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HEALTH PHYSICS

LECTURE I

HEALTH PHYSICS, ITS HISTORY AND DEVELOPMENT

by Karl Z. Morgan

Health Physics is a new name applied to a newly developed and specialized branch of Radiology. The name was first used in its present application at the Metallurgical Laboratory of the University of Chicago in the summer of 1942. The initial objectives of the Metallurgical Project were to: (1) Develop a chain reacting pile using natural uranium, (2) Separate plutonium chemically, and, (3) Obtain theoretical and experimental data for effecting an explosive chain reaction. It was recognized at the very beginning of these efforts that radiation hazards of a heretofore undreamed of magnitude would be encountered. Some doubt was registered as to the advisability of proceeding with this project after reviewing the past history of radiation damage and reflecting the serious consequences if radiation damage were permitted to increase in proportion to the potential increase in radiation exposure.

Only about two pounds of radium had been mined and made available to man's use in the world in 1942, and yet with this and with the small amount used by the dial painting industry, seventeen fatalities had been recorded following ingestion of radium and six fatalities*(1) following inhalation of radium dust. Hundreds of persons had been reported injured and perhaps many more cases had been unreported. In addition twenty-eight deaths*(2) had been recorded in the United States and Canada up to 1935 as a result of exposure to X-rays. The proposed plutonium project developments would mean working with radiation equivalent to millions of pounds*(3) of radium. It is no wonder then that potential radiation hazards occasioned considerable concern from the very start of the Plutonium Projects. It is for this reason that Dr. E. O. Wollan was called to head up the first Health Physics department in 1942 and the radiologist, Dr. R. S. Stone, was shortly afterward made Associate Project Director for Health of the Plutonium Projects.

The principal function of Health Physics has been to make a study of radiation problems and to devise means of preventing radiation damage. The need for this science began in 1895 when Roentgen discovered X-rays and 1896 when Becquerel discovered the radiations from uranium. In fact, one of the first producers of X-ray tubes, Mr. Grubbe of Chicago, noticed the X-ray damage to his hands as early as 1896, and 170 cases of X-ray injuries were recorded by 1900.

Many important developments in Health Physics date back to the time of Roentgen. Among the more interesting early instrument contributions, we might mention dose meters developed by G. Contremoulins (1902), G. Holzknecht (1902), R. Sabourand (1904) and B. Szilard (1914). In 1902 W. Rollins first formulated

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*(1) Reported by R. D. Evans in report on <u>Survey of Literature Dealing with Radium Poisoning</u>.

(2) Cases reported by Percy Brown.

(3) At the rate of 3×10^{10} fissions/sec - watt and 200 mev. per fission a 10^8 watt pile is equivalent to about 2×10^6 lbs. of Ra plus its chain products.

an idea of tolerance dose; L. Seitz and H. Wintz introduced the term "skin-unit dose" in 1920; G. Hevesy employed Ra D in tracer studies in 1923 and H. Fricke and O. Glasser developed the thimble chamber in 1925. As early as 1915, S. Russ made recommendations to the British Roentgen Society regarding Health Physics radiation safety measures. As typical of more important current developments, one might mention the W. H. Bragg - L. N. Gray principle; depth dose measurements by such persons as W. V. Mayneord, H. M. Parker, R. Dresser and A. Meltzer; radiation quality measurements by L. S. Taylor and G. Singer; radiation quantity measurements by G. Failla, L. D. Marinelli, O. Glasser and L. S. Taylor and neutron equivalent roentgens measurements by P. C. Aebersold and G. Failla.

The Health Physics department at Clinton Laboratories has been headed by K. Z. Morgan since H. M. Parker went to Hanford in the spring of 1944 to organize a similar department there. The Health Physics department at Chicago has been headed by J. E. Rose since the fall of 1944. The directors of the three above named departments should be contacted if specific information on Health Physics problems not discussed in this lecture series is desired. Much of the Health Physics work at the three places is similar. Personnel monitoring service must be furnished; laboratories, separations plants and pile buildings must be surveyed; off-area gases and waste solutions must be checked; new Health Physics instruments must be developed; special radiation experiments must be performed; radiation calculations must be made and various tolerance limits determined. The Chicago organization is typical of what may be needed by a university actively engaged in atomic energy research. It has required an average of about thirty men for its operation. The Hanford organization has been a model for large industrial plants which are interested in production. It has placed less emphasis on research, but has developed its Health Physics Service*(4) to a peak of perfection. It employs about 150 men. Clinton Laboratories is in between the two extremes. Its organization of seventy persons devotes a larger percent of its time to research than does Hanford, but it has more service problems than Chicago. It is expected that recent developments such as the operation of the Hanford plant by the General Electric Company, the establishment of the Argonne National Laboratories and the current expansion at Clinton Laboratories may influence the future programs of Health Physics at these three sites. A Health Physics organization chart is given in Figure 1 to illustrate the distribution of effort required to perform this function at Clinton Laboratories and to serve as an estimate of what might be needed elsewhere.

Even as late as the fall of 1943, when the Clinton Laboratories pile began operating, it was hoped that radiation surveys would be done primarily by operations men, production supervisors and scientific personnel. However, a number of nearly serious accidents caused a change in plans, and it became evident that an independent group of Health Physics surveyors should be made available as soon as possible. These surveyors should be trained in the proper use of the approximately twenty commonly used Health Physics instruments; they should know, for example, how to collect an air sample and measure the argon activity if the pile fans should shut down; they should be able to construct neutron shields that would not scatter gamma rays; they should know the air tolerance levels and when pressure masks should be worn; they should know how a properly functioning hood should operate and how it should be used. Radiation hazards in an atomic energy plant were found to be so insidious and persons were observed to be so intently absorbed in their own experiments and inclined to overlook some of these unseen dangers, that it was considered wise to have an independent group devote full attention to radiation surveys.

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*(4) Called Health Instrument Service at Hanford.

The responsibilities of Health Physics have expanded rapidly. In addition to plant surveys, off-area surveys, personnel monitoring, and instrument development, there were many other assignments. Special scattering and shielding measurements had to be made; plans for new pile design were checked for radiation safety; tolerance levels had to be set for the various fission products and for induced radioactive products; assistance had to be given to setting up suitable laws by which radioactive products could be shipped by railroad and airplane; consideration has to be given to the best final disposal of the numerous radioactive products so as not to contaminate dangerously the surface of our planet; the effects of epithermal neutrons and neutrinos on tissue have yet to be investigated. These are only a few of the many tasks assigned to Health Physics. Advice is constantly being sought by organizations outside the project on such questions as how to set up a decontamination laundry; how to evaluate various radiation hazards and where to procure certain Health Physics instruments that were developed on the projects. Senior Health Physics Surveyors are being trained and sent to other locations where they offer advice on radiation problems and assist in setting up new Health Physics organizations. There is already considerable pressure to have a Health Physics school set up at Clinton Laboratories where men from universities, industrial concerns and from the armed forces can come for a year or more of training in this field.

As one looks into the future there seems to be considerable need for Health Physicists, regardless of other developments in the atomic age. There is a great opportunity for Physicists, Chemists, Engineers and junior men and women in this field. On the one hand Health Physicists can be of great assistance in setting up a suitable, necessary and sufficient world atomic development authority inspection system. If on the other hand an atomic war is to come, it is important to have a large force of Health Physicists to make measurements of air and water radioactivities, to recommend which areas should be evacuated and to determine the best decontamination procedures. In any case, the immediate need and the principal purpose of this series of discussions is to inform new personnel at Clinton Laboratories of the radiation hazards involved and to acquaint them with the tolerance levels and instruments available that will assist in maintaining operations within safe limits. Experience has indicated that the best protection against radiation hazards is a clear understanding and a full appreciation of Health Physics problems by all who work with radioactive materials. The accomplishment in developing the proper respect for radiation among the laboratory personnel is considered the greatest single factor that has prevented any known radiation damage to persons working on the plutonium projects. This statement is made with the knowledge that an adverse change in this condition would probably lead very soon to fatal consequences.

10/31/46

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