. The uncertainties originate more from lack of precision in the handling/processing of the detectors. These include factors such as lack of compensation for the radon exposure during the time spent in transit between the workplace and the measurement service provider, bad quality control practices.

The second part of the experiment focused on the assessment of the risk posed by exposure to radon in the workplace. This involved understanding the data and models developed by international agencies such as the International Commission on Radiation Protection (ICRP).

Using the risk estimates calculated by the ICRP, it is estimated that roughly 48 people per year die in the Republic of Ireland from terminal lung cancer due to exposure to radon in the workplace. The estimate was based on the overall working...
population and the average radon level for Ireland of 77 Bq m$^{-3}$.

The figure seems alarmingly high but in reality the true figure for the number of deaths due to radon exposure in the workplace may be far higher. It is possible that many workers are exposed to a level that is far in excess of the average radon level. The measurements taken in the health boards showed that nearly 50% of workplaces measured had radon levels above the national average. If this trend was repeated in workplaces across the country then the total number of deaths due to radon would be much higher than 48 per year.

Irish legislation demands that employers must ensure that the radon concentration on their premises is below the reference limit of 400 Bq m$^{-3}$. Workers who are exposed to the reference level for their entire working life stand a one in 180 chance of developing lung cancer.

However, this report demonstrates that in Ireland 48 people per year may develop lung cancer from concentrations far below the reference limit.

The measurements taken in the Health Board premises indicate that overall there will be very few workplaces above the reference limit. This indicates that current government legislation will not be able to significantly reduce the number of people who may die from radon exposure in the workplace. The vast majority of people who will develop lung cancer from radon exposure will do so in workplaces that are below the reference limit.

The results of the measurements in the Health Boards show that in one workplace the measured radon concentration was above that stipulated by the Ionising Radiation Act, 1991. The actions based on this measurement are that the employer has been written to by the RPII indicating that the workplace is over the reference limit. The RPII will conduct further testing to confirm that the radon concentration is above the reference limit.

If the results of the second set of measurements confirm that the radon concentration is above the reference limit then the employer must take action to reduce the radon level. Failure to lower the radon level could lead to legal action.