

# **The New Concept Regarding The Monitoring Of Occupational Exposure Due To Radon And Radon Decay Products At Workplaces In Water Works In Germany**

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With the exception of the regulations valid for the territory of the former GDR, exposure of humans due to natural radiation sources has up to now not been regulated by law in Germany. The Directive 96/29/Euratom of the Council of the European Communities required for the member states, among others, the protection against exposure due to natural radiation sources for works correspondingly classified. In 2001 Germany has implemented this requirement through the amending of the Radiation Protection Ordinance (StrlSchV). In future natural radiation exposures that may occur in certain fields of work will be monitored as well. These new fields of work also include the workplaces in water works.

## **New legal provisions**

Since the possibility of enhanced radiation exposure due to natural sources varies a lot at different works the legislator has defined so-called "fields of work" where radiation exposure due to natural radioactivity has to be monitored. Due to the aforementioned situation the new Radiation Protection Ordinance also assigns water works to these fields of work. Water works include all facilities for water winning, purification and distribution, e.g. filter devices or elevated reservoirs, but also the neighbouring working areas.

The new Radiation Protection Ordinance provides for a step-wise concept for the protection of employees against enhanced radiation exposures due to the inhaling of radon containing air (see flow diagram). In the first step the water works have to estimate the possible radon exposure at their workplaces. Since the radon concentrations in the companies cannot be prognosticated measurements in the indoor air of the water works are required. If these estimations result in the possibility of enhanced radiation exposure it has to be checked if remediation measures can be possibly taken in a second step. The involving of the employees in radiation protection monitoring depends on the success of these measures.

## **Consequences for the water work works as employers**

According to the new Radiation Protection Ordinance it is the duty of the employer to carry out an estimation of the radon exposure to be expected at his workplaces. Workplace means here works to be performed by one person, even if these works are carried out at different places of work. If the employer had had radon measurements or

other appropriate measures carried out earlier, their results may possibly be used for the estimation.

As a rule, measurements for an estimation of radon exposure have to be performed only once. In most cases, radon exposure is measured with so-called radon-exposimeters which the employees have to wear over a certain period of time at work. The employer may give order to a measuring centre to carry out the measurements. The number of radon-exposimeters to be requested is equal to the number of different workplaces plus one reference exposimeter ("blank value"). This means that for several persons with the same tasks/the same work profile radon exposure has to be determined with the help of a radon-exposimeter only by one person. On request of the employers the exposimeters are delivered by measuring centres and are evaluated there, too. The employer then gets a test certificate showing the radon exposure. He can use this test certificate as proof of the fulfilment of his duties towards the regulatory authority.

If the determined radon exposure is so low that the intervention level of  $2 \times 10^6 \text{ Bqh/m}^3$  is fallen below during the calendar year, the employer does generally not have to take further steps, if it is not possible to decrease the radon exposure further with appropriate measures (requirement of minimisation). He has, however, to perform this estimation again if a workplace is essentially modified which could lead to enhanced radon exposure of the employees. Besides structural changes, essential modifications can also mean organisational modifications leading, for example, to modified duration of stay at specific places of the employees.

If the result of this estimation is that the intervention level of  $2 \times 10^6 \text{ Bqh/m}^3$  during the calendar year is exceeded, the employer has to perform remediation measures to decrease the radon exposure.

Possible measures include, for example, an improved ventilation of the affected rooms or a sealing of the radon sources like water storage tanks and treatment rooms against the other working areas.

Measurements within the scope of remediation measures do not refer to persons but to rooms. Since in most cases only some rooms of a water work contribute significantly to the radon exposure of the employees, these rooms have at first be localised with the help of radon concentration measurements. To elaborate a remediation concept a private or official measuring institute should be contacted. The success of these remediation measures has then to be documented with further radon exposure measurements.

Another possible method to decrease the exposure is to reduce the employees' duration of stay in rooms with enhanced radon concentrations. It will, however, possibly be difficult to monitor this organisational measure.

These examples show that in the case of the intervention level of  $2 \times 10^6 \text{ Bqh/m}^3$  during the calendar year being exceeded, remediation measures are the most important method, since they make a further radiation protection monitoring of the personnel

unnecessary and simultaneously decrease the risk of further health damages for the employees.

The employer must guarantee through further regular personal measurements that none of his employees exceeds the radon exposure limit of  $2 \times 10^6 \text{Bq/m}^3$  during the calendar year. Furthermore, these employees have to be examined by a physician once per calendar year in future. Additionally, the employer has, among others, to report regularly the measured radon exposure values of his employees to the responsible authority, so that their names can be entered into the Radiation Protection Register.

Measurements for the radiation protection monitoring of the personnel are continuous personal measurements with radon exosimeters. Corresponding order to perform these measurements has to be given to a measuring centre chosen by the authority.

### **Works on behalf of the water works**

The aforementioned regulations regarding the estimating and monitoring of radon exposure also apply to companies whose members carry out ordered works in water works. This concerns particularly companies regularly or frequently performing works like, for instance, container cleanings. These works may involve very long duration of stay and very high radon concentrations. Members of these companies must in future have radiation passports into which the respective exposures are entered.

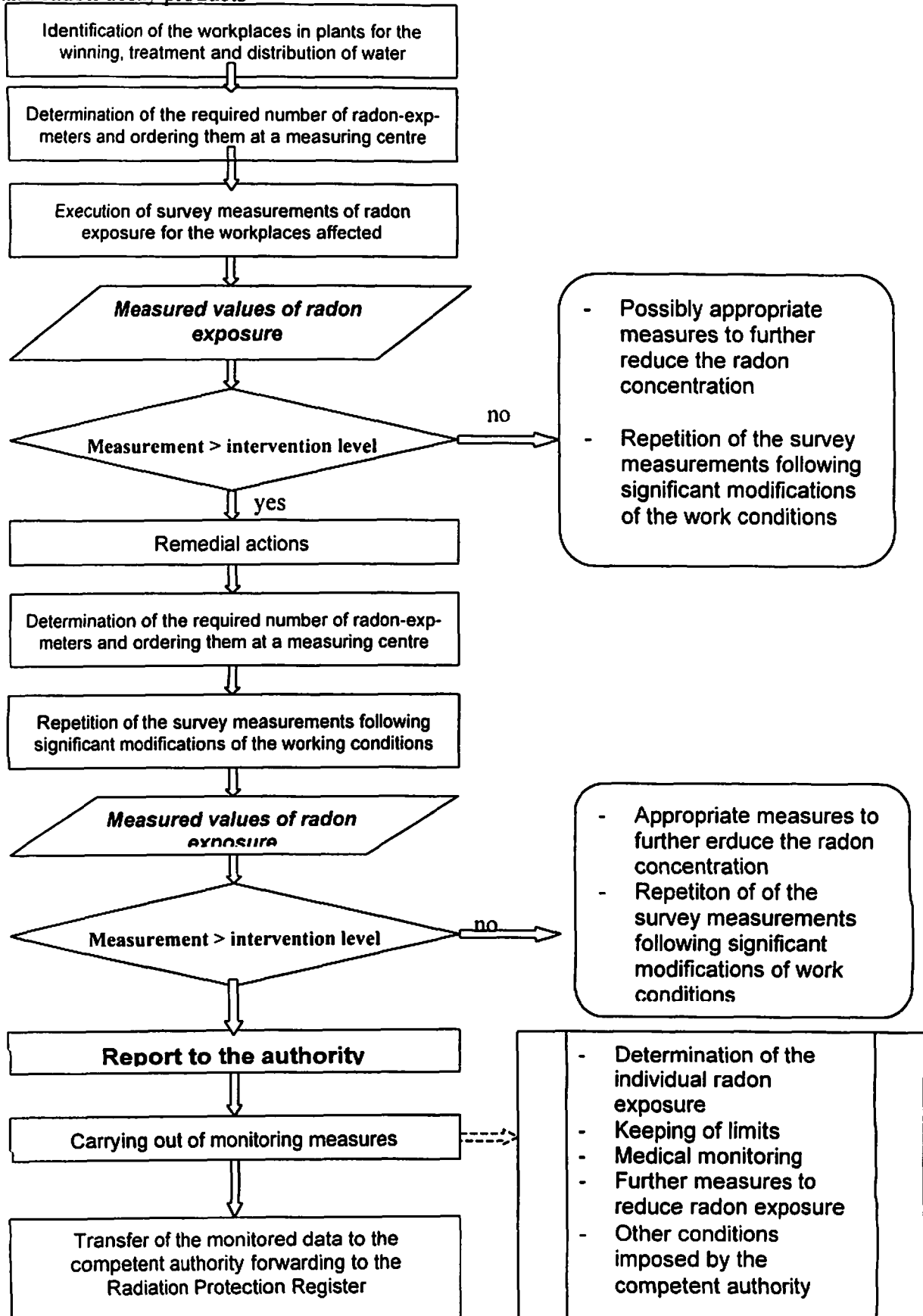
Companies whose members do not especially work in water works also have to observe these new regulations in future. The situation simplifies for companies who only work in water works from time to time with a working time of less than 50 hours per year or who only enter work areas with radon concentrations less than  $1000 \text{Bq/m}^3$ . Estimations have shown that no monitoring is required in these cases. Implementing provisions concerning this are presently being elaborated.

The water works have to report known or assumed enhanced radon concentrations in areas of work of agencies to those responsible there. Agency staff should, however, nevertheless get knowledge of the radon concentrations in water works prior to working there, if it is expected that the annual working time in such facilities will be more than 50 hours.

### **Directive for the registration and monitoring of workplaces exposed to radon decay products**

Details on the involving and monitoring of workplaces and the uniform implementation of the regulations of the new Radiation Protection Ordinance into practice are to be regulated in a national directive that is currently being elaborated by a working group with members of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, the Federal Office for Radiation Protection and single federal state governments.

Flow diagram of the registration and monitoring of workplaces with radiation exposures due to radon and radon decay products



## **Presumed content of the directive**

According to the concept of the competent working group the directive to be elaborated will include recommendations for the harmonised action of the competent federal state authorities, the responsible measuring centres and the operators of the involved plants regarding the involving and monitoring of workplaces with exposures due to radon and radon decay products. Correspondingly to the current state of discussion the directive will state in 5 chapters measures in connection with the involving of the workplaces as well as to optimise exposure, give details on the monitoring methods to be applied, on the requirements on the used measuring systems including quality assurance as well as on the evaluating of the monitoring data and their transfer to the central Radiation Protection Register and it will state requirements on the evaluating institutions.

The introducing chapter will include general information on the area of application and the purpose of this directive as well as the mentioned target groups. The second chapter will deal with general fundamentals of exposure determination and their evaluation. Comments on the determining of exposure data and body doses and on connections between different reference values and the exposure respective dose limit will be given. The necessity of using special measuring quantities for this field of radiation protection is derived from the complex working mechanism of the radon decay products, and links between the single measuring quantities and parameters will be reported. The measuring methods required for the determining of these measuring quantities will be described in detail. This includes methods to measure the potential alpha energy concentration of indoor air at workplaces, the personal potential alpha energy exposure, the personal radon exposure and the workplace-specific radon concentration in the indoor air.

Specifications regarding the approval of measuring devices for operational monitoring by the Federal Office for Radiation Protection and the authorisation of measuring centres by the responsible federal state authorities will be made within the scope of the requirements on the used measuring systems. The participation of the measuring centres in regular comparison measurements of their measuring system in the Federal Office for Radiation Protection and the performance of sufficiently frequent calibrations of the respective operational measuring method in an accredited calibrating laboratory of the DKD (German Calibration Service) will be a prerequisite for the authorisation.

The 3<sup>rd</sup> chapter will deal with the registration and evaluation of the workplaces, in particular with the technical-organisational possibilities to implement the corresponding legal requirements. The question who will carry out the survey measurements, which measurements will have to be carried out how often and which measuring methods have to be applied will be central here. The responsibility for the evaluation of the determined exposure data and conclusions to be drawn from this regarding the initiation of appropriate measures to reduce radiation exposure also requires being clarified. Possibly necessary verification measurements in the case of successful remediation below the level the work places are regarded to be monitored due to technical measures will be explained regarding their extent and the schedule to be kept.

If the remediation measures are not successful the operator has to report this to the responsible authority, so that the measures to create the organisational prerequisites for radiation protection monitoring dealt with in chapter 4 of the directive can be initiated. This concerns, in particular, the operational radiation protection organisation (radiation protection supervisors, radiation protection officers, radiation protection directive), the establishing of radiation protection areas, the protection of the population and the environment, the gaining of expertise in radiation protection as well as the guarantee of medical monitoring.

The 5<sup>th</sup> chapter includes the detailed regulations regarding physical radiation protection control. In the section Performance of monitoring criteria for the suitability of the single methods described in chapter 2 to measure the potential alpha energy concentration of indoor air at workplaces, of the personal potential alpha energy exposure, the personal radon exposure and the radon-concentration at workplaces for monitoring in dependency of the special exposure conditions are explained. Taking into account the respective radiation risk a step-wise monitoring concept is derived as general monitoring method. To implement this concept the responsible authority - in agreement with the operator - is to determine the appropriate measuring method and the measurement frequency in dependency of the radiological conditions at the workplaces. It may demand that the radiation protection supervisor or radiation protection officer makes as a precaution additional statements on the exposure conditions like duration of stay at the single workplaces of the persons to be monitored, concentration variations or equilibrium factors. Likewise it should be able to determine criteria for the monitoring of groups to guarantee optimum use of the necessary measuring devices.

In the section Evaluation of the monitoring data statements will be made on the procedure for the treatment and interpretation of the measured data. The statements on the evaluating methods to be applied include detailed information regarding the procedure in the case of additional internal and/or external exposures, on conditions for the allocating of an additional dose by the competent authority and on the form and content of the notes concerning the data gained during monitoring.

The last section of the 5<sup>th</sup> chapter will refer especially to requirements on the evaluating institution. It is to include detailed requirements for a uniform structuring and use of forms and documents within the scope of data capture and up-dates as well as for reporting, availability and documentation of results. The stating of deadlines, addressees and contents for reporting is to create the prerequisites that the data can be evaluated and processed optimally by the responsible authorities and the central Radiation Protection Register. Possibly minimum requirements on the equipment of the evaluating institution regarding technology, room and personnel will conclude *this* chapter.

## Summary

Besides the possible risks to health due to radioactivity in the medical field or the use of the characteristics of radioactive substances, also radiation exposures will be monitored in future that may occur as a result of natural radioactivity at workplaces. Each water

works must, therefore, in future be responsible for the estimating of the radon exposure of their employees. In the case of enhanced radon exposures the water works will have to reduce this exposure by appropriate building or organisational measures. If the exposure remains high nevertheless, the personnel has to undergo in future a continuous radiation protection monitoring. It is, however, expected that those additional measures will only have to be taken for a very small number of the water works. In these cases building remediation measures are certainly the most effective and sustainable method. Considerations regarding radiation protection should, therefore, already be taken into account in the planning of new facilities for water capturing, treatment and distribution.

## References

- [1] Commission of the European Communities Council Directive 96/29/EURATOM of 13 May 1996 Laying Down the Basic Safety Standards for the Protection of the Health of Workers and the General Public Against the Dangers Arising from Ionising Radiation. Official Journal of EC, Series L, No. 159 of 1996
- [2] Ordinance on the Protection against Damage and Injuries Caused by Ionizing Radiation (Radiation Protection Ordinance) last amendment by the Ordinance of July 20, 2001 Bundesgesetzblatt I, No. 38, July 26, 2001
- [3] Heinrich, T., Hübel, K., Schindlmeier, W., Radonexponierte Arbeitsplätze in bayerischen Trinkwassergewinnungsanlagen, 30. Annual meeting of the "Fachverband für Strahlenschutz", Lindau, S. 538 (1998)
- [4] Hingmann, H., Allinger, Th., Korte, Th., Kubetzek, L., Peeck, D. A., Weber, U., 30. Annual meeting of the "Fachverband für Strahlenschutz", Lindau, S. 544 (1998)
- [5] Bale, W. F., Hazards Associated with Radon and Thoron, Unpublished memorandum to the U. S. Atomic Energy Commission (reprinted in Health Phys. 38, 1061, 1980 (1951))
- [6] Schraub, A., Aurand, K., Jacobi, W., Untersuchungen zur strahlenbiologischen Bedeutung der Folgeprodukte des Radons, Arch. Phys. Ther. 7, S. 437 (1955)
- [7] 1. Durchführungsbestimmung zur Verordnung über die Gewährleistung von Atomsicherheit und Strahlenschutz vom 11. Oktober 1984. GBl. der DDR Teil I Nr. 30 (1984) S. 348
- [8] Beck, T.; M. Knittel, V. Schmidt, F. Wolf, J. Schwedt, W. Ullmann: Das personalgebundene Meßsystem für die Bestimmung der individuellen Strahlenexposition von Bergarbeitern der WISMUT GmbH, 30. Annual meeting of the "Fachverband für Strahlenschutz", Lindau, S. 160 (1998)
- [9] International Commission on Radiological Protection, Protection against Radon-222 at Home and at Work, ICRP Publication 65, Annals of the ICRP Volume 23 No.2 (1993)