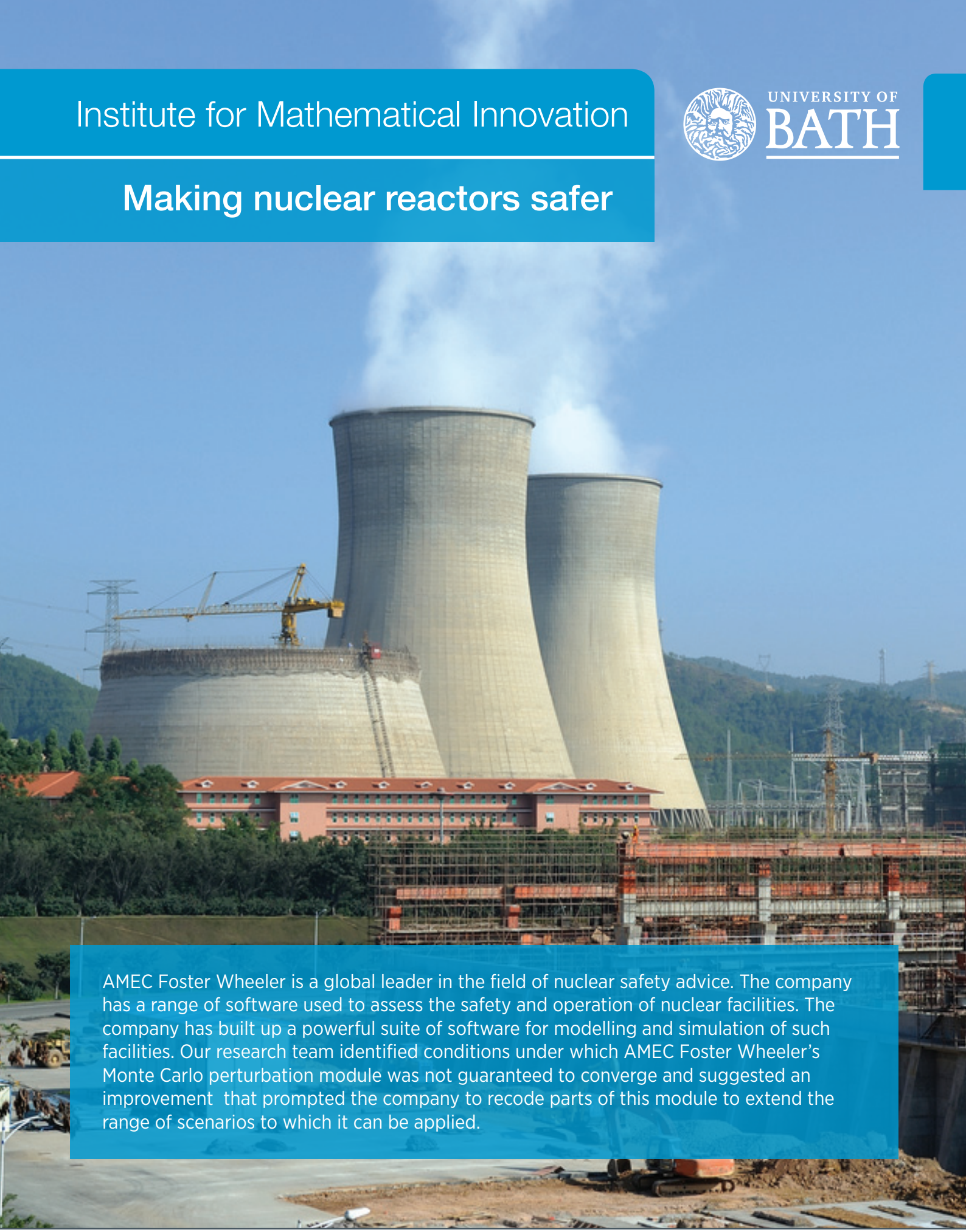
Institute for Mathematical Innovation

UNIVERSITY OF BATH

# Making nuclear reactors safer



AMEC Foster Wheeler is a global leader in the field of nuclear safety advice. The company has a range of software used to assess the safety and operation of nuclear facilities. The company has built up a powerful suite of software for modelling and simulation of such facilities. Our research team identified conditions under which AMEC Foster Wheeler's Monte Carlo perturbation module was not guaranteed to converge and suggested an improvement that prompted the company to recode parts of this module to extend the range of scenarios to which it can be applied.

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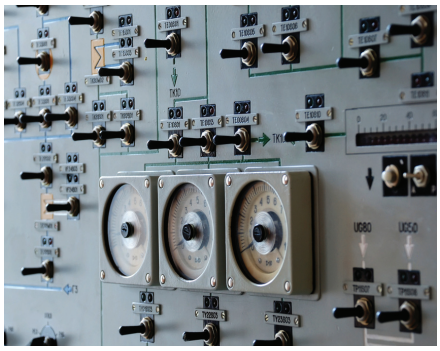
# Making nuclear reactors safer

AMEC Foster Wheeler is a global leader in the field of nuclear safety advice and analysis. The company has a range of software used to assess the safety and operation of nuclear reactors, including tools for criticality calculations (determining whether or not a given geometric configuration is capable of sustaining a chain reaction or not) and for reactor physics calculations (analysing the physical properties of a reactor that is currently sustaining a chain reaction). These computations are essential for reactor analysis and assessing the safety limits for fuel transportation and storage.

## The challenge

Increasing safety standards and demands for improved plant performance lead to requirements for improved fidelity of modelling and simulation tools and to extend the domain of applicability of the modelling tools to cover a wider range of plant scenarios. This was the case with one of the tools for perturbation analysis, which was found not to converge reliably when used over an extended range of scenarios. Reliability is paramount in the nuclear industry which sets very high safety standards. AMEC Foster Wheeler approached mathematicians at the University of Bath to help understand the lack of reliability and to suggest remedies.



## The solution

Our researchers drew on their knowledge of relevant areas of numerical analysis, including numerical linear algebra, partial differential equations and eigenvalue problems, that are the fundamental mathematical building blocks which are used in modelling nuclear reactors. The research team identified conditions under which AMEC Foster Wheeler's Monte Carlo perturbation module was not guaranteed to converge, and as a result could suggest a method to extend the range of scenarios for which it converges. This prompted the company to recode parts of the module in order to extend its range of applicability.

## The benefits

AMEC Foster Wheeler's nuclear modelling software is used throughout the UK nuclear industry and in many countries around the world. The research carried out by mathematicians at Bath had a clear impact on the robustness of AMEC Foster Wheeler's software and hence on the ability of the company to compete as a world leader in the development of these software tools. The company has now started a new programme of research with the University of Bath.

*"The work performed for the CASE project provided considerable insight into the convergence of the perturbation scheme and suggested improvements to the method. Our reactor physics code has been modified in the light of the improved understanding, resulting in improved robustness of the scheme over a wider range of applications. Without such improvements to the existing method it would have been necessary to develop alternative methods to satisfy industry needs, at considerable cost to the nuclear industry."*

Paul Smith,
AMEC Foster Wheeler