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ABSTRACT

Operating procedures are important for the safe and efficient operation of the Tritium Systems Test Assembly (TSTA). TSTA has been operating for four years with tritium in a safe and efficient manner. The inventory of tritium in the process loop is 100 grams and several milestone runs have been completed. This paper describes the methods used to operate TSTA.

INTRODUCTION

The Tritium Systems Test Assembly (TSTA), located at the Los Alamos National Laboratory, is a prototype fusion reactor tritium fuel reprocessing system. It was built for the demonstration of tritium handling systems necessary for tritium-burning fusion reactors. The facility has been operating with tritium for approximately four years. The current inventory of tritium is approximately one hundred grams, with DOE approval for a maximum inventory of two hundred grams. Coordination of the varied operations and activities is important to assure both safety and effectiveness of the operations and the personnel working in the facility. In this paper we will describe how the TSTA facility is operated with respect to both personnel and operating procedures. The information presented will be of interest for other tritium facilities currently under construction for the fusion energy programs.

TSTA ORGANIZATION

Figure 1 shows the TSTA 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. Four JAERI personnel are assigned to TSTA for a one year, then replaced by four others. Operation of TSTA remains the responsibility of Los Alamos personnel.

The Steering committee is composed of two US and two Japanese personnel. They plan the major experimental programs. 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 26 TSTA personnel who are responsible for operation of TSTA, 11 professional staff, four Facility operators, three mechanical technicians, three electrical technicians, one Health Physics Technician (HPT) and four JAERI staff.

Actual daily operations are the responsibility of the Operational Safety and Integration Team. The daily operations are coordinated by the TSTA Facility Operators.

TSTA EXPERIMENTS AND SYSTEMS

There are varied experiments ongoing at TSTA. The primary goal of TSTA is the operation of the TSTA tritium process flow loop. This loop is used to simulate the fueling systems for a fusion reactor. This system is described in detail in ref. 1. Current status of TSTA is presented in ref. 2 at this meeting. The primary components of the loop are: transfer pumps for moving the DT gas through the system; a fuel cleanup system for the removal of impurities from the gas stream, a cryogenic isotope separation system for the separation of hydrogen isotopes in to streams of T_2, D_2 and DT; and a cryogenic vacuum pumping system for pumping a simulated torus.

The second type of experiments at TSTA are those involved with small scale nonloop experiments. These experiments are necessary for determining the design of components and testing of new components for the fuel processing loop. 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 electrolysis of tritiated water; a test of the tritium compatibility of a piezo electric valve; and measurements of catalyst conversion efficiency. Other experiments at TSTA involve testing of tritium contamination effects. In general, these experiments are done with personnel from other fusion energy programs from the US and foreign countries.

The loop experiments are controlled by a main process computer control and data acquisition system (MDAC). Nonloop experiments are controlled locally either through manual operations or a local computer.

There are safety systems to support the experiments. These are: a system to treat waste gases to remove tritium before the gases are released to the environment; a system to recover accidentally released tritium from the room air; tritium monitoring for room air and stack exhausts and emergency and uninterruptible power.

TSTA is a computer controlled system. Most interactions and control of the system are performed from the control room through the Man Machine Interface (MMI). Four system computer consoles are used to monitor any of the 200 system displays. In addition, there are several displays available to monitor historical data and current trends of any of the 550 analogue parameters. Safety systems such as the gaseous waste treatment system (TWT) and tritium monitoring system are automatically controlled by MDAC. Other systems are controlled by individual commands given by Facility Operators from the MMI. Alarms are displayed at the MMI for variables out of limit.

OPERATIONS

The operations ongoing at TSTA fall into two distinct operating modes, loop and nonloop 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 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. 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.

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 experiments. 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 analysis 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 offnormal or emergency situations, TSTA personnel whom 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 operating periods allow time for maintenance and repair, operation of the nonloop experiments, fabrication of process systems, 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 responsi ble for the work so that the Duty Operator can understand the implications and interaction 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 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 noted. This meeting also keeps all personnel TSTA 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 published. The report contains the following information: summary of the operations for the last week; unusual occurrences; tritium inventory, including both 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).

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 program. The program deals with the theory and operations of each of the TSTA systems. Training for each system is covered by a qualification card which has check spaces 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.

Visitor training and indoctrination are also important. 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.

QUALITY ASSURANCE PROGRAM

TSTA operates under a Quality Assurance (QA) program based on ASNI/ASME NQA-2 "Quality Assurance requirements for Nuclear Facilities". 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 (ref 3). 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 different appropriate people depending on the subject under review. When applicable, 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.

DOCUMENTATION AND PROCEDURES

Documentation is an important part of the TSTA operations. 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 plan; 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 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 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, the same 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) involving radia ion, liquid hydrogen and hazardous waste are approved in this manner. The Working with Tritium document requires external approval.

ALARA

Operations at TSTA are conducted within the ALARA (As Low As Reasonably Achievable) philosophy toward radiation. Personnel exposures are kept to a minimum. Total personnel exposure from the four years of tritium operations from TSTA operations are less than 200 person mrem. Exposures are determined with biweekly urine analysis. If exposures are higher than normal, project management meats 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 1500 dpm/100 cm^2 (dpm, disintegrations per minute). Guidelines at Los Alamos are, clean areas 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 1500 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 the four years of tritium operations have been approximately 34 Curies. Monthly releases during 1987 averaged 1.5 Curies. When releases greater than this occur, the cause is investigated.

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 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.

CONCLUSIONS

Safe and efficient operation of an tritium facility starts with proper system design and proceeds by good operating methods and procedures. The operations at TSTA are an example of how safe and efficient operations can be performed. Many of the procedures discussed in this paper can be of use to other tritium facilities.

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 and J. R. Bartlit, "Fusion Tritium Program in the United States," to be presented at this conference.

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

TSTA ORGANIZATION CHART - OPERATIONS

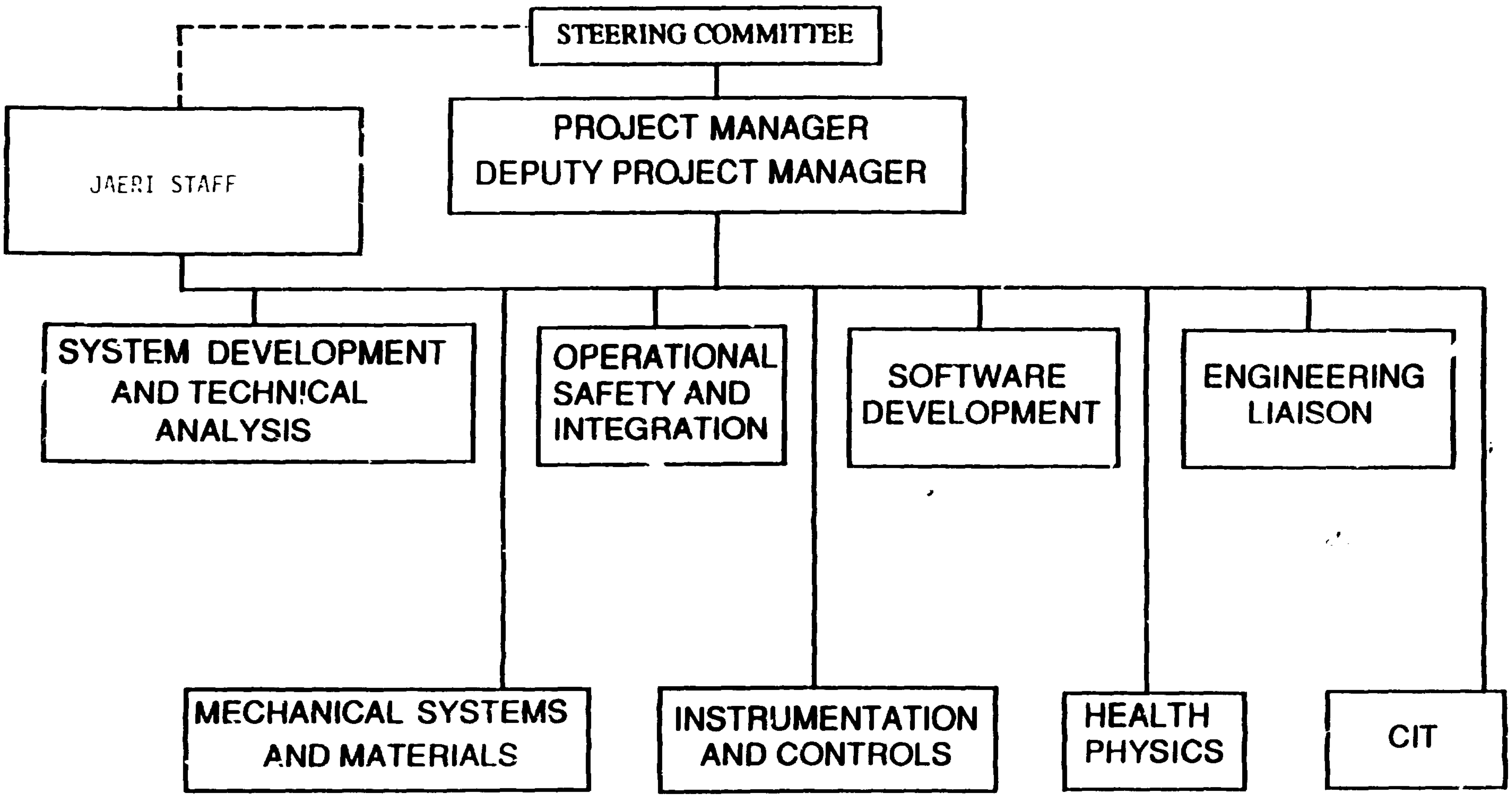

Figure 1 TSTA organization