ORNL-TM-3857

FAST REACTOR SHIELDING MONTHLY PROGRESS REPORT FOR APRIL 1972,

189a No. 10028, Activity No. 40 01 61

OAK RIDGE NATIONAL LABORATORY
OPERATED BY UNION CARBIDE CORPORATION • FOR THE U.S. ATOMIC ENERGY COMMISSION

ORNL-TM- 3857

Contract No. W-7405-eng-26

Neutron Physics Division

FAST REACTOR SHIELDING MONTHLY PROGRESS REPORT FOR APRIL 1972, 189a No. 10028, Activity No. 40 01 61

Report Written By:

F. R. Mynatt
M. L. Gritzner
R. E. Maerker
B. J. McGregor

Work Done By:

R. M. Freestone, Jr.
M. L. Gritzner
K. M. Henry, Jr.
J. L. Hull
J. Lewin
R. E. Maerker
J. J. Manning
B. J. McGregor
J. N. Money
F. J. Muckenthaler
F. R. Mynatt
L. R. Williams

JUNE 1972

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37830
operated by
Union Carbide Corporation
for the
U. S. ATOMIC ENERGY COMMISSION

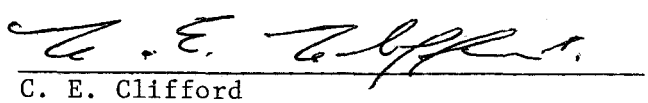
Monthly Progress Report

April 1972

FAST REACTOR SHIELDING

Activity No. 40 01 61
189a No. 10028

Approved by:

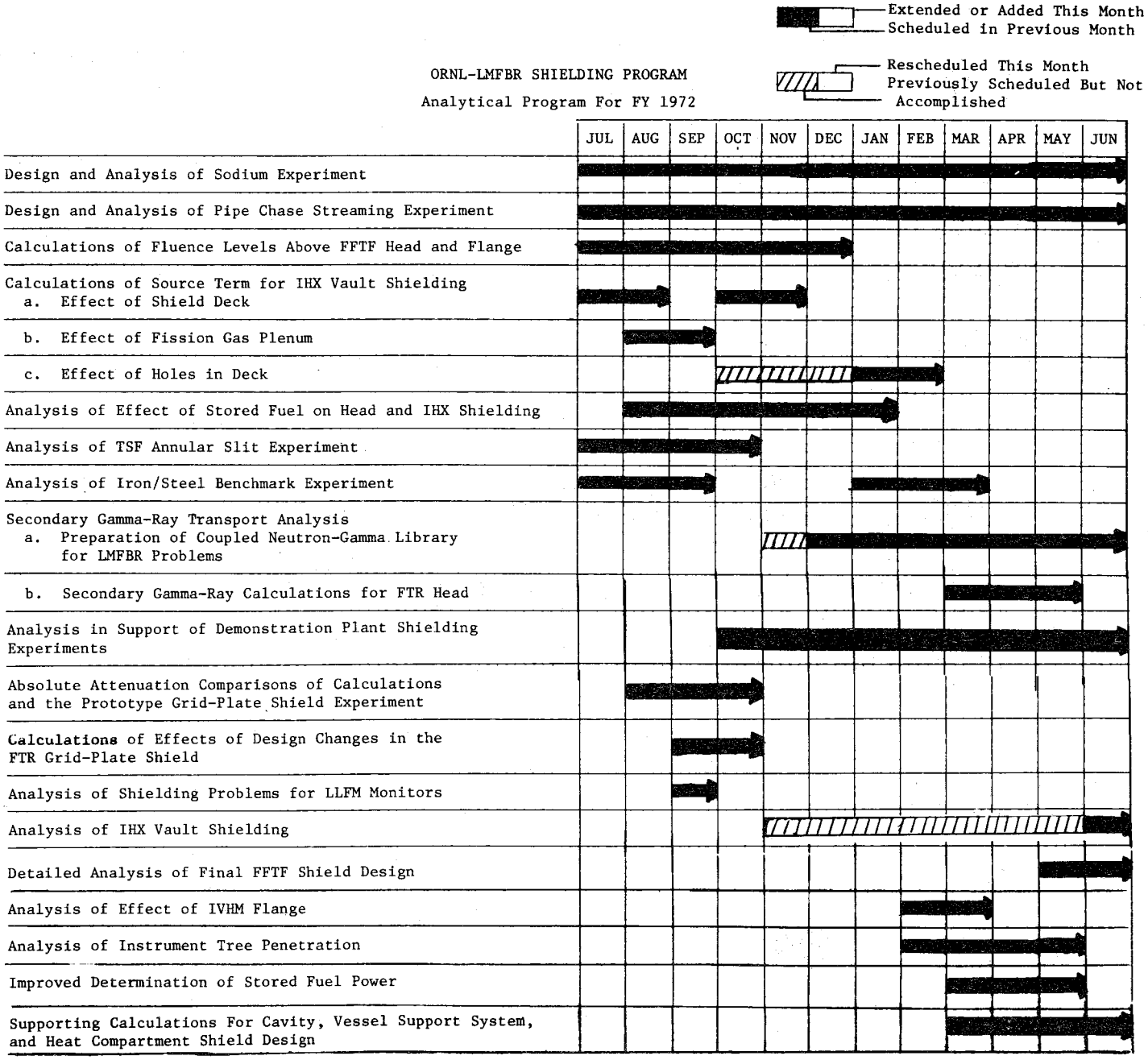


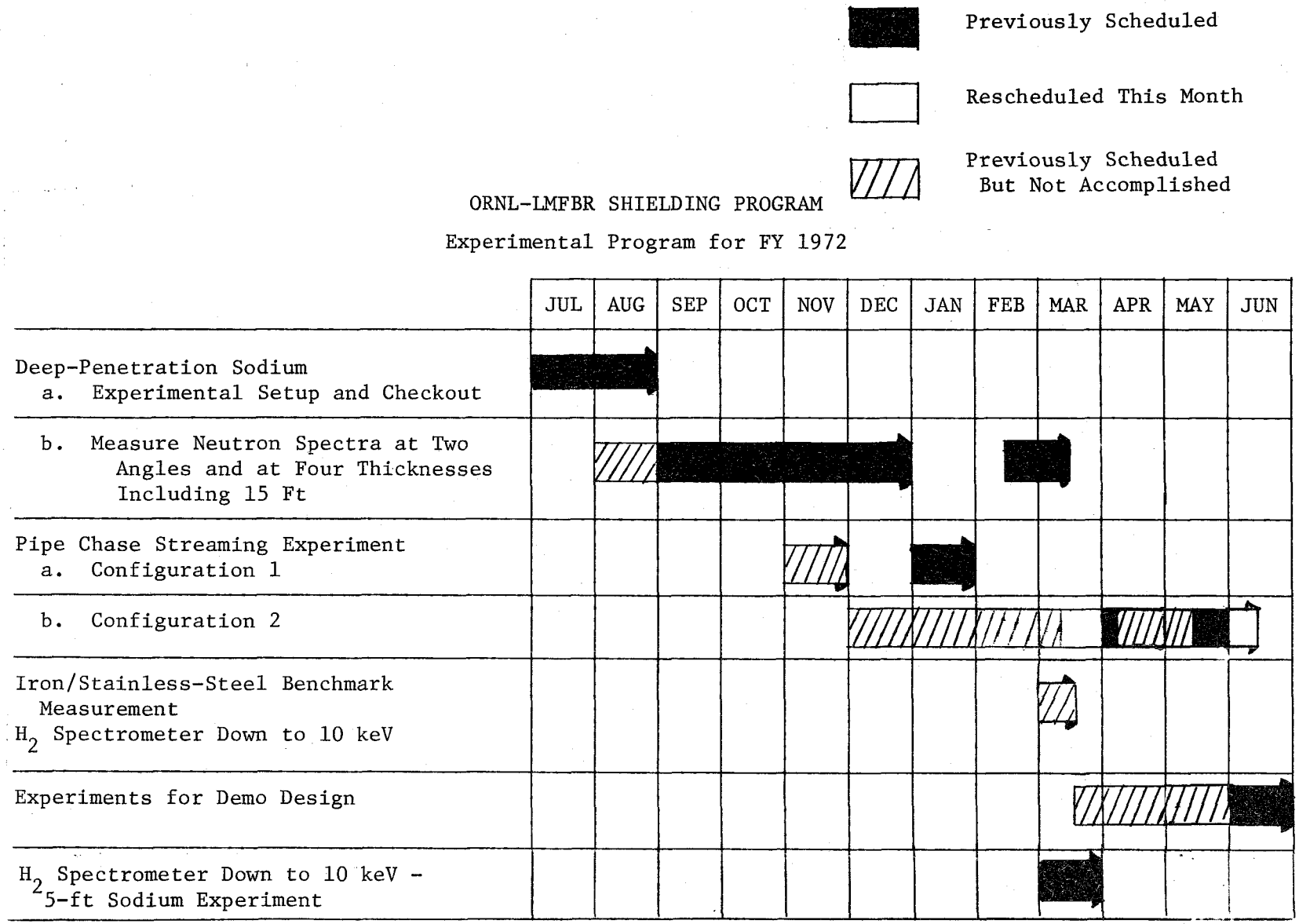
C. E. Clifford
Associate Director
Reactor and Weapons Radiation Shielding
Neutron Physics Division

TABLE OF CONTENTS

Abstract

This report summarizes the progress made by the ORNL Neutron Physics Division in Fast Reactor Shielding Research during the month of April 1972.


Extended or Added This Month
Scheduled in Previous Month
Rescheduled This Month
Previously Scheduled But Not Accomplished
ORNL-LMFBR SHIELDING PROGRAM
Analytical Program For FY 1972
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
Design and Analysis of Sodium Experiment
Design and Analysis of Pipe Chase Streaming Experiment
Calculations of Fluence Levels Above FFTF Head and Flange
Calculations of Source Term for IHX Vault Shielding
a. Effect of Shield Deck
b. Effect of Fission Gas Plenum
c. Effect of Holes in Deck
Analysis of Effect of Stored Fuel on Head and IHX Shielding
Analysis of TSF Annular Slit Experiment
Analysis of Iron/Steel Benchmark Experiment
Secondary Gamma-Ray Transport Analysis
a. Preparation of Coupled Neutron-Gamma Library for LMFBR Problems
b. Secondary Gamma-Ray Calculations for FTR Head
Analysis in Support of Demonstration Plant Shielding Experiments
Absolute Attenuation Comparisons of Calculations and the Prototype Grid-Plate Shield Experiment
Calculations of Effects of Design Changes in the FTR Grid-Plate Shield
Analysis of Shielding Problems for LLFM Monitors
Analysis of IHX Vault Shielding
Detailed Analysis of Final FFTF Shield Design
Analysis of Effect of IVHM Flange
Analysis of Instrument Tree Penetration
Improved Determination of Stored Fuel Power
Supporting Calculations For Cavity, Vessel Support System, and Heat Compartment Shield Design


Previously Scheduled
Rescheduled This Month
Previously Scheduled But Not Accomplished
ORNL-LMFBR SHIELDING PROGRAM
Experimental Program for FY 1972
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
Deep-Penetration Sodium
a. Experimental Setup and Checkout
b. Measure Neutron Spectra at Two Angles and at Four Thicknesses Including 15 Ft
Pipe Chase Streaming Experiment
a. Configuration 1
b. Configuration 2
Iron/Stainless-Steel Benchmark Measurement
H2 Spectrometer Down to 10 keV
Experiments for Demo Design
H2 Spectrometer Down to 10 keV - 5-ft Sodium Experiment

A. Current FFTF Studies

Several of the DOT calculations for the cavity shield deck and vessel support system were performed during April but reported in the March monthly progress report for the sake of completeness. The remaining effort during April was devoted to several new calculations which should be completed during May.

1. Stored Fuel Power

The head compartment neutron dose level is at present directly proportional to the stored fuel fission power, and the uncertainty factor of five which has been associated with the two-dimensional approximation in the stored fuel power calculation is the largest single uncertainty in this problem. A series of calculations was initiated in order to obtain a three-dimensional solution which would eliminate any ambiguity with the buckling approximation. The primary three-dimensional calculation is to be obtained with the DOT-DOMINO-MORSE coupled technique. A DOT 50-group S_6, P_1 full reactor r-z calculation is to be used to obtain an internal angular flux distribution on a vertical surface just outside the core barrel. A three-dimensional MORSE adjoint Monte Carlo calculation will be performed for the zone from the core barrel to the vessel including the three stored fuel arrays. Each fuel subassembly in the stored fuel is represented by a homogenized cylinder. The DOMINO coupling program is to be used to couple the adjoint MORSE calculation with the DOT angular fluxes, thus giving the stored fuel power. As a backup calculation, DOT forward and adjoint calculations will be performed for a cylindrical representation of a single stored fuel array containing 22 fuel subassemblies. These calculations will be coupled in various

fashions with the full r-z reactor calculation to approximate the three-dimensional calculation. The results from the advanced stored fuel calculations should be available during May.

2. Analysis of Head Compartment Shield Concept

During the latter part of April, ORNL was advised by ARD that calculations of a head compartment shield concept were desirable to aid in the decision of whether to pursue the cavity shield concept. Preparations were begun for a sequence of DOT calculations for a reactor configuration having no cavity shield or vessel support system shield and having a head compartment shield consisting of 9 in. of SA-508 steel above 6 in. of polyethylene shaped as a cylindrical box elevated 21 in. over the reactor cover. The objective of the calculations is to determine the neutron and secondary gamma-ray dose distributions above the head compartment shield and to determine the maximum activation rate for Mn and Co in the cover. These calculations will be completed in May.

B. Analysis of Pipe Chase Experiment

A draft report has been prepared on the calculations of the first phase of this experiment as reported in the previous monthly, pages 25-29, and work is proceeding on the next phase which is the calculation of the current TSF setup which is the IHX isolation valve cavity simulation (see December 1971 monthly, ORNL-TM-3695, Fig. 15). In this series of experiments the TSF beam strikes the wall of a steel-lined concrete room which contains the pipe assembly used in the first part of the experiment. Measurements will be performed within the cavity and at the exit face of the pipe assembly penetration.

The calculations will be performed in two stages. The first stage will be the calculation of the transport in the cavity which defines the angular flux at the pipe penetration location. The second stage will be the calculation of transport through and beyond the pipe assembly.

The effects of geometry are being checked by comparison between DOT and AMC, a three-dimensional albedo Monte Carlo code, for a similar concrete cavity without the steel lining. DOT calculations have been made in the cavity with a symmetric S-12 (96 angles) quadrature set. Preliminary indications are that this quadrature set adequately defines the angular flux source term at the pipe entrance but spurious peaks and valleys are evident in the scalar flux in the plenum due to ray effects. A one-iteration restart with the S-380 quadrature adequately smoothed out the ray effects. In general, the DOT and AMC results are in good agreement. These comparisons are continuing.

A number of five energy group cross-section sets and a 14-energy-group set have been prepared in order to experiment with few-group DOT

calculations of streaming in the cavity and pipe chase. The code to change an angular flux tape generated over a large circular surface to one over a smaller off-center circular surface and a different quadrature set is in the testing stage.

C. TSF Experiments

The TSR-II reactor has been inoperative from April 14 through May 16, which was beyond the end of this reporting period,due to a malfunction in a control rod drive mechanism in the center of the core. Prior to the shutdown, proton recoil neutron spectra measurements were made for the 5-ft sodium tank setup using the new hydrogen counter system with pulse shape discrimination. After the TSR-II shutdown, the new hydrogen counter system was further tested by measuring transmission from iron slabs under the TSF-SNAP reactor. Both of these configurations have previously been studied with the older hydrogen counter system and the objective of the new measurements is to check by comparisons with the older data.

INTERNAL DISTRIBUTION

1-3. L. S. Abbott
4. J. L. Anderson
5. A. R. Buhl
6. G. T. Chapman
7-11. C. E. Clifford
12. M. L. Gritzner
13. W. O. Harms
14. L. B. Holland
15. W. E. Kinney
16. R. E. Maerker
17. F. C. Maienschein
18-19. B. J. McGregor
20. F. J. Muckenthaler
21. F. R. Mynatt
22. E. M. Oblow
23. F. G. Perey
24. W. A. Rhoades
25. R. T. Santoro
26. H. E. Seagren
27. A. H. Snell
28. D. B. Trauger
29. D. K. Trubey
30. G. E. Whitesides
31. H. Feshbach (consultant)
32. H. Goldstein (consultant)
33. C. R. Mehl (consultant)
34. H. T. Motz (consultant)
35-36. Central Research Library
37. ORNL Y-12 Technical Library Document Reference Section
38-40. Laboratory Records
41. Laboratory Records ORNL RC
42. ORNL Patent Office

EXTERNAL DISTRIBUTION

43. R. Avery, Director, Applied Physics Division, Argonne National Laboratory, 9700 S. Cass. Ave., Argonne, Ill. 60439
44. R. Balent, Vice President, Power Systems Programs, Atomics International, P. O. Box 309, Canoga Park, Calif. 91304
45. W. L. Bunch, Radiation & Shield Analysis, WADCO, P. O. Box 1970, Richland, Wash. 99352
46-47. E. G. Case, Director, Division of Reactor Standards, U. S. Atomic Energy Commission, Washington, D. C. 20545
48. R. J. Creagan, Manager, LMFBR Project, Advanced Reactor Division, Westinghouse Electric Corp., Waltz Mill Site, P. O. Box 158, Madison, Pa. 15663
49. J. B. Dee, Head, GCFBRReactor Engineering, Gulf General Atomic, P. O. Box 608, San Diego, Calif. 92112
50. M. W. Dyos, Westinghouse Electric Corp., Waltz Mill Site, P. O. Box 158, Madison, Pa. 15663
51. R. Ehrlich, Manager, Advanced Development Activity, Knolls Atomic Power Laboratory, General Electric, P. O. Box 1072, Schenectady, N. Y. 12301
52. L. F. Fidrych, Manager, Design Engineering, Breeder Reactor Development Operation, General Electric, 310 DeGuigne Drive, Sunnyvale, Calif. 94086
53. P. F. Fox, Westinghouse Electric Corp., Advanced Reactor Division, Waltz Mill Site, P. O. Box 158, Madison, Pa. 15663
54. J. G. Gallagher, Deputy Manager, Engineering, WADCO, P. O. Box 1970, Richland, Wash. 99352
55. S. A. W. Gerstl, Argonne National Laboratory, 9700 S. Cass Ave., Argonne, Ill. 60439
56. P. Greebler, General Electric Co., Breeder Reactor Development Operation, 310 DeGuigne Drive, Sunnyvale, Calif. 94086

57. W. H. Hannum, Division of Reactor Development and Technology, U. S. Atomic Energy Commission, Washington, D. C. 20545
58. P. B. Hemmig, Division of Reactor Development and Technology, U. S. Atomic Energy Commission, Washington, D. C. 20545
59. P. L. Havenstein, Chief, Instrumentation and Control Branch, U. S. Atomic Energy Commission, Washington, D. C. 20545
60. P. L. Hofmann, Manager, Systems Analysis, WADCO, P. O. Box 1970, Richland, Wash. 99352
61. E. E. Kintner, Division of Reactor Development and Technology, U. S. Atomic Energy Commission, Washington, D. C. 20545
62. H. T. Knight, Manager, Engineering Development Laboratory, WADCO, P. O. Box 1970, Richland, Wash. 99352
63. K. O. Laughon, USAEC Site Representative, ORNL
64. J. W. Lewellen, Division of Reactor Development and Technology, U. S. Atomic Energy Commission, Washington, D. C. 20545
65. W. B. Loewenstein, Argonne National Laboratory, 9700 S. Cass Ave., Argonne, Ill. 60440
66. C. P. McCallum, Division of Space Nuclear Systems, U. S. Atomic Energy Commission, Washington, D. C. 20545
67-69. P. A. Morris, Director, Division of Reactor Licensing, U. S. Atomic Energy Commission, Washington, D. C. 20545
70. T. E. Murley, Division of Reactor Development and Technology, U. S. Atomic Energy Commission, Washington, D. C. 20545
71. R. C. Paquette, Westinghouse Electric, Advanced Reactor Division, Waltz Mill Site, P. O. Box 158, Madison, Pa. 15663
72. T. A. Pitterle, Westinghouse Electric Corp., Advanced Reactor Division, Waltz Mill Site, P. O. Box 158, Madison, Pa. 15663
73. D. R. Riley, Chief, Core Design Branch, Division of Reactor Development and Technology, U. S. Atomic Energy Commission, Washington, D. C. 20545
74. T. Rockwell, MPR Associates, Inc., 1140 Connecticut Ave. NW, Washington, D. C. 20036
75. W. J. Rowan, Westinghouse Electric Corp., Advanced Reactor Division, Waltz Mill Site, P. O. Box 158, Madison, Pa. 15663
76. E. E. Sinclair, Division of Reactor Development and Technology, U. S. Atomic Energy Commission, Washington, D. C. 20545
77. E. R. Specht, Atomics International, P. O. Box 309, Canoga Park, Calif. 91304
78. D. C. Spencer, Westinghouse Electric Corp., Advanced Reactor Division, Waltz Mill Site, P. O. Box 158, Madison, Pa. 15663
79. D. G. Stenstrom, Argonne National Laboratory, 9700 S. Cass Ave., Argonne, Ill. 60440
80. M. L. Weiss, General Electric Co., Breeder Reactor Development Operation, 310 DeGuigne Drive, Sunnyvale, Calif. 94086
81-82. Technical Information Center (TIC)
83-84. Research and Technical Support Division