

Status of the Fusion Component Failure Rate Database (FCFR-DB)

*International Energy Agency Cooperative Agreement on
Environmental, Safety, and Economic Aspects of Fusion Power*

*5th Specialists Meeting on Component Failure Rate Data
IEA-ESE/FP Task 5, Failure Rate Database*

2005.04.05

Jesús Izquierdo

FEEL
FUSION ENERGY
ENGINEERING LABORATORY



UNIVERSITAT POLITÈCNICA
DE CATALUNYA



ESCOLA TÈCNICA SUPERIOR D'ENGINYERIA
INDUSTRIAL DE BARCELONA
DEPT. DE FÍSICA I ENGINYERIA NUCLEAR

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Upgrade of FCFR-DB

**ENEA + FEEL
background and human resources**

An opportunity to upgrade the FCFR-DB by

- Refinement of the FCFR-DB v1.05 component taxonomy (component classification)
 - Refinement and enumeration of every relevant system in a generic fusion facility (fusion system breakdown)
-
- Synthesis of the failure mode list
 - Introduction of JET and TLK data

Efficient Classification Taxonomy Characteristics

- **Completeness**
- **Consistency**
- **Hierarchical**
- **Flexible**
- **Internationally standardized**

Advantages

- Ease of browsing
- Narrowing searches
- Improved profit
- Providing context
- Interoperability/Online DB
- Greater Stability
- Greater Familiarity
- Cost savings

American Institute of Chemical Engineers

OREDA

International Atomic Energy Agency

International Electrotechnical Committee

Component classification

An overview
of the FCFR-DB v1.05
(Family, Type
and four Subclasses)



<u>Family</u>	<u>Type</u>
Containment system	Concrete barrier
	Containment
	Containment access
	Expansion Volume
	Glove Box
	Liner
	Penetration
Electrical component	Busbar
	Circuit breaker
	Coil
	Wire
	Commutator
	Contact
	Switch
	Relay

Component classification

Rebuilding families according to IAEA TECDOC 478

FCFR-DB 1.05v

Containment system
Electrical component
Mechanical Component
Hydraulic Component
Instruments
HVAC
Gas-cooled system
HIGH Vacuum
Liquid Metal-cooled Systems
Magnet systems
Tritium systems
Miscellaneous

Mechanical components

Electrical components

**Instrumentation and control
components**

Component Classification

<p>Mechanical (697 rec.)</p>	<p>Piping Seals and joints Valves Pumps Compressors Tanks, pools and containers Heat exchangers Strainers, filters, demineralizer Other single and multi-part components</p>
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Component Classification

<p style="text-align: center;">Electrical (39 rec.)</p>	<p>Conductors Circuit breakers Relays Transformers Power supplies Motors Solid state devices Resistors Inductors Capacitors Other electrical equipment or electrical part</p>
<p style="text-align: center;">I&C (96 rec.)</p>	<p>Sensors (ionization chamber, temperature sensor,...) Transmitters Signal conditioning Switches Other I&C equipment, instrumentation for experiments</p>

Fusion System Breakdown

- **Structural systems**

It includes all systems that make up the structure, basically passive components as vacuum vessel, cryostat or hot cell building but also elements from the tokamak itself that could be considered active as magnets or diagnostics.

- **Supply systems**

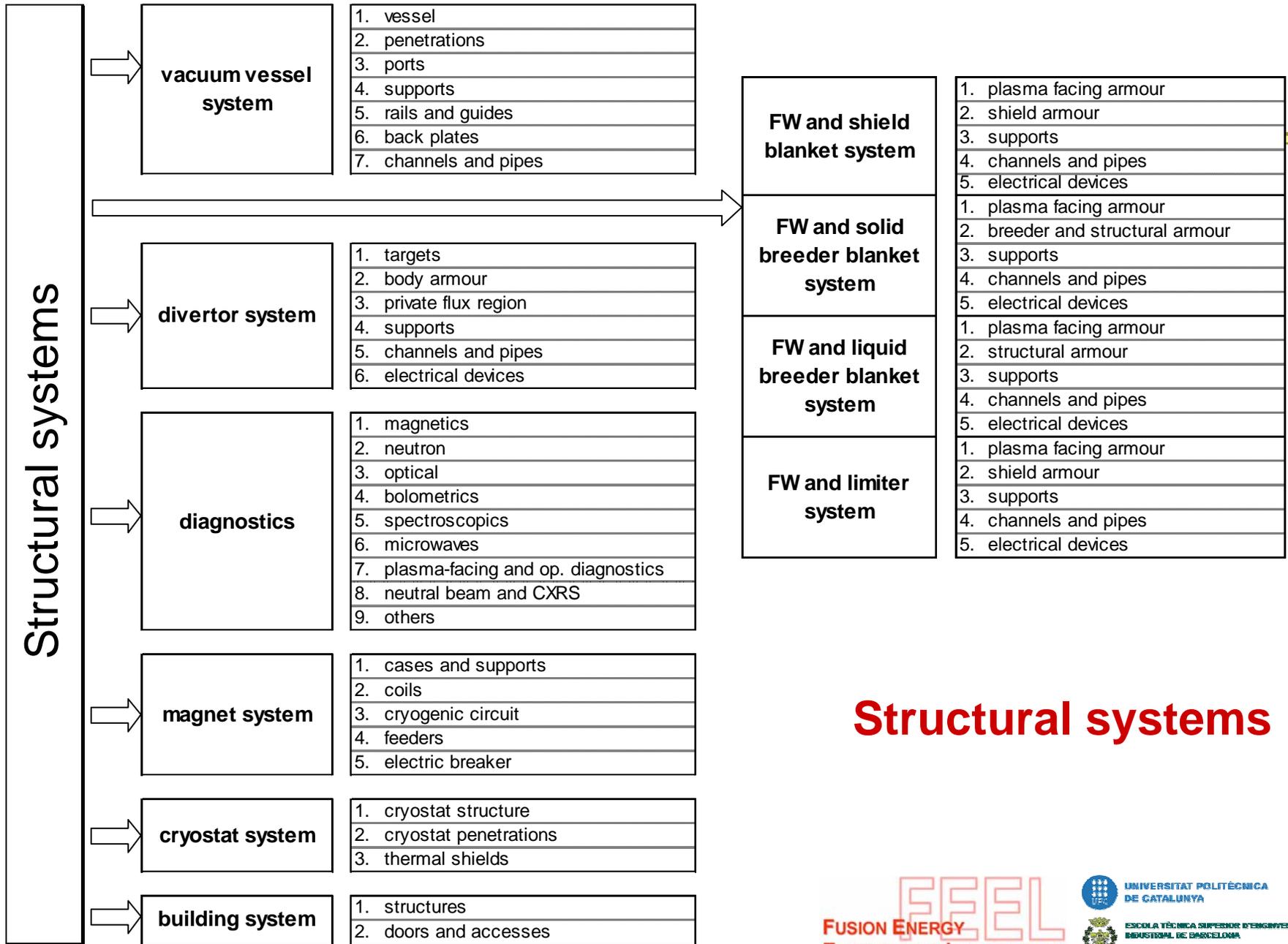
Mostly includes systems with mass or energy transfer function such as heat transfer systems or vacuum systems. Also it includes conventional services as HVAC or gas distribution.

- **I&C systems**

Systems with measurement and control functions.

- **Safety systems**

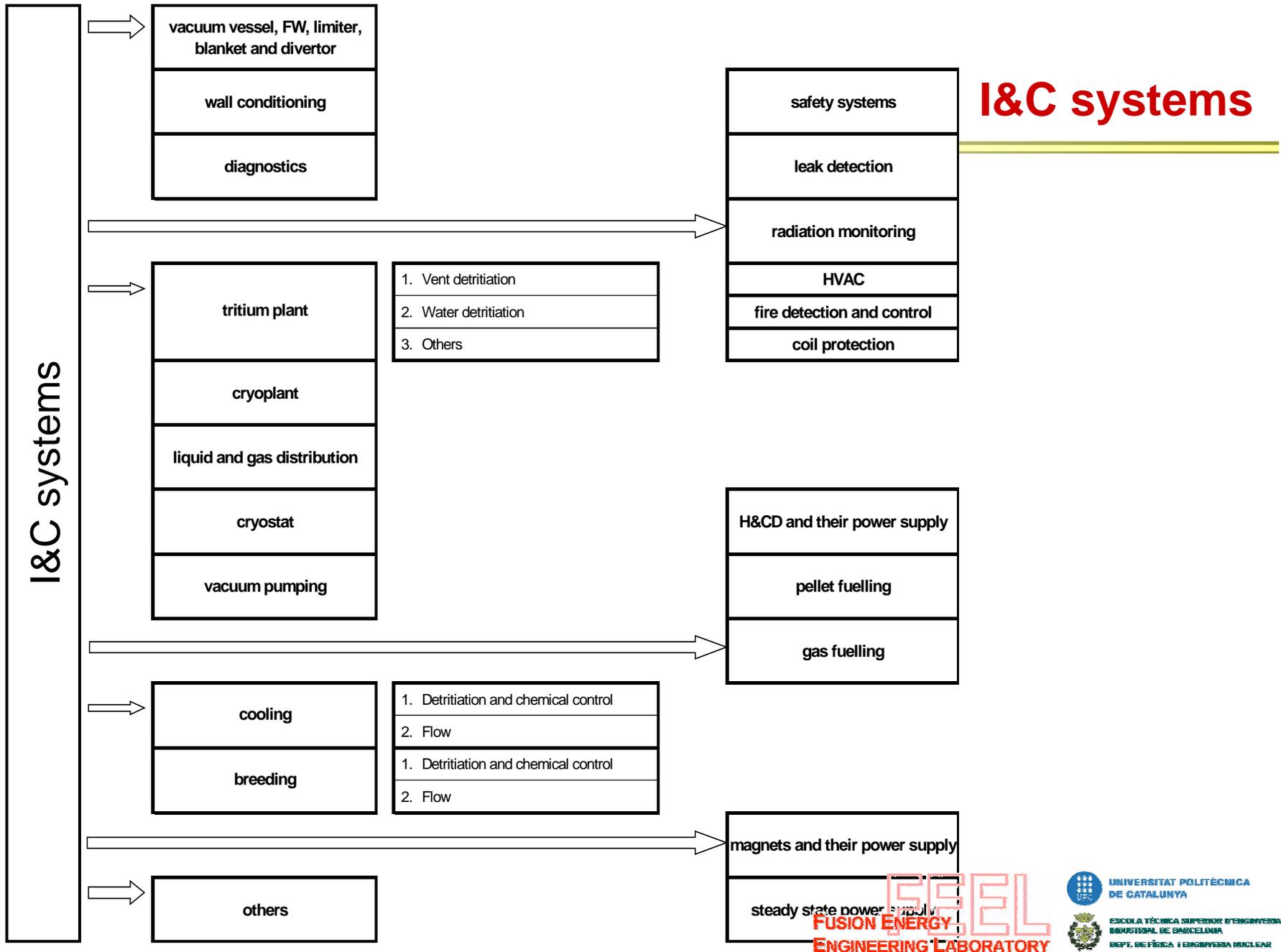
It includes all systems that carry out its function under accident situations (emergency systems) or that have a clear safeguard function (protection against voltage or internal missiles)



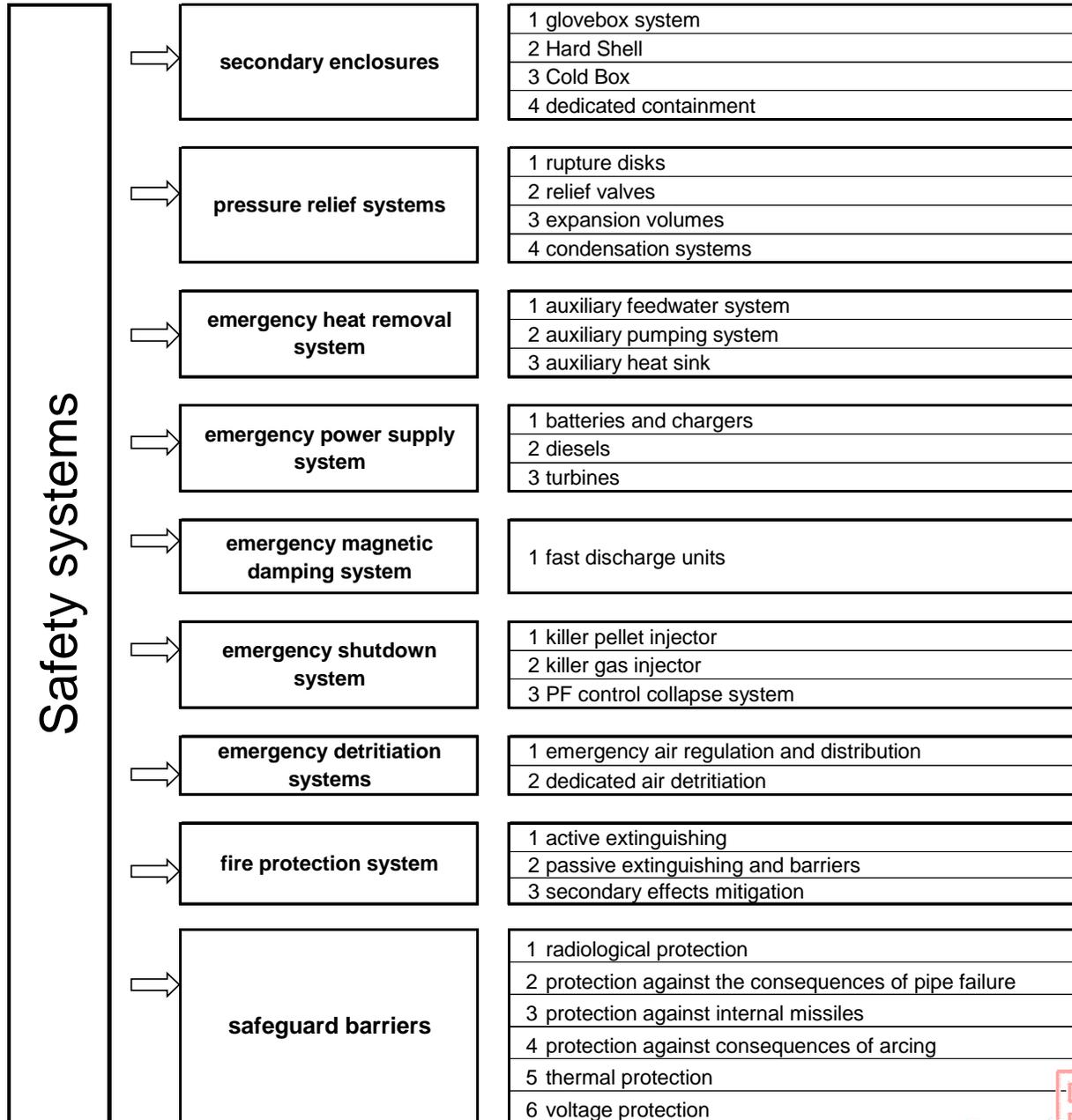
Structural systems

Supply systems

- cryogenic system
- rough vacuum system
- high vacuum system
- fuel processing system
- liquid breeder system
- primary water heat transfer system
- primary helium heat transfer system
- primary lithium heat transfer system
- secondary heat transfer system
- plasma heating & fuelling system
- wall conditioning system
- power supply system
- remote handle system
- HVAC system
- water detritiation systems
- vent detritiation system
- radwaste management systems
- miscellaneous systems



Safety systems



Failure modes

Reclassifying of *failure modes in Common Data* without loss of information - 2004.06.04

Initial 'Failure modes' in Common Data (before reclassifying)	Final 'Failure modes' in Common Data (after reclassifying)	Affected components ('-' is used when affected components have not been counted, usually when no change between initial and final)
All Failure Mode	All Failure Mode	--
Degraded Err Gas Flow/Degraded Reduced output	Degraded output	-- 3 compressors 1 pump
Fail to change position Blocked	Fail to change position	-- 1 safety valve
Fail to close No activation No disactivation	Fail to close	-- 1 valves 1 valves
Fail to function Fail to operate Fails to check Fails to function Bistables High power applications Low power applications Fails to provide proper output Functional failure	Fail to function	-- 30 various 1 check valve 1 air cooler 1 solid device 1 solid device 1 solid device 1 battery wet cell 3 I&C from T-Book

JET and TLK data

Data collected by Dr. Pinna related to:

- Active Gas Handling System - JET
 - 130 failures/malfunctions from 1995 to 2002
 - Mostly fails to open/close, external leaks, erratic/no output and fails to run
 - Valves, pumps, transformers, I&C, amplifiers...
- Vacuum system - JET
 - 600 leaks from 1983 to 2002
 - Bellows, flanges, valves,...
- Relevant components - TLK
 - 54 failures/malfunctions
 - Pumps, coolers, blowers,..

Summary

Current status of FCFR

- A new quasi-standard, complete, consistent, hierarchical and flexible component classification (3 families and 25 types)
- A Fusion System Breakdown (59 subsystems under 4 general systems)
- A synthesized list of failure modes (43% reduction)
- Several tens of new records
- An additional checking of data introduced

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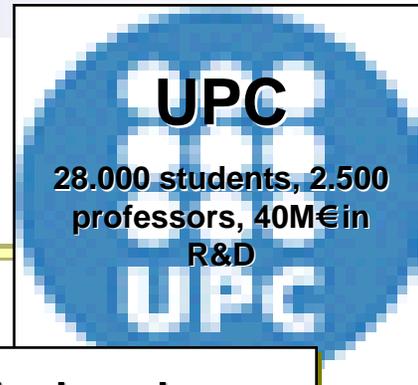
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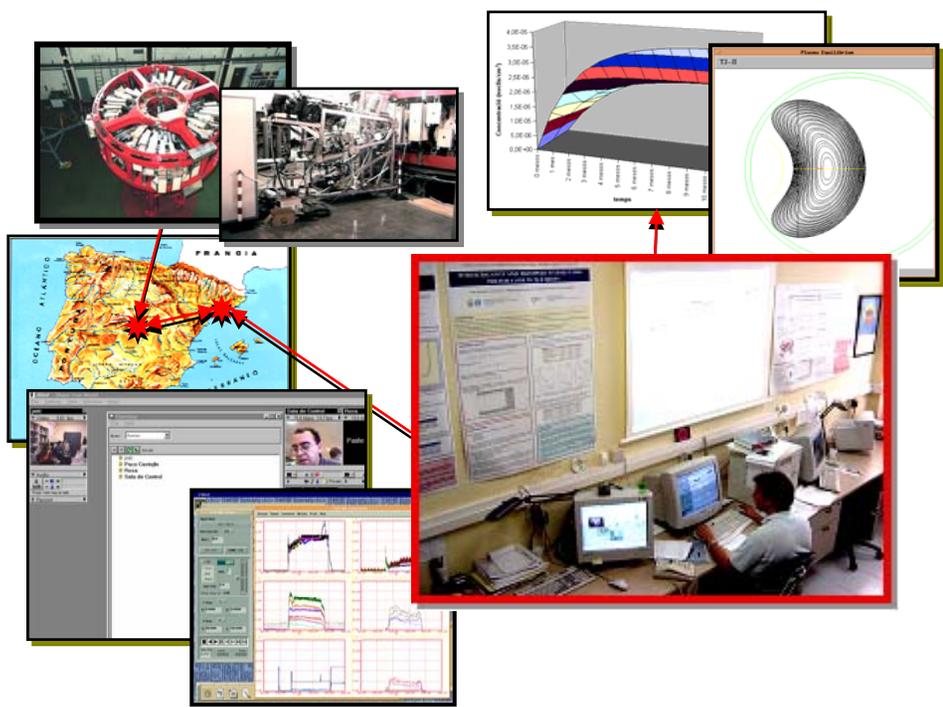


Nuclear Engineering
Technical School
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FEEL
Fusion Energy Engineering Laboratory
is a remote thermonuclear fusion lab.
It's dedicated to the study of controlled
fusion phenomena, technological and
physically. It develops several activities in
national and international fusion projects
in research and university environments.

- Euratom-CIEMAT
- Euratom-IPP
- Euratom-ENEA
- ITER International Team
- Joint European Torus (JET)
- National Institute for Fusion Science (NIFS)
- European Fusion Development Agreement
- Consejo de Seguridad Nuclear
- United Kingdom Atomic Energy Authority
- Comisariat Energíe Atomique
- Università degli Studi di Pavia



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FCFR-DB Component Classification - 2004.06.08

Family	Type	Subtype 1	Subtype 2
Mechanical	Piping	Fittings Sections Nozzles Various	
	Seals and joints	Welds Flanges Gaskets Bellows Various	
	Valves	Air operated Air-fluid operated Solenoid operated Explosive operated Hydraulic operated Motor operated Piston operated Manual operated Specific relief valves Without operator	Butterfly / Globe Butterfly Gate Pressure regulating