Fusion Capabilities

Project Examples

Cernavoda Tritium Removal Facility – Selection of Catalyst for LPCE Columns in Tritium Removal Facility

Project location: **Romania**
Client: **S.N. Nuclear Electrica S.A.**

- Kinectrics and its long-term partner, Romanian National Research and Development Institute For Cryogenic And Isotopic Technologies (ICSI), completed the technical design of a tritium glovebox and cryogenic distillation systems for the **Cernavoda Tritium Removal Facility** to be built in Romania
  - A commercial scale TRF is under construction and is expected to begin operation in the second half of this decade
- As part of a broader project where Kinectrics is serving as the Owner's Engineer for the design, procurement, construction and commissioning of the Cernavoda Tritium Removal Facility, Kinectrics executed a scope to select the catalyst and packing for the Liquid Phase Catalyst Exchange (LPCE) columns
  - This required the analysis of available suppliers' material. Selection criteria evaluated included pressure drop, availability, LPCE column design, cost, socio-economic factors and operational experience.

UKAEA Tritium Framework Agreement

Project location: **Altrincham & Culham, UK**
Client: **United Kingdom Atomic Energy Authority (UKAEA)**

As a part of the STEP Fuel Cycle Tritium Framework Agreement, Kinectrics provided its expertise in Tritium Engineering to support the UKAEA in the following product areas:

- Fuel Cycle, In-Vessel Components, Power Infrastructure, Materials Capability, Lifecycle Management

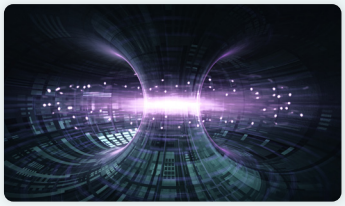
Our subject matter experts are also supporting the UKAEA on the following:

- Design of individual technologies/systems containing tritium across the product areas
- Modelling of individual tritium systems, including both steady state and dynamic model
- Integration of various tritium systems together to form an overall process, from both a design and modelling point of view
- Design of test rigs featuring tritium to validate modelling results and/ or contribute towards R&D

Tokamak Fusion Test Reactor (TFTR)

Project location: **Princeton, USA**
Client: **Princeton Plasma Physics Laboratory (PPPL)**

- Kinectrics completed the design and delivered a complete tritium removal facility and isotope separation system for the Tokamak Fusion Test Reactor (TFTR) at the Princeton Plasma Physics Laboratory in the United States
  - The system is based on a once-through purification concept using palladium/silver diffusers and four inter-linked cryogenic distillation columns
  - The system was equipped with numerous in-situ and ex-situ tritium measurements units, instruments, and analysers
- We also supported PPPL with the design of hydrogen and tritium safety systems to be used in the event of a leak to prevent radiological and explosion hazard
  - The original system, designed nearly 40 years ago, was replaced with a more modern and sophisticated instruments for tritium and hydrogen area measurements as well as an integrated control and instrumentation system
- Our skilled staff and their attention to detailed design allowed us to successfully perform the procurement engineering activities for the above scopes of work resulting in a minimal as built changes and an overall high level of client satisfaction



CNSC Regulatory Framework for Readiness to Regulate Fusion Technologies

Project location: **Toronto, CA**
Client: **Canadian Nuclear Safety Commission**

- This project scope evaluated the CNSC's Regulatory Framework's readiness to regulate fusion technologies and to accept and evaluate a license application for a Fusion Power Reactor. The project involved the following elements:
  - Developing hypothetical preliminary descriptions of fusion facilities covering a range of approaches to fusion to use to test the Regulatory Framework
  - Researching and interviewing regulators and stakeholders on their approach to regulation of fusion technologies in the USA, UK, France, and Japan, as well as relevant International Atomic Energy Agency (IAEA)
  - Assessing the readiness of the CNSC's Regulatory Framework to license a fusion facility using the hypothetical models
- This project demonstrates Kinectrics' expertise in evaluating a regulatory framework's readiness for fusion, and uniquely positions us to perform a similar scope for other clients

Fusion Blanket Literature Review

Project location: **Altrincham & Culham, UK**
Client: **United Kingdom Atomic Energy Authority (UKAEA)**

- A literature review on molten salt-based breeder blankets was presented by EASL (A division of Kinectrics)
  - The aims of the review were to highlight the potential benefits of using molten salts as working fluids in breeder blankets, to describe the molten salt-based concept designs presented in the literature, and to identify areas where further research was needed to clarify or resolve known issues with these designs
- The work provided an overview of breeder blanket technologies proposed for various fusion reactor designs. It aimed to assist the blanket technology selection for the spherical tokamak for energy production (STEP) at UKAEA
  - Ten blanket concept designs were presented including a description of their fundamental design features and proposed materials selection, discussing the relative advantages and disadvantages and assessing the technical maturity of each
  - A Mendeley database was used for this task and the information was digitised on XML files

UK Atomic Energy Authority

Glovebox Extract Ventilation System Ductwork Support Design

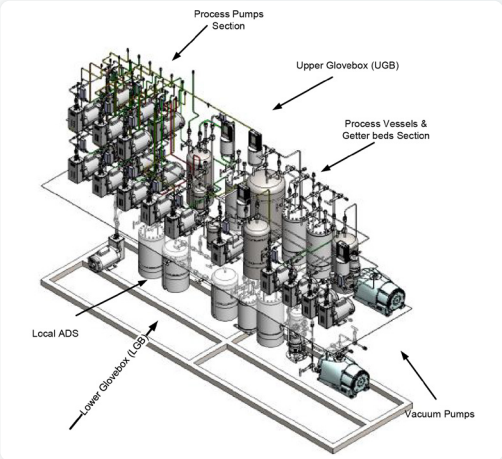
Project location: **Altrincham & Culham, UK**
Client: **United Kingdom Atomic Energy Authority (UKAEA)**

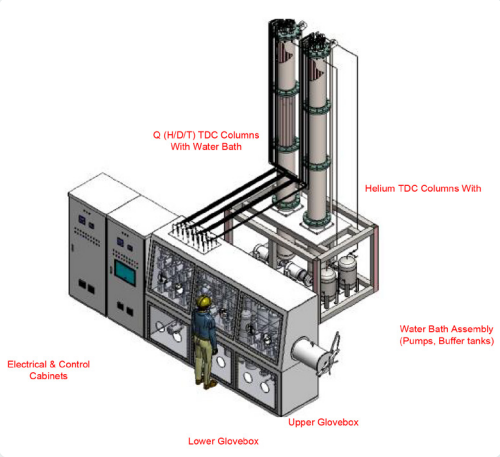
- UKAEA selected EASL (A division of Kinectrics) to undertake the structural design of ductwork supports on their glovebox extract ventilation system based on knowledge of EASL's past performance in pipework and ductwork support design
- EASL specified the support location and type required to achieve compliance of the ductwork with the relevant design code and provided technical input to the installation phase of the project
- This project highlights EASL's capability to understand and develop a client's requirements and provide an innovative design solution including a demonstration of compliance
  - It shows EASL's commitment to clients throughout the project life cycle, including the provision of support and specialist advice during the installation of an EASL design solution
- EASL benefited the client by ensuring the ductwork supports associated with their glovebox extract ventilation system were adequately designed and manufactured and installed correctly and safely on the client's site

UK Atomic Energy Authority

System for Simultaneous Separation of H & He ISS

- Kinectrics led the Modeling and Design of a system, using Thermal Diffusion Columns (TDC), for separation of Hydrogen (H/D/T) and Helium (He-3/He-4) isotopes from gas mixture
- For a processing capacity of 10,000 std. L/ year, the system was composed of the following sub-systems:
  - Vacuum System (VS)
  - Feed Purification System (FPS)
  - Sampling & Measurement System (SMS)
  - Tritium Safety System (TSS)
  - Tritium Handling & Storage System (THSS)
  - TDC Based ISS For Helium Isotopologues (ISS-He)
  - TDC Based ISS For Hydrogen Isotopologues (ISS-Q)





System for Simultaneous Separation of H & He ISS

DBB Vessel Preliminary Design Support

Project location: **Altrincham & Culham, UK**
Client: **United Kingdom Atomic Energy Authority (UKAEA)**

- The Mega Amp Spherical Tokamak (MAST) facility at Culham Centre for Fusion Energy is undergoing a major upgrade (MAST-UE) that will enhance the UK's role in international fusion research
- A new double beam box (DBB) vessel which houses the two Positive Ion Neutral Injectors (PINIs) is required for the upgrade. EASL (A division of Kinectrics) was tasked with assessing the new DBB design to ensure it meets the above criteria, to ensure it is compatible for manufacture and to ensure it meets inspection/welding design code requirements.
- A linear, elastic FEA was run first, with a focus on finding areas with the potential for gross plastic deformation. To ensure the model is accurate, areas of interest were refined, and necessary weld details were modelled. Carefully modelling the minimum detail necessary reduced the cost to the client and the lead time. Various modifications to the design were recommended by EASL and implemented by the client after the first phase. This allowed for the complexity of manufacturing to be significantly reduced without compromising the client's requirements. Assembly order was also carefully defined to simplify manufacture, reduce distortion and improve inspectability.

UK Atomic Energy Authority