Re-use of uranium mining waste rock in the public domain: main outcomes of the review of the current situation in the Limousin Area (France)

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Abstract:

For more than 50 years, more than 200 uranium mining sites scattered over a large part of the French territory were prospected and put in production. Rehabilitation of most sites is now complete and remaining activity mainly consists of surveillance and control and of maintenance of several water treatment facilities. During uranium mining works, an extremely large amount of waste rock was excavated, around 200 millions tons. The related activity resulting from uranium and its progenies, vary from a few thousand Bq/kg up to several tens of thousands of Bq/kg. In most cases, the waste rock was left at the production site or used to fill open-pit mines and rehabilitate the landscape. Part of the materials was also transferred in public domain, generating thereby uncontrolled exposures of the population, depending on the uses.

1 CONTEXT

For more than 50 years, more than 200 uranium mining sites scattered over a large part of the French territory were prospected and put in production. Haute-Vienne, in the mid-west of France, played a leading position. It yielded nearly 40% of the total national production. Rehabilitation of most sites is now complete and remaining activity mainly consists of surveillance and control and of maintenance of several water treatment facilities. AREVA NC (formerly COGEMA) is responsible for the management and monitoring of all these sites and facilities.
In 2003, the French authorities asked AREVA NC to produce a report presenting the results of ten years (1994-2003) of monitoring of the rehabilitated sites and their environment.
In 2006, the Institute of Radioprotection and Nuclear safety (IRSN) was requested to perform the appraisal of this report in order to propose possible options, to the regulatory body, to improve the management and monitoring provisions and reduce impacts of the sites over the short and long term. In addition, the issues related to the re-use of waste rock in the public domain had to be considered. The findings of the IRSN technical review were outlined in a report issued in 2009 available on the web site of the Institute, along with the other reports. They led to the analysis of the current situation in France. Although the transfer of waste rock in the public domain ended in 1992, the management of situations brought on by this practice is still relevant today.

2 MAIN ISSUES FROM THE PRACTICE OF RE-USE OF WASTE ROCK IN THE PUBLIC DOMAIN

The uranium ore mining comes along with high quantities of waste rock with no economical interest with regard to their uranium content. To produce 1 tonne of ore, an average 9 tonnes of waste rock in the case of open-pit mines and 0.65 tonnes in the case of underground mines were generated. For the total 52 million tonnes of ore produced in France, around 200 million tonnes of waste rock were produced.

Given the presence of uranium and its radioactive decay products, this waste rock has a specific activity varying from a few thousand Bq/kg up to several tens of thousands of Bq/kg.

The uranium content of these rocks range theoretically from the natural content of local granites (around 20 ppm as an average) to the cut-off level defined on the basis of temporary economics (from 100 ppm to 400 ppm). However, in practice, some materials with locally higher uranium concentration may have been aimed toward waste rock instead of ore, as a consequence of potential error within the radiological in situ sorting and/or of inappropriate sampling for radiological controls.

Waste rock was used as backfilling materials for tailings repository and for site remediation and landscaping. Some of the waste rock mined was piled near the mining works, constituting thereby waste dumps.
Additionally to these main uses of waste rock, the transfer for public purposes has to be noticed. Much is not known concerning the total quantity of waste rock re-used in public domain. It is supposed to be quite low in comparison with the total of waste rock extracted during the mining works. The transfers in the public domain were carried out before 1984 within the framework of good relations with the neighbourhood and more substantially after 1984 within the context of sales contracts with local quarry and public works companies, when dedicated to being marketed by these companies.

Public persons may thereby be exposed to the radioactivity originating from waste rock.

3 MAIN EXPOSURE PATHWAYS AND APPROAC OF THE DOSIMETRIC IMPACT FOR GENERIC SITUATIONS

The practice of re-using waste rock can induce situations where radioactive ground level is locally higher than the local natural background one. Depending on where they are located and the uses to which they are put, the existence of such situations can lead to exposure of the public.
Four main potential exposure pathways have been identified for people living nearby areas backfilled with waste rock:

- external exposure to radiation emitted by radionuclides present in the materials ;
- internal exposure by inhaling the radon contained in the air in confined spaces (this is thought to be negligible in the case of exposure in open air due to dilution in the atmosphere) ;
- possible internal exposure by ingesting earth;
- inhaling radionuclides after resuspension of dust particles.

Based on available data and on knowledge of situations that have been subject to investigations, it is possible to define standard exposure scenarii and assess the corresponding received doses. The dosimetric calculations carried out are not intended to provide an accurate assessment of every individual situation. They are aimed rather at estimating the order of magnitude of the doses received in exposure scenarii representative of real situations.

Three scenarii representative of the most significant exposure situations can be suggested:

- a pedestrian walking along paths where waste rock has been used as landfill;
- outdoor activities on land that has been backfilled using waste rock and then surfaced (football pitch, car park, school playground, etc.);
- living in houses built using filling materials consisting of waste rock.

The scenarii have been assessed on the basis of waste rock containing 100 ppm of uranium. They have been classified hereunder in descending order according to the scale of their dosimetric impact on the population. The dose has been compared to the value of 1 mSv/y set by the Euratom Directive 96/29 for public exposure to nuclear activities.

- Buildings constructed on top of waste rock are the situations that have the most serious potential impact. The added external exposure results in estimated individual doses ranging from 0.5 mSv/year to over 1 mSv/year, depending on the content of the filling materials. In addition, radon concentrations above 1,000 Bq/m^3, and which, in some cases, may be as high as 10,000 Bq/m^3, are likely to be found in certain rooms in one-storey houses or in basements, since waste rock is a source of radon in addition to that found naturally in granitic areas. The doses received by the residents of such houses may exceed several tens of mSv/year. When such concentration levels are observed, in excess of the benchmark value set for public buildings, action must be taken to reduce the concentrations of radon in these houses.
- Use entailing intensive activity in areas outside buildings where waste rock has been used as landfill is a second type of problem. In various places, such as a school playground or village square with no surfacing, people, and especially children, are at risk of exposure of 0.1-0.5 mSv/year. In all cases, the doses received are below the dose limit of 1 mSv/year. Moreover, it cannot be excluded that waste rock and materials with content higher than the value of 100 ppm used in the calculations (blocks of tailings, for example) may exist locally and, in such cases, will imply individual doses closer to 1mSv/year. It is therefore recommended that investigations be carried out to detect such situations.
- Other situations that have entailed the use of waste rock as landfill material in places where people do not spend very much time (car parks and paths) imply a very low dosimetric impact, of just a few hundredths of a mSv/year at most. No particular action is necessary in such cases, provided that different future uses are not recorded.

For waste rock with higher concentrations of uranium, the order of magnitude of the doses received by the public will be proportional to the uranium content of the waste rock.

4 CURRENT MANAGEMENT OF RE-USE OF WASTE ROCK IN THE PUBLIC DOMAIN

4.1 Weak points of the past practices

Main weak points have been highlighted concerning the practice of waste rock transfer to the public domain with regard to risk control. They differ depending on whether the transfers occurred before or after the year 1984.
In 1984, a specific supervising procedure was implemented aiming at filing all relevant data concerning the beneficiary of the transfer, the uses and the characteristics of the yielded materials as well as setting limits in terms of uranium content. Before the year 1984, the waste rock transfer was not supervised by any constraint and a lack of knowledge has to be conceded: quantities dispatched, uses, exposure levels, …
After the year 1984, efforts to improve risk control were made, in particular the implementation of constraints. Some weaknesses still remain. They are linked to the case where the use declared by the beneficiary does not correspond to the existing situation and also the case where the uranium content of the materials exceeds the constraint of 100 ppm.
As a matter of fact, during mining operations, the waste rock was separated from the ore-rich rock by measuring the radioactivity of the load (in buckets or dumper trucks). Given the quantities involved, this method was relatively imprecise. Blocks of ore could easily be mixed up with waste rock.
And even though the transfers were compliant with the procedure specifications, the risk associated with the changes of uses in the future is not dealt with.

4.2 A recent national regulation

In July 2009, a framing letter, cosigned by the French Safety Authorities (ASN) and the Ministry of Environment, was sent to the local authorities (prefects). It aims at defining the actions to undertake within the context of the management of the former uranium mines in France. One action is dedicated to the management of the waste rock according to two thrusts : investigating further into the areas backfilled with waste rock and reducing the related impacts, if necessary.
On a more detailed scale, the framing letter considers necessary to :

- fordid any project aiming at promoting waste rock derived from former uranium mine sites ;
- implement planning restrictions for areas with significant deposits of waste rock in order to keep the memory and to avoid a re-use of the materials outside the listed deposit areas ;
- inventory the areas outside the perimeter of the former uranium mines ;
- inventory the soil uses where waste rock outside the perimer of the former uranium mines was listed ;
- verify the compatibility between uses and exposures.

In reference to the recommendations given by the authorities, the priority is now to identify the public areas where waste rock has been used, to characterise the exposure levels and, if necessary, to undertake action to reduce exposure levels where justified.
The difficulty lies in the appreciation of what is an incompatible use. The regulation deriving from the health code is based on the European Directive 96/29 CE (Euratom Directive) setting up the basic standards for the health protection of the population and the workers against hazards arising from ionising radiation. Nuclear activities are defined within the Health Code as any activity likely to lead to the exposure of people to ionising radiation from either an articicial source or a natural source if this source has neen processed for its radioactive or fissile properties. The related dose limit for the public from nuclear activities is 1 mSv/y. Even if the re-use of waste rock is not included in the scope of nuclear activities such as described in the Health Code, the value of 1 mSv/y is considered as the default refence value.

4.3 Actions planned by AREVA

Given the increasing concerns for the issues of the re-use of waste rock in the public domain, concerns that have been increased as a result of a TV programme dedicated to the issues of uranium mining in France, AREVA has defined an action plan with the particular objective of making an inventory of the areas backfilled with waste rock (U > 300 ppm).
The responsibility for the inventory lies with AREVA. Nevertheless, it should be a concerted approach, including the local information committees (CLI/CLIS) and the population and it will be supervised by the local authorities through their technical support service.
Two stages are identified. The first stage planned for october 2009 consists of the qualification of a methodology of detection by air, based on an investigation from helicopter of one thousand square kilometers in the Limousin Région. In 2010, provided the validity of the methodology is demonstrated, two thousand additional square kilometers would be investigated. These investigations, carried out through helicopter measurements, would be complemented by *in situ* controls of the exposure levels and the assessment of the compatibility between the exposure levels and the listed uses. Such investigations are

intended to lead to the management of inconsistent situations, in agreement with the authorities.

5 CONCLUSION

IRSN assessment of the current situation in the Limousin Région came to the conclusion that the main risk for the population results from radon accumulation in dwellings with waste rock-bearing foundations. The level of radon activity in such dwellings depends on various parameters like the uranium (and progenies) content of the foundation materials, the type of building, the characteristics of the airing system, …

Two situations can be distinguished :

- case of re-use of materials with homogeneous radiological properties. In this case, attention should be paid to the use of waste rock as foundation materials. With regards to health effect, actions are needed to reduce the exposure to radon, that is to reduce the air concentration of radon in dwellings.
- case of re-use of materials with locally radiological anomaly. This situation need to be assessed in order to define the best management solution (removal and storage of the materials or maintain of the materials in situ and implementation of planning restrictions)

The recent AREVA action plan is expected to contribute to increasing knowledge as regards the uses of waste rock and the extent of the areas concerned and to improve thereby the risk control for the population. Attention should be paid to verifying that the investigations planned by AREVA are able to detect the situations presenting hazards, and in particular the situations where radon accumulates indoors.

In all cases, it is crucial to keep records of the presence of the waste rock to prevent future developments (especially building construction) from generating further risks of exposure. This can be done through the implementation of planning restrictions and by making available records, maps, … ensuring the traceability of the location of the materials.
In addition, it is also essential to ensure that waste rock stored at the sites (as for example waste rock dump) are not used without taking specific precautions. Several cases where waste dumps have been used or cases of planned use can still be found at former mining sites (especially in Limousin and the Vendée).