# MYRRHA/XT-ADS PRIMARY SYSTEM DESIGN AND EXPERIMENTAL DEVICES

## Background

The EUROTRANS project is an integrated project in the 6th European Framework Program in the context of P&T (Partitioning and Transmutation). The objective of this project is to work towards an ETD (European Transmutation Demonstration) in a step-wise manner. The first step is to carry out an advanced design of a small-scale XT-ADS (eXperimental Transmutation in an Accelerator Driven System) for realisation in a short-term (say about 10 years) as well as to accomplish a generic conceptual design of EFIT (European Facility for Industrial Transmutation) for realisation in the long-term. The MYRRHA-2005 design served as a starting basis for the XT-ADS. Many options have been revisited and the framework is now set up.
While the MYRRHA-2005 design was still a *conceptual* design, the intention is to get at the end of the EUROTRANS project (March 2009) an *advanced* design of the XT-ADS, albeit a first advanced design.

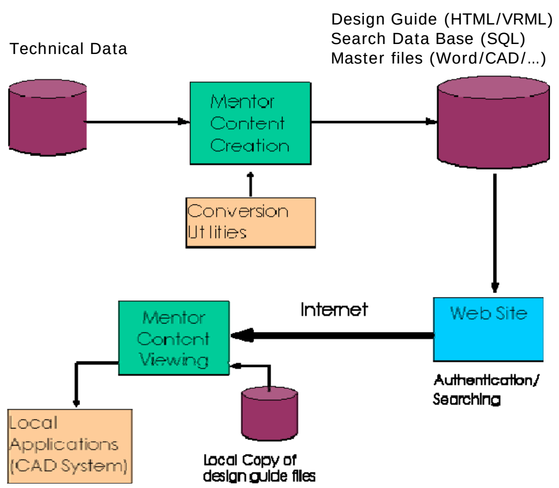
## Objectives

While the design work performed during the first years of the project (2005-2006) was mainly devoted to optimise and enhance the primary and secondary system configuration according to the suggestions and contributions of our industrial partners (Ansaldo Nucleare, Areva, Suez-Tractebel) within the DM1 (Domain 1 "DESIGN"), the last year work objectives mainly consisted of:

- the release of the Remote Handling Design Catalogue for XT-ADS (1st version);
- the formulation of the specification of the experimental devices according to the XT-ADS objectives and adapted to the actual XT-ADS core and core support structure design;
- the detailed calculations of the main XT-ADS primary and secondary system components.

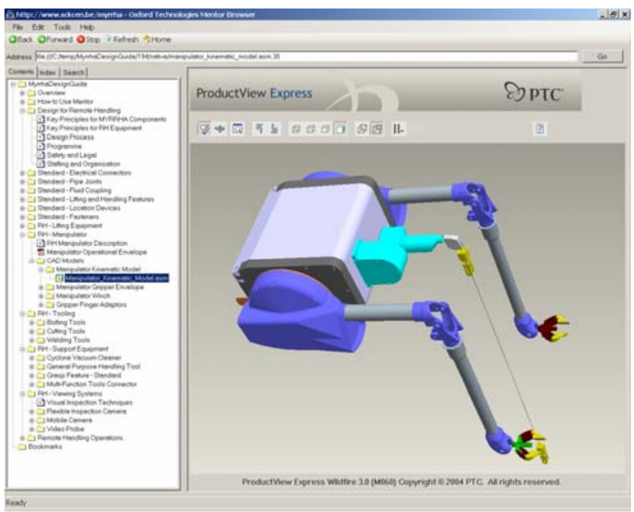
## Principal results

The RHDC (Remote Handling Design Catalogue) for XT-ADS provides information and guidance to engineers, CAD designers and technicians with a view to ensuring that the XT-ADS machine and its remote maintenance system as well, are designed in a way fully compatible with the remote handling requirements. The catalogue contents have been derived in cooperation with Oxford Technologies taking advantage from their experience with the fully remote maintenance of the EFDA-JET Fusion Tokamak.




*The RHDC is implemented as an internet web-site*

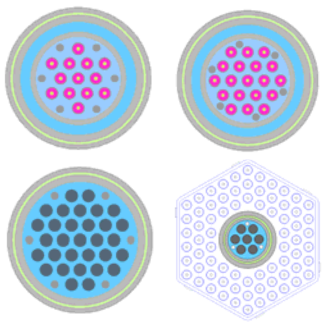
The first version of this design guide was released in April 2007 and is since then accessible on a SCK•CEN network server over the internet for selected users including Ansaldo and Areva engineers. It has been utilized so far by Ansaldo for the design of the in-vessel fuel assembly manipulators.




*The Mentor Browser user-interface*

The RHDC is viewed using a specially developed application (Mentor Browser) and was created and is maintained using a similar application (Mentor Creator). The user interface, as shown in the right picture, illustrates the wealth of information about how to design for RH compatibility and the wide range of compatible file formats. Finally, this version serves as the basis for expansion of information as XT-ADS progresses.

The design of experimental devices was commenced for four different arrangements of test sections to be inserted into IPS (In Pile Sections) positions:

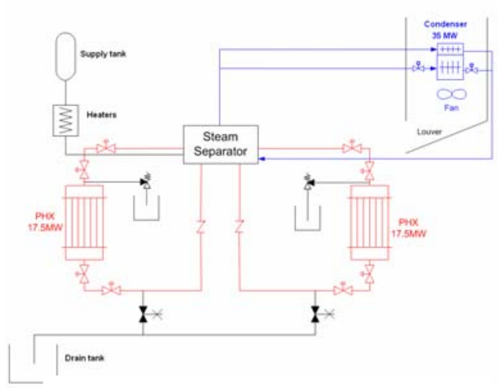


*4 different arrangements of test sections in IPS*

- test sections for fuel pin irradiations containing 13 or 19 fuel pins;
- test sections for structure materials irradiation campaigns containing 31 samples;
- a modified fuel assembly with a small test specimen.

These configurations were applied as well for evaluation of their impact on the XT-ADS core neutron physics characteristics. Inserts into IPS positions contain first of all a two-fold safety tube arrangement which allows insertion of the test section from above and decoupling partially or totally the thermo-hydraulic conditions within the test sections from the core. In case of IPS for fuel pin irradiations, a separate forced convection cooling for the test specimens is to be foreseen. In case of IPS for structure materials irradiation campaigns it might be feasible to cool the test specimen arrangement by thermal conduction to the inter wrapper coolant flow.

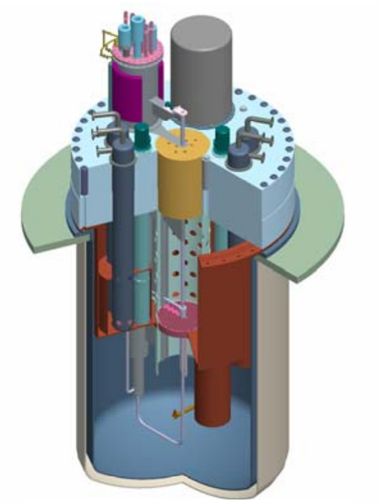
Prior to finalising the sizing of the main components of primary and secondary cooling systems (e.g. heat exchangers and steam condensers), the primary system operating temperature & pressure management had to be defined. Several approaches were considered:




*Secondary cooling system scheme*

- constant core inlet temperature of 300°C over the whole power range (0-70 $MW_{th}$);
- steadily increasing core inlet temperature from 200°C to 300°C between zero and full power (0-70 $MW_th$). The main advantage of this concept is that the whole secondary system always can operate at much lower pressure (~ 1.6 MPa), mitigating consequences of a tube rupture in the heat exchangers and in the steam condensers or ruptures in the steam transport pipes. The secondary system nevertheless has to be designed for the maximum pressure that could be reached during incidental transients (~ 8.6 MPa). A technical note has been prepared by SCK•CEN justifying acceptability of lower operating temperature in terms of risks of radiation hardening and embrittlement, corrosion, creep and swelling for the candidate materials of irradiated structures;
- intermediate option: steadily increasing temperature from 200°C to 300°C between 0 and 50 $MW_{th}$ and keeping constant temperature of 300°C over a limited range of power (50-70 $MW_{th}$).

As a result, the secondary cooling system components are conservatively designed for a maximum pressure of 8.6 MPa.



*XT-ADS overall geometry*

Finally, the picture on the left illustrates the overall geometry of the XT-ADS facility, showing the reactor vessel and lid, guard vessel, diaphragm, core structure, primary heat exchangers and pumps, spallation loop and in-vessel fuel manipulators.

## Future developments

The framework for XT-ADS design has been set up. The future work, until March 2009, end of the EUROTRANS project, is the continuation of the detailed design studies of every XT-ADS component. The main partners (SCK•CEN, Ansaldo, Areva, Suez-Tractebel) are sharing the work to be performed. SCK•CEN is in charge of the primary systems (including the reactor main cooling system, the reactor vessel and cover) and of the in-service inspection and repair studies.

## Main contact person

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## Main reference

D. De Bruyn, D. Maes, L. Mansani & B. Giraud (2007) "From MYRRHA to XT-ADS: the design evolution of an experimental ADS system", AccApp'07 Conference, Pocatello, Idaho, July 30 – August 02, 2007.