



WORKSHOP 2

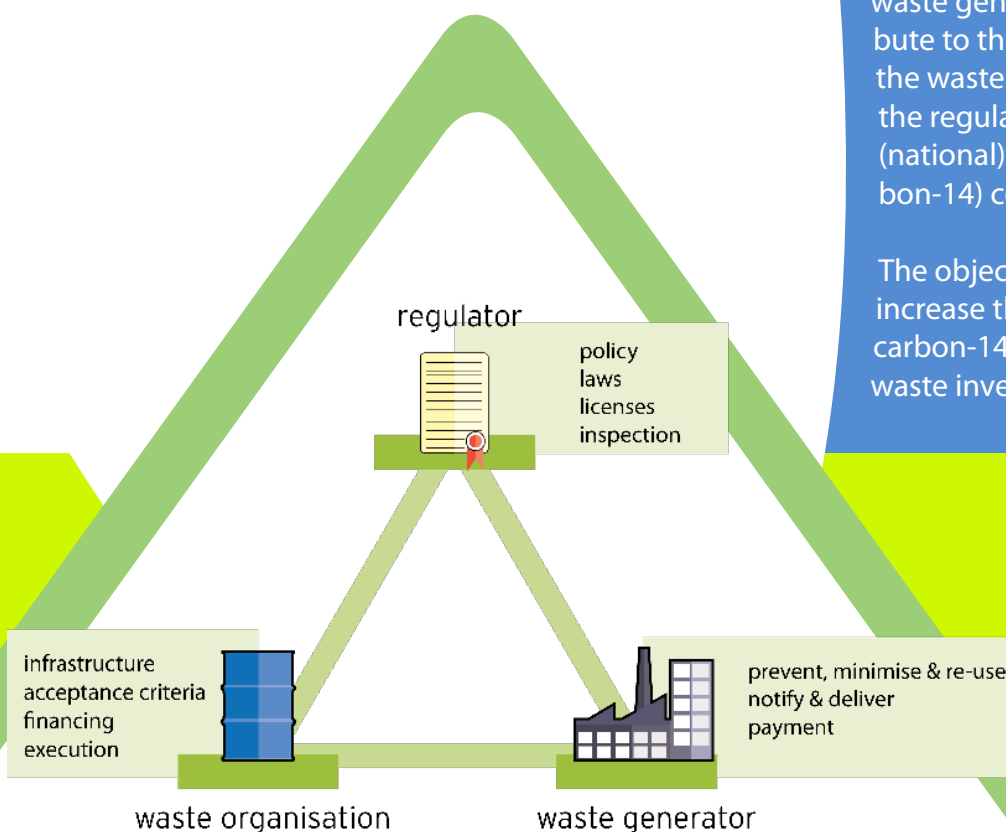
CAST (Carbon-14 Source Term) is an EU research project that aims to develop understanding of the potential release of carbon-14 from radioactive waste materials under conditions relevant to waste packaging and disposal to underground geological disposal facilities. The project focusses on the release of carbon-14 as dissolved and gaseous species from irradiated metals (steels, Zircalloys), irradiated graphite and spent ion-exchange resins.

Carbon-14 is a radionuclide that cannot be measured from the waste non-destructively. The substantiation for the carbon-14 content and distribution can therefore be best defined upon generation or processing e.g. in discussion with the waste generator or producer. This workshop can be used by countries advanced or executing the disposal of (one of) these 4 types of waste to optimize the disposal volume. This workshop can help countries less advanced into disposal of waste in drafting the carbon-14 inventory for the 4 types of waste investigated in CAST.

Two workshops are envisaged in CAST for participants with an interest in the research executed in CAST, but who can also contribute to the confidence in national safety assessments. The research is evaluated from different perspectives in order to specify this contribution. The scientific progress is already evaluated by the CAST Advisory Group and results obtained in CAST have been and will be presented at several scientific fora.

For an implementation of the new understanding developed in CAST, stakeholders with a responsibility in the management of radioactive waste are envisaged. The institutional arrangement of these responsibilities can be viewed in a triangle in which regulators, waste (management) organisation and waste generators have clearly defined roles. The waste organisation is responsible for the management and eventual disposal of (carbon-14 containing) waste. For CAST, the waste generator (or producer) can contribute to the reliability of the characterization of the waste for disposal; the contribution by the regulator is expected to depend on the (national) progression in disposal of (carbon-14) containing waste.

The objective of the second workshop is to increase the confidence and reliability of the carbon-14 source term for the four types of waste investigated in CAST.



Dissemination from CAST

A two-fold aim for the second workshop is:

1. to present the results obtained;
2. to discuss the outcomes with regulators, waste management organisations and waste generators

The second workshop takes place in Lyon at IBIS hotel near the Institute de Physique Nucleaire because the obtained results are presented there in the CAST Final symposium. The photo on the right is the location where the symposium and workshop will be held.



Steels

Steel is frequently used in water moderated reactors, and the largest structural material is the reactor vessel. Irradiated steel becomes (decommissioning) waste. Irradiated steel has an oxide layer at time of decommissioning. This layer passivates iron by which the corrosion rate can be more than two orders in magnitude smaller than without this layer. Cementitious materials further condition this layer. A significant fraction of carbon-14 may have decayed and is not released to the surroundings. The latest results of the carbon speciation during release will be presented at the symposium. A small fraction of carbon-14 is measured to be released as a gas.

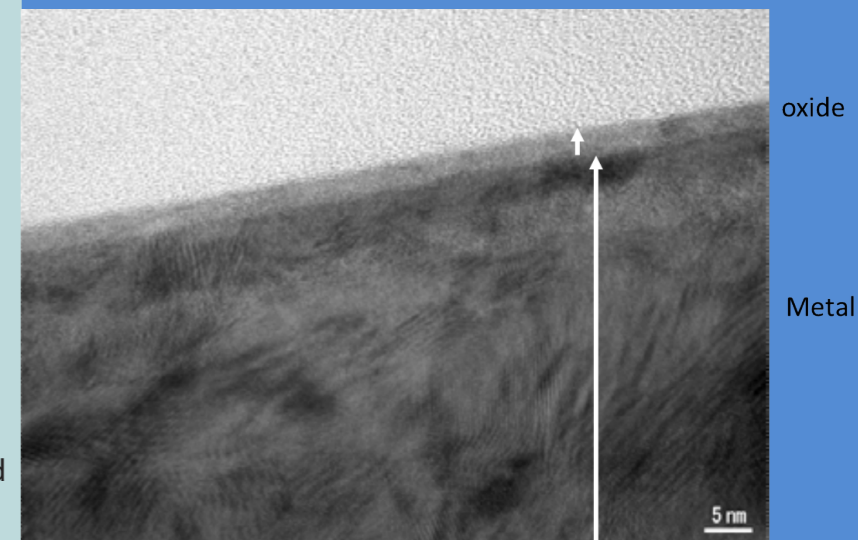


Photo on the left of irradiated steel is from CAST report D 2.5: Annual Progress Report on WP2- year 1

Contribution to CAST

The generation of the neutron activated radionuclide carbon-14 can be limited by reducing the nitrogen content in water and solid materials used in the reactor. As Low As Reasonably Achievable (ALARA) is preliminary explored for the types of waste investigated in CAST. Every country has its own measures and sharing each other's practices can further limit unnecessarily carbon-14 generation and increase the reliability of the carbon-14 content in waste.

Irradiated steel, zircaloy and graphite are investigated in CAST. For each solid material, each participating country presents - preferably by the waste generator :

- What is the nitrogen content?
- How is the nitrogen content determined / specified?
- What is the neutron irradiation period and thermal fluence?

Spent ion exchange resins are also investigated in CAST. These resins concentrate carbon-14 as an anion from the coolant and or moderator water. The carbon-14 concentration in resins depends on the substance to control the pH of the water and waste treatment.

Graphite waste

Some types of reactors use graphite moderators and reflectors, instead of water. This produces irradiated graphite, which may release carbon-14 under geological disposal conditions. In CAST, the results obtained in CarboWaste is put in a disposal perspective.

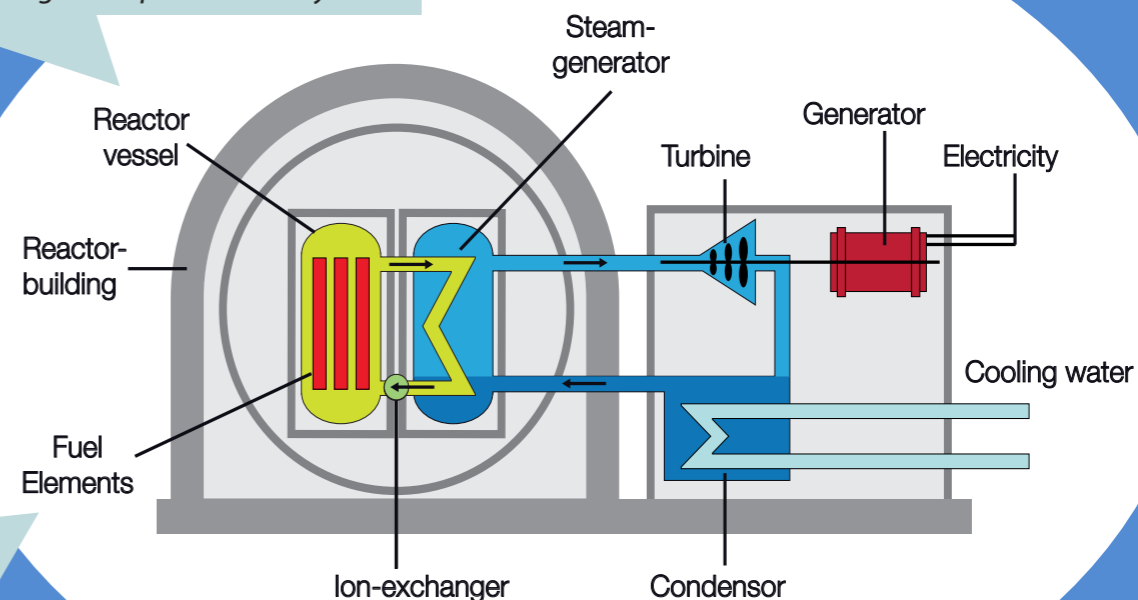
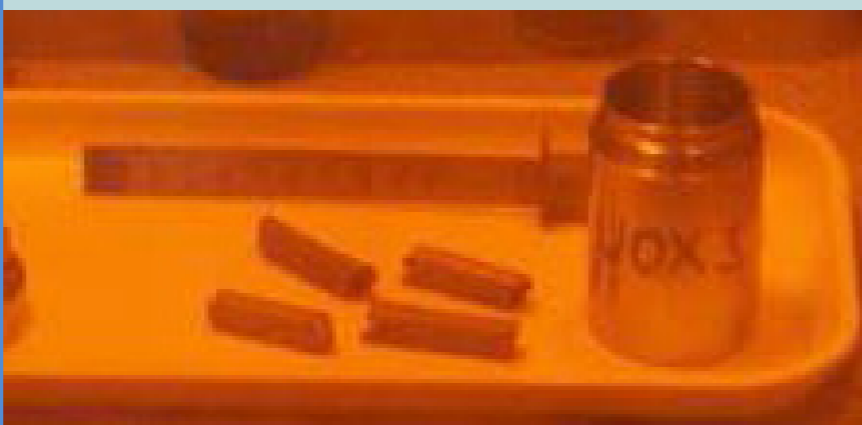
For the regulators, an overview of achievements of technical results for workshop 2 will be available soon at www.projectcast.eu in the section Training. Attempts have been made to answer the questions raised in the first workshop in this overview. This contribution from CAST to the regulators is to be evaluated in the second workshop. Initiated discussions can be completed during the second workshop.

Zircaloy

The cladding of fuel elements is preferably Zircaloy for its better corrosion resistance than for example stainless steel. Zircaloy is also a hydride-forming element that contains all tritium generated in nuclear fuel. In alkaline and pure water, Zircaloy gradually transforms into brittle zirconium as it corrodes. CAST provided further confidence in the low corrosion rates of Zircaloy.

From processing structural waste in AREVA La Hague, the flattened hulls were discarded to maximize the surface/volume ratio for experiments in CAST.

Photo from CAST report D3.2: Definition of operating conditions and presentation of the leaching experiments.



Ion-Exchange Resins

Ingress of air and the chemical substance to control the pH can both be a nitrogen source in the coolant and or moderator. Corrosion products from steel and zircaloy can also be an origin of carbon-14 in the primary circuit of the reactor. The base material for most resins used for filtering water is polystyrene, a chemical resistant organic material against nucleophilic attack. Conditioning of spent ion exchange resins with cementitious materials is therefore not expected to enhance degradation of these resins. The potential carbon-14 release mechanism may take place anion exchange. Gaseous carbon-14 release is not expected. *Photo below from a fractured cementitious surface with embedded resin beads.*



16 January 2018	18 January 2018
First day symposium: see flyer available at www.projectcast.eu	14:00-17:00 Workshop for regulators, waste management organisations and waste generators
Context carbon-14 in safety assessments Results obtained in CAST for neutron irradiated steel and Zircaloy	14:00-14:30 Evaluation regulators second overview technical achievements
17 January 2018	14:30-16:00 Contribution each participating country preferably waste generators
Second day symposium: see flyer available at www.projectcast.eu	16:00-16:30 Understanding potential carbon-14 release mechanisms
Results obtained in CAST for spent ion exchange resins and neutron irradiated graphite Outcomes of CAST in safety assessments	16:30-17:00 Wrap-up and closure
18 January 2018	
Third day symposium, morning: see flyer available at www.projectcast.eu	
Dissemination overview Expert review findings from Advisory Group Panel session waste management organisations	

A lot of public accessible reports are made in CAST. Detailed experimental set-ups are expected to be of interest for researchers performing experimental work e.g. at universities and institutes. Overviews are made to have a state-of-the art of knowledge and understanding in disposal of carbon-14 containing waste. This knowledge and understanding is integrated in a conceptual model and calculated in a safety assessment. The second workshop of CAST is organised in conjunction with the final CAST symposium since the dissemination of the final findings are considered to be of interest to regulators, waste organisations and waste generators. The outcomes of the research are presented for each type of waste investigated in CAST. On the final day, waste generators of each country i.e. experts working at a nuclear plant are asked to present the relevant knowledge available of carbon-14 in order to bind the carbon-14 inventory for the types of waste investigated in CAST and to share experiences to limit carbon-14 generation. The understanding of the potential release mechanism for each type of waste investigated in CAST will be discussed.

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CAST

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