Nuclear Blanket And Shielding Problems In Demonstration

A theoretical study was made of the blanket that must surround a thermonuclear plasma to provide energy conversion and removal, neutron and gamma-ray shielding, and regeneration of the tritium burned in the D-T reaction. Power distributions and heat transfer were calculated and materials problems analyzed for blanket assemblies that A.J. Impink, Jr. has shown are capable of tritium regeneration. The blanket arrangement chosen as a model consisted of a molybdenum vacuum wall in the form of a long cylindrical shell, cooled by fused Li2BeF4 and surrounded by an annulus, 55 cm thick, consisting of fused Li2BeF4 and graphite to channel the flow of coolant. Nuclear heating was calculated on a digital computer for neutron flux distributions calculated by Impink. In vacuum walls of 1, 2, and 3 cm of molybdenum, 16, 25, and 31%, respectively, of the D-T neutron energy are absorbed. The total heat liberated in the inner blanket is 17.5 Mev per fusion. The absorption of secondary gamma rays accounts for half of the total heating and almost all of the heating of the vacuum wall. Heat transfer and thermal

stress limit the thermonuclear power to 400-500 watts/sq. cm of neutron energy incident on the molybdenum first wall, which is 2 cm thick.

The Department of Energy (DOE) Office of Fusion Energy (OFE) and the Division of Reactor Research and Technology (DRRT) jointly sponsored the development of a coupled fine-group cross section library. This 171-neutron, 36-gamma-ray group library was based upon ENDF/B-IV and was intended to be applicable to fusion reactor neutronics and LMFBR core and shield analysis. Versions of the library are available from the Radiation Shielding Information Center (RSIC) at the Oak Ridge National Laboratory in both AMPX and CCCC formats. Computer codes for energy group collapsing, interpolation on Bondarenko factors for resonance self-shielding and temperture corrections, and various other useful data manipulations are also available. The experience gained in the generation, validation and utilization of this library along with its broad range of applicability has led to the request for updating this data set using ENDF/B-V. Additional support in this regard has been provided by the Defense Nuclear Agency (DNA) and by the Electric Power Research

Institute (EPRI) in support of weapons analyses and light water reactor shielding and dosimetry problems, respectively. The purpose of the report is to provide detailed specifications and rationale for the proposed ENDF/B-V update (designated VITAMIN-E) to the VITAMIN-C library.

ITER (International Thermonuclear Experimental Reactor) Shield and Blanket Work Package Report

Proceedings of the 8th Symposium on Engineering Problems of Fusion Research

A Journal of the American Nuclear Society and the European Nuclear Society

Fusion Reactor Blanket/shield Design Study

Fusión Nuclear

Thermal Design of Nuclear Reactors

With the strong commitment of the US to the success of the ITER burning plasma mission, and the project overall, it is prudent to consider how to take the most advantage of this investment. The production of energy from fusion has been a long sought goal, and the subject of several programmatic investigations and time line proposals [1]. The nuclear aspects of fusion research have largely been avoided experimentally for practical reasons, resulting in a strong emphasis on plasma

science. Meanwhile, ITER has brought into focus how the interface between the plasma and engineering/technology, presents the most challenging problems for design. In fact, this situation is becoming the rule and no longer the exception. ITER will demonstrate the deposition of 0.5 GW of neutron heating to the blanket, deliver a heat load of 10-20 MW/m2 or more on the divertor, inject 50-100 MW of heating power to the plasma, all at the expected size scale of a power plant. However, in spite of this, and a number of other technologies relevant power plant, ITER will provide a low neutron exposure compared to the levels expected to a fusion power plant, and will purchase its tritium entirely from world reserves accumulated from decades of CANDU reactor operations. Such a decision for ITER is technically well founded, allowing the use of conventional materials and water coolant, avoiding the thick tritium breeding blankets required for tritium self-sufficiency, and allowing the concentration on burning plasma and plasma-engineering interface issues. The neutron fluence experienced in ITER over its entire lifetime will be ?0.3 MW-yr/m2, while a fusion power plant is expected to experience 120-180 MW-yr/m2 over its lifetime. ITER utilizes shielding blanket modules, with no tritium breeding, except in test blanket modules (TBM) located in 3 ports on the midplane [2], which will provide early tests of the fusion nuclear environment with very low tritium production (a few g per year).

Nuclear Reactor Shielding
ERDA Research Abstracts
ERDA.
Neutron Blanket Calculations for Thermonuclear Reactors, II
Fundamentals of Its Utilization for Energy Supply

A description of the EBR-II shield and the methods employed in arriving at the final design are presented. The major shield design problems for that reactor are enumerated and discussed.

A joint study of tokamak reactor first-wall/blanket/shield technology was conducted by Argonne National Laboratory (ANL) and McDonnell Douglas Astronautics Company (MDAC). The objectives of this program were the identification of key technological limitations for various tritium-breeding-blanket design concepts, establishment of a basis for assessment and comparison of the design features of each concept, and development of optimized blanket designs. The approach used involved a review of previously proposed blanket designs, analysis of critical technological problems and design features associated with each of the blanket concepts, and a detailed evaluation of the most tractable design concepts. Tritium-breeding-blanket concepts were

evaluated according to the proposed coolant. The ANL effort concentrated on evaluation of lithium- and water-cooled blanket designs while the MDAC effort focused on helium- and molten salt-cooled designs. A joint effort was undertaken to provide a consistent set of materials property data used for analysis of all blanket concepts. Generalized nuclear analysis of the tritium breeding performance, an analysis of tritium breeding requirements, and a first-wall stress analysis were conducted as part of the study. The impact of coolant selection on the mechanical design of a tokamak reactor was evaluated. Reference blanket designs utilizing the four candidate coolants are presented.

An ENDF/B-V Multigroup Cross-section Library for LMFBR Core and Shield, LWR Shield, Dosimetry and Fusion Blanket Technology

Energy Research Abstracts

Erice-Trapani (Sicily), September 9th-20th, 1974

Journal of the British Nuclear Energy Society

Pulsed Fusion Reactors

An up-to-date reference and text that discusses the design of shields for radioactive sources, X-ray machines, low energy accelerators, and nuclear *reactors. Introduces dosimetry in industry and medicine, examining the prediction and measurement of dose in the body from external and internal sources, and the biological effects of ionization radiation. The unified treatment emphasizes recent practice and includes modern computer methods and results. And, the considerable data presented in tabular and graphical forms provide a ready reference that minimizes the need for supplementary literature.*

This report summarizes nuclear-related work in support of the US effort for the International Thermonuclear Experimental Reactor (ITER) Study. The purpose of this work was to prepare for the first international ITER workshop devoted to defining a basic ITER concept that will serve as a basis for an indepth conceptual design activity over the next 2-1/2 years. Primary tasks carried out during the past year included: design improvements of the inboard shield developed for the TIBER concept, scoping studies of a variety of tritium breeding blanket options, development of necessary design guidelines and evaluation criteria for the blanket options, further safety considerations related to nuclear components and issues regarding structural materials for an ITER device. 44 refs., 31 figs., 29 tabs.

Soviet Atomic Energy

Thermal Design of Nuclear Reactors

Experimental Breeder Reactor-II (EBR-II) Shield Design
Index
Proceedings of the Topical Meeting on the Technology of Controlled Nuclear Fusion

This paper summarizes nuclear-related work in support of the US effort for the International Thermonuclear Experimental Reactor (ITER) Study. Primary tasks carried out during the past year include design improvements of the inboard shield developed for the TIBER concept, scoping studies of a variety of tritium breeding blanket options, development of necessary design guidelines and evaluation criteria for the blanket options, further safety considerations related to nuclear components, and issues regarding structural materials for an ITER device. The blanket concepts considered are the aqueous/Li salt solution, a water-cooled, solid breeder blanket, a helium-cooled, solid-breeder blanket, a blanket cooled by helium containing lithium-bearing particulates, and a blanket concept based on breeding tritium from He3. 1 ref., 2 tabs.
Treats not only the physical, but the technological, ecological, and economic basis for using controlled nuclear fusion to produce energy. Topics on the development of fusion are examined without reference to the currently favored magnetic confinement and tokamak lines of fusion research except where problems are specific to them, in the case of a tokamak with deuterium-tritium plasma, for example. Discusses other less developed but potentially promising concepts for the future production of

powerful neutron sources.

Thermal and chemical aspects of the thermonuclear blanket problem

ERDA Energy Research Abstracts

Fusion Nuclear Science Pathways Assessment

INIS Atomindeks

Proceedings of the magnetic fusion energy blanket & shield workshop

The blanket and shield assemblies of fusion reactors will contain a significant number of very sizable penetrations (neutral beam injection ducts, pumping ports, etc.). The combination of high-energy neutrons and large penetrations will introduce severe design problems that are quite different from those encountered previously. Fusion reactors with their penetrations are very complex geometric structures and in calculating nuclear effects (heating, activation, etc.) tradeoffs must be made between computing efficiency and the accuracy in the geometric modeling. The types of problems that arise due to large penetrations will be illustrated by the calculations that have been carried out to aid in the design of the shielding for the neutral beam injectors of the Tokamak Fusion Test Reactor being built at Princeton University.

US ITER (International Thermonuclear Experimental Reactor) Shield and Blanket Design Activities

Proceedings

Inventory of Current Energy Research and Development

Euro Abstracts

Radiation Shielding and Dosimetry