

France orders material testing from SCK•CEN

In 2015, France found high carbon concentrations in the steel of power generators in its nuclear power plants. What is the effect of this ‘carbon segregation’ on the mechanical properties of the material? Contracted by the *Autorité de Sûreté Nucléaire* (ASN), the French counterpart of FANC, SCK•CEN took up the gauntlet to demonstrate safety. Literally.

In 2015, carbon segregations were discovered in the bottom and cover of the FA3 EPR (Flamanville’s European Pressurized Water Reactor). “Segregation occurs in the solidification process. The first element that crystallises when steel solidifies is the most common element, i.e. iron. The other elements, which are present in smaller amounts (such as carbon and sulphur), are trapped in the still molten areas and solidify last”, explains researcher Rachid Chaouadi. “The problem is that these so-called segregation areas are subject to increased brittleness.” After this discovery, the *Autorité de Sûreté Nucléaire* (ASN) ordered all operators to inspect other components. In total, high carbon concentrations were found in the steel of the primary base of power generators in 18 out of 58 French nuclear reactors. “In twelve reactors, the concentrations found were even ‘particularly high’”, says Rachid.

The discovery opened up a social debate about the safety of existing reactors. “What is the effect of carbon segregation on the properties of steel?”, explains Rachid. To clarify this question, France launched a research programme. Part of the tests were outsourced to SCK•CEN. “We are entrusted with such tasks quite regularly and have developed extensive expertise in this field. Thanks to this internationally acknowledged expertise, we came in the picture as potential independent partners”, says Rachid.



Tough metal

Pressured by the French nuclear safety authority ASN, *Électricité de France* (EDF) – the world’s largest energy company – had the material checked to ensure that it still met the standard requirements. The research at SCK•CEN was commissioned by Framatome, formerly Areva NP and now a member of EDF Group. “The divergent composition of the steel in the primary base of the power generators has an impact on the mechanical properties of the material”, says researcher Marlies Lambrecht. “We focused on this in our tests. The tests we carried out enabled us to determine the mechanical properties of the material, including the fracture toughness.” SCK•CEN started in March 2018 and, since then, has completed a few hundred tests. The approach with the ‘Charpy V-notch’ tests was not particularly soft. “This is an international standard test whereby researchers break up the test samples with a heavy sledgehammer”, explains Marlies. “The results we produce are used by EDF in their justification to keep the power generators running.”

Most tests produced the expected results, except for a few ‘Charpy V-notch’ tests. “The energy required for the sledgehammer to break the test samples was below the admissible values. Yet, our internal calculations demonstrate that the results are still within the statistical limits of fracture mechanics”, concludes Rachid Chaouadi.

To allow for a deeper analysis, the current contract was extended. Rachid: “These tests will take place in February or March 2019. We will forward the results directly to Framatome, who will use these results and other research to compile a dossier to be submitted to the French nuclear watchdog.”

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