Application of constraint satisfaction algorithms for conditioning and packing activated control rod assemblies in MOSAIK$^{®}$-casks

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In the wake of the decommissioning of numerous nuclear power plants in Germany, techniques to reduce the number of costly waste casks or containers are sought after. The large bandwidth of limits (dose rate, mass, individual nuclide activities, chemical composition ...) the waste packages have to comply with for both interim storage facilities and the repository Konrad render the manual planning of packaging concepts prohibitive. However, in the past, the planning for packaging has been performed in this way, albeit on the basis of several facilitating assumptions.

Surprisingly, to the best of our knowledge, the automated computer-assisted generation of packaging plans for radioactive waste has not been demonstrated previously. In this talk we demonstrate how the conditioning and packing of 160 control rod assemblies was optimised using constraint satisfaction algorithms. These algorithms can be executed by a computer in a few minutes, thus considerably accelerating the generation of packaging plans, while optimising the utilisation of the waste casks and containers with respect to mass, activity, dose rate, etc. This automated and computer-assisted procedure took into account complex logistical boundary conditions present during decommissioning, such as space requirements, the sequence of the waste and the (lack of) availability of suitable waste casks. In addition, packaging concepts based on several scenarios (cask availability, space requirements, ...) were easily and automatically generated once the packaging rules had been coded. We demonstrate the successful application of these algorithms to a real packaging campaign of control rod assemblies of a boiling water reactor, for which excellent results were achieved.

We also present an anonymised outlook of a much larger scale project, in which the logistics and storage of radioactive waste packages is mathematically optimised. Finally, we give prospects on these techniques to other, similar logistical problems currently faced in nuclear technology and decommissioning.