Agenzia nazionale per le nuove tecnologie,
l'energia e lo sviluppo economico sostenibile

The role of Nuclear Material Characterization Laboratory in the field of radioactive wastes research

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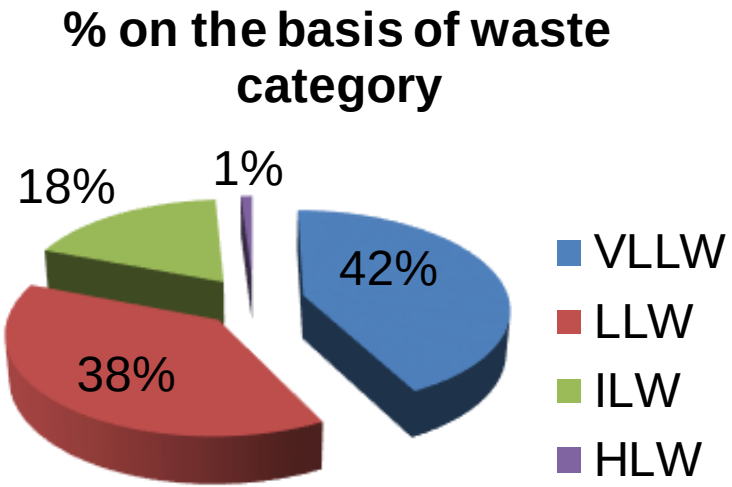
Radwaste inventory in Italy*

Italy will generate ≈ 95.000 m^3 on the next 50 years. They come from:

- Existing waste from the operations of NPP's and Fuel Cycle installations, shutdown in the 80's
- Future waste from decommissioning of NPP's and Fuel Cycle installations, shutdown in the 80's
- Non-nuclear institutional waste generated to date
- Non-nuclear institutional waste from future medical, industry and research activities

Forecast of overall volumes disposed of



*Source: A. Paratore. SOGIN SpA – NEA Workshop on the Management of Non-Nuclear Radioactive Waste – Legnaro, 2 May 2017

Italian radioactive waste classification*

Waste Category	Limits
Exempt Waste	Waste that can be free-released according to the Italian regulation (T/2<75 d; < 1 Bq/g)
Very Short Lived	Waste containing very short half-life radionuclides (T½ < 100 days) that, within 5 years, can be free-released according to the Italian regulation.
Very Low Activity	Waste with a total radioactivity concentration ≤ 100 Bq/g of which alpha-emitters ≤ 10 Bq/g.
Low Activity	Waste with a radioactivity concentration as follows: - Short half-life radionuclides (T½ < 31 years) ≤ 5 MBq/g - Long half-life radionuclides ≤ 400 Bq/g - ^{59}Ni and ^{63}Ni ≤ 40 kBq/g
Medium Activity	Waste with a radioactivity concentration exceeding the LLW limits and without heat generation
High Activity	Waste with a high concentration of long half-life radionuclides and/or heat generation

*Source: A. Paratore – NEA Workshop on the Management of Non-Nuclear Radioactive Waste – Legnaro, 2 May 2017

Radioactive waste storage major locations

In Italy there are many sites for the temporarily store radioactive waste and sources that derive from nuclear medicine and scientific and technological research.

It is at the end of administrative process the siting of Italian national repository

Italian National Repository and Technology Park*

Radioactive waste strategy

- The National Repository is a surface environmental infrastructure where radioactive waste can be safely disposed. Once constructed, the decommissioning of Italian nuclear plants can be completed and all radioactive waste, including that generated by nuclear medicine, industrial and research activities, will be appropriately managed.
- The Technology Park, to be built along with the National Repository, will be conceived as a research centre open to international partnerships and equipped to carry out activities in the area of radioactive waste management and sustainable development, in agreement with the local communities.
- The National Repository is expected to receive progressively an overall amount of about 90,000 cubic meters of radioactive waste, 60% of which deriving from nuclear plant decommissioning and the remaining 40% from scientific research, medical and industrial applications, including waste produced to date and that which is estimated to be generated over the next 50 years.

*Source: SOGIN SpA website – https://www.sogin.it/en/about-us/The-Technology-Park-and-The-National-Repository/Pages/the-technology-park-and-the-national-repository.aspx

ENEA

ENEA is the National Agency for New Technologies, Energy and Sustainable Economic Development, a public body aimed at research, technological innovation and the provision of advanced services to enterprises, public administration and citizens in the sectors of energy, the environment and sustainable economic development

- Since its very foundation, ENEA performs R&D on nuclear fission. At present, activities are mainly focused on research and development of advanced nuclear systems for innovative production plants and for medium-, long-term problem solving related to both the availability of fuel resources and the reduction of long-life radioactive wastes.
- Still within nuclear fission, ENEA plays an important role for: qualification of nuclear components and systems; ionizing radiation metrology; radiation protection.
- ENEA hosts the National Contact Point for the transport of radioactive materials and the Integrated Service for the management of non-electro-nuclear radioactive waste.
- ENEA is a member of ARIUS/ERDO - Working Group

Nuclear material characterization lab: role and tasks

- Planning and execution of radiological characterization measurements for nuclear materials and radioactive waste.
- Study, development, and application of innovative radiological characterization techniques for radioactive materials.
- Qualification and characterization of conditioning matrices for radwaste management.
- Provision of technical-scientific and operational Public Administration Offices for issues related to radiological characterization.
- National Contact Point for the fight against illegal radioactive material trafficking.

RADIOLOGICAL CHARACTERIZATION

Objective: determine the intrinsic characteristics of the materials at the time of manufacture

Destructive Analysis Techniques carried out in the laboratory with chemical methods feature:

- accuracy and precision;
- long measurement times;
- Loss of integrity of the original material;
- Need of uniform and sufficiently representative samples;

Liquid Scintillation Counting

ICP-MS (Inductively Coupled Plasma-Mass Spectrometry)

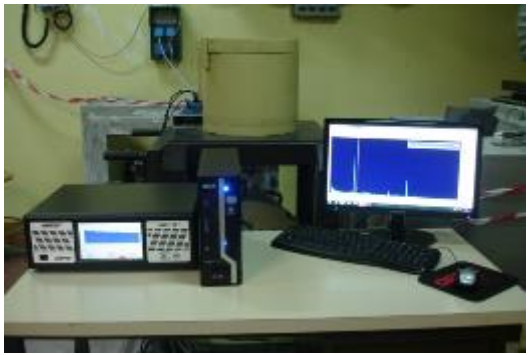
α Spectrometry

RADIOLOGICAL CHARACTERIZATION

Non-Destructive Analysis Techniques

- observation of nuclear spontaneous (passive) or induced radiation (active):
- no alteration of the physical and chemical form of the material;
- generally short measuring times;
- lower accuracy.

SRWGA – Sea Radioactive Waste Gamma Analyzer



Multi Group Analysis System

RAMAN, UV-Vis, FTIR Spectroscopy

Mobile Laboratory

Mobile Laboratory and In Situ characterization

Our mobile laboratory is specifically designed and equipped to carry out non-destructive characterization analysis of radioactive materials in the field

In the rear part a mobile platform is installed to have an easy handling of the ISOCS (In Situ Object Counting System) system or other transportable instruments.

The mobile laboratory is equipped with custom-designed housings for the instrumentations and has a radiochemical fume hood that allows the confinement of suspected samples.

ISOCS – In Situ Object Counting System

SSNC - Small Samples Neutron Counters

InSpector 1000

Radiochemical fume hood

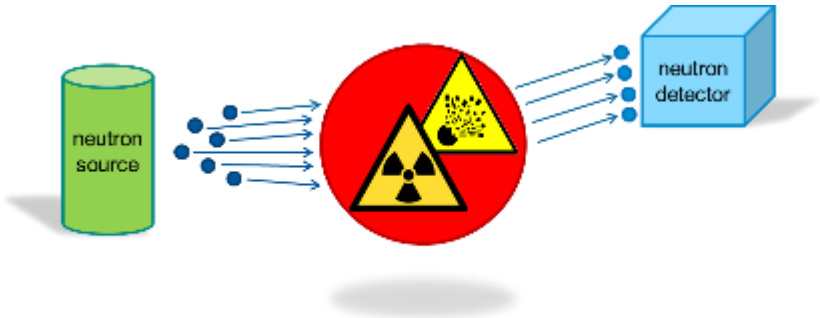
LB123P Berthold Plutonium Monitor

Neutron Active Interrogation System

The purpose of the system is the non destructive determination of the amount of fissile and fertile material as ^{235}U, ^{239}Pu, and ^{238}U in suspected samples.

Main Components:

- interrogation neutron source – Neutron Generator
- moderator for the neutron thermalization – Polyethylene
- neutron detectors – ^{3}He detectors



Waste management in the Italian context: Integrated Service

- The Integrated Service for the management of non-electronuclear radioactive waste is a group of authorized Operators (including NUCLECO) which ensures all the stages of radioactive waste management cycle produced in the medical, industrial, and scientific activities.

- ENEA is responsible, by Law, for the Integrated Service and, since 2007, pursuant to Legislative Decree No. 52 of 6 February 2007, the Integrated Service deals also with orphan sources (radioactive sources whose origin cannot be determined).

- ENEA plays a major role in the management of low- and medium-level radioactive waste and high-activity sealed radioactive sources originating from medical, industrial, and scientific activities.

THE CETRA LABORATORY (1)

The CETRA is our facility dedicated to the researches on encapsulation technologies for nuclear wastes.

The CETRA was the Italian national reference laboratory for the qualification and characterization of cement matrices for the encapsulation of nuclear waste according to the Italian technical guide n° 26 ENEA DISP.

Mechanical, physical and chemical tests performed in CETRAlab:

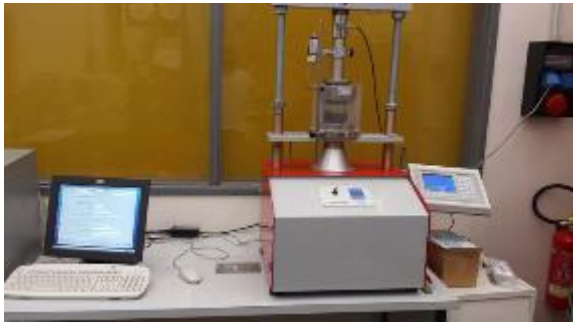
- Compressive strength test
- Resistance to thermal cycling freeze-thaw (i.e. 30 thermal cycles of 24 hours from -40 ° C to + 40 ° C)
- Resistance to radiation (i.e. compressive strength up to 500 N/cm2 following exposition 106 Gy)
- Fire resistance (ASTM D 635-81)
- Leaching in water
- Biodegradation resistance
- Immersion resistance (i.e. 90 days in fresh water without swelling)

THE CETRA LABORATORY (2)

MP - AES

VICAT apparatus

Environmental test chambers



Micro-Press

Research areas of the laboratory for conditioning and treatment of radioactive wastes

1. Pyroprocess experiments and experimental studies on Sodalite as matrix for immobilization of spent chloride salt waste
2. Physical and chemical treatments of carbon-14 contaminated wastes (i.e. steels, Zircaloys, irradiated graphite) (Carbowaste, CAST)

Glovebox for pyroprocess experiment

Research areas of candidate

1. Novel phytoremediation strategies using hyperaccumulating plants for the production of valuable no-food oil and recovery of radioactive contaminated waters
2. Innovative materials to improve the mechanical and thermal properties of concrete

Recent scientific work

- R. Mancini, D. Mirabile Gattia, F. Girardi. Study on improved cements with Graphene Oxide" *Proceedings of the 25th International Symposium on Metastable, Amorphous and Nanostructured Materials* (ISMANAM 2018) Rome, Italy 2-6 July 2018.

Thanks for your attention

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