nuclearеurope
Supporting a sustainable future

CLEARANCE OF MATERIALS

NUCLEAR

IS A LOW-CARBON ENERGY SOURCE

ENSURES SECURITY OF SUPPLY

IS ENVIRONMENTALLY, ECONOMICALLY AND SOCIALLY SUSTAINABLE

EU NUCLEAR INDUSTRY IN NUMBERS

ACCOUNTS FOR
25%
OF ELECTRICITY

ALMOST
50%
OF LOW-CARBON ELECTRICITY

SUPPORTS AROUND
1Mn
JOBS

TURNOVER OF
100bn
PER YEAR

September 2022

Introduction

Many people associate nuclear power with long-lived radioactive waste which needs to be isolated for long periods of time. It is true that the operation, maintenance, and decommissioning of nuclear facilities generates certain amounts of such waste. However, the volume of highly radioactive material generated is fairly low. Most materials found within a nuclear power plant are considered as either potentially contaminated or only contaminated on the surface, which in most cases allows them to be cleaned up. Any material from a nuclear facility is considered radioactive until it undergoes a process called clearance which potentially means that it no longer has to undergo regulatory control.

The purpose of this document is to provide insights on the clearance process and the benefits it brings.

1. How does material become radioactive?

Within the nuclear industry there are three different reasons why a material can be considered as radioactive:

(1) Materials that are radioactive from the start.
(2) Materials that have been exposed to radiation causing activation of the material.
(3) Materials that have, or may have, been contaminated by radioactive particles.

A small part of the material within a nuclear power plant may fall under two or all three of the points listed above. Most materials are either not radioactive to start with nor exposed to radiation which would change the properties of the material.

Contaminated materials can, in most cases, be cleaned (decontaminated) as the radioactivity is only on the surface.

2. What is clearance?

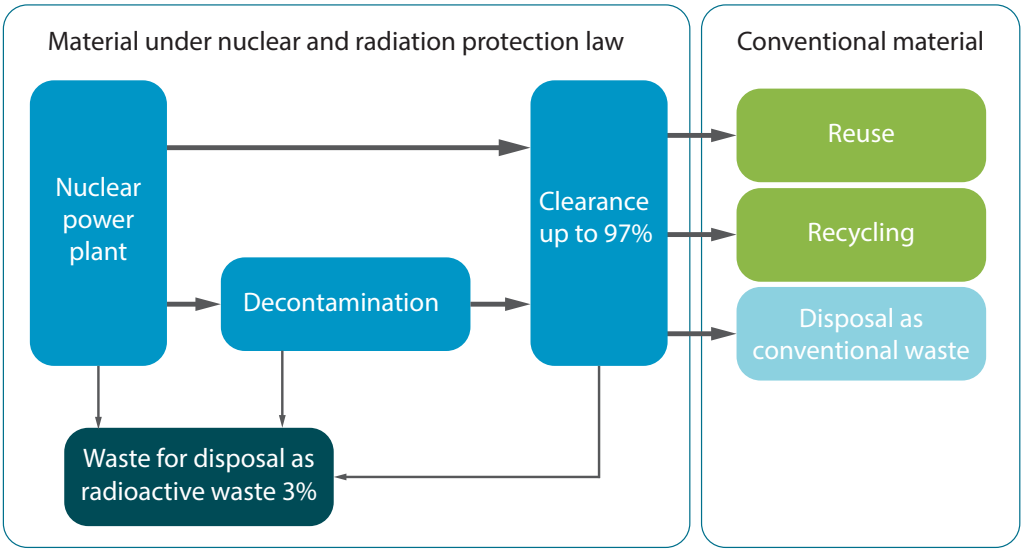

Figure 1: What is clearance?

According to the International Atomic Energy Agency (IAEA)[1] clearance is the "Removal of regulatory control by the regulatory body from radioactive material or radioactive objects within notified or authorized facilities and

[1] International Atomic Energy Agency. (2018). IAEA safety glossary: terminology used in nuclear safety and radiation protection. Internat. Atomic Energy Agency.

activities". It is based on a clearance "value, established by a regulatory body and expressed in terms of activity concentration, at or below which regulatory control may be removed from a source of radiation within a notified or authorized practice." The clearance value is supported by data and conservative scenario analyses.

3. How can radioactive materials become clean and suitable for re-use and recycling?

Firstly, it must be stated that most materials from within a nuclear installation are only potentially contaminated, i.e. the only thing which needs to be done is to conduct verification measurements prior to their clearance.

Secondly, most of the materials which are contaminated have either a surface layer or material properties which prevent contamination (of any kind) from entering the structure of an object. For example, painted concrete walls or metals. Radiological contamination is typically either loose or fixed particles on a material surface.

Surface contaminated materials can be rendered non-radioactive either through cleaning or by removing the contaminated surface layer. This is called decontamination. Decontamination can be performed in different ways, ranging from use of a wet tissue to advanced mechanical, chemical or thermal processes. The success of the decontamination is always verified by proper measurements.

It must be noted that any material which may have absorbed a radioactive contamination that cannot be properly quantified, is not a candidate for clearance.

4. Benefits of clearance

There are several benefits to the implementation of clearance:

- Components can get a second life thanks to re-use.
- Material is recycled into new products reducing the need for virgin material.
- Cleared waste can be disposed of at conventional disposal sites for non-hazardous or hazardous waste.
- Final radioactive waste repositories are only limited to waste that does have to be isolated.
- Reduction of CO2 footprint thanks to re-use and recycling.

The EU's Waste Framework Directive[2] adopted in 2008 establishes a waste hierarchy according to which waste should be subject to re-use and recycling prior to disposal. Clearance is a strong tool which supports this hierarchy within the nuclear industry.

Clearance offers a second life to materials and objects that would otherwise end up being disposed of, whilst at the same time ensuring that the radiological level of these materials is under the regulatory limit.

In addition to promoting a circular economy, clearance also enables a reduction in licensed radioactive waste repository volumes. Some of the waste that goes through the clearance process will end up being being treated as conventional waste destined for energy recovery or disposal. Energy recovery is preferred over disposal as per the waste hierarchy.

Clearance enables the nuclear industry to reduce the volumes of waste which require final disposal and helps to apply a circular economy within the sector thanks to increased re-use and recycling.

[2] *Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on Waste and Repealing Certain Directives (Text with EEA Relevance)*. 5 July 2018, http://data.europa.eu/eli/dir/2008/98/2018-07-05/eng.

5. Which types of materials are candidates for clearance?

As mentioned earlier, most of the materials inside a nuclear installation are neither affected by neutron activation nor contaminated by radionuclides. Some slightly contaminated materials can be cleaned through simple means, whilst other materials require more advanced decontamination. Experience in Germany shows that when decommissioning a power plant only 3 percent of the waste generates must be stored as radioactive waste[3]. Indeed, a lot of the plant equipment has a significant value if it can be re-used or recycled outside of the nuclear sector.

Examples of equipment suitable for re-use include cranes, electric motors, gear boxes, structural arrangements.

Examples of materials that can be recycled include steel (carbon and stainless), aluminium, copper, brass, titanium, lead, and construction materials such as concrete.

Most of the radioactive waste and material with low radioactivity concentrations is solid, but there are situations when liquids (and even gases) may also be suitable for clearance[4].

6. Exclusions and exemptions

Clearance must not be mistaken with exemptions or exclusions that represent different ways whereby certain substances are not controlled by a regulatory body.

- Exemptions:

Exemption refers to the determination by a regulatory body that a source or practice need not be subject to some or all aspects of regulatory control.

- Exclusions:

Excluded exposures are such that it is not possible to implement control measures through regulatory action, regardless of their magnitude. For example, it is not feasible or practical to control the activity of potassium in the human body or cosmic radiation on the surface of the Earth.

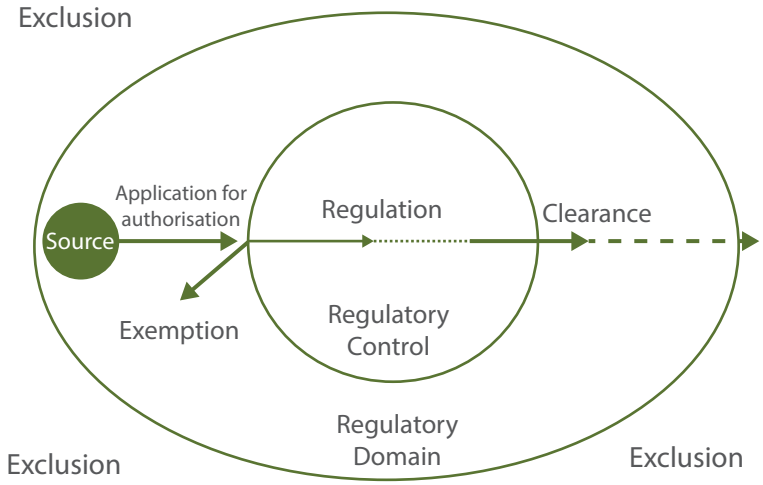

Figure 2: Clearance, Exemption, Exclusion[5]

Clearance is, as mentioned previously, "Removal of regulatory control by the regulatory body from radioactive material or radioactive objects within notified or authorized facilities and activities".

[3] Clearance during Nuclear Power Plant Decommissioning | Portal on Nuclear Safety.
[4] International Atomic Energy Agency. (2021). IAEA safety standards for protecting people and the environment.
[5] V. Ljubenov (2017) *IAEA Activities Related to Clearance and Exemption*, IAEA. [Presentation]

7. Clearance process

The clearance process is both safe and secure. It involves the owner of the material and the regulatory body. In terms of treatment, it may require segregation, segmentation, decontamination and/or a thermal process prior to radiological assessment.

Only very short-lived radioactive waste can be cleared after storage, when its radioactivity falls below the clearance levels. Other properties, e.g. the hazardous properties of the waste or material, will determine whether other controls remain in place or become appropriate[6].

Clearance is deeply linked to the concept of triviality of exposure, generally taken to mean:

- The radiation risks to individuals caused by the practice or source are low enough to be considered as trivial
- The collective radiological impact of the practice or source is low enough so as not to warrant regulatory control under prevailing circumstances
- The practices and sources are inherently safe, with no appreciable likelihood of scenarios that could lead to doses above the dose limit.

In quantitative terms, this is generally related to the stipulation that the effective dose expected to be incurred by any member of the public due to cleared materials is around 10 micro-Sieverts (μSv) or less in a year. In comparison, the average dose from other sources (not related to nuclear installations), are in the order of thousands of micro-Sieverts per year[7].

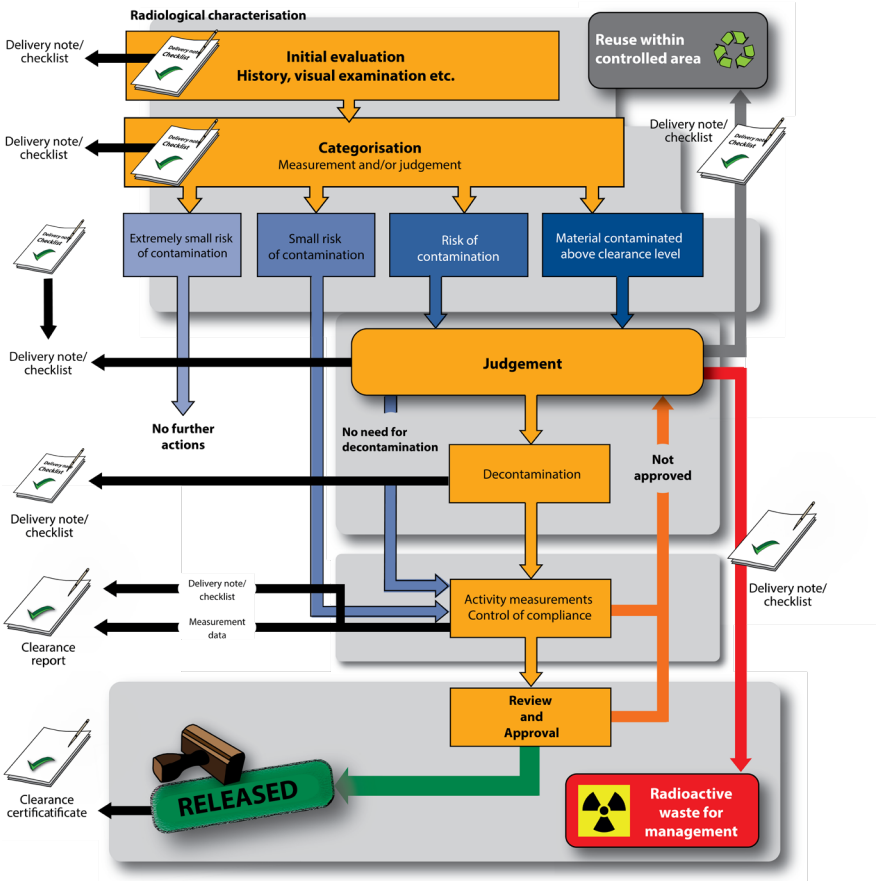

Figure 3: The clearance process (example from Sweden)[8]

[6] IAEA (2021), *op. cit.*

[7] A. Larsson (2019) *Clearance of Metal for Recycling -Different Approaches and Key References,* World Nuclear Association. [Presentation]

[8] Ibid.

8. Types of clearance

There are multiple clearance options available, allowing flexibility, security and offering a specific path for every material subject to clearance[9]:

Metals:

- General clearance of metals for direct reuse, recycling or eventual disposal
- Specific (conditional) clearance of metals enables the melting in a conventional foundry, together with other materials, in the process of manufacturing new products
- Processing (decontamination and melting) in a licensed nuclear facility and clearance of the castings generated enables recycling into new products.

Other materials:

- General clearance of components and materials for reuse or recycling
- General or specific clearance of building rubble for direct reuse or recycling
- General or specific clearance for disposal at a disposal site for non-hazardous or hazardous waste.

9. EU harmonization

Many countries have based their clearance regulation (or part of it) on guidance documents by the International Atomic Energy Agency and/or European Atomic Energy Community.

Nevertheless, clearance options are implemented according to various circumstances, based on country-specific evaluations. For example, sometimes clearance may not be possible due to current regulatory restrictions (such as in France).

In practice, different clearance conditions may be implemented within the different countries, while manufactured products or materials may circulate within any EU country. The result is that conditions for release may appear to be defined at a national level, while part of the materials or products in use in the country may satisfy other requirements for use in another country.

This de facto emphasizes the fact that, at least at European level, the clearance framework should be consistent, and the current different national regulations should be harmonized.

As far as products (such as recycled metals) are often exchanged world-wide, a common approach to clearance and release should also be developed at an international level.

[9] OECD Nuclear Energy Agency. (2008). *Release of radioactive materials and buildings from regulatory control: A status report.*

About us

nucleareurope is the Brussels-based trade association for the nuclear energy industry in Europe. The membership of nucleareurope is made up of 15 national nuclear associations and through these associations, nucleareurope represents nearly 3,000 European companies working in the industry and supporting around 1.1 million jobs.

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