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HIGHLIGHTS

The Health Physics Research Reactor (HPRR) is the primary research tool at the Dosimetry Applications Research (DOSAR) Facility. In addition to use by the DOSAR staff, the HPRR is used by a wide segment of the scientific community for a variety of experimental purposes. This report is a compilation and analysis of data concerning HPRR uses, users, and operations through the end of FY 1984.

INTRODUCTION

The Health Physics Research Reactor (HPRR) is the primary research tool at the Dosimetry Applications Research (DOSAR) Facility. It is the only fast pulse reactor at the Oak Ridge National Laboratory (ORNL) and has been described extensively in the literature.¹⁻³ Early in FY 1982, the HPRR was designated as a Department of Energy (DOE) User Facility.⁴⁻⁵ Since receiving this designation, it has been necessary for the DOSAR staff to collect and have available an increasing amount of data concerning HPRR uses, users, and operations. This document is a collection of data which have been required in recent months and is published to preserve the data in one place for ease of future use by interested parties. The data are current through FY 1984. The remainder of the document consists of data tables, brief comments of explanation and analysis of the data in the tables, a summary, and appropriate references.

NUMBER OF HPRR OPERATIONS

The number of HPRR operations has traditionally been defined as the number of days during which the reactor was operated at least once. There can be several runs (i.e., criticalities) during a given operation. The HPRR was operated 2,792 different days from the initial startup on 3-30-62 to 9-30-84. Table I shows the number of operations for each three-month segment during that period. The average number of operations per fiscal year during the 23 fiscal years of history is 121. The average number of operations during the last two years is 126. The 46 operations in the fourth quarter of FY 1984 is the second highest quarterly total in the history of the reactor.

HPRR UTILIZATION FACTOR

The HPRR has never been used like a power production reactor where operating time is a primary figure of merit. The DOSAR staff is a research staff, not a production staff, and the amount of HPRR use has always been related to their research programs and the testing needs of various other users. It is, however, interesting to see how much the HPRR has been used throughout the years. This has traditionally been done by defining the utilization factor as the fraction of available days during which the reactor was operated (e.g., if the HPRR could have been operated 20 days during one month and was only operated on 10 of those days, the utilization factor would be 50%).

Table 2 is a listing of the utilization factor by fiscal year. The overall average utilization factor is about 64%. The factor has not increased since the HPRR was designated as a DOE user facility. The DOSAR staff is unaware of any users who came to the HPRR due to the user facility designation or its associated publicity. There has been an increase in the number of users, but not in reactor operating time.* This increase is due to the aggressive programs of training and personnel dosimetry intercomparison studies (PDIS) initiated by the DOSAR staff.* Because groups are involved and a single HPRR operation serves many users, the number of users increased while the utilization factor did not.

* Data to support these statements appear in this document in Tables 4, 10, and 11.

TYPE OF USE

Quarterly report letters to DOE concerning DOSAR activities were initiated in FY 1979. For reporting purposes, five basic types of HPRR users were defined. Table 3 contains the percent of HPRR operations for each of the five types of use for each year from FY 1973 through FY 1984 as well as the averages for the past twelve years. Biological effects studies (mainly by ORNL Biology Division researchers) and DOSAR staff use of the HPRR (dosimetry and nuclear engineering experiments as well as required operational checks) have each accounted for 30% of the operations over the past twelve years. Development of personnel neutron and gamma-ray dosimeters, nuclear accident dosimeters, and criticality alarm systems by non-DOSAR personnel are included in the category of dosimeter development which has accounted for 14% of HPRR operations. Two annual dosimetry intercomparison studies, one for personnel dosimetry and one for accident dosimetry, have accounted for 6% of HPRR operations (see Tables 9 and 10 and the associated text for more information on these studies). The remaining 20% of HPRR operations was used for training in the areas of radiation dosimetry and nuclear engineering. During the six year period from 1976-1981, the HPRR was operated 99 times to help train 361 nuclear engineering students from eight different colleges and universities.⁷

NUMBER OF USERS

The number of HPRR users by fiscal year from 1979 through 1984 is shown in Table 4. It is noteworthy that the number of users dramatically increased in FY 1982-1984 as compared to FY 1979-1981. As previously stated, this increase is primarily due to participants in the new training courses (e.g., 36 participated in FY 1983) initiated in FY 1982

and to increased participation in the PDIS. About 30% of all HPRR users over the past six years have been from universities. They constitute the largest use category by number of users but not by number of HPRR operations (this will be considered in Table 5). Other categories with significant numbers of users include national laboratories other than ORNL (15%), nuclear utilities (13%), ORNL (12%), and the military (5%). The remaining 25% is divided among dosimeter vendors, hospitals, various government agencies, small laboratories, and other organizations.

OPERATIONAL TIME BY USE CATEGORY

The HPRR has users who require multiple operations and some who require only one. Thus, the number of users is not directly proportional to the HPRR operating time. The HPRR operational time by category of user is presented in Table 5. From Table 4, it can be determined that 12% of HPRR users over the past six years have been associated with ORNL. In Table 5, it is seen that 48% of the HPRR operational time was used by this 12% of the total number of users.

Table 5 shows that the ORNL use of the HPRR increased significantly in FY 1981 and following years over FY 1979 and FY 1980. This is primarily due to an increase in neutron radiobiology experiments by ORNL's Biology Division. The unusually large amount of operational time (35%) used by universities in FY 1979 is partially explained by the fact that one user (University of Tennessee Center for Health Studies - Memphis) performed a single experiment which used 18 days of HPRR time. The types of users of the HPRR seem to be narrowing to these five: ORNL, other national laboratories, universities, nuclear utilities, and the military. Users in the category "Others" in Table 5 accounted for 25-30% of HPRR operations in FY 1979 and FY 1980 but only 7% in

USERS AND OPERATIONAL TIME:**ALTERNATE CATEGORIES TO IDENTIFY FOREIGN USERS AND INDUSTRY USERS**

To respond to recent data requests, the number of HPRR users and the operational time information presented in Tables 4 and 5 has been revised to specifically include categories of foreign users and industrial users. Foreign users are all non-USA users regardless of their affiliation (e.g., university, private company, government laboratory). The category "industry" includes utilities, reactor suppliers, dosimeter vendors, and other commercial organizations. The revised information is presented in Table 6.

For each of the five years considered in Table 6, foreign users made up from 10-20% of the total number of HPRR users. They did, however, account for only 3-6% of the HPRR operational time. This is due to the fact that foreign use of the HPRR is primarily in the dosimetry intercomparison studies where many users are involved with each operation of the reactor. During the same period, industrial users made up from 13-24% of the total number of users and accounted for 7-14% of the operational time.

MAIL-IN USERS

There are two basic ways in which a user may perform an experiment at the HPRR. The user may come to the facility and perform the experiment or mail the experimental item (e.g., a radiation dosimeter) to DOSAR and have the staff do the work and return the item by mail. Table 7 shows the number of users who have participated by mail for each of the previous six years. About 40% of the HPRR users over the past six years have participated by mail. The fraction of mail-in participants

dropped to 32% in FY 1983 and to 28% in FY 1984. The majority of mail-in users are participants in the PDIS.

TOURS

Tours of the HPRR and the DOSAR Facility are very popular with ORNL visitors. The DOSAR staff conducts 45-minute tours for an average of about 190 persons each year. The exact numbers of persons given tours during each of the past seven fiscal years is shown in Table 8. It is estimated⁸ that about 4,000 persons have toured the HPRR since 1962.

NUCLEAR ACCIDENT DOSIMETRY INTERCOMPARISON STUDIES

Nuclear Accident Dosimetry (NAD) Intercomparison Studies have been conducted using the HPRR at the DOSAR Facility since 1965. These annual studies attract international attention and have been well-documented and described.⁹⁻¹¹ Typically, the HPRR is operated in the pulse mode to simulate three different criticality accidents during the week-long NAD studies. Dosimetrists measure the absorbed neutron and gamma-ray dose and compare their results with those of experts from other organizations and with reference dosimetry provided by the DOSAR staff.¹² Lectures by recognized experts on subjects related to accident dosimetry and panel discussions of topics of current interest are interspersed among the experiments.

Table 9 is a list of all NAD studies to date along with the number of participant organizations. It should be noted that each participant organization typically sends two persons to the NAD study. To date, a total of 60 different organizations (20 foreign) have participated in at least one NAD study. Fourteen different organizations have participated in five or more NAD studies.

PERSONNEL DOSIMETRY INTERCOMPARISON STUDIES

Personnel Dosimetry Intercomparison Studies (PDIS) have been conducted using the HPRR at the DOSAR Facility since 1974. These important annual studies attract wide participation and have been well documented and described.- Contrary to the high doses and simulated nuclear accident operations in the NAD studies, the PDIS simulate neutron and gamma-ray exposures more routinely obtained by radiation workers. Participants mail their dosimeters to the DOSAR Facility where they are exposed to radiation from the HPRR. The dosimeters are then returned to the sender for evaluation. The participant then reports results to the DOSAR staff for comparison with results from the other participants and with reference dosimetry.

Table 10 is a list of all PDIS to date along with the number of participant organizations. To date, a total of 95 different organizations (31 foreign) have participated in at least one PDIS. Twenty-two of these organizations have participated in four or more of the PDIS. The participants have made a total of 3,557 neutron dose equivalent measurements and 3,533 gamma dose equivalent measurements.

TRAINING COURSES

In 1982, formal training courses in Personnel Radiation Dosimetry (PRD) and Criticality Accident Dosimetry (CAD) were developed by the DOSAR staff. Educational needs of radiation dosimetrists had become obvious from our analysis of many years of PDIS and NAD intercomparison results. These week-long courses are designed to meet those needs.- Table 11 is a list of the training courses conducted to date along with the number of participants and the participation fee.

HPRR FUNDING

The HPRR is funded by DOE's Office of Health and Environmental Research. The funding levels for each fiscal year from 1978 through 1985 are shown in Table 12. The dollar amounts shown in the table are the actual dollars for the year indicated and are not adjusted to be constant dollars associated with any particular year.

SUMMARY

It is obvious from the information presented in this document that the HPRR is modestly funded and heavily used for a variety of research, development, and training activities.

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Table 1. Number of HPRR operations^a by fiscal quarter

Fiscal year	Number of operations in quarter				Total in FY
	1	2	3	4	
1962	0	2	49	0	51 ^b
1963	0	0	17	32	49
1964	43	34	35	39	151
1965	37	44	37	42	160
1966	35	44	36	34	149
1967	34	18	24	23	99
1968	34	22	22	37	115
1969	33	42	36	46	157
1970	40	42	37	32	151
1971	23	27	27	30	107
1972	26	46	29	39	140
1973	28	25	39	32	124
1974	29	32	39	36	136
1975	27	30	34	21	112
1976	28	32	34	37	131
1977	31	40	44	21	136
1978	28	40	48	36	152
1979	22	32	20	40	114
1980	32	21	23	11	87
1981	17	26	35	36	114
1982	27	20	32	27	106
1983	30	31	36	40	137
1984	21	25	22	46	114
Total					2792

^aNumber of different days during which the HPRR was operated. (More than one run can be made during one operation).

^bThese 51 operations were performed at the Nevada test site.

Table 2. HPRR utilization factor^a

Fiscal year	Utilization factor, %
1962	b
1963	b
1964	76
1965	80
1966	75
1967	50
1968	58
1969	79
1970	76
1971	54
1972	70
1973	62
1974	68
1975	56
1976	66
1977	68
1978	76
1979	57
1980	44
1981	57
1982	53
1983	69
1984	57

^aThe utilization factor for the HPRR has traditionally been defined as the number of days operated divided by the number of days available for operation. Weekends, Mondays (reserved for maintenance), and holidays are not available for operation. There are, on the average, 199 days per year available for operation. The factor is seasonal; December and January are usually low use months.

^bNot meaningful due to reactor relocation and other unusual circumstances.

Table 3. Percent of HPRR operations by type of use

Type of use ^a	Percent in FY shown												12-year average
	73	74	75	76	77	78	79	80	81	82	83	84	
Biological effects studies	30	33	37	38	28	43	31	17	9	36	26	29	30
DOSAR ^b	47	23	31	19	17	20	28	29	55	21	43	37	30
Dosimeter development ^c	4	10	9	6	16	16	20	6	15	26	11	12	14
Dosimeter intercomparison studies ^d	2	8	3	4	3	9	7	19	9	6	4	5	6
Training ^e	17	26	20	33	36	12	14	29	12	11	16	17	20

^aThese types are the five reported to DOE in quarterly reports.

^bIncludes DOSAR staff experiments as well as routine checks.

^cNon-DOSAR only.

^dNuclear Accident Dosimetry (NAD) intercomparison studies and Personnel Dosimetry Intercomparison Studies (PDIS).

^eNuclear engineering and health physics students from universities and participants in DOSAR dosimetry training courses.

Table 4. Number of HPRR users by category

Category of user	Number of users in fiscal year						6-year total
	1979	1980	1981	1982	1983	1984	
ORNL	8	10	6	11	13	22	70
National labs ^a	16	12	12	14	10	22	86
Universities	17	19	18	29	58	30	171
Nuclear utilities	7	5	4	12	35	11	74
Military	2	1	4	6	10	6	29
Others ^b	17	17	19	23	31	29	136
Totals	67	64	63	95	157	120	566

^aOther than ORNL.

^bIncludes dosimeter vendors, hospitals, NRC, NBS, Y-12, K-25, and other labs.

Table 5. HPRR operational time by use category

Category of user	Percent of operational time in fiscal year						6-year average
	1979	1980	1981	1982	1983	1984	
ORNL	29	40	57	48	57	54	48
National labs ^a	4	6	4	3	5	5	5
Universities	35	18	18	26	16	27	23
Nuclear utilities	5	6	6	3	6	4	5
Military	1	1	3	2	9	3	3
Others ^b	26	29	13	18	7	7	16
Totals	100	100	100	100	100	100	100

^aOther than ORNL.

^bIncludes dosimeter vendors, hospitals, NRC, NBS, K-25, Y-12 and other labs.

Table 6. Number of HPRR users and percent of use by categories including foreign users and industry

Category of user	FY 80		FY 81		FY 82		FY 83		FY 84	
	N ^a	P ^b	N	P	N	P	N	P	N	P
ORNL	10	40	6	57	11	48	13	57	22	54
National labs ^c	12	6	12	4	14	3	10	5	22	5
Universities	11	13	10	10	19	17	50	14	30	27
Industry ^d	11	14	8	13	17	14	38	10	21	7
Foreign	9	5	12	6	19	6	17	4	12	3
Other ^e	11	22	15	10	15	12	29	10	13	4
Totals	64	100	63	100	95	100	157	100	120	100

^aN = Number of users.

^bP = Percent of HPRR use.

^cOther than ORNL.

^dIncludes utilities, dosimeter vendors, reactor suppliers, etc.

^eIncludes military, hospitals, NRC, NBS, K-25, Y-12, etc.

Table 7. Number of mail-in users of the HPER

Fiscal year	Mail-in users	Users who came to the facility	Total
1979	32	35	67
1980	29	35	64
1981	34	29	63
1982	48	47	95
1983	51	106	157
1984	34	86	120

Table 8. Number of persons given tour of the HPRR

Fiscal Year	Number
1978	163
1979	177
1980	169
1981	163
1982	206
1983	294
1984	163

Table 9. Nuclear accident dosimetry (NAD) intercomparison studies at the HPRR

NAD study number	Date	Number of participant organizations
1	Mar. 22-26, 1965	7
2	Oct. 18-22, 1965	7
3	May 17-24, 1967	11
4	Dec. 4-8, 1967	6
5	July 8-19, 1968	10
6	July 8-18, 1969	11
7	July 20-31, 1970	14
8	May 3-15, 1971	14
9	July 17-28, 1972	11
10	Aug. 27-Sept. 7, 1973	11
11	July 29-Aug. 9, 1974	10
12	Oct. 20-24, 1975	16
13	Aug. 16-20, 1976	10
14	July 13-22, 1977	11
15	Aug. 14-22, 1978	19
16	Aug. 13-17, 1979	13
17	Aug. 11-15, 1980	13
18	Aug. 10-14, 1981	13
19	Aug. 9-13, 1982	9
20	Sept. 12-16, 1983	9
21	Aug. 6-10, 1984	5

Note: No participant fee was charged for the first 19 NAD studies. A fee of \$650 was charged for NAD 20 and \$675 was charged for NAD 21 participation.

Table 10. Personnel dosimetry intercomparison studies (PDIS) at the HPRR

PDIS number	Date	Radiation source	Number of participant organizations
1	May 14-16, 1974	HPRR	11
2	Feb. 18-19, 1976	HPRR	12
3	Mar. 15-17, 1977	HPRR	8
4	Mar. 14-16, 1978	HPRR	23
5	Mar. 20-22, 1979	HPRR	29
6	Mar. 25-27, 1980	HPRR	29
7	Mar. 31-Apr. 10, 1981	HPRR	34
8 ^a	Apr. 19-23, 1982	HPRR/Accelerators/ Cf-252	48
9	Apr. 18-22, 1983	HPRR	28
10	Apr. 9-13, 1984	HPRR	31

^aJoint study co-sponsored by ORNL and the Commission of European Communities. European irradiation locations include Gesellschaft für Strahlen-und Umweltforschung (GSF) in Neuherberg and the Physikalisch-Technische Bundesanstalt (PTB) in Braunschweig.

Note: No fee has been charged PDIS participants.

Table 11. Formal training courses presented by the DOSAR staff

Course identification	Dates given	Number of participants	Fee, \$	Comments
PRD ^a	March, 1982	21	850	HPRR ^b
PRD	November, 1982	20	875	HPRR
CAD ^c	April, 1983	6	750	HPRR
PRD	May, 1983	10	875	HPRR
CAD	November, 1983	10	750	HPRR
PRD, CAD	February, 1984	35	none	Taiwan Power Company sponsored in Taiwan
PRD	May, 1984	14	875	HPRR
PRD	June, 1984	14	225	ANS-sponsored one-day version in New Orleans. Fee paid to ANS.

^aOne week Personnel Radiation Dosimetry Training Course.

^bHPRR operated during course to assist in training.

^cOne week Criticality Accident Dosimetry Training Course.

Table 12. HPRR funding by DOE/OHER^a

Fiscal year	Funding^b, \$(000)
1978	274
1979	296
1980	329
1981	356
1982	376
1983	366
1984	369
1985	369

^aDepartment of Energy, Office of Health and Environmental Research.

^bThese funds are divided between the Health and Safety Research Division (60%) and Operations Division (40%).

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