EDUCATION AND TRAINING*

by

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Health physics had its origin as a profession at the University of Chicago in 1942-43 as indicated in Figure 1. Health physics research soon became recognized as the study of the effects of ionizing radiation on matter with the immediate objective to maximize the ratio of benefits to hazards and the principal long-range goal was recognized as the development of a coherent theory of radiation damage. In carrying out these objectives, we today find health physics research programs employing physicists, chemists, engineers, biologists and mathematicians working together on theoretical and experimental problems. They are working at all levels--nuclear, atomic, molecular, gas, liquid, plasma, solid, crystal, living cell, animal and the ecosystem.

From the very beginning, education and training have been vital parts of all health physics programs. Table 1 lists a few of the hundreds of health physicists who received training in our Laboratory during the early period of 1943-1947. In spite of this realization and the establishment of special AEC fellowship programs in a number of the universities beginning in 1949, the supply of young graduates with proper education and training in health physics has always fallen short of meeting the demands of our constantly expanding need and an ever-unfolding of new and challenging opportunities for the health physicist. Figure 2 indicates the number of AEC fellowship students each year at the various participating universities. Table 2 indicates where these students were employed in 1964. I believe it is encouraging that 68% were in health physics.

In 1955 the Health Physics Society was formed and at present it has approximately 3,000 members. In 1959 the American Board of Health Physics began to carry out its function in the certification of health physicists. In 1966 the International Radiation Protection Association was formally organized and it now has more than 6,000 members in over 50 countries of the world.

Looking back through the years, it is evident that health physics has done a tremendous job, especially in the nuclear energy industry which has become one of the safest of all modern industries. Applied health physics activities, however, have not been limited to

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Figure 1

A. H. Compton and R. S. Stone coined HEALTH PHYSICISTS because in 1942-1943 a radiation HEALTH problem was assigned to a group, mostly PHYSICISTS, as follows:

E. O. Wollan (cosmic ray physicist)
H. M. Parker (medical physicist)
C. C. Gamertsfelder (physicist)
K. Z. Morgan (cosmic ray physicist)
J. C. Hart (chemist)
R. R. Coveyou (mathematician)
O. G. Landsverk (physicist)
L. A. Pardue (physicist)

Table 1

L. J. Cherubin (Louie)	R. B. Krum (Bernie)	C. S. Maupin (Clint)
L. L. German (Larry)	T. E. Shea (Tom)	J. W. Rust (John)
J. W. Healy (Jack)	O. R. Placak (Ollie)	S. Harris (Saul)
C. M. Patterson (Pat)	C. B. Powell (Clint)	J. S. Handloser (John)
W. McAdams (Bill)	C. P. Straub (Connie)	R. J. Connelly (Ralph)
A. H. Holland (Albert)	B. Kalmon (Ben)	M. Cohen (Mars)
V. C. Tipton (Van)	L. R. Setter (Ray)	A. B. Chitton (Art)
R. H. Pennington (Ralph)	F. W. Chambers (Bill)	V. C. Archer (Vic)
H. W. Speicher (Wilber)	O. W. Kochtitsky (Wilber)	J. S. Reed (Jim)
P. B. Klevin (Paul)	S. C. Ingraham (Sam)	J. G. Terrill, Jr. (Jim)

Figure 2

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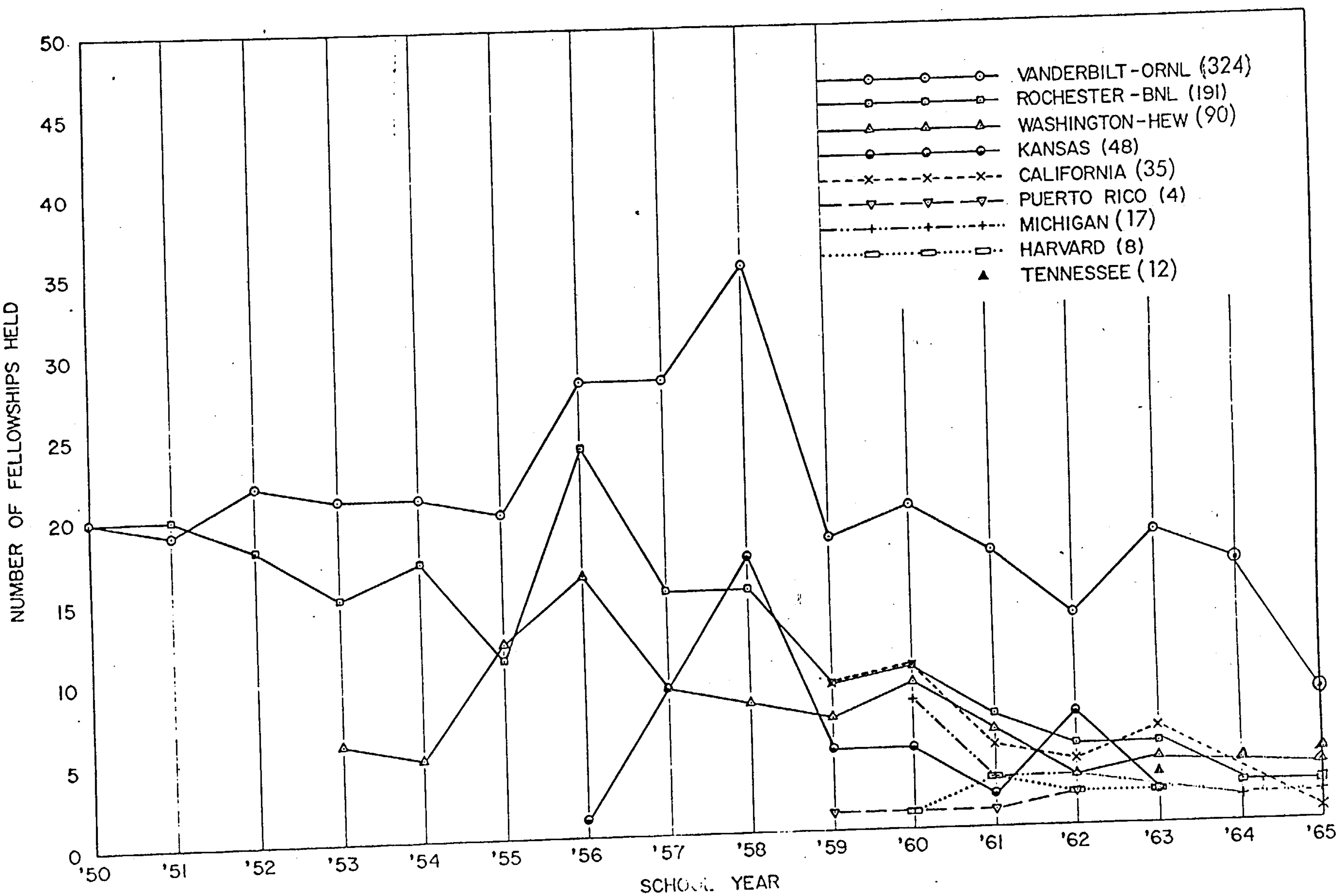

AEC HEALTH PHYSICS FELLOWSHIPS (1st. YEAR APPOINTMENTS) AT BEGINNING OF SCHOOL YEAR AT INDICATED UNIVERSITIES. EACH CURVE BEGINS WITH THE YEAR THE PROGRAM BEGAN IN A SCHOOL, NUMBERS IN PARENTHESIS INDICATES TOTAL NUMBER OF FELLOWS ON EACH PROGRAM.

Table 2

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ACTIVITY OF FELLOWS IN SPRING, 1964

(1964 activity of former Fellows who were on programs for school years 1950-51 through 1960-61)

FIELD OF EMPLOYMENT	IN HEALTH PHYSICS FIELD	NOT IN HEALTH PHYSICS FIELD	TOTAL
INDUSTRY	51 (16%)	42 (27%)	93 (20%)
GOVERNMENT	140 (44%)	17 (11%)	157 (34%)
ACADEMIC EMPLOYMENT	60 (19%)	28 (19%)	88 (19%)
FURTHER STUDY	46 (15%)	31 (21%)*	77 (16%)
MILITARY	13 (4%)	17 (11%)*	30 (6%)
OTHER KNOWN	6 (2%)	16 (11%)*	22 (5%)
	316 (68%)	151 (32%)	467
UNDETERMINED			44*
			511

*THESE HAVE NOT NECESSARILY LEFT THE FIELD OF HEALTH PHYSICS.

the nuclear energy industry for today health physicists are actively engaged in national laboratories, all the military services, state, federal and public health agencies, hospitals, private industry, space agencies and all the international agencies. Most of the leaders in organizations such as the National Council on Radiation Protection and the International Commission on Radiological Protection are health physicists and are professionally active in some of the health physics education and training, research and applied programs. Table 3 gives the results of a recent (1967) survey of the kinds of employment of the 3,000 members of the Health Physics Society.

In spite of this rather phenomenal development and growth of this new science and profession, I believe we are just now stepping onto a new vista. Here before us are many new and far more difficult problems. When health physics began, we had, in a way, a rather simple and single objective--making the nuclear energy industry a safe one--and I believe we have done a rather good job at this. However, this industry is just now preparing to leap forward. For example, as of April 1967 there were 70 nuclear reactors either operable (14), under construction (13), planned (32) or announced (11) for the production of power in our country. These will generate some 33 billion watts of power. It is expected that all of these reactors will be operable by the end of calendar year 1970. Furthermore, it is expected that approximately 200 nuclear power generators will be operable by the end of calendar year 1980. If we make what I consider a rather niggardly estimate that one senior health physicist, two junior health physicists and 10 health physics technicians will be needed for each billion watts of nuclear power, we would need by the end of 1970, 33 senior health physicists, 66 junior health physicists and 330 health physics technicians to man this program. By the end of 1980, we would need 100 senior health physicists, 200 junior health physicists and 1,000 health physics technicians. This comes at a time when only 2% or approximately 60 health physicists are employed in the nuclear power industry and when we are not even supplying new health physicists at the present retirement rate in our profession. Furthermore, as we have seen above, more and more health physicists are needed in these other areas of research, state inspections, space agencies, etc., and we can expect these demands to increase considerably in the years immediately ahead. Six-tenths of a percent or a total of about 20 health physicists are associated with programs of the space agencies. I expect as these programs move into their next phase of long-range missions to the planets that reactor engines will provide the principal source of power for

Table 3

EMPLOYMENT OF MEMBERS OF THE HEALTH PHYSICS SOCIETY

	Percentage
Educational	16.6
U. S. A. E. C.	11.3
Public Health	10.7
Industrial	10.7
Medical	7.6
Armed Services	6.0
Self Employed	3.6
I. A. E. A.	2.2
Power Plant	1.9
N. A. S. A.	0.6
Insurance Companies	0.1
U. S. Department of Labor	0.1
U. S. Department of Interior	0.1
Transportation	0.1
National Science Foundation	0.1
U. S. Geological Survey	0.1
Certified Health Physicist	23.2
Radiation Physicist (American Board of Radiology)	4.6

space flights and health physicists will be vital parts of the mission both on the ground and in flight operations.

Several hundred health physicists (or 17% of the membership of the Health Physics Society) are at present associated with colleges and universities where they are serving as senior health physicists or radiation protection officers and, in addition, are teaching courses in health physics, radiation physics, radiation chemistry, radiation biology, radiation ecology, radioactive waste disposal, etc. College-level textbooks in some of these subjects are now being written and some of them will shortly be available for classroom use. The book titled A Textbook in Health Physics, prepared for the most part by members of our Health Physics Division, is just this month available in the bookstores. From the limited contacts I have had with colleges and universities, I estimate that during the present school year, approximately 100 universities will be offering graduate courses in one or more of the above-named subjects--some at the undergraduate level. Likewise, more and more research programs in these schools as well as those in national laboratories, private industry, military research establishments and hospital studies are being identified as health physics research.

At present, 11% of the health physicists are in public health and 8% are in medical organizations. I believe these health physicists are just now beginning to consider seriously our biggest and most important problem to date--that of reducing unnecessary medical diagnostic exposure. For over two decades, some of us have been calling attention to this problem and pointing out the fact that more than 90% of man-made exposure to ionizing radiation derives from this source. Yet very little progress has been made. Health physicists in their surveys and in many of their publications have shown that some dentists are giving 10 to 100 times the skin dose that others are delivering for the same diagnostic information and some technicians are giving 10 to 100 times the skin dose delivered by others for the same type of chest x-ray examination. Yet almost invariably the medical doctor, the dentist or the technician giving the lesser doses obtains sharper x-ray images and consequently more and far better medical information.

I believe the best way we can prepare for the increasing role of responsibility of the health physicist is by doing all we can to improve education and training facilities for those who come after us. Along with our education and training programs, we must not neglect our research and especially research on basic and fundamental problems of health physics. It is here that we can expect our long-range and lasting contribution to this new science. It is here that we must attract some of our best and most promising young health physicists who, as a result of their education and training, can stand proudly shoulder-to-shoulder with the best scientists in our country.

As indicated above, there is need for health physicists with many different types of background, training and experience, e.g. physics, ecology, chemistry, engineering, etc. It does not seem desirable to attempt to supply all this background and training to any one student but rather to train different types of health physicists--some for applied operations, others for teaching and/or research in health physics physics, health physics ecology, health physics engineering, etc. At Vanderbilt University and the University of Tennessee, we specialize in training health physicists with a background in physics and applied operations and, in addition, at the University of Tennessee we have a program in which radiation ecology is the principal subject area. Dr. S. I. Auerbach will discuss this shortly. In any case, we believe our Ph. D. graduates should stand shoulder-to-shoulder with the best of scientists in their area of specialty. As a consequence, those with a physics specialty must meet all the usual requirements for the Ph. D. in physics and, in addition, they must meet the special requirements listed in Table 4 to assure that they are health physicists as well as physicists. Dr. R. D. Birkhoff will discuss this program in more detail and describe a new program we plan at the University of Tennessee for the training of health physics technicians and junior health physicists.

Table 4

FEATURES OF ORNL-UT DOCTORATE PROGRAM THAT MAKE IT A HEALTH PHYSICS AS WELL AS A PHYSICS PROGRAM

1. ONE OF PRELIMINARY EXAMINATIONS WILL BE GIVEN ON GENERAL HEALTH PHYSICS
2. SUMMERS OF STUDENTS WILL BE SPENT IN THE HEALTH PHYSICS DIVISION AT ORNL
3. CURRICULUM WILL INCLUDE SPECIAL COURSES* IN
   - A. GENERAL HEALTH PHYSICS (Physics 472-3)
   - B. RADIATION CHEMISTRY (Chemistry 546)
   - C. RADIATION BIOLOGY (Zoology 577-8)
   - D. RADIATION PHYSICS (Physics 661, 662, 663)
4. DISSERTATION WILL BE ON SUBJECT RELATING TO IONIZING RADIATION

*400 COURSES ARE UNDERGRADUATE LEVEL; 500 COURSES ARE GRADUATE LEVEL AND 600 COURSES ARE ADVANCED GRADUATE LEVEL