A STEP on the path to commercial fusion: a nuclear analysis overview

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The Spherical Tokamak for Energy Production (STEP) is an ambitious programme to generate net energy from fusion and to stimulate an industry that will help prove its commercial viability. It will achieve this by producing a prototype tokamak powerplant to provide energy to the grid.

The project is currently refining the overall plant architecture, plasma configuration and supporting technologies into a fully integrated design. Significant progress has been made on defining the machine geometry, validating the plasma operating scenarios, and developing the manufacturing and materials strategies required for a spherical tokamak operating at power reactor-relevant conditions. Parallel workstreams are maturing the site and building consenting, licensing approach, digital engineering environment and supply-chain capabilities.

Neutronics analysis plays a central, critical role in STEP's design, informing component lifetime predictions, shielding optimisation, tritium breeding performance, nuclear heating, activation, and maintenance strategies. This presentation outlines the robust workflows and methodologies used within STEP to enable rapid design iteration, parametric exploration, and uncertainty quantification, while ensuring version control and that radiation environments are accurately characterised throughout the tokamak, blanket, shield, and auxiliary systems.

As the programme progresses and formal Development Consent Order (DCO) applications commence (required in the UK for nationally significant infrastructure projects), increasing attention is being directed beyond the tokamak itself to encompass supporting systems such as power and cooling infrastructure, as well as the overall building and site layout. This broader focus is necessary to enable an integrated assessment of all nuclear hazards.

In addition to addressing nuclear responses within the tokamak, this presentation will outline ongoing work to extend the nuclear analysis across the wider building complex, ensuring that radiation environment requirements and operational considerations are consistently understood and integrated throughout the entire facility.

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