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TECHNICAL REPORTS SERIES No. 20

Heavy Water Lattices:

Second Panel Report

REPORT OF A PANEL
HELD IN VIENNA,
18-22 FEBRUARY 1963

INTERNATIONAL ATOMIC ENERGY AGENCY - VIENNA, 1963

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IAEA, VIENNA, 1963
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FOREWORD

The continuous progress being made in reactor design is due, to a large extent, to a clearer understanding of core physics. This advance has been made possible by the relatively recent development of powerful theoretical and experimental methods.

Realizing the importance of this subject, the International Atomic Energy Agency convened a panel on heavy-water lattices in 1959 and a panel on light-water lattices in 1962. Both meetings commanded wide interest and were very useful in bringing together and comparing data obtained in different countries. It was recommended that another meeting be convened early in 1963 to review once again the subject of heavy-water lattices in the light of progress made since 1959.

A second panel on heavy-water lattices was therefore held from 18 to 22 February 1963 in Vienna and was attended by prominent physicists from most of the laboratories engaged in this field throughout the world. The participants presented written contributions and status reports describing the past history and plans for further development of heavy-water reactors in their respective countries. Valuable discussions took place, during which recommendations for future work were formulated. All this material is presented in the following pages. It is hoped that all scientists engaged in this field will find it useful.

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For the sake of speed of publication the present Proceedings have been printed by composition typing and photo-offset lithography. Within the limitations imposed by this method, every effort has been made to maintain a high editorial standard; in particular, the units and symbols employed are to the fullest practicable extent those standardized or recommended by the competent international scientific bodies.

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CONTENTS

GENERAL SUMMARY 9
R. Ramanna (Chairman)

STATUS REPORTS

Status report on heavy water lattices from Canada 13
E. Critoph (Canada)
Past and projected wave in France on heavy-water reactors 14
R. Naudet (France)
Summary of the past history and plans for the further development of heavy-water reactors in the Federal Republic of Germany 16
W. Oldekop (Federal Republic of Germany)
Study of heavy water lattices in India 20
B.P. Rastogi and K.R. Srinivasan (India)
Development work on heavy-water-moderated reactors in Norway 24
V.O. Eriksen (Norway)
D_2O reactor physics activities in Switzerland 29
R.W. Meier (Switzerland)
Status of heavy-water reactors in the United Kingdom 31
J.E.R. Holmes (United Kingdom)
Status report – United States of America 32
F.E. Driggers (United States of America)
Status report for Yugoslavia 34
J. Pop-Jordanov (Yugoslavia)
Report on heavy water lattices study at the Institute for Theoretical and Experimental Physics, USSR 35
P.P. Blagovolin (USSR)

SUMMARIES OF DISCUSSIONS

Techniques for lattice evaluation 37
J.L. Crandall
Calculations for lattice parameters 39
B.I. Spinrad
Summary of computing techniques 41
F.E. Driggers
Neutron spectra 43
D.C. Leslie
Power, temperature and void coefficients 45
H. Ager-Hanssen
Burn-up physics 46
E. Critoph

SUPPORTING PAPERS

Highlights of Chalk River work on the physics of heavy water lattices since the 1959 IAEA Panel 51
R.E. Green, H. Märkl, C.B. Bigham, O. Okazaki, J.W. Hilborn and E. Critoph (Canada)

Rapport d'ensemble sur l'expérimentation AQUILON 93
Y. Girard et R. Naudet (France)
Description de quelques expériences récentes dans AQUILON 123
Y. Girard et R. Naudet (France)
Some theoretical studies on criticality calculations for small D_2O assemblies with high enrichment 147
K.H. Joest and G. Memmert (Federal Republic of Germany)
Pulsed neutron experiments on subcritical heavy water lattices (Abstract only) 163
H. Meister (Federal Republic of Germany)
Calculation of thermal neutron spectra in D_2O lattices 165
W. Oldekop (Federal Republic of Germany)
The age of neutrons in heterogeneous lattices 189
V.C. Deniz (India)
The study of the first ZERLINA core 201
V.C. Deniz (India)
Reactor physics experience obtained from the experimental operation of the Halden heavy-water boiling reactor 211
H. Ager-Hanssen and J.E. Lunde (Norway)
Buckling measurements of 3% enriched stainless-steel clad U_2O fuel elements in D_2O moderator 251
K. Bryhn-Ingebrigtsen, J. Smit and C.H. Millar (Norway)
Measurement of resonance absorption in U^{238} using a chemical separation technique for isolation of Np^{239} (Abstract only) 255
J. Thomassen and H.H. Windsor (Norway)
Heavy water lattice calculations in Sweden 257
B. Pershagen (Sweden)
Experimental reactor physics work on heavy water lattices in Sweden 305
R. Persson, E. Hellstrand and E. Johansson (Sweden)
Distributions fines dans des grappes pour réacteurs uranium métallique-eau lourde, refroidis par gaz 343
J.P. Schneeberger, B. Gloor, J. Marti, E. Perpignan (Switzerland)
Few-group nuclear design methods for heavy-water reactors 371
D. Hicks (United Kingdom)
A preliminary description of THULE 417
D.C. Leslie and M.J. Terry (United Kingdom)
A theoretical interpretation of the pressure-tube, heavy-water, zero-energy experimental in Dimple 445
D.A. Newmarch (United Kingdom)
Efficacy of experimental physics studies on heavy water lattices 503
J.L. Crandall et al. (United States of America)
BSQ, an IBM-704 code to calculate heavy water lattice parameters 551
F.E. Driggers (United States of America)
Calculated effects of neutron rethermalization in D_2O coolants 573
F.E. Driggers (United States of America)
Методика физических расчетов тяжеловодных реакторов с естественным ураном и обзор некоторых экспериментальных и теоретических работ 581
П.П. Благовошин (СССР)
Remarks on the physics of heavy water lattices 599
B.I. Spinrad and R.W. Meier (European Nuclear Energy Agency – ENEA)
Fast-neutron spectrum in ORGEL-type reactors 611
L. Amyot (EURATOM C.C.R., Ispra)
A simplified method for organic, heavy water lattice calculations 621
G. Casini, A. Kind and G. Rossi (EURATOM C.C.R., Italy)
Development programme for D_2O lattice reactivity calculations 637
G. Casini, A. Kind and G. Rossi (EURATOM, C.C.R., Ispra)
List of Participants 645

GENERAL SUMMARY

R. RAMANNA - CHAIRMAN

The second Panel meeting on the physics of heavy water lattices was convened in Vienna from 18 to 22 February 1963 by the International Atomic Energy Agency. The following scientists took part in the discussions either as Panel members or observers:

Canada:	Panel Member:	E. Critoph
Federal Republic of Germany:	Panel Member:	W. Oldekop
	Observers:	K.H. Joest H. Meister
France:	Panel Member:	R. Naudet
	Observer:	Y. Girard
India:	Panel Member:	R. Ramanna (Chairman)
Norway:	Panel Member:	V.O. Eriksen
	Observers:	H. Ager-Hanssen J.E. Lunde C.H. Millar
Sweden:	Panel Member:	B. Pershagen
	Observer:	R. Persson
Switzerland:	Panel Member:	R.W. Meier
	Observers:	T. Auerbach J.P. Schneeberger
United Kingdom:	Panel Member:	J.E.R. Holmes
	Observers:	C.J. Kenward D.C.M. Leslie
United States of America:	Panel Member:	F.E. Driggers
	Observers:	J.L. Crandall H. Kouts B.I. Spinrad

USSR:	Panel Member:	P.P. Blagovolin
Yugoslavia:	Observer:	J. Pop-Jordanov
ENEA:	Observer:	H. Smets
EURATOM:	Observers:	G.P. Casini W. Hage A. Kind F. Lafontaine

The number of laboratories represented at this meeting was very much more than at the first one, a fact which demonstrated the increased interest in this type of physics. The discussions were specially distinguished by a free exchange of views on the contributed papers, and the Panel was able to summarize a series of recommendations for further work in this field. The sessions were devoted to status summaries on progress in various countries interested in heavy water lattice physics, evaluation of the replacement technique and exponential experiments, discussions on the various components of the four-factor formula and the methods to calculate this by using high-speed computers, neutron spectra within the lattice, problems concerning power and void coefficients and, finally, burn-up physics.

The recommendations of the Panel are summarized in various reports compiled by some of the scientists attending the meeting and are reproduced in these Proceedings. These summaries were discussed at the final session and several interesting and valuable comments were made. It was suggested that more intensive experiments should be conducted for lattices containing thorium in order to get more information on thorium breeders. Also it was mentioned that some experiments along these lines have been carried out at Argonne, and at Brookhaven a programme is being undertaken on the study of mixed oxide lattices containing uranium-233 and thorium.

There was considerable discussion on the merits of the substitution techniques and their regions of validity and also on the possible use of the pulsed neutron technique. It was recommended that experiments on substitution methods should involve a complete set of measurements and not be merely restricted to buckling measurements. Only through such detailed experiments is it possible to estimate the range of the validity of such techniques.

It was pointed out that the measurements on the resonance integral conducted by various groups show a discrepancy well above experimental error. It was suggested that these experiments should be repeated and a critical review of measurements and interpretations of these should be undertaken at some centre. There was also a short discussion on whether it is possible to define a minimum theoretical description for the evaluation of any of the reactor parameters. The view of the Panel was that no useful purpose would be served by undertaking to define such a minimum.

One of the important problems in reactor physics is the inability to measure the neutron spectrum at any given point inside a reactor lattice. The Panel noted that theoretical investigations are of the greatest importance in predicting reactor neutron spectra, and for such investigations the inform-

ation on the scattering law is essential. A semi-empirical approach using an adjusted scattering law would be of some value in preliminary investigations.

While discussing the problems of temperature and void coefficient, the Panel was strongly of the opinion that experiments in reactor physics should be undertaken not only with newly built unpoisoned lattices but also with assemblies which have been operating over a period of time. This would help in understanding both operating coefficients and burn-up factors. Among other points raised by the Panel, the need for fundamental nuclear data, especially those concerning fission products and plutonium isotopes, was stressed. The Panel also expressed the view that it is necessary to have a compilation centre for reactor physics constants, as the results of investigations in various groups all over the world are not easily available to each another. This would facilitate inter-comparison and avoid duplication. It was felt that the IAEA would be the most suitable centre for such compilation work.

The majority of the participants have expressed the opinion that another panel on Heavy Water Lattices should be convened in 2 - 3 years' time after this meeting.