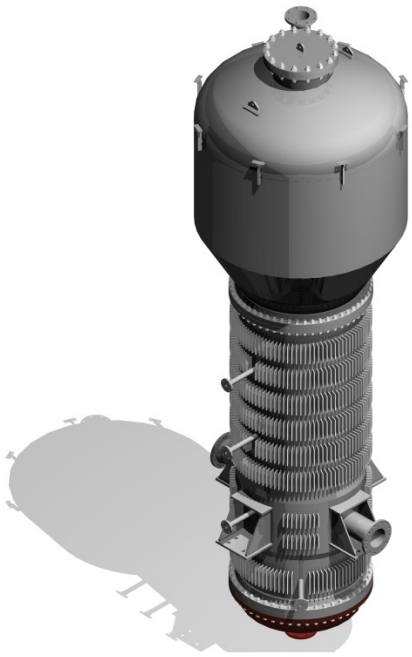
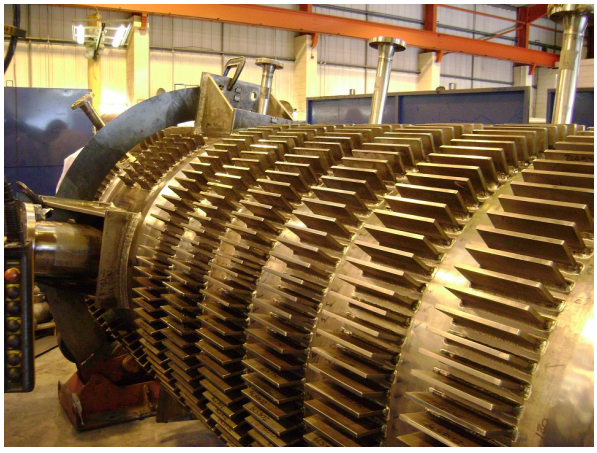
FINNED UF_6 REACTOR VESSEL DESIGN

The wide range of expertise and experience offered by FCL's engineers frequently enables us to offer a solution to previously intractable in-service problems. One example of this involved the development of a replacement reactor vessel used for the processing of uranium hexafluoride powder for the UK nuclear industry. The nature of the process initially requires external heat input via an array of heaters, but subsequently becomes highly exothermic requiring forced cooling of the vessel, governed by an autonomous control system relying on input data from an array of temperature sensors. In order to increase the heat flux in to and out of the vessel, the external surfaces of the reactor are provided with an array of fins. The frequent switches between heating and cooling conditions create an extremely onerous fatigue duty due to the associated fluctuations in thermal stress levels, such that the existing vessel had suffered from repeated severe cracking around the ends of the fins and at the vessel support brackets and, at the time of FCL's involvement, was deemed to be beyond further economic repair.

Selection of basic pressure envelope thicknesses was underwritten by design-by-rule calculations carried out in accordance with ASME Section VIII Division 1, and FCL then carried out an extensive series of sensitivity studies using Pro/MECHANICA (now CREO/Simulate) linear elastic stress and thermal analyses to optimise the design of the external fins and the support brackets. These studies identified a number of highly beneficial modifications to these items which, combined with additional recommendations on fabrication methods such as changes to weld design and the use of controlled surface grinding on all welds in high-risk areas, were predicted to significantly improve the fatigue resistance of the replacement vessel. FCL then proceeded to prepare a final set of calculations and analyses to confirm that the modifications introduced would not have a detrimental influence on the maximum achievable heat flux, and to formally substantiate the design of the vessel and its support frame for all loading conditions including pressure, weight, thermal and seismic loading.





To ensure consistency of all aspects of the vessel design documentation, FCL also produced a complete set of fabrication drawings, which assisted in achieving third party design approval with a minimum of comments. The benefit of using FCL has become apparent during the subsequent operation of the replacement vessel, which to date has not suffered from any significant cracking.

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