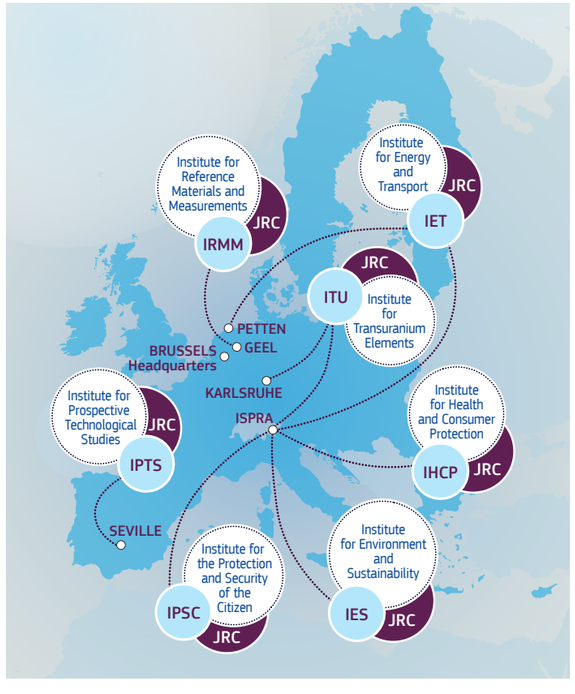

Joint Research Centre

The European Commission's in-house science service

JRC mission

As the Commission's in-house science service, the Joint Research Centre's mission is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle.

Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges while stimulating innovation through developing new methods, tools and standards, and sharing its know-how with the Member States, the scientific community and international partners.

Facts & figures about the JRC

Established in 1957
Around 3 000 scientific and technical personnel
7 scientific institutes
1 370 publications in 2014

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Serving society
Stimulating innovation
Supporting legislation

European Commission

Science for nuclear safety and security

This leaflet provides an overview of the work of the Joint Research Centre, the European Commission's in-house science service, in the domain of nuclear safety and security.

There are currently more than 130 nuclear reactors in operation in 14 EU countries which produce 28% of the European Union's electricity, representing 66% of Europe's low-carbon electricity generation. The choice whether to use nuclear power in the energy mix is a national decision of the EU Member States. Some countries apply a nuclear phase-out policy, others have opted for long-term operation, while some countries decided to build new nuclear plants.

Ensuring nuclear safety and security has always been a priority for the EU. The March 2011 Council conclusions as well as the 2014 Nuclear Summit's final communiqué emphasise the need to give priority to the highest standards for nuclear safety and security in the EU and internationally.

The JRC supports the European Commission in fulfilling the obligations set up by the Euratom (European Atomic Energy Community) Treaty and several recommendations, decisions, regulations and directives in the areas of nuclear research, training and education and radiation protection.

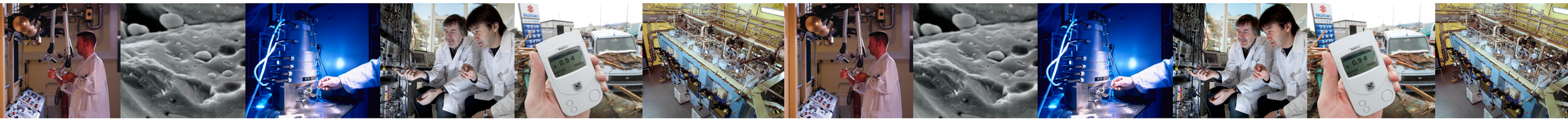
JRC research encompasses the safety of nuclear reactors, the nuclear fuel cycle, waste and decommissioning, the safe operation of nuclear energy systems, as well as nuclear safeguards, non-proliferation and trafficking of nuclear material.

Nuclear safety

Nuclear safety activities cover the whole life cycle of a nuclear installation, including nuclear reactor and fuel safety, nuclear waste management, decommissioning and emergency preparedness.

The JRC performs research in close collaboration with European partners to determine material properties and degradation mechanisms in order to assess safety margins for structural materials, fuel and nuclear components under normal and accident scenarios. The experimental work is conducted in dedicated laboratories that can simulate stress corrosion of reactor components or the behaviour of fuel under irradiation, and it is complemented with modelling and numerical simulation.

The JRC's AMALIA laboratory investigates the degradation mechanisms of structural materials exposed to light-water reactor environments, and in particular, corrosion and stress-corrosion cracking, which can contribute to ageing.



Joint Research Centre

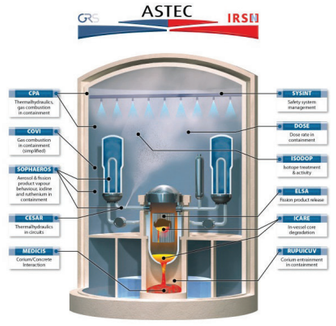
Within its unique experimental facilities, the JRC performs research to determine the safety limits of nuclear fuels and cycles under normal/off-normal operating conditions and severe accident scenarios. The final safety objective is to assess mechanical integrity of the fuel assemblies during reactor lifetime and beyond, and fuel response to transient conditions and to severe reactor accident conditions.

The JRC hot cells facility for the study of nuclear fuel safety. Nuclear fuel safety research involves experiments simulating under normal, transient and accidental conditions, in order to determine the safety limits of nuclear fuel.

The JRC closely co-operates with national and international organisations to support the development and improvement of nuclear safety standards. Beyond EU borders, and under the relevant EU instruments, the JRC supports projects addressing nuclear safety in EU candidate countries and other countries.

Accessing and analysing operational experience feedback from more than 400 operational nuclear reactors worldwide is important to improve nuclear safety. The JRC-operated European Union Clearinghouse initiative supports the EU nuclear safety authorities, technical support organisations, international organisations and the broader nuclear stakeholders community in this field.

The JRC was also involved in the EU nuclear 'stress tests' carried out after the accident in Fukushima. One of the main outcomes focuses on the importance of further reinforcing safety in the EU, and in particular accident analysis and management, as well as emergency preparedness of the EU countries.



The JRC's work on severe accident modelling and analyses for nuclear power plants focuses on the further development of the Accident Source Term Evaluation Code (ASTEC) computer code, the European reference computer code for the simulation of severe accidents in nuclear power plants.

© Institut de Radioprotection et de Sûreté Nucléaire (IRSN)/ Gesellschaft für Anlagen- und Reaktorsicherheit (GRS)

The JRC also works in the field of decommissioning and waste management to support governance and technology deployment, since many nuclear installations in Europe will soon reach the end of their operational lifecycles.

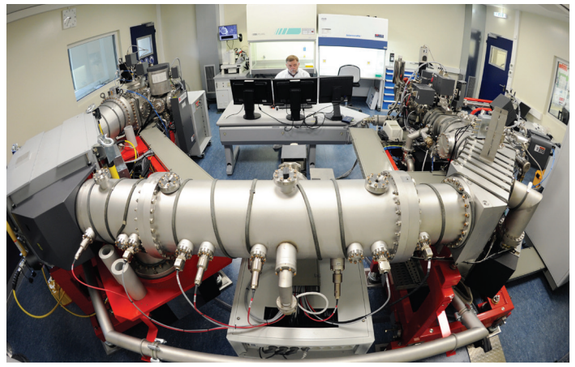
Nuclear safety: https://ec.europa.eu/jrc/en/research-topic/nuclear-safety

Nuclear security

Nuclear security deals with the physical protection and control of nuclear materials. JRC research topics in this area include nuclear safeguards, additional protocol, open source information on nuclear non-proliferation, combating illicit trafficking of nuclear materials and nuclear forensic analysis.

The JRC provides scientific, technical and operational support to the Commission's Directorate-Generals for Energy, which is responsible for nuclear safeguards, for Home Affairs, and for Development Cooperation under the chemical, biological, radiological and nuclear (CBRN) security action plan. It also co-operates with major partners in EU Member States and countries worldwide, as well as with the International Atomic Energy Agency (IAEA) in the areas of nuclear measurements, process monitoring, containment and surveillance and advanced safeguard approaches.

The JRC also contributes to the development and implementation of EU strategic trade controls, to the development of specific expertise in the forensic analysis of nuclear and radioactive materials, to the testing and standardisation of equipment, and to the enhancement of border security and related training efforts for frontline first responders and national experts in the detection and identification of nuclear materials.



The large geometry – secondary ion mass spectrometer which carries out highly sensitive trace analysis for the detection of clandestine nuclear activities and for the identification of seized materials from illicit trafficking. Inaugurated in 2012, the joint JRC and Directorate-General for Energy project verifies ^{235}U enrichments in declared facilities and supports the IAEA for the verification of the absence of undeclared nuclear activities.

Nuclear safeguards and security: https://ec.europa.eu/jrc/en/research-topic/nuclear-safeguards-and-security

Reference measurements, materials and standards

The JRC is a world-renowned and accredited provider of nuclear reference materials and measurements, which are important tools for the enforcement and monitoring of EU legislation. As the guardian of the European treaties, the Commission watches over the effective regional nuclear safeguards, by implementing inspections, reporting and providing technical and scientific support to its Member States in close partnership with the IAEA.

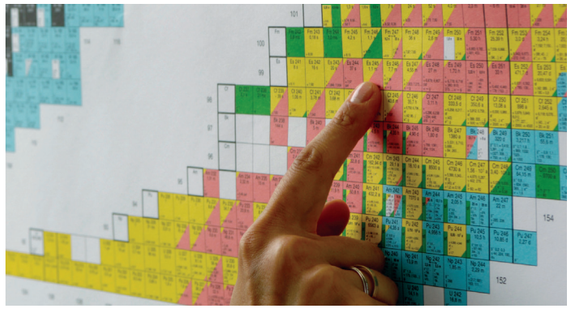
While the EU helps to ensure that nuclear energy activities in all Member States are pursued and enforced with the highest standards of nuclear safety, security and non-proliferation, it is fundamental that these EU standards are also harmonised with global initiatives. The JRC supports these activities by developing and providing nuclear reference materials and standards, which are used as benchmarks for control measurements and conformity assessments, so that safety and safeguards authorities and nuclear laboratories can demonstrate that their measurement results are reliable, traceable and globally comparable. The JRC also performs reference measurements that are used for safety and security assessments and for implementing standards.

Standardisation: http://europa.eu/!wK44mr

Nuclear knowledge management, training and education

The Euratom Treaty clearly underlines the role of the European Commission as the responsible entity for facilitating nuclear research in Member States and for carrying out an EU research and training programme. With its activities, the JRC supports the unanimous understanding among Member States to invest in nuclear safety and security research through cross-cutting activities such as education and training (E&T), in order to ensure that top-level competence and expertise for nuclear safety assessments are available in the EU.

The JRC's current education and training efforts can be grouped into three major activities: the management of nuclear expert knowledge, the contribution to the European E&T activities by hosting students and organising internships and specialised training courses in the fields of nuclear safety, safeguards, security and forensics, and the monitoring of human resources' development in the nuclear field in Europe.



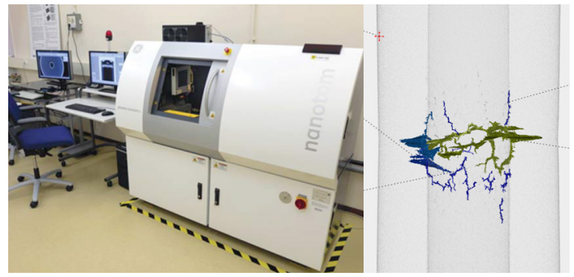
The JRC provides updates of the Karlsruhe Nuclide Chart, a living periodic table displaying all known isotopes of all elements and their radioactive data in a distinctly easy to navigate colour scheme. The Karlsruhe Nuclide Chart has been tracking new elements since 1958 and is the product of a longstanding partnership between the JRC and Karlsruhe Institute of Technology.

More info: https://ec.europa.eu/jrc/en/research-topic/nuclear-knowledge-management-training-and-education

Fostering the innovation flow

The JRC pursues innovation through EU research programmes in the areas of nuclear materials for new reactor technologies, nuclear transmutation, nuclear safeguards and nuclear non-proliferation, and safe design of innovative reactors.

The JRC works on nuclear structural materials that can be used in harsh new reactor environments by performing pre-normative research and development (R&D), delivering qualified data into codes and standards, developing novel test techniques, and advanced inspection procedures, which are intended for use in the next generation of reactors.

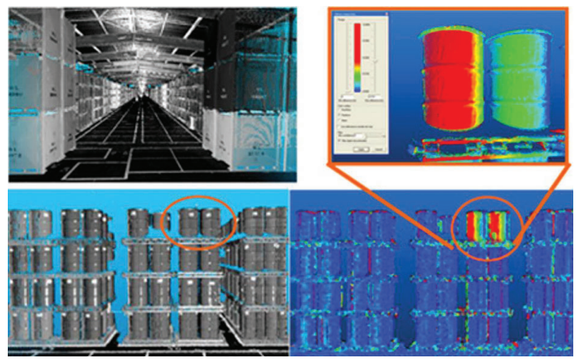


Three-dimensional X-ray tomography represents a powerful tool for the dimensional analysis and the detection of defects in service-exposed materials and components. The example on the right-hand side reveals cracks in a tubular component subjected to thermal fatigue.

Long-lived radionuclides, which are by-products of nuclear fission reactions, are of major concern for nuclear waste management. Fundamental safety properties at different stages of irradiation are addressed by innovative JRC programmes for the transmutation of these long-lived radionuclides to shorter-lived isotopes.

Research in nuclear safeguards and non-proliferation aims to prevent or detect the misuse of nuclear material. In order to tackle new security concerns associated with growing and increasingly advanced facilities, the JRC undertakes research and development in nuclear safeguards, non-proliferation and nuclear security with a view to develop high quality process monitoring, sealing and laser-based 3D verification techniques, and to carry out open-source media analyses.

As the safety of innovative reactor designs is essential in view of their potential deployment in Europe, the JRC works in partnership with European organisations on dedicated Euratom projects to develop safety assessment methodologies for innovative reactor designs, and to establish guidelines. Internationally, safety of future reactor designs is addressed within the Generation IV International Forum (GIF) where the JRC is actively contributing both with research, and as implementing agent of Euratom. It also applies innovative multi-physics computational approaches for safety analyses under simulated normal, transient and accidental operational modes.



The JRC has developed laser-based systems that create accurate 3D models of nuclear facilities, both indoor and outdoor, and which are able to detect any change to the nearest millimetre. 3D systems were introduced to support Design Information Verification (DIV) activities in large and complex nuclear facilities, such as storage areas at an enrichment plant.

Thematic report on nuclear safety and security: https://ec.europa.eu/jrc/sites/default/files/jrc-science-for-nuclear-safety-security-report.pdf