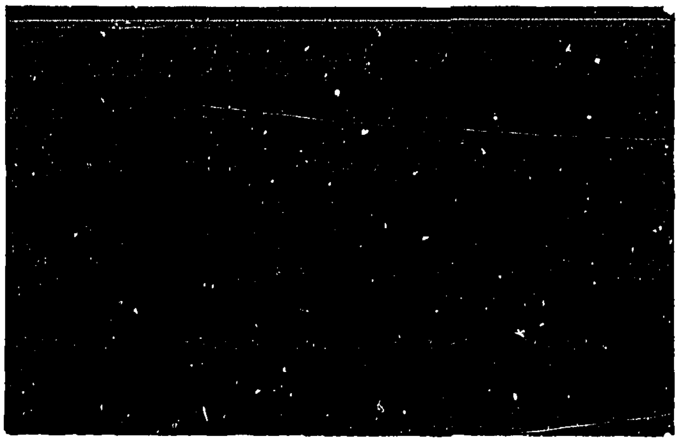
Canadian Fusion Fuel Technology Project



THE CANADIAN FUSION FUEL TECHNOLOGY PROJECT REPRESENTS PART OF CANADA'S OVERALL EFFORT IN FUSION DEVELOPMENT. THE FOCUS FOR CFFTP IS TRITIUM AND TRITIUM TECHNOLOGY. THE PROJECT IS FUNDED BY THE GOVERNMENTS OF CANADA AND ONTARIO, AND BY THE UTILITY ONTARIO HYDRO; AND IS MANAGED BY ONTARIO HYDRO.

CFFTP WILL SPONSOR RESEARCH, DEVELOPMENT, DESIGN AND ANALYSIS TO EXTEND EXISTING EXPERIENCE AND CAPABILITY GAINED IN HANDLING TRITIUM AS PART OF THE CANDU FISSION PROGRAM. IT IS PLANNED THAT THIS WORK WILL BE IN FULL COLLABORATION AND SERVE THE NEEDS OF INTERNATIONAL FUSION PROGRAMS.

Database for Fusion
Devices and Associated
Fuel Systems

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The information compiled by W.J. Holtslander on the TSTA Fuel System as a hard copy data base was used extensively as a format and an example of application. The Fuel System Technical Forecast Handbook prepared as a part of the technical risk assessment of the Fusion Fuel System carried out by McDonnell Douglas Astronautics Company was also used frequently as a base for comparison.

Executive Summary

Database for Fusion Devices and Associated Fuel Systems

A computerized database storage and retrieval system has been set up for fusion devices and the associated fusion fuel systems which should be a useful tool for the CFFTP program and other users.

The features of the Wang "Alliance" system are discussed for this application, as well as some of the limitations of the system. Recommendations are made on the operation, upkeep and further development that should take place to implement and maintain the system.

Table of Contents

1.0 INTRODUCTION

1.1 Purpose

The purpose of this assignment is to establish a permanent computerized database system for existing and forthcoming fusion devices including the associated fuel systems for tritium burning machines.

1.2 Scope

The scope of the assignment includes but is not limited to the following:

1) Survey and classification of existing fusion devices, fuel systems, including studies of proposed systems.

2) Evaluation of status of fusion devices and fuel systems.

3) Establishment of formats for a database system for fusion devices and fuel systems.

4) Entry of data into the database based on information currently available.

5) Means of maintaining and updating systems.

6) Means of dealing with studies and undefined system of the future.

7) Evaluation of Database System.

8) Recommendations for further development.

2.0 DATABASE SYSTEMS

A database management system (DBMS) is primarily a computerized means of storing, retrieving, updating and manipulating information. It is somewhat analagous to word processing but is applied to the storage and manipulation of generalized file information rather than the generation of individual documents produced by word processing techniques.

The primary rationale for going to a database approach include the following:

1) Allows independent access by many users to a common base of data.

2) Ease of storage and retrieval of information in the form and according to the desired priority.

3) Ease of modification and updating of stored information.

4) Comparison of stored data from similar systems.

2.1 General Requirements

Database techniques would normally be used in situations where data from a large number of comparable systems, continually in a state of flux, is being updated and there is a need to make comparisons with similar data from a large number of other systems.

Typically the information recorded in data base systems are numeric or very brief text descriptions that complete a standard information format and which would be applicable to many systems.

Ontario Hydro utilizes database systems for the storage and retrieval of operating data and maintainance records for the primary production equipment in the various generating stations. Operating, performance or reliability data from units at Pickering A can be readily compared with similar information from Bruce, as an example. Personnel files are maintained on a database system, as another example, in which data for projections, on pension requirements, unemployment contribution and other direct overheads can be stored, compared or reformatted for comparisons between departments.

3.0 DATABASE FOR FUSION DEVICES

For the purposes of the Canadian Fusion Fuels Technology Project (CFFTP) a record of the various fusion devices, including existing experimental machines, proposed near term reactors and studies for longer term projects would be extremely useful and would be particularly suitable for a database approach.

3.1 Structure

The fusion device database has been divided into a number of "drawers" representing the leading fusion device concepts:

1) Tokamaks
2) Reverse Field Pinch
3) Stellarator
4) Mirror Machines
5) Compact Reactors
6) Other Magnetic Confinement
7) Inertial Confinement
8) Misc Component and System Testing Facilities

The format for the database (Appendix I) was developed primarily based on the information necessary for Tokamaks. While, initially, this same format can be used as a starting point for the other fusion concepts, each of the others (reverse field pinch, stellarator, etc) will eventually require their own specific format to properly describe the device. This is the primary reason for segregating the fusion concepts in "drawers" rather than as an additional field within a device description (record).

Under the seven fusion concepts, each of the primary fusion devices has been identified with its country of origin and the generic device description. Under the Generic Device Description it is the intention to classify the devices generically as follows:

1) Experimental
2) Proof of Principle
3) Engineering Test Reactor
4) Demonstration Reactor
5) Commercial Reactor.

The above generic classification should further indicate whether the project or device is existing or a study. For instance, the designation of Demonstration Reactor - Study would clearly indicate the study stage, whereas the designation Demonstration Reactor would indicate an existing or real project.

3.2 Completion of Database

The format for the database system has been installed on the CFFTP Wang Computer using the Alliance Visual Memory Program. Examples of completed computer printed records are attached in Appendix 1 for the current projects TFTR, JET, INTOR, FED, STARFIRE, and TSTA.

The balance of existing fusion devices and studies for future projects have been entered into the database as far as known at the present. These records, listed in Appendix II, are only partially complete and will have to be finalized as more information becomes available.

3.3 Updating of File Records

In addition to the computerized database records it is recommended that parallel hard copy files be maintained, where information on each of the fusion device or studies can be stored until ready for updating on the computer. For instance, articles or papers concerning the various devices can be highlighted by individuals and can then be stored in the appropriate hard copy file until a convenient time when the computer database can be updated by a designated individual.

Alternately, the files can be modified directly by any individual which would obviate the need for parallel hard copy files to a large extent. Individual updating would be feasible on the assumption that all interested individuals have terminals and that the individuals, in fact, carry out the required updating. It is obvious that the success of the database system depends on the quality of the information contained in the computer files and that regular updating by either of the above methods is mandatory.

It is recommended that individual updating be attempted initially but that if problems are encountered a dedicated individual be assigned the updating responsibility as one of his functions.

4.0 DATABASE FOR FUSION FUEL SYSTEMS

The initial work in setting up a database system for the Fusion Fuel System was carried out by W. Holtslander - AECL in preparing a hard copy format and report based on the TSTA Fuel System.

The intention of this further work on the database is primarily to computerize the hard copy work and to amalgamate it with the standardized fuel cycle that was produced as a result of the McDonnell Douglas (MDAC) Technical Risk Assessment contract.

4.1 Structure

Because of the limitations of the Alliance Visual Memory Program it was necessary to allocate the device names as "drawers" and the various subsystems are listed as "records". The description of the subsystems is at the "field" level and the equipment components of each subsystem are listed as a sub-record. The difficulty with this arrangement is that the sorting and retrieving capabilities of the system are done at the "field" level and that comparisons can only then be made between similar subsystem descriptions (fields) in a different device fuel system (drawer) on a manual basis. This would be a cumbersome means of making comparisons and most of the advantages of quick sorting and retrieving normally associated with a data base system would be lost. Comparisons are usually made between similar "fields" at the "record" level, on a fully automated basis. More will be said about this in 5.0.

4.2 Completion of Fusion Fuel System Database

There are presently only 1 or 2 fuel systems that are existing or in the process of being developed that are independent of each other in concept.

1) Tritium System Test Assembly - TSTA
   - a full scale trial fuel system for a fusion device at Los Alamos, based on flows adequate for FED or INTOR.

2) JET - Culham, England
   - will be a full fuel system processing, separating and purifying the reactor gases from JET, but only in the early design stages.

There is thus only the developed system at TSTA, at this point in time. Other fuel systems, on which information is available, such as FED, INTOR, STARFIRE are all based on TSTA, except that STARFIRE would be scaled up to commercial size.

The first tritium burning device at TFTR, Princeton has a Tritium Storage and Delivery System, which essentially only stores the tritium on tritide beds and provides it as required to the torus, there is no treatment of waste gases. There is however, fairly extensive clean-up systems for the storage and delivery glove box, torus and vault.

As a demonstration of the database, only the TSTA system has been entered into the computer (see attached Appendix III). Other fuel systems can be treated in the same fashion as more information becomes available.

4.3 Flow Diagrams

With the programs currently available, it is not possible to enter flow diagrams for the fuel cycle subsystems into the computer and will have to be stored in the parallel hard copy files.

4.4 Updating of Records

The same considerations apply as for the fusion device database with the choice between:

1) Individuals - each with terminals, carrying out the updating.

2) Dedicated individual - with assigned responsibility carrying out modifications highlighted by others.

The recommendation is to try the individual update approach initially.

There is provision to record under "Revisions" the revision number, initials and date of revision in order that currency of the information is indicated.

4.5 Improvements to Fuel System Database

Several modifications to the fuel system database can be considered after implementation of the database and the accumulation of some experience in its operation.

4.5.1 Reduce Heirarchy Levels

The difficulties in automatic retrieving and sorting of the fuel system database can be partially overcome by redefining the fuel system subsystems, i.e., plasma chamber evacuation, impurity removal, etc., by their generic name which hopefully will be common to all fuel systems as they are developed.

It is possible to redefine the generic subsystem names as "fields" by force fitting the subsystem general description into the subrecord structure used for describing the components, i.e., essentially eliminating one level of the heirarchy. This would allow automatic sorting and retrieving between fuel devices of the fuel subsystems.

The redefined system could also be included as part of the fusion device database at this point, although, the nature of the information stored in each database is drastically different. A major drawback to this otherwise attractive solution, lies in the inflexibility of the Alliance program to changes in the structure. For instance, a major change or addition of a field could cause the retyping of the rather voluminous fuel system database for each device as new fields cannot be simply inserted.

4.5.2 Word Processing Mode

Another possible solution to the fuel system database restrictions is to use the Word Processing Mode rather than the Visual Memory of the Wang computer. By taking this path, the assumption would be made that at this point in time and for the next ten years, there would only be a very limited number of fuel systems to be dealt with and that the retrieving, sorting and comparing features for the fuel system database would consequently be of minimal benefit.

By using the word processing mode, the rather severe restrictions in changing format, major test changes, etc. experienced in "Visual Memory" would be avoided. The very large amounts of text inherent in the fuel system database lends itself more to word processing but the price to be paid would be the sorting and retrieving functions.

There is a limited sorting function available in word processing that is restricted to alphabetic or numeric sorts of specifically defined columns of data, but would not be of significant use in this application.

5.0 LIMITATIONS OF PROGRAM

1) Records in a Drawer - No Limit

In the fusion device database there is no limit to the number of devices that can be stored, or to the number of subsystems that can be described in a given fuel system.

2) Fields in a Record - 240

This is not a difficult restriction in either database as the number of fields required in either case is much less than 240.

3) Characters in a Text Field - 255

This is a rather severe restriction as the 255 characters represents approximately 3 lines of typed description which is not adequate in the majority of cases. The only apparent solution is to repeat the name of the field to obtain a further 3 lines of description. must change somewhat - cannot have identical field names SH.

4) Characters in a Numeric Field - 20

This does not appear to be an onerous restriction as numerical data does not normally require more than 20 characters.

5) The normal word processing capabilities for modifying, deleting, displacing, etc are severely restricted in the Visual Memory mode. Small changes can be accomodated easily but major changes to format etc, woul require extensive retyping or the use of the Output Through Form mode.

6) Sorting is restricted to fields within similar records. Sub-records can not be sorted.

6.0 OTHER DATABASE PROGRAMS

Database programs for large computers are widely available but are expensive and are not suitable for application to micro-computers. Special database programs for micro-computers such as the Wang have only just become available and will go through a period of development over the next several years.

It is recommended that this program develoment be monitored closely for programs that would more closely fit the needs of the CFFTP database requirements.

7.0 RECOMMENDATIONS AND CONCLUSIONS

1) The database has been set up for the fusion devices and the associated fuel systems of tritium burning machines.

2) The application of the database has been most successful as applied to the fusion devices due to the nature of the information being stored.

3) The application of the database for the fusion fuel systems has been successful but with some limitations on the flexibility of sorting and retrieving information.

4) The fusion device database requires further work to complete and fill in the detailed device descriptions. This could be a continuing project for students or trainees.

5) The fuel system database requires further limited work to complete the database on existing systems for TFTR and JET as the information becomes available.

6) Regular updating of the data in the database must be carried out if the system is to be useful. Initially this should be done by individuals in the group, each with a terminal, as the information becomes available in reports, journals, etc. A dedicated individual would have to be assigned responsibility of updating should this approach fail..

7) Further monitoring of database program development is required for programs suitable for mini-computers and perhaps more suitable for CFFTP requirements.

8) Parallel hard copy files will have to be set up and maintained for both the fusion devices and the fuel system databases to store interim data and information not suitable for storage on a computer, ie, flow charts.

9) The two options for improving the fuel system database should be examined further after the database has been implemented and in operation for a period of time.

APPENDIX I

Fusion Device Database

Tokamak

Device Name	: Tokamak Fusion Test Reactor - TFTR
Developer	: Princeton Plasma Physics Laboratory - PPPL
Location (Country/Place)	: USA/ Princeton, N.J.
Contacts/Address/Phone	: Dr. Roy Little (609) 683-2208 Princeton Plasma Physics Laboratory Princeton, N.J., 08544
Generic Device Description	: Proof of Principle
Objectives	: 1)Demons. fusion energy prod. from pulsed burning of D2 and T2 2)Attain plasma conditions of temp., 5-10 keV; density(n), 10exp14/cm3; nTau greater than 10exp 13; 3)NBI system capable of 20 MW 4)Mag netic field , 5T 5)Prod. 1-10 megajoules energy
Key Dates/Status	: Dec. 1982 - first plasma 1986 - ignition
Project Cost - $M	: 314
Fuel System	: Tritium storage and delivery only, see TFTR fuel system database
Major Radius - m	: 2.48
Minor Radius - m	: .85
Beta %	: 2.0
Ion Temperature - keV	: 5.0
Lawson Criterion - nTau	: 3x10exp13/cm3
Magnetic Field B (T) Tesla	: 5.2
Magnetic Field B (P) Tesla	: not known
Breeding Ratio	: none
Tritium Inventory - kg	: .005
Tritium Consumption - kg/a	: .040
Plasma Heating	: Ohmic heating, NBI
First Wall Mat'l	: SS 304 LN
Blanket Material	: Test module, gas cooled, Zircaloy clad, LiO rods
Coolant	: none
Impurity Removal	: none
Revisions	: Rev(0)PWW/April/83

References

a.: TFTR Preliminary Safety Analysis Report

b.: Journal of Fusion Energy, vol 1, NO. 2, 1981, p 155

1 Records printed

Tokamak

Device Name	:	Joint European Torus - JET
Developer	:	Euratom
Location (Country/Place)	:	U.K.(England)/Culham
Contacts/Address/Phone	:	P.H. Rebut, John R. Dean, Phone 011-44-235-28822 Jet Joint Undertaking Fusion Technology Division Abington, Oxfordshire OX14 3EA, United Kingdom
Generic Device Description	:	Proof of Principle
Objectives	:	Obtain and study plasma conditions with dimensions approaching those for fusion reactors, confinement properties, plasma-wall interactions and impurity influx, heating plasma to fusion temps., effects of production of alpha particles
Key Dates/Status	:	1983 - initial operation on H2 1984/85 - full scale tests 1986 - first tritium burning, breakeven
Project Cost - $M	:	185
Fuel System	:	Commencing initial design early 1983, see JET fuel system database
Major Radius - m	:	2.96
Minor Radius - m	:	1.25 x 2.10
Beta %	:	
Ion Temperature - keV	:	
Lawson Criterion - nTau	:	breakeven or ignition
Magnetic Field B (T) Tesla	:	3.5
Magnetic Field B (P) Tesla	:	
Breeding Ratio	:	none
Tritium Inventory - kg	:	.020
Tritium Consumption - kg/a	:	.200
Plasma Heating	:	Ohmic, NBI, RF(ICRH or LHRH not yet decided)
First Wall Mat'l	:	High nickle stainless, not specified
Blanket Material	:	not applicable
Coolant	:	"
Impurity Removal	:	"
Revisions	:	Rev(0)PWW/April/83

References

a.: JET Joint Undertaking, Annual Report 1980

b.: The JET Project, EUR-JET-R7

References

a.: Various data filed in JET binder

b.:

1 Records printed

Tokamak

Device Name	: International Tokamak Reactor - INTOR
Developer	: International Atomic Energy Agency - IAEA
Location (Country/Place)	: none as yet
Contacts/Address/Phone	:
Generic Device Description	: Engineering Test Reactor, Study
Objectives	: 1)Ignited D-T plasma 2)Controlled burn pulse- 100s 3)Part.& heat flux-1MW/m2 4)Superconducting T & P coils 5)Divertor 6)Blanket heat removal & T2 prod. 7)Fuel cycle 8)Remote maintenance 9)5-10MW power
Key Dates/Status	: 1987 - Assumed committment date 1992 - Stage I, initial operation 1995 - Stage II operation 2000 - Stage III operation
Project Cost - $M	: not known
Fuel System	: Similar in most respects to TSTA, see INTOR fuel system database
Major Radius - m	: 5.2
Minor Radius - m	: 1.4
Beta %	: 5.6
Ion Temperature - keV	: 10.0
Lawson Criterion - nTau	: 1.96x10exp13/cm3
Magnetic Field B (T) Tesla	: 12.0
Magnetic Field B (P) Tesla	: 8.0
Breeding Ratio	: .65
Tritium Inventory - kg	: 3.9
Tritium Consumption - kg/a	: Stage I - 1.3, Stage II - 2.23, Stage III - 4.46
Plasma Heating	: Ohmic, 75 MW of NBI with 4 injectors
First Wall Mat'l	: 316 Stainless
Blanket Material	: Solid lithium silicate, LiSiO3
Coolant	: Blanket - H2O, First wall - D2O
Impurity Removal	: Poloidal divertor, tungsten and ZM-6(moly. alloy)
Revisions	: Rev(0)PWW/April/83

References

a.: INTOR Report, Phase One, 1980/81

b.:

1 Records printed

Tokamak

Device Name	:	Fusion Engineering Device - FED
Developer	:	Dept of Energy, Fusion Engineering Design Center, Oak Ridge
Location (Country/Place)	:	USA/none as yet
Contacts/Address/Phone	:	T.E. Shannon, Manager Fusion Engineering Design Center Oak Ridge National Laboratory Oak Ridge, Tenn.
Generic Device Description	:	Engineering Test Reactor, Study
Objectives	:	1)Sustained production of fusion power 2) Extract energy from blanket 3)Demonstrate full fuel cycle operation, including breeding and recovery 4)Demon -strate integration of fusion technologies
Key Dates/Status	:	Study complete, project held due to USA budget restrictions. Decision between competing proof of principle concepts by 1988
Project Cost - $M	:	2,172
Fuel System	:	TSTA based system, see FED fuel system database
Major Radius - m	:	5.0
Minor Radius - m	:	1.3
Beta %	:	5.2
Ion Temperature - keV	:	10.0
Lawson Criterion - nTau	:	
Magnetic Field B (T) Tesla	:	8.0 T and later 10.0 T
Magnetic Field B (P) Tesla	:	
Breeding Ratio	:	0
Tritium Inventory - kg	:	.825 during 8T, 1.470 during 10 T
Tritium Consumption - kg/a	:	1.4 during 8T, 2.6 during 10T
Plasma Heating	:	1 MW of ECRH(electron cyclotron resonance heating) ICRH(ion cyclotron), 50 MW of NBI
First Wall Mat'l	:	SS with graphite armor
Blanket Material	:	none
Coolant	:	none
Impurity Removal	:	Pumped limiter
Revisions	:	Rev(0)PWW/April/83

References

a.: FED Design Description, vol 1-6
b.:

1 Records printed

Tokamak

Device Name	: STARFIRE
Developer	: Argonne National Laboratory
Location (Country/Place)	: USA/none as yet
Contacts/Address/Phone	: M.A. Abdou, P.A. Finn Argonne National Laboratory
Generic Device Description	: Commercial Reactor, Study
Objectives	: 1)Steady state plasma with lower hybrid rf heating and current drive 2)ECRH start up 3)Super conducting EF coils outside TF coils 4)Water cooled solid breeder 5)Mat'l outside breeder with 30 yr. life
Key Dates/Status	: Study completed, commitment of commercial reactor will not take place until approx. 2005 - 2010
Project Cost - $M	: 2,123
Fuel System	: TSTA based system, see STARFIRE fuel system database
Major Radius - m	: 7.000
Minor Radius - m	: 1.940
Beta %	: 6.7
Ion Temperature - keV	: 24.1
Lawson Criterion - nTau	:
Magnetic Field B (T) Tesla	: 11.1
Magnetic Field B (P) Tesla	: 4.5
Breeding Ratio	: 1.044
Tritium Inventory - kg	: 11.25
Tritium Consumption - kg/a	: 0
Plasma Heating	: Lower hybrid rf heating and current drive - 90 MW
First Wall Mat'l	: Titanium modified 316 austenitic stainless
Blanket Material	: Alpha lithium aluminate, LiA102/Zr5Pb3
Coolant	: H20 - blanket and first wall
Impurity Removal	: Pumped limiter
Revisions	: Rev(0)PWW/April/83

References

a.: STARFIRE Design Description

b.:

1 Records printed

Tokamak

Device Name	:	Tritium System Test Assembly, TSTA
Developer	:	Los Alamos National Laboratory
Location (Country/Place)	:	USA/ Los Alamos, New Mexico
Contacts/Address/Phone	:	James L. Anderson, John R. Bartlit (505)-667-1410 (505)-667-5419 Los Alamos National Laboratory P.O. Box 1663 Los Alamos, New Mexico, 87545
Generic Device Description	:	Experimental, Prototype fuel system
Objectives	:	1)Demonstrate the fusion fuel cycle2)Develop, test and qualify equipment for tritium service 3)Develop environmental protection systems 4)Build database for tritium handling 5)Demonstrate long term safe handling of T2 6)Develop T2 components
Key Dates/Status	:	Feb. 1983 - official opening
Project Cost - $M	:	14.0
Fuel System	:	Simulated system as prototype for USA fusion devices, 360 g mol/day, handles tritium
Major Radius - m	:	not applicable
Minor Radius - m	:	"
Beta %	:	"
Ion Temperature - keV	:	"
Lawson Criterion - nTau	:	"
Magnetic Field B (T) Tesla	:	"
Magnetic Field B (P) Tesla	:	"
Breeding Ratio	:	"
Tritium Inventory - kg	:	.150
Tritium Consumption - kg/a	:	insignificant
Plasma Heating	:	not applicable
First Wall Mat'l	:	"
Blanket Material	:	"
Coolant	:	"
Impurity Removal	:	"
Revisions	:	Rev(0)PWW/April/83

References

a.: Tritium Handling Requirements etc. J.L. Anderson, IEEE Vol 69,NO.8, 81
b.: TSTA Final Safety Analysis

1 Records printed

Appendix II
Summary of Fusion Devices
Fusion Device Database

Tokamak
Device Name : STARFIRE
Developer : Argonne National Laboratory
Location (Country/Place) : USA/none as yet
Generic Device Description: Commercial Reactor, Study

Tokamak
Device Name : FER
Developer :
Location (Country/Place) : Japan
Generic Device Description: Engineering Test Reactor

Tokamak
Device Name : International Tokamak Reactor - INTOR
Developer : International Atomic Energy Agency - IAEA
Location (Country/Place) : none as yet
Generic Device Description: Engineering Test Reactor, Study

Tokamak
Device Name : Next European Torus - NET
Developer : Euratom
Location (Country/Place) : none as yet
Generic Device Description: Engineering Test Reactor, Study

Tokamak
Device Name : Fusion Engineering Device - FED
Developer : Dept of Energy, Fusion Engineering Design Center, Oak Ridge
Location (Country/Place) : USA/none as yet
Generic Device Description: Engineering Test Reactor, Study

Tokamak
Device Name : T-20
Developer : Kurchatov Institute, Moscow
Location (Country/Place) : USSR (Russia)/Moscow
Generic Device Description: Engineering Test Reactor, Study

Tokamak
Device Name : Torus II
Developer :
Location (Country/Place) : France
Generic Device Description: Experimental

Tokamak
Device Name : TFR-600 (Tokamak Fontenay aux Roses)
Developer :
Location (Country/Place) : France/
Generic Device Description: Experimental

Tokamak
Device Name : WEGA
Developer :
Location (Country/Place) : France/
Generic Device Description: Experimental

Tokamak
Device Name : TEXTOR
Developer :
Location (Country/Place) : FRG (Germany)/ Julich
Generic Device Description: Experimental

Tokamak
Device Name : Pulsator
Developer :
Location (Country/Place) : FRG (Germany)/
Generic Device Description: Experimental

Tokamak
Device Name : ASDEX Divertor Tokamak
Developer : Max-Planck-Institut fur Plasmaphysic,
Location (Country/Place) : FRG (Germany)/ Garching
Generic Device Description: Experimental

Tokamak
Device Name : Frascati Tokamak - FT
Developer : Associazione Euratom-CNEN silla Fusione
Location (Country/Place) : Italy, Frascati, Rome
Generic Device Description: Experimental

Tokamak
Device Name : DIVA
Developer :
Location (Country/Place) : Japan /
Generic Device Description: Experimental

Tokamak
Device Name : JFT-2
Developer :
Location (Country/Place) : Japan /
Generic Device Description: Experimental

Tokamak
Device Name : TOSKA
Developer :
Location (Country/Place) : UK/
Generic Device Description: Experimental

Tokamak
Device Name : DITE
Developer : United Kingdom Atomic Energy Athority - UKAEA
Location (Country/Place) : UK/Culham
Generic Device Description: Experimental

Tokamak
Device Name : Alcator C
Developer : Plasma Fusion Center, MIT
Location (Country/Place) : USA, Cambridge, Mass.
Generic Device Description: Experimental

Tokamak
Device Name : Princeton Large Torus - PLT
Developer : Princeton Plasma Physics Laboratory - PPPL
Location (Country/Place) : USA, Princeton, N.J.
Generic Device Description: Experimental

Tokamak
Device Name : ORMAK
Developer :
Location (Country/Place) : USA/
Generic Device Description: Experimental

Tokamak
Device Name : Texas Experimental Torus - TEXT
Developer : Fusion Research Center, Univ. of Texas
Location (Country/Place) : USA/ Austin
Generic Device Description: Experimental

Tokamak
Device Name : ISX-B
Developer : Oak Ridge National Laboratory - ORNL
Location (Country/Place) : USA/ Oak ridge, Tenn.
Generic Device Description: Experimental

Tokamak
Device Name : Poloidal Diverter Experiment - PDX
Developer : Princeton Plasma Physics Laboratory - PPPL
Location (Country/Place) : USA/ Princeton, N.J.
Generic Device Description: Experimental

Tokamak
Device Name : Doublet III
Developer : General Atomics
Location (Country/Place) : USA/ San Diego
Generic Device Description: Experimental

Tokamak
Device Name : Tritium System Test Assembly, TSTA
Developer : Los Alamos National Laboratory
Location (Country/Place) : USA/ Los Alamos, New Mexico
Generic Device Description: Experimental, Prototype fuel system

Tokamak
Device Name : JT-60
Developer : Japan Atomic Energy Research Institute, JAERI
Location (Country/Place) : Japan /Tokai Mura
Generic Device Description: Proof of Principle

Tokamak
Device Name : Joint European Torus - JET
Developer : Euratom
Location (Country/Place) : U.K.(England)/Culham
Generic Device Description: Proof of Principle

Tokamak
Device Name : Tokamak Fusion Test Reactor - TFTR
Developer : Princeton Plasma Physics Laboratory - PPPL
Location (Country/Place) : USA/ Princeton, N.J.
Generic Device Description: Proof of Principle

Tokamak
Device Name : T-15
Developer : Kurchatov Institute, Moscow
Location (Country/Place) : USSR (Russia)/Moscow
Generic Device Description: Proof of Principle

29 Records printed

Reverse Field Pinch

Device Name : ZETA
Developer :
Location (Country/Place) : Italy / Padua
Generic Device Description: Experimental

Reverse Field Pinch

Device Name : ETA-BETA II
Developer : Centro di Studio sui Gas Ionizzati, Universita di Padova
Location (Country/Place) : Italy, Padua
Generic Device Description: Experimental

Reverse Field Pinch

Device Name : TPE-1R(M)
Developer :
Location (Country/Place) : Japan
Generic Device Description: Experimental

Reverse Field Pinch

Device Name : HBTX1A
Developer :
Location (Country/Place) : UK (England)/ Culham
Generic Device Description: Experimental

Reverse Field Pinch

Device Name : ZT-40
Developer : Los Alamos Scientific Laboratory - LASL
Location (Country/Place) : USA/Los Alamos
Generic Device Description: Experimental

5 Records printed

Stellarator

Device Name : Wendelstein VII-A
Developer : Max-Planck-Institut fur Plasmaphysik
Location (Country/Place) : FRG (Germany)/ Garching
Generic Device Description: Experimental

Stellarator

Device Name : JIPP T-II
Developer : Institute of Plasma Physics, Nagoya University
Location (Country/Place) : Japan, Nagoya
Generic Device Description: Experimental

Stellarator

Device Name : L-2
Developer : P.N. Lebedev Institute of Physics
Location (Country/Place) : Russia / Moscow
Generic Device Description: Experimental

Stellarator

Device Name : CLEO
Developer : Euratom/ UKAEA Fusion Assoc.
Location (Country/Place) : UK (England)/ Culham
Generic Device Description: Experimental

Stellarator

Device Name : Advanced Toroidal Facility - ATF-1
Developer : Oak Ridge National Laboratory -ORNL
Location (Country/Place) : USA/ Oak Ridge
Generic Device Description: Experimental, Study

5 Records printed

Mirror Machine
Device Name : GAMMA-6
Developer : University of Tsukuba
Location (Country/Place) : Japan, Ibaraki-ken
Generic Device Description: Experimental

Mirror Machine
Device Name : GAMMA 10
Developer : University of Tsukuba
Location (Country/Place) : Japan/ Ibaraki-ken
Generic Device Description: Experimental

Mirror Machine
Device Name : Tandem Mirror Experiment - Upgrade, - TMX-U
Developer : Lawrence Livermore National Laboratories - LLNL
Location (Country/Place) : USA / Livermore, Calif.
Generic Device Description: Experimental

Mirror Machine
Device Name : Tandem Mirror Experiment - TMX
Developer : Lawrence Livermore National Laboratory - LLNL
Location (Country/Place) : USA/ Livermore, Calif.
Generic Device Description: Experimental

Mirror Machine
Device Name : PHAEDRUS
Developer : University of Wisconsin
Location (Country/Place) : USA/ Madison
Generic Device Description: Experimental

Mirror Machine
Device Name : Magnetic Fusion Test Facility, MFTF-B
Developer : Lawrence Livermore National Laboratory -LLNL
Location (Country/Place) : USA / Livermore, Calif.
Generic Device Description: Proof of Principle

6 Records printed

Other

Device Name	: Nagoya Bumpy Torus - NBT
Developer	: University of Nagoya
Location (Country/Place)	: Japan / Nagoya
Generic Device Description	: Experimental

Other

Device Name	: Elmo Bumpy Torus, EBT-S
Developer	: Oak Ridge National Laboratory - ORNL
Location (Country/Place)	: USA / Oak Ridge, Tenn.
Generic Device Description	: Experimental

Other

Device Name	: Elmo Bumpy Torus Proof of Principle, EBT-P
Developer	: Oak Ridge National Laboratory - ORNL
Location (Country/Place)	: USA / Oak Ridge, Tenn.
Generic Device Description	: Proof of Principle, Study

3 Records printed

Appendix III

Fuel System Databse

TSTA

Generic Subsystem : Plasma Chamber Evacuation
Subsystem Name : Vacuum Facility - VAC
Description & Function: A vacuum tank to simulate the torus of a fusion reactor to provide a test station for large vacuum pump that will remove unburned DT plus impurities from the torus for reprocessing in the TSTA.
All components have secondary containm-
Desc & Func cont'd : ment in the form of gasketed aluminum box vented to the building exhaust. It is operated at a slight negative pressure and monitored for tritium. In the event of tritium relase ventilation is switched to emergency tritium clean-up.
Development Aspects : To test the performance of large cryopumps for the exhaust removal (16 cubic metres/s for DT, 1.6 cubic metres/s for He) and the separation of helium ash from unburned fuel. To examine the transient behaviour of toroidal chambers by various of the gas
Develpmt Asp cont'd : injection and removal rates.
References : D.D. Coffin and C.R. Walthers, "Vacuum Pumping of Tritium in Fusion Power Reactors", Proc. 8th Symp Eng. Prob. of Fusion Res, Nov 1979.
H.C. Hseuth et al, "Cryopumping of He by charcoal and
Refer's cont'd : a compound cryopump design for TSTA", ibid
T.S. Batzer, et al "A neutral beam line pump with helium cryotrapping ability", Proc. 10th Symp Fusion Tech. 1978.

Components

Name : Vacuum Chamber
Function : To simulate the fission reactor torus
Description: Austenitic stainless steel cylinder, 1 cubic metre volume with flange-attached dished ends
Cryopumps attached to ends through 0.4 metre flange
Numerous small ports for instrumentation and gas supply.
Desc cont'd:

Components

Name : Cryopumps
Function : To remove DT plus impurities from the vacuum chamber
Separation of DT from helium ash
Description: -Three designs of two stage pumps being tested. - The first stage pumps DT by condensation on liquid-helium cooled plate. - Second stage pumps He by three methods-cryosorption of He at liquid helium temp on molecular sieve (LANL), on charcoal
Desc cont'd: (BNL) and by an argon spray condensation (LLNL).

Components

Name : Evacuation Pump
Function : To evacuate the vacuum chamber.
Description: Leybold Turbomolecular pump, nitrogen pumping speed of 0.5 cubic metres/s at 10 to the minus one to 10 to the minus five Pa.
Elastomer O-rings
Desc cont'd:

Components

Name : Valves
Function : To isolate components

Description: Packless electricically or pneumatically operated
Stainless steel, gate with metal to metal or elastomer O-ring seals.

Desc cont'd:

<u>Components</u>

Name : Pipe/Fittings

Function : Connection of components

Description: 300 series stainless steel, TIG welding
Metal wire flange seals.

Desc cont'd:

TSTA

Generic Subsystem : Plasma Exhaust Transfer
Subsystem Name : Transfer Pumps - TPU
Description & Function: To provide steady flow of DT gas at proper condition to the various parts of TSTA. The TPU consists of three modules serving various subsystems. Each module contains one or more stages of mechanical pumping, remotely controlled gas valves and pres-
Desc & Func cont'd : sure instrumentation, plus sorption pump. All modules are placed within inert atmosphere glove boxes.
Development Aspects : Minimal, evaluate new pumps for tritium service.
Develpmt Asp cont'd :
References : J.L. Anderson, "Tritium Handling Requirements and Development for Fusion". Proc. IEEE 69 1069 (1981)
Refer's cont'd :

Components

Name : Transfer of Circulation Pumps
Function : Move DT
Description: Metal Bellows Corp. model MB-601 pump
all wetted parts are metal
double headed can operate in series in parallel or independently
Desc cont'd: on the application for regenerating cryopumps use the French metal bellows sealed scroll pump

Components

Name : Sorption Pump
Function : To evacuate the transfer pump cavity and associated piping whenever the pump must be shut down for maintenance
Description: flow through pump
capacity 25 L (STP) D2
Copper construction
charcoal absorbant
Desc cont'd: pump body associated Dewar flask and liquid N2 system outside glove box

TSTA

Generic Subsystem : Impurity Removal
Subsystem Name : Fuel Cleanup
Description & Function: Purification of plasma exhaust and recovery of tritium from impurities.
Desc & Func cont'd :
Development Aspects : Recovery technique for tritium from impurities
Study two different processes
Develpmt Asp cont'd :
References :
Refer's cont'd :

Components
Name : 02 Removal Reactor (CR-1)
Function : Few hundred mLs in volume
remove 02 from DT mixture
Description: Cu or precious metal catalyst
Desc cont'd:

Components
Name : Molecular sieve beds
Function : Two services, neutral beam injection and main fuel system
Operate at 75 K
Description: 5 cm i.d. 110 cm long 200 mL
fabricated of copper
contain 1.6 kg mole sieve
Desc cont'd:

Components
Name : Oxidation Reactor (CR-2)
Function : Complete oxidation of all impurities to water and carbon and nitrogen oxides
operates at 800 K
Description: few hundred mLs in volume
Cu or precious metal catalyst
Desc cont'd:

Components
Name : DTO Freezer
Function : traps water from CR-2 by freezing at 160 K
Description: few hundred mLs in volume
Cu plate or tube-fin consumption
Desc cont'd:

Components
Name : Uranium Beds (HMB-1,2,3,4)
Function : three sets of beds, primary at 1170 K for method 1, secondary at 500 K and method 2 has two at 750 K
Description: approx. 1360 mL
3.8 cm dia x 1.2 m long
Desc cont'd:

Components
Name : Electrolytic Cell
Function : Proposed as a desirable component to replace the hot metal bed to decompose DTO
Description: Subject of a Don Dautovich development project
Desc cont'd:

TSTA

Generic Subsystem : Isotope Separation/ Enrichment
Subsystem Name : Isotope Separation System
Description & Function: The system is four cryogenic hdrogen distillation columns to separate H, D, and T into a tritium free H2 and HD stream, and pur streams for D2, DT and T2. It is designed to handle the full flow of FED or INTOR, 360 mol DT/day plus 275 mol D2/day from
Desc & Func cont'd : neutral beam vacuum pumps. The system contains isotopic equilibrators and hydrogen storage either as a gas or uranium hydride.
Development Aspects : These are minimal since cryogenic distillation of hydrogen is fairly well demonstrated. The system is designed to demonstrate computerized control of the operation, monitoring and safe shutdown of the system.
Develpmt Asp cont'd :
References : J.R. Bartlit, R.H. Sherman and W.H. Denton, "Hydrogen Isotope Distillation for the Tritium Systems Test Assembly", Proc. 3rd ANS Meeting on Technology for Controlled Nuclear Fusion, p. 778, 1978
Refer's cont'd : J.R. Bartlit, R.H. Sherman, R.A. Shutz and W.H. Denton "Hydrogen Isotope Distillation for Fusion Reactors" Cryogenics, p. 275, 1979

Components
Name : Distillation Columns (4)
Function : To separate hydrogen isotope in the fusion fuel reprocessing system
Description: four columns: #1 4.1 m packed height 2.8 cm i.d.; #2 4.1 m packed height 1.9 cm i.d.; #3 3.2m packed height 2.4 cm i.d.; #4 4.1 m packed height 3.8 cm i.d.
packed with 2 x 4 x 4 mm helical stainless steel packing,
Desc cont'd: thermally insulated by common vacuum jacket that provides secondary containment. Includes overhead reflux condenser operates at 17 K. Includes electrically heated reboiler

Components
Name : Equilibrators (2)
Function : To promote the hydrogen isotope equilibrium reactions H2, D2, T2 = HD, HT, DT
Description:
Desc cont'd:

Components
Name : Heat Exchangers
Function : To conserve regrigeration
Description:
Desc cont'd:

Components
Name : Refrigerator
Function : To liquify hydrogen for distillation
Description: Two helium compressors, only one required
Provide 400 watts of refrigeration at 20 K
Desc cont'd:

Components
Name : Vacuum Shell Assembly
Function : Provides insulation for cryogenic distillation columns and

secondary containment for tritium

Description: Shell 0.75 m diameter x 6.2 m high, contains thermal shields at 77 K
Connected to house vacuum and high vacuum pump

Desc cont'd:

Components

Name : Uranium Getter Beds

Function : One or two distillation columns to provide a dump system for the hydrogens contained if refrigeration is lost

Description: Connected to column but outside vacuum shell
Each bed contains 15 kg of finely divided uranium

Desc cont'd:

Components

Name : Storage Tank

Function : To store hydrogens at less than 100 psia at room temperature if refrigeration fails

Description: Stainless steel tank

Desc cont'd:

TSTA

Generic Subsystem : Fuel Storage
Subsystem Name : Not applicable
Description & Function:
Desc & Func cont'd :
Development Aspects :
Develpmt Asp cont'd :
References :
Refer's cont'd :

TSTA

Generic Subsystem : Fuel Preparation/ Delivery
Subsystem Name : Inventory Control
Description & Function: This subsystem is made up of an input/output manifold for standard LP-50 tritium gas shipping containers, a uranium bed, a standard volume and a precision pressure gauge. It will provide a periodic assay of all the tritium in the fuel loop, and pro-
Desc & Func cont'd : vide cumulative monitoring of stack. This subsystem will make use of capabilities in other subsystems. Components enclosed in glove box. DOE requires determination of tritium inventory every 6 mos. to be done by PVT measurement & gas analyses .
Development Aspects : Minimal
Develpmt Asp cont'd :
References : TSTA, Preliminary Safety Analysis Report
Refer's cont'd :

Components

Name : Standard Volume
Function : For measurement of quantity of DT via PVT
Description: Located outside glove box. maintained at constant temp. by water jacket or fluid immersion
All welded stainless steel, 0.1 m3
Desc cont'd:

Components

Name : Precision Pressure Gauge
Function : For measurement of quantity of DT via PVT
Description: 0 - 200 kPa I .05%
temperature controlled
all metal, qualified for hydrogen service
Desc cont'd:

Components

Name : Uranium Getter Bid
Function : To aid gas transfer and provide storage
Description: 6 kg of uranium with an internal heater
Desc cont'd:

TSTA

Generic Subsystem : First Wall Blanket
Subsystem Name : Not applicable
Description & Function:
Desc & Func cont'd :
Development Aspects :
Develpmt Asp cont'd :
References :
Refer's cont'd :

TSTA

Generic Subsystem : Blanket Tritium Removal/ Tritium Recovery
Subsystem Name : Not applicable
Description & Function:
Desc & Func cont'd :
Development Aspects :
Develpmt Asp cont'd :
References :
Refer's cont'd :

TSTA

Generic Subsystem	:	Steam Generator
Subsystem Name	:	Not applicable
Description & Function	:	
Desc & Func cont'd	:	
Development Aspects	:	
Develpmt Asp cont'd	:	
References	:	
Refer's cont'd	:	

TSTA

Generic Subsystem : Low Level Tritium Water Processing
Subsystem Name : Tritium Waste Treatment (TWT)
Description & Function: The system provides routine processing of all gaseous effluents to remove tritium before release to the environment. It operates by catalytic conversion of all hydrogen isotopes to water and organics to water and CO_2. The system is designed to treat
Desc & Func cont'd : 0.025 m3/s of gases and reduce the tritium level by 106.
Development Aspects : Performance evaluation of commercial components
Develpmt Asp cont'd :
References : J.E. Nasis, "Performance and improvements of the Tritium Handling facility at the Los Alamos Scientific Laboratory." Proc, Topical Mtg on Tritium Technology in Fusion, Fusion and Isotopic Applications, pg. 347,p
Refer's cont'd : April, 1980 J.L. Anderson, F.A. Domiano, and J.E. Nasise, "Tritium handling facilities at the Los Alamos Scientific Laboratory" Proc. 23 Conf. on Remote Systems Technology p. 77, Nov. 1975

Components

Name : Tanks Low Pressure receiver (1)
Function : Receives gases from various systems, H_2 & O_2 may be added
Description: stainless steel 7.4 m3
Desc cont'd:

Components

Name : Tanks - input storage tanks (2)
Function : evacuated tanks to provide emergency storage
Description:
Desc cont'd:

Components

Name : Tanks High pressure storage (2)
Function : One for normal operation 3 atm one for emergency storage
Description: stainless steel 1.3 m3
Desc cont'd:

Components

Name : Recombiner
Function : Oxidizes hydrogens to water and organics to CO_2 and water
Description: consists of a gas-to-gas heat exchanger catalyst reactor and water cooled gas after cooler
catalyst operates at 810 K
Desc cont'd:

Components

Name : Compressors (2)
Function : move gas through the system
Description: reciprocating dry cylinder two stages suction .3 - .5 atm, discharge 3 atm
Desc cont'd:

Components

Name : Dryers
Function : Remove water from gases
Description: standard two tower achieves 183 K dew point from 30% relative humidity at 295 K and 3 atm

Desc cont'd:

Components

Name : Valves

Function :

Description: ball valves with cast bronze bodies and s.s. ball and stem
ethylene-propylene O-ring
connected with soldered copper tubing

Desc cont'd:

TSTA

Generic Subsystem : Air Processing

Subsystem Name : Emergency Tritium Cleanup System (ETC)

Description & Function: ETC reduces the probability of tritium release to the environment should the tritium containment be breached The ETC is an air treatment system that pumps contaminated air through a pressure metal catalytic recombiner and collects the water produced

Desc & Func cont'd : in tanks and on molecular sieve drying beds. The system is automatically actuated and computer controlled with a flow rate of 0.65 m3/s. It is designed to reduce a tritium concentration of 355 Ci/m3 to 40 x 10-6 Ci/m3 within 24 h

Development Aspects : To carry out experiments to allow aspects of room air detritiation to be studied under controlled conditions

Develpmt Asp cont'd :

References : M.E. Muller, "Conceptual design of an emergency tritium cleanup system" Proc. 3rd ANS Top. Meeting on Technology of Controlled Nuclear Fusion, p. 270, May, 1978

Refer's cont'd :

Components

Name : Compressors (Main and standby)

Function : To move air through the catalyst bed and driers
To replace primary unit in case of failure

Description: primary compressor is a Pennsylvania Class HOF-CP reciprocating type, normal capacity 0.69 m3/s unit inlet 0.77 atm, 293 K and outlet 3.5 atm and 450 K
Rotary screw oil free type eg., Atlas Copco ZA3

Desc cont'd: 0.32 m3/s

Components

Name : Catalytic Reactor

Function : To oxidize tritiated hydrogen to water

Description: Contains 0.23 m3/s of a catalyst made up of a blend of precious metals in 3 mm x 3 mm pellets in a high surface area substrate
vessel is almost spherical 0.91 m dia. made of 316 s.s. max.

Desc cont'd: temp 755 K press atm

Components

Name : Air Cooler

Function : To cool exit gases from reactor to near the dew point

Description: Water cooled shell tube heat exchanger

Desc cont'd:

Components

Name : Condenser

Function : to remove water from air

Description: refrigerated type compressed air dryer
capacity to cool 0.5 m3/s of air with 3% water from 310 K to 275 K at 3.1 atm

Desc cont'd:

Components

Name : Tritiated Water Storage Tanks

Function : To contain water removed from air by the condenser
Three tanks to segregate according to tritium concentration

Description: Two small tanks 57 L each one large tank 757 L
304 L stainless steel
Desc cont'd:

Components
Name : Dryers
Function : Final drying of air - two systems supplied one for room cleanup experiments one standby for emergency
Description: designed to process 0.5 m3/s air at 286 K 3 atm with 2500 ppm water
1.06 m dia 1.4m deep mol semi bed
molecular sieve is Line e type 4A 1.5mm spheres
Desc cont'd:

Components
Name : Heater
Function : to heat air for molecular sieve regeneration
Description: 100 KW GE air circulation heater designed for tritium service
Desc cont'd:

TSTA

Generic Subsystem : Fuel System Waste Processing
Subsystem Name : Not applicable
Description & Function:
Desc & Func cont'd :
Development Aspects :
Develpmt Asp cont'd :
References :
Refer's cont'd :

TSTA

Generic Subsystem	: Hot Cell Tritium Recovery
Subsystem Name	: Not applicable
Description & Function	:
Desc & Func cont'd	:
Development Aspects	:
Develpmt Asp cont'd	:
References	:
Refer's cont'd	:

TSTA

Generic Subsystem : Instrumentation & Control
Subsystem Name : Master Data Acquisition and Control (MDAC)
Description & Function: This system controls all of the TSTA subsystems. The primary functions are: (1) measurement of physical parameters; (2) control components; (3) provision for alarms and corrective action; (4) real time data reduction; (5) archiving of data;
Desc & Func cont'd : (6) tritium inventory; (7) equipment status and health parameter displays. The MDAC consists of a data acquisition unit, a process control unit, a man-machine interface, a computer unit and a software unit.
Development Aspects :
Develpmt Asp cont'd :
References : TSTA Preliminary Safety Analysis Report
Refer's cont'd :

Components
Name : Computers (4)
Function :
Description:
Desc cont'd:

Components
Name : Process (2)
Function : Interface with the data acquisition system the process control system and the man-machine interface
Description: Data General Eclipse C330
Desc cont'd:

Components
Name : Safety (2)
Function : Assume control when they detect an unsafe system that has not been corrected by the process control system
Description: LSI-11/23 computers
Desc cont'd:

Components
Name : Data Acquisition System and Process Control
Function : Collect Data from the various parts of TSTA - true components are integrated
Description: four micro computers act as front-end controllers collection of transducers and controllers
Desc cont'd:

Components
Name : Man-Machine Interface
Function : Serves as an interface between the system operators and MDAC
Description: contains three sections - process, safety and support centre three categories, process mini computers, front-end controller minicomputers and safety minicomputers
Desc cont'd:

Components
Name : Software
Function :
Description: Three categories, process minicomputers, front-end controller minicomputers and safety minicomputers
Desc cont'd:

TSTA

Generic Subsystem : Process Monitoring
Subsystem Name : Tritium Monitoring System (TM)
Description & Function: Instrumentation will provide measurement of stack releases, safety measurements, initiation monitoring and control of cleanup systems, monitoring and controlling the process loop. These will include ion chambers, and special sensors such as
Desc & Func cont'd : plastic scintillators
Development Aspects : Evaluation of instrumentation
Develpmt Asp cont'd :
References : J.L. Anderson "Tritium Handling Requirements and Development for Fusion", Proc. IEEE 69, 1981 p. 1069
Refer's cont'd :

Components
Name : Various Ion Chamber instruments (see attached table)
Function :
Description:
Desc cont'd:

Components
Name : Hard-wired Readouts
Function : control room readout of remote monitors
Description: Panel meters connected to instrument meters
Desc cont'd:

Components
Name : Stack Bubbler
Function : to measure tritium released through the stack
Description: glycol filled with precious metal catalyst
sample lines 03 cm Cu at 100 mL/min
system consists of 3, 30 mL bubblers in series a Pd sponge catalyst at 330oC, plus 3 more 30 mL bubblers in sews, a
Desc cont'd: rolameter, a flow controller and a pump

Components
Name : ETC Water Monitor
Function : measure tritium in water after condenser in ETC system
Description: scintillation flow cell with photo multiplier tubes and associated electronics
Desc cont'd:

Components
Name : Liquid Scintillation Spectrometer
Function : to measure tritium in water
Description: standard and commercial instrument
Desc cont'd:

15 Records printed