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1

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FIVE YEARS OF TRITIUM HANDLING EXPERIENCE AT THE TRITIUM SYSTEMS TEST ASSEMBLY*

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ABSTRACT

The Tritium Systems Test Assembly (TSTA) at Los Alamos National Laboratory is a facility designed to develop and demonstrate, in full scale, technologies necessary for safe and efficient operation of tritium systems required for tokamak fusion reactors. TSTA currently consists of systems for evacuating reactor exhaust gas with compound cryopumps; for removing impurities from plasma exhaust gas and recovering the chemically-combined tritium; for separating the isotopes of hydrogen; for transfer pumping; for storage of hydrogen isotopes; for gas analysis, and for assuring safety by the necessary control, monitoring, and tritium removal from effluent streams. TSTA also has several small scale experiments to develop and test new equipment and processes necessary for fusion reactors. Tritium was introduced into TSTA in June 1984. Current inventory is approximately 100 grams. Approximately 10^7 Curies of tritium have been processed in closed loop operation at TSTA. Total tritium releases from the facility stack have been less than 75 Curies. Total operating personnel exposures are less than 500 person-mrem. Exposures to the general public from TSTA tritium releases are extremely small (less than 10^{-2} mrem). Total tritium buried as waste is less than 56 000 Curies. In this paper, data on component reliability, failure types and rates, and waste quantities are presented. TSTA has developed a Quality Assurance program for preparing and controlling the documentation of the procedures required for the design, purchase, and operation of the tritium systems. Operational experience under normal, abnormal, and emergency conditions is presented. One unique aspect of operations at TSTA is that the design personnel for the TSTA systems are also part of the operating personnel. This has allowed for the relatively smooth transition from design to operation. TSTA has been operated initially as a research facility. As the systems become better defined, operations are proceeding toward production modes. The DOE requirements for the operation of a tritium facility like TSTA include personnel training, emergency preparedness, radiation protection, safety analysis, and preoperational appraisals. The integration of these requirements into TSTA operations is discussed.

INTRODUCTION

The Tritium Systems Test Assembly (TSTA), located at the Los Alamos National Laboratory (LANL), Los Alamos, New Mexico, is a prototype fusion reactor fuel reprocessing system. Its purpose is for the development and demonstration of technologies for tritium handling systems necessary for deuterium-tritium burning fusion reactors. Also equally important is demonstrating that the large tritium inventories required for fusion reactors can be routinely handled with low radiation exposures to operating personnel or the public and without significant environmental releases. The methods that TSTA has implemented to achieve the technical and safety

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goals involve both a well designed and constructed system and an effective operating plan. Co-ordination of the varied operations and activities is important to assure both safety and effectiveness of the operations and the personnel working in the facility. TSTA systems are designed for computer control and monitoring.

TSTA has been operating with tritium for approximately five years. The current inventory of tritium is approximately one hundred grams, with DOE approval for a maximum inventory of two hundred grams. Total stack releases to the environment are less than 75 Curies during tritium operations and total personnel exposures to tritium total are less than 0.5 rem. Both of these are well below the self imposed project goals, which, in turn, are much below any DOE or EPA legal requirements.

TSTA ORGANIZATION

Figure 1 shows the TSTA personnel organization structure. TSTA was designed and built as a Department of Energy (DOE) program. In 1987 TSTA became a jointly funded effort between the Japan Atomic Energy Research Institute (JAERI) and the DOE. During the five-year joint program, four JAERI personnel are assigned to TSTA for one year periods of stay. Operation of TSTA remains the responsibility of Los Alamos personnel. The Steering Committee is composed of two US and two Japanese personnel. The Steering Committee provides general programmatic and budget guidance to the project. The project operations are directly managed by the TSTA Project Manager and Deputy Project Manager. As the figure indicates, the TSTA personnel are grouped into several teams with responsibilities covering the range of skills and activities needed at the facility.

There are 24 TSTA personnel responsible for the activities at TSTA, 10 professional staff, three Facility Operators, one software person, one Quality Assurance specialist, three mechanical technicians, one and one half electrical technicians, one Health Physics Technician (HPT) and four JAERI staff. Actual daily operations are the responsibility of the Operational Safety and Integration Team composed entirely of TSTA personnel. The daily operations are coordinated by the TSTA Facility Operators who are members of the Operational Safety and Integration Team.

TSTA SYSTEMS

TSTA Process Systems

One of the primary goals of TSTA is the operation of the TSTA tritium process loop. The loop is used to simulate the fuel processing systems for a fusion reactor. The system is described in detail in ref. 1 and 2. The TSTA subsystems and their interconnections are shown in Fig. 2. The primary components of the loop are:

- Transfer pumps (TPU) for moving the DT gas through the system.
- A fuel cleanup system (FCU) for the removal of impurities [illegible] from the DT gas stream and recovering chemically combined tritium from the impurities.
- A four column cryogenic isotope separation system (ISS) for the separation of hydrogen isotopes into streams of HD, T_2, D_2 and DT.
- A cryogenic compound vacuum pumping system (VAC) for pumping the exhaust gas from a simulated torus containing deuterium tritium gas along with impurities.
- A tritium storage system (TTB) capable of storing the entire inventory [illegible] over 200 [illegible] on beds of depleted uranium.
- An impurity injection system (IMS) for adding impurities to the DT gas stream.

The process systems were assembled from commercially available components. Piping is either copper or stainless steel. Elastomers, plastics, liquid metals and organic or halogenated lubricants are not allowed in the process system. The only exception to the no-organic rule is that polyimide stem tips are used in the TSTA valves. Two stage metal bellows pumps are used to move DT gas through the processes. Components in the system are easily removed since they are installed using zero-clearance gasket fittings. Although a typical TSTA system contains hundreds of fittings, leak integrity is comparable to that of an all welded system; yet serviceability is excellent because failed components can be easily replaced. Active process components are controlled with the TSTA computer.

The TSTA process system contains approximately 1000 m of tubing, 2000 welds or brazes, 2000 fittings, 200 bellows sealed valves, 100 transducers, and 10 pumps. To date we have had one failure in a weld joint, 20 fittings which leaked and were repaired by tightening or gasket replacement, one metal bellows pump failure (after 4000 hours operating time), two bellows seal valves which leaked through the seat, one bellows seal valve which leaked through the body, and ten pressure transducer failures due to tritium incompatibility.

TSTA Safety Systems

Safety systems provide protection for operating personnel, offsite personnel, and the environment. These systems are:

- The tritium waste treatment system (TWT), which removes tritium from all gaseous waste streams that could possibly contain tritium. The process used to remove tritium is catalytic oxidation of tritium and tritiated compounds to water and collection of the water on molecular sieve.
- Secondary containment is provided around all process piping and components. Fifteen gloveboxes with a nitrogen atmosphere are used. Interconnecting piping between systems in different gloveboxes is also secondarily contained. High tritium levels (greater than [illegible] mCi/m^3), high pressures, or high O_2 levels will initiate a once through purge of the glovebox. The purge exhaust gas is processed by the TWT.
- Tritium monitoring of the room air, stack and ventilation ducts exhaust air flow, and glovebox atmosphere provide rapid detection of tritium releases from process piping into secondary containment or into the TSTA room air. If room tritium levels reach [illegible] mCi/m^3 the room is automatically isolated and the tritium can be recovered.
- The emergency room air detritiation system (ETC) can capture tritium that is accidentally released into room air. Capture is based on catalytic oxidation and water collection on molecular sieve. The system flow is 43 m^3/hr.
- TSTA is a computer controlled and monitored system (Master Data Acquisition and Control, MDAC). Most interactions and control of the system are performed from the control room through the Man Machine Interface (MMI). Four system computer display consoles are used to monitor any of the 200 system displays. In addition, there are several computer terminals available to monitor historical data and also to plot current trends of any of the 570 analog parameters or 1700 digital measurements. Trending of real time data allows for the rapid detection of system failures or changes. Data from all TSTA variables are stored either on a hard disk (last three months) or magnetic tape. Safety systems such as the emergency waste treatment system (TWT) and tritium monitoring systems are automatically controlled by MDAC. Other systems are controlled by individual commands given by Facility Operators from the MMI. Three levels of alarms are displayed at the MMI for variables out of limit.
- Commercial power to the facility is backed up by a diesel generator (DG) and an uninterruptible power supply (UPS). The UPS provides smooth power to the computer.

tem and other systems which are affected by small changes of voltage. The EGS will automatically supply facility power if commercial power fails. If the EGS fails to start, the UPS can provide battery supplied power for at least 30 minutes, to safely shut the TSTA systems down.

Other TSTA experimental systems

Seven of the TSTA gloveboxes are used for small scale nonloop experiments. These experiments are used for determining the design of components, testing of new components for the fuel processing loop, and to determine tritium contamination effects. Some of these experiments are: a tritium pellet injector; a palladium diffuser for the separation of hydrogen isotopes from impurities; a ceramic electrolysis cell for the decomposition of tritiated water; a test of the tritium compatibility of a piezo electric gas injection valve; and measurements of catalyst conversion efficiency. In general, these experiments are done with personnel from other fusion energy programs from the US and foreign countries.

OPERATIONS

One unique aspect of operations at TSTA is that the design personnel for the TSTA systems are also part of the operating personnel. This has allowed for the relatively smooth transition from design to operations. TSTA has been operated initially as a research facility. As the system is better defined, operations are proceeding toward production modes. The operations ongoing at TSTA fall into two distinct operating modes, loop and nonloop operations.

Loop Operations

TSTA process flow loop operations generally involve approximately 100 grams of tritium circulating in the loop. During loop operations at least two knowledgeable TSTA personnel must be on site monitoring the process at all times. We currently are operating with three eight-hour shifts. The two shifts during the day and evening are operating shifts, while the night shift is a holding shift. There is at least one Facility Operator as a member of each shift. The length of the loop operations is usually one to two weeks. One of the limitations on the length is the small TSTA staff. Plans are to add three more Facility Operators to the TSTA staff in the spring of 1989. The frequency of loop runs is currently five to six per year. In the next several years the length of these runs will increase to a duration of several months.

Table I is a listing of the loop operation experiments performed to date at TSTA. During these runs approximately [illegible] Curies of tritium have been circulated through the TSTA flow loop.

During loop operations, the small scale nonloop experiments are also done. However, the activity of these experiments may decrease since loop operations generally require participation of most of the TSTA staff.

During loop runs, TSTA personnel are given various responsibilities. A Test Director for each shift is designated. The Test Director is in charge of the operation of the experiment. He or the alternate must be onsite at all times. On each shift, one of the Facility Operators is designated the Loop Operator. The Loop Operator handles the control of the loop operation from the MMI. The various other TSTA personnel have responsibilities for the local operations necessary at the various systems such as gas analyses and attaching and detaching tritium containers. The Loop Operator and Test Director coordinate all the operations from the control room. Whenever necessary, consulting personnel are included in the discussions. For abnormal or emergency situations, TSTA personnel who are considered experts are assigned to each system. These are the personnel who the Test Director consults during an emergency. Short meetings or Huddles are held as needed to discuss observations, decide appropriate actions, to keep all TSTA personnel abreast of the current operations, and make changes in plans. Shift change meetings are held to inform the oncoming shift of the status of the system.

Nonloop operations

Nonloop operating periods allow time for upgrades, maintenance and repair, operation of the nonloop experiments, fabrication of process systems, training and preparation of documentation. These times tend also to be very active times with many operations going on simultaneously. At times, the same TSTA systems are needed for the various experiments or operations. To coordinate operations at TSTA, one of the Facility Operators is appointed to the position of Duty Operator. This position rotates through the four operators on a weekly basis.

The Duty Operator is the central person for the monitoring and the coordination of the daily operations in the facility. All work in the facility must be explained to the Duty Operator by the person responsible for the work so that the Duty Operator can understand the implications and interactions with other systems. The Duty Operator will halt operations if there is insufficient information to assess the possible hazards or if he feels further analysis of interactions is necessary. The Duty Operator is also responsible to periodically monitor the TSTA safety system parameters, such as operation of the TWT and system radiation levels.

Scheduling meetings are held every Friday morning for all TSTA personnel. The Duty Operator runs the meeting. Plans for the next week are discussed. During this meeting, conflicts and interactions between the various operations are resolved. This meeting also keeps all personnel informed about the what is going on at TSTA. A time period in the meeting is devoted to safety concerns, both radiation and others. A schedule for the next weeks operation is distributed to all personnel TSTA. The schedule also lists any safety items that were raised at the meeting.

A weekly report of TSTA operations is internally published. The report contains the following information: summary of the operations for the last week, unusual occurrences; tritium inventory, including location, input, and output; inventory of tritium in the waste treatment system, tritium releases to the environment through the stack, unusual contamination levels in the facility, solid waste generated, and a listing of all the "RED" alarms recorded by the TSTA computer (RED alarms are those which require immediate action by the Duty Operator).

Emergency abnormal operations

An Emergency Plan has been prepared for response to emergency and abnormal conditions which could result in injury to personnel or tritium releases from the facility. This document contains a discussion of hazards and responses to those hazards. Annually, a planned emergency is staged to test the response of TSTA personnel and the other Los Alamos National Laboratory support personnel.

TRAINING

Training and certification are important parts of the TSTA program. Training is required for both the TSTA Facility Operators and other personnel who are involved in tritium operations at TSTA, including TSTA personnel and visiting staff.

Facility Operators are required to participate in a training program that is part of the TSTA Quality Assurance (QA) program. The program deals with the theory and operation of each of the TSTA systems. Training for each system is covered by a qualification card which has check pieces for both theoretical knowledge and practical demonstration of operations on the system.

Both classroom lectures and on the job training are used. The instruction is generally given by TSTA personnel. Operators are also sent to external training courses as appropriate. After completion of the training for each system, the qualification card is signed off. Periodic retraining and recertification are required. This is particularly true in the areas of tritium safety.

All external personnel are required to be familiar with the TSTA Emergency Plan, rules governing working with tritium, and rules for TSTA operations. In addition, documentation dealing with the explicit work in which they will be involved must be read and understood. Visitors involved in hands-on tritium experiments, are assigned to one of the TSTA personnel (generally a Facility Operator) to work with them in all operations involved with tritium. They are given a tour of TSTA, emergency procedures are explained and the evacuation alarms are sounded. Certification is documented on a visitor indoctrination form which the visitor and a TSTA staff must sign. Restrictions on their work are documented on this form.

The new DOE order specifying performance based training for personnel who work at nuclear facilities will be released this spring. The impact on TSTA is currently being evaluated. Implementating this order will require substantial time from TSTA professional staff to develop a training program which can be accredited by DOE.

QUALITY ASSURANCE PROGRAM

TSTA operates under a Quality Assurance (QA) program based on ASNI ASME NQA-2 "Quality Assurance requirements for Nuclear Facilities" (ref 3). This program is an integral part of the daily operations of the facility. One QA Specialist from a separate LANL group is assigned full time to the TSTA project. The QA program details the documentation requirements for the project, procurement and receiving procedures, training program, failure reporting, and calibration procedures. Documentation used in the operation of TSTA is discussed in the next section.

An important element of the QA program is the review process. All documentation, operating procedures, test plans, system design and system design changes, and purchase requests must be approved by a review board. This is accomplished by circulating the item to a review board consisting of knowledgeable TSTA personnel who are not directly responsible for the item, TSTA management and the Quality Assurance specialist. The review board comprises appropriate people depending on the subject under review. When appropriate, external people are included in the review process. Comments are made in writing. It is the responsibility of the initiator of the item to assure that the concerns are resolved. After resolution of the comments, the item is approved and placed in the TSTA QA system. The review board process is of great benefit to the TSTA program since it requires peer review. Information exchange and communications among TSTA personnel are increased through the use of this process.

Since TSTA is a computer controlled system a substantial amount of software has been prepared for the monitoring and control of the system. The software must be approved through the same review board system described above. In addition, a software test plan is prepared which describes how the computer programs will be tested before the program is installed on the main process control computer. "Bugs" in the program are determined at this stage. To assure that the TSTA software has not been changed without the proper approvals, a software validation program is periodically run. This program checks the current software program with a control copy kept by the TSTA QA specialist. Any deviations from the QA approved program are determined by the validation program.

DOCUMENTATION AND PROCEDURES

Each of the systems of TSTA is described in a series of documents dealing with the design and operation of the system. This includes a System Design Description (SDD) for each system. The topics covered in the SDD are: system function; system design and configuration; design considerations; performance characteristics; components parts and materials; instrumentation and control; interfaces to other systems; operating limits; failure modes and effects analysis; operating modes; maintenance procedures; and emergency procedures. The SDD is the primary reference for details of the system.

All experiments conducted at TSTA (including both loop and the small-scale nonloop experiments) must have a QA approved Test Plan. The Test Plan must address the following areas: purpose of the experiment; configuration of the apparatus, interfaces to all affected systems; TSTA systems required for the experiment; personnel who will be involved in the experiment; schedule; possible hazards that may exist and response to these hazards; outline of the experiments planned; and data requirements. The Test Plan is the working document for the experiments. The plan is approved with a TSTA design review board. This allows for incorporation of other ideas into the plan.

For one-time operations, a Special Work Permit for Radiation Work is used. This is a Los Alamos National Laboratory form which briefly describes the operation, radiation levels involved, protective requirements such as clothing, gloves and monitoring. The form is approved by the TSTA Health Physics Technician, the Operations Supervisor and the TSTA Duty Operator and must be posted at the site of the work. The permit is valid for a limited time.

Another important TSTA document is "Working with Tritium." This document gives the rules to follow when working on tritium systems. The topics discussed are: training requirements; radiation badges and urinalysis program; air lock procedures; TSTA "two man rule"; rules for work in gloveboxes; use of the portable ventilation duct; replacement of a glovebox glove; handling tritium contaminated equipment; waste disposal; and protective clothing.

In addition to the internal approval for TSTA QA documents, some operating procedures must be approved by the Materials Science and Technology Division Office and the Laboratory Health Safety and Environment Division. Standard Operating Procedures (SOPs) for the TSTA systems and procedures involving radiation, liquid hydrogen and hazardous waste are approved in this manner.

ALARA

Operations at TSTA are conducted within the ALARA (As Low As Reasonably Achievable) philosophy toward hazards for personnel and the environment. Personnel radiation exposures are kept to a minimum by both the design of TSTA and the operating methods. Total personnel radiation exposure from the five years of tritium operations at TSTA operations are less than 500 person mrem. Exposures are determined with biweekly urine analysis. If exposures are higher than normal, project management meets with the individual to determine the causes and identify ways to reduce the exposure.

Routine swipes of surfaces in tritium areas of the facility are taken biweekly by the HPT. Normal readings for swipeable contamination are less than 1000 dpm/100 cm^2 (dpm = disintegrations per minute). Guidelines at Los Alamos are: clean areas (defined by LANL) are less than 1000 dpm/100 cm^2, experimental areas between 1000 and 10,000 dpm/100 cm^2. If contamination levels are higher than 1500 dpm/100 cm^2, the area is cleaned up until the level is below

1000 dpm/100 cm^2. A report of the levels is distributed biweekly. The TSTA Duty Operator also takes swipes on a weekly basis. These are taken in varied locations in both the tritium and nontritium areas of TSTA such as on tools, door knobs desks, etc. Records of these swipes are kept in a TSTA notebook.

TSTA goals for tritium emissions to the environment are less than 200 Curies per year. Total tritium releases from TSTA during almost five years of tritium operations have been approximately 75 Curies. Monthly releases during 1987 averaged 1.5 Curies. When releases greater than this occur, the cause is investigated. Figure 3 shows the monthly TSTA stack releases since 1985.

Another element of the ALARA program at TSTA is management of radioactive waste. TSTA process systems have been designed to minimize the amount of radioactive waste generated in the processes. New processes are being developed which will reduce the solid waste further. Table II gives an account of the tritiated waste generated at TSTA from 1985 to 1988. Low level waste is typically room trash. Medium level waste is hardware (pumps, piping, transducers) removed from the TSTA systems and high level is HTO adsorbed on molecular sieve from the TWT. In 1987 approximately 20,000 Curies of tritium was inadvertently evacuated to the TWT through a valve which was incorrectly indicating closed. No tritium was released to the environment from this system failure.

For preplanned maintenance on contaminated systems, care is taken to reduce personnel exposures. Supplied air is available for emergency use. For some operations self contained breathing apparatus are used. When nonsecondarily-contained lines are opened, a portable ventilation duct is placed near the line. If trace tritium is released, the contamination will be swept to the TSTA stack. The TSTA HPT is always present when contaminated or possibly contaminated lines are opened. At times when releases to the room are possible, access to the tritium areas is restricted.

TSTA SAFETY REVIEWS AND ANALYSIS

An important goal of the TSTA project is the demonstration that the tritium systems for a fusion reactor can be operated safely with low personnel radiation exposures and no significant effect on the environment. Safety is a prime concern in all aspects of TSTA operation. During the design phase of TSTA, a Failure Modes and Effects Analysis (FMEA) was done for each system. Both a Preliminary Safety Analysis Report (PSAR) and a Safety Analysis Report (SAR) were completed (ref 4). These reports include a description of the systems, the operations and accident analysis. The SAR requires updating as the TSTA modes of operation and systems are significantly changed.

Independent review of the TSTA design and operations is required by Los Alamos National Laboratory and DOE. Table III lists the external TSTA reviews. Preparation for these appraisals has taken a considerable amount of time from the TSTA staff. The Technical Safety Appraisal (TSA), required approximately two man-years of preparation.

CONCLUSIONS

Safe and efficient operation of a tritium facility starts with proper system design and proceeds by good operating methods and procedures. The TSTA has demonstrated safe and efficient operations with tritium over its five years of tritium handling.

REFERENCES

1. J. L. Anderson and J. R. Bartlit, "Tritium Technology Studies at the Tritium Systems Test Assembly," Fusion Technology 10, 1329 (1986).

2. J. L. Anderson et. al., " Experience of TSTA Milestone Runs with 100 Grams-Level Tritium "Fusion Technology 14, 438 (1988) .

3. F. L. Kerstiens and R. C. Wilhelm, "Tritium Systems Test Assembly Quality Assurance Program," Los Alamos National Laboratory Report LA-10716-MS, (1986).

4. R. V. Carlson, "Safety Analysis Report for the Tritium Systems Test Assembly," Nuclear Technology Fusion 4, 545 (1983).

TSTA ORGANIZATION CHART - OPERATIONS

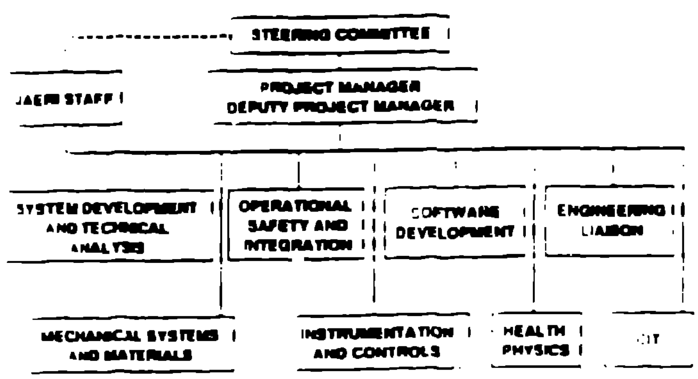

Figure 1

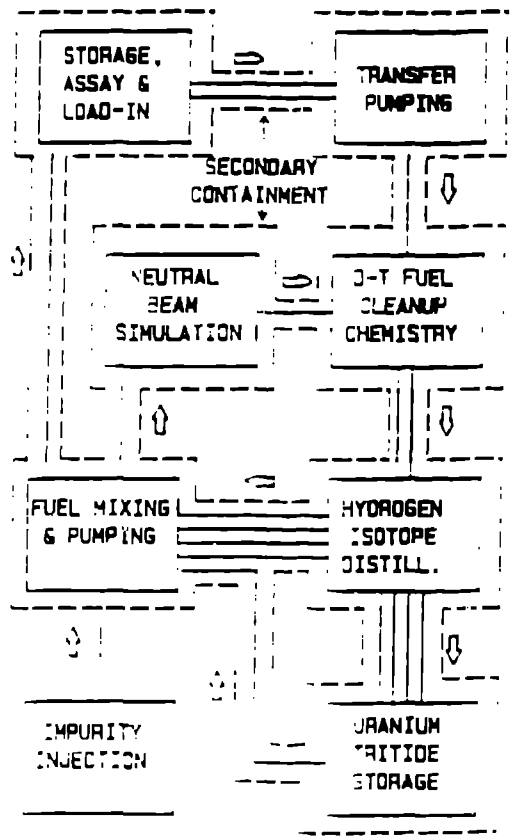

Figure 2. TSTA loop

MONTHLY TSTA STACK TRITIUM RELEASES

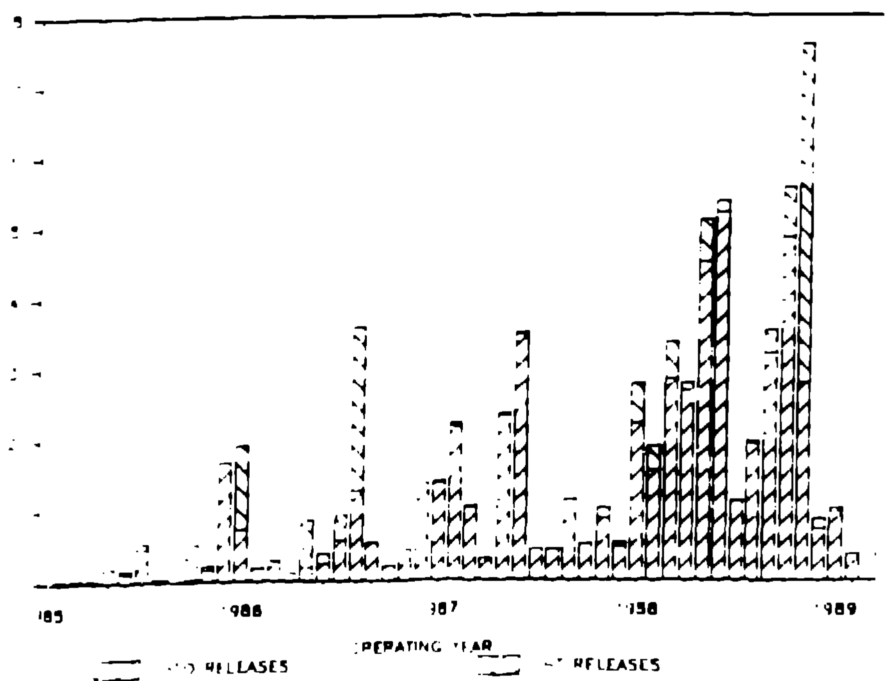

Figure 3

TABLE I

TSTA LOOP OPERATION EXPERIMENTS

Date	Length (days)	Process Systems used (remarks)
June, 1984	4	ISS/TPU/UTB
July, 1984	5	ISS/TPU/UTB
Januray, 1986	5	ISS/FCU/UTB
Januray, 1986	5	ISS/TPU/FCU/UTB
September, 1986	5	ISS/TPU/FCU/UTB
December, 1986	5	ISS/TPU/FCU/UTB
June, 1987	5	ISS/TPU/UTB (refrigerator failure)
July, 1987	5	ISS/TPU/UTB
October, 1987	6	ISS/TPU/UTB
December, 1987	6	ISS/TPU/UTB
February, 1988	1	ISS/TPU/FCU/IMS/UTB (cryogenic ISS plug)
February, 1988	1	ISS/TPU/FCU/IMS/UTB (cryogenic ISS plug)
February, 1988	5	ISS/TPU/FCU/IMS/UTB
April, 1988	5	ISS/TPU/UTB
May, 1988	7	ISS/TPU/FCU/IMS/VAC/UTB
July, 1988	4	ISS/TPU/FCU/IMS/UTB
November, 1988	7	ISS/TPU/NBI/IMS/UTB (cryogenic ISS plug)
January, 1989	7	ISS/TPU/NBI/IMS/UTB

TABLE II

TRITIATED WASTE GENERATED AT TSTA

Year	Volume (m^3) tritium (Curies)		
	Low level	Medium level	High level*
1985	7/0.2	0/0	0/0
1986	7/0.2	0.2/0.1	0.6/1300
1987	4/0.8	0.2/1.0	2.0/26000
1988	8.6/0.1	0.3/15	1.3/8000

*Low level <20 mCi/m^3

Medium level >20 Ci/m^3 and <100 Ci/m^3

High level >100 Ci/m^3

TABLE III

REVIEWS OF TSTA

Review	Date	Comments
Design review panel (10 technical experts)	1979-1983	Annual meetings to evaluate TSTA technical design
DOE Preoperational Inspection	1984	TSTA system evaluation by DOE/AL before tritium introduction into the system
Facility operations program review	June 1986	DOE/OFE review of all facility operations including safety
Fuel Cleanup preoperational inspection	1986	DOE/AL evaluation of the fuel cleanup system before tritium introduction
HSE-DIV appraisal	Feb. 1988	Annual facility evaluation of TSTA by LANL Health, Safety, and Environment Div.
Cryopump system preoperational inspection	May 1988	DOE/AL evaluation of the vacuum system before tritium introduction
DOE/LAAO Pre-TSA TSTA inspection	June 1988	
DOE/AL Technical Safety Appraisal	July 1988	DOE indepth appraisal of TSTA 15 people evaluating TSTA for [illegible] weeks
MST-DIV appraisal	Dec. 1988	Annual Material Science and Technology Division appraisal of TSTA
HSE-DIV appraisal	Mar. 1989	Annual facility evaluation of TSTA by LANL Health, Safety, and Environment Div.