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1961 WINTER MEETING  
NOVEMBER 7-9

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**TRANSACTIONS OF THE  
AMERICAN NUCLEAR SOCIETY**

**1961 WINTER MEETING**

**Chicago, Illinois**

**November 7-9, 1961**

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The Transactions are summaries of the technical  
papers presented at the national meetings

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**86 E. Randolph Street**  
**Chicago 1, Illinois**

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# AMERICAN NUCLEAR SOCIETY

86 East Randolph Street  
Chicago 1, Illinois

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<i>Student Program:</i> Ray C. Barral (ARF)	<i>Ladies Program:</i> Mrs. J. L. Kuranz
<i>Finance:</i> Ira G. Dillon (ANL)	<i>Treasurer:</i> Delbert M. Leppke (PS&E)
<i>Tours &amp; Visits:</i> Douglas Ericson (USAEC)	<i>Registration:</i> Charles W. Terrell (ARF)
<i>Banquet, Refections:</i> Herbert C. Hoff (COM-ED)	<i>Convention Secretary:</i> Richard R. Quinn (N-C)

# TECHNICAL SESSIONS

## SPECIAL SESSIONS

### (INVITED PAPERS)

**Session 1** **Tuesday, November 7**  
Normandie Lounge

#### DISTINGUISHED LECTURER'S ADDRESS

Chairman: *W. B. Lewis (AECL)*

2:00 Atomic Energy in the Indian Economy, *H. J. Bhabha, Chairman, Indian AEC*

**Session 2** **Thursday, November 9**  
Waldorf Room

#### Special Session

#### RADIOACTIVITY IN THE ATMOSPHERE

Chairman: *J. Moteff (GE-NMPO)*

9:00 to 12:00 Several experts will present papers on measurements of radioactivity in the atmosphere.

**Session 3** **Wednesday, November 8**  
Waldorf Room

#### Special Session

#### RECENT ADVANCES IN SPENT REACTOR FUEL PROCESSING

Chairman: *R. C. Vogel (ANL)*

- 9:00 1 The Salt Cycle Process Concept, *K. M. Harmon (GE-HAPO)*
- 2 Fluoride Volatility Processing of Low Enriched Fuels, *A. A. Jonke, J. Fischer, W. Meham (ANL)*
- to 3 Fluoride Volatility Processing of High-Enrichment Uranium Fuels, *G. I. Cathers (ORNL)*
- 4 Recent Advances in Aqueous Processing, *R. E. Blanco (ORNL)*
- 12:00 5 Recent Advances in Pyrometallurgical Processes, *L. Burris, Jr., M. Levenson, J. H. Schraidt, R. K. Steunenberg (ANL)*

**Session 4** **Cancelled**

**Session 5** **Tuesday, November 7**  
Lower Tower

#### Special Session

#### REACTOR STRUCTURAL MATERIALS

Chairman: *K. Anderson (KAPL)*

- 9:00 1 Review of Selected Physical and Mechanical Properties of Zircaloy-2, *A. R. Kephart (KAPL)*
- 2 Corrosion of Aluminum in Reactor Service, *J. E. Draley, W. E. Ruther (ANL)*
- 3 Magnetic Properties of Irradiated SA 212-B Pressure Vessel Steel, *N. Balai, R. J. K. Bloch (ANL)*
- to 4 Nickel-Chromium-Iron Alloy—Its Application to Large Power Generating Equipment. A Summary of Engineering Data, *W. L. Fleischmann (KAPL)*
- 12:00 5 Structural Materials for Molten-Salt Reactor Systems, *J. H. DeVan (ORNL)*

**Session 6** **Tuesday, November 7**  
Waldorf Room

#### Special Session

#### APPLICATION OF CRITICAL EXPERIMENT INFORMATION TO DESIGN

Chairman: *B. I. Spinrad (ANL)*

- 9:00 1 The Use of Mock-Up Critical Experimental Results in the Nuclear Design of Power Reactors, *R. T. Bayard (W-BAPD)*
- 2 Lattice Physics in the Design of Heavy Water Reactors, *F. Driggers (DuP-SR)*
- 3 Mockup Analysis for Fast Reactor Design, *W. B. Loewenstein (ANL)*
- to 4 The Definition and Measurement of Reactivity, *H. Kouts (BNL)*
- 5 The Theory and Measurement of Criticality, *C. Kelber (ANL)*
- 12:00 6 The Comparison of Design Methods with Critical Experiments for Power Reactors, *M. Edlund (B & W)*

## Session 7

Wednesday, November 8

Lower Tower

Special Session

Reactor Operations Division

POWER REACTOR OPERATIONAL AND  
MAINTENANCE EXPERIENCE

Chairman: C. B. Zitek (COM-ED)

- 9:00 1 Radioactive Maintenance Experiences at  
VBWR, J. B. Violette (GE-APED, Pleasanton)
- 2 Preparing EBWR for High Power Operation,  
E. A. Wimunc (ANL)
- to 3 Sodium Reactor Experiment Operating Experience,  
L. E. Glasgow (AI)
- 4 Some Significant Aspects of Shippingport  
Operations, G. M. Oldham (DLC)
- 12:00 5 Yankee Operating Experience through October  
1961, W. P. Johnson (YAEC)-

## Session 8

Wednesday, November 8

Waldorf Room

Special Session

Reactor Operations Division

OPERATION OF REACTOR FACILITIES  
ON THE UNIVERSITY CAMPUS

Chairman: A. Robeson (VPI)

- 2:00 1 Operation Problems of a Campus Reactor  
Facility, F. V. Remick (PSU)
- 2 Operating Campus Reactors as Training  
Facilities, L. C. Wilbur (WPI)
- to 3 The AEC Position, C. K. Beck (USAEC)
- 4 Standards for Operating Reactors on Campus,  
T. J. Connolly (SU)
- 5 Research with a Low Power Reactor Facility,  
L. G. Barrett (B & W)
- 6 The National Research Council Committee  
on Research Reactors, R. G. Cochran (Tex  
A & M)
- 5:00 A panel discussion will follow presentation  
of the papers.

## Session 9

Tuesday, November 7

Lower Tower

Special Session

Reactor Mathematics and  
Computations DivisionCOMPUTATIONAL ASPECTS OF REACTOR  
KINETICS

Chairman: W. K. Ergen (ORNL)

- 3:00 1 A Review of Methods for Describing the  
Detailed Time Behavior of Reactors, A. F.  
Henry (W-BAPD)

- 2 On the Measurement of Dynamic Characteristics  
of Nuclear Reactor Systems, E. P. Gyftopoulos  
(MIT)
- to 3 Linear Theory and Transfer Functions in  
Reactor Analysis, D. S. St. John (DuP-SR)
- 5:00 A panel discussion will follow presentation  
of the papers.

## Session 10

Tuesday, November 7

Waldorf Room

Special Session

Shielding Division

PANEL DISCUSSION: SPACE RADIATION  
AND ITS SHIELDING

Chairman: E. P. Blizard (ORNL)

- 3:00 Panel Members: J. A. Van Allan (SUI); J.  
W. Keller (NASA, Huntsville); N.M. Schaeffer  
(Convair); C. D. Zerby (ORNL); J. E.  
Naugle (NASA, Washington); C. Tobias  
(UCRL); C. Sonthaus (UCRL)
- to
- 5:00 Audience participation is invited.

## REGULAR SESSIONS

(DIVISIONAL)

## NINTH CONFERENCE ON

HOT LABORATORIES

AND EQUIPMENT

(Sessions 11 through 16)

## Session 11

Tuesday, November 7

Upper Tower

Hot Laboratory Division

## HOT LABORATORIES FOR RESEARCH

Chairman: M. J. Feldman (ANL, Idaho)

Vice Chairman: S. E. Dismuke (ORNL)

- 9:00 Welcome to the Ninth Conference, W. B.  
Lewis (AECL)
- 9:20 1 Introductory Remarks, Chairman
- 9:35 2 A New Postirradiation Examination Labora-  
tory at Oak Ridge National Laboratory,  
A. R. Olsen (ORNL)
- 9:55 3 Livermore Alpha-Gamma-Neutron Chemis-  
try Cell, M. S. Coops, C. L. Hanson (UCRL-  
L)

- 10:15 4 A Chemistry Hot Cell for Handling Alpha-Gamma Activities, *J. R. Berreth, R. P. Schuman (Phillips)*
- 10:50 5 Transuranium Development Facility, *B. B. Klima (ORNL)*
- 11:10 6 Radioactive Materials Laboratory of the Union Carbide Nuclear Company, *C. F. VandenBulck (RML)*
- 11:30 7 NASA Plum Brook Reactor Hot Laboratory Facility, *R. E. Oldrieve (NASA)*

- 9:40 3 The Mobot Mark II Remote Handling System, *J. W. Clark (HA)*
- 10:15 4 The ANL Model 3 Master-Slave Electric Manipulator—Its Design and Use in a Cave, *R. C. Goertz, R. A. Blomgren, J. H. Grimson, G. A. Forster, W. M. Thompson, W. H. Kline (ANL)*
- 10:35 5 An Electronically Controlled Servomanipulator, *S. Barabaschi, S. Cammarata, C. Mancini, A. Pulacci, F. Roncaglia (CSN)*
- 10:55 6 Transistorized Servo System for Master-Slave Electric Manipulators, *C. W. Potts, G. A. Forster, R. H. Maschhoff (ANL)*
- 11:10 7 A Technique for Making Extremely Flexible Electric Cables, *R. C. Goertz, G. A. Forster, J. H. Grimson (ANL)*

Session 12 Tuesday, November 7  
Upper Tower

*Hot Laboratory Division*

GLOVE AND SHIELDED BOXES

Chairman: *N. B. Garden (Consultant)*  
Vice Chairman: *G. J. Deilly (DuP-SR)*

- 3:00 1 Introductory Remarks, *Chairman*
- 3:15 2 The Plutonium Fuel Fabrication Facility at Argonne National Laboratory, *A. B. Shuck (ANL)*
- 3:35 3 Gloveboxes for Plutonium Metallurgy Research at Argonne, *L. R. Kelman, J. L. Armstrong, W. H. Livernash, H. V. Rhude (ANL)*
- 3:55 4 Prevention and Control of Fires in Glove boxes Containing Plutonium, *R. R. King (GE-HAPO)*
- 4:15 5 Fiberglass Reinforced Plastic Gloveboxes for Plutonium Analytical Research, *J. P. Hughes, A. G. Jastrab (ANL)*
- 4:35 6 Gastight Cell and Magnetic Remote Controlled Manipulator, *M. Desroche (CEN), G. Chérel (SGN)*
- 4:55 7 Remote Metallography at Metallurgy Division, Atomic Energy Research Establishment, Harwell, *J. H. Evans, J. H. Venables (AERE, Harwell)*

Session 13 Wednesday, November 8  
Upper Tower

*Hot Laboratory Division*

GENERAL PURPOSE MANIPULATORS

Chairman: *R. C. Goertz (ANL)*  
Vice Chairman: *J. L. Colp (Sandia)*

- 9:00 1 Introductory Remarks, *Chairman*
- 9:20 2 Extended Reach Manipulator, *C. E. Saunders (AMF)*

Session 14 Wednesday, November 8  
Upper Tower

*Hot Laboratory Division*

HOT LABORATORY OPERATIONS AND EQUIPMENT

Chairman: *J. M. Davis (AI)*  
Vice Chairman: *R. E. Olson (GE-HAPO)*

- 2:00 Hot Laboratory Division business meeting
- 2:30 1 Introductory Remarks, *Chairman*
- 2:40 2 Replication of Surfaces for Hot-Cell Application, *R. E. McDonald, B. W. McCollum, G. A. Moore (ORNL)*
- 2:55 3 The Examination of Highly Active Specimens and Rigs by Radiography at Dounreay, *K. M. Swanson (UKAEA, Dounreay)*
- 3:10 4 Semi-Remote Control of Two-High-Four-High Laboratory Rolling Mills, *G. J. Pokorny, A. B. Shuck (ANL)*
- 3:40 5 Procedure for Disassembling a Uranium-Bismuth Loop in the BNL Metallurgy Hot Cell, *J. G. Y. Chow, J. R. Hare, A. F. Nielsen, F. P. Pallas (BNL)*
- 3:55 6 New Decontamination Chamber, *M. E. McMahon (GW-HAPO)*
- 4:10 Introduction of authors and discussion of the following papers, which will not be presented orally
- 7 A Replaceable Gastight Utility Plug for Shielded Facilities, *R. A. Blesch, R. B. Wehrle (ANL)*
- 8 The Metallographic Facilities in the Radiometallurgy Laboratory at Hanford, *W. J. Gruber, E. C. Watts (GE-HAPO)*
- 9 An Automatic Data Processing System for the Hot Laboratory, *J. T. Conboy (GE-APED, Pleasanton)*

## Technical Sessions

- |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>10 Technique for Hydrostatic Burst Testing of Irradiated Tubing, <i>C. L. Boyd, E. C. Watts (GE-HAPO)</i></p> <p>11 Expendable Abrasive Cutoff Machine, <i>W. B. Doe (ANL)</i></p> <p>12 A Comparator for Post-Irradiation Thermal Conductivity Measurements, <i>B. S. Shabel, S. C. Smith (KAPL)</i></p> <p>13 Design and Operation of a 15,000-Cubic Foot Helium Recirculating and Purification System, <i>R. M. Mayfield, W. G. Tope (ANL)</i></p> <p>14 Precision Remote Plotting of Radiation Dose Distributions, <i>F. X. Rizzo, D. Huszagh, P. Fallon, A. Quadrado (BNL)</i></p> <p>15 Pneumatically Placed Concrete Shielding, <i>R. W. Dascenzo (GE-HAPO)</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <p><b>Session 16</b></p> <p style="text-align: right;"><b>Thursday, November 9</b></p> <p style="text-align: center;"><b>Grand Ballroom East</b></p> <p style="text-align: center;"><i>Hot Laboratory Division</i></p> <p style="text-align: center;"><b>TRANSFER SYSTEMS AND SHIELDING WINDOWS</b></p> <p style="text-align: right;">Chairman: <i>P. J. Peterson (LASL)</i><br/>Vice Chairman: <i>W. B. Doe (ANL)</i></p> <p>2:00 1 Personnel Access to Alpha-Gamma Caves Using Plastic Suits and Enclosures, <i>R. A. Blomgren (ANL)</i></p> <p>2:15 2 New Frogman Technique, <i>L. Csiba (KFA)</i></p> <p>2:30 3 Remote Plastic Bag Passout Unit for High-Level Radiochemical Operations, <i>E. S. Fleischer, T. C. Parsons, P. W. Howe (UCRL)</i></p> <p>2:45 4 Alpha-Gamma Transfer Systems, <i>M. Wilson, L. Thorn (LASL)</i></p> <p>3:15 5 Neutron Shielding Calculations for Current Window Designs, <i>F. C. Hardtke (ANL)</i></p> <p>3:30 6 Zinc Bromide Windows for Neutron and Gamma Ray Shielding, <i>C. H. Youngquist, L. M. Rentschler (ANL)</i></p> <p>3:45 7 A New Approach to the Problem of Cloudy Radiation Shielding Windows, <i>J. S. Mazza, T. E. McGary (PPG)</i></p> <p>4:00 8 Gastight Seal and Installation Technique for a Kilocurie Gamma Shielding Window, <i>K. R. Ferguson, D. E. Czernik, L. M. Saffranski (ANL)</i></p> |
| <p><b>Session 15</b></p> <p style="text-align: right;"><b>Thursday, November 9</b></p> <p style="text-align: center;"><b>Grand Ballroom East</b></p> <p style="text-align: center;"><i>Hot Laboratory Division</i></p> <p style="text-align: center;"><b>SPECIAL PURPOSE HOT LABORATORIES AND FACILITIES</b></p> <p style="text-align: right;">Chairman: <i>V. Culler (Corning)</i><br/>Vice Chairman: <i>J. B. Godel (BNL)</i></p> <p>9:00 1 The Brookhaven High Intensity Radiation Development Laboratory, <i>O. A. Kuhl (BNL)</i></p> <p>9:15 2 Machines Developed for Use in the High Intensity Radiation Development Laboratory, <i>D. W. Huszagh, G. Nugent (BNL)</i></p> <p>9:30 3 The Postirradiation Examination Facilities at Windscale Works, U.K.A.E.A., <i>V. M. Eldridge, K. Saddington (UKAEA, Windscale)</i></p> <p>9:50 4 Features of the Sandia Engineering Reactor Facility Irradiation Cell, <i>J. L. Colp (Sandia)</i></p> <p>10:05 5 Steam Cleaning Facility for Liquid Metal Cooled Fuel Elements, <i>H. L. Brinkman, W. Wilson (AMF)</i></p> <p>10:35 6 Laboratory for Plutonium Fuel Element Fabrication at Cadarache, <i>Y. Duvaux, R. Mas, A. Junca, H. Dick (CEA)</i></p> <p>11:10 7 Decanning of Irradiated Fuel Elements at Marcoule, <i>C. Oger (SGN)</i></p> <p>11:25 8 Radioactive Waste Handling at the Hanford Facility, <i>C. G. McCormack (GE-HAPO)</i></p> <p>11:40 9 Sandia Pulsed Reactor Facility Building Design and Construction Details, <i>R. G. Struss (Sandia)</i></p> | <p><b>Session 17</b></p> <p style="text-align: right;"><b>Tuesday, November 7</b></p> <p style="text-align: center;"><b>Bel Air Room</b></p> <p style="text-align: center;"><i>Isotopes and Radiation Division</i></p> <p style="text-align: center;"><b>ANALYSIS AND APPLICATIONS</b></p> <p style="text-align: right;">Chairman: <i>W. Meinke (UM)</i></p> <p>9:00 1 A New Digital Computer Program for Processing Neutron Activation Analysis Data Utilizing the IBM 709, <i>W. M. Breen, L. E. Fite, D. Gibbons, R. E. Wainerdi (Tex A &amp; M)</i></p> <p>9:20 2 Nuclear Method for a Rapid Analysis of Iron Ore, <i>R. C. Greenwood, J. Reed, C. A. Stone (ARF)</i></p> <p>9:40 3 An Improved Procedure for the Determination of U-235 in Impure Uranium Materials Using Neutron Activation Techniques, <i>W. D. Kelley, B. L. Twitty (NL, Ohio)</i></p> <p>10:00 4 Quantitative Elemental Analysis by Critical Edge Absorption of Beta Particle Excited X-Rays, <i>G. D. McPherson (U Waterloo)</i></p>                                                                                                                                                                                                                                                                                                                                            |

- 10:20 5 Cavitation and Erosion Damage Measurements with Radioisotopes, *W. J. Walsh (Ames), F. G. Hammitt (UM)*
- 10:40 6 Design of Radiochemical Reactors with Special Reference to the Polymerization of Ethylene, *M. M. Levine, M. Steinberg (BNL)*

- 3:50 6 Integral Equation Method for Space-Dependent Reactor Kinetics, *D. Baroncini Adler, F. T. Adler (UI)*

Session 18 Tuesday, November 7  
Bel Air Room

*Isotopes and Radiation Division*

MEASUREMENT AND COUNTING TECHNIQUES

Chairman: *A. Schrodt (N-C)*

- 3:00 1 Counting Tritium as Water Vapor in a Geiger Flow-Counter, *R. L. Ely, Jr., L. F. Ballard (RTI)*
- 3:20 2 Application of Silicon Photodiodes to Scintillation Counters, *A. J. Tuzzolino, E. L. Hubbard, M. A. Perkins, C. Y. Fan (U Chi)*
- 3:40 3 Low Energy Beta Counting System Using Scintillating Fibers, *C. A. Stone, C. Preston (ARF)*
- 4:00 4 Scintillating Ion Exchange Resins, *A. H. Heimbuch (Tracerlab)*
- 4:20 5 Sensitivity of Neutron Moisture Probe, *P. R. Klein, E. J. Betinis (N-C)*
- 4:40 6 Radiation Applications to Thixotropic Propellant Testing Problems, *J. F. Wakeman, R. J. Darby (ARL)*

Session 19 Wednesday, November 8  
Private Dining Room 4

*Reactor Mathematics and Computations Divisions*

COMPUTER CODES AND REACTOR ANALYSIS

Chairman: *Margaret D. Butler (ANL)*

- 2:00 1 SYBURN - A Synthesized Two-Dimensional P1 or DSN Burnup Code, *G. A. Cannon, E. A. Colbeth, T. M. Olsen (Martin)*
- 2:20 2 Some Convergence Studies of GAZE--A New One-Dimensional, Multigroup, Neutron Diffusion Theory Code for the IBM-7090, *S. Lemihan, G. Joanou, E. Leshan (GA)*
- 2:40 3 AIMFIRE--A Fuel Economics Code, *R. A. Blaine (AI)*
- 3:00 4 Fuel Distribution for an Arbitrarily Specified Power Distribution and Multiplication Factor, *R. B. Shain, W. B. Green (DAC)*
- 3:20 5 Neutron Slowing Down with Resonance Absorption: Exact Solution, *F. T. Adler, D. Baroncini Adler (UI)*

Session 20 Tuesday, November 7  
Private Dining Room 4

*Shielding Division*

SHIELDING I

Chairman: *A. D. Rossin (ANL)*

- 9:00 1 Particle Streaming in Beam Tubes, *W. O. Doggett (NCS)*
- 9:20 2 Comparison of Theory and Measurement of Photon Streaming in a Straight Rectangular Concrete Duct, *C. W. Terrell (ARF)*
- 9:40 3 Measured Radiation Distributions in Shelter Entranceways, *G. W. Terrell, A. J. Jerri, R. O. Lyday, Jr. (ARF)*
- 10:00 4 Comparison of the Conceptual and Detailed Designs of the Graphite Shield for the Enrico Fermi Fast Breeder Reactor, *R. J. Beaudry, H. E. Hungerford (APDA)*
- 10:20 5 Experimental Buildup Factors for Semi-Infinite Water Target and Cobalt-60 Slab Sources, *F. X. Rizzo, L. Galanter (BNL)*
- 10:40 6 An Experimental Determination of "In and Down" Scattering of Cobalt-60 Gamma Rays from a Plane Source, *J. F. Batter, Jr. (TOI)*

Session 21 Wednesday, November 8  
Private Dining Room 4

*Shielding Division*

SHIELDING II

Chairman: *W. O. Chatfield (BSC)*

- 9:00 1 Experimental Evaluation of Reactor Containment Shielding, *H. S. Bloomfield, A. Foderaro (PSU)*
- 9:20 2 Calculation of Reactor Core Gamma-Ray Spectra, *M. J. Barrett (A-C, Wash.)*
- 9:40 3 Comparison of Calculations with Experimental Data from the Hanford Shield Facility, *E. G. Peterson (GE-HAPO)*
- 10:00 4 Experimental and Calculated Neutron Flux and Spectrum in a Reactor Core and Reflector, *S. H. Weiss, E. F. Clancy, R. A. Robinson (Alco)*
- 10:20 5 Measurements of Secondary Gamma Rays from Tungsten, Stainless Steel and Borated Steel, *S. T. Friedman (Aerojet)*
- 10:40 Business Meeting of the Shielding Division

## REGULAR SESSIONS

Session 22

Tuesday, November 7

Private Dining Room 2

NEUTRON SPECTRA AND THERMAL  
CROSS SECTIONSChairman: *H. C. Honeck (BNL)*

- 9:00 1 Calculated and Measured Neutron Energy Spectral Distributions Using the Threshold Detector Technique, *W. D. Lanning, K. W. Brown (W-BAPD)*
- 9:20 2 Integral Spectrum Measurements with Lutetium, *T. F. Parkinson, S. Salah (UF)*
- 9:40 3 Measurement of Neutron Spectra and Decay Constants in a Water Moderated Multiplying Assembly, *J. C. Young, G. D. Trimble, D. H. Houston, P. R. Heid, J. R. Beyster (GA)*
- 10:00 4 The Effects of Chemical Binding on Neutronics of Graphite-U-235 Reactors, *D. E. Parks, N. F. Wikner (GA)*
- 10:20 5 Measurement of Ratio of Eta of Uranium-233 to Uranium-235 in the Reactivity Measurement Facility, *D. R. deBoisblanc, E. Fast (Phillips)*
- 10:40 6 Thermal Neutron Cross Sections of Co-58 Isomers and the Effect on Fast Flux Measurements Using Nickel, *C. H. Hogg, L. D. Weber, E. C. Yates (Phillips)*
- 11:00 7 The Negative Energy Resonance Parameters of Th-232 and U-234, *G. S. Cooper, J. D. Garrison, W. A. Hines (GA)*

Session 23

Wednesday, November 8

Astoria Room

RESONANCE INTEGRALS AND  
CONVERSION RATIOSChairman: *M. C. Edlund (B&W, Lynchburg)*

- 9:00 1 Method for Measurement of Conversion Ratio (and Resonance Escape Probability), *H. M. Antúnez (GE-APED, Pleasanton)*
- 9:20 2 Conversion Ratio in Light Water Superheat Lattices—Analysis, *G. T. Petersen (GE-APED, San Jose)*
- 9:40 3 Comparison of Measured and Computed Conversion Ratio in the Dresden Reactor, *R. J. McWhorter, C. P. Ruiz, D. L. West (GE-APED, San Jose)*
- 10:00 4 A Monte Carlo Calculation of the Resonance Escape Probability of Thorium in a Homogeneous Reactor, *D. L. Bushnell (NIU)*
- 10:20 5 Nonuniform Spatial Distribution of Resonance Neutrons in Reactor Lattices, *E. U. Vaughan (AI)*

- 10:40 6 Doppler Measurements of Thorium Dispersed in Graphite, *R. Bardes, J. Brown, D. Pound, J. Sampson (GA)*
- 11:00 7 Activation Measurements of Resonance Integrals by a 1/v Component Subtraction Method, *R. Bardes, J. Brown, M. Drake, J. Sampson (GA)*
- 11:20 8 A New Method for the Calculation of Resonance Integrals, *L. W. Nordheim, G. Kuncir (GA)*
- 11:40 9 Resonance Capture in Mixtures of U-238 and Th-232, *R. L. Crowther (GE-APED, San Jose)*

Session 24

Thursday, November 9

Williford Room A

## NEUTRON AGE AND DIFFUSION LENGTH

Chairman: *P. F. Zweifel (UM)*

- 9:00 1 Moments Calculations of the Fermi Age in Various Moderators, *G. D. Joanou, A. J. Goodjohn, N. F. Wikner (GA)*
- 9:20 2 Neutron Age in ThO<sub>2</sub>-D<sub>2</sub>O-H<sub>2</sub>O Lattices, *D. M. Roberts, W. G. Petus (B&W, Lynchburg)*
- 9:40 3 Age Measurements in Diphenyl and Mineral Oil, *R. W. Campbell, R. K. Paschall (AI)*
- 10:00 4 Temperature Dependence of the Neutron Diffusion Length in Paraffin and Polyethylene, *L. J. Esch (KAPL)*
- 10:20 5 Thermal Neutron Diffusion Length Measurements in Light Water, *W. C. Ballowe, W. R. Morgan (GE-APED, Pleasanton)*
- 10:40 6 Thermal Neutron Diffusion Length Measurements in Absorbing Aqueous Solutions, *J. Miller (AI)*
- 11:00 7 Measurement of Neutron Diffusion Parameters of Heavy Water at Different Temperatures by Pulsed Source Method, *N. K. Ganguly, A. W. Waltner (NCS)*
- 11:20 8 The Angular Distribution Shift Effect, *J. S. Martinez, A. J. Kirschbaum, T. H. Pigford (UCRL-L)*

Session 25

Thursday, November 9

Williford Room A

## REACTOR PHYSICS ANALYSIS

Chairman: *H. W. Graves (WAPD)*

- 2:00 1 Small Source Theory Oscillations in Exponential Pile Flux Distributions, *D. E. Wood (GE-HAPO)*

- 2:15 2 Calculation of Clustered Rod Lattices Using Subcell Collision Probabilities, *H. Soodak, R. Sullivan (UNC, NY)*
- 2:30 3 Asymmetric Core Experiments and Their Analysis by a Three-Dimensional Code and Two Flux Synthesis Techniques, *R. J. Roseberry, T. F. Ruane (KAPL)*
- 2:45 4 Comparison of Measured and Calculated Three-Dimensional Flux Peaking, *R. J. Holl, P. S. Lacy (A-C), C. Larson (NSPC)*
- 3:00 5 Synthesis of Three-Dimensional Flux Shapes, *S. Kaplan (W-BAPD)*
- 3:15 6 Theoretical Analysis of the Snell Experiment, *P. Michael, J. Chernick, A. Aronson (BNL)*
- 3:30 7 Criticality and Flux by Iteration Using Conditional Monte Carlo, *D. W. Drawbaugh, C. F. Saalbach, A. H. Killinger (W-AL)*
- 3:45 8 Nonuniformly Moderated Flat Power Reactors Having Finite Reflectors, *J. M. Ravets (CE), J. R. Lamarsh (Cornell)*
- 4:00 9 Epithermal Absorption in Slab Lattices, *M. Goldsmith (W-BAPD)*
- 4:15 10 The Behavior of Extrapolation Distance in Pulsed Systems, *E. M. Gelbard, J. A. Davis (W-BAPD)*

**Session 26** **Tuesday, November 7**  
**Private Dining Room 4**

**REACTOR DEPLETION AND BURNUP**

Chairman: *J. R. Triplett (GE-HAPO)*

- 3:00 1 Specifying a Mode of Operation for the Peach Bottom High Temperature Gas Cooled Reactor, *S. Jaye, F. Todt, K. Van Howe (GA)*
- 3:20 2 The Behavior of Flat Power Reactors During Burnup, *J. S. Ingley, J. R. Lamarsh (Cornell)*
- 3:40 3 The Effect of Water-to-Uranium Ratio on Consumption of Fissionable Material in Slightly-Enriched Water Moderated Reactors, *J. Bengston (CE)*
- 4:00 4 The Determination of the Effects of Various Materials with Thermal Resonances on the Temperature Coefficient of High Temperature Graphite Moderated Reactors, *P. U. Fischer, N. F. Wikner (GA)*
- 4:20 5 Poison Mixtures which Improve Thermal Reactor Operating Characteristics, *J. H. Bick, R. J. Doyas (AI)*

**Session 27**

**Wednesday, November 8**  
**Private Dining Room 2**

**CRITICAL EXPERIMENTS I**

Chairman: *J. S. King (UM)*

- 9:00 1 An Experimental Technique for the Measurement of Neutron Captures in U-235 and Natural Boron, *D. A. Gavin, P. J. Tetrault, T. F. Ruane, D. J. Anthony (KAPL)*
- 9:20 2 Measured Nuclear Parameters for Natural Uranium Rod Lattices in D<sub>2</sub>O, *T. J. Hurley, G. F. O'Neill (DuP-SR)*
- 9:40 3 Comparison of Exponential and Critical Bucklings for Natural Uranium Rods in Heavy Water, *E. C. Wingfield, E. J. Hennelly (DuP-SR)*
- 10:00 4 Flux Measurements in Superheater Cells, *H. F. Finn, A. Selep, R. H. Vollmer (A-C)*
- 10:20 5 Critical Experiments with Low Enriched Double Annular Superheater Fuel Elements in Light Water and Their Analysis, *P. G. Klann, C. O. Dechand, E. Fein, W. B. Wright (CE)*
- 10:40 6 Description and Analysis of Some "Over-Moderated" Critical Experiments from 68-550°F, *G. H. Miley, R. D. Gillespie, J. W. Pollard, J. A. Bistline (KAPL)*
- 11:00 7 Description and Analysis of Some Semi-Distributed Boron Cores, *G. H. Miley, B. Miller, J. H. Homes (KAPL)*
- 11:20 8 Analysis of Highly Enriched Water Moderated Critical Assemblies—Part I: The Calculational Model and Analysis of Slab Experiments at Room Temperature, *R. J. Breen, G. F. Bogar, D. R. Connors, H. J. Litke, D. S. Rampolla, J. A. Smith (W-BAPD)*
- 11:40 9 Analysis of Highly Enriched Water Moderated Critical Assemblies—Part II: Analysis of Slab Experiments with Absorbing Septa and Varying Temperatures, *H. J. Litke, G. F. Bogar, R. J. Breen, D. R. Connors, D. S. Rampolla, J. A. Smith (W-BAPD)*

**Session 28**

**Wednesday, November 8**  
**Private Dining Room 2**

**CRITICAL EXPERIMENTS II**

Chairman: *G. Dessauer (DuP-SR)*

- 2:00 1 Experiments and Calculations on Unmoderated Uranium-Molybdenum Alloys Critical Assemblies, *J. T. Mihalcz, W. E. Kinney (ORNL)*
- 2:15 2 Analysis of a Beryllium Moderated Critical Experiment, *G. Srikantiah (BNL)*

## Technical Sessions

- |                                                                                                             |    |                                                                                                                                                                                                                           |                                                                                                             |   |                                                                                                                                     |
|-------------------------------------------------------------------------------------------------------------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|---|-------------------------------------------------------------------------------------------------------------------------------------|
| 2:30                                                                                                        | 3  | Pressure Tube Reactor Critical Experiment, <i>R. R. Powell, P. M. Williams (AMF)</i>                                                                                                                                      | 11:10                                                                                                       | 7 | Xenon-135 Transients Resulting from Time-Varying Shutdowns of Thermal Reactors, <i>J. R. Fredsall (GE-HAPO), A. L. Babb (UW)</i>    |
| 2:45                                                                                                        | 4  | Critical Experiments on 4%-Enriched UO <sub>2</sub> Lattices Moderated by D <sub>2</sub> O-H <sub>2</sub> O Mixtures, <i>N. L. Snidow, R. H. Clark, C. E. Barksdale, R. H. Lewis, T. C. Engelder (B&amp;W, Lynchburg)</i> | 11:30                                                                                                       | 8 | Stability of a Boiling D <sub>2</sub> O Power Reactor, <i>D. Randall (DuP-SR)</i>                                                   |
| 3:00                                                                                                        | 5  | Nuclear Analysis of 4%-Enriched UO <sub>2</sub> Lattices Moderated by D <sub>2</sub> O-H <sub>2</sub> O Mixtures, <i>W. A. Wittkopf, K. E. Roach (B&amp;W, Lynchburg)</i>                                                 | 11:50                                                                                                       | 9 | Analysis of Reactor Fluctuations, <i>D. R. Harris (W-BAPD)</i>                                                                      |
| 3:15                                                                                                        | 6  | Initial Operation and Experimentation with the Consolidated Edison Thorium Reactor, <i>R. M. Ball (B&amp;W, Lynchburg)</i>                                                                                                | <b>Session 30</b> <span style="float: right;"><b>Thursday, November 9</b></span><br><b>Williford Room C</b> |   |                                                                                                                                     |
| 3:30                                                                                                        | 7  | Coolant Void Coefficients in the Carolinas-Virginia Tube Reactor Critical Experiments, <i>G. N. Hamilton (WAPD)</i>                                                                                                       | <b>NUCLEAR DESIGN OF SHIPPINGPORT PWR CORE 2</b>                                                            |   |                                                                                                                                     |
| 3:45                                                                                                        | 8  | Final Mockup Experiments for the SM-2 Core Design, <i>E. W. Schrader, W. J. McCool, T. M. Raby, L. D. Walthousen, S. H. Weiss (Alco)</i>                                                                                  | Chairman: <i>R. T. Bayard (W-BAPD)</i>                                                                      |   |                                                                                                                                     |
| 4:00                                                                                                        | 9  | Nuclear Measurements for Development of High Performance Replacement Cores for Army Reactors, <i>T. M. Raby, W. J. McCool, S. N. Kemp, L. D. Walthousen, K. C. Sontheimer (Alco)</i>                                      | 9:00                                                                                                        | 1 | PWR Core 2 Reactor and Analytic Model Description—Part 1, <i>M. R. Stuart, R. T. Bayard (W-BAPD)</i>                                |
| 4:15                                                                                                        | 10 | Some Recent Zero Power Physics Measurements on the Organic Moderated Reactor Experiment, <i>W. B. Wolfe, R. J. Mack (AI, Idaho)</i>                                                                                       | 9:20                                                                                                        | 2 | PWR Core 2 Reactor and Analytic Model Description—Part 2, <i>C. A. Flanagan, W. H. Hannum (W-BAPD)</i>                              |
| <b>Session 29</b> <span style="float: right;"><b>Thursday, November 9</b></span><br><b>Williford Room B</b> |    |                                                                                                                                                                                                                           | 9:40                                                                                                        | 3 | An Evaluation of the "ZIP" Synthesis Depletion Technique as Applied to a PWR Seed-Blanket Slab Reactor, <i>C. D. Sphar (W-BAPD)</i> |
| <b>REACTOR DYNAMICS AND STABILITY</b>                                                                       |    |                                                                                                                                                                                                                           | 10:00                                                                                                       | 4 | A Generalized Treatment of Fission Product Poisoning, <i>T. R. England, R. J. Eckert (W-BAPD)</i>                                   |
| Chairman: <i>W. K. Ergen (ORNL)</i>                                                                         |    |                                                                                                                                                                                                                           | 10:20                                                                                                       | 5 | Depletion Studies of PWR-2, <i>C. A. Flanagan, G. E. Pence (W-BAPD)</i>                                                             |
| 9:00                                                                                                        | 1  | MARK MILLS AWARD PAPER (See page vii)—The Measurement of Dynamic Nuclear Reactor Parameters by Method of Stochastic Processes, <i>R. W. Albrecht (UW)</i>                                                                 | 10:40                                                                                                       | 6 | Criticality Predictions of the PWR-2 Design Model, <i>R. F. Valentine, R. P. Cristman (W-BAPD)</i>                                  |
| 9:20                                                                                                        | 2  | Experimental Investigation of the Kinetic Behavior of a 4%-Enriched UO <sub>2</sub> Reactor in Spert-I, <i>A. H. Spano, L. A. Stephan (Phillips)</i>                                                                      | 11:00                                                                                                       | 7 | Measurement and Calculation of the Power Distribution in the PWR-2 Mockup, <i>K. P. Barr, R. P. Cristman, W. Baer (W-BAPD)</i>      |
| 9:50                                                                                                        | 3  | Self-Limiting Power Excursion Tests of a D <sub>2</sub> O-Moderated Reactor, Spert-II, <i>J. E. Grund (Phillips)</i>                                                                                                      | 11:20                                                                                                       | 8 | Self-Shielded Boron Representation for PWR-2, <i>N. G. Demas, R. C. Shank (W-BAPD)</i>                                              |
| 10:10                                                                                                       | 4  | Analysis of the Sodium Reactor Experiment Prompt Power Coefficient, <i>C. W. Griffin (AI)</i>                                                                                                                             | 11:40                                                                                                       | 9 | Boron Capture Fraction Measurements in PWR-2 Geometry, <i>W. Baer (W-BAPD)</i>                                                      |
| 10:30                                                                                                       | 5  | Photographic Studies of In-Pile Fast Reactor Fuel Sample Meltdown, <i>C. E. Dickerman, G. Golden, L. E. Robinson (ANL)</i>                                                                                                | <b>Session 31</b> <span style="float: right;"><b>Thursday, November 9</b></span><br><b>Williford Room B</b> |   |                                                                                                                                     |
| 10:50                                                                                                       | 6  | Effect on Neutron Level of Hydraulic Fluctuations During Reverse-Flow Core Operation of the Homogeneous Reactor Experiment-2, <i>C. G. Lawson, F. N. Peebles, S. J. Ball, W. R. Mixon (ORNL)</i>                          | <b>INSTRUMENTATION AND CONTROL</b>                                                                          |   |                                                                                                                                     |
|                                                                                                             |    |                                                                                                                                                                                                                           | Chairman: <i>W. H. Jordan (ORNL)</i>                                                                        |   |                                                                                                                                     |
|                                                                                                             |    |                                                                                                                                                                                                                           | 2:00                                                                                                        | 1 | Development of Techniques for the Continuous Monitoring of Core Normalcy at the Sodium Reactor Experiment, <i>R. A. Lewis (AI)</i>  |
|                                                                                                             |    |                                                                                                                                                                                                                           | 2:20                                                                                                        | 2 | Sandia Pulsed Reactor Control System Design and Operation, <i>P. D. O'Brien (Sandia)</i>                                            |

- 2:40 3 The Helical Control Rod, *C. R. MacVean, J. R. Lamarsh (Cornell), W. G. Chesnut (Dewey)*
- 3:00 4 A Fluidized Bed Control Rod, *M. J. Driscoll (UF)*
- 3:20 5 B<sub>4</sub>C-In-Tubes Control Rods, Lifetime Optimization, *E. W. Hoyt, F. H. Megerth, H. E. Williamson (GE, APED, San Jose)*
- 3:40 6 Development of a Continuous In-Core Neutron Flux Monitor Using Argon Gas, *C. R. F. Smith (AI)*
- 4:00 7 The Use of Cobalt Glass for High Intensity Electron Dosimetry, *K. Eklund, R. Timmerman (RDI)*

- 3:20 2 Irradiation Effects on Beryllium Oxide, *R. P. Shields, J. E. Lee, Jr., W. E. Browning, Jr. (ORNL)*
- 3:40 3 Irradiation Behavior of Boron-10 Iron Base Alloys, *W. Yeniscavich, R. G. Gray, H. B. Meieran (W-BAPD)*
- 4:00 4 Radioisotopic Investigation of OMRE Coolants, *L. Baurmash, S. J. Wode (AI)*
- 4:20 5 A Throwaway Dynamic Capsule for Testing Defective Fuel, *H. S. Dreyer, H. T. Watanabe (Aerojet)*

Session 32 Tuesday, November 7  
Astoria Room

ADVANCED CONCEPTS AND DIRECT  
CONVERSION DEVICES

Chairman: *C. Williams (BNL)*

- 9:00 1 The 25-Mw Prototype PTR Design, *J. MacPhee, R. Powell, P. Williams, C. Linnert, S. Roffis (AMF)*
- 9:20 2 A 10-Mw (Thermal) Molten-Salt Reactor Experiment, *A. L. Boch, W. B. McDonald, E. S. Bettis (ORNL)*
- 9:40 3 The Preliminary Design of the Advanced Test Reactor, *D. R. deBoisblanc (Phillips)*
- 10:00 4 Advanced Test Reactor Preliminary Design—Reactor Physics, *R. S. Marsden, D. R. deBoisblanc (Phillips)*
- 10:20 5 Thermal Analysis of a Direct-Conversion Reactor Using Natural-Circulation Water Cooling, *W. R. Clendinning (TI)*
- 10:40 6 The Fission Electric Cell Reactor, *W. F. Krieve, J. Heindl (JPL)*
- 11:00 7 Direct Conversion of Nuclear Energy Into Electrical or Thrust Energy, *K. M. Fuechsel (Silversprings, Md.)*
- 11:20 8 Fog Flow for Reactor Cooling, *G. A. Sofer, L. Goldstein (UNC, NY)*

Session 33 Tuesday, November 7  
Private Dining Room 2

IRRADIATION DAMAGE AND  
IN-PILE TESTING

Chairman: *M. Novick (ANL, Idaho)*

- 3:00 1 Irradiation Properties of U-Mo Alloys, *W. A. Holland (AI)*

Session 34 Thursday, November 9  
Grand Assembly Room

REACTOR FUEL MATERIALS I

Chairman: *D. Sinizer (AI)*

- 9:00 1 Fabrication Development of Aluminum Powder Metallurgical Alloys for Fuel Elements, *G. V. Alm (AI)*
- 9:20 2 Production of the Plutonium-1.25 w/o Aluminum, Experimental Breeder Reactor-I Core IV Fuel Rods, *W. R. Burt, Jr., A. G. Hines (ANL)*
- 9:40 3 Development of Graphite Matrix Fuel Elements, *W. E. Parker, M. J. Smith (SCC)*
- 10:00 4 Fabrication of Core Materials from Aluminum-Coated Fuel-Bearing Fiberglass, *R. Baskey (Clevite)*
- 10:20 5 The Development of a Low Temperature Process for UO<sub>2</sub> Pellet Fabrication, *R. B. Holden, N. Fuhrman, L. D. Hower, Jr. (UNC, Conn.)*
- 10:40 6 The Synthesis of Refractory Nuclear Feed Materials in Liquid Metal Media, *A. Schneider, L. Burris, Jr., S. Lawroski (ANL)*

Session 35 Thursday, November 9  
Williford Room C

REACTOR FUEL MATERIALS II

Chairman: *R. E. Macherey (ANL)*

- 2:00 1 Fabrication of Tantalum Fuel Containers for the LAMPRE-I Molten Plutonium Reactor, *G. S. Hanks (LASL), R. S. Kirby (ATL), J. M. Taub (LASL)*
- 2:20 2 The Development of High Purity Tantalum and Alloys for Liquid Plutonium Containment in LAMPRE-I, *R. M. Bidwell, W. E. Ferguson, C. C. Burwell, K. V. Davidson, W. R. Wykoff, R. W. Anderson (LASL)*

- |      |   |                                                                                                                    |      |   |                                                                                                                                                                   |
|------|---|--------------------------------------------------------------------------------------------------------------------|------|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2:40 | 3 | Corrosion Testing of LAMPRE-I Fuel, C. C. Burwell, R. M. Bidwell, J. E. Kemme, B. J. Thamer (LASL)                 | 2:40 | 3 | Measurement of Void Fractions in Parallel Rod Arrays, R. A. Condon, N. C. Sher (A-C)                                                                              |
| 3:00 | 4 | Metallurgical Aspects of the SRE Fuel Element Damage Episode, J. L. Ballif (AI)                                    | 3:00 | 4 | The Critical Discharge of Steam-Water Mixtures from Pipes, F. R. Zaloudek (GE-HAPO)                                                                               |
| 3:20 | 5 | Compatibility of Uranium Carbides with 304 Stainless Steel in Sodium, B. A. Webb (AI)                              | 3:20 | 5 | Comparison of Heat Transfer Characteristics of Fuel Elements in Particulate and in Solid Forms, J. C. Chen (BNL)                                                  |
| 3:40 | 6 | Simulated Boiling-Water-Reactor Corrosion Facility, W. L. Pearl, M. D. Fitzsimmons, M. Siegler (GE-APED, San Jose) | 3:40 | 6 | Heat Transfer Coefficients for a Wire Wrapped 19-Rod Bundle Fuel Element, J. G. Knudsen, J. M. Batch (GE-HAPO)                                                    |
| 4:00 | 7 | Thermal Cycling Induced Growth of Nickel-Europium Oxide Cermets, J. R. Miller, W. G. Baxter (GE-MNPO)              | 4:00 | 7 | Thermal and Hydraulic Operating Performance of the Shippingport Pressurized Water Reactor—Predictions versus Measurements, P. A. Bickel, W. J. Gallagher (W-BAPD) |

Session 36 Tuesday, November 7  
Astoria Room

CHEMISTRY AND PROCESSING

Chairman: O. F. Hill (GE-HAPO)

- |      |   |                                                                                                                                                                        |
|------|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3:00 | 1 | Fission Gas Release and Swelling During Postirradiation Heating of Prototype Alloy for the Second Experimental Breeder Reactor, N. R. Chellew, R. K. Steunenberg (ANL) |
| 3:20 | 2 | A Countercurrent, Multistage, Fused Salt-Molten Metal Extractor, P. R. Josephson, L. E. Burkhardt (ISU)                                                                |
| 3:40 | 3 | Effect of Flux Composition on the Reduction of Uranium, Thorium and Plutonium Oxides by Zinc-Magnesium Alloy, J. B. Knighton, R. K. Steunenberg (ANL)                  |
| 4:00 | 4 | Fluorination of Uranium and Plutonium in Solid Mixtures, L. Anastasia, J. Fischer, L. Trevorrow (ANL)                                                                  |
| 4:20 | 5 | Behavior of Iodine and Xenon in the Homogeneous Reactor Test, W. D. Burch, L. B. Shappert (ORNL)                                                                       |
| 4:40 | 6 | A Physical Theory of Adsorption of a Radioactive Gas, R. Madey (RAC)                                                                                                   |

Session 37 Wednesday, November 8  
Astoria Room

HEAT TRANSFER AND FLUID FLOW

Chairman: A. Amorosi (APDA)

- |      |   |                                                                                                                               |
|------|---|-------------------------------------------------------------------------------------------------------------------------------|
| 2:00 | 1 | Experimental Investigation of Downcomer Entrainment in a Natural Circulation Air-Water Loop, F. M. Stern, R. C. Marshall (CE) |
| 2:20 | 2 | Steam Volume Fraction in a Bubbling Two-Phase Mixture, J. F. Wilson, R. J. Grenda, J. F. Patterson (A-C)                      |

Session 38 Thursday, November 9  
Waldorf Room

GENERAL REACTOR ENGINEERING

Chairman: E. L. Zebroski (GE-APED, San Jose)

- |      |   |                                                                                                                                                                                |
|------|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2:00 | 1 | Thorium Reactor Evaluation: Fuel Yield and Fuel Costs in Five Thermal Breeders, L. G. Alexander, W. L. Carter, R. H. Chapman, B. W. Kinyon, J. W. Miller, R. Van Winkle (ORNL) |
| 2:30 | 2 | D <sub>2</sub> O Reactor Cost Studies, J. W. Wade and H. D. Brown (DuP-SR)                                                                                                     |
| 3:00 | 3 | Startup of the First Molten Plutonium Reactor, B. M. Carmichael, G. L. Ragan (LASL)                                                                                            |
| 3:20 | 4 | Some Effects Peculiar to the Liquid Metal Fuel of LAMPRE-I, G. L. Ragan, B. M. Carmichael (LASL)                                                                               |
| 3:40 | 5 | An American Reports on the OEEC Halden Reactor Project: An Example of International Cooperation, L. W. Fromm, Jr. (ANL)                                                        |
| 4:00 | 6 | The Gas-Cooled Reactor Experiment, A Valuable Developmental Tool, D. C. King, R. H. Chesworth (Aerojet, Idaho)                                                                 |
| 4:20 | 7 | Fuel Element Handling System for Hanford New Production Reactor, W. W. Barton (AMF), J. F. Nesbitt (GE-HAPO)                                                                   |
| 4:40 | 8 | Leakage Characteristics of Conventional Building Components for Reactor Housing Construction, R. L. Koontz, C. T. Nelson, L. Baumash (AI)                                      |

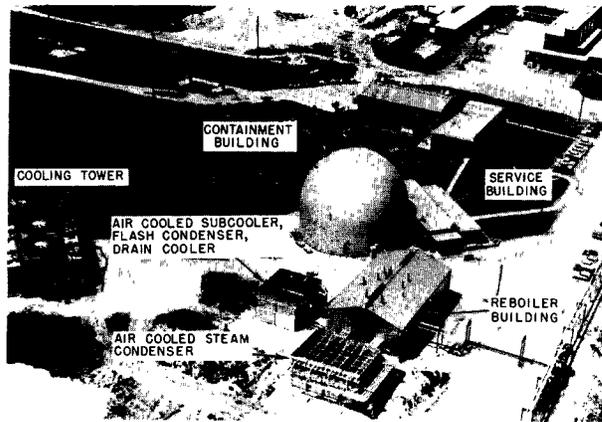


Fig. 1. Aerial view of EBWR 100-Mwt Facility.

A complete new operating manual was written for the EBWR facility because of the number of changes and tie-ins to the original plant that were made. The reactor operators assisted staff members in revising drawings and by supplying information to members writing the manual. The operators were especially valuable in the latter function since they possessed several years of operating experience and contributed practical knowledge that proved quite helpful in the preparation of the manual.

In addition to the aforementioned revisions a new design manual has almost been completed. This will supplement the information cited in the original plant design manual.<sup>4</sup>

**Reactor Operator Training.** A very limited amount of reactor operation work has been carried on since the plant was shut down for the modification. In addition to procedural changes required by revisions within the containment shell, the plant operation will be further complicated by a number of heat exchangers located outside the shell. To refresh operators' knowledge and to give them a better understanding of the plant and its operation, as well as to familiarize them with the details of the added equipment, a training program was instituted. It was started in June of 1960 after the reactor was operated at power for a check-out. Lectures were given by the EBWR staff engineers and scientists covering just about every facet of basic information required for the operation of the facility. Some of the topics were:

- Basic power plant operation and practice
- Fundamental heat transfer
- Basic reactor physics
- Reactor safety
- Instrumentation and controls
- Steam and thermodynamic fundamentals
- Design philosophy and component description
- Water treatment

In addition, the shift supervisors were assigned the task of lecturing on systems or components that were somewhat of a specialty with them. Drawings of particular systems in the plant were placed nearby in easily visible locations for quick reference.

At the time of this writing the operators are being trained on the reactor console and plant operation. This will not only enhance their knowledge but also prepare them for integrating the remaining portion of the facility when the modifications have been completed.

As soon as vital heat-exchanger equipment is received and installed, the test program will be continued using a

stepwise power approach to determine the maximum stable operating power of the EBWR facility.

<sup>1</sup>V. Kolba, "EBWR Test Reports," ANL-6229 (Nov. 1960).

<sup>2</sup>J. A. De Shong, "Upping EBWR's Power," *Nucleonics* 16, 6, (June 1958), pp. 68-72.

<sup>3</sup>N. Balai and T. Kettles, "EBWR Pressure Vessel Modifications," ANL-6162 (to be published).

<sup>4</sup>"EBWR Design Manual," Supplement to ANL-5607 (to be published).

### LM-05180 7-3 Sodium Reactor Experiment Operating Experience, L. E. Glasgow (AI).

The SRE is a 20-Mwt graphite moderated experimental reactor, built and operated by Atomics International, a Division of North American Aviation, Inc.<sup>1</sup> The reactor heat is dissipated in the steam turbine generator of the Southern California Edison Company experimental station.<sup>2</sup> Typical steam conditions are 900°F at 650 psig; 1000°F steam has been achieved.

Plant design started July 1, 1954, construction was completed in March, 1957, and first power was in July, 1957. The reactor has been used to demonstrate the technical feasibility of the concept and to obtain engineering information applicable to large scale plants. The experience and data gained has been used extensively in the design of the Hallam plant.<sup>3</sup>

The overall plant has performed well and, despite the experimental nature of the plant, it has achieved a plant availability factor of 75% over a one-year period.<sup>4</sup> The principal cause of outage was failure of the tetralin-cooled freeze seals on the pumps. The present seals, utilizing NaK as a coolant, have given no difficulty.

The plant has shown excellent load-following capability. Load swings from one-half to full power at 20%/min, and nearly constant steam temperature (within 20°F) have been demonstrated.

The experimental fuel program has provided us with the equivalent of 20 years of reactor startups and shutdowns and fuel handling experience. The fuel washing system worked perfectly more than 1000 times and then on one occasion we experienced a pressure excursion in the wash cell. The system was redesigned to prevent a recurrence.

The main intermediate heat exchanger has been found to be insufficiently baffled at the U-bend, which results in a log mean temperature difference of 90°F compared to the 60°F predicted. Under 5% of full load the exchanger exhibits temperature stratification. A replacement exchanger has been built which eliminates these difficulties.<sup>5</sup>

The horizontal, once-through steam generator initially showed a temperature difference of 200°F from the bottom to top side. Southern California Edison, in cooperation with the manufacturer, remedied the difficulty by orificing the tubes.

The control and safety rod performance has been excellent. The maximum diametrical change observed on the control rods was 0.006 in., after 2140 Mwd (7.5% B<sup>10</sup> burnup). Maintenance on the drives has been extremely low requiring two brake disk replacements in three years. There have been no difficulties with the safety rods.

No difficulty has been experienced in maintaining the O<sub>2</sub> concentration below 10ppm by means of the gas-cooled

cold traps. Hot traps operating at 1300°F and utilizing stainless steel packing have been developed to remove the carbon, resulting from tetralin decomposition, from the SRE sodium.

Eight bellows-seal valves were replaced because of damage, resulting from solid sodium extruding through the pipe during preheating operations. No failures occurred with bellows-seal valves which remain heated. The freeze seal type valve has operated with 100% reliability.<sup>8</sup>

The principal instrumentation difficulties were due to line transients. This has been corrected by providing separate power for the instrumentation from a low torque to inertia motor generator sets.

The tetralin leak which developed in the main primary pump added approximately four gallons of tetralin to the main primary sodium.<sup>7-8</sup> The tetralin decomposed into hydrogen and carbon. The carbonaceous material lodged in the fuel channels, partially obstructed the flow and provided local coolant by-passing of the fuel. This resulted in overheating and damaging of the fuel elements to the extent that they swelled and stuck in the channels. Of the 43 fuel elements in the reactor, 13 were damaged. The upper halves of ten of the broken elements were removed by a modified standard procedure utilizing a new fuel handling machine.<sup>9</sup> An examination of the top of the core revealed a layer of black, flocculent, carbonaceous-appearing material on the tops of the cans. On top of this layer, and scattered at random, were about 82 separate fuel slugs, some bits of fuel cladding, and several pieces of wire wrap. These were removed.

Most of the flocculent carbonaceous material was removed by vacuuming the tops of the cans. This carbon material proved to be an excellent getter for fission fragments. Its specific activity was approximately a factor of  $10^5$  greater than that of the sodium. Sixteen moderator cans and the lower halves of the stuck fuel were removed as a unit.<sup>10</sup> The first can required one week for its removal; the last two hours. With the exception of the inert gases no fission fragments escaped the primary containment.

In spite of the release of fission fragments into the sodium, modification of the sodium piping has proven to be remarkably straightforward, simple and safe.

Following the mechanical recovery of the core, the reactor was refueled with fuel consisting of 7.6 w/o U in Th. The critical mass, temperature coefficient, flux distribution, relative element worths, and zero power transfer function measurements agreed with the calculations of these quantities within estimated accuracy.

An unexpected result from the physics investigation of the core was the appearance of a positive power coefficient. Power and flux ramp tests combined with hydraulic test data, critical assembly work, and an in-core bowing test with a specially constructed fuel element definitely established that bowing of the fuel element was the cause of the positive coefficient. Seven spare elements were wire-wrapped to prevent bowing and placed in the central region of the core. This reduced the coefficient from 9¢/Mw to 5.5¢/Mw, but at the same time introduced a 1% to 2% stable oscillation in the reactor flux. Wrapping five additional elements decreased the positive coefficient to 4¢/Mw and decreased the oscillation by one-half. Wrapping all core elements will bring the coefficient to -5.5¢/Mw and eliminate the oscillation.

Pile oscillator, flow oscillation, and noise analysis techniques are being employed to identify the detail mechanism involved in the reactivity oscillation.<sup>11</sup>

The following conclusions may be drawn from the SRE operating experience:

1. The technical feasibility of the Sodium Graphite Reactor concept has been amply demonstrated up to 1000°F.
2. Maintenance work on the core and the primary system can be accomplished in a simple, direct, and safe manner.
3. The containment features of the SRE primary system were proven by retaining all of the fission fragments released from the twelve severely damaged fuel elements.
4. The components which were developed for the SRE have proven to be functionally satisfactory. Improvements in the reliability aspects of the SRE pumps and valves should provide a plant availability factor in excess of 90%.
5. The equipment and techniques developed for studying physics of the first core have proven invaluable in resolving the anomalies observed on the second core.

<sup>1</sup>C. Starr and R. W. Dickinson, *Sodium Graphite Reactors*, Addison-Wesley, Reading, Mass., 1958, pp. 13-28.

<sup>2</sup>A. C. Werden, Jr., "First Atomic Power Station," *Electrical West*, Nov. 1956.

<sup>3</sup>R. J. Beeley and J. E. Mahlmeister, "Operating Experience with the Sodium Reactor Experiment and Its Application to the Hallam Nuclear Power Facility," NAA-SR-5464 (1960).

<sup>4</sup>R. W. Dickinson and L. E. Glasgow, "Operating Experience and Advanced Designs of Sodium Graphite Reactors," ASME 59-A-192 (1960).

<sup>5</sup>K. W. Foster, "Thermal Performance of the SRE Main Intermediate Heat Exchanger," NAA-SR-3775, (to be published).

<sup>6</sup>J. S. McDonald, "Valve Stem Freeze Seal for High Temperature Sodium Systems," NAA-SR-4869, (to be published).

<sup>7</sup>R. W. Dickinson, "Coolant Block Damages SRE Fuel," *Nucleonics*, 18, 1, January, 1960.

<sup>8</sup>A. A. Jarrett et al., "SRE Fuel Element Damage," NAA-SR-4488 (Aug. 1959).

<sup>9</sup>R. E. Durand, "Sodium Reactor Operating Experience," *Chem. Eng. Prog.* 57, No. 3, March, 1961.

<sup>10</sup>R. A. Lewis, "Detection of SRE Moderator Can Damage," *Trans. Am. Nuclear Soc.*, 3, No. 2, December, 1960.

<sup>11</sup>C. W. Griffin and J. G. Lundholm, "Measurement of the SRE Power Coefficient and Reactor Parameters Utilizing the Oscillator Techniques," NAA-SR-3763.

#### 7-4 Some Significant Aspects of Shippingport Operations, G. M. Oldham (DLC).

The No. 1 main unit generator at Shippingport Atomic Power Station was synchronized and placed into service on Duquesne Light Company's electrical distribution system on December 18, 1957. It is recognized that this first full-scale nuclear power plant is of a developmental nature and is operated with the primary objective of gaining information and advancing reactor technology. Basically, the information gained can be categorized into three general areas of interest, namely (1) design, (2) operations,