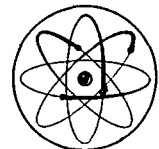


**PHYSICAL
RESEARCH
PROGRAM:**

**RESEARCH CONTRACTS AND
STATISTICAL SUMMARY**

DIVISION OF PHYSICAL RESEARCH

July 1, 1973



UNITED STATES ATOMIC ENERGY COMMISSION

FOREWORD

Prior to 1972, the then Division of Research published separately the reports entitled "Research Contracts in the Physical Sciences" and "A Statistical Summary of the Physical Research Program." On July 1, 1972, the first consolidated version of the information concerning the basic physical research program previously contained in these two reports was issued.

In December 1971, the Division of Research was redesignated the Division of Physical Research and the controlled fusion program separated from it to become a new Division of Controlled Thermonuclear Research.

The AEC-sponsored physical research program consists of theoretical and experimental investigations designed to support the objectives of the AEC's nuclear and non-nuclear energy efforts. The program is directed toward discovery of natural laws and new knowledge, and to improved understanding of the physical sciences as related to the development, use, and control of nuclear and other forms of energy. The ultimate goal is to develop a scientific underlay for the overall AEC effort and the fundamental principles of natural phenomena so that these phenomena may be understood and new principles formulated.

The Director of the Division of Physical Research carries out his responsibilities for the direction of the physical research program through four Assistant Directors who, until July 1973, managed six scientific categories (subprograms) in the AEC budget for Physical Research, viz., Assistant Directors for (1) high energy physics, (2) physics and mathematics (categories: medium energy physics, low energy physics, mathematics and computer sciences), (3) chemistry, and (4) metallurgy and materials. A fifth Assistant Director (for Administration) assists in the coordination of the budgetary and non-technical aspects of the program, such as budget preparation, proposal and contract administration, reporting, travel, personnel, etc.

Effective July 22, 1973, the Division of Physical Research was reorganized in order to provide an interdisciplinary programmatic orientation allowing improved focus on areas of common research objectives and to provide for better coupling of the physical research programs to the AEC's current and future missions. Under this reorganization, the six discipline-oriented budget categories referred to above were restructured into four functional program categories: (1) high energy physics, (2) nuclear sciences, (3) materials sciences, and (4) molecular sciences, each headed by an Assistant Director.

Since this report is based entirely on FY 1973 data and represents the status of the physical research program as of July 1, 1973, no attempt has been made to recast the information contained herein into the new structure.

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MAJOR RESEARCH CENTERS AND RESEARCH CONTRACTS

Approximately three-fourths of the total physical research program costs are associated with research conducted in AEC-owned, contractor (non-Federal)-operated, Federally Funded Research and Development Centers (FFRDC's). The major portion of these costs are spent at the well known multi-program "national" laboratories at Ames, Iowa; Argonne, Illinois; Brookhaven, New York; Los Alamos, New Mexico; Berkeley, California; and Oak Ridge, Tennessee; and at the comparable high energy physics research centers at Batavia, Illinois; and Stanford, California.

A little less than one-fourth of the costs are associated with the support of research conducted in other laboratories (designated "off-site"). Virtually all of the off-site research is conducted at educational institutions, and is based almost entirely on unsolicited proposals.*

There is no clear line of demarcation between National Laboratories, other Federally Funded Research and Development Centers, and off-site laboratories. The AEC investment in facilities ranges from zero for some contractors to tens of millions of dollars for others, and the annual level of AEC support ranges from a few thousand dollars for some contractors, to tens of millions of dollars for others--the spectrum is broad with no significant breaks.

Some of the FFRDC's research and development activities include programs in, e.g., applied technology, biomedical and environmental research, reactor research and development, waste management and transportation, or controlled thermonuclear research. These activities are funded from sources other than the Division of Physical Research. The physical research program at these FFRDC laboratories provides, in varying degrees, some of the basic investigations underlying the more applied or developmental activities of such laboratories. Other FFRDC's include laboratories that are engaged in research in a single, well-defined area. All FFRDC's have the following common characteristics:

1. They are operated for the Federal Government by universities, not-for-profit organizations or private industry.
2. They are treated as national facilities.
3. They represent large investments (several millions of dollars) in AEC-owned capital facilities.
4. They have large annual levels (several millions of dollars) of AEC support.

The objective of the basic research program is to search for and discover new knowledge within the mission-oriented framework of AEC. It is from this expanding reservoir of knowledge that developmental accomplishments are ultimately achieved. The off-site program complements the FFRDC's in the advancement of science in those disciplines that are fundamental to AEC's programs.

The off-site contract-research program has a number of distinct benefits:

1. When the amount provided by AEC is added to other funds available to the contractor, the effectiveness of the contractor's program, as well as the basic research effort of AEC, is increased.
2. AEC receives the services, in basic research activities fundamental to AEC's future capabilities, of highly qualified scientists who prefer employment at outside laboratories or who prefer to teach and to do research at educational institutions.
3. The contract-research program, by providing for the conduct of research at educational institutions, contributes to the training of scientists in fields relevant to AEC's programs.

*The direct support provided under the physical research program for miscellaneous other activities, such as for other Federal agencies, National Academy of Science committees, conferences, book translations, etc., is of such type and modest extent that it is excluded from this report.

The following tables summarize the level of effort of the physical research program as of the end of Fiscal Year 1973. No attempt has been or should be made to add the dollar levels of FFRDC's to those of the off-site program in this analysis since they are not arrived at on comparable bases. The funding levels of FFRDC's reflect the FY 1973 costs for operations and capital equipment while the dollar figures for the off-site program represent the contract amounts authorized, as opposed to costs incurred, for all contracts in effect as of the end of FY 1973, including funds provided for equipment regardless of who retains title. The figures for scientific man-years and publications are based on information provided in contract proposals and/or other information supplied by contractors. Man-year figures do not include an estimated 1,976 graduate students engaged in performing research at the universities and laboratories (\$ in thousands):

<u>AEC Budget Category</u>	<u>Amount</u>	<u>FFRDC's</u>				
		<u>Man- Years</u>	<u>Publi- cations</u>	<u>Off-Site Contract Research</u>		
				<u>Amount*</u>	<u>Man- Years</u>	<u>Publi- cations</u>
High Energy Physics	\$120,733	1,292	583	\$ 22,593	452	602
Medium Energy Physics ...	15,414	38	115	3,919	72	55
Low Energy Physics	18,556	297	350	8,981	193	433
Mathematics & Computers .	2,479	52	73	2,431	31	99
Chemistry	39,272	601	794	7,081	168	522
Metallurgy & Materials ..	19,392	331	545	6,104	92	373
General Purpose Equipment	1,023	-	-	-	-	-
TOTAL	\$216,869	2,611	2,460	\$ 51,109	1,008	2,084

On July 1, 1973, there were 330 off-site research agreements in effect, at a total estimated level of effort of \$56.3 million, with the AEC contributing the \$51.1 million referred to above; all with educational and a few other non-profit research institutions (\$ in thousands):

	<u>Number of Agreements</u>	<u>Total Project Cost</u>	<u>Contractor Contribution**</u>	<u>AEC Contribution</u>
High Energy Physics	45	\$ 24,546	\$ 1,953	\$ 22,593
Medium Energy Physics	19	4,186	267	3,919
Low Energy Physics	35	10,544	1,563	8,981
Mathematics & Computers	15	2,790	359	2,431
Chemistry	123	7,784	703	7,081
Metallurgy & Materials	93	6,460	356	6,104
TOTAL	330	\$ 56,310	\$ 5,201	\$ 51,109

*Represents amount of AEC estimated support ceiling included in the latest extension of contracts in effect as of 7/1/73. (Contracts are usually written for one year and extended annually as appropriate.)

**This is a lower figure than actual contractor contributions since there is a large number of contracts where the universities contribute to the cost of the research but do not show or estimate a specified dollar amount.

On the following pages are presented a statistical analysis of the physical research program in more detail. Separate analyses are made for the research conducted at FFRDC's and for the off-site program. The analysis is based on information contained in proposals and other material supplied by the contractors; much of the data, especially for the FFRDC's and the larger of the off-site projects, was provided specifically for this report. Definitions used are:

Equipment: Any item individually costing more than \$200 (sometimes \$300) and that is expected to have an extended period of service, generally one year or more, in its original form. Title may vest in either the Government or in the contractor.

Publications: Usually refer to journal publications but includes letters such as appear in Physical Review letters, and notes such as appear in Journal of the American Chemical Society, and other journals. Contributions to books are included if they represent summaries and evaluations of a limited area, e.g., contributions to the Annual Review of Nuclear Science. Also included are papers (not abstracts) that appear in published proceedings of technical meetings including international meetings, and installation reports that are available for sale.

Scientific Man-Year: A scientific man-year is the full-time equivalent of a research employee who has a B.S. degree, the equivalent, or better, and who is directly engaged in or supervising the activity. Ten scientific employees engaged on a half-time basis would constitute five man-years.

For the off-site contract-research (university) program, the following definitions are used:

Principal Investigators: Usually are members of the academic staff and includes professors, chairmen/heads of departments, associate professors, or assistant professors who direct the project.

Other Permanent Scientific Staff: Are generally professors, associate professors or assistant professors who work with the principal investigators. (The principal investigator and other professional staff usually divide their time between teaching and the research project.) Also includes visiting scientists, i.e., those at the faculty level but who do not have a position on the faculty of the educational institution where they are temporarily working.

Research Associates: Are generally working full-time on the research investigation and usually are in the post-doctoral category.

Research Assistants: Usually are graduate students working for their doctorate or masters degree.

FEDERALLY FUNDED RESEARCH AND DEVELOPMENT CENTERS

For purposes of this report, the following may be considered FFRDC's operated for AEC (including only those supported in whole or in part under the physical research program). The listing is consistent with "Federally Funded Research and Development Centers" as defined by the National Science Foundation.

<u>Name of Laboratory, Contractor, and Principal Staff</u>	<u>Level of Physical Research Program Support - FY 1973</u>	
	<u>Operations</u>	<u>Equipment</u>
	(in thousands)	
AMES LABORATORY, Iowa State University of Science and Technology, Ames, Iowa	\$ 6,063	\$ 562
Director Robert Hansen		
Deputy Director Velmer A. Fassel		
ARGONNE NATIONAL LABORATORY, University of Chicago and Argonne Universities Association, Argonne (Lemont), Illinois	33,897	2,734
Director Robert G. Sachs		
Deputy Directors:		
For Research M. V. Nevitt		
For Operations R. V. Laney		
Associate Directors:		
High Energy Physics T. H. Fields (Acting)		
Physical & Biological		
Research M. V. Nevitt (Acting)		
Educational Affairs S. A. Miller		
Engineering Research &		
Development J. A. Kyger		
Energy & Environment E. G. Pewitt		
BROOKHAVEN NATIONAL LABORATORY, Associated Universities, Inc., Upton, New York	37,729	4,017
Director George H. Vineyard		
Associate Directors:		
Life Sciences, Chemistry,		
and Safety Victor P. Bond		
High Energy Physics Ronald Rau		
Administration Vincent R. O'Leary		
LAWRENCE BERKELEY LABORATORY, University of California, Berkeley, California	29,181	1,671
Director Edwin M. McMillan		
Associate Directors:		
Donner Laboratory of Biology		
and Medicine James L. Born		
Inorganic Materials Research		
Division Leo Brewer		
Chemical Biodynamics Lab. ..		
Melvin Calvin		
Nuclear Chemistry Division .		
Glenn T. Seaborg		
Physics Division		
Robert W. Birge		
Administration		
Harold A. Fidler		
Support		
Elmer L. Kelly		

<u>Name of Laboratory, Contractor, and Principal Staff</u>	<u>Level of Physical Research Program Support - FY 1973</u> (in thousands)	
	<u>Operations</u>	<u>Equipment</u>
LOS ALAMOS SCIENTIFIC LABORATORY, University of California, Los Alamos, New Mexico	\$ 9,433	\$ 2,969
Director Harold M. Agnew Technical Associate Director . Raemer E. Schreiber		
MOUND LABORATORY, Monsanto Research Corp., Miamisburg, Ohio	440	135
Project Director (President, Monsanto Research Corp.) ... Howard K. Nason Director, Mound Lab. (Vice President, Monsanto Research Corp.) Richard K. Flitcraft		
NATIONAL ACCELERATOR LABORATORY, Universities Research Association, Batavia, Illinois	19,194	14,012
Director Robert R. Wilson Deputy Director Edwin L. Goldwasser Associate Directors: Planning Advice Thomas L. Collins Planning & Programming James R. Sanford		
OAK RIDGE NATIONAL LABORATORY, Union Carbide Corp., Oak Ridge, Tennessee	25,514	1,638
Director Floyd L. Culler (Acting) Associate Directors: Administration F. R. Bruce Basic Physical Sciences A. Zucker Biomedical & Environmental Services J. R. Totter Reactor & Engineering D. B. Trauger		
PACIFIC NORTHWEST LABORATORY, Battelle Memorial Institute, Richland, Washington	664	80
Director Edward L. Alpen Associate Directors: Research & Development James J. Fuquay Research & Development D. L. Condotta		
STANFORD LINEAR ACCELERATOR CENTER, Stanford University, Palo Alto, California	25,028	1,908
Director W. K. H. Panofsky Deputy Director Sidney D. Drell Associate Directors: Research Division J. Ballam Technical Division R. B. Neal Business Services F. V. L. Pindar Administrative Services R. H. Moulton, Jr.		

Costs and Manpower
As of July 1, 1973

<u>Laboratory</u>	<u>Total Costs</u> <u>(In thousands)</u>	<u>Scientific Man-Years</u>		<u>Number of</u> <u>Graduate Students</u> <u>Engaged in Research</u>	<u>Number of</u> <u>Publications</u>
		<u>Permanent</u>	<u>Visiting</u>		
Ames Laboratory	\$ 6,625	66	2	188	255
Argonne National Laboratory	36,631	545	68	143	592
Brookhaven National Laboratory ..	41,746	402	64	112	212
Lawrence Berkeley Laboratory	30,852	362	72	241	521
Los Alamos Scientific Laboratory	12,402	88	11	7	84
Mound Laboratory	575	8	0	0	15
National Accelerator Laboratory .	33,206	212	27	0	109
Oak Ridge National Laboratory ...	27,152	363	20	32	555
Pacific Northwest Laboratory	744	8	1	4	16
Stanford Linear Accelerator Center	26,936	278	14	24	101
TOTAL	\$ 216,869	2,332	279	751	2,460

AMES LABORATORY

<u>Category</u>	<u>Total Costs</u> <u>(In thousands)</u>	<u>Scientific Man-Years</u>		<u>Number of</u> <u>Graduate Students</u> <u>Engaged in Research</u>	<u>Number of</u> <u>Publications</u>
		<u>Permanent</u>	<u>Visiting</u>		
High Energy Physics	\$ 499	7	0	19	15
Low Energy Physics	584	4	0	12	18
Mathematics and Computers	148	2	0	3	16
Chemistry	2,721	23	1	96	119
Metallurgy and Materials	2,611	30	1	58	87
General Purpose Equipment	62	-	-	-	-
TOTAL	\$ 6,625	66	2	188^{a/}	255^{b/}

a/Includes 55 students engaged in research activities but whose salaries are not paid by Ames.

b/Includes 6 publications that resulted from collaborative efforts with other universities.

ARGONNE NATIONAL LABORATORY

<u>Category</u>	<u>Total Costs</u> <u>(In thousands)</u>	<u>Scientific Man-Years</u>		<u>Number of</u> <u>Graduate Students</u> <u>Engaged in Research</u>	<u>Number of</u> <u>Publications</u>
		<u>Permanent</u>	<u>Visiting</u>		
High Energy Physics	\$ 16,846	181	27	82	126
Medium Energy Physics	170	3	0	0	0
Low Energy Physics	4,745	70	11	15	114
Mathematics and Computers	1,084	25	1	18	25
Chemistry	7,969	160	12	17	180
Metallurgy and Materials	5,817	106	17	11	147
TOTAL	\$ 36,631	545	68	143^{a/}	592^{b/}

a/Includes 134 students engaged in research activities but whose salaries are not paid by ANL.

b/Includes 145 publications that resulted from collaborative efforts with other universities.

BROOKHAVEN NATIONAL LABORATORY

<u>Category</u>	<u>Total Costs</u> <u>(In thousands)</u>	<u>Scientific Man-Years</u>		<u>Number of</u> <u>Graduate Students</u> <u>Engaged in Research</u>	<u>Number of</u> <u>Publications</u>
		<u>Permanent</u>	<u>Visiting</u>		
High Energy Physics	\$ 26,770	208	20	32	35
Medium Energy Physics	260	4	0	0	0
Low Energy Physics	5,014	58	9	14	35
Mathematics and Computers	661	12	1	0	7
Chemistry	5,094	83	18	23	89
Metallurgy and Materials	3,089	37	16	43	46
General Purpose Equipment	858	-	-	-	-
TOTAL	\$ 41,746	402	64	112^{a/}	212^{b/}

^{a/}Includes 104 students engaged in research activities but whose salaries are not paid by BNL.

^{b/}Includes 64 publications that resulted from collaborative efforts with other universities.

LAWRENCE BERKELEY LABORATORY

<u>Category</u>	<u>Total Cost</u> <u>(In thousands)</u>	<u>Scientific Man-Years</u>		<u>Number of</u> <u>Graduate Students</u> <u>Engaged in Research</u>	<u>Number of</u> <u>Publications</u>
		<u>Permanent</u>	<u>Visiting</u>		
High Energy Physics	\$ 16,166	180	35	46	185
Medium Energy Physics	1,768	7	10	4	16
Low Energy Physics	336	10	0	3	10
Mathematics and Computers	213	3	0	4	11
Chemistry	10,331	141	22	98	213
Metallurgy and Materials	1,935	21	5	86	86
General Purpose Equipment	103	-	-	-	-
TOTAL	\$ 30,852	362	72	241^{a/}	521^{b/}

^{a/}Includes 48 students engaged in research activities but whose salaries are not paid by LBL.

^{b/}Includes 42 publications that resulted from collaborative efforts with other universities.

LOS ALAMOS SCIENTIFIC LABORATORY

<u>Category</u>	<u>Total Costs</u> <u>(In thousands)</u>	<u>Scientific Man-Years</u>		<u>Number of</u> <u>Graduate Students</u> <u>Engaged in Research</u>	<u>Number of</u> <u>Publications</u>
		<u>Permanent</u>	<u>Visiting</u>		
Medium Energy Physics	\$ 12,241	86	10	6	81
Low Energy Physics	101	1	1	1	3
Chemistry	60	1	0	0	0
TOTAL	\$ 12,402	88	11	7	84^{a/}

^{a/}Includes 7 publications that resulted from collaborative efforts with other universities.

OAK RIDGE NATIONAL LABORATORY

<u>Category</u>	<u>Total Cost</u> <u>(In thousands)</u>	<u>Scientific Man-Years</u>		<u>Number of</u> <u>Graduate Students</u> <u>Engaged in Research</u>	<u>Number of</u> <u>Publications</u>
		<u>Permanent</u>	<u>Visiting</u>		
High Energy Physics	\$ 310	6	1	0	12
Medium Energy Physics	975	14	0	2	18
Low Energy Physics	7,462	123	4	8	157
Mathematics and Computers	373	8	0	1	14
Chemistry	12,804	129	8	17	187
Metallurgy and Materials	5,228	83	7	4	167
TOTAL	\$ 27,152	363	20	32^{a/}	555^{b/}

^{a/}Includes 32 students engaged in research activities but whose salaries are not paid by ORNL.

^{b/}Includes 137 publications that resulted from collaborative efforts with other universities.

OTHER FFRDC LABORATORIES

<u>Category</u>	<u>Total Costs</u> <u>(In thousands)</u>	<u>Scientific Man-Years</u>		<u>Number of</u> <u>Graduate Students</u> <u>Engaged in Research</u>	<u>Number of</u> <u>Publications</u>
		<u>Permanent</u>	<u>Visiting</u>		
MOUND LABORATORY					
Low Energy Physics	190	3	0	0	7
Chemistry	293	3	0	0	6
Metallurgy and Materials	92	2	0	0	2
NATIONAL ACCELERATOR LABORATORY					
High Energy Physics	33,206	212	27	0	109
PACIFIC NORTHWEST LABORATORY					
Low Energy Physics	124	2	1	4	6
Metallurgy and Materials	620	6	0	0	10
STANFORD LINEAR ACCELERATOR CENTER					
High Energy Physics	26,936	278	14	24	101

OFF-SITE CONTRACT-RESEARCH PROGRAM

In conducting this program, AEC typically uses a special research support agreement. Under this type of agreement, the AEC will contribute to the cost of performing the research, up to a specified amount (referred to as the "support ceiling"), in consideration for the performance of proposed research activities broadly defined in the agreement and in accordance with the provisions of the agreement.

When the special research support agreement is used for not-for-profit organizations other than educational institutions, AEC's commercial cost principles may be used in determining actual cost, or the contract provisions may be revised to provide for a lump-sum payment to the contractor in consideration for its commitment to perform particular research at a specified level of effort.

Very large projects, and in all cases those with an estimated cost in excess of \$500,000 annually, are financed by means of a cost-type contract which permits closer AEC surveillance of the work in accordance with appropriate contractual provisions not included in the special research support agreement. This type of contract is generally used for large-scale research programs performed in laboratories using equipment or facilities that are usually either partially or wholly AEC owned or controlled and/or for projects that do not lend themselves to accurate cost estimates. The total costs of the research may be shared by the contractor and AEC.

Occasionally, no-fund contracts are used in the contract-research program when AEC loans property to an outside organization as AEC's support to the research project or when the organization wishes to enter into a study contract in a certain area of research before it actually undertakes the research. Also, contracts are frequently extended without additional funds being added when the research project is being completed or terminated and additional time is required to bring the project to an orderly close.

In most cases, the contractor proposes to share in the cost of the work conducted under the contract. In order to support the maximum number of important and worthwhile projects within the limits of available funds and to have tangible evidence of a university's interest in the proposed research, it is AEC policy to encourage cost-sharing by the universities. Although sharing by the institution in the cost of the project is desirable, such sharing is not a pre-requisite for AEC support, which, in the final analysis, is determined by the prospective quality of the proposed research, the relative interest of AEC and the institution in the research, and availability of funds on the part of both AEC and the contractor. Thus, AEC will pay up to the full cost of a research project.

Most research contracts are written for terms of one year, renewable for additional annual terms. Sometimes contract terms may run somewhat more or less than one year (e.g., 9 or 15 months), usually for the purpose of establishing a different renewal date. There may also be cases where the contract may be written for several (usually three) years, but with the legal commitment for funding remaining on an annual basis. Occasionally, multi-year contracts with full funding are executed, generally where procurement of a major piece of equipment is involved, or where the nature of the research project is such that a clearly defined, fixed term can be established within which the entire research can be carried out.

In practice, contracts tend to run for several years, some for as much as ten years or more. Most research projects are not of the type that can be completed in one year, or in any specified longer time period that can be estimated in advance with reasonable accuracy. This is informally recognized by the parties concerned, whenever a new research project is approved for support and the customary one year contract written.

An examination of the age at termination of contracts that have terminated in recent years shows that about 15% had been in effect for less than 3 years, some 25% for 3 to 5 years, 30% for 5 to 10 years, and about 30% for 10 years or more, and that the average age at termination was $7\frac{1}{2}$ years.

Proposals for research contracts are usually initiated by the scientist interested in doing the work and are submitted through administrative channels of his institution to the appropriate division at the AEC Headquarters, depending on the scientific area of the proposed research project. Under the various divisions listed below are examples of the scientific areas falling within their cognizance:

Division of Applied Technology:

General energy development, including non-nuclear technology concerned with all phases of energy production, conversion, transmission, and storage, and environmental effects thereof;
Applications of underground explosions, including nuclear and non-nuclear, for resource recovery and other applications;
Isotopes development, with emphasis on energy-related applications.

Division of Biomedical & Environmental Research:

Life Sciences, including medicine, biology, ecology and marine studies;
Atmospheric sciences;
Radiological and chemical physics;
Health protection and instrumentation technology;
Nuclear education and training; Faculty Institutes and fellowships and traineeships.

Division of Controlled Thermonuclear Research:

Plasma physics as related to controlled thermonuclear processes;
Fusion power and energy conversion technology.

Division of Physical Research:

Physical Sciences, covering chemistry, metallurgy, ceramics, solid state physics, elementary particle physics, nuclear structure physics, atomic physics, and mathematics and computer research.

Division of Reactor Research and Development:

General reactor technology, fast breeder reactor development, nuclear reactor safety, and environmental effects of central power station heat rejection and utilization.

Division of Waste Management and Transportation:

Volume reduction and solidification technology for radioactive waste;
Waste treatment technology;
Decontamination technology, developments for waste storage and disposal;
Packaging developments for shipment of radioactive materials.

Those interested in submitting proposals for research support under this program may obtain a copy of a "Guide for the Submission of Research Proposals" from AEC Headquarters, Washington, D. C., 20545, or from an AEC field office.

Scientific reports on basic research investigations are usually published in the open literature. Special reporting of results in detail before they are ready for publication generally is not required of the contractors. AEC supports open publication and wide dissemination as the normal and most desirable means for reporting the findings of fundamental research.

Contract-research projects in effect as of July 1, 1973, and supported by the AEC Headquarters Division of Physical Research are listed on pp. 22-38, by AEC Budget Category, and including the name and location of the contractor, the name(s) of the principal investigator(s), a short descriptive title of the research, and the level of AEC support (i.e., contract amount authorized, as opposed to costs incurred and including funds provided for equipment) during the most recent funding period. The amounts listed are for one year unless otherwise indicated.

During Fiscal Year 1973, the Division of Physical Research received 222 formal unsolicited proposals for new research, representing requests for a total of \$11.1 million. On hand at the beginning of FY 1973 pending reviews were 140 new proposals requesting \$6.1 million, for a total of 362 proposals representing requests for \$17.2 million (\$ in millions):

	<u>On Hand 7/1/72</u>	<u>Received in FY 1973</u>	<u>Total</u>
High Energy Physics	20 - \$ 1.0	28 - \$ 1.8	48 - \$ 2.8
Medium Energy Physics	24 - 1.2	8 - .5	32 - 1.7
Low Energy Physics	54 - 1.8	57 - 2.5	111 - 4.3
Mathematics & Computers	2 - .6	23 - .7	25 - 1.3
Chemistry	16 - .6	25 - 2.6	41 - 3.2
Metallurgy & Materials	24 - .9	81 - 3.0	105 - 3.9
TOTAL	140 - \$ 6.1	222 - \$11.1	362 - \$17.2

	<u>Approved in FY 1973</u>		<u>Declined, Etc. in FY 1973</u>		<u>On Hand 6/30/73</u>	
High Energy Physics	3	- \$.34	26	- \$ 1.1	19	- \$ 1.4
Medium Energy Physics	3	- .08	24	- 1.3	5	- .4
Low Energy Physics	0	- 0	47	- 1.4	64	- 2.9
Mathematics & Computers ..	3	- .14	21	- 1.1	1	- .1
Chemistry	4	- .12	25	- 1.0	12	- 2.0
Metallurgy & Materials ...	8	- .23	71	- 2.6	26	- 1.0
TOTAL	21	- \$.91	214	- \$ 8.5	127	- \$ 7.8

Competition for available funds for new research projects has become increasingly severe in recent years, with new award amounts declining sharply since 1965 (\$ in millions):

<u>Fiscal Year</u>	<u>On Hand at Beginning of Year</u>	<u>Received During Year</u>	<u>Approved During Year</u>	<u>Declined, etc. During Year</u>	<u>On Hand at End of Year</u>
1965	184	336 - \$ 32.9	60 - \$ 6.1	276 - \$ 25.0	184
1966	184	366 - 33.8	58 - 5.1	331 - 39.9	161
1967	161	391 - 42.1	56 - 3.2	292 - 16.2	204
1968	204	358 - 41.7	58 - 2.2	356 - 36.4	148
1969	148	417 - 42.3	76 - 2.6	270 - 41.8	219
1970	219	412 - 46.6	31 - 1.5	421 - 68.7	179
1971	179	326 - 14.4	18 - .9	321 - 14.6	166
1972	166	200 - 8.7	21 - .7	205 - 11.5	140
1973	140	222 - 11.1	21 - .9	214 - 8.5	127

Under AEC's annual review and renewal system, the yearly turnover rate, i.e., numbers of new projects approved and existing contracts terminated, until recently has tended to be in the 10-15% range, with an average of some 60 new contracts written and a corresponding number of old contracts terminating each year. In recent years, however, numbers of new projects started have been sharply lower and terminations higher, resulting in a significant reduction in numbers of active contracts. New contracts, for administrative reasons, sometimes are written as separate new tasks under an existing contract; likewise, existing contracts occasionally may be split into two or more separate contracts. The following table illustrates the situation FY 1965-1973 (\$ in millions):

<u>Fiscal Year</u>	<u>New Contracts</u>	<u>Contract Terminations</u>	<u>No. of Contracts at End of Year</u>
1965	60 - \$ 6.1	59 - \$ 1.1	493 - \$ 65.8
1966	58 - 5.1	54 - 1.4	505 - 66.4
1967	56 - 3.2	41 - .9	516 - 71.0
1968	58 - 2.2	48 - 1.5	525 - 71.1
1969	76 - 2.6	58 - 1.2	543 - 71.1
1970	31 - 1.5	59 - 2.1	515 - 68.5
1971	18 - .9	40 - 1.5	484 - 61.7
1972	21 - .7	142 - 9.8	368 - 50.2
1973	21 - .9	57 - 2.5	330 - 51.1

Again here, it is important to note that dollar figures pertaining to the off-site program represent contract amounts authorized, as opposed to costs incurred, and include funds provided for equipment regardless of who takes title.

CONSOLIDATED BUDGET OF THE 330 OFF-SITE PROJECTS
INCLUDED IN THE PHYSICAL RESEARCH PROGRAM
As of July 1, 1973
(Dollars in Thousands)

Items of Expense

SRSA Projects	Total		High Energy Physics		Medium Energy Physics		Low Energy Physics		Math and Computers		Chemistry		Metallurgy and Materials	
	Total	%		%		%		%		%		%		%
Salaries and Wages	\$ 8,118	51.0	1,254	48.2	354	42.2	908	56.2	293	59.1	2,921	50.8	2,388	51.7
Equipment	764	4.8	91	3.5	151	18.0	50	3.1	5	1.0	286	5.0	181	3.9
Materials and Supplies	2,445	15.4	555	21.3	111	13.3	163	10.1	29	5.9	851	14.8	736	15.9
Travel	450	2.8	131	5.0	70	8.4	45	2.8	13	2.6	126	2.2	65	1.4
Communications	29	.2	6	.2	4	.5	4	.2	1	.2	7	.1	7	.2
Publication Costs	228	1.4	39	1.5	7	.8	18	1.1	8	1.6	89	1.5	67	1.4
Indirect Expenses	3,892	24.4	528	20.3	141	16.8	428	26.5	147	29.6	1,469	25.6	1,179	25.5
TOTAL	\$15,926	100.0	2,604	100.0	838	100.0	1,616	100.0	496	100.0	5,749	100.0	4,623	100.0
Contributed by Universities	1,625	10.2	385	14.8	76	9.1	242	15.0	17	3.4	637	11.1	268	5.8
Supported by AEC	14,301	89.8	2,219	85.2	762	90.9	1,374	85.0	479	96.6	5,112	88.9	4,355	94.2
Incl. Unexpended Balance of ..	364		79		16		12		4		167		86	

Cost-Type Projects

Salaries and Wages	\$18,334	45.4	9,579	43.6	1,530	45.7	4,214	47.2	1,201	52.3	999	49.1	811	44.2
Equipment	3,452	8.5	2,033	9.3	258	7.7	627	7.0	194	8.5	171	8.4	169	9.2
Materials and Supplies	7,014	17.4	3,788	17.3	601	18.0	1,737	19.5	161	7.0	324	15.9	403	21.9
Travel	1,360	3.4	1,015	4.6	129	3.8	167	1.9	14	.6	19	.9	16	.9
Communications	143	.3	104	.5	2	.1	14	.1	3	.1	9	.5	11	.6
Publication Costs	271	.7	131	.6	13	.4	77	.9	13	.6	18	.9	19	1.0
Indirect Expenses	9,810	24.3	5,292	24.1	815	24.3	2,092	23.4	708	30.9	495	24.3	408	22.2
TOTAL	\$40,384	100.0	21,942	100.0	3,348	100.0	8,928	100.0	2,294	100.0	2,035	100.0	1,837	100.0
Contributed by Universities	3,488	8.6	1,568	7.1	191	5.7	1,321	14.8	342	14.9	66	3.2	0	0.0
Supported by AEC	36,896	91.4	20,374	92.9	3,157	94.3	7,607	85.2	1,952	85.1	1,969	96.8	1,837	100.0
Incl. Unexpended Balance of ..	124		35		28		61		0		0		0	

NUMBER OF SCIENTIFIC EMPLOYEES,
RESEARCH ASSISTANTS & PUBLICATIONS
UNDER THE PHYSICAL RESEARCH PROGRAM

<u>Category</u>	<u>Principal Investigators</u>		<u>Research Associates</u>		<u>Other Permanent Scientific Staff (Incl. Visitors)</u>		<u>Research Assistants</u>	<u>Publications</u>
	<u>No.</u>	<u>MY's</u>	<u>No.</u>	<u>MY's</u>	<u>No.</u>	<u>MY's</u>		
High Energy Physics	151	67	239	177	334	208	384	602
Medium Energy Physics	33	13	38	30	62	29	57	55
Low Energy Physics	54	24	105	92	158	77	232	433
Mathematics & Computers ..	19	6	21	8	33	17	48	99
Chemistry	132	38	154	120	19	10	237	522
Metallurgy & Materials ...	123	31	72	50	28	11	267	373
TOTAL	512	179	629	477	634	352	1,225	2,084

TYPE OF ORGANIZATIONS

<u>Projects with:</u>	<u>Division Total</u>	<u>High Energy Physics</u>	<u>Medium Energy Physics</u>	<u>Low Energy Physics</u>	<u>Math and Computers</u>	<u>Chemistry</u>	<u>Metallurgy and Materials</u>
State Institutions	180	26	10	21	5	66	52
Private Institutions ..	148	19	9	14	10	55	41
Municipal Institutions.	2	0	0	0	0	2	0
TOTAL	330	45	19	35	15	123	93

OPERATIONS OFFICES ADMINISTERING
THE BUSINESS ASPECTS OF THE AGREEMENTS

<u>Operations Offices</u>	<u>Division Total</u>	<u>High Energy Physics</u>	<u>Medium Energy Physics</u>	<u>Low Energy Physics</u>	<u>Math and Computers</u>	<u>Chemistry</u>	<u>Metallurgy and Materials</u>
Chicago	199	27	8	19	9	74	62
Idaho	1	0	1	0	0	0	0
Nevada	1	0	0	0	0	1	0
Oak Ridge	67	5	5	8	1	32	16
Richland	17	2	2	2	0	7	4
San Francisco	44	11	3	6	5	8	11
Savannah River	1	0	0	0	0	1	0
TOTAL	330	45	19	35	15	123	93

TYPE OF AGREEMENTS

<u>Type</u>	<u>Division Total</u>	<u>High Energy Physics</u>	<u>Medium Energy Physics</u>	<u>Low Energy Physics</u>	<u>Math and Computers</u>	<u>Chemistry</u>	<u>Metallurgy and Materials</u>
Cost Contracts	65	27	11	16	4	4	3
SRSA	265	18	8	19	11	119	90
TOTAL	330	45	19	35	15	123	93

AGREEMENTS BY AEC DOLLAR LEVEL

<u>Dollar Level</u>	<u>Division Total</u>	<u>High Energy Physics</u>	<u>Medium Energy Physics</u>	<u>Low Energy Physics</u>	<u>Math and Computers</u>	<u>Chemistry</u>	<u>Metallurgy and Materials</u>
0	5	0	0	0	0	1	4
1 - 9,999	3	0	0	0	0	3	0
10,000 - 19,999	11	0	0	0	1	6	4
20,000 - 29,999	49	2	2	1	0	27	17
30,000 - 39,999	59	1	4	2	2	24	26
40,000 - 49,999	40	1	0	2	1	22	14
50,000 - 59,999	26	0	1	1	6	14	4
60,000 - 69,999	18	1	0	2	0	8	7
70,000 - 79,999	5	0	0	1	0	3	1
80,000 - 89,999	12	1	0	4	1	3	3
90,000 - 99,999	9	2	1	1	0	2	3
100,000 - 249,999	43	12	8	7	2	7	7
250,000 - 499,999	23	10	1	7	1	2	2
500,000 +	27	15	2	7	1	1	1
TOTAL	330	45	19	35	15	123	93

SUMMARY OF OFF-SITE CONTRACTS BY STATE

<u>State and Contractor</u>	<u>Number of Contracts</u>	<u>FY 1973 Funding* (in 1000 's)</u>
<u>Alabama</u>	<u>1</u>	<u>\$ 30</u>
Alabama, University of, University	1	30
<u>Alaska</u>	<u>1</u>	<u>22</u>
Alaska, University of, Fairbanks	1	22
<u>Arizona</u>	<u>3</u>	<u>149</u>
Arizona State University, Tempe	2	80
Arizona, University of, Tucson	1	69
<u>Arkansas</u>	<u>1</u>	<u>36</u>
Arkansas, University of, Fayetteville	1	36
<u>California</u>	<u>42</u>	<u>6,537</u>
California Institute of Technology, Pasadena	9	2,135
California, University of, Berkeley	3	234
California, University of, Davis	2	131
California, University of, Irvine	4	628
California, University of, Los Angeles	9	1,318
California, University of, Riverside	2	284
California, University of, San Diego	3	852
California, University of, Santa Barbara	1	190
California, University of, Santa Cruz	1	150
Southern California, University of, Los Angeles	3	69
Stanford University, Stanford	5	546
<u>Colorado</u>	<u>5</u>	<u>690</u>
Colorado School of Mines, Golden	1	32
Colorado, University of, Boulder	4	658
<u>Connecticut</u>	<u>9</u>	<u>3,087</u>
Connecticut, University of, Storrs	2	66
The New England Institute, Inc., Ridgefield	1	40
Yale University, New Haven	6	2,981
<u>District of Columbia</u>	<u>5</u>	<u>134</u>
Georgetown University	1	39
George Washington University	1	28
Howard University	3	67
<u>Florida</u>	<u>8</u>	<u>528</u>
Florida State University, Tallahassee	4	386
Florida, University of, Gainesville	4	142
<u>Georgia</u>	<u>4</u>	<u>138</u>
Georgia Institute of Technology, Atlanta	3	110
Georgia, University of, Athens	1	28
<u>Hawaii</u>	<u>2</u>	<u>447</u>
Hawaii, University of, Honolulu	2	447

*Dollar figures are based on obligations made specifically from FY 1973 funds, for operations and equipment, for the 330 contracts in effect as of July 1, 1973.

<u>State and Contractor</u>	<u>Number of Contracts</u>	<u>FY 1973 Funding (in 1000's)</u>
<u>Illinois</u>	<u>17</u>	<u>\$ 4,394</u>
Chicago, University of, Chicago	5	333
Illinois Institute of Technology, Chicago	2	97
Illinois, University of, Urbana	6	3,557
Northwestern University, Evanston	4	407
<u>Indiana</u>	<u>8</u>	<u>2,169</u>
Indiana University, Bloomington	1	182
Notre Dame, University of, Notre Dame	1	1,098
Purdue University, Lafayette	6	889
<u>Iowa</u>	<u>1</u>	<u>50</u>
Iowa, University of, Iowa City	1	50
<u>Louisiana</u>	<u>2</u>	<u>61</u>
Southern University, Baton Rouge	2	61
<u>Maryland</u>	<u>15</u>	<u>2,245</u>
Johns Hopkins University, Baltimore	5	265
Maryland, University of, College Park	10	1,980
<u>Massachusetts</u>	<u>17</u>	<u>7,496</u>
Brandeis University, Waltham	3	308
Clark University, Worcester	1	20
Harvard University, Cambridge	3	1,409
Massachusetts Institute of Technology, Cambridge	6	5,253
Massachusetts, University of, Amherst	2	190
Tufts University, Medford	1	290
Worcester Polytechnic Institute, Worcester	1	26
<u>Michigan</u>	<u>15</u>	<u>1,781</u>
Michigan State University, East Lansing	5	243
Michigan Technological University, Houghton	3	118
Michigan, University of, Ann Arbor	3	1,273
Wayne State University, Detroit	4	147
<u>Minnesota</u>	<u>8</u>	<u>1,296</u>
Minnesota, University of, Minneapolis	8	1,296
<u>Mississippi</u>	<u>1</u>	<u>22</u>
Mississippi, University of, University	1	22
<u>Missouri</u>	<u>5</u>	<u>228</u>
Washington University, St. Louis	5	228
<u>Montana</u>	<u>2</u>	<u>66</u>
Montana State University, Bozeman	1	27
Montana, University of, Missoula	1	39
<u>Nebraska</u>	<u>1</u>	<u>25</u>
Nebraska, University of, Lincoln	1	25
<u>Nevada</u>	<u>1</u>	<u>13</u>
Nevada, University of, Reno	1	13
<u>New Hampshire</u>	<u>3</u>	<u>67</u>
Dartmouth College, Hanover	3	67

<u>State and Contractor</u>	<u>Number of Contracts</u>	<u>FY 1973 Funding (in 1000's)</u>
<u>New Jersey</u>	<u>7</u>	<u>\$ 1,502</u>
Institute for Advanced Study, Princeton	1	85
Princeton University, Princeton	5	1,399
Rutgers University, New Brunswick	1	18
<u>New York</u>	<u>46</u>	<u>4,888</u>
Clarkson College of Technology, Potsdam	2	48
Columbia University, New York	7	931
Cornell University, Ithaca	9	757
New York, City University of, Brooklyn College	2	70
New York, State University of, Albany	2	63
New York, State University of, Buffalo	1	100
New York, State University of, Stony Brook	6	333
New York University, New York	1	1,102
Rensselaer Polytechnic Institute, Troy	4	92
Rochester, University of, Rochester	6	1,165
Rockefeller University, New York	1	0
Syracuse University, Syracuse	2	168
Yeshiva University, New York	3	59
<u>North Carolina</u>	<u>8</u>	<u>1,023</u>
Duke University, Durham	2	755
North Carolina State University, Raleigh	2	116
North Carolina, University of, Chapel Hill	4	152
<u>Ohio</u>	<u>10</u>	<u>801</u>
Case Western Reserve University, Cleveland	5	322
Cincinnati, University of, Cincinnati	1	45
Kent State University, Kent	1	42
Ohio State University, Columbus	3	392
<u>Oklahoma</u>	<u>1</u>	<u>30</u>
Oklahoma, University of, Norman	1	30
<u>Oregon</u>	<u>6</u>	<u>252</u>
Oregon State University, Corvallis	4	127
Oregon, University of, Eugene	2	125
<u>Pennsylvania</u>	<u>21</u>	<u>3,307</u>
Carnegie-Mellon University, Pittsburgh	9	1,502
Lehigh University, Bethlehem	1	28
Lincoln University, Lincoln University	1	15
Pennsylvania State University, University Park	3	69
Pennsylvania, University of, Philadelphia	3	1,454
Pittsburgh, University of, Pittsburgh	3	158
Temple University, Philadelphia	1	81
<u>Puerto Rico</u>	<u>1</u>	<u>34</u>
Puerto Rico, University of, Mayaguez	1	34
<u>Rhode Island</u>	<u>4</u>	<u>515</u>
Brown University, Providence	4	515
<u>Tennessee</u>	<u>7</u>	<u>336</u>
Oak Ridge Associated Universities, Oak Ridge	1	126
Tennessee State University, Nashville	1	26
Tennessee, University of, Knoxville	5	184

<u>State and Contractor</u>	<u>Number of Contracts</u>	<u>FY 1973 Funding (in 1000's)</u>
<u>Texas</u>	<u>16</u>	<u>\$ 1,658</u>
Baylor University, Waco	1	20
Houston, University of, Houston	3	170
Rice University, Houston	2	634
Texas A & M University, College Station	6	228
Texas, University of, Austin	4	606
<u>Utah</u>	<u>4</u>	<u>115</u>
Associated Western Universities, Inc., Salt Lake City	1	25
Utah, University of, Salt Lake City	3	90
<u>Vermont</u>	<u>1</u>	<u>18</u>
Vermont, University of, Burlington	1	18
<u>Virginia</u>	<u>4</u>	<u>399</u>
Virginia Polytechnic Institute & State Univ., Blacksburg	1	44
Virginia, University of, Charlottesville	3	355
<u>Washington</u>	<u>8</u>	<u>1,269</u>
Washington State University, Pullman	1	57
Washington, University of, Seattle	6	1,202
Western Washington State College, Bellingham	1	10
<u>Wisconsin</u>	<u>5</u>	<u>2,038</u>
Marquette University, Milwaukee	1	36
Wisconsin, University of, Madison	4	2,002
<u>Wyoming</u>	<u>1</u>	<u>100</u>
Wyoming, University of, Laramie	1	100

HIGH ENERGY PHYSICS

- Brandeis University, Waltham, Massachusetts. Lawrence E. Kirsch and Howard J. Schnitzer, Research in Elementary Particle Physics. \$165,000.
- Brown University, Providence, Rhode Island. David Feldman, Anatole M. Shapiro, and Robert E. Lanou, Jr., Experimental and Theoretical High Energy Physics. \$335,000.
- California Institute of Technology, Pasadena, California. Robert L. Walker, Experimental, Theoretical and Phenomenological Research. \$1,350,000.
- California, University of, Davis, California. Richard L. Lander, High Energy Particle Physics Research. \$80,000.
- California, University of, Irvine, California. Frederick Reines, Studies of Neutrino and Cosmic Ray Interactions. \$350,000.
- California, University of, Irvine, California. Jonas Schultz and Paul E. Condon, Study of Elementary Particle Interactions. \$160,000.
- California, University of, Los Angeles, California. Harold K. Ticho and Donald H. Stork, Research in High Energy Physics. \$414,000.
- California, University of, Riverside, California. Robert T. Poe and Anne Kernan, High Energy Physics. \$220,000.
- California, University of, San Diego, California. Oreste Piccioni and Norman Kroll, Experimental and Theoretical Particle Physics. \$600,000.
- California, University of, Santa Barbara, California. David O. Caldwell, High Energy User Group. \$190,000.
- California, University of, Santa Cruz, California. Clemens A. Heusch, Experimental Elementary Particle Research. \$150,000.
- Carnegie-Mellon University, Pittsburgh, Pennsylvania. Roger B. Sutton, High Energy Physics Users and Theoretical Research. \$840,120.
- Colorado, University of, Boulder, Colorado. Uriel Nauenberg and David F. Bartlett, High Energy Physics. \$136,000.
- Columbia University, New York, New York. T. D. Lee, Theoretical High Energy Physics. \$288,000.
- Duke University, Durham, North Carolina. William D. Walker, Study of the Interactions between Elementary Particles and Nuclei, and Development of Detection Methods. \$185,000.
- Florida State University, Tallahassee, Florida. Joseph E. Lannutti, Elementary Particle Physics. \$192,000.
- Harvard University, Cambridge, Massachusetts. R. Wilson, High Energy Physics Research. \$1,371,377.
- Harvard University, Cambridge, Massachusetts. Tai Tsun Wu, High Energy Collision Processes. \$27,000.
- Hawaii, University of, Honolulu, Hawaii. Vincent Z. Peterson and San Fu Tuan, Research in High Energy Nuclear Physics. \$421,500.
- Illinois, University of, Urbana, Illinois. A. Wattenberg, High Energy Physics Users; Theoretical Research. \$1,611,074.
- Indiana University, Bloomington, Indiana. Richard M. Heinz, Homer A. Neal, Shu-Yuan Chu and Archibald W. Hendry, Research in Experimental and Theoretical High Energy Physics. \$182,000.
- Institute for Advanced Study, Princeton, New Jersey. Roger F. Dashen and Stephen L. Adler, Problems in Particle Theory, \$85,000.

HIGH ENERGY PHYSICS

- Johns Hopkins University, Baltimore, Maryland. Gabor Domokos, Research in Theoretical Physics. \$45,000.
- Maryland, University of, College Park, Maryland. George A. Snow, High Energy Accelerator and Colliding Beam User Group. \$675,000.
- Massachusetts Institute of Technology, Cambridge, Massachusetts. Fred J. Epling, High Energy Physics Research. \$2,685,472.
- Massachusetts, University of, Amherst, Massachusetts. Janice B. Shafer, High Energy Physics. \$149,000.
- Michigan, University of, Ann Arbor, Michigan. Daniel Sinclair, High Energy Physics Users and Theoretical Research. \$771,400.
- Minnesota, University of, Minneapolis, Minnesota. Stephen Gasiorowicz and Hans W. J. Courant, Theoretical and High Energy Physics Research. \$280,000.
- Northwestern University, Evanston, Illinois. Jerome L. Rosen and Donald H. Miller, High Energy Experimental Physics. \$285,000.
- Ohio State University, Columbus, Ohio. Thomas A. Romanowski, K. Tanaka and W. W. Wada, High Energy Physics. \$305,000.
- Oregon, University of, Eugene, Oregon. Michael J. Moravcsik, Theory of Elementary Particles. \$97,000.
- Pennsylvania, University of, Philadelphia, Pennsylvania. Sherman Frankel, High Energy Physics Research. \$1,394,312.
- Princeton University, Princeton, New Jersey. Frank Shoemaker, High Energy Physics Research. \$1,198,847.
- Purdue University, Lafayette, Indiana. Frank J. Loeffler, Masao Sugawara and Earle C. Fowler, Fundamental Particle Physics. \$649,306.
- Rochester, University of, Rochester, New York. A. C. Melissinos and S. Okubo, High Energy Physics Users and Theoretical Research. \$822,829.
- Rockefeller University, New York, New York. Rodney L. Cool and Abraham Pais, Research in Experimental and Theoretical High Energy Physics. \$530,000 (2 years).
- Stanford University, Stanford, California. David M. Ritson, High Energy Reactions. \$300,000.
- Syracuse University, Syracuse, New York. K. C. Wali, Research in Elementary Particle Theory. \$125,000.
- Tennessee, University of, Knoxville, Tennessee. William M. Bugg, Elementary Particle Interactions. \$55,000.
- Texas, University of, Austin, Texas. E. C. G. Sudarshan and Yuval Ne'eman, Research in Elementary Particle Theory. \$165,000.
- Tufts University, Medford, Massachusetts. Allan M. Cormack, Experimental High Energy Physics Research. \$290,000.
- Washington, University of, Seattle, Washington. Jere J. Lord, High Energy Physics Studies of Particle Interactions in Heavy Elements. \$33,150.
- Wayne State University, Detroit, Michigan. Suraj N. Gupta, Quantum Theory of Fields. \$25,000.
- Wisconsin, University of, Madison, Wisconsin. D. Reeder, High Energy Physics Users and Theoretical Research. \$1,369,587.
- Yale University, New Haven, Connecticut. J. Sandweiss, High Energy Physics Users and Theoretical Research. \$1,115,000.

MEDIUM ENERGY PHYSICS

- Associated Western Universities, Inc., Salt Lake City, Utah. G. Victor Beard, Research Participation at LAMPF. \$25,000.
- California Institute of Technology, Pasadena, California. Felix Boehm, Research in Nuclear Spectroscopy, X-Rays, and Medium Energy Physics. \$123,000.
- California, University of, Los Angeles, California. George J. Igo, Intermediate Energy Nuclear Physics Users Group. \$145,000.
- California, University of, Los Angeles, California. Roy P. Haddock and B. M. K. Nefkens, Particle Physics. \$240,000.
- Carnegie-Mellon University, Pittsburgh, Pennsylvania. Peter D. Barnes, Experimental Nuclear Physics. \$100,000.
- Case Western Reserve University, Cleveland, Ohio. Harvey B. Willard, Medium Energy Nuclear Physics Research. \$105,000.
- Colorado, University of, Boulder, Colorado. Robert A. Ristinen, Study of Fundamental Nuclear Interactions. \$30,000.
- Houston, University of, Houston, Texas. John C. Allred, Clark Goodman and B. W. Mayes, III, Pion Interactions at Medium Energies. \$100,000.
- Maryland, University of, College Park, Maryland. Nathan S. Wall, Experimental Intermediate Energy Nuclear Physics. \$740,000.
- Massachusetts Institute of Technology, Cambridge, Massachusetts. Fred J. Epling, Intermediate Energy Physics Research. \$1,299,807.
- Minnesota, University of, Minneapolis, Minnesota. Norton M. Hintz, Experimental Nuclear Physics. \$18,470 (7 months).
- Montana, University of, Missoula, Montana. Mark J. Jakobson, Total Pion Cross Section Measurements. \$39,390.
- Rice University, Houston, Texas. Gerald C. Phillips, Nuclear and Extra-Nuclear Physics. \$197,265.
- Temple University, Philadelphia, Pennsylvania. W. Kenneth McFarlane, Experimental Investigation of Pion Decays at the Los Alamos Meson Physics Facility. \$81,167.
- Texas A & M University, College Station, Texas. L. C. Northcliffe, Study of the Neutron-Proton Interaction in the 300-700 MeV Energy Region. \$39,922 (7 months).
- Virginia, University of, Charlottesville, Virginia. Ralph C. Minehart, Stanley E. Sobottka and Klaus O. H. Ziock, Experiments on the Nuclear Interactions of Pions. \$180,000.
- Washington, University of, Seattle, Washington. Isaac Halpern, Experimental and Theoretical Nuclear Physics. \$43,000.
- Wyoming, University of, Laramie, Wyoming. Glen A. Rebka, Jr. and Raymond Kunselman, Pion-Nucleon Interactions and Mesonic Atoms. \$100,006.
- Yale University, New Haven, Connecticut. Vernon W. Hughes, Medium Energy Physics Research Program. \$257,286.

LOW ENERGY PHYSICS

Alaska, University of, Fairbanks, Alaska. Syun-Ichi Akasofu, A Study of Magnetospheric Substorms in Conjunction with the Vela Satellite Data. \$22,000 (7 months).

Brown University, Providence, Rhode Island. Stavros Fallieros and Frank S. Levin, Nuclear Excitations and Reaction Mechanisms. \$49,895.

California Institute of Technology, Pasadena, California. Felix Boehm, Research in Nuclear Spectroscopy, X-Rays, and Medium Energy Physics. \$165,000.

California, University of, Berkeley, California. Carson D. Jeffries, Dynamic Nuclear Polarization and Solid State Physics. \$100,000.

California, University of, Berkeley, California. John H. Reynolds, Mass Spectroscopy Research. \$61,000.

California, University of, Berkeley, California. Paul B. Price, Jr., Astrophysical and Super-heavy Element Studies with Nuclear Tracks in Solids. \$72,904.

California, University of, Los Angeles, California. George C. Kennedy, Compressibility Measurements. \$60,000.

Carnegie-Mellon University, Pittsburgh, Pennsylvania. Peter D. Barnes, Experimental Nuclear Physics. \$10,000.

Colorado, University of, Boulder, Colorado. Robert A. Ristinen and Ernest S. Rost, Study of Fundamental Nuclear Interactions. \$451,625.

Columbia University, New York, New York. W. W. Havens, Jr. and Edward Melkonian, Research Program in Neutron Spectroscopy. \$135,000.

Columbia University, New York, New York. L. James Rainwater, Research in Neutron Velocity Spectroscopy. \$307,979.

Columbia University/Lamont-Doherty Geological Observatory, Palisades, New York. Lynn R. Sykes and Klaus H. Jacob, A Comprehensive Study of the Seismotectonics of the Aleutian Arc. \$80,000.

Duke University, Durham, North Carolina. Henry W. Newson, Studies of Nuclear Structure Using Neutrons and Charged Particles. \$570,000.

Illinois, University of, Urbana, Illinois. George H. Miley and Joseph T. Verdeyen, Advanced Methods for Nuclear Reactor-Gas Laser Coupling. \$37,600 (8 months).

Johns Hopkins University, Baltimore, Maryland. Leon Madansky and Y. K. Lee, Nuclear Moments and Nuclear Structure. \$80,000 (7 months).

Kansas State University, Manhattan, Kansas. James C. Legg, Atomic and Nuclear Research with Accelerators. \$319,000.

Maryland, University of, College Park, Maryland. Manoj K. Banerjee and William M. MacDonald, Theoretical Studies in Nuclear Reactions and Nuclear Structure. \$214,865.

Massachusetts Institute of Technology, Cambridge, Massachusetts. Fred J. Epling, Low Energy Research. \$749,628.

Michigan, University of, Ann Arbor, Michigan. W. C. Parkinson and R. S. Tickle, 83-Inch Cyclotron Research Program. \$450,000.

Michigan, University of, Ann Arbor, Michigan. Glenn F. Knoll and William Kerr, Absolute Neutron Cross Section Measurements. \$51,630.

Minnesota, University of, Minneapolis, Minnesota. J. Morris Blair, George W. Greenlees and Norton M. Hintz, Experimental Nuclear Physics. \$670,000.

LOW ENERGY PHYSICS

New York, State University of, Buffalo, New York. Gregory Breit, The Theories of Nucleon-Nucleon Interactions, Nuclear Reactions and Atomic Hyperfine Structure. \$99,997.

New York, State University of, Stony Brook, New York. G. E. Brown, Andrew D. Jackson, Jr., Thomas T. S. Kuo and Akito Arima, Research in Theoretical Nuclear Physics. \$175,000.

North Carolina State University, Raleigh, North Carolina. L. W. Seagondollar, Nuclear Structure Research at the Triangle Universities Nuclear Laboratory. \$80,000.

North Carolina, University of, Chapel Hill, North Carolina. Eugen Merzbacher, Studies of Nuclear Processes. \$81,043.

Oak Ridge Associated Universities, Oak Ridge, Tennessee. E. H. Spejewski, University Isotope Separator--Oak Ridge. \$126,414.

Rice University, Houston, Texas. G. C. Phillips, G. K. Walters and Neal F. Lane, Nuclear and Extra-Nuclear Physics. \$436,852.

Rochester, University of, Rochester, New York. J. Bruce French and Daniel S. Koltun, Nuclear Structure Theory. \$120,000.

Southern California, University of, Los Angeles, California. H. H. Forster, Nuclear Physics Research. \$125,000 (2 years).

Southern University, Baton Rouge, Louisiana. Kuang-Hsiang Liu and Zorawar Singh, Experimental and Theoretical Nuclear Physics. \$46,000.

Texas, University of, Austin, Texas. S. A. A. Zaidi and Taro Tamura, Research in Nuclear Physics. \$395,000.

Washington, University of, Seattle, Washington. David Bodansky and Ernest M. Henley, Experimental and Theoretical Nuclear Physics. \$1,020,000.

Wisconsin, University of, Madison, Wisconsin. H. T. Richards and L. W. Anderson, Research in Nuclear Physics and Atomic Collisions. \$499,221.

Yale University, New Haven, Connecticut. Vernon W. Hughes and Howard L. Schultz, Electron Linear Accelerator Program and Other Low Energy Physics Research. \$145,000.

Yale University, New Haven, Connecticut. D. Allan Bromley, MP Tandem Van de Graaff Research Program. \$963,230.

MATHEMATICS AND COMPUTER RESEARCH

California Institute of Technology, Pasadena, California. H. B. Keller, Numerical Analysis and Computing. \$55,000 (19 months).

California, University of, Los Angeles, California. Gerald Estrin, Research Program for the UCLA Variable Structure Computer System. \$250,000.

Harvard University, Cambridge, Massachusetts. Garrett Birkhoff, Mathematical Problems in Nuclear Reactor Theory. \$10,723.

Illinois, University of, Urbana, Illinois. C. W. Gear and W. J. Poppelbaum, Computer Systems Research. \$415,000.

Illinois, University of, Urbana, Illinois. James E. Robertson, Experiments with an Image Processing Computer. \$185,000.

Johns Hopkins University, Baltimore, Maryland. Michael J. Flynn, Studies in the Organization of Computer Systems. \$50,000.

Kent State University, Kent, Ohio. Richard S. Varga, Use of Variational and Projectional Methods in Numerical Analysis. \$42,000.

Maryland, University of, College Park, Maryland. Bertie E. Hubbard and Ivo Babuska, Studies of the Numerical Solution of Elliptic and Parabolic Boundary Value Problems. \$56,756.

New York, State University of, Stony Brook, New York. Martin A. Leibowitz and Daniel Dicker, Research in Applied Mathematics. \$59,976 (3 years).

New York University, New York, New York. Paul R. Garabedian, Courant Institute of Mathematical Sciences. \$1,101,659.

Northwestern University, Evanston, Illinois. Erwin H. Bareiss, Computational Complexity in Multidimensional Neutron Transport Theory Calculations. \$50,000.

Princeton University, Princeton, New Jersey. John W. Tukey and Geoffrey S. Watson, Research on Data Analysis in the Physical Sciences. \$34,400.

Southern California, University of, Los Angeles, California. Richard Bellman, Mathematical Problems in Medicine. \$32,500.

Stanford University, Stanford, California. George B. Dantzig, Robert B. Wilson and Richard W. Cottle, Systems Optimization Research. \$85,000.

Stanford University, Stanford, California. Gene H. Golub and William F. Miller, Research in Numerical Analysis and Computer Science. \$58,750.

CHEMISTRY

- Alabama, University of, University, Alabama. Lowell D. Kispert, ELDOR Investigations of Radiation Processes. \$30,000.
- Arizona State University, Tempe, Arizona. LeRoy Eyring, Solid State Chemistry of Rare Earth Oxides. \$53,000.
- Arkansas, University of, Fayetteville, Arkansas. Paul K. Kuroda, Nuclear Chemistry. \$36,000.
- Baylor University, Waco, Texas. Malcolm Dole, Radiation Chemistry of High Polymers. \$20,000.
- Brandeis University, Waltham, Massachusetts. Henry Linschitz, Photochemical Reactions of Complex Molecules in Condensed Phase. \$117,120 (2 years).
- Brandeis University, Waltham, Massachusetts. Saul G. Cohen, Effects of Mercaptans and Disulfides on Photochemical and High Energy Radiation Induced Reactions. \$25,648.
- Brown University, Providence, Rhode Island. E. F. Greene, Experimental Chemical Kinetics: A Study of Chemical Reactions by Means of Molecular Beams and Shock Wave Techniques. \$50,000.
- California Institute of Technology, Pasadena, California. Frederick H. Shair, Diffusion of Molecular Species at Low Concentrations in Glow Discharge. \$20,311 (29 months).
- California Institute of Technology, Pasadena, California. Aron Kuppermann, Studies in Chemical Dynamics and Radiation Chemistry. \$118,000.
- California Institute of Technology, Pasadena, California. Jesse L. Beauchamp, The Application of Ion Cyclotron Resonance to the Study of Ion-Molecule Interactions. \$80,000 (2 years).
- California, University of, Davis, California. John W. Root, Recoil Studies in Chemical Dynamics. \$51,000.
- California, University of, Irvine, California. Frank S. Rowland, Radiochemical Research. \$118,000.
- California, University of, Irvine, California. Max Wolfsberg, Theoretical Studies on Isotopic Mass Effects in Chemistry. \$95,042 (2 years).
- California, University of, Los Angeles, California. M. F. Nicol, Inter- and Intra-Molecular Energy Transfer Studies. \$63,000.
- California, University of, Los Angeles, California. M. A. El-Sayed, Phosphorescence-Microwave Multiple Resonance Spectroscopy of Polyatomic Molecules. \$55,000.
- Carnegie-Mellon University, Pittsburgh, Pennsylvania. Truman P. Kohman, Nuclear Chemistry and Geochemistry Research. \$40,000.
- Carnegie-Mellon University, Pittsburgh, Pennsylvania. Robert H. Schuler, Radiation Chemistry. \$375,000.
- Carnegie-Mellon University, Pittsburgh, Pennsylvania. Albert A. Caretto, Jr., High Energy Nuclear Reactions. \$42,000.
- Carnegie-Mellon University, Pittsburgh, Pennsylvania. Joe V. Michael, Reactions of Hydrogen Atoms. \$23,649.
- Carnegie-Mellon University, Pittsburgh, Pennsylvania. Morton Kaplan, Research in Nuclear Chemistry. \$40,500.
- Chicago, University of, Chicago, Illinois. Edward Anders, Radiochemical and Geochemical Studies. \$49,000 (2 years).
- Chicago, University of, Chicago, Illinois. Nathan Sugarman and Anthony Turkevich, Nuclear Chemistry Research. \$163,400.

CHEMISTRY

- Chicago, University of, Chicago, Illinois. Ugo Fano, Basic Studies of Atomic Dynamics. \$52,000.
- Chicago, University of, Chicago, Illinois. Yuan Tseh Lee, The Dynamics of Chemical Reactions. \$77,635.
- Clark University, Worcester, Massachusetts. Daeg S. Brenner, Research in Nuclear Spectroscopy. \$20,000.
- Clarkson College of Technology, Potsdam, New York. Milton Kerker, Studies on Colloidal Particles: Scavenging of Aerosol Particles by a Falling Macroscopic Particle. \$33,000.
- Columbia University, New York, New York. Richard N. Zare, Separation of Isotopes. \$35,362.
- Columbia University, New York, New York. J. M. Miller, Study of Heavy-Ion Induced Nuclear Reactions. \$55,000.
- Columbia University, New York, New York. Charles F. Bonilla, High Temperature Transport Properties and Processes of Gases and Alkali Metals. \$30,000.
- Florida State University, Tallahassee, Florida. Gregory R. Choppin, Nuclear Chemistry. \$70,875 (21 months).
- Florida State University, Tallahassee, Florida. Russell H. Johnsen, Radiation Induced Effects in Organic Systems. \$42,000.
- Florida State University, Tallahassee, Florida. Raymond K. Sheline, An Experimental Study of Nuclear Models. \$81,000.
- Florida, University of, Gainesville, Florida. M. Luis Muga, Thin Film Detectors. \$34,600.
- Florida, University of, Gainesville, Florida. Robert J. Hanrahan, Radiation Chemistry of Hydrocarbon and Alkyl Halide Systems. \$36,000.
- George Washington University, Washington, D. C. Nicolae Filipescu, Lanthanide Ions as Sensitive Probes in Intermolecular Energy Transfer and Organic Photochemistry. \$28,000.
- Georgia Institute of Technology, Atlanta, Georgia. Richard W. Fink, Nuclear and X-Ray Spectroscopy with Radioactive Sources. \$49,500.
- Georgia Institute of Technology, Atlanta, Georgia. James A. Knight, Jr., Radiation Chemistry of Mono-substituted Aromatic Compounds. \$23,000.
- Georgia, University of, Athens, Georgia. Charles E. Melton, Radiolysis of Water in a Wide Range Radiolysis Source. \$28,000.
- Houston, University of, Houston, Texas. Gerhard G. Meisels, Principal Processes in the Radiolysis of Gases by High Energy Electrons and Fission Recoils. \$70,000.
- Houston, University of, Houston, Texas. L. C. Witte, The Vapor Explosion - Heat Transfer and Fragmentation. \$26,728 (20 months).
- Howard University, Washington, D. C. Peter Hambright, Kinetic, Magnetic and Mössbauer Studies on Porphyrin Systems. \$20,000.
- Howard University, Washington, D. C. Lue-Yung Chow Chiu, Theoretical Study of Fine and Hyperfine Structures and Their Effect on Radiative Interaction and Energy-Transfer Processes. \$26,500 (18 months).
- Illinois, University of, Chicago, Illinois. Lester Winsberg, Study of High-Energy (p, xn) Reactions. \$14,000.
- Iowa, University of, Iowa City, Iowa. William C. Stwalley, The Distribution of Energy in Bimolecular Chemiluminescent Reactions Involving Hydrogen Atoms. \$50,000.

CHEMISTRY

- Johns Hopkins University, Baltimore, Maryland. Walter S. Koski and Joyce J. Kaufman, Studies in Hot Atom and Radiation Chemistry. \$58,182.
- Kansas State University, Manhattan, Kansas. Herbert C. Moser, Properties of Excited Species in the Frozen State as Studied by Photolysis, Low-Energy Electron Radiolysis and Bombardment with Energetic Tritium Atoms. \$6,281.
- Kansas, University of, Lawrence, Kansas. Paul W. Gilles, High Temperature Chemistry. \$64,000.
- Lincoln University, Lincoln University, Pennsylvania. Saligrama C. SubbaRao, Tunneling in Proton Transfer Reactions. \$15,193.
- Maryland, University of, College Park, Maryland. Joseph Silverman, Radiation-Induced Effects in Polymers and Related Compounds. \$50,027.
- Maryland, University of, College Park, Maryland. Everett R. Johnson, Radiation Induced Decomposition of Inorganic Salts. \$20,000.
- Maryland, University of, College Park, Maryland. Glen E. Gordon, Victor E. Viola, Jr., and William B. Walters, Research in Nuclear Chemistry. \$110,000.
- Michigan State University, East Lansing, Michigan. Harry A. Eick, An Investigation of Some Lanthanide Carbon, Nitrogen, Chalcogen, and Halogen Systems at Elevated Temperatures. \$25,000.
- Michigan State University, East Lansing, Michigan. James L. Dye, Properties of Solvated Electrons and Associated Species in Metal Solutions and Kinetics of Electron- and Proton-Transfer Reactions. \$38,949.
- Michigan State University, East Lansing, Michigan. Max T. Rogers, Electron Spin Resonance Studies of Radiation Effects. \$29,426.
- Michigan State University, East Lansing, Michigan. William C. McHarris and Frederick M. Bernthal, Nuclear Chemistry Research. \$108,000.
- Minnesota, University of, Minneapolis, Minnesota. Sanford Lipsky, The Contribution of Electronically Excited States to the Radiation Chemistry of Organic Systems. \$59,812.
- Minnesota, University of, Minneapolis, Minnesota. Robert W. Carr, Jr., Studies in Chemical Reactivity. \$30,000.
- Mississippi, University of, University, Mississippi. Theodore J. Klingens, Investigation of Gamma-Ray Induced Polymer Formation in the Carboranes. \$22,000.
- Nebraska, University of, Lincoln, Nebraska. Edward P. Rack, Hot Atom Chemistry of Neutron Capture Reactions and Isomeric Transitions. \$25,000.
- Nevada, University of, Reno, Nevada. Richard D. Burkhart, A Measurement of Diffusion Coefficients of Short-Lived Species in Solution by Photochemical Space Intermittency. \$13,000.
- The New England Institute, Inc., Ridgefield, Connecticut. S. J. Tao, Positronium Chemistry. \$40,000.
- New York, City University of/Brooklyn College, Brooklyn, New York. Harmon L. Finston, Applications of Nuclear and Radiochemical Techniques in Chemical Analysis. \$27,000.
- New York, City University of/Brooklyn College, Brooklyn, New York. Takanobu Ishida, Studies of Carbon Isotope Fractionation. \$43,000.
- New York, State University of, Albany, New York. Hassaram Bakhru, Nuclear Spectroscopy and Nuclear Reaction Work. \$23,000.
- New York, State University of, Stony Brook, New York. John M. Alexander, Nuclear Reaction Studies. \$46,800.

CHEMISTRY

- New York, State University of, Stony Brook, New York. Oliver A. Schaeffer, High Energy Nuclear Interactions with Matter and Nuclear Processes in Nature. \$54,000.
- North Carolina, University of, Chapel Hill, North Carolina. Richard C. Jarnagin, Ionizing States and Species Detected By Ultraviolet Photoelectron Spectroscopy at Surfaces. \$20,000.
- Northwestern University, Evanston, Illinois. James T. Waber, Effect of Nuclear Shape on the Electronic Orbitals of Superactinide Elements. \$25,000.
- Notre Dame, University of, Notre Dame, Indiana. John L. Magee, Radiation Chemistry. \$1,097,678.
- Ohio State University, Columbus, Ohio. Richard F. Firestone, Kinetics of Ionizing Radiation Induced Reactions. \$43,271.
- Ohio State University, Columbus, Ohio. Leon M. Dorfman, Pulse Radiolysis Studies of Fast Reactions in Molecular Systems. \$43,413.
- Oregon State University, Corvallis, Oregon. Carroll W. DeKock, Gaseous Metal Halide Molecular Symmetries and Reactions with Small Molecules in Low Temperature Matrices. \$5,000.
- Oregon State University, Corvallis, Oregon. Walter D. Loveland, Studies of Low Energy Induced Nuclear Fission. \$33,300 (18 months).
- Oregon State University, Corvallis, Oregon. T. Darrah Thomas, Research in Nuclear Chemistry. \$67,500.
- Oregon, University of, Eugene, Oregon. Richard M. Noyes, Diffusion Controlled Reactions and Exchange Reactions in Solution. \$27,900.
- Pennsylvania State University, University Park, Pennsylvania. F. W. Lampe, The Radiation Chemistry and Mass Spectrometry of Silanes and Germanes. \$40,579.
- Pennsylvania, University of, Philadelphia, Pennsylvania. David White, Rotational Ordering in the Solid Molecular Hydrogens. \$26,327.
- Pittsburgh, University of, Pittsburgh, Pennsylvania. Robert L. Wolke, Recoil Studies of Nuclear Reactions. \$32,400.
- Pittsburgh, University of, Pittsburgh, Pennsylvania. David W. Pratt, Microwave-Optical Double Resonance Spectroscopy. \$30,000.
- Princeton University, Princeton, New Jersey. John Turkevich, Research in the Field of Catalysis. \$68,000.
- Princeton University, Princeton, New Jersey. R. C. Axtmann, Chemistry of Excited States and Interfacial Phenomena. \$30,605 (21 months).
- Princeton University, Princeton, New Jersey. Robert A. Naumann, Research in Nuclear Chemistry. \$67,500.
- Puerto Rico, University of, Mayaguez, Puerto Rico. Rupert Lee, Hot-Atom and Radiation Chemistry. \$33,764.
- Purdue University, Lafayette, Indiana. L. B. Rogers, Fundamental Studies of Separation Processes. \$56,000.
- Purdue University, Lafayette, Indiana. Norbert T. Porile, Deexcitation Processes in Nuclear Reactions. \$54,000.
- Purdue University, Lafayette, Indiana. Patrick J. Daly, Radiochemical Investigations of Nuclear Properties. \$42,500.
- Purdue University, Lafayette, Indiana. James W. Cobble, Thermodynamics of Heavy Elements and Studies in Nuclear Chemistry. \$49,500.

CHEMISTRY

- Rensselaer Polytechnic Institute, Troy, New York. Daniel Sperber, Neutron and Gamma Emission From Highly Excited States and States With High Spin. \$33,900 (18 months).
- Rensselaer Polytechnic Institute, Troy, New York. Ivor L. Preiss, Nuclear Structure Studies. \$29,400.
- Rochester, University of, Rochester, New York. H. Marshall Blann, Nuclear Reaction Mechanisms. \$45,000.
- Rochester, University of, Rochester, New York. John R. Huizenga, Studies of Nuclear Fission, Low-Energy Nuclear Reactions and Transuranic Nuclei. \$70,000.
- Rochester, University of, Rochester, New York. Jacob Bigeleisen, Fundamental Studies in Isotope Chemistry. \$80,000.
- Rutgers University, New Brunswick, New Jersey. Rolfe H. Herber, Studies in Nuclear and Radiochemistry. \$18,000.
- Southern University, Baton Rouge, Louisiana. Curtis W. McDonald, Solvent Extraction Studies Using High-Molecular-Weight Amines. \$15,000.
- Syracuse University, Syracuse, New York. S. Alexander Stern, Separation of Krypton and Xenon from Reactor Atmospheres by Selective Permeation. \$42,767 (2 years).
- Tennessee State University, Nashville, Tennessee. Rubye P. Torrey, Gaseous Ion Chemistry: Analytical Applications. \$26,000 (19 months).
- Tennessee, University of, Knoxville, Tennessee. T. Ffrancon Williams, Research Concerning Ionic and Free Radical Reactions in Radiation Chemistry. \$51,750.
- Tennessee, University of, Knoxville, Tennessee. Joseph R. Peterson, Physical-Chemical Studies of the Transuranium Elements. \$25,000.
- Texas A & M University, College Station, Texas. Thomas T. Sugihara, Nuclear Spectroscopy. \$37,800.
- Texas A & M University, College Station, Texas. Ronald D. Macfarlane, Mass Spectrometry of Short-Lived Nuclear Species. \$61,100.
- Texas A & M University, College Station, Texas. Yi-Noo Tang, Reactions of High Energy Radioactive Atoms Resulting from Nuclear Transformation in the Systems of Silicon-Containing Compounds. \$21,000.
- Texas A & M University, College Station, Texas. Rand L. Watson, Ionization Phenomena. \$34,200.
- Texas A & M University, College Station, Texas. Joseph B. Natowitz, Angular Momentum Effects in Nuclear Reactions. \$34,200.
- Texas, University of, Austin, Texas. George W. Watt, Unusual Oxidation States of Transitional Elements. \$25,000.
- Utah, University of, Salt Lake City, Utah. Leonard D. Spicer, Gas Phase Studies of the Kinetics and Mechanism of High Energy Sulfur Atom Reactions and Some Novel Aspects of Hot Halogen Reactions. \$34,000.
- Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Hans J. Ache, Reactions of Charged and Neutral Recoil Particles. \$44,000.
- Washington State University, Pullman, Washington. John B. Gruber, Spectroscopic Studies of Actinide Ions in Crystalline Solids. \$57,142.
- Washington University, St. Louis, Missouri. Arthur C. Wahl, Radiochemical Studies of the Fission Processes. \$30,000.

CHEMISTRY

- Washington University, St. Louis, Missouri. Demetrios G. Sarantites, Low Energy Nuclear Reactions and Spectroscopy. \$34,200.
- Washington University, St. Louis, Missouri. Peter P. Gaspar, Reaction Studies of Hot Silicon and Germanium Radicals. \$38,000.
- Washington University, St. Louis, Missouri. Franklin B. Shull, The Cyclotron as an Instrument for Chemical Research. \$100,000.
- Washington University, St. Louis, Missouri. Edward S. Macias, Spectroscopy of Nuclear Systems. \$26,288.
- Washington, University of, Seattle, Washington. Albert L. Babb and Kermit L. Garlid, Liquid and Gas Phase Separations. \$34,459.
- Wayne State University, Detroit, Michigan. Larry Kevan, Radiolysis Studies on Reactive Intermediates. \$85,000 (19 months).
- Wayne State University, Detroit, Michigan. Edward C. Lim, Deuterium Isotope Effects in Electronic Relaxation of Large Polyatomic Molecules. \$37,000.
- Western Washington State College, Bellingham, Washington. Edward F. Neuzil, Fission Studies on Elements Below Polonium. \$9,500.
- Wisconsin, University of, Madison, Wisconsin. John E. Willard, Studies in Hot Atom and Radiation Chemistry. \$70,000.
- Worcester Polytechnic Institute, Worcester, Massachusetts. Alfred A. Scala, The Gas Phase Radiolysis and Vacuum Ultraviolet Photolysis of Heterocyclic Organic Compounds. \$25,822.
- Yale University, New Haven, Connecticut. R. James Cross, Jr., Research on High Energy Chemical Reactions. \$25,500.
- Yale University, New Haven, Connecticut. Robert Beringer, Heavy Ion Linear Accelerator Research Program. \$474,644.
- Yeshiva University, New York, New York. William Spindel, Stable Isotope Studies. \$56,257 (2 years).
- Yeshiva University, New York, New York. Marvin J. Stern, Isotope Effects on Rate and Equilibrium Processes. \$35,670.
- Yeshiva University, New York, New York. Max Lipsicas, A Nuclear Magnetic Resonance Study of the Gas-Liquid Critical Point in Hydrogen and its Isotopic Modifications. \$23,000.

METALLURGY AND MATERIALS

- Arizona State University, Tempe, Arizona. James T. Stanley, Study of Ferrite Formation in Neutron Irradiated Austenitic Stainless Steels. \$27,312.
- Arizona, University of, Tucson, Arizona. Carl T. Tomizuka, Impurity Diffusion in Solids. \$68,800.
- Brown University, Providence, Rhode Island. Joseph Gurland and James R. Rice, A Combined Macroscopic and Microscopic Approach to the Fracture of Metals. \$80,000.
- California Institute of Technology, Pasadena, California. Thad Vreeland, Jr., Dislocation Mobility and Density in Metallic Crystals. \$65,000.
- California Institute of Technology, Pasadena, California. Pol Duwez and C. C. Tsuei, Studies in Alloy Structures and Properties. \$259,000.
- California, University of, Los Angeles, California. Alan J. Ardell, Particle Size Distribution Effects in Precipitation Hardening. \$62,000.
- California, University of, Los Angeles, California. Didier de Fontaine, Fourier Space Computer Simulation of Crystalline Imperfections. \$29,000.
- California, University of, Riverside, California. A. W. Lawson, Electric and Magnetic Properties of Transition Metals and Their Compounds. \$63,580.
- California, University of, San Diego, California. John C. Wheatley, Research on the Properties of Materials at Very Low Temperatures. \$162,438.
- California, University of, San Diego, California. Huey-Lin Luo, New Materials by Low Temperature Condensation. \$90,000.
- Carnegie-Mellon University, Pittsburgh, Pennsylvania. Joseph O. Artman, Optical and Microwave Spectroscopy of Np and Co in Scheelites and Other Crystalline Environments. \$30,395.
- Case Western Reserve University, Cleveland, Ohio. Richard W. Hoffman, Solid State Physics. \$83,000.
- Case Western Reserve University, Cleveland, Ohio. Ronald Gibala, Dislocation-Solute Atom Interactions in Alloys. \$42,000.
- Case Western Reserve University, Cleveland, Ohio. A. J. Dahm, Motion of Ions in Solid Helium. \$37,360.
- Case Western Reserve University, Cleveland, Ohio. Terence E. Mitchell, Experiments in High Voltage Electron Microscopy. \$55,000.
- Chicago, University of, Chicago, Illinois. Stuart A. Solin, The Study of Phonons in Amorphous and Crystalline Solids. \$40,000.
- Cincinnati, University of, Cincinnati, Ohio. John Moteff, Radiation Effects to BCC Refractory Metals and Alloys. \$45,000.
- Clarkson College of Technology, Potsdam, New York. Joseph L. Katz, Nucleation of Voids. \$14,770 (16 months).
- Colorado School of Mines, Golden, Colorado. David L. Olson and Walter L. Bradley, Liquid Lithium Corrosion and Corrosion-Fatigue Research. \$32,000.
- Colorado, University of, Boulder, Colorado. Richard C. Mockler and William J. O'Sullivan, Critical Scattering of Laser Light by Thin Fluid Films. \$40,471.
- Connecticut, University of, Storrs, Connecticut. James M. Galligan, Electron-Dislocation Interactions at Low Temperatures. \$32,000.
- Connecticut, University of, Storrs, Connecticut. John E. Morral, Cluster Carburizing. \$34,146.

METALLURGY AND MATERIALS

- Cornell University, Ithaca, New York. R. H. Silsbee and Raymond Bowers, Solid State Physics: Magnetic Phenomena. \$130,800.
- Cornell University, Ithaca, New York. R. O. Pohl and A. J. Sievers, Experimental Phonon Physics. \$136,000.
- Cornell University, Ithaca, New York. Arthur L. Ruoff, Elastic and Plastic Deformation of Solids. \$120,000.
- Cornell University, Ithaca, New York. Che-Yu Li, Grain Boundary Sliding and Structure. \$36,000.
- Cornell University, Ithaca, New York. Robert W. Balluffi and David N. Seidman, Defects in Metal Crystals. \$208,000.
- Cornell University, Ithaca, New York. James A. Krumhansl, Theory of Structure and Dynamics in Condensed Matter. \$60,000.
- Cornell University, Ithaca, New York. H. H. Johnson, Effect of Environment on Fracture Behavior. \$32,489.
- Cornell University, Ithaca, New York. Edward J. Kramer, A Study of the Interaction Between Magnetic Fluxoids and Crystal Defects in Type II Superconductors. \$34,032.
- Cornell University, Ithaca, New York. Paul S. Ho, An Electromigration Study of Void Kinetics in Metals. \$74,946 (34 months).
- Dartmouth College, Hanover, New Hampshire. P. Bruce Pipes, Experimental Determination of the Temperature Dependence of Metallic Work Functions at Low Temperatures. \$22,903.
- Dartmouth College, Hanover, New Hampshire. Walter E. Lawrence, Theory of Electron-Phonon Scattering Effects in Metals. \$15,318.
- Dartmouth College, Hanover, New Hampshire. John R. Merrill, Studies of Electrical Conduction in Metals. \$28,503.
- Florida, University of, Gainesville, Florida. Robert E. Reed-Hill, Deformation Processes in Refractory Metals. \$33,000.
- Florida, University of, Gainesville, Florida. John J. Hren and Craig S. Hartley, Quantitative Analysis of Solute Segregation in Alloys by Transmission Electron Microscopy. \$38,000.
- Georgetown University, Washington, D. C. William D. Gregory, The Study of Very Pure Metals at Low Temperatures. \$39,000.
- Georgia Institute of Technology, Atlanta, Georgia. Bruce G. LeFevre and Edgar A. Starke, Jr., A Study of the Structure and Mechanical Properties of Ordered Alloys. \$37,000.
- Hawaii, University of, Honolulu, Hawaii. William Pong, Photoelectric Emission from Thin Films in the Vacuum Ultraviolet Region. \$25,844.
- Howard University, Washington, D. C. Arthur N. Thorpe, Radiation Damage in Optically Transparent Materials (Zircons). \$20,000.
- Illinois Institute of Technology, Chicago, Illinois. Harold Weinstock, Thermal Measurements on Solids Below 1^oK. \$65,094.
- Illinois Institute of Technology, Chicago, Illinois. Lawrence J. Broutman, The Strengthening and Toughening of Brittle Materials. \$32,000.
- Illinois, University of, Urbana, Illinois. Robert J. Maurer, The Science of Materials. \$1,294,035.
- Johns Hopkins University, Baltimore, Maryland. William F. Hartman, Acoustic Emission and the Portevin-le Chatelier Effect. \$32,000.

METALLURGY AND MATERIALS

- Lehigh University, Bethlehem, Pennsylvania. Betzalel Avitzur, Forming of Composite Materials. \$28,000.
- Marquette University, Milwaukee, Wisconsin. Robert N. Blumenthal, Defect Structures in Non-stoichiometric Oxides. \$35,964.
- Maryland, University of, College Park, Maryland. R. J. Arsenault, An Investigation of Irradiation Strengthening of BCC Metals and Solid Solutions. \$45,000.
- Maryland, University of, College Park, Maryland. Ian L. Spain, The Galvanomagnetic Properties of Graphite in the Temperature Range 4-300°K and Pressure Range 0-10,000 bars. \$30,384.
- Maryland, University of, College Park, Maryland. M. J. Marcinkowski, Alloy Strengthening Due to Atomic Order. \$38,000.
- Massachusetts Institute of Technology, Cambridge, Massachusetts. C. G. Shull, Low Temperature and Neutron Physics Studies. \$129,742.
- Massachusetts Institute of Technology, Cambridge, Massachusetts. W. D. Kingery and R. L. Coble, Basic Research in Crystalline and Noncrystalline Ceramic Systems. \$300,000.
- Massachusetts Institute of Technology, Cambridge, Massachusetts. Sow-Hsin Chen and Sidney Yip, Thermal Neutron Scattering Studies of Molecular Dynamics and Critical Phenomena in Fluids and Solids. \$88,000.
- Massachusetts, University of, Amherst, Massachusetts. Allan R. Hoffman, Ultrasonic Attenuation Studies of the Electronic Structure of Metals. \$41,045.
- Michigan State University, East Lansing, Michigan. Gerald L. Pollack, Properties of Rare-Gas Solids. \$41,768.
- Michigan Technological University, Houghton, Michigan. A. A. Hendrickson and Donald A. Koss, Structure and Properties of Solid Solutions. \$40,175 (21 months).
- Michigan Technological University, Houghton, Michigan. Donald E. Mikkola, Effect of Annealing on the Substructure of Cold Worked fcc Metals and Alloys. \$32,863.
- Michigan Technological University, Houghton, Michigan. Dale F. Stein, A Study of Grain Boundary Segregation using the Auger Electron Emission Technique. \$45,085.
- Minnesota, University of, Minneapolis, Minnesota. William Zimmermann, Jr., Lewis H. Nosanow, Walter V. Weyhmann and Allen M. Goldman, Experimental and Theoretical Studies in Solid State and Low Temperature Physics. \$165,736.
- Minnesota, University of, Minneapolis, Minnesota. Thomas E. Hutchinson, "In Situ" Electron Microscope Investigation of the Nucleation and Growth of Sputtered Thin Films. \$38,000.
- Minnesota, University of, Minneapolis, Minnesota. William W. Gerberich, Analysis of the Ductile-Brittle Transition Temperature in Fe-Binary Alloys. \$33,780.
- Montana State University, Bozeman, Montana. R. T. Wimber, High-Temperature Oxidation of Iridium. \$27,008.
- New York, State University of, Albany, New York. James W. Corbett and David Peak, Theory of Reaction Kinetics. \$40,000.
- New York, State University of, Stony Brook, New York. John C. Bilello, Applications of Microdynamics and Lattice Mechanics to Problems in Plastic Flow and Fracture. \$45,000.
- New York, State University of, Stony Brook, New York. Herbert Herman, Fatigue-Enhancement of Diffusion. \$12,050.
- North Carolina State University, Raleigh, North Carolina. Thomas S. Elleman, Diffusion of Gases in Solids. \$36,286.

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- North Carolina, University of, Chapel Hill, North Carolina. James H. Crawford, Jr., Investigation of Defect Structures by Electric Polarization and Relaxation Methods. \$30,922.
- North Carolina, University of, Chapel Hill, North Carolina. Charles S. Smith, Jr., Pressure Variation of Single Crystal Elastic Constants. \$20,387.
- Northwestern University, Evanston, Illinois. M. Meshii, Effect of Point Defects on Mechanical Properties of Metals. \$47,000.
- Oklahoma, University of, Norman, Oklahoma. Ronald R. Bourassa, Thermoelectric Size Effect in Noble Metals. \$29,956.
- Oregon State University, Corvallis, Oregon. James R. Welty, Natural Convection Heat Transfer in Liquid Metals. \$21,696.
- Pennsylvania State University, University Park, Pennsylvania. Arnulf Muan, Thermodynamic Properties of Solid Solutions at High Temperatures. \$27,301 (18 months).
- Pennsylvania State University, University Park, Pennsylvania. Richard C. Bradt and John H. Hoke, Ceramic Research. \$28,053.
- Pennsylvania, University of, Philadelphia, Pennsylvania. David P. Pope, Dislocation Mobilities in Ordered Alloys. \$33,383.
- Pittsburgh, University of, Pittsburgh, Pennsylvania. Raymond S. Craig and W. E. Wallace, Thermal, Structural and Magnetic Studies of Metals and Intermetallic Compounds. \$95,240.
- Purdue University, Lafayette, Indiana. Richard E. Grace, Transport and Thermodynamic Properties of Solids. \$38,000.
- Rensselaer Polytechnic Institute, Troy, New York. Norman S. Stoloff, Fatigue Behavior of BCC Metals. \$28,700.
- Rensselaer Polytechnic Institute, Troy, New York. H. Michael Gilder, Effect of Hydrostatic Pressure on Self-Diffusion Rates in Hexagonal Metals. \$40,000 (21 months).
- Rochester, University of, Rochester, New York. James C. M. Li, Diffusional Creep of Multi-Component Systems. \$27,000.
- Southern California, University of, Los Angeles, California. Terence G. Langdon, Grain Boundary Sliding During High-Temperature Creep. \$36,000.
- Stanford University, Stanford, California. Craig R. Barrett and William D. Nix, Structure Dependence of High Temperature Deformation of Metals. \$54,000.
- Stanford University, Stanford, California. Norman A. D. Parlee, Nitride Forming Reactions in Liquid Uranium Alloys. \$48,348.
- Tennessee, University of, Knoxville, Tennessee. E. E. Stansbury and C. R. Brooks, Application of Adiabatic Calorimetry to Metal Systems. \$26,246.
- Tennessee, University of, Knoxville, Tennessee. Joseph E. Spruiell, Microstructure-Property Relationships in Austenitic Stainless Steels. \$26,000.
- Texas, University of, Austin, Texas. Thomas H. Courtney, Elevated Temperature Morphological Stability of Metal Matrix Fiber Composites. \$21,016.
- Utah, University of, Salt Lake City, Utah. Ronald S. Gordon, Impurity Effects on the Creep of Polycrystalline Magnesium and Aluminum Oxides at Elevated Temperatures. \$25,152.
- Utah, University of, Salt Lake City, Utah. J. Gerald Byrne, Positron Lifetime Measurements as a Non-destructive Technique to Monitor Fatigue Damage. \$30,652.

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Vermont, University of, Burlington, Vermont. John S. Brown, Thermodynamic and Transport Properties of Interstitial Hydrogen Isotopes in Palladium. \$18,361.

Virginia, University of, Charlottesville, Virginia. Robert V. Coleman, Electronic Properties of Metals and Alloys. \$76,000.

Virginia, University of, Charlottesville, Virginia. Doris Kuhlmann-Wilsdorf, Investigations on the Behavior of Point Defects and Dislocations. \$98,911 (18 months).

Washington, University of, Seattle, Washington. Robert L. Ingalls, Mössbauer Studies at High Pressure. \$35,000.

Washington, University of, Seattle, Washington. Douglas H. Polonis, A Study of Phase Transformations and Superconductivity. \$36,441.

Wayne State University, Detroit, Michigan. Yeong-Wook Kim, Electron Paramagnetic Resonance Studies of Radiation Effects in Solids and Chemical Compounds. \$38,500 (2 years).

Wisconsin, University of, Madison, Wisconsin. Gerald L. Kulcinski, Void Nucleation and Growth in Heavy Ion and Electron Bombarded Pure Metals. \$63,000.