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Istituto Superiore per la Protezione
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TECHNICAL GUIDE N. 29

Siting criteria for a near surface disposal facility for low and intermediate level radioactive waste

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The Technical Guides, issued by ISPRA pursuant to art. 153 of the Legislative Decree n. 230 of 17 March 1995 and subsequent amendments, are documents which disclose best practices on operational and technical measures to implement legislative provisions in the field of nuclear safety and radiation protection, as well as criteria and methodology of its control activity.

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Contents

I. Introduction

I.1 Preamble

The characteristics of a site where to realize a disposal facility for low and intermediate level radioactive waste, as well as those of waste conditioning and of the facility engineering structures, have to provide for the confinement and isolation of the radionuclides from the biosphere in order to ensure in the long term period the protection of population, environment and property.

With regard to the disposal of low level radioactive waste ï mostly containing short lived radionuclides, namely with a half-life of less than 30 years, and low concentrations of long lived radionuclides - and for intermediate level radioactive waste which decays below certain concentration levels, according to the established radiation protection objectives within a period of some hundreds of years, the international recommendations consider suitable for its disposal a near surface facility.

The siting process of a near surface disposal facility, hereinafter referred to as ñdisposal facilityò, in line also with the recommendations issued by international organisations, is implemented through consecutive phases of surveys and assessments.

The first phase[1] consists in the selection of different areas on a national scale, conducted on the basis of criteria related to physical, chemical, naturalistic and anthropic characteristics of the territory, which make an area suitable for the construction of a disposal facility for low and intermediate level radioactive waste. For this purpose it is used a data set immediately available and usable, that could not be exhaustive, but already existing and collected in a systematic manner, as well as a number of preliminary surveys.

The first phase leads to the identification of a number of ñpotentially eligibleò areas possibly with a related order of suitability.

The term ñpotentially eligible areaò refers to wide areas whose characteristics are favourable to identify sites able to be confirmed as suitable to host the disposal facility, as a result of further

[1] This first phase corresponds to the phases defined ***ñ****conceptual and planning stage****ò*** and ***ñ****area survey stage* ***ï*** *regional mapping or investigation phase****ò*** in the IAEA (International Atomic Energy Agency) recommendations.

detailed surveys and investigations, and on the basis of the results of safety assessments conducted considering the disposal facilityôs design characteristics.

The second phase[2] is aimed at selecting, among the ñpotentially eligibleò areas, the sites to be investigated in detail. The selection is performed on the basis of assessments conducted with regional scale data, of possible site investigations and taking into account socio-economic aspects.

The third phase[3] is focused on the detailed technical characterisation of one or more sites, in particular with regard to their related behaviour in the long term, in order to finally identify the site where to realize the disposal facility.

The specific technical data acquired during the above mentioned site characterization process will be included in the technical documentation to be attached to the application for the disposal facility construction licence, as foreseen by the legislation in force.

The radiation protection objectives in normal operation conditions of the disposal facility, and also in the subsequent phases, are established in the respect of the ñbelow regulatory concernò criteria, laid down in the Italian radiation protection legislation. The radiation protection objectives in accident conditions are defined in a way that the radiological impact on the population of such accidents should not require the adoption of any specific protective measure for the population, even with reference to the worst conceivable severe accident scenarios.

I.2 Objectives

This Technical Guide establishes the siting criteria of a near surface disposal facility for low and intermediate level radioactive waste.

With reference to the procedure laid down in the Title III of the Legislative Decree n.31 of 15 February 2010 and subsequent amendments, for the siting, construction and operation of the National Disposal Facility within a Technology Park, the criteria established in this Guide are applied in the siting process of the aforementioned disposal facility from the definition of the proposed national Chart of potentially eligible sites to the selection of the suitable site.

[2] The second phase corresponds to the phase defined ***ñ****area survey stage* ***ï*** *site screening phase****ò*** in the IAEA recommendations.
[3] The third phase corresponds to the phase defined ***ñ****site investigation stage****ò*** and ñ*detailed site characterization stage****ò*** in the IAEA recommendations.

I.3 Identification of criteria

In order to implement the siting process described in the preamble, the present Guide defines ñ*Exclusion Criteria*ò (EC) and ñ*Investigation Criteria*ò (IC), determined with consideration of the following aspects, in accordance with the recommendations issued by the international organisations and in particular the IAEA:

- geological, geomorphologic and hydraulic stability of the area in order to ensure the safety performance of the engineering structures to be realized by means of multiple artificial barriers;
- radioactive waste confinement by natural barriers provided by the hydrogeological and chemical characteristics of the soil in order to prevent the possible release of radionuclides into the biosphere;
- disposal facility construction in the respect of the existing regulatory constraints in the fields of environmental protection and conservation of the natural and cultural heritage;
- disposal facility isolation from anthropic infrastructures and from human activities, taking into account the mutual impact arising from the presence of the disposal facility and the transport of radioactive waste;
- disposal facility isolation from natural subsoil resources;
- disposal facility protection against extreme weather conditions.

The ñ*Exclusion Criteria*ò and the ***ñInvestigation Criteriaò*** are a set of fundamental requirements and assessment factors that must be considered in different phases of the siting process, consistently with the level of detail of the investigation proper of each phase.
The ñ*Exclusion Criteria*ò have been defined to exclude those areas of the national territory, whose characteristics do not ensure the full compliance with the above mentioned requirements. These requirements, together with the features of waste conditioning and those of the facilityôs engineering structures, have to ensure the necessary safety margins for the confinement and isolation of the waste from the biosphere. The application of the exclusion criteria is done through verifications based on regulations, and on the immediately available technical data and knowledge, also with the use of Geographic Information Systems.

The ñ*Investigation Criteria***ò** have been defined to allow the evaluation of the areas identified with application of the ñ*Exclusion Criteria*ò. These can lead to the exclusion of further portions of the territory within the potentially eligible areas, in order to identify sites of interest. These criteria are useful for both the elaboration of a suitability order of the potentially eligible areas and for the characterization of the sites of interest. The ***ñ****Investigation Criteria***ò** are applied through investigations and specific evaluations, also with the aim to confirm the absence of excluding elements not identified in the phase of first application of the ñ*Exclusion Criteria*ò.

Anyhow the ñ*Exclusion Criteria*ò and the ***ñ****Investigation Criteria***ò** not to be considered exhaustive, and any further relevant aspects arising during the subsequent detailed surveys and investigations have to be taken into account.

The following ñ*Exclusion Criteria*ò and ***ñ****Investigation Criteria***ò** are listed without an order of priority or preference.

II. Criteria

II.1 Exclusion criteria (EC)

The following areas shall be excluded:

EC1. with presence of active or quiescent volcanoes

Areas with active or quiescent volcanoes, such as: Etna, Stromboli, Colli Albani, Campi Flegrei, Ischia, Vesuvio, Lipari, Vulcano, Panarea, Isola Ferdinandea.

EC2. with high seismic activity

These are areas characterized by a maximum horizontal acceleration (PGA) defined on horizontal rigid reference site equal or greater than 0.25 g, considering a return period of 2475 years, accordingly to the Technical Norms for Constructions in force [Ref. 22,23], since in these areas the successive seismic site analysis could reveal conditions

potentially able to jeopardise the safety of the disposal facility during the loading and after the closure as well as during the institutional control period[4].

EC3. interested by superficial faulting

The active faults are listed in the database called ITHACA (ITaly HAzard from CApable faults) and in the DISS database (Database of Individual Seismogenic Sources).

EC4. characterized by geomorphological and/or hydraulic risk and/or hazard of any grade as well as river belts

To assess the risk of flood and landslide it is necessary to consider areas with geomorphological and/or hydraulic risk of any magnitude (from moderated to very high) and river belts classified A,B,C in the River Basin Plans (PAI), as well as areas registered in the Italian Landslide Inventory (IFFI).

EC5. with holocene alluvial deposits

These areas are characterized by Holocene alluvional deposits. The exclusion of these areas is an additional preventing measure, in order to minimize the hydrological risk.

EC6. located above 700 m a.s.l.

Above this altitude orography becomes more complex and more structured, slopes are steeper and rainfall are more abundant. Morphogenetic processes related to fluvial denudational and slope landforms due to gravity become more intense as the altitude increases.

EC7. characterized by an average slope greater than 10%

These slopes could expose the facility to surface erosion, transport and sedimentation phenomena related to the washout of meteoric precipitations[5].

[4] Seismic hazard data are available at http://esse1.mi.ingv.it/
[5] For the slope values and all other topographic data reference is made to calculations elaborated within GIS, using as base data the Digital Model defined for the whole national territory by the Italian Military Geographic Institute or equivalent.

EC8. within 5 km from the current coast line or, if more distant, located under 20 m a.s.l.

These areas can be subject to marine ingression; moreover, they are characterized by the presence of shallow groundwater, saline wedges, river outfall and delta, dunes, lagoons and marshes. The corrosive effects of the marine climate may have an impact on the resistance to degradation of the disposal facility's structure. The areas near the coast are, in general, touristic and densely populated.

EC9. interested by morphogenetic karst processes or with presence of sinkholes

The morphogenetic karst process causes high permeability due to fractures and abundant groundwater circulation. Potential collapses of hypogean cave karst vaults can cause problems even at surface level. Area with presence of sinkholes are listed in the National Database of Sinkholes.

EC10. with near surface piezometric levels or with piezometric levels which could anyhow interfere with the foundation of the disposal facility

Proximity of groundwater, with the known seasonal and non-seasonal changes in its levels, can reduce the isolation grade of the disposal facility and facilitate the radionuclides transfer into the biosphere. For the same reason areas with spring water and the intake structures of aqueducts are to be excluded.

EC11. naturalistic, protected under the legislation in force;

These are areas characterised by the presence of landscape assets, habitats and animal and plant species to be preserved: national, regional and interregional parks, national and regional nature reserves, nature oasis, geo-parks, SACs (Special Areas of Conservation) and SPAs (Special Protection Areas), and humid areas as identified by the Ramsar Convention [Ref. 11,14,15][6];

EC12. at a unsuitable distance from residential zones

The distance from residential zones has to be such to prevent possible interferences, taking into account also the expected future development of the zone itself.

[6] The protected natural areas of Italy are listed in the cartographic geo-portal of the Ministry of environment and protection of land and sea.

EC13. within a distance of 1 km from highways, all principal suburban roads, and the main and complementary railway lines

This distance from these communication routes[7] takes into account the potential impact that accidents, especially in case of transport of hazardous materials (gas, flammable liquids, explosives) can have on the disposal facility.

EC14. with known presence of underground resources

The exploitation of underground resources already considered by the territorial planning tools and constraints [water, energy (gas, oil or geothermal) and mining] may be affected by the construction of the disposal facility and may result in future settlements of human activities, compromising the isolation of the disposal facility.

EC15. with industrial activities involving major accident hazards[8], dams and artificial hydraulic barriers, airports or operating military shooting ranges

In presence of dams or artificial hydraulic barriers also those areas which would become floodable in case of barriersô break must be excluded.

II.2 Investigation criteria (IC)

In the siting phase the following aspects shall be assessed:

IC1. presence of secondary volcanic activities

Further significant aspects, such as the presence of sites with secondary volcanic activities or of volcanic materials remoulded by superficial and/or gravitational flows, have to be assessed in the phase of detailed characterisation. Reference has to be made also to phenomena not assessed under EC1.

[7] Classification of the roads is available at the DBPrioir database.
[8] See L.D. n.334/99

IC2. presence of significant vertical movements as a result of subsidence and uplift phenomena (tectonic and/or isostatic)

These phenomena are linked to natural causes of geological and/or anthropogenic nature.

IC3. geological-morphostructural setting and presence of lithotypes with vertical and lateral variation

These aspects affect the geological-technical modelling required for the evaluation of the disposal facility interaction with the ground. Reference has to be made also to phenomena other than those assessed under EC3.

IC4. presence of endorheic type river basins

These closed basins have no outflowing river and constitute a convergence point for the surface hydrographic network. In case of intense and long rainfall the deepest points of the endorheic basin can become subject to water stagnation. Reference has to be made to phenomena other than those assessed under EC4.

IC5. presence of accelerated erosion phenomena

In these areas, in rapid morphological evolution, there are many gullies, crest lines, edge of erosional fluvial scarp, deep valleys and high density of drainage. Reference has to be made to phenomena other than those evidenced under EC4.

IC6. weather and climatic conditions

a) *rainfall, snowfall and wind regimes;*
b) *extreme events.*

IC7. physical and mechanical parameters of the soil

These features affect in particular the soil bearing capacity and the susceptibility to liquefaction phenomena.

IC8. hydrogeological parameters

(a) distance of piezometric levels from the near surface level and from the foundation of the facility and their periodic, seasonal and non-seasonal fluctuations;

(b) distance from springs and other water collection points;

(c) characteristics of hydraulic conductivity of the aquifers, including thetop and bottom boundaries of aquifers and acquicludes, their lateral extension and their permeability and storage coefficient;

(d) average hydraulic gradient of the area and velocity of underground stream;

(e) effective infiltration rate;

(f) extension of the groundwater recharge areas of the aquifers and their distance from the examined area;

(g) use of water for direct or indirect human nutrition scopes;

(h) degree of complexity and possibility of modelling the aquifer system.

Reference has to be made to phenomena and parameters other than those assessed under EC10.

IC9. chemical parameters of soil and groundwater

Some features, such as cationic exchange capacity, presence of organic substances, presence of oxide /hydroxides of Fe, Mn and Al, etc. provide information on the effectiveness of the ground to limit the transfer of radionuclides in the groundwater. Other features may, on the contrary, determine degradation of the structures of the disposal facility.

IC10. Habitats, animal and plant species of conservation importance, as well as geosites

It should be taken into account, beyond the protected natural areas referred to under CE11, the Annexes of the Directives 92/43/EEC and 2009/147/EC for habitats, plant and animal species, also the ISPRA database of Geosites. In the characterization phase also the possible presence of endangered species reported in the Italian Red List of Flora and Fauna (International Union of Conservation of Nature - IUCN) shall be considered.

IC11. agricultural production of outstanding quality and places of archaeological and historical interest

IC12. availability of primary transport infrastructures

The availability of infrastructures (such as for example highways, principal suburban roads, main and complementary railway lines) allows to easily reach the disposal facility, minimizing the risks associated to possible accidents during the transport of radioactive waste.

IC13. presence of relevant or strategic critical infrastructures

The possible mutual impact arising from the proximity of critical or strategic infrastructures (such as for example facilities for production, storage and distribution of electricity, natural gas and fuel, and the strategic operating military settlements) has to be assessed.

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13. Legge 9 dicembre 1998, n. 426 ï ***ñ****Nuovi interventi in campo ambientale****ò***.

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15. Decreto del Presidente della Repubblica 13 marzo 1976, n. 488 e successivo Decreto del Presidente della Repubblica 11 febbraio 1987 n. 184 ï *ñRatifica della Convenzione di Ramsar sulle zone umide del 2 febbraio 1971***ò**.
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32. IAEA ï International Review of the ISPRA Technical Guide No. 29 on ***ñ****Siting Criteria of a Near Surface Disposal Facility for Low Level Radioactive Waste****ò*** ï September 2013.

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