



**ENTE PER LE NUOVE TECNOLOGIE, L'ENERGIA E L'AMBIENTE**  
**Associazione ENEA-EURATOM sulla Fusione**

**FUSION DIVISION**  
**NUCLEAR FUSION TECHNOLOGIES**

**FUSION COMPONENT FAILURE RATE DATABASE (FCFR-DB)**  
**Vers. Dec. 2001**  
**Users Manual and Collected Data**

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# OBJECTIVES

- To realise a specific database, collecting statistical data on component failures, typically the ones useful in performing safety and reliability analysis on fusion devices.
- The set of data collected should contain, firstly, information for systems foreseen in ITER reactor.
- Database accessible “on line” by the way of an INTERNET browsers.

The work is set in the frame of the EFDA Fusion Technology Work Programme 2000, Task TW0-TRP-SEA4 – Plant Safety Assessment. The overall activity is also set in the frame of the International Energy Agreement (IEA), task 5.

# Background

Because the innovative aspects of fusion devices, generally, not many information are available on literature about availability and reliability of their components. So that, to perform probabilistic assessment of fusion devices, analysts have to consider also data coming from other technological experiences, like nuclear fission power plants, chemical plants, aeronautic, military and industrial systems. This, firstly because it seems very useful to have the largest knowledge of different component behaviours in order to predict availability data for fusion facilities safety/reliability assessment. Furthermore, the spread of the data that could be collected referring to the same kind of component can give a good idea of the uncertainty which is being introduced in the analysis when using a given data base.

**So that, in the data collection will be recorded data coming from operating experiences on fusion and from other different sources.**

# Introduction to the database

The database is developed in the frame of Lotus Domino and it is installed in a server AFX.

Dedicated applications for Lotus Notes are developed to perform data entry and to perform the database administration.

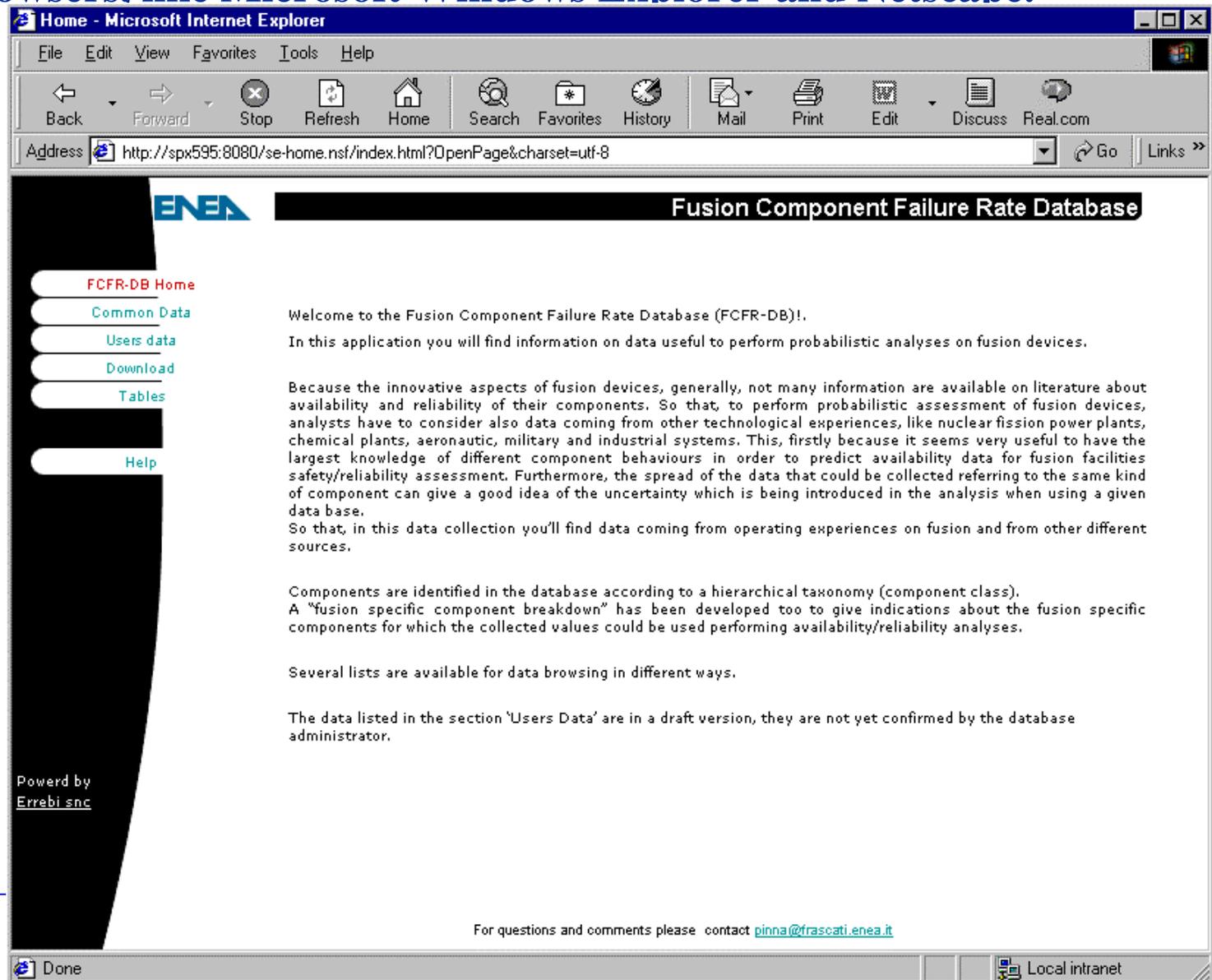
# Introduction to the database

The screenshot displays the 'CFR V1.04 - 1. AFBY Family Name - Lotus Notes' application. The interface includes a menu bar (File, Edit, View, Create, Actions, Help), a toolbar with various icons, and a workspace area. On the left, a tree view shows the database structure under 'CFR DB for Fusion Reactors technology Version V1.04'. The main area shows a table of data with the following columns: Date, Description, Failure Mode, Reference, Failure Rate, Unc. distr., and Op. Mo.

Date	Description	Failure Mode	Reference	Failure Rate	Unc. distr.	Op. Mo.
28/05/2001	PRESSURIZER	Leak	INEEL-EGG-FSP-7922	Mean: 1.0E-2 (1/y)		
28/05/2001	PRESSURIZER	Low pressure	INEEL-EGG-FSP-7922	Mean: 3.0E-2 (1/y)		
28/05/2001	PRESSURIZER	High pressure	INEEL-EGG-FSP-7922	Mean: 3.0E-2 (1/y)		
09/04/2001	VALVE CONDENSER STEAM DISCHARGE VALVE	All Failure Mode	IAEA-TECDOC-478	Mean: 2.3E-5 (1/h) Max: 10 Minimum: 1.7E-05 Error Factor: 1.30	Undefined(M-I All)	
09/04/2001	VALVE CONDENSER STEAM DISCHARGE VALVE	Fail to close	IAEA-TECDOC-478	Mean: 3.2E-6 (1/h) Max: 10 Minimum: 1.6E-06 Error Factor: 2.00	Undefined(M-I All)	
09/04/2001	VALVE CONDENSER STEAM DISCHARGE VALVE	Fail to open	IAEA-TECDOC-478	Mean: 6.3E-6 (1/h) Max: 10 Minimum: 3.7E-06 Error Factor: 1.70	Undefined(M-I All)	
09/04/2001	VALVE CONDENSER STEAM DISCHARGE VALVE	Leakage/External leak	IAEA-TECDOC-478	Mean: 4.8E-6 (1/h) Max: 10 Minimum: 2.6E-06	Undefined(M-I All)	

# Introduction to the database

Dedicated routines are developed to let the access to data by the way of Internet browsers, like Microsoft Windows Explorer and Netscape.



The screenshot shows a Microsoft Internet Explorer browser window. The title bar reads "Home - Microsoft Internet Explorer". The address bar contains the URL: <http://spx595:8080/se-home.nsf/index.html?OpenPage&charset=utf-8>. The browser toolbar includes buttons for Back, Forward, Stop, Refresh, Home, Search, Favorites, History, Mail, Print, Edit, Discuss, and Real.com. The main content area displays the "Fusion Component Failure Rate Database" website. The website has a black header with the ENEA logo on the left and the title "Fusion Component Failure Rate Database" on the right. A left sidebar contains navigation links: "FCFR-DB Home", "Common Data", "Users data", "Download", "Tables", and "Help". The main text area contains the following content:

Welcome to the Fusion Component Failure Rate Database (FCFR-DB)!.  
In this application you will find information on data useful to perform probabilistic analyses on fusion devices.

Because the innovative aspects of fusion devices, generally, not many information are available on literature about availability and reliability of their components. So that, to perform probabilistic assessment of fusion devices, analysts have to consider also data coming from other technological experiences, like nuclear fission power plants, chemical plants, aeronautic, military and industrial systems. This, firstly because it seems very useful to have the largest knowledge of different component behaviours in order to predict availability data for fusion facilities safety/reliability assessment. Furthermore, the spread of the data that could be collected referring to the same kind of component can give a good idea of the uncertainty which is being introduced in the analysis when using a given data base.

So that, in this data collection you'll find data coming from operating experiences on fusion and from other different sources.

Components are identified in the database according to a hierarchical taxonomy (component class). A "fusion specific component breakdown" has been developed too to give indications about the fusion specific components for which the collected values could be used performing availability/reliability analyses.

Several lists are available for data browsing in different ways.

The data listed in the section 'Users Data' are in a draft version, they are not yet confirmed by the database administrator.

At the bottom of the page, it says "Powered by Errebi snc" and "For questions and comments please contact [pinna@frascati.enea.it](mailto:pinna@frascati.enea.it)". The browser status bar at the bottom shows "Done" and "Local intranet".



# Introduction to the database

The access to the database is restricted to Users operating for fusion, typically to Associations that are IEA members.

The web - site, where is the link to the database, is

<http://spx595.frascati.enea.it:8080/homepage.nsf>

That is the page dedicated to the ENEA activities on Safety and Environment for fusion technology.

The access is regulated by UserIDs and Passwords distributed by ENEA, which operate under the EFDA approval.

# Introduction to the database

The screenshot shows a web browser window with the address `http://spx595:8080/homepage.nsf`. The browser interface includes a menu bar (File, Edit, View, Favorites, Tools, Help) and a toolbar with icons for Back, Forward, Stop, Refresh, Home, Search, Favorites, History, Mail, Print, Edit, Discuss, and Real.com. The main content area is titled "EURATOM - ENEA Association on Fusion Research" and "Welcome to Safety and Environment on fusion technology". It contains a paragraph about the goal of fusion activities, a list of main activities of the "S&E" Group, and a list of safety studies. A diagram on the right illustrates the relationship between Facility Design, Occupational Radiation Exposure, Waste Management, Source Terms, Plant Safety Assessment, and Environmental Impact. The browser status bar at the bottom shows "Done" and "Local intranet".



# Introduction to the database

The data related to component failures are recorded in documents.

The **“Common Data”** set includes the documents available for all the Users.

The **“Users Data”** set includes documents for which the data entry is not yet terminated or, not yet checked and approved.

# Common Data set

The retrieval of documents can be done by using several different lists.

## Ordering the documents according different fields:

- ⊕ by Component class
- ⊕ by Failure Mode
- ⊕ by Fusion specific breakdown
- ⊕ by Reference
- ⊕ by free choosing

## Browsing lists of different information:

- ▼ Failure data (information on failures)
- ▼ Fusion specific breakdown
- ▼ Validation info (data control, i.e.: validation, IEA consensus)



# Common Data set

## by Component class

Address http://spx595:8080/se-home.nsf/by\_component\_class.html?OpenPage&charset=iso-8859-1 Go Links >>

**ENE A** **by component class**

Failure Data Fusion comp. Breakdown Validation Info

Expand Collapse Search

Date	Description	Failure Mode	Reference	Failure Rate	Unc.distr.	Op.Mode	App.Chara
▶ Electrical component							
▶ HIGH Vacuum							
▶ HVAC							
▼ Hydraulic Component							
▶ Compressor							
▶ Condenser							
▶ Fan							
▶ Feedwater system							
▶ Filter							
▶ Heat exchanger							
▶ Piping							
▶ Pressurizer							
▼ Pump							
<input checked="" type="checkbox"/> <a href="#">04/06/2001</a>	PUMP	Fail to run	IAEA-TECDOC-478	Mean: 2.9E-5 (1/h)	LogNormal (EF)	All	Error Factor: 4
<input checked="" type="checkbox"/> <a href="#">04/06/2001</a>	PUMP	Fails to start	IAEA-TECDOC-478	Mean: 1.69E-5 (1/h)	LogNormal (EF)	All	

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# Common Data set

## by Component class

Workspace CFR V1.04 - 1. AFBy Family Name\2. Failure Data notes

CFR DB for Fusion Reactors technology Version V1.04

- Common Data
  - by Component Class
    - Failure Data
      - Fusion comp. Breakdown
      - Validation Info
    - by Failure Mode
    - by Fusion specific Breakdown
    - by Reference
    - by free choosing
  - 2. Users Data
  - 3. Download
  - 4. Tables
    - Component classification
    - Fusion component breakdown
    - Failure Mode List
    - Reference List
    - Operation Mode List
    - Units List
    - Uncertainty Distribution List
    - Help documents
    - Help visible in Web
    - All Documents
  - 5. Export Data

Failure Mode	Reference	Failure Rate	Unc. distr.	Failure No.	Comp. No.	Damaged Comp No.	Failure/Comp. No.	Time/Comp. (h)
<b>Containment system</b>								
<b>Containment</b>								
<input checked="" type="checkbox"/> Fail to seal	EGG-FSP-7922	Mean: 8.0E-4 (1/d)						
<b>Containment access</b>								
<input checked="" type="checkbox"/> Fail to function	EGG-FSP-7922	Mean: 6.2E-6 (1/h)						
<input checked="" type="checkbox"/> Fail to seal	EGG-FSP-7922	Mean: 7.0E-6 (1/h)						
<b>Penetration</b>								
<input checked="" type="checkbox"/> Fail to seal	EGG-FSP-7922	Mean: 1.2E-7 (1/h)						
<input checked="" type="checkbox"/> Fail to seal	EGG-FSP-7922	Mean: 1.5E-7 (1/h)						
<input checked="" type="checkbox"/> Fail to seal	EGG-FSP-7922	Mean: 2.7E-7 (1/h)						
<b>Electrical component</b>								
<b>Busbar</b>								
<input checked="" type="checkbox"/> All Failure Mode	INEEL-EGG-FSP-7922	Mean: 1.0E-8 (1/h)						
<b>Circuit breaker</b>								
<input checked="" type="checkbox"/> Spurious trip	INEEL-EGG-FSP-7922	Mean: 1.0E-5 (1/h)						
<input checked="" type="checkbox"/> Fail to operate	WASH 1400	Mean: 1.25E-3 (1/d)	LogNormal					
		Median Value: 1.0E-03	(Md-U95-L5)					
		Upper Bound 95%: 3.0E-03						
		Lower Bound 5%: 3.0E-04						
<input checked="" type="checkbox"/> Premature transfer	WASH 1400	Mean: 1.25E-6 (1/h)	LogNormal					
		Median Value: 1.0E-06	(Md-U95-L5)					
		Upper Bound 95%: 3.0E-06						
		Lower Bound 5%: 3.0E-07						
<b>Converter</b>								
<b>Inverter</b>								
<input checked="" type="checkbox"/> Fail to operate	INEEL-EGG-FSP-7922	Mean: 1.0E-4 (1/h)						
<b>Electric accumulator</b>								
<b>Battery</b>								
<input checked="" type="checkbox"/> Fails to provide proper output	INEEL-EGG-FSP-7922	Mean: 1.0E-6 (1/h)						
<input checked="" type="checkbox"/> Fail to operate	INEEL-EGG-FSP-7922	Mean: 1.0E-6 (1/h)						
<b>Electric Generator</b>								
<b>DC</b>								

# Common Data set

## by Failure mode



by failure mode

Failure Data
Fusion comp. Breakdown
Validation Info

FCFR-DB Home

by component class

by failure mode

fusion specific breakdown

by reference

by free choosing

Help

Expand
Collapse
Search

Date	Description	Failure Mode	Reference	Failure Rate	Unc.distr.	Op.Mode	App.Charac.
<ul style="list-style-type: none"> <li>▶ Abnormal startup of idle pump</li> <li>▶ All Failure Mode</li> <li>▶ Bistables</li> <li>▶ Blocked</li> <li>▶ Casing rupture</li> <li>▶ Contacts fail to transfer</li> <li>▶ Degraded</li> <li>▶ Err Gas Flow/Degraded</li> <li>▼ External Leakage</li> </ul>							
<a href="#">04/20/2001</a>	VALVE SELF OPERATED CHECK	External Leakage	IAEA-TECDOC-478	Mean: 2.66E-8 (1/h) Median Value: 3 Upper Bound 95%: 1.0E-07 Lower Bound 5%: 1.10	LogNormal (Md-U95-L5)	All	9.1
<a href="#">05/09/2001</a>	VALVE MOTOR OPERATED GENERAL	External Leakage	WASH 1400	Mean: 2.66E-8 (1/h) Median: 4 Upper Bound: 1.0E-07 Lower Bound: 1.30	Undefined (Md-U-L)	All	9.2
<a href="#">05/09/2001</a>	VALVE AIR OPERATED GENERAL	External Leakage	WASH 1400	Mean: 2.66E-8 (1/h) Median: 10	Undefined (Md-U-L)	All	9.3

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# Common Data set

## by Fusion specific breakdown

The screenshot shows a web application interface for ENEA. The main title is "fusion specific breakdown". There are three tabs: "Failure Data", "Fusion comp. Breakdown", and "Validation Info". The "Fusion comp. Breakdown" tab is active. Below the tabs are buttons for "Expand", "Collapse", and "Search".

On the left side, there is a navigation menu with the following items:

- FCFR-DB Home
- by component class
- by failure mode
- fusion specific breakdown (highlighted in red)
- by reference
- by free choosing
- Help

The main content area displays a table with the following columns: Date, Description, Failure Mode, Reference, Failure Rate, Unc.distr., Op.Mode, App.Charac., Data validation, and IEA Co. The table contains the following data:

Date	Description	Failure Mode	Reference	Failure Rate	Unc.distr.	Op.Mode	App.Charac.	Data validation	IEA Co
▶ Containment systems									
▶ Fuelling system									
▼ Heat Transfer System (water cooling)									
▶ Condenser									
▶ Electrical component									
▶ Heat exchanger									
▶ Pressurizer									
▶ Pump									
▼ Turbine									
<input checked="" type="checkbox"/> <a href="#">05/29/2001</a>	TURBINE	Trip	INEEL-EGG-FSP-7922	Mean: 1.0E-0	(1/y)			not validated	not ap
<input checked="" type="checkbox"/> <a href="#">05/29/2001</a>	TURBINE	Trip with turbine bypass failure	INEEL-EGG-FSP-7922	Mean: 1.0E-2	(1/y)			not validated	not ap
<input checked="" type="checkbox"/> <a href="#">05/29/2001</a>	TURBINE BYPASS	Fail to open	INEEL-EGG-FSP-7922	Mean: 6.0E-2	(1/y)			not validated	not ap
▶ Valves									
▶ (Not Categorized)									

At the bottom of the page, there is a footer that reads "Powered by Errebi snc".

# Common Data set

## by Reference



by reference

Failure Data
Fusion comp. Breakdown
Validation Info

Expand
Collapse
Search

Date	Description	Failure Mode	Reference	Failure Rate	Unc.distr.	Op.Mode	App.Charac.
▶ AICHE							
▶ EGG-FSP-7922							
▶ IAEA-TECDOC-478							
▶ INEEL-EGG-FSP-7922							
▶ INEEL/CON-2000-00347							
▶ INEEL/EXT-98-00892							
▶ IREP NUREG 2728							
▶ OREDA							
▶ RAC							
▶ RAGUSA							
▼ T-BOOK							
<input checked="" type="checkbox"/> <a href="#">05/10/2001</a>	PUMP CENTRIFUGAL	Spurious Stop	T-BOOK	Mean: 2.3E-5 (1/h) 5th percentiles: 0.00 95th percentiles: 0.00	Gamma (5-95)	All	Application LWR
<input checked="" type="checkbox"/> <a href="#">05/10/2001</a>	PUMP CENTRIFUGAL	Spurious Stop	T-BOOK	Mean: 1.1E-5 (1/h) 5th percentiles: 0.00 95th percentiles: 0.00	Gamma (5-95)	All	Application LWR

FCFR-DB Home  
 by component class  
 by failure mode  
 fusion specific breakdown  
**by reference**  
 by free choosing  
 Help

Powered by Errebi snc

# Common Data set

by free choosing

by free choosing

Expand Collapse Search

FCFR-DB Home  
by component class  
by failure mode  
fusion specific breakdown  
by reference  
by free choosing

Help

Powerd by Errebi snc

Date	Description	Failure Mode	Reference	Failure Rate	Unc.distr.	Mean Rep.Rate	Op.Mode	App.Charac.
<a href="#">04/03/2001</a>	AIR COOLER	Fail to operate	IREP NUREG 2728	Mean: 1.0E-5 (1/h) Median: 3 Error Factor: 3.0E+00	Undefined (Md-EF)		All	
<a href="#">04/03/2001</a>	Blower fan	All Failure Mode	IAEA-TECDOC-478	Mean: 2.5E-6 (1/h) Recommended: 2.5E-06 Max: 2.8E-06 Min: 2.3E-06	Undefined (R-M-m)		All	
<a href="#">04/03/2001</a>	BLOWER VENTILATOR AIR CIRCULATING FAN	All Failure Mode	IAEA-TECDOC-478	Mean: 2.5E-6 (1/h) Recommended: 2.5E-06 Max: 3.4E-06 Min: 1.9E-06	Undefined (R-M-m)		All	
<a href="#">04/03/2001</a>	COMPRESSOR MSIV AIR COMPRESSOR	Fail to run	IAEA-TECDOC-478	Mean: 4.3E-3 (1/h) Max: 0.00 Min: 2.7E-03	Undefined (M-m)		All	
<a href="#">04/03/2001</a>	COMPRESSOR MSIV AIR COMPRESSOR	Fails to start	IAEA-TECDOC-478	Mean: 2.5E-3 (1/d) Max: 0.00 Min: 5.9E-04	Undefined (M-m)		All	
<a href="#">04/03/2001</a>	COMPRESSOR CONTAINMENT AIR CONTROL	Fail to run	IAEA-TECDOC-478	Mean: 2.5E-3 (1/h) Max: 0.00	Undefined (M-m)		All	

# Users data set

It includes documents for which the data entry is not yet terminated or, not yet checked and approved.

ENE A Users data

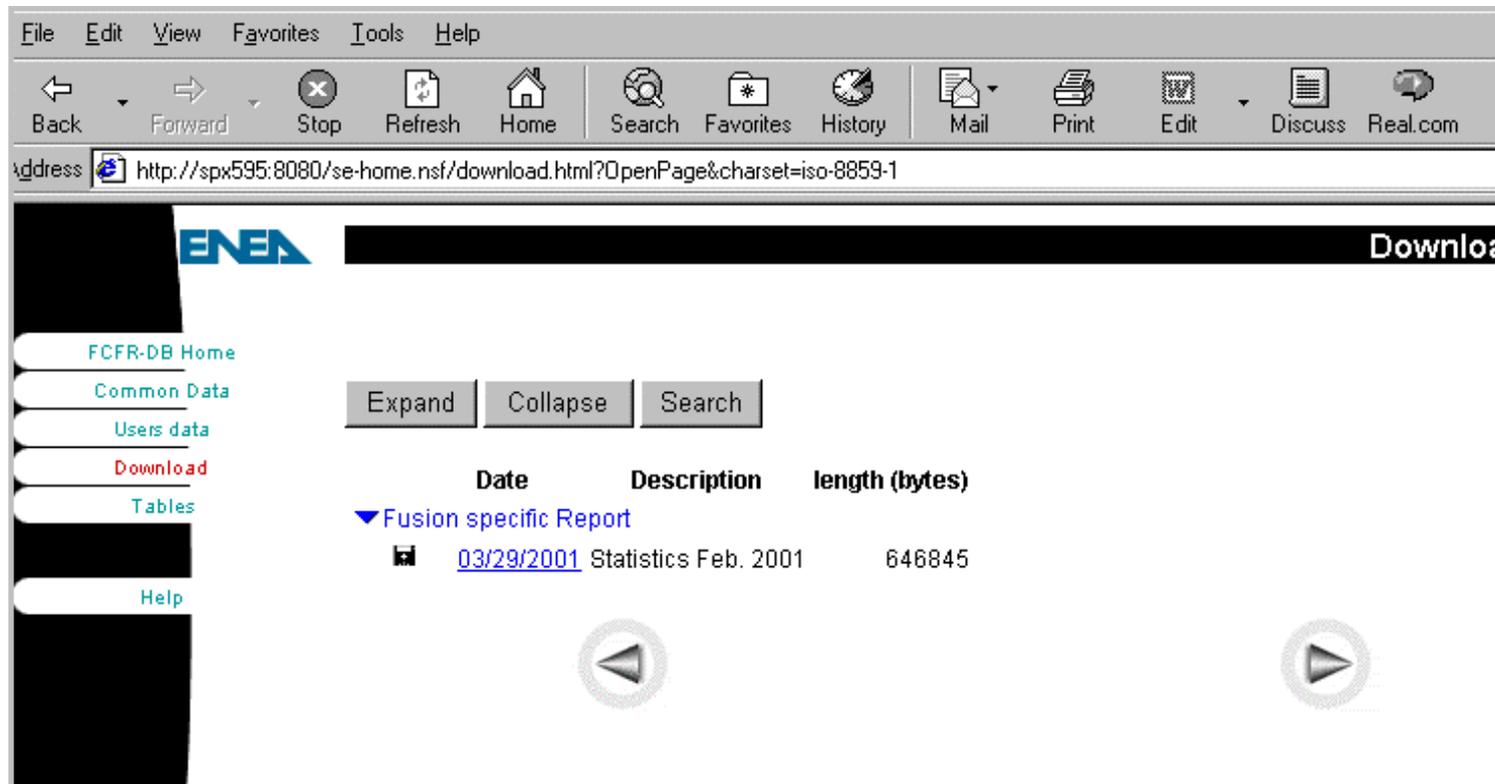
Expand Collapse Search

Date	Description	Document status	Data validation	IEA consens	Failure Mode	Reference
▶ Gas-cooled system						
▶ Liquid Metal-cooled Systems						
▼ Magnet systems						
▼ Subsystems						
<input type="checkbox"/> 05/22/2001	CENTRAL CELL MAGNET	not accepted	not validated	not approved	Conductor short	EGG-FSP-7922
<input type="checkbox"/> 05/22/2001	CENTRAL CELL MAGNET	not accepted	not validated	not approved	Leads burn up	EGG-FSP-7922
<input type="checkbox"/> 05/22/2001	CENTRAL CELL MAGNET	not accepted	not validated	not approved	Insulator deteriorates	EGG-FSP-7922
<input type="checkbox"/> 05/22/2001	CENTRAL CELL MAGNET	not accepted	not validated	not approved	Overall	EGG-FSP-7922
<input type="checkbox"/> 05/22/2001	NORMAL CHOKE COILS	not accepted	not validated	not approved	Coolant leakage at joint	EGG-FSP-7922
<input type="checkbox"/> 05/22/2001	NORMAL CHOKE COILS	not accepted	not validated	not approved	Overall	EGG-FSP-7922
<input type="checkbox"/> 05/22/2001	SUPERCONDUCTOR CHOKE COILS	not accepted	not validated	not approved	Overall	EGG-FSP-7922
<input type="checkbox"/> 05/22/2001	END CELL MAGNETS	not accepted	not validated	not approved	Overall	EGG-FSP-7922
<input type="checkbox"/> 05/22/2001	CENTRAL CELL SHIELD	not accepted	not validated	not approved	Water leak	EGG-FSP-7922
<input type="checkbox"/> 05/22/2001	CHOKE COIL SHIELD	not accepted	not validated	not approved	Water leak	EGG-FSP-7922
<input type="checkbox"/> 05/22/2001	END COIL SHIELD	not accepted	not validated	not approved	Water leak	EGG-FSP-7922
<input type="checkbox"/> 05/22/2001	MAGNET POWER	not accepted	not	not	Shorted thyristor	EGG-FSP-

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# Download

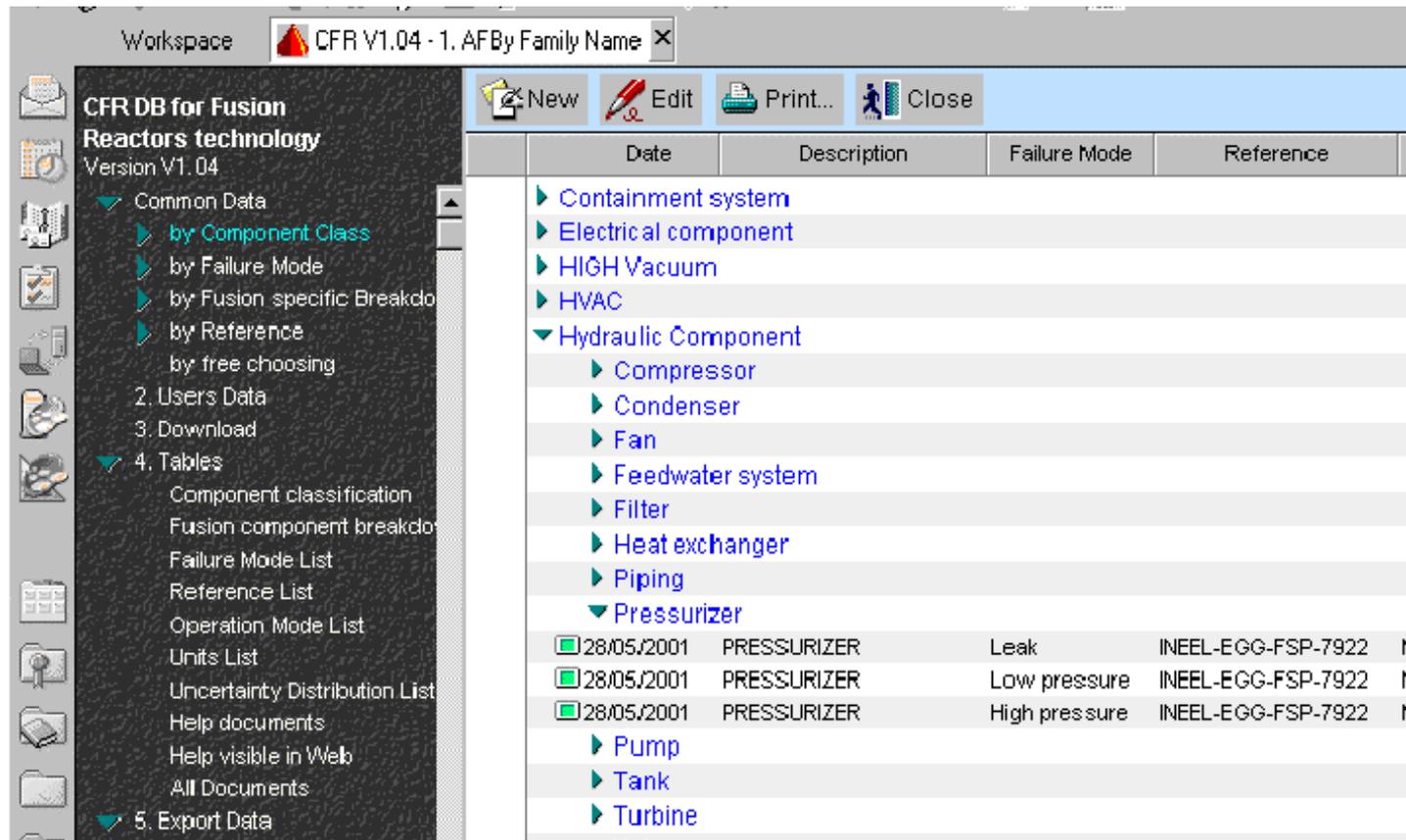
This function lets the Users to perform the download of the files showed in the list. Typically, the files are sets of data extracted from the database.



**The files are prepared by the database Administrator.  
Users that need dedicated files can require them to the Administrator.**

# Tables

Several tables are foreseen to generate a fixed standard in the data nomenclature to use in the data entry/updating and to assist the Users.



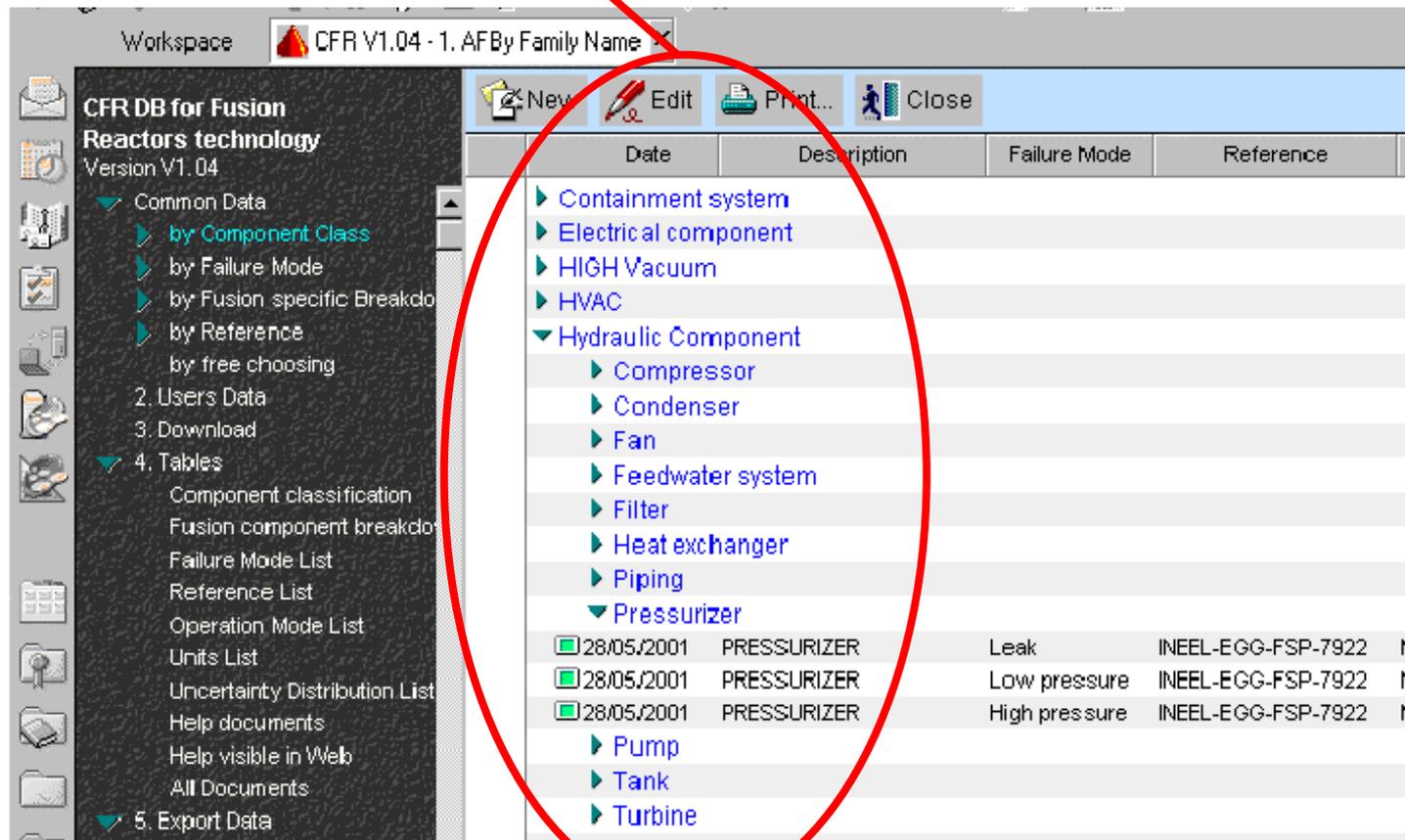
The screenshot shows a software application window titled 'CFR V1.04 - 1. AFBy Family Name'. The interface is divided into a left sidebar and a main content area. The sidebar contains a tree view under 'CFR DB for Fusion Reactors technology Version V1.04'. The '4. Tables' folder is expanded, showing sub-items like 'Component classification', 'Fusion component breakdo', 'Failure Mode List', 'Reference List', 'Operation Mode List', 'Units List', 'Uncertainty Distribution List', 'Help documents', 'Help visible in Web', and 'All Documents'. The main content area displays a table with the following columns: Date, Description, Failure Mode, and Reference. The table contains three rows of data for 'PRESSURIZER' components, all dated '28/05/2001' and with a reference of 'INEEL-EGG-FSP-7922'. The failure modes listed are 'Leak', 'Low pressure', and 'High pressure'.

Date	Description	Failure Mode	Reference
28/05/2001	PRESSURIZER	Leak	INEEL-EGG-FSP-7922
28/05/2001	PRESSURIZER	Low pressure	INEEL-EGG-FSP-7922
28/05/2001	PRESSURIZER	High pressure	INEEL-EGG-FSP-7922

# Tables

## ⊕ Component classification

Components are identified in the database according to a hierarchical taxonomy.



Workspace CFR V1.04 - 1. AFBy Family Name

CFR DB for Fusion  
Reactors technology  
Version V1.04

- Common Data
  - by Component Class
  - by Failure Mode
  - by Fusion specific Breakdown
  - by Reference
  - by free choosing
- 2. Users Data
- 3. Download
- 4. Tables
  - Component classification
  - Fusion component breakdown
  - Failure Mode List
  - Reference List
  - Operation Mode List
  - Units List
  - Uncertainty Distribution List
  - Help documents
  - Help visible in Web
  - All Documents
- 5. Export Data

Date	Description	Failure Mode	Reference
	Containment system		
	Electrical component		
	HIGH Vacuum		
	HVAC		
	Hydraulic Component		
	Compressor		
	Condenser		
	Fan		
	Feedwater system		
	Filter		
	Heat exchanger		
	Piping		
	Pressurizer		
28/05/2001	PRESSURIZER	Leak	INEEL-EGG-FSP-7922
28/05/2001	PRESSURIZER	Low pressure	INEEL-EGG-FSP-7922
28/05/2001	PRESSURIZER	High pressure	INEEL-EGG-FSP-7922
	Pump		
	Tank		
	Turbine		

# Tables

## ⊕ Component classification

Components are identified in the database according to a hierarchical taxonomy. They are categorised in:

- *family name*,
- *type* and,
- *four different subclasses*.

The last ones, to take into account four different levels of technical characteristics, such as, to better specify different components, where it needs.

# Tables

## ⊕ Component classification

**Component classification**

FCFR-DB Home  
Component classification  
Fusion component breakdown  
Failure mode list  
Reference list  
Operation mode list  
Units list  
Uncertainty distribution list  
Help

**Familyname - Type - Subclasses Information**

- ▶ Containment system
- ▶ Electrical component
- ▶ Gas-cooled system
- ▶ HIGH Vacuum
- ▶ HVAC
- ▼ Hydraulic Component
  - ▶ Compressor
  - ▶ Condenser
  - ▶ Fan
  - ▶ Feedwater system
  - ▶ Filter
  - ▶ General
  - ▶ Heat exchanger
- ▼ Pump

Horizontal

The component breakdown is available as an assistance tool in data entry, data retrieval and query of component failure data documents.

Documents on component failure data can be recorded only if a component class is assigned.

Users that recognise the need of new classes have to require the data list updating to the database administrator.

# Tables

## ⊕ Fusion component breakdown

A specific breakdown of components used in fusion facilities has been theorised on the base of the present knowledge in the fusion facility processes.

This because, the main sets of data, which are collected in the database, come from different operating experiences than fusion, at least for the moment. Consequently, the indication about possible extrapolations on the use of data in fusion could be useful information for the database Users.

By the "fusion component breakdown" it is possible to correlate the information on generic components to systems/sub-systems/components of fusion facilities in order to give safety analysts and designers of fusion facilities indication about the specific utilisation in fusion field of the recorded data.

Precisely, the systems/sub-systems/components of fusion facilities for which the collected data could be taken as reference in performing safety/reliability analyses.

# Tables

## ⊕ Fusion component breakdown

Normally, in each document related to component failure data more than one "fusion class" could be indicated.

ENE A

fusion specific breakdown

Failure Data Fusion comp. Breakdown Validation Info

Expand Collapse Search

Date	Description	Failure Mode	Reference	Failure Rate	Unc.distr.	Op.Mode	App.Char
▶	Containment systems						
▶	Fuelling system						
▼	Heat Transfer System (water cooling)						
▶	Condenser						
▶	Electrical component						
▶	Heat exchanger						
▶	Pressurizer						
▶	Pump						
▼	Turbine						
☑	<a href="#">05/29/2001</a> TURBINE	Trip	INEEL-EGG-FSP-7922	Mean: 1.0E-0	0 (1/y)		
☑	<a href="#">05/29/2001</a> TURBINE	Trip with turbine bypass failure	INEEL-EGG-FSP-7922	Mean: 1.0E-2	2 (1/y)		
☑	<a href="#">05/29/2001</a> TURBINE BYPASS	Fail to open	INEEL-EGG-FSP-7922	Mean: 6.0E-2	2 (1/y)		
▶	Valves						
▶	(Not Categorized)						

FCFR-DB Home  
by component class  
by failure mode  
fusion specific breakdown  
by reference  
by free choosing

Help

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rebi snc

ENE A

# Tables

## ⊕ Fusion component breakdown

Six hierarchical levels are foreseen to classify the components in detail:

- *fusion plant system,*
- *fusion plant sub-system and,*
- *four different sub-classes.*

# Tables

## ⊕ Fusion component breakdown

**ENE A** Fusion component breakdown

FCFR-DB Home  
Component classification  
**Fusion component breakdown**  
Failure mode list  
Reference list  
Operation mode list  
Units list  
Uncertainty distribution list  
Help

Expand Collapse Search

Familyname Type Subclasses Information	DocumentUniqueID
▶ Auxiliary systems	
▶ Blanket	
▶ Containment systems	
▶ Cryogenic systems	
▶ Electrical Power distribution systems	
▶ Electrical Safety systems	
▶ Fuelling system	
▶ Generic Electrical Components	
▶ Heat Transfer System (helium cooling)	
▶ Heat Transfer System (liquid lithium cooling)	
▶ heat Transfer System (liquid sodium cooling)	
▼ Heat Transfer System (water cooling)	
▶ Compressor	

Powerd by

▶ ceramic breaks in piping

**The “fusion component breakdown” is available as an assistance tool in data entry, data retrieval and query of component failure data documents.**

**Users that recognise the need of breakdown updating have to require it to the database administrator.**

**ENE A**

# Tables

## ⊕ Failure mode list

This Table is dedicated to record information about the failure mode of the generic component for which the data on failures have been evaluated.

A "Failure Mode" data list has been prepared to assist the user in the data entry, data retrieval and query of component failure data documents.

Few samples of failure modes are:

- *fail to close,*
- *fail to open,*
- *fail to reach design specification,*
- *fail to run,*
- *fail to start,*
- *fail to stop,*
- *founded during maintenance,*
- *internal leak,*
- *leakage/external leak,*
- *not defined failure,*
- *plug,*
- *rupture,*
- *short circuit*
- *short to ground,*
- *spurious function*

# Tables

## ⊕ Reference list

A data list named "References" is dedicated to record information about the data sources.

A "References" Table has been prepared to assist the user in the data entry, data retrieval and query of component failure data documents.

Three fields (columns) form the table:

- *Reference code*, for a short identification of the data sources.  
This code is the information recorded in the document related to component failure data
- *Description*, for a detailed description of the data sources.
- *Note*, for comments on the data sources.

# Tables

## ⊕ Operation mode list

In the document related to component failure data a field, named "Operation Modes", is dedicated to record information about the operating mode of the generic component for which the data on failures have been evaluated.

An "Operation modes" Table has been prepared to assist the user in the data entry, data retrieval and query of component failure data documents.

Few samples of operating modes are:

- *Stand-by*
- *Intermittent*
- *Cyclical*
- *Batch Operation*
- *Continuous*

# Tables

## Units list

Numeric component failure data need to be indicated by a unit measure, e.g.: **1/h**, **1/y**, **1/d** (1/demand), **h**, etc.

A "Units list" Table has been prepared to assist the users in the data entry and data retrieval of component failure data documents.

# Tables

## ⊕ Uncertainty distribution list

In the document related to component failure data, in the fields related to values where uncertainty is counted, information on uncertainty distribution type and related parameters are recorded.

This is applied typically for failure rates, failure probability on demands, repair rates.

An "Uncertainty distribution list" Table has been prepared to assist the users in the data entry and data retrieval of component failure data documents.

Eight fields are foreseen in the Table:

- *Mean value*
- *Uncertainty distribution type*
- *a maximum of three parameters*



# Tables

## ⊕ Uncertainty distribution list

Uncertainty distribution	Parameters		
	First	Second	Third
Beta	scale factor	shape factor	
Discrete	5th percentiles	50th percentiles	95th percentiles
Gamma	scale factor	shape factor	
Gamma	5th percentiles	95th percentiles	
Lognormal	median value	upper bound	lower bound
Lognormal	median value	error factor	
Normal	standard deviation		
Uniform			

**Eight fields are foreseen in the Table:**

- *Mean value*
- *Uncertainty distribution type*
- *a maximum of three parameters*



# Tables

## ⊕ Uncertainty distribution list

Workspace CFR V1.04 - Admin\Uncertainty Distribution List Reference X notes

Save Save and Close Close

### Uncertainty Distribution

Distribution:  LogNormal (Md-U95-L5)

First Parameter Description:  Median Value

Format:  0.0E+00

Visibel:  Yes  No

Second Parameter Description:  Upper Bound 95%

Format:  0.0E+00

Visibel:  Yes  No

Third Parameter Description:  Lower Bound 5%

Format:  0.0E+00

Visibel:  Yes  No

- 0
- 0.0
- 0.00
- 0.000
- 0.0E+00
- 0.00E+00
- 0.000E+00

# Export data

Information can be exported from the database to **Microsoft Excel files**.

The Users have to select the documents they want to extract from the chosen list of data and press the dedicated button to Export data.

Failure Mode	Reference	Failure Rate	Unc. distr.	Failure No.	Comp. No.	Damaged Comp No.	Failure/Comp. No.	Time/Cor. (h)
<b>HIGH Vacuum</b>								
<b>General</b>								
<input checked="" type="checkbox"/> Rupture	INEEL/EXT-98-00892	Mean: 1.0E-10 (1/mh) Error Factor: 30.00	Exponential					
<b>Pump</b>								
<b>Vacuum Pump</b>								
<input checked="" type="checkbox"/> Internal leak	INEEL/EXT-98-00892	Mean: 2.0E-6 (1/h) Error Factor: 4.70	Exponential					
<input checked="" type="checkbox"/> Plug	INEEL/EXT-98-00892	Mean: 9.9E-6 (1/h) Error Factor: 2.00	Exponential					
<input checked="" type="checkbox"/> Internal leak	INEEL/EXT-98-00892	Mean: 2.0E-6 (1/h) Error Factor: 4.70	Exponential					
<b>Cryogenic</b>								
<input checked="" type="checkbox"/> Fail to operate	INEEL/EXT-98-00892	Mean: 1.0E-6 (1/h) Error Factor: 10.00	Exponential					
<input checked="" type="checkbox"/> Leak into	INEEL/EXT-98-00892	Mean: 2.0E-5 (1/h) Error Factor: 1.70	Exponential					
<input checked="" type="checkbox"/> Fail to operate	INEEL/EXT-98-00892	Mean: 1.5E-5 (1/h) Error Factor: 1.20	Exponential					
<input checked="" type="checkbox"/> Leak	INEEL/EXT-98-00892	Mean: 6.0E-3 (1/y) Error Factor: 2.20	Exponential					
<b>Rough Vacuum Gauge</b>								
<input checked="" type="checkbox"/> Fail to operate	INEEL/EXT-98-00892	Mean: 1.0E-4 (1/h) Error Factor: 10.00	Exponential					

**This routine is available only in the Lotus Notes frame.**

**Users, who have available only the Internet frame, can require export of data to the Administrator, who will export the data sets required and will provide the Excel files in the Download section.**

# Help on line

The Help on line is available by dedicated routines. The help documents are accessible by selecting the dedicated voice in the menu.

**FCFR-DB Home**  
**Common Data**  
Users data  
Download  
Tables  
**Help**

ENE A Help

Expand Collapse Search

**Helpdocument for Form named**

- [1. Introduction to the database](#)
- [2. Common Data](#)
  - [2.1. by component class](#)
  - [2.2. by failure mode](#)
  - [2.3. by Fusion specific breakdown](#)
  - [2.5. by free choosing](#)
- [3. Users data](#)
- [4. Download](#)
- [5. Tables](#)
  - [5.1. Component classification](#)
  - [5.2. Fusion component breakdown](#)
  - [5.3. Failure mode list](#)
  - [5.4. Reference list](#)
  - [5.5. Operation mode list](#)
  - [5.6. Units list](#)
  - [5.7. Uncertainty distribution list](#)
  - [5.8. All documents](#)
- [6. Export data](#)
  - [6.1. Fusion component breakdown](#)
  - [6.2. Component classification](#)
  - [6.3. Common data](#)

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# Document on components data

The data related to component failures are recorded in documents.

They can be achieved from the “Common Data” list and the “Users Data” list.

FCFR-DB Home

- by component class
- by failure mode
- fusion specific breakdown
- by reference
- by free choosing

Expand Collapse Search

Date	Description	Failure
	▶ Containment systems	
	▶ Fuelling system	
	▼ Heat Transfer System (water cooling)	
	▶ Condenser	
	▶ Electrical component	
	▶ Heat exchanger	
	▶ Pressurizer	
	▶ Pump	
	▼ Turbine	
05/29/2001	TURBINE	Trip
05/29/2001	TURBINE	Trip
05/29/2001	TURBINE	turbi
05/29/2001	TURBINE	bypa
05/29/2001	TURBINE	failu
05/29/2001	TURBINE	Fail
	BYPASS	

powered by trabi snc

New Save Print... Close

### Users Data

Creation Date: 05:19:36 PM Today  
Created by: Administrator

Short description:

Family Name	Type	SubClass 1	SubClass 2	SubClass 3	SubClass 4
Reference:		OperationMode:		FailureMode:	

Design

Component Boundaries Design Characteristics  
Application Characteristics Note

Failure and Repair

Mean Failure Rate (1/h): Mean Repair Time (h):  
Failure Rate U. Distribution: Mean Repair Rate (1/h):  
Repair rate U. Distribution:

Fusion Specific assigned to Generic Component

Add entry - Remove entry - Copy entry List - Paste entry List

### Failure Data

Number of failures	Real global time of comp. unav. (h)
Number of components	Real mean time of comp. unav.
Number of damaged components	Real mean time of System unav. (h)
Number of failure / component	Test interval
Mean working time / component (h)	First date of failures
Global working time (h)	Last date of failures
Global number of demands	

### Document Status

Document:  accepted  not accepted First Data Entry: 03/04/2002

Data Validation:  validated  not validated Last Modification Date:

Data Consensus in IEA context:  approved  not approved



# Document on components data

New Save Print... Close

### Users Data

Creation Date: 05:19:36 PM Today  
 Created by: Administrator

**Short description:**

Family Name	Type	SubClass 1	SubClass 2	SubClass 3	SubClass 4
Reference:		OperationMode:		FailureMode:	

**Design**

Component Boundaries  
 Application Characteristics

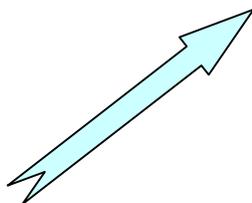
Design Characteristics  
 Note

**Failure and Repair**

Mean Failure Rate (1/h):  
 Failure Rate U. Distribution:

Mean Repair Time (h):  
 Mean Repair Rate (1/h):  
 Repair rate U. Distribution:

Fusion Specific assigned to Generic Component  Add entry -  Remove entry -  Copy entry List -  Paste entry List



## ⊕ Component boundaries

Free text to indicate "Boundaries" of main component: which parts and mechanisms are included in the main component itself.

**Failure Data**

Number of failures		Real global time of comp. unav. (h)	
Number of components		Real mean time of comp. unav.	
Number of damaged components		Real mean time of System unav. (h)	
Number of failure / component		Test interval	
Mean working time / component (h)		First date of failures	
Global working time (h)		Last date of failures	
Global number of demands			

**Document Status**

Document:  accepted  not accepted First Data Entry: 03/04/2002

Data Validation:  validated  not validated Last Modification Date:

Data Consensus in IEA context:  approved  not approved

# Document on components data

**Users Data**  
 Creation Date: 05:19:36 PM Today  
 Created by: Administrator

**Short description:**

Family Name	Type	SubClass 1	SubClass 2	SubClass 3	SubClass 4
Reference:		OperationMode:		FailureMode:	

**Design**

Component Boundaries	Design Characteristics
Application Characteristics	Note

**Failure and Repair**

Mean Failure Rate (1/h):  
 Mean Repair Time (h):  
 Duration:

entry List - Paste entry List

Document:  accepted  not accepted First Data Entry: 03/04/2002  
 Data Validation:  validated  not validated Last Modification Date:  
 Data Consensus in IEA context:  approved  not approved

## Design characteristics

Free text to indicate design related technical feature of the main component.

As samples :

- *function/application* (e.g., about valves: bypass, control/regulation, isolation/stop, pressure reducing, relief/safety, vent, etc.)
- *capacity performance* (e.g., about valves: size, design pressure, design temperature; about electric motors: nominal power, rotational speed, nominal voltage)
- *construction features* (e.g., about valves: body construction type, body, seat and disc materials, kind of sealing for valves; i.e. about electric motors: cooling type, cooling medium, bearing type, lubrication type, body type, orientation)
- *safety class standards*

# Document on components data

**Users Data**  
 Creation Date: 05:19:36 PM Today  
 Created by: Administrator

**Short description:**

Family Name	Type	SubClass 1	SubClass 2	SubClass 3	SubClass 4
Reference:		OperationMode:		FailureMode:	

**Design**

Component Boundaries  
 Application Characteristics  
 Design Characteristics  
 Note

**Failure and Repair**

Failure Rate (1/h)  
 Mean Repair Time (h)  
 Mean Repair Rate (1/h)  
 Failure Rate U. Distribution  
 Mean Repair Rate (1/h)  
 Mean Repair Time (h)

entry List - Paste entry List

Document:  accepted  not accepted  
 Data Validation:  validated  not validated  
 Data Consensus in IEA context:  approved  not approved

First Data Entry: 03/04/2002  
 Last Modification Date:

⊕ **Application characteristics**

Free text to indicate use and application of the main component. As samples :

- *process related data* (e.g., about valves: pressure, temperature, medium handled)
- *environment related data* (e.g.: type of industry, vibrations, environmental temperature, radiation, type of installation, position relative to sea-level, climate, humidity, environmental pressure),
- *power factor* (useful for instance in case of electric motor and diesel generators components),
- *maintenance system* (e.g.: inspection, breakdown, scheduled, condition monitoring)

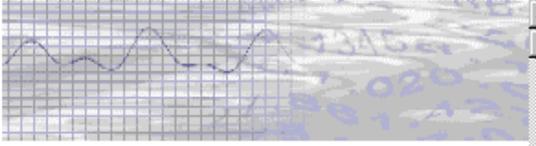


# Document on components data

New Save Print... Close

## Users Data

Creation Date: 05:19:36 PM Today  
 Created by: Administrator



### Short description:

Family Name	Type	SubClass 1	SubClass 2	SubClass 3	SubClass 4

Reference:  OperationMode:  FailureMode:

### Design

Component Boundaries  Design Characteristics   
 Application Characteristics  Note

### Failure and Repair

Mean Failure Rate ( 1/h):  Mean Repair Time ( h):   
 Failure Rate U. Distribution:  Mean Repair Rate ( 1/h):   
 Repair rate U. Distribution:

Fusion Specific assigned to Generic Component  Add entry -  Remove entry -  Copy entry List -  Paste entry List

---

### Failure Data

Number of failures	<input type="text"/>	Real global time of comp. unav. (h)	<input type="text"/>
Number of components	<input type="text"/>	Real mean time of comp. unav.	<input type="text"/>
Number of damaged components	<input type="text"/>	Real mean time of System unav. (h)	<input type="text"/>
Number of failure / component	<input type="text"/>	Test interval	<input type="text"/>
Mean working time / component (h)	<input type="text"/>	First date of failures	<input type="text"/>
Global working time (h)	<input type="text"/>	Last date of failures	<input type="text"/>
Global number of demands	<input type="text"/>		

### Document Status

Document:  accepted  not accepted First Data Entry: 03/04/2002  
 Data Validation:  validated  not validated Last Modification Date:  
 Data Consensus in IEA context:  approved  not approved

Statistical values

Fusion specific breakdown

Failure data

Document status

# Document on components data

## ⊕ Document status

- **Document: Accepted / Not Accepted**

Each new document from Users will be entered as "not accepted". They will be listed as "Users data". Documents identified as of public utility have to be accepted in order to let the listing/browsing in the "Common Data" set.

- **Data validation: Validated / Not Validated**

Each new document will be entered as "not validated". Document validation is intended as a check performed on recorded data, as well as a qualification of the data source and/or of the methodology applied to statistically evaluate the data.

- **Data consensus in IEA context: "approved" / "not approved"**

Each new document will be entered as "not approved". The activity on the component failure rate database is set in the International Energy Agency (IEA) agreement on the Environmental, Safety and Economic Aspects of Fusion Power (IEA ESE). Precisely, in Task 5 of the IEA ESE. Participants to the IEA Task 5 have to check data and, can certificate the data with their approval.

## **Data actually recorded**

- ⊕ **about 250 different Component Classes**
- ⊕ **about 470 different voices of the Fusion component breakdown**
- ⊕ **about 830 documents as Common data**
- ⊕ **about 330 documents as Users data**

# Source of data actually recorded

Reference Code	Description	Note
AICHE	Centre for Chemical Process Safety of the American Institute of Chemical Engineers - Guidelines for Process Equipment Reliability Data	Component data are particularly referred to chemical process plants. Information obtained by twenty-five different data banks
IAEA-TECDOC-478	Component reliability data for use in probabilistic safety assessment IAEA - TECDOC - 478 (1988)	Includes data sources from: Swedish reliability data book; NUREG 2815; NUREG 2728; IREP; IEEE 500; Shoreham Nuclear Power Plant PSA; NUREG CR 4550; Sizewell B PWR Preconstruction Report; Oconee Nuclear Power Plant PRA; Old PWR Reactor; Heavy Water Reactor (HWR) Assessment; Zion Nuclear Power Plant PSS; NUREG documents with LER rates; IPRD for Nuclear Plant components; EPRI NP - 2433; The German Risk Study (phase A)
INEEL-EGG-FSP-7922	L.C. Cadwallader, S.J. Piet; 1988 Failure Rate Screening Data for Fusion Reliability and Risk Analysis	Data evaluated by Idaho National Engineering Laboratory for application to fusion components. This document contains failure rate screening data for application to fusion components. The screening values are generally fission or aerospace industry failure rate estimates that can be extrapolated for use by fusion system designers, reliability engineers and risk analysts. Failure rate estimates for tritium-bearing systems, liquid metal-cooled systems, gas-cooled systems, water-cooled systems and containment systems are given. Preliminary system availability estimates and selected initiating event frequency estimates are presented. This first edition document is valuable to design and safety analysis for the Compact Ignition Tokamak and the International Thermonuclear Experimental Reactor.
INEEL/CON-2000-00347	Comparisons of Facility-specific and Generic Component Failure Rates for Tritium-bearing Components Used in Fusion Research	This paper compares component failure rates for continuous operation and function-on-demand components that confine tritium, and provides recommendations on values to use for fusion applications. Since a tritium release to the environment can create a significant public hazard, the safety and reliability of tritium systems is a very important for fusion research experiments and future power plants. Probabilistic safety assessment techniques are used to evaluate the safety of tritium handling. A foundation for meaningful probabilistic safety assessment is the application of accurate component failure rate data. The component failure rate values discussed here have been calculated and analysed from fusion research facilities, the US Tritium Systems Test Assembly and Japan's Tritium Processing Laboratory. The generic failure rate data compared in this paper were taken from published sources in the US and Canada.

## Source of data actually recorded (contd)

Reference Code	Description	Note
INEEL/EXT-98-00892	Selected Component Failure Rate Values from Fusion Safety Assessment Tasks, September 1998	This report is a compilation of component failure rate and repair rate values that can be used in magnetic fusion safety assessment tasks. Several safety systems are examined, such as gas cleanup systems and plasma shutdown systems. Vacuum system component reliability values, including large vacuum chambers, have been reviewed. Values for water-cooling system components have also been reported here. The report concludes with the examination of some equipment important to personnel safety, primarily sensors to detect hazardous conditions such as oxygen deficiency, toxic gas atmospheres, combustible gases, and airborne releases of radioactivity. These data should be useful to system designers to calculate scoping values for the availability and repair intervals for their systems, and for probabilistic safety or risk analysts to assess fusion systems for safety of the public and the workers.
INEL-EGG-FSP-10928	T.D. Marshall, L.C. Cadwallader; In-Vessel ITER Tubing Failure Rates for selected materials and coolants; March 1994	Data elaborated by Idaho National Engineering Laboratory to identify the best performer from an operational safety and availability perspective.
IREP NUREG 2728	Interim Reliability Evaluation Program Procedures Guide from NUREG/CR 2728, 1983	This data bank collects information about many American nuclear Light Water Reactors (LWRs)
OREDA	Offshore Reliability Data (1984)	Data collected on report ENEA FUS TECN S&E 6/96, A. Mosso, A. Ponta, and T. Pinna, Screening of Failure Data for component typically used in Fusion facilities, March 1996
RAC	Reliability Analysis Center: Non electronic Parts Reliability Data	Data collected on report ENEA FUS TECN S&E 6/96, A. Mosso, A. Ponta, and T. Pinna, Screening of Failure Data for component typically used in Fusion facilities, March 1996
RAGUSA	Introduzione all'analisi del rischio nell'industria	Data collected on report ENEA FUS TECN S&E 6/96, A. Mosso, A. Ponta, and T. Pinna, Screening of Failure Data for component typically used in Fusion facilities, March 1996
T-BOOK	Reliability Data of Components in Nordic Nuclear Power Plants (1992)	Data collected on report ENEA FUS TECN S&E 6/96, A. Mosso, A. Ponta, and T. Pinna, Screening of Failure Data for component typically used in Fusion facilities, March 1996
WASH 1400	Reactor Safety Study (1975)	

*Thank you!*