EFDA TECHNOLOGY WORKPROGRAMME 2005

TT-TRITIUM BREEDING AND MATERIALS
Fuel Cycle

TW5-TTFD-TPI-51(Art. 5.1b) DEVELOPMENT OF ITER PRM AND STANDARD PARTS CATALOGUES IN CATIA V5 FOR TRITIUM-CONTAINING SYSTEMS AND COMPONENTS

***Deliverable*: Development of 2-D and 3-D symbols for WDS components.**

Alin Lazar, Sebastian Brad, Marius Zamfirache, Sorin Soare,
Nicolae Sofalca, Mihai Vijulie

National Institute for Cryogenics and Isotope Technologies (ICIT), Rm. Valcea

1. Introduction

A PRM (Project Resource Management) and Standard Parts Catalogues in CATIA V5 for Tritium-containing Systems and Components are required. The Project Resource Management (PRM) is a framework of the project which on the one hand gives a tool to customize the working environment, on the other hand it organizes the design process to ensure design compliance with established standards, specifications, standardization, industrial conventions, terminology and practice. Feature Dictionaries, Catalogues for components as well as for standards and specifications are main parts of the CATIA V5 PRM.

Objectives:

- Preparing of selected standards and specifications based on the guidelines from "TLK Classes Piping classification" [1], "TLK Classes Equipment classification" [2], and the "IKARUS-Project Instructions" [3] into the PRM, in order to create 2D symbol for WDS in CATIA V5. The 2D symbols were created using the Equipment and Systems (E&C) workbench and were inserted in 2D symbol catalogues.
- Creation of a 3D parts in CATIA V5 for the system that compose the WDS, in order to be inserting in feature dictionary and Standard Parts Catalogues, in accord with the requirements for tritiated water processing. The 3D parts were created using the "Part Design" module. This module also provide tools for creating de parametric parts in order to build "Part Family" of each part and inserted those into 3D parts catalogues. The elements of P&ID, pipes, piping parts and equipment carry attribute information that were defined in the PRM.

2. Development of 2-D symbols

The 2-D symbols for the equipment and piping components were developed according to EN ISO 10628 standard [7] and inserted into a test catalogue. The designer will be able to choose the 2-D symbols from the catalogues and to insert those symbols in Process Flow Diagram (PFD) and Piping and Instrument Diagram (P&ID) for a Water Detritiation System.

For the application “Piping & Instrumentation Diagrams (P&ID)” from the “Equipment and Systems” workbench, the following settings were done (by Tritium Laboratory Karlsruhe (TLK) team) in the PRM-FZK-TLK in order to ensure compliance with established design standards [7]:

- The grid module for diagrams M = 2,5 mm;

- 1,0 mm (0,4 M) for main flow lines;
- 0,5 mm (0,2 M) for graphical symbols for equipment, rectangular frames, process equipment, subsidiary flow lines, energy carrier lines and auxiliary system lines;
- 0,25 mm (0,1 M) for graphical symbols for valves and fittings and piping accessories, symbols for process measurement and control functions, control and data transmission line, reference lines, other auxiliary lines.

According with the TLK_Classes_Piping classification [1], TLK_Classes_Equipment classification [2], EN ISO 10628 [7] standard and using the PRM-FZK-TLK [3] from 4.11.2005 the following 2-D symbols were developed:

- for 2-D Piping Classes: shut-off valves, controls valves, check valves, valves with safety functions, fittings, fittings with safety functions, nozzle, other graphical symbols.
- For 2-D Equipment Classes: liquid pumps, compressors, vessels, heat exchangers, heater and cooling facilities, reactors, and separation equipments.

All of the symbols for piping components and equipments have their functions defined from PRM-FZK-TLK, piping connectors and also internal flow.

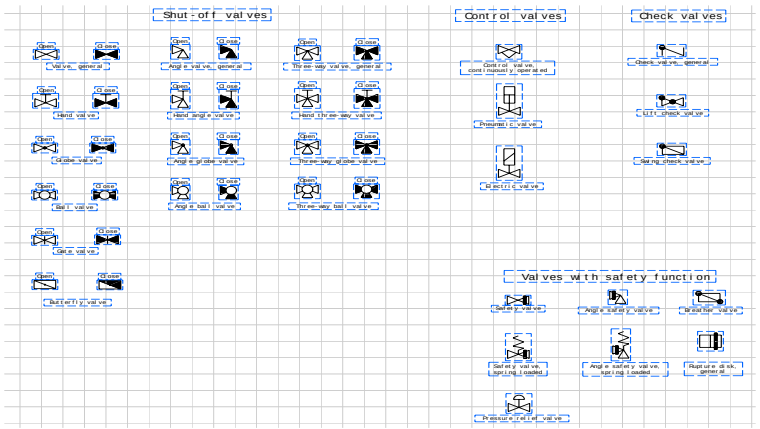

Figure 1. The 2-D symbols for the valves

For testing the function of piping symbols, a test catalogue (2DPipingWDScatalog) was created. This catalogue will not be part of PRM-FZK-TLK [3]; it was produced for 2-D symbols testing purpose only. The catalogue consists of four chapters: valves chapter, fittings chapter, nozzle chapter and other symbols chapter. Each chapter has a family-tree with the 2-D symbols.

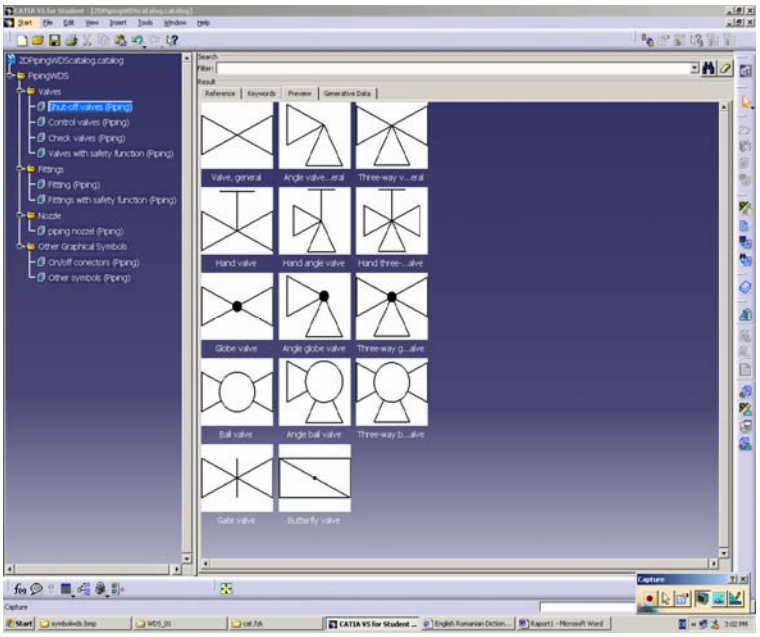

Figure 2. A picture of Shut-off valve family from valves chapter

For equipment components, the following symbols were produced: liquid pumps, compressors, vessels, heat exchangers, heater and cooling facilities, reactors (isotopic exchange column, chemical reactor), separation equipment (adsorber, absorber, permeators, filters, drier, and separators) and electrolysis cell.

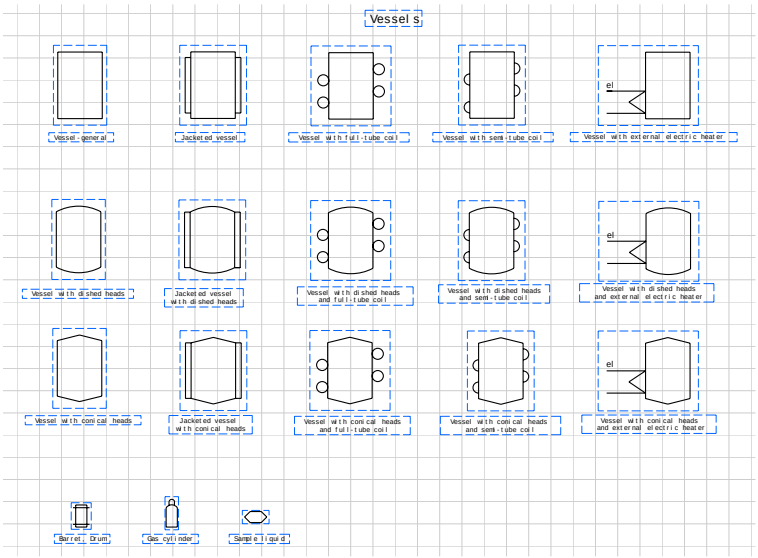

Figure 3. The 2-D symbols for vessels

For testing the function of the equipment symbols, a test catalogue (2DEquipmentsWDS) was developed. This catalogue will not be part of PRM-FZK-TLK [3];

it was created just for 2-D symbols testing purpose. The catalogues is composed from ten families of 2-D symbols: Isotope Exchange column family, Electrolysis family, Pumps family, Compressor family, Heat exchanger family, vessels family, Chemical Reactors family, Storage&Sample family, Drive family and Facility for heating/cooling family.

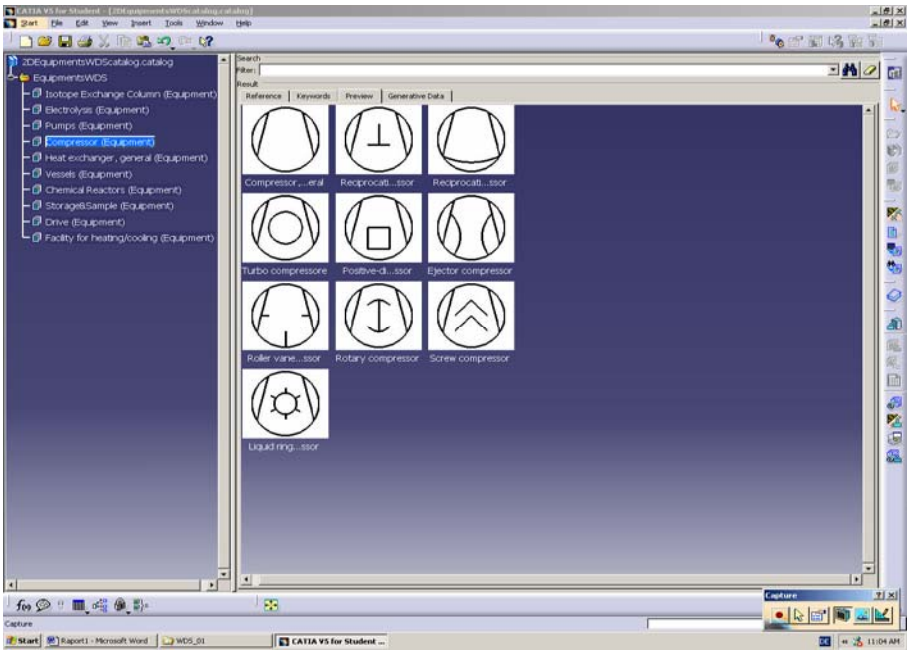

Figure 4. A picture of compressor family

The 2-D graphical elements of P&ID, pipes, piping parts and equipments have as attributes the information defined in the Project Resources Manager (PRM) [3]. This will by helpful for the designer to choose the right components from catalogues and to insert them into P&ID and PFD for WDS.

3. Development of 3-D Parts

The 3-D components needed to be designed using the “Part Design” module that provides the tools for creating and managing the 3D components and also for creating parametrical parts.

Some 3-D parts for WDS were designed and tested in “Part Design” application, while other 3-D parts are under construction. Also, a 3-D test catalogue will be build in order to test these 3-D parts in “Piping Design” and “Equipment Arrangement” application from the “Equipment and Systems” workbench.

The 3-D part was done parametrically in order to allow the designer to modify these parameters according to his design. The parameters were organized in sets and are described for each part. The shape and dimension for those parts were choosen from different company catalogues and literatures [4-6] available in library and on internet. Also, for these parts it was necessary to create the geometry for connectors. The connector is a CATIA function used

to connect two or more 3-D parts. The connectors are defined on the existing geometry in “Piping Design” and “Equipment Arrangement” applications.

The main components of the WDS facilities are: the electrolysis unit, the isotope exchange column (LPCE, VPCE), the condensers, the oxygen stripping column, the permeator, the heat exchangers, the liquid pumps, the filters, the adsorbed, the absorber, the drier, the separators, the vessels and piping components (valves, union couplings, Tee couplings, cross couplings etc) [4].

The 3-D parts were developed in accordance with the “IKARUS-Project Instructions” [3] and considering the 3D Equipment Classes [2] and 3D Piping Classes [1] classification made by TLK team. For WDS the following 3-D parts were developed:

- for 3-D Equipment Classes: isotope exchange columns, vessel, centrifugal pump, diaphragm pump with horizontal motor and diaphragm pump with vertical motor, permeatore, condenser, shell and tube heat exchanger, double-pipe heat exchanger, U-type heat exchanger, floating head heat exchanger and electrolysis unit.
- for 3-D Piping Classes: 90° reducing elbow, 90° union elbow, reducing Tee, union Tee, cross and reducing union.

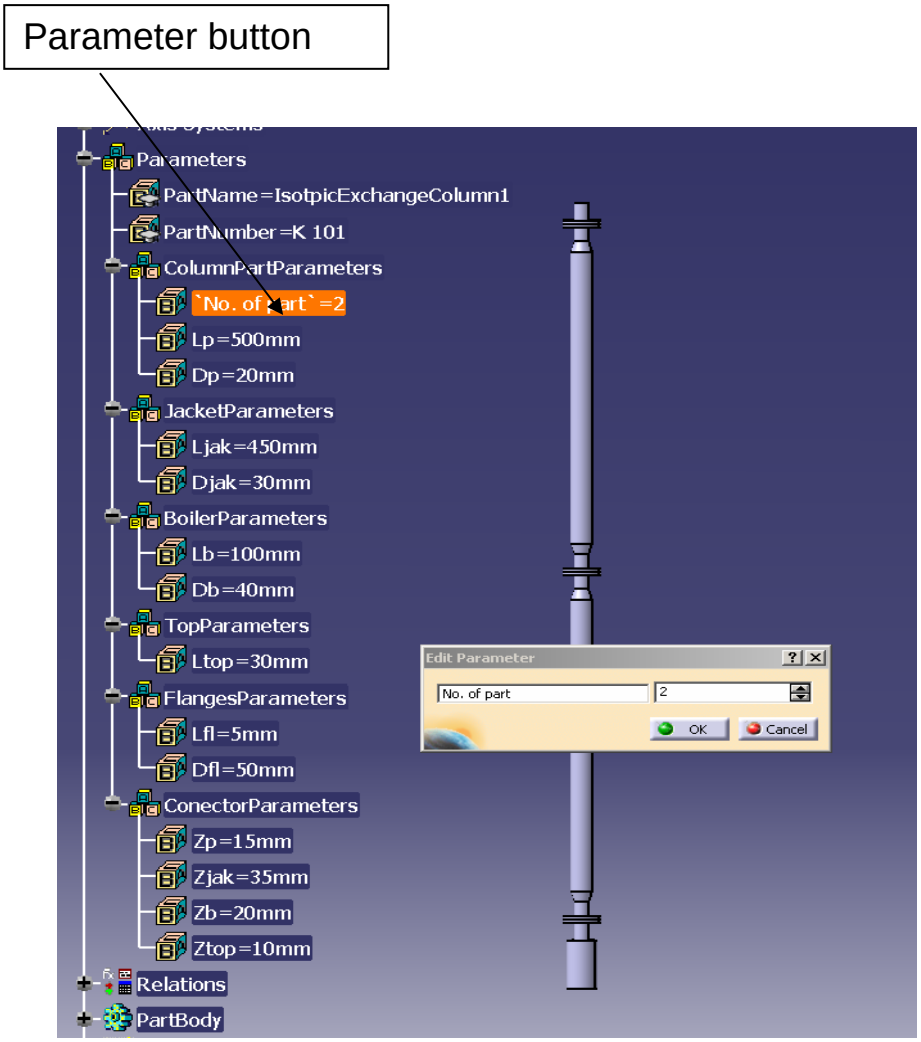

Figure 5. Isotope Exchange Column

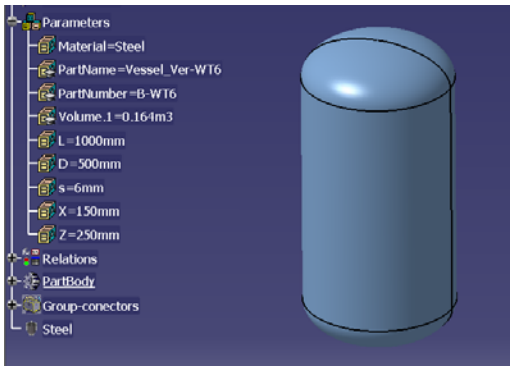

Figure 6. Vessels

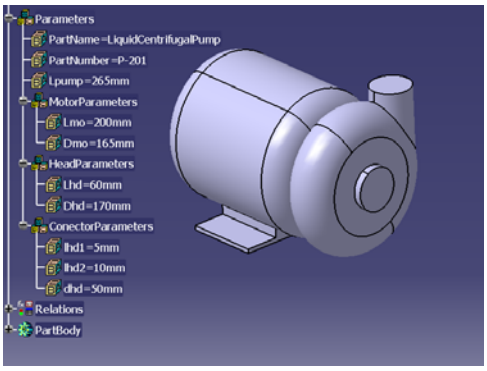

Figure 7. Centrifugal Pump

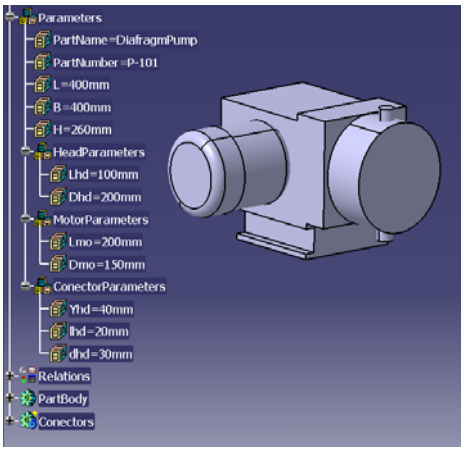

Figure 8. Diaphragm Pump with horizontal motor

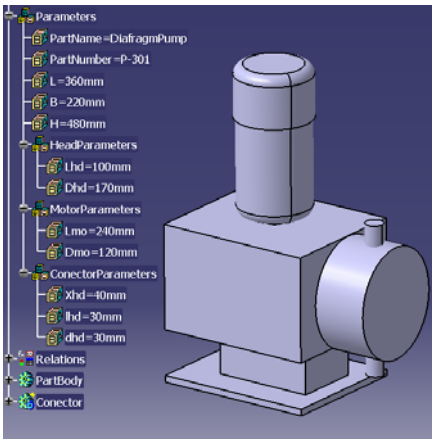

Figure 9. Diaphragm Pump with vertical motor

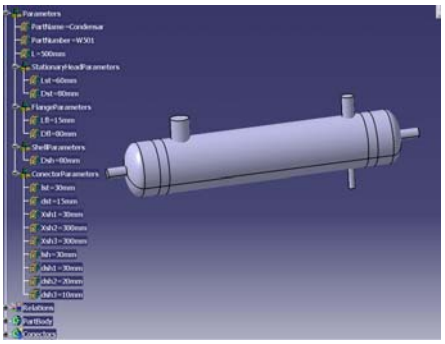

Figure 10. Condenser

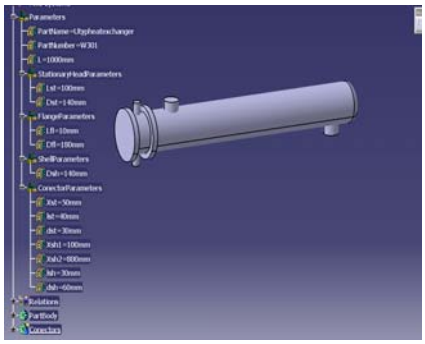

Figure 11. U-type Heat Exchanger

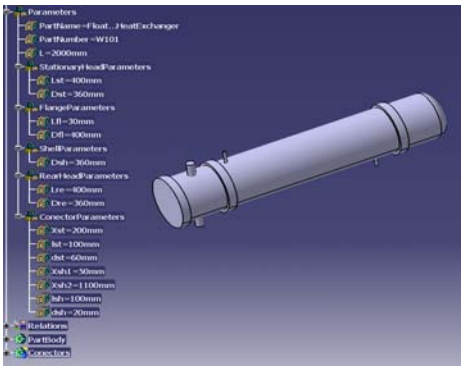

Figure 12. Floating head heat exchanger

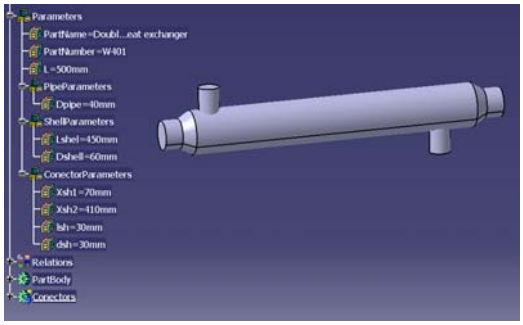

Figure 13. Double-pipe heat exchanger

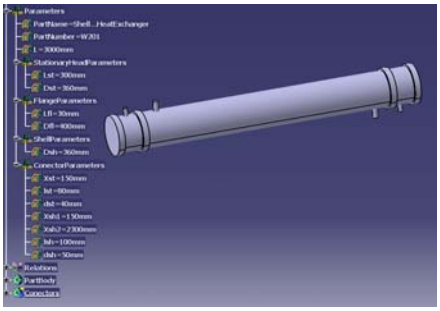

Figure 14. Shell and tube heat exchange

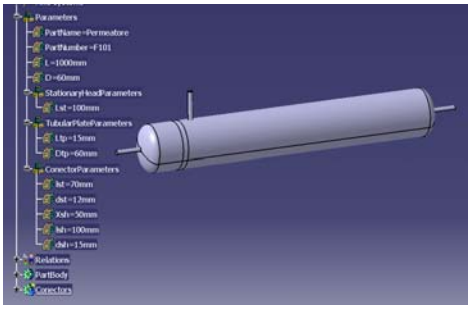

Figure 15. Permeatore

Also, the butt weld 3-D fittings are under construction: 90º Reducing Elbow, 90º Union Elbow, Union Tee, Reducing Tee, Cross. Some of the 3-D part for piping is shown below. For each piping parts, a Design Table was created with dimensional parameters, in order to allow to the designer to choose the right dimension for his designs.

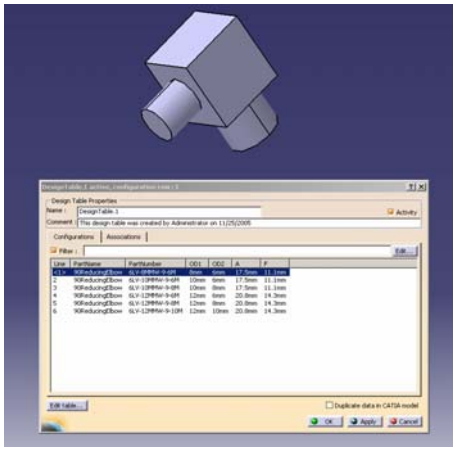

Figure 16. 90° Reducing Elbow

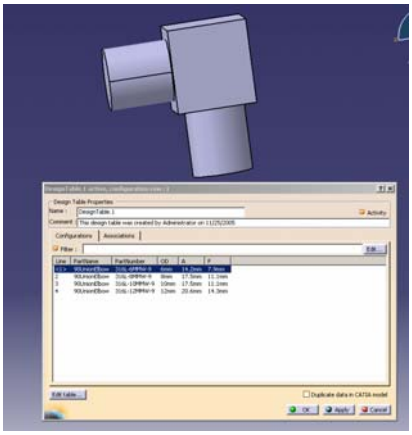

Figure 17. 90° Union Elbow

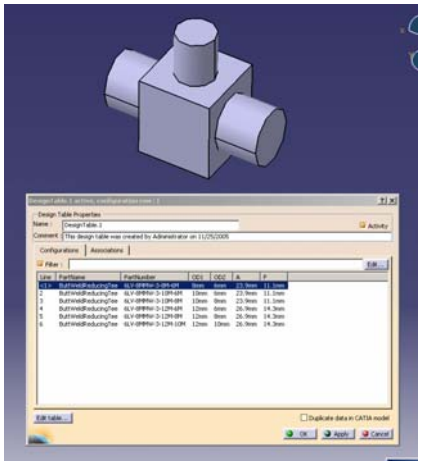

Figure 18. Reducing Tee

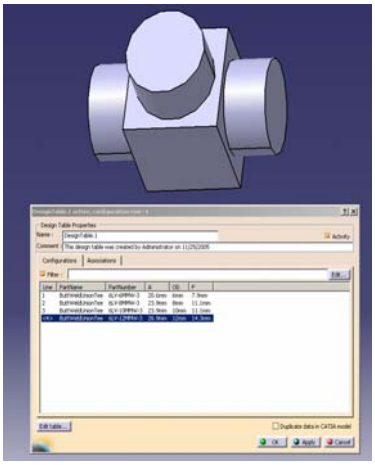

Figure 19. Union Tee

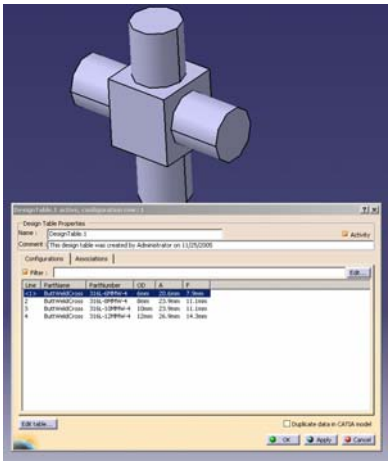

Figure 20. Cross

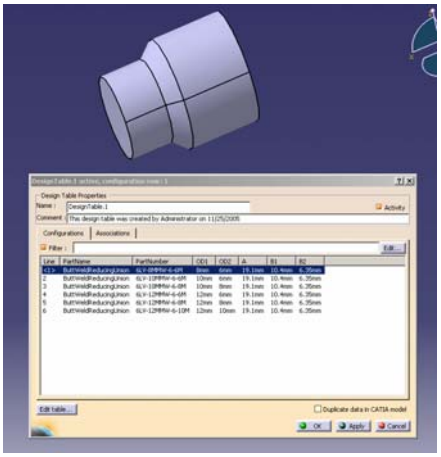

Figure 21. Reducing Union

Work related to these topics belongs to the task TW5-TTFD-TPI- 51 (Art.5.1b) from the EFDA Technology Workprogramm 2005 and was done in collaboration with FZK Association team during the period September 2005 - February 2006.

4. Conclusions

The following applications from CATIA V5 such as Piping & Instrumentation Diagrams, Piping Design, Equipment Arrangement, Part Design, Wireframe and Surface and Catalog Editor were used to develop the 2-D symbols and 3-D parts for piping and equipments components of a WDS system.

The 2-D symbols for the equipment and piping components were developed according to EN ISO 10628 standard [7] and considering the classification and settings done by TLK-team in the PRM-FZK-TLK [1,2,3]in order to ensure compliance with established design standards. These symbols were inserted in the test catalogues created in Catalog Editor application, and intensive tested in Piping & Instrumentation Diagrams, prior to their embedding into the PRM Catalogues. The 2-D graphical elements of P&ID, pipes, piping parts and equipments have attribute information that is defined in the PRM-FZK-TLK. This will help the designer to choose the right components from catalogues and to insert them into P&ID and PFD for WDS.

The 3-D part for the equipment and piping components were develop according to the specifications, industrial conventions, terminology, literatures [4,5,6] available in library and internet and experienced practice. All parts were parametrically built in order to allow the designer to modify the part geometry according to his design.

2-D logical design and 3-D models are logically related through the common functions definition in the PRM. The layout will be realized starting with P&ID and 2-D layout will be converted to 3-D space reservation and will continue with equipment placement, placement of piping parts and parts placement from the CATIA V5 PRM and catalogues.

The following activities related to task TW5-TTFD-TPI-51, shall continues during 2006, by completing the remaining 3-D part for WDS components, by improving the 2-D and 3-D testing catalogues with the new symbols and 3-D parts and by testing them (in accordance with "IKARUS-Project Instructions" by FZK-team) in "Piping Design" and "Equipment Arrangement" application, prior to their insertion in the FZK-PRM Catalogues.

The final result of the work shall be a complete set of drawings and descriptive documentation for the project "Development of ITER PRM and Standard Parts Catalogues in CATIA V5 for Tritium-containing Systems and Components".

References

[1] **Beloglazov S., Wagner R.,** "*TLK Classes Piping classification*".

[2] **Beloglazov S., Wagner R.,** "*TLK Classes Equipment classification*".

[3] **Wagner R.,** "*IKARUS-Project Instructions*".

[4] **Vasaru G.,** "*Tritium Isotope Separation*", CRC Press, Inc. (1993)

[5] **Nelik L.,** "*Centrifugal and Rotary Pumps. Fundamentals with Applications*", CRC Press LLC (1999).

[6] **Kakac S., Hongtan L.,** "*Heat Exchangers. Selection, Rating and Thermal Design*", CRC Press LLC (1998).

[7] **European Standard,** "*EN ISO 10628*", "EN ISO 3511", "EN ISO 7200".