

## Assessing the safety of a future facility

**Evaluating the safety of something that has never existed on such a scale: this is the challenge faced by IRSN experts with the future ITER experimental facility, from its conception, already completed, to its operation, in the future.**

Whereas French nuclear power plants derive their energy from nuclear fission, the aim of the ITER experimental facility [1], currently in construction in Cadarache (Bouches-du-Rhône, France), is to demonstrate the scientific and technological feasibility of the production and use of fusion energy. The ITER facility will be constantly under the attentive eye of IRSN experts who are seeing to the safety of the scientific experiment, never before conducted at such a scale, from its conception, a little before the end of the 2000s, up to the end of its operational phase, planned in several decades.

### Nuclear fusion or fission: what is the difference?

Current nuclear reactors produce energy from the fission of heavy atoms. The reactors prefigured by ITER will enable the generation of electricity from the fusion of light atoms. Explanations.

#### The principle of fusion

Fusion consists in combining two hydrogen atoms (deuterium and tritium) at temperatures of several millions of degrees, as exists at the heart of stars. When these light nuclei undergo fusion, the nucleus created is in an unstable state. It tries to recover a stable state by ejecting an atom of helium and a neutron with a lot of energy.

#### The principle of fission

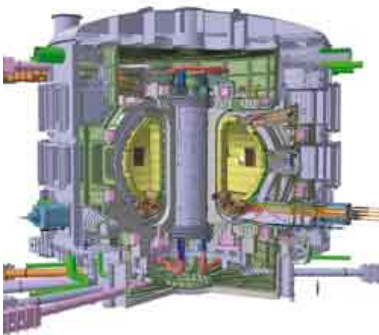
Fission consists in projecting a neutron into an unstable atom (uranium 235 or plutonium 239), which absorbs the neutron, causing it to break up into two lighter atoms. This produces energy, radioactive radiation and two or three neutrons capable in turn of provoking fission. And so on. This is what is known as a chain reaction mechanism

### The ITER experimental facility

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## A giant tokamak

ITER may be viewed as a large buoy-shaped vacuum chamber, known as a "tokamak". In this magnetic confinement chamber, the fuel, a mixture of deuterium and tritium (two isotopes of hydrogen), is heated to temperatures above 150 million degrees in order to obtain a hot plasma, an environment in which light elements such as deuterium and tritium can undergo fusion. This fusion reaction produces an inert gas, helium and, above all, energy.



"Plasma represents the fourth state of matter: when a solid element is heated, it becomes liquid; if it is heated further, it becomes a gas; and if it is heated even further, it becomes a plasma", recalls Didier Perrault, expert of the Institute responsible for coordinating the twenty or so IRSN specialists in fire, radiation protection, explosion, civil engineering, etc., mobilized to evaluate the safety of the ITER facility.

In nature, plasma is found in the sun, in the stars, in the aurora borealis and in lightning, where it reaches temperatures of several tens of millions of degrees. At a lower energy level, plasma is used in video screens, for example.

Given its size and thus the quantity of tritium (a radioactive element) necessary on the site, the ITER facility is classified as a basic nuclear facility (the acronym INB is used in French) according to French legislation.

"Out of the 250 tokamaks already constructed in the world, ITER is the first to be classified in this category of facility", explains Didier Perrault.

"In terms of safety, it should be

### Key figures

**500 MW of energy produced:** ITER has been designed to produce 500 MW of energy from an external energy input of 50 MW, in other words to generate ten times the input power. The fusion power record, held by the European JET tokamak in the United Kingdom, is 16 MW.

**150 million degrees** will be the temperature within the ITER tokamak,

considered in the same way as a i.e. ten times that which exists at the nuclear reactor.” heart of the Sun.

The ITER organization is required, as an operator, just as EDF is for example for each of its nuclear power plants, to submit a creation authorization application to ASN (French Nuclear Safety Authority) and it is then subjected to the technical expert appraisal of IRSN.

**Note :**

1. ITER: International Thermonuclear Experimental Reactor. Iter also signifies “path” in Latin. For more information: [www.iter.org](http://www.iter.org).