Radiation protection and environmental radioactivity

RADIATION PROTECTION

At the moment, Italy does not produce energy through nuclear fission processes and does not plan to build nuclear power plants; however, radioactive materials capable of generating exposure to ionizing radiation are present in the radioactive waste produced by the previous nuclear program and in the structures and systems of nuclear plants subjected to decommissioning. The use of ionizing radiation sources continues, as in the rest of the world, to be carried out in medicine, industry and research.

No exposure to ionizing radiation, however low, can be considered risk free. For this reason, in any activity that involves risks associated with ionizing radiation it is necessary to guarantee an appropriate protection system for the individuals involved.

Radiation protection, or health protection against ionizing radiation, has the objective of preserving the health and well-being of workers, of the individuals and of the population as a whole, reducing the risks that can derive from exposure to ionizing radiation connected to those human activities for which the use of ionizing radiation sources is justified in relation to the benefits deriving from this to society and its members. Depending on its objective, it also provides environmental protection as regards human returns.

In relation to radiation protection, ISIN carries out preliminary investigations, technical assessments, monitoring and surveillance activities with reference to both nuclear installations and the use of ionizing radiation sources (radionuclides and x-ray machines).

In particular, the Inspectorate carries out the preliminary investigations and issues to the competent ministries the opinions required by the legislation in force for the use of ionizing radiation sources, with regard to radiation protection and the safe management of the sources; ISIN carries out assessments of the radiological impact on workers and on the individuals of the population and incidental scenarios, within authorization procedures concerning nuclear installations, carrying out their own supervision at nuclear installations and at all installations where activities are carried out to the radiation protection laws.

Furthermore, the Inspectorate carries out the technical assessments and checks about safety of the sources; concerning radioprotection, ISIN prepares and adopts technical opinions requested by Public Administrations and private subjects and prepares guides.

The Inspectorate provides technical and regulatory support to the Civil Protection Authorities as part of the interventions planned following radiological emergencies and specific situations of national importance, also participating in Prefectural Commissions established by the competent Prefectures, with the carrying out of on-site inspections; it performs and adopts, in terms of radiation protection of workers and the population, technical investigations and opinions concerning the reclamation and safety measures of sites contaminated by radionuclides.

ISIN also carries out checks on the monitoring of environmental radioactivity in areas neighbouring to nuclear installations, by updating the data relateing to the monitoring of discharges of radioactive effluents from nuclear sites in normal and emergency conditions, taking care of the systematic collection, evaluation and publication.

It performs control and supervision activities regarding the exposure, deriving from work activities, to particular natural sources of radiation subject to the radiation protection laws.

The Inspectorate is the National Contact Point with regard to the international control system, established by the Code of Conduct of the International Atomic Energy Agency (IAEA) on safety and security on radioactive sources and on the system of controls on imports and exports of sealed radioactive sources between IAEA Member States (in accordance with the additional Guidance). ISIN participates in the activities of international organizations and institutions of the European Union and provides technical support for the development of national and international standards on radiation protection. ISIN experts participate in the Examination Commissions for the registration in

the list of names of the Qualified Experts and the Authorized Physicians, for the expression of the judgment of suitability for the technical exercise of nuclear plants.

Environmental radioactivity

The Inspectorate ensures the environmental radioactivity surveillance activities required by current legislation. Except for nuclear accidents (such as Chernobyl and Fukushima), radioactivity in the environment has mainly natural origins and only a small part is of artificial origin.

The natural radioactivity is both of cosmic origin (cosmic rays) and of terrestrial origin, due to the primordial radionuclides present in the earth's crust since its formation.

The main source of exposure of the population to natural radioactivity of terrestrial origin is represented by radon decay products, a radioactive gas generated in soils and rocks that accumulates in closed settings (homes, schools, workplaces). A further source of exposure to natural radiation may derive from products or residues from certain work activities with materials containing natural radionuclides (Naturally Occurring Radioactive Material - NORM). Exposure to radon in workplaces and NORM activities were introduced in 2000 with Legislative Decree no. 241 which amended Legislative Decree no. 230 of 1995. There are currently no standards in place for exposure to radon in residential places.

Artificial radioactivity is generated as a result of human activities related to the production of nuclear energy, to the use of radioactive sources in the medical-diagnostic, industrial and scientific research fields and to the production of war material. In the environment, artificial radioactivity is especially due to atmospheric atomic tests in the 1960s and to nuclear accidents, in particular that of Chernobyl in 1986 and that of Fukushima in 2011, which however affected Italy to an extremely large extent marginal.

Control of environmental radioactivity

In Italy, the control on environmental radioactivity is regulated by the legislation of '95 and by its subsequent modifications and additions. The Ministry of the Environment and the Protection of the Territory and the Sea exercises control on the environment while the Ministry of Health exercises control on food and beverages for human and animal consumption.

The set of controls is divided into national and regional surveillance networks. The regional networks are managed by the individual Regions; the national networks are RESORAD, the ISIN alarm networks (REMRAD and GAMMA) and the alarm network managed by the Ministry of Internal Affairs.

To these must be added the local surveillance networks of environmental radioactivity of nuclear plants and managed by the operators of the plants themselves, on which ISIN performs the institutional control function. RESORAD uses radiometric surveys and measurements of the regional and provincial Agencies for the protection of the environment of the National System for the protection of the environment (SNPA) and of other bodies, institutions and suitably equipped bodies such as the Experimental Zooprophylactic Institutes.

ISIN performs the functions of coordination and guidance of the RESORAD, provides for the collection and dissemination of the results of the measurements carried out; manages the national database on environmental radioactivity (DBRad) and transmits to the European Commission information on the surveys carried out.

The main objective of the network is to monitor the space-time trend of radioactivity in the matrices of the various environmental and food sectors according to Guidelines which consider the Recommendation of the European Commission no. 2000/473/Euratom.

In June 1998, the Italian national network was able to highlight, through the revelation of an anomalous presence of radioactivity in the air, an accident at the Spanish foundry of Algeciras, in which a source of Cesium-137 was

melted. In March 2011, it was the RESORAD that detected the first traces of radioactivity in the environment following the accident at the Fukushima nuclear power plant and the only one, for analytical perception, able to provide data in environmental and food matrices in the following days.

In order to ensure the homogeneity of the surveys, the sampling and measurement methods, the RESORAD Network Manual was drawn up: it collects all the informations on the structure, the sampling plans, the sampling methods and measurement and data flow of the network itself. In addition to the manual, further reference documents are available, results of surveys and guidelines concerning the protection of the population from exposure to ionizing radiation.

Radon

See the average municipal concentrations. [1]

Radon, in the absence of incidental events, represents the main source of exposure to radioactivity for the population. The World Health Organization, through the International Agency for Research on Cancer (IARC) has evaluated the carcinogenicity of radon since 1988 and has included it in Group 1 [2] of human carcinogens. Worldwide consolidated estimates attribute radon to be the second leading cause of lung cancer after tobacco smoke with a risk proportional to concentration. In Italy it is estimated that, out of approximately 30,000 lung cancer cases that occur every year, over 3,000 are attributable to radon [3], most of which among smokers and ex-smokers.

Radon is a radioactive gas produced by the decay of uranium, naturally present in soils and rocks with different concentrations depending on their composition. The radon emitted by the soils, diversified according to the geology of the territory, is present everywhere in the air we breathe but, while outdoors it disperses not reaching high concentrations, in closed places (indoor radon - homes, schools, environments of work, buildings in general) accumulates reaching, in some cases, concentrations such as to pose a high risk to health. Some building materials and water are secondary sources of radon. Additional causes, such as the construction methods of the buildings, with particular reference to the attack on the ground, and the lifestyle habits of the occupants, can affect the presence of radon. The set of these factors, all highly variable, contributes to a highly diversified spatial distribution of the concentration of indoor radon in the area, mainly governed by local geolithology. Even between individual buildings similar and close to each other it is possible to find a strong difference in the concentration of radon.

In response to the risk deriving from exposure to radon, the current Italian legislation, Legislative Decree no. 230/1995 [4] and subsequent amendments, regulates only exposures in the workplace, including schools, excluding residential environments. Employers are required to measure the average annual radon concentration for the types of workplaces indicated in the field of application, for example underground workplaces, other particular workplaces with well-defined characteristics or located in identified areas with a high probability of high concentrations. Above the level of action, set at 500 Bq m-3, remedial actions are required, in addition to administrative obligations of communication to the competent bodies, to reduce the concentration below the aforementioned level. The remedial actions may not be taken if it is demonstrated, through a qualified expert, that no worker is exposed to a dose greater than 3 mSv, with the exception of schools and kindergartens. Where, despite the adoption of remedial actions, the concentration is still higher than the level of action, the employer applies the consequent health protection provisions of the workers envisaged by current legislation.

Directive 2013/59 / Euratom [5], which has yet to be transposed into Italian legislation, provides for a new regulatory framework aimed at reducing the long-term risk deriving from exposure to radon. More stringent provisions are introduced for protection in the workplace and specific requirements also for protection from radon exposure in residential environments. Each EU Member State must establish reference levels for the average annual concentration of radon, both for homes and workplaces, which do not exceed 300 Bq m-3. The Directive also provides indications on risk management tools, such as the adoption of a national action plan that establishes objectives, action strategies and roles of the administrations. In this context, a fundamental role is attributed to the identification of areas where the average annual concentration of radon is expected to exceed the national reference level in a significant number of buildings.

ISIN monitors and controls indoor radon gas through its own measurement surveys and through the collection of data from the regional and provincial agencies for environmental protection (ARPA APPA) of the National System for Environmental Protection (SNPA) and other competent institutional bodies. In addition, it ensures technical support for the development of national and international standards regarding the exposure to radon of the population and workers.

In the 1990s ISIN, then ENEA-DISP, and the Istituto Superiore di Sanità (ISS), in collaboration with the regional health departments and with the Regional Reference Centers for the Control of Environmental Radioactivity, now merged into the ARPA/APPA, carried out a national survey on the concentration of radon in about 5,000 homes, from which the national average concentration of radon equal to 70 Bq m-3 was estimated, a value higher than the European average of about 55 Bq m-3 ea the world one equal to about 40 Bq m-3, and the average concentrations of the Regions and autonomous Provinces which showed values that oscillate from about 25 Bq m-3 to about 120 Bq m-3. At a national level, the average annual concentration of radon is estimated to be above 300 Bq m-3 in about 2% of homes.

Although the estimates of the average radon concentrations in the Regions and autonomous Provinces and the average value estimated for Italy by the national survey are still taken as a reference, many other investigations have been carried out since then by the Regions, through the ARPA APPA, and by the ISIN itself for the measurement of radon, not only in homes but also in schools and workplaces, making tens of thousands of measurements of the average annual concentration of radon. Taking the houses as a reference, however, the percentage of houses measured is rather small compared to the total number of houses on the national territory.

The regional surveys were carried out using different methods and criteria which, although valid for the purpose of classifying the territorial areas, make a direct comparison complicated. In order to undertake a process of harmonization of data at national level, also with the aim of representing in a more homogeneous way between the Regions and autonomous Provinces the spatial variability of the concentration of radon and making information available,

ISIN has initiated a collection of estimates of the average radon concentrations in Italian municipalities prepared by the ARPA APPA and for Lazio by ISIN itself. At present the information is available in 4,241 Municipalities, with a territorial coverage corresponding to 53% of Italian Municipalities, but is fragmented and concentrated mostly in the Regions of northern and central Italy. Furthermore, the differences in the methods of carrying out radon measurement surveys essentially attributable to two main types of approaches are reflected, that of measuring dwellings located exclusively or mainly on the ground floor and that of measuring dwellings located on different floors. The estimates of the average municipal concentrations obtained from measurements carried out exclusively or mainly on the ground floor concern more than 80% of the Municipalities being assessed and over 40% of all Italian Municipalities.

Based on this information, ISIN has developed a thematic map of the average municipal concentrations of radon [1]. The values ??shown in the thematic map must be consulted taking into account the information returned by the spatial interrogation of the municipal units in relation to the type of data used or estimates made. It is also important to remember that the high variability of the concentration of radon between the different houses, even of the same Municipality, does not allow the value of the municipal average to be used as a reliable indicator of the value of the concentration of radon in a specific home located in the same Municipality. . The only way to have a reliable estimate of the concentration of radon in a specific home is to carry out a direct measurement, which indicatively costs a few tens of euros, excluding any inspections.

Further collection and communication of radon data carried out by ISIN are those carried out as a contact point for Italy in the context of the European Atlas of Natural Radiation [6] - European Indoor Radon Map project, where the The Inspectorate ensures support to the European Commission for the processing of spatial statistics of the data requested by the Joint Research Center, aimed at the creation and continuous updating of the map of radon levels harmonized at European level.

Further information on radon is contained in the chapter dedicated within the ISIN Report on Surveillance of environmental radioactivity in Italy 2019. [7]

Radiometric laboratories

The ISIN radioactivity measurement laboratories perform the function of instrumental and technical-scientific support to the institutional activities of the Inspectorate on environmental radioactivity control, including the monitoring of radon gas and NORM (Naturally Occurring Radioactive Material), in surveillance of nuclear installations and in the case of radiological emergencies, for the purposes of assessing the state of the environment and for the health protection of the population and workers.

The laboratories also provide support to public administrations and judicial authorities in the field of radioactivity in the environment and in food, in the preparation of recovery and intervention plans in the context of sites contaminated with the presence of radioactive materials.

The ISIN radiometric laboratories are:

- the gamma spectrometry laboratory;
- the radiochemistry laboratory;
- the radon laboratory.

The main instrumentation supplied to the laboratories and the analyzes carried out in environmental and food matrices are:

- high resolution gamma spectrometers for the determination of the concentration of activity of gamma emitting radioactive elements;
- alpha spectrometers for determining the concentration of activity of alpha emitting radioactive elements;
- alpha and beta proportional counters for determining the concentration of activity of alpha and beta emitter radioactive elements;
- scintillation chambers, ionization chambers, solid-state trace detectors, electrons for measuring the concentration of radon activity;
- radon chamber for controlled exposures;
- portable instrumentation for field activities (gamma dose in air and alpha and beta contaminameters).

ISIN also manages the Laboratory for the measurement of radioactivity in atmospheric particulate, called ITL10, of the International Monitoring System (IMS), on behalf of the Ministry of Foreign Affairs and International Cooperation, in compliance with the Treaty on total banning of nuclear tests - (CTBT) of the United Nations.

The Treaty provides for the obligation not to carry out any experiments on the explosion of nuclear weapons or any other type of nuclear explosion and for the purposes of its entry into force must be ratified by all participating States. Currently, not all States have ratified it.

The International Monitoring System consists of a set of detection networks: seismic, infrasonic, hydro-acoustic and atmospheric radioactivity.

The ITL10 laboratory is one of 16 strategically distributed laboratories able to carry out highly specialized and sensitive measurements of radioactivity in atmospheric particulate matter and which represent the maximum technology for this type of measurement. The analyzes are able to detect and characterize radionuclide traces in the air due to a nuclear event, in any part of the world that may occur, also estimating the occurrence date. The additional information available to the International Monitoring System also allows us to establish its origin. The ITL10 laboratory became operational on December 14, 2016.

Last update: Tuesday 30 June 2020

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[1] https://sinrad.isinucleare.it/radon/mappa-medie
[2] https://monographs.iarc.fr/wp-content/uploads/2018/09/ClassificationsAlphaOrder.pdf
[3] http://www.salute.gov.it/imgs/C_17_opuscoliPoster_283_ulteriorallegati_ulteriorealleg ato_15_alleg.pdf
[4] https://www.normattiva.it/uri-res/N2Ls?urn:nir:stato:decreto.legislativo:1995-03-17;230!vig=
[5] https://eur-lex.europa.eu/legal-content/IT/TXT/PDF/?uri=CELEX:32013L0059&from=IT
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