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TFTR DT PREPARATION PROJECT STATUS

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INTRODUCTION

The objective of the DT Preparation Project on the Tokamak Fusion Test Reactor (TFTR) is to provide the capability required to perform a sequence of deuterium-tritium experiments in a manner which is consistent with DOE orders and the Environmental, Safety and Health requirements of DOE and PPPL. These experiments will include the study of confinement and heating of DT plasmas, determining the effects of alpha particles, demonstration of DT technical capability and the demonstration of DT power production. The TFTR Research Plan summarizing these activities is shown in figure 1.

TRITIUM SYSTEMS

A significant portion of the work involved in this project relates to the ability to provide full tritium handling capability to TFTR. This includes the commissioning of the tritium handling equipment, upgrading the HVAC systems for tritium containment, the safety analysis and documentation necessary to implement tritium operations on TFTR and the training of tritium operators. This scope is contained within the Tritium Operations Branch of TFTR along with the tritium monitoring capability for tritium operations.

In order to accomplish this goal of full tritium handling capability for TFTR several tritium systems have been employed. First, there is the Tritium Storage and Delivery System (TSDS), which receives, stores and delivers tritium to the three injection systems (torus gas injection, neutral beam gas injection, and the tritium pellet injector). Secondly, the three Tritium Cleanup Systems which remove the tritium by oxidation from the various streams or room air: the Torus Cleanup System (TCS), the Tritium Storage and Delivery Cleanup System (TSDCS) and the Tritium Vault Cleanup System (TVCS). And finally, the Tritium Regeneration System (TRS) which regenerates the cleanup system drier beds and deposits the oxidized tritium on molecular sieve beds in shipping containers.

With the exception of the Quadrupole Mass Spectrometer analytical system, which is presently in its final commissioning stage, the TSDS is fully operational. Deuterium, which behaves as tritium except for its radioactive properties, is being used as its transfer and performance testing medium. The TRS, TCS and TSDCS are also fully operational. As soon as the insulation of the piping and equipment of these systems is completed the final performance testing can occur, confirming the last remaining design requirements. The TVCS is currently undergoing the final helium leaktest before this system can be declared operational.

The area and stack monitoring systems are being discussed elsewhere at this meeting [1]. The purpose of these systems is to detect any tritium that may be released to the atmosphere, either into a room or into the environment. The design of these systems has been completed, and the installation to be started soon. These systems should be installed and fully tested by February 1992.

TRITIUM DELIVERY SYSTEMS

The delivery of tritium from the tritium vault systems to the tokamak involves three systems, the Torus Gas Injection System (TGIS), the Neutral Beam Gas Injection System (NBGIS), and the Tritium Pellet Injector (TPI). The design of these systems is currently underway.

The scope of work for the Torus Gas Injection Systems includes the modifications necessary for DT operations to the Torus Vacuum Pumping System (TVPS), the Non-Tritium Gas Injection System (NTGIS), the Glow Discharge System (GDC), and the Residual Gas Analyzer (RGA).

The modification of the Neutral Beam Gas Injection System will concentrate on minimizing the amount of tritium required for each pulse, adding the required double containment and tritium compatible components. The baseline plan for feeding tritium and deuterium gas to the sources is that it will be done downstream of the grids. This will allow the tritium to be fed at ground potential through a stainless steel tube that does not pass through the SF6 surrounding the source.

The redesign of the existing Deuterium Pellet Injector (DPI) to a high spped Tritium Pellet Injector (TPI) is a task which is being done jointly with ORNL. The redesign is now in the design phase and the subsequent fabrication, installation and testing will continue to be a joint effort with the

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goal of starting testing on TFTR with deuterium in March 1992.

NEUTRAL BEAM MODIFICATIONS

Aside from the neutral beam gas injection modifications discussed above, the major task for the neutral beams is to develop a cryogenic cold trap to prevent halogens, such as the SF6 used for the neutral beams and the ICRF transmission lines, from contaminating the tritium recovery system during beamline regeneration. The required effectiveness of this cold trap is being developed at this time through tests at Los Alamos on the effects of various quantities of SF6 on the tritium cleanup system catalytic beds.

Several modifications to neutral beamauxiliary systems are necessary to accommodate the nuclear environment of the Test Cell. Modifications are required to the deuterium and auxiliary gas systems, the helium gas system (for cryopanel regeneration), the SF6 system, the cryogenic system and the beamline water system. All gas bottles and control electronics which require personnel interface will be relocated to the Test Cell Basement. The liquid helium refrigeration control station will be relocated to the TFTR control room.

The problems which must be addressed for the neutral beam water systems are twofold. First, a water stoppage, although of low probability, has the consequence of extensive damage to beamline components. Restarting water flow within one hour is required to prevent frozen and possibly ruptured water lines. More reliable flow switches and remotely operated control valves are being installed to ensure that the restarting of water flow occurs. The second problem stems from the use of teflon in the joints and valve seals within the plumbing system. Teflon is not the best choice in a high radiation environment. A replacement material is being investigated.

Finally, as part of the beamline upgrade, all existing elastomer seals will be replaced with either a metallic seal or by a differentially pumped pair of elastomer seals. The gases pumped from the interstitial volume will be monitored for tritium content.

TOKAMAK/FACILITY MODIFICATIONS

Remaining areas of work include the sealing of wall and floor penetrations in the Test Cell and Test Cell Basement. This sealing is required for various combinations of fire seals, gas seals and radiation shielding, depending on the location and size of the penetration. In addition, a one foot thick shielding wall along the north side of the Test Cell will be installed to permit a greater number of shots without exceeding the boundary limit.

Finally, a major facility modification is the seismic qualification of systems within the Test Cell, Test Cell Basement, and Mechanical Equipment Room. This task involves evaluating the seismic adequacy of systems and components in these areas and making modifications as required so that a certificate of seismic qualification can be issued by an organization recognized by DOE as an authority in this field.

DIAGNOSTICS

The scope of work for the diagnostic systems includes the installation of two new diagnostics, the Gyrotron Scattering diagnostic and the Alpha Particle CHERS diagnostic. The Gyrotron Scattering diagnostic is necessary for the measurement of the energy distribution of the confined high energy fusion-generated alpha particles. This diagnostic is making use of borrowed components and is to be carried out in collaboration with MIT. The Alpha Particle CHERS diagnostic is to be designed for the measurement of the thermalizing confined alpha particles. This instrument is being developed in collaboration with the University of Wisconsin. Both systems are planned to be operational by July 1992 so a full check out of them can occur during DD operations prior to dt experiments.

The balance of the scope of work for the diagnostics involves the shielding of detectors and electronics as well as the remote operation of some aspects of other diagnostics.

COST AND SCHEDULE

The estimated costs for the DT Preparation Project are shown in figure 2. These costs were generated from bottoms-up cost estimates. The scope of each job and the associated technical uncertainties have undergone a peer and management review during which contingency requirements were identified on a job by job basis. The contingency budget is shown only in FY93 due to funding constraints in FY92. Contingency requirements during FY92 will be resolved with schedule delays.

DT operation is planned to begin in May 1993. However, as noted above, the lack of contingency funding in FY92 may require schedule delays of up to two months. Figure 3 shows the schedule for the major activities that need to be achieved in order to reach DT operation successfully.

SUMMARY

TFTR is moving rapidly toward performing Deuterium-Tritium (DT) experiments. A demonstration of tritium handling capabilities within the tritium vault is scheduled to begin in August 1992 with an inventory of up to1000 Ci. A major shutdown to complete DT modifications is scheduled to begin in October 1992, and DT Operations are scheduled to begin in July 1993.

This work has been performed under Department of Energy contract No. DE-AC02-76CH03073.

[1] "Stack and Area Monitoring Systems for the Tokamak Fusion Test Reactor (TFTR), G. Pearson, L. Meixler, R. Sissingh, The 14th Symposium on Fusion Engineering.

TFTR RESEARCH PLAN

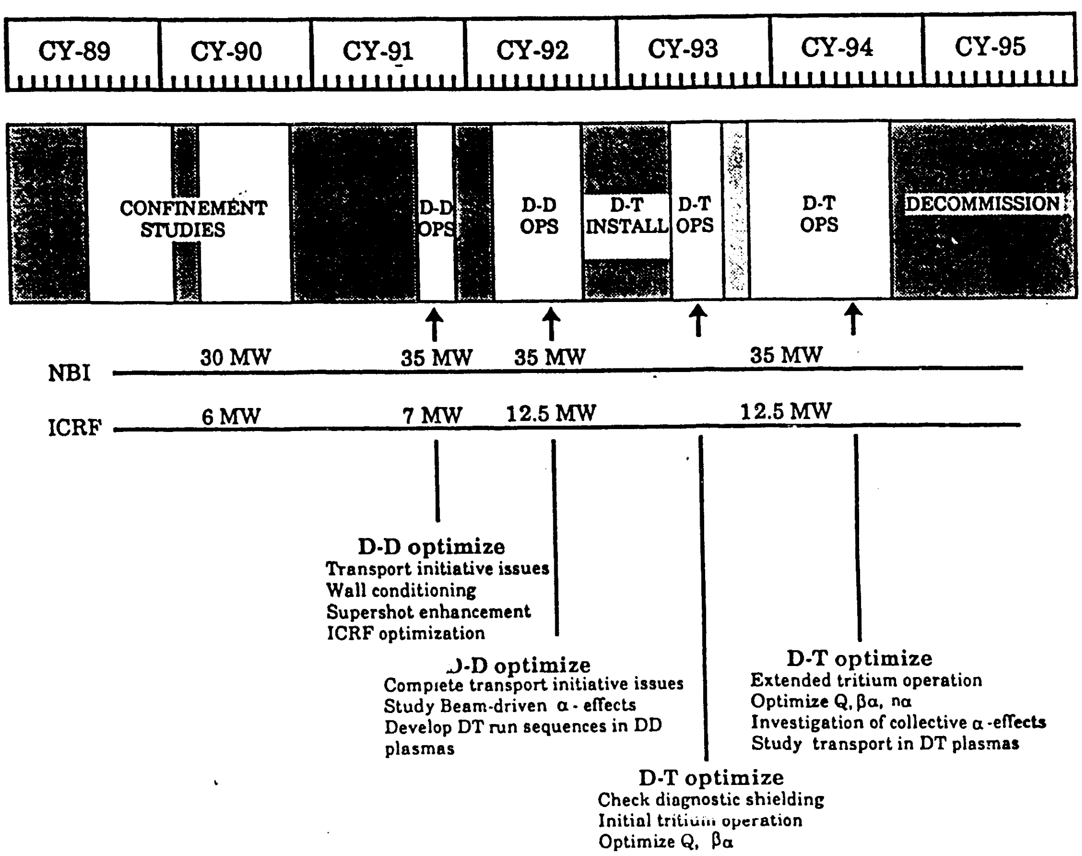


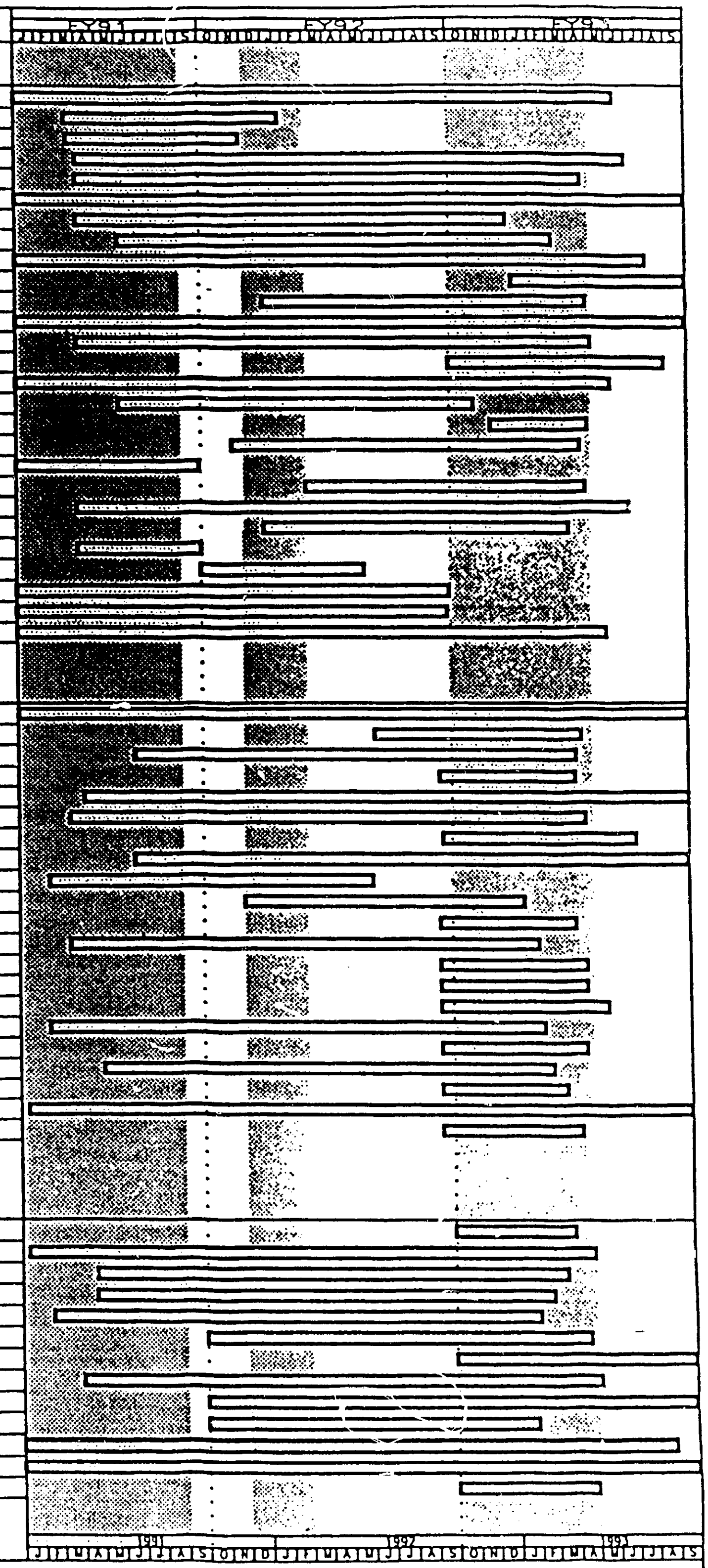
Figure 1

DT PREP PROJECT COSTS IN $K

	FY91	FY92	FY93	TOTAL
PROJECT MANAGEMENT	821	2131	1876	4828
TOKAMAK OPERATIONS	3173	8611	6942	18726
DIAGNOSTICS	1229	2375	4084	7688
HEATING SYSTEMS	706	3010	2276	5993
CONTINGENCY	0	0	4432	4432
TOTAL	5929	16127	19610	41667

Figure 2

TOKAMAK OPERATIONS		
T900	TRITIUM SYSTEMS TESTING	SISSINGH
T9A0	AREA PROCESS TRITIUM MONITORING	SISSINGH
T9B0	STACK MOINTORING SYSTEM	SISSINGH
T9C0	DT SYSTEM HVAC MOD	SISSINGH
T9E0	DT TRITIUM SYSTEM OPERATORS	SISSINGH
TAA0	D-T PREP RAD MONITORING	GILBERT
TAB0	TFTR TRIT.LINE & GAS INJ.	LAMARCHE
TAD0	DT MODS TO TVPS/NTGDS/GDC	LAMARCHE
TAE0	DT VACUUM SYSTEM SUPPORT	LAMARCH
TAG0	EX-VESSEL REMOTE HANDLING	BARNES
TAH0	ICRF ANTENNA SYSTEM DT MODS	RAFTOPOULOS
TAJ0	PENETRATION FILLING FOR DT	WESTER
TAK0	SEISMIC QUALIFICATIONS	PERRY
TAL0	GROUND FAULT LOCATOR	O'NEILL
TAT0	TRITIUM PELLET INJECTOR	SENKO
TAU0	TC NORTH WALL AD'L SHLDG	PERRY
TAV0	TF COIL SEALING FOR DT OPS	ALTON
TAW0	TRITIUM SYSTEM DRIER	SISSINGH,R.
TCY0	RMS/EZB STUDY	KUGEL
WLE0	D-SITE BOUNDARY ACCESS CONTROL	KOLINCHAK
WLS0	TGIS&NTGIS CTRLS UPGRD	RAUCH
WLZ0	TFTR RGA UPGRADE	RAUCH
WM10	TSDS CONTROL SYSTEM	SCHOBERT
WM50	REMOTE DISPLAY OF TRITIUM MONITORS	SCHOBERT
Y030	ENVIRONMENT MONITOR DATA	KU
Y130	DT NEUTRONIC ANALYSIS FOR	KU
Y150	RADIATION ANALYSIS ME	KU
TFTR DT DIAGNOSTICS		
DT10	DIAGN DT SYS ENGRG	RENDA,G.
DT30	FOURIER TRANSFORM DT PREP	PARSELLS
DT40	SPRED,VIPS RELOC	LONG
DT60	XCS PENETRATION & SHIELDING	FAUNCE
DT70	EPITHERMAL NEUTR DTCTR SYS DT	DAUGERT
DTA0	2ND GRATING POLYCHROMATOR	MCCARTHY
DTC0	DIAG DT CALIBRATION	RENDA,G.
DTD0	TVTS DT UPGRADE	LABIK,G.
DTE0	ALPHA PARTICLE CHERS	MCCARTHY
DTF0	VACUUM VESSEL ILLUMIN	NAGY
DTG0	CHARGE EXCHANGE DNB DT PREP	DAUGERT
DTH0	CHERS RELOCATION TO HC	NAGY
DTJ0	HET RADIOM REMOTE CALIB	LEMUNYAN
DTK0	NS SYSTEM DT UPGRADE	DAUGERT
DTL0	ESCAP ALPHA PART SYS DT PREP	LEMUN
DTM0	NM SYSTEM DT PREP	NAGY
DTN0	NEUTR ACTIV SYS DT PREP	LEMUN
DTP0	PLASMA TV RADIATION SHLDG	NAGY
DTQ0	MICROWAVE SCATTER DT UPGR	MCCARTHY
DTT0	GYROTRON SCATTERING	RENDA
DTX0	PHA & HARD XRAY DT PREP	FAUNCE
DT HEATING SYSTEMS		
FCPC	REMOTE OPER FOR DT	FROMM,N.
N100	NB LPIS GAS INJEC.DT MECH	WRIGHT,K.
N120	NB WATER SYSTEM	GOLIAN,T.
N140	AUX GAS SYSTEM	GOLIAN,T.
N160	NB SEAL UPGRADE	VIOLA,M.
N170	NB DT SEISMIC ANALYSIS	KAMINSKY,E.
N180	DT AS BUILTS	VIOLA,M.
N240	NB DT COLD TRAP	VIOLA,M.
N760	BL INSTRUMENTATION UPGRADE	O'CONNOR,T.
N910	SF6 CONTROL SYSTEM	MCCORMACK,B
N920	NB GAS SYS PERFORMANCE UP	OLDAKER,M.
NB00	TFTR HSD DT PHYSICIST	L GRISHAM
NC10	REMOTE REFRIGERATOR	MCCORMACK,B



TFTR DT PREPARATIONS

Figure 3

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