LA-UR-80-175

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SUBMITTED TO: For presentation at the 8th International Conference on Plasma Physics and Controlled Nuclear Fusion Research to be held at Brussels, Belgium, July 1-10, 1980 sponsored by the International Atomic Energy Agency.

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*Work completed under the auspices of the U.S. Department of Energy

University of California

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Form No. 836 R3
St. No. 2629
1/78

UNITED STATES
DEPARTMENT OF ENERGY
CONTRACT W-7405-ENG. 36

THE DEVELOPMENT OF TRITIUM TECHNOLOGY FOR THE UNITED STATES MAGNETIC FUSION ENERGY PROGRAM[+]

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Tritium technology development for the DOE fusion program is taking place principally at three laboratories, Argonne National Laboratory, Los Alamos Scientific Laboratory, and Mound Facility. This paper will review the major aspects of each of the three programs and look at aspects of the tritium technology being developed at other Laboratories within the United States.

The tritium technology development program at Mound has two principal components. First in a Tritium Effluent Control Laboratory (TECL) which is an ongoing program to develop methods for reducing both airborne and aqueous tritium effluents from tritium handling facilities. This includes studies of improved tritium containment methods, of glovebox and room atmosphere detritiation systems, and most recently, of water detritiation by a combination of electrolysis and catalyzed chemical exchange. The TECL also includes a cryogenic distillation system for hydrogen isotopes separation and a capability for controlled tritium release experiments. The second major project at Mound is the design and construction of the Tritium Storage and Delivery System (TSDS) for the Tokamak Fusion Test Reactor (TFTR). TSDS will have a tritium inventory of approximately 7.5 grams, which will be stored on uranium beds. Tritium is supplied as needed to the reactor by heating one of the uranium beds to fill a metering volume which, in turn, supplies the injection valves. A quadrupole mass analyzer is included in TSDS to permit rapid determination of the purity of the tritium. The TSDS, which will be completed in mid-1980, will be capable of storing and supplying measured amounts of pure tritium to fuel the TFTR. Mound is also training TFTR technicians to safely operate TSDS and other TFTR tritium systems.

The program on fusion reactor research at the Argonne National Laboratory (ANL) includes a number of applied research topics covering a variety of interrelated areas of fusion tritium technology. The principal focus of this work is on studies of fuel handling, breeder-blanket processing, and tritium containment. These studies are both experimental and analytical in character and have in recent years, spearheaded technological advances in a number of important fusion-specific areas. For example, the continuing fusion reactor fuel cycle systems analyses, conducted at ANL since the mid 1970's, have contributed to the basis for the large-scale fuel cycle test facility at the Los Alamos Scientific Laboratory. Chemical methods for tritium extraction and impurity control in flowing liquid lithium

[+]This work is supported by the Office of Fusion Energy US Department of Energy

systems have been developed and tested successfully on a meaningful scale. In the fusion materials chemistry area, hydrogen permeation characteristics of the more promising classes of fusion-reactor structural materials have been examined for a wide range of temperatures, hydrogen activities, and material surface conditions. Several unique concepts for increasing tritium-permeation resistance have evolved from these latter studies. During the past year, the scope of work in these areas has been expanded to include analytical and developmental studies on solid tritium breeding materials.

The Tritium Systems Test Assembly (TSTA) is dedicated to the development, demonstration, and interfacing of technologies related to the deuterium-tritium (DT) fuel cycle for fusion reactor systems. The first such reactor system to be built might be the Engineering Test Facility (ETF) or the International Tokamak Reactor (INTOR). The ETF would be followed by an Engineering Prototype Reactor (EPR) and later a Demonstration Reactor (DEMO), which would produce net electricity to be supplied to the commercial power grid. These later reactors will build and expand on the tritium handling system designed for ETF or INTOR. The Los Alamos Scientific Laboratory (LASL) plans to design, fabricate, construct, test and bring the Tritium Systems Test Assembly into operation by the end of 1981. LASL will then operate TSTA for several years thus gaining data on the efficiency, adequacy, reliability and availability of the components and subsystems at TSTA before the final design of an ETF or INTOR tritium handling facility is chosen.

The principal program objectives for TSTA are:

- To develop and demonstrate the fuel cycle for fusion power reactors;
- To develop and test environmental and personnel protective systems;
- To develop, test, and qualify equipment for tritium service;
- To provide a final demonstration facility that could be directly copied for a D-T burning fusion machine;
- To demonstrate long-term reliability of components;
- To demonstrate long-term safe handling of tritium with no major releases or incidents; and
- To investigate and evaluate the response of the fuel cycle and environmental packages to normal, off-normal, and emergency situations.

The TSTA will consist of a large gas loop, which can simulate the proposed fuel cycle for a fusion facility. The gas loop will be designed to handle up to 360 gram moles per day DT. This flow will provide cycle operating experience on a scale that is equal to or greater than the full scale fuel cycles currently being addressed for ETF and INTOR systems. Included in the process loop are systems to evaluate vacuum pumps, chemical impurity removal from the exhaust gas, hydrogen isotope separation, fuel injection, gas circulation pumps and interfaces with neutral beam and breeding blanket extraction systems. To accomplish this at TSTA will require an onsite tritium inventory of approximately 200g.