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LOS ALAMOS SCIENTIFIC LABORATORY

of

THE UNIVERSITY OF CALIFORNIA

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# HEALTH DIVISION ANNUAL REPORT

1949

PROGRESS REPORT UNCLASSIFIED

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## PROGRESS REPORT

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ANNUAL REPORT - 1949
HEALTH DIVISION

## INTRODUCTION

(Thomas L. Shipman, M.D., Health Division Leader)

Before making an attempt to weigh the assets and liabilities of our work of the past year, I should like to digress immediately in order to review the philosophy under which our Division has developed. It has now completed its first full year under my leadership; some of the ideas and plans that I had on my arrival have been radically changed, while others, the majority of them, have been strongly reinforced. Health service at Los Alamos started out entirely as a means of protecting the workers and preventing injuries. Gradually and inevitably the concept of "health" broadened as it was realized that general matters of physical and mental well-being were matters of importance in the relationship between the worker and the work he was doing. The end of the war and the subsequent transition from Manhattan District to AEC left the health and medical services certainly in no less a turmoil than the rest of the Laboratory. Out of this turmoil, however, emerged an even broader concept of health service--the realization that it was not a static matter and that it was constantly undergoing change and development. Greater emphasis was placed on the research aspects of the work, first from a programmatic point of view and, later, with increasing interest in fundamentals. The advice of Prof. Philip Drinker of the Harvard School of Public Health, the backing of Dr. Shields Warren of the Division of Biology and Medicine, and the guidance of Dr. Louis Hempelmann, aided by Dr. Wright Langham and Dr. Harriet Hardy, produced a framework that was ready-made at the time of my arrival at the end of 1948.

The present report is an attempt to indicate what I and my associates have done with the responsibility that was ours, to explain, from an admittedly biased point of view, what we feel we have accomplished and what our hopes for the future are. I wish to emphasize that I feel that I can take very little credit for the accomplishments; I have the feeling that they have just happened while I was fortunate enough to be here. The credit belongs to my associates, the Group Leaders, who have been without exception as cheerful, willing and able collaborators as one could hope for.

### A. Growth of Division

At the start of 1949, H-Division had 87 employees; at present, there are 117. The breakdown on these figures is as follows.

| | Jan. 1949 | Jan. 1950 |
|---|---|---|
| Division Office | 9 | 11 |
| H-1 (Radiologic Safety) | 22 | 31 |
| H-2 (Occupational Health) | 29 | 18 |
| H-3 (Safety) | 3 | 3 |
| H-4 (Bio-Medical Research) | 20 | 29 |
| H-5 (Industrial Hygiene) | - | 17 |

These figures may be explained as follows.

1. Division Office. The increase represents one all-round machinist in the Division machine shop and one additional clerk in the Property Section.
2. H-1. Seven of the nine new workers were badly needed monitors.
3. H-2. This drop is almost entirely the effect of transforming the old Industrial Hygiene and Occupational Biochemistry Sections into Group H-5.
4. H-4. Of the nine new workers, two are staff members, four are technicians, and one a clerk.
5. H-5. Of the present seventeen workers, ten are former members of H-2, while seven are new.

The 29% increase in the size of the Division may seem large, but it must be remembered that the Health services had just undergone a complete reorganization and, at the start of the year, the Division simply was not up to full manpower to carry out the necessary day-by-day tasks.

The changes in floor area also represent progress. The annex of the Medical Research Laboratory is now fully utilized, and another one of the old barracks in TA 32 has been taken over as a warehouse. Q-Building was completely remodeled, while an addition to ML-Building, the Occupational Biochemistry Laboratory, is nearly completed. More space is urgently needed by the Monitoring Section, and plans for a temporary solution have been formulated. Further expansion, save at the expense of doubling-up, will have to await new permanent construction in the Hospital, the new Medical Research Laboratory, and in the new Tech Area on South Mesa.

A considerable amount of new laboratory equipment was obtained during the year, items worthy of mention being the infrared spectrophotometer, the ultracentrifuge, and electrophoresis apparatus. By and large, we feel that we are now an excellently equipped Division, and no major purchases are contemplated in the near future.

## B. Establishment of Group H-5

The only major organizational change in the Division was the establishment of Industrial Hygiene with Group status. This not only resulted from the large number of unique toxicological problems that exist at Los Alamos, but also reflects the nationwide and growing importance of Industrial Hygiene as a special field. The new Group, H-5, has already proven its value and importance for the future.

## C. Organization of the Division

It might be well to interject here a few comments on our organization which is, in some respects, rather unique. At Los Alamos, all health agencies except the Hospital itself are unified in a single organization. Radiologic Safety, Industrial Safety, Occupational Medicine, Industrial Hygiene, and Research are all unified into a single administrative group. This is a rare arrangement, but it represents the dream, the ideal that has been before the eyes of those with any experience in the field of Industrial Health. I can only say that in my opinion it works, and it might very well be adopted elsewhere in Industry. In passing, I might mention the fact that Los Alamos apparently is the only major installation of the AEC where all records of exposures to radiation or radioactive materials are routinely placed in the workers'

medical record. Elsewhere, a sharp cleavage seems to exist between the Health Physics and the Medical Groups. We can boast of complete harmony and cooperation.

D. Contacts - Internal and External

One factor in the inner workings of the Division that to me is both significant and reassuring is this very harmony and spirit of cooperation. Rarely does a problem confront us that involves only a single group, and never have the various groups failed to join forces and, unified, attack the problem. Each Group Leader maintains a friendly and helpful interest in the work of the others, always prepared to offer whatever assistance or advice may be needed. It is my feeling that the morale of the entire Division is high, and that all hands take a pride in the work being done.

In the same way, we have felt an increasing awareness, on the part of other Divisions, of the work being done by H-Division. Requests to us for help or advice have become far more frequent, and in return we find a very cheerful willingness to help us with our problems. There seems to be none of the feeling that H-Division is either a necessary evil or a disciplinary body devised to torment hard-working scientists. Without this friendly interchange, all of our work becomes futile. Of particular gratification is the free exchange of ideas and standardization of methods between some of our members and those of CMR-12. Harry Schulte, who serves in both Divisions, and Tom White deserve the credit for this, and it has essentially eliminated what once was a source of occasional friction.

E. Relations with the Hospital

No one factor during the past year has, in my opinion, been of any greater importance and all-round benefit than the development of a warm and cordial relationship between the staffs of H-Division and the Los Alamos Hospital. There formerly existed the feeling that each group had a sharply demarcated sphere of responsibility, with the result that the constant state of mild feudin' occasionally seemed about to break into open warfare. The reorganization of the Hospital administration has changed all this, and there now exists the very healthy realization that we all have a common aim, that a person cannot have one part of his health on one side of a fence and one part on the other. Health Division physicians now have regular appointments as either Active or Consulting Members of the Hospital staff, and the Hospital staff members are being drawn slowly but surely into participation in our own program. Two definite spheres of activity still exist, but a broad zone of overlap is now clearly recognized. Construction of the new Hospital will serve to cement more firmly the interlocking that must always exist. The steps already taken by the Hospital Trustees and by Dr. Hausner are a source of great gratification to this Division.

F. Our Expanding Services

H-Division is currently providing a very considerable number of services that were not formerly available. These various services and programs are not, in my opinion, remarkable or unusual; they simply represent an approach to what I consider a properly rounded and complete program. We have even more projects for the future, but below are listed a number of new projects that were undertaken during the past year. These have been picked at random and are in no particular order.

1. Intensive study of GMX workers at S-Site with reference to possible absorption of toxic materials.

2. A fourteen-week indoctrination course for selected representatives of the Security Service and the Fire Department. In this course, Mr. Reider had the help of all Divisions in the Laboratory. The purpose of the course was to acquaint those taking it with hazards or problems peculiar to particular buildings or locations.

3. Institution of a training course in monitoring and radiation safety for selected members of the AESS. This course was arranged at the request of the AEC Emergency Stockpile Program.

4. Despite the change in administration at the Sandia Laboratory, we are continuing to provide essentially the same health services as before until they can organize their own services. It is felt that, in certain specialized fields, we shall continue to serve in at least an advisory capacity for some time to come.

5. J-Division activities have drawn members from most of our Groups into their problems. We are currently providing monitoring service at Eniwetok; Wright Langham and Harry Whipple act as advisors to Alvin Graves; Dr. Whipple reviews all Holmes and Narver physical exams; while the rest of us stand by prepared to offer whatever help is called for.

6. The Colorado Raw Materials Office of the AEC sought and obtained help from our Division. Dr. Whipple and Mr. Schulte made an inspection trip of the area at the request of the Division of Biology and Medicine.

7. Members of our Division together with others from CMR and the Sanitation Department have given freely of their time in the various meetings and consultations on the general subjects of waste disposal and air contamination.

8. The Chalk River Conference to establish tentative tolerance levels to radiation was attended by Wright Langham. The results of this meeting provide us with one of our biggest headaches for 1950.

9. The addition of Dr. Lushbaugh to our staff has been a boon to both the Division and the Hospital. Our staff members now have competent histopathological advice, while the Hospital has a first-class pathologist and laboratory director.

10. Meteorological service is now available to Los Alamos with the help of personnel furnished by the Air Weather Service at Kirtland Field. These men operate under the administration of H-Division.

11. A contract for certain special services was entered into between H-Division and the Department of Industrial Hygiene at the University of Colorado Medical School. We feel that this has already paid dividends.

12. Bayo Canyon and the operations carried out there provided the Division with its greatest single problem. The difficulties encountered were great, and the Monitoring and Biophysics Sections of Group H-1 deserve special credit.

## G. Army Medical Corps Officers

The assignment to our staff of officers from the Medical Corps of the Army has been a thoroughly happy arrangement. The men selected for us have been of the highest calibre and they have fitted into our program with ease and grace. Every member of the group has made a definite contribution to our research program and has, at the same time, been perfectly willing to accept his due share of the less popular routines of the Division. Major Brennan has, as Commanding Officer, fulfilled the duties of group leader, while at the same time he and Captain Harris deserve special commendation for preparing a handbook to serve as a guide for all medical and biological experiments to be carried out in conjunction with J-Division activities. Captains Atchley,

Schlaseman, Keating, and Schulman have also made contributions far beyond our original expectations.

## H. Medical and Biological Research at Los Alamos

I cannot let the opportunity pass without commenting on the philosophy and policies that underly our own research and development activities. By definition of the AEC and by direction of the Congress, research into basic biology, medicine and allied sciences is one of the Commission's responsibilities. In the bulletin "Atomic Energy and the Life Sciences", published in July, 1949, by the AEC, we find listed on page 17 four general fields of research and development. We are definitely engaged in carrying out research in all four of these fields. It must not be forgotten that medical research at this Project was born of necessity during the war. The research work was essential to the work of the Laboratory, but it was not expected to be any more permanent than the rest of the Laboratory. Recent development and more recent plans for the future have brought about a change. We now have here one of the world's greatest physics laboratories, destined to be even greater. Nowhere else exists such an array of reactors, accelerators, radiation-producing instruments, and radioactive sources. Nowhere else in the world has a mouse ever been placed inside a concentrated critical assembly! We have worn somewhat threadbare our old plea for justification of our existence on the basis of essentiality to the weapons program. The clear truth is that a Laboratory such as Los Alamos cannot afford to exist without offering space to a group engaged in Medical, Biochemical, and Biophysical research; the opportunities are far too great to be ignored. So long as Los Alamos exists as a physical and chemical laboratory, it will require a medical research group to service its needs; but so long as it continues as a world center for study of nuclear physics with a staff of competent scientists, it cannot overlook the fact that in its brotherhood place must be made for basic medical researchers who are in the brotherhood not as camp followers of the weapons program but as reputable and sincere scientists in their own right, entitled to a place at the table. Medical research at Los Alamos has already made numerous additions to the general body of knowledge through contributions to the literature, and more work awaits publication. We are just beginning to appreciate and realize the opportunities and possibilities presented in the utilization of the vast array of new instruments now in the hands of the physicists. As a matter of fact, we are probably not too far behind the physicists themselves.

Los Alamos can and should become a national and a world center of biomedical research just as much as it should become a great center of research into physics, chemistry, and metallurgy. Such a program should not necessarily connote growth and expansion out of proportion with the rest of the Laboratory, but it does require the maintenance of a permanent staff of highest quality with permanent laboratory facilities adequate for the task to be done. The need for permanent and enlarged quarters cannot be understated; expensive equipment is housed in temporary, cramped, flimsy and inflammable quarters, all of which are definitely scheduled for demolition. The workers need not glorified but at least adequate, working quarters that will help us to hold good staff members and attract new ones. The size of new facilities and the ultimate expansion of the staff should never get out of reasonable proportion to the rest of the Laboratory.

## I. H-Division in Relation to the Rest of the Laboratory

An appraisal of the present status of the health services of the Laboratory against the background of the Laboratory is perhaps a fitting conclusion to this part of the Annual Report. Considering all the circumstances, I do not feel that the Division is significantly too large or too small. We need a few additional workers, but not many. For our present stage of development, I think that we are offering the Laboratory reasonably adequate service, but much remains to be done; present services must be expanded, new services added. Greater efficiency and greater accuracy must be achieved. Scientific acumen, however, can never replace a feeling for humanity and an obligation for service not merely to science but to mankind.

## GROUP H-1, RADIOLOGIC SAFETY

(Thomas N. White, Ph.D., Group Leader)

In the work of the three original Sections -- Monitoring, Electronics, and Biophysics -- of the Radiologic Safety Group, the main changes during 1949 have occurred in the Monitoring Section. This is due, in part, to a greater volume of work arising from the increase in Laboratory personnel, and, in part, to an effort to give attention to some radiologic risks that had not been given adequate attention in the past. The work of the Electronics Section has increased somewhat in volume and variety, but there has been no marked change. The number of special problems requiring attention by the Biophysics Section has increased considerably. Because of the major demands made on the Biophysics Section by the fall-out problem, it has been impossible to give adequate time to many other important problems. In order to aid in dealing with the problem of radioactive fall-out from a cloud, a new Section -- the Meteorology Section -- was organized about July 1, comprising a small detachment of Air Weather Service personnel provided by the Air Force.

### A. Routine Programmatic Work

Starting about the first of the year, the personnel film badges were changed to provide an unshielded area of film that will respond to beta or soft-gamma radiation. The main result of this change was the discovery of many cases of high exposure, and a fair number of overexposures to beta radiation from normal uranium. This led to some reorganization of uranium shop and inspection work.

Early last Fall, through the cooperation of the Microscopy Laboratory of P-Division, routine fast-neutron monitoring of personnel of selected groups was started. The method, essentially the same as that used at Oak Ridge, depends on counting proton-recoil tracks in a photographic nuclear emulsion. Admittedly a tedious method, and considerably less sensitive than is needed, it was finally adopted, as the best method available, after considerable study of possible alternatives.

Starting with the organization of the Meteorology Section about July 1, there was added to the routine work of the Group the preparation of daily local weather forecasts, with special attention to forecasts for the operations of GMX-5.

In October, a monitor was sent to Eniwetok to take care of radiologic safety problems in connection with current decontamination and construction work.

The volume of film-badge work at Los Alamos has increased by 50% during the year. Fingerprint impression work was discontinued September 30, pending the outcome of a more thorough study of past experience. There has been no obvious correlation between occurrence of finger-ridge abnormality and radiation exposure, and it seems unlikely that the work should be continued on the same basis as in the past.

The Electronics Section was relieved of responsibility for machine-shop work for the Division at the end of April when this work was taken over by a group under the Division Office.

On the following page is given a table of statistics for some of the routine work that can be measured quantitatively:

Monthly Volume of Routine Work

| Type of Work | Low Month | Average | High Month |
|---|---|---|---|
| Film Badges | 1712 | 2724 | 3346 |
| Pocket Chambers, Tested & Calibrated | 40 | 147 | 372 |
| Overexposures* | 0 | 10 | 24 |
| Survey Reports | 1 | 4 | 8 |
| Sources Issued | 0 | 4 | 11 |
| Vehicles Checked | 17 | 29 | 60 |
| Vehicles Decontaminated | 0 | 9 | 33 |
| Salvage Items Monitored | 1457 | 2215 | 3836 |
| Instruments Repaired | 69 | 90 | 107 |
| Instruments Calibrated | 55 | 69 | 80 |
| Instruments Issued | 0 | 11 | 80 |

*Most of these were exposures slightly in excess of the new proposed maximum permissible exposures

B. Research and Development Work

The major job in this category was the investigation of the seriousness of fall-out of particles of radioactive materials from clouds. This investigation was started early in the year after extensive contamination was discovered on the road near the East Gate to Los Alamos shortly after an experiment. A great deal of time and manpower was spent on efforts to determine fall-out patterns of activity on the ground and to correlate these with attempted measurements of radioactive concentration and particle-size distribution in the air during fall-out. The ruggedness of the terrain made this work very difficult and time-consuming, and most of the efforts were abortive because of the variability of the winds. Patience and persistence, mainly in the Biophysics Section, were finally rewarded by good luck after six months of hard work, and some significant quantitative results were obtained. These results are still very meager but they justify a fairly confident conclusion that there is no serious hazard at a distance of two miles from the Site in question under representative wind conditions. Biological data on the results of inhaling the material involved are quite meager and it is believed that the effort to protect populated areas from the cloud should be continued.

Instruments were developed for continuous beta and gamma monitoring of various points around the Los Alamos area. These instruments are tied in by means of telephone lines to a central location where a record is made on a graphical recorder. Six locations are currently being monitored, and more can be added after the system has passed through its trial period.

A program of systematic investigation of the response of Eastman Type K (badge) film to typical beta and x-ray spectra is in progress.

A portable fast-neutron survey meter has been developed and is under test. This meter operates by counting fissions in enriched normal uranium. Other methods of measuring neutron fluxes by means of survey meters are also being investigated.

Serious troubles have been encountered because of the unreliability of conventional GM counter survey meters in monitoring out-of-doors at low temperatures. Work is in progress to overcome this difficulty by changing the gas filling of the counter tubes and by various methods of protecting batteries from low temperatures.

The Biophysics Section has given assistance to the local AEC management on the Disaster Program by providing technical advice on instrument stockpile problems and by giving instruction on disaster monitoring to AESS personnel.

## C. Future Program

In the field of routine work, the following are expected to be added in the near future.

### 1. Work-Order Monitoring

Past experience has shown that many maintenance and construction jobs have been started without adequate health clearance. This is not the fault of the Engineering Division or of Zia Tech Maintenance who have always asked the Health Division for advice when it was known that this was desirable in connection with a projected job. Failures have occurred mainly because of lack of knowledge of the existence of health hazards in various locations. After extended discussion of this problem, it has been decided that the most satisfactory solution is to place a full-time health monitor on duty to review all job requests and construction plans. It is contemplated that this review will cover non-radiologic as well as radiologic health hazards. A man now is in training for this position.

### 2. Inspection

In the past, many cases of contamination, overexposure, misuse of radiation sources, etc., have been discovered more-or-less by accident. Shortage of personnel has made it impossible to undertake routine spot-checking of many areas and activities that are not covered by routine monitoring. A man is in training for this inspection work.

Much of the work listed above under Research and Development will be continued during 1950. It will probably be desirable to attempt to obtain some further data on fall-out when warm weather returns. It is not intended to make another major effort in this direction unless additional personnel and space can be obtained for the Biophysics Section. Highest priority is currently being assigned to those problems raised by the Chalk River proposal of low permissible levels, particularly for plutonium and polonium activity. These problems may require a major effort on the part of the Biophysics Section during 1950.

It is strongly desired that personnel of the Biophysics Section should have an opportunity to participate in some of the research work of H-4 Bio-Medical Research Group. Examples of work in which cooperation should be mutually profitable are:

a. Investigation of the biological effectiveness of fast-neutron beams of various energies.
b. Measurement of the biological effectiveness of slow neutrons.
c. A variety of problems in dosimetry that arise in planning the biological program for the next tests at Eniwetok.

At the present time it is not possible for the Biophysics Section to participate in such work because of the urgency of several of the practical problems now on hand.

D. Future Requirements

In so far as routine work is concerned, the main immediate need is for an Alternate Leader for the Monitoring Section. Considerable effort has been made to find an Alternate Leader but has so far been unsuccessful. The space available for routine work is somewhat crowded but is adequate in most respects. The principal shortcoming is the lack of a separate space with special facilities for decontamination of instruments, tools, etc.

As mentioned above, the most serious space and personnel shortage exists in the Biophysics Section. Since there is at present no possibility of obtaining any appreciable increase in the space available for this Section, there is little point in considering any appreciable increase in personnel. It is hoped that within a few months it may be possible to obtain one or perhaps two additional young physicists from the Spring group of graduates.

## GROUP H-2, OCCUPATIONAL HEALTH

(Robert S. Grier, M.D., Group Leader)

Group H-2, Occupational Health Group, is primarily medical in nature, and its functions might be considered analogous to those of a full-time plant physician in private industry. The routine work of this Group is largely of a preventive nature and may be broken down into essentially three phases. One phase is primarily concerned with screening of new personnel from a medical point of view, with a conscientious attempt to try to place a given individual in a position that is not incompatible with his general health. Serious consideration of minor defects or past illnesses is given in the placement of an individual in order that an employee will not be placed in an environment in which his past illnesses or disabilities conceivably might make him more susceptible to injury or a hazard to his fellow workers. In addition, a considerable portion of our work is concerned with termination physical examinations, both for the employee's protection and for the protection of the University and the Government, in order to be reasonably certain that he has suffered no injury from exposure to any of the numerous hazards here. In addition, a conscientious effort is made to discover any disease present, whether occupational in origin or not; if such is found, the employee is so advised and urged to seek treatment. We have also acted as advisors to the Sandia Laboratory and have passed on all their pre-employment and termination physical examinations.

Another phase of our work involves periodic examinations of various individuals who are exposed to any of a number of hazards. These examinations may be medical or chemical, or both, depending on the hazard to which the individual is exposed.

A subdivision of this same function is that of review of the radiation exposure records from Group H-1 and chemical analyses records from H-5. In the event that any abnormality in these reports appears, the individuals concerned are called in and whatever medical measures may be necessary are taken; an attempt is made to see that the cause for such over-exposure is corrected so that the accident will not be repeated.

A third phase of the work consists of the general medical treatment of minor illnesses and injuries, occupational or otherwise, which are not serious enough to require hospitalization but which require medical attention.

### A. Special Activities

During the past year we have felt that the problems at S-Site demand more attention than has been given in the past and, as a result, there has been an increased frequency of laboratory examinations of heavily exposed personnel, an increased number of physical examinations of the same personnel and, in addition, the introduction into our own laboratory of a number of routine liver function tests. Also, a physician pays at least one visit a week to the dispensary at this outlying Site to check on various personnel, and he is available to everyone at that Site and surrounding Sites for any problems that may arise. A registered nurse is in constant attendance in the dispensary at this Site.

Probably the greatest single step forward has been a closer liaison between the Hospital group and H-Division which has led to the appointment to the Hospital staff of various members of the Health Division with the privilege of bringing industrial medical cases into the Hospital under the care of H-2. This has resulted in an

increased exchange of ideas between the two medical groups and the development of a routine procedure in the event of an emergency so that the medical services of both groups are not wasted in duplication of effort and activities that are at cross purposes with each other. Although this liaison still leaves something to be desired, the difficulties are largely of a minor nature which are slowly but steadily moving toward a solution that should be satisfactory to both groups.

B. Research Projects

In addition to the routine programmatic duties of the Group, a definite research and development program has been launched. It is difficult to attribute this program entirely to any one Group, as individuals in several Groups are involved. As mentioned earlier, one of the projects that is felt to warrant increased attention has been that at S-Site; in an endeavor to serve this group to a better advantage, it has been found that much fundamental knowledge concerning the control and medical aspects of TNT metabolism is entirely lacking. For this reason, the medical group of H-2 originated, with the help and wholehearted cooperation of H-4 and H-5, a study of the toxicology of TNT using Carbon-14 which is labeled in the benzene ring.

From the literature, little has been known about the fate of TNT in the body, and in the past it has been impossible to account for more than 15 to 20 percent of an administered dose in animals. In addition, little is known about skin absorption of the material; in view of the discrepancy between the amount that can be found in the air and the amounts of breakdown products found in the urine of men exposed, it has become apparent that the greatest means of access in this particular group seems to be through the skin. It is hoped that through this study a number of answers may be found to such specific questions as:

1. What is the absorption, excretion, distribution, and storage of TNT in the organism?
2. What are the metabolic breakdown products in the organism? Through the individual identification of these compounds it is hoped that one of them may lend itself to the development of a specific urinary test that can be better correlated with the degree of exposure and absorption than any now available.
3. What is the action of TNT or its metabolic products within the body that lead to toxicity? A better biochemical understanding of their action may lead to a means of prevention or decreasing susceptibility to intoxication.

To date, from a few preliminary studies, it is apparent that there are from 9 to 12 radioactive breakdown products in the urine of animals to whom Carbon-14 TNT has been administered. In addition, we have been able to account for between 85 and 90 percent of the injected doses but, as yet, the identification of these metabolites has not been worked out.

C. Personnel Changes, Floor Space and Equipment

The present personnel in Group H-2 consists of:

1 Group Leader,
1 Secretary,
1 Full-Time Research Technician,
5 Hematologists,

4 Nurses,
3 Clerk-Typists,
2 Laboratory Helpers.

In addition, we have at present the full-time assistance of Alternate Division Leader Dr. Harry O. Whipple, who has been of inestimable aid to this Group, and the part-time services of 4 to 5 Army physicians who are attached to H-4. Assistance is also given this Group by Dr. Robert Carter, Assistant Group Leader of H-4, and Dr. Clarence Lushbaugh, pathologist.

Renovation of Q-Building was completed early in 1949 with the relocation of the dispensary in enlarged quarters which included the creation of an extra office for a full-time physician. The decontamination room was converted into an additional laboratory for the Hematology Section, to be used for performing additional laboratory tests. Through the courtesy of Group H-4, a laboratory has been acquired for the use of H-2 for work on radioactive TNT and has been equipped to handle this problem.

## D. General Plans

### 1. Pre-Employment Examinations

At the present time, the majority of pre-employment examinations are done by the applicant's personal physician; in many cases this is not an entirely satisfactory procedure. In view of the fact that many candidates for employment are at one time or another at the Project for the purpose of interview, it would be advantageous for the pre-employment physical examination to be done at this time by our Group. Such a plan is contemplated during the coming year. To facilitate this, and through the cooperation of the Hospital Group, several examining rooms are to be made available for the use of the Health Division. These will be located outside the Technical Area, so that the necessity of clearance will be obviated.

### 2. Periodic Examinations

During the past year, because of the lack of full-time medical assistance, it has been largely impractical if not impossible to do periodic examinations on all employees in the Laboratory. During the coming year, with the full-time assistance of Dr. Whipple and the coming of Dr. Alexander, it is hoped that the number of periodic examinations can be greatly increased. In considering personnel on whom these examinations are to be performed, attention is to be given at the outset to the examination of Division and Group Leaders and personnel in key positions whose replacement would prove difficult. It is further contemplated that a program of electrocardiography for all people over forty years of age will be instituted, with special emphasis on key personnel of administrative, theoretical, and top scientific classifications.

Another facet of this periodic checkup would be an increased emphasis on psychological attitudes and factors in the lives of these people, expecially in view of the fact that, in all probability, there will be a period of increased activity and tension within the Laboratory, dependent on the present world situation..

From the research point of view, this Group is in a singularly fortunate position, for there is no dearth of problems that are constantly demanding solution, and to accomplish these solutions there are, at present, no guideposts. For a number of years, the literature on industrial hygiene and toxicology has largely been concerned with the description of diseases and syndromes associated with exposure to various toxic substances; but, in general, little concrete work as to the fundamental

biochemistry and understanding of the mechanism of production of disease has been done. As a result, the whole field of industrial toxicology offers an unparalleled opportunity for fundamental research along the outlines noted above.

In addition, this Laboratory is uniquely situated in its opportunity to make significant contributions to the understanding of the toxicology and biochemistry of a host of common compounds, as well as a number of compounds that are unknown outside this Project. Through such studies, two purposes can be served:

a. A direct contribution to the welfare and safety of the personnel involved in handling of new and unknown compounds, as well as known toxic agents.
b. The opportunity to blaze a trail for those who may handle such compounds in the future.

This is a very real situation and one that fires the imagination of anyone who will think through the problems and all their implications. This type of research can be of inestimable value to the entire program should the day ever come that large-scale operations demand the use of compounds at present used on only a limited scale. In a Laboratory such as Los Alamos, with its fortunate concentration of all scientific disciplines and equipment, it would seem criminal not to avail ourselves of this potential to advance our knowledge of industrial toxicology and biochemistry both for our own good and for the general welfare of the country at large.

The time has also apparently arrived for a somewhat drastic change in the keeping of medical records and forms. The general philosophy behind this contemplated program lies in an attempt to make our present records more complete, yet somewhat simpler, to eliminate a certain amount of unnecessary duplication and transcription and, above all, to make certain information more readily available. It would be further desirable, in so far as possible, to cooperate with other AEC installations in establishing more uniformity from Project to Project.

One of the things contemplated in the near future is an attempt, in cooperation with the Radiation Group and the Industrial Hygiene Group, to set up some form of mechanical recording such as IBM, in order to achieve a closer correlation between radiation, chemical exposure, hematology and physical examination. To accomplish this end, serious consideration should be given to the employment of a person or persons, probably on a temporary basis, in order to set up such a system and to indoctrinate all personnel so that all needed information can be efficiently entered and correlated. Such a person might well be one with previous medical record experience and, in addition, experience in IBM operation. In contemplating such outside help, it might be well also to consider this sort of project in conjunction with the Hospital, in view of the fact that the Occupational Health Group will eventually become integrated with the Hospital; a similarity of records, methods and forms, in so far as feasible, would be highly desirable.

## E. Comments on Future Needs

In order to accomplish some of the programs previously outlined, several factors must be taken into consideration:

1. In order that a more complete coverage from the preventive point of view be made, it would seem desirable that there be at least three full-time physicians employed, and this need is largely met through the acquisition of Dr. Alexander who will join the Group in the early part of the summer. However, should the Laboratory continue to expand, some consideration

should be given to the possibility of acquiring a fourth physician, full-time with H-2. This does not mean that these full-time physicians should be entirely utilized for annual physical examinations, pre-employment, etc; they should be so chosen that they definitely and concretely contribute their part to the research program previously outlined.

2. With the expansion of a general Laboratory program, the possibility of the establishment of additional dispensary and nursing aid, especially on the night shifts, must be considered, should these night operations involve a significant number of people.

Further, as the research phase of the program develops, the addition of another technician should be contemplated, but not until the work is further along and a definite need is well established.

F. Summary

It is the hope of this Group that we will be considered as more than a simple service organization concerned only with cuts, bruises, and physical examinations. We regard ourselves as a Group that can contribute a great deal to the over-all program of the Laboratory in fundamental research. In addition, we should hope to be able to anticipate new problems and hazards that the Laboratory as a whole may encounter. It is to be hoped that the Laboratory will find this Group with the answers, or the willingness to find the answers, so that the general program may go on safely, efficiently, and with minimum danger to personnel in general.

Perhaps one of the greatest assets and sources of strength of this Group and of the Division as a whole has been the close cooperation and mutual good feeling between this Group and the other Groups of the Health Division. Because of this close cooperation, it is impossible to consider H-2 as an isolated Group but rather as a facet of H-Division and the rest of the Laboratory.

## GROUP H-3, SAFETY

(Roy Reider, Group Leader)

Disabling-injury experience at Los Alamos Scientific Laboratory is summarized in the following tabulation, showing five-year statistics for comparative purposes.

DISABLING INJURY EXPERIENCE
Los Alamos Scientific Laboratory

| Year | Hours Worked | No. of Accidents | No. of Days Lost* | Frequency** | Severity*** |
|---|---|---|---|---|---|
| 1945 | 3,036,000 | 20 | 7,571 | 6.6 | 2.49 |
| 1946 | 3,162,000 | 22 | 26,026 | 7.0 | 8.23 |
| 1947 | 2,605,000 | 21 | 103 | 8.1 | 0.04 |
| 1948 | 2,926,000 | 16 | 239 | 5.5 | 0.08 |
| 1949 | 3,465,000 | 20 | 250 | 5.8 | 0.07 |

* The high figures for the years 1945 and 1946 are due to the arbitrary assigning of fixed lost-time changes to cases resulting in a fatality or permanent disability. This is a nationally used standard.

** Frequency is the measure of number of injuries per 1,000,000 hours worked.

*** Severity is a measure of seriousness of accidents, and is given as number of days lost per 1,000 hours worked.

### A. Accident Analysis

Twenty disabling injuries were recorded for the Laboratory in the year 1949. The average disability was 13 days.

The type of accidents is as follows:

| | |
|---|---|
| Back strains | 11 |
| Falls | 2 |
| Dropped objects | 1 |
| Motor vehicles | 1 |
| Eye injuries | 2 |
| Handling tools | 2 |
| Mechanical equipment | 1 |
| Total | 20 |

It may be of interest to note that, in the report summarizing the accident experience for the Laboratory in 1948, the following comment was made: "There were more disabling injuries at the Los Alamos Scientific Laboratory in 1948 from dropped objects on toes than there were from radioactivity. Industrial safety shoes became available at Los Alamos in December 1948; their widespread use may be expected to aid in the reduction of toe injuries." In 1949 there were no disabling injuries from either dropped objects on toes or exposure to radioactivity.

The frequency of accidents at the Laboratory has shown little appreciable change in the past 5 years, although the severity of such accidents has been low for the past three years.

## B. Fire Loss Experience

There were 13 fires in Laboratory facilities during the year 1949. The fires were from the following causes:

| | |
|---|---|
| Electrical defects | 4 |
| Tuballoy | 2 |
| Processes | 2 |
| Hot-plate | 1 |
| Storage of lithium | 1 |
| Gas-leak | 1 |
| Welding | 2 |
| Total | 13 |

In all but one case the fire damage was slight. One tuballoy fire resulted in a loss of approximately $7,500.00. The total estimated dollar loss of all fires in this period is less than $10,000.00.

In addition to the actual fires, there were 65 alarms to which the Fire Department responded but where there was no fire. Most of these alarms were due to sensitivity of heat-actuated devices that were set off by varying causes such as workmen, steam heat, and so forth.

The over-all fire experience for 1949 may be considered good. All groups appear to be quite fire-conscious and to cooperate readily with all requirements of the Fire Protection Division of the Atomic Energy Commission.

The Laboratory has been cooperating with the semi-annual programs sponsored by the Atomic Energy Commission held during Fire Prevention Week in the Fall, and Clean-Up Week in the Spring.

## C. Motor Vehicles

Motor vehicles operated by the Laboratory in 1949 were involved in 62 accidents. The dollar loss to the government vehicles was $3,450.00, and the public loss was $610.00. Four of the accidents resulted in injury to personnel, only one of which was disabling. The accident ratio was 5.9 accidents for every 100,000 miles traveled.

This motor vehicle experience cannot be compared with former years, since records were not accurately maintained before 1949. However, comparing the Laboratory's experience of one accident per 18,000 miles -- each one averaging approximately $65.00 damage -- with commercial experience it may be said that the goal for 1950 should be to reduce this rate by a factor of at least two before it may be considered fair.

A program was started during 1949 to collect all information pertaining to the motor vehicle accident and send this information to the group leader via his division office. This appears to have caused a greater concern over automotive accidents and has resulted in stronger action within the groups to help reduce the occurrence of such incidents.

It is of interest to note that the problem of repeaters in automobile accidents has been non-existent within the Laboratory. During 1949, no employee had two accidents in which he was negligent.

The Atomic Energy Commission, SFO, in April, 1949, relaxed the requirements for obtaining a license to drive government vehicles. Previously, a skill, a physical-aptitude, and a mental test were required. The present standards require only a valid state license and knowledge of the proper procedure for reporting accidents.

A six months' review of experience with those drivers obtaining licenses under the relaxed requirements showed fewer accidents than would have been statistically expected.

D. Major Safety Projects, 1949

1. A comprehensive training program was held for Security and Fire personnel of the AEC. This program indoctrinated these employees in Laboratory emergency risks and procedures necessary.

2. A new-employee orientation course includes a safety lecture given by a representative of Group H-3.

3. All new security guards receive a Laboratory-safety orientation lecture by a representative of Group H-3.

4. A Zia Company in-service training program for craftsmen includes lectures by H-Division representatives, including those of H-3.

5. All large Divisions and Departments of the Laboratory are now organized for self-improvement in safety matters by safety committees with which H-3 acts as technical advisor.

6. Increased emphasis in the Laboratory was given to safety education. Safety information on specific problems increased manyfold over preceding years. Visual aids were widely used. Particular emphasis was given to and is still needed on the avoidance of strains. Safety education, suitable for Laboratory personnel, remains the most fertile field for accident-prevention activity in 1950.

7. During the Clean-Up Week (Spring) and Fire Prevention Week (Fall) campaigns sponsored by the Atomic Energy Commission, SFO, the Laboratory cooperated with fire-extinguisher training, clean-up schedules, and distribution of information.

8. Industrial safety shoes, sold by the Zia Company and available to all employees received considerable attention with good results. More than 100 Laboratory employees, not previously protected, purchased these shoes. Shoe model displays, literature distribution, and special safety education contributed to this program.

9. A special acid-bottle safety carrier was designed, purchased and stocked by the Laboratory. Intra-plant transportation of acid bottles requires the use of these safety carriers.

10. The CMR-Division had an accident-free period of 469 days lasting from September 7, 1948, to December 19, 1949, with an exposure of 921,500 man-hours.

11. A safety survey was made of the Los Angeles Experimental Machine Shop in June, 1949. This shop is operated under the direction of Laboratory Group SD-1.

## GROUP H-4, BIO-MEDICAL RESEARCH

(Wright H. Langham, Ph. D., Group Leader)

### A. Historical Introduction (Wartime Organization)

#### 1. Founding of the Los Alamos Bio-Medical Research Group

In the Fall of 1944, the Los Alamos Scientific Laboratory, then under the Manhattan District, did not have a bio-medical research group. It became apparent at that time that the diagnosis of exposure of laboratory personnel to the very toxic substance plutonium was rapidly becoming a major problem. At this time, three laboratory technicians were employed to consider the development of a method for the analysis of the urine of personnel as a means of determining whether or not they had accumulated dangerous amounts of this material. They were equipped with one alpha counter and assigned a standard laboratory (eighteen feet by twenty feet). By the end of the war, this group had expanded to seven people housed in three temporary laboratories. They had succeeded in working out a method for the determination of exposure of personnel to plutonium and had actually applied it to the diagnosis of the exposure of personnel. They were fortunate enough to get the method in operation in time to determine that twelve of the laboratory's personnel were approaching the accepted tolerance dose of one microgram of plutonium. During 1946 and 1947, the group continued to grow, and accomplished much toward the working-out of procedures for the diagnosis of exposure of personnel to toxic agents peculiar to the Los Alamos Laboratory and the development of atomic energy. They also conducted a number of research investigations into the metabolism of plutonium in the animal organism, its rate of urinary excretion, and its possible bearing on the general health of animals. They continued their studies of the exposure of personnel in Los Alamos Laboratories, and eventually worked out the most reliable information regarding the deposition and rate of excretion of this very toxic material by the human system. At this time, the facilities had expanded to give laboratories housing a staff of sixteen people.

During 1948, the staff continued to grow, and began to expand into fields of fundamental research as the diagnostic procedures and the routine monitoring of personnel began to become the responsibilities of the other groups in the Health Division. At this time, the bio-medical research program began to include the training of military personnel. Seven medical officers and six enlisted men of the Army Medical Corps received training and experience with the bio-medical research group through participation in the various research activities both fundamental and applied. By the end of 1948, the staff consisted of twenty-seven persons now housed in thirteen laboratories provided by the remodeling of the old military police barracks. The equipment at this time had been expanded in keeping with the needs of the increased staff and its more diversified program. By the end of 1948, the bio-medical research group of the Los Alamos Scientific Laboratory had adopted the philosophy of providing a first-class but small staff of highly specialized and capable persons. About sixty percent of their time would be spent on research concerned primarily with health, medical and biological problems of interest to the Los Alamos Scientific Laboratory as the atomic weapons development and testing center of the Atomic Energy Commission. The other forty percent of the time of the staff would be spent in scientific research of a more fundamental nature dealing with the biological effects of ionizing radiation and the use of radioactive isotopes for the study of problems in biology and medicine. The bio-medical research group has continued to expand and work on the basis stated above.

## B. Present Organization

Since November of 1948, the bio-medical research group has been housed in twenty-three laboratories composed of three rooms in the technical area and twenty rooms provided by remodeling discarded military police barracks. During 1949, an additional barrack was converted into a storage and stock room of approximately 2000 square feet. The latter addition increased the total space serving the group from about 7600 square feet at the close of 1948 to about 9600 square feet at the close of 1949.

The equipment added during the past year includes some of the most specialized tools available for the study of the effects of radiation on biological systems. Included among this equipment are the ultracentrifuge, the infrared spectrophotometer, the ultraviolet spectrophotometer, the electrophoretic apparatus, several microtomes and microscopes, technicon fraction collector, tissue-freezing dehydration equipment, technicon autometric tissue-fixing equipment, vibrating-reed electrometers, alpha and beta counters of every available type, refrigerated centrifuges, and other excellent pieces of equipment essential to the conducting of the most modern type of biological and medical research.

Despite the temporary buildings and laboratories, the excellent equipment and the feeling of security that has come about as a result of the permanent building program of the Los Alamos Laboratory is reflected in the high caliber of the present bio-medical research staff. During the past year, two M.D.'s and three Ph.D.'s have been added. These include a pathologist, enzymologist, two biochemists and a physical chemist.

At the close of 1949, the staff consists of thirty-four persons, five of which are Army officers participating in the program for the purpose of gaining training and experience. Among the thirty-four persons are seven with M.D. degrees, six with Ph.D. degrees, and twelve with B.A. or B.S. degrees. There are ten Staff Members, five military persons (of Staff Member rank), two Research Assistants, fifteen scientists, and two with administrative classification. Four other medical doctors who are members of the hospital or the Tech Area staff are also participating part-time in the research program.

The group, in general, is also supported by a number of auxiliary personnel including animal-colony caretakers, workshop foreman, electronics technicians, clerical personnel of the Division Office, and stock and property clerks.

During the summer, three additional persons were added as a part of the Los Alamos summer employment program. One was from the University of Chicago, one from George Washington University, and one from California Institute of Technology. The summer program was also heightened and stimulated by having Dr. A. Baird Hastings of Harvard spend one month working in the research group.

The activities of the research group are divided into three sections:

Organic Chemistry
Radiobiology
Biochemistry

A more detailed report of the progress of each section during 1949 is given below.

## C. Progress of Specific Projects During 1949

### 1. Organic Chemistry Section

The Organic Chemistry Section is primarily concerned with the labeling of biologically and medically important substances with isotopes. Among the isotopes that have been introduced as labels into various medically and biologically important compounds are Iodine-131, Sulfur-35, Carbon-14, Hydrogen-3, and Nitrogen-15. A number of these compounds are now being released through the Isotopes Branch of the Atomic Energy Commission for distribution to research workers outside the Atomic Energy Commission Organization.

It should be pointed out that the activities of this section were not confined to those mentioned above. This is the only general Organic Chemistry Section at the Los Alamos Scientific Laboratory and it was called upon a number of times to aid other groups and divisions of the Laboratory. Such services consisted of micro-organic analyses, preparation and purfication of special organic compounds, and the production of large organic crystals for special purposes. The section participated in one project of wide general interest to the Weapons Program, a discussion of which is omitted below for reasons of classification.

The following projects were essentially completed by the Organic Chemistry Section during 1949:

a. The synthesis of di-iodo trypan blue labeled with Iodine-131. This compound is being currently used in various hospitals for the diagnosis of brain tumors.

b. The synthesis of thiourea labeled with Sulfur-35 and Carbon-14. Labeled thiourea is an important material because it is an intermediate in the synthesis of a large number of drugs of wide value to biological and medical research. It is also a member of the class of drugs that has the ability to depress the action of the thyroid gland and thereby be of therapeutic value in the treatment of certain types of goiter.

c. The degradation of nicotine isolated from tobacco plants grown in a carbon dioxide atmosphere to give specially labeled Carbon-14 nicotinic acid. Nicotinic acid is, of course, of considerable importance to biology and medicine in that it is the vitamin the deficiency of which is responsible for the disease known as pellagra.

d. The synthesis of urea labeled both with Carbon-14 and Nitrogen-15 in the same molecule. The double labeling of urea is of extreme importance because urea is known to be the end product of the breakdown of proteins and amino acids by the human body.

e. The synthesis of TNT labeled with Carbon-14. The importance of the labeling of this compound lies in the fact that TNT is a toxic substance, the physiological effects of which are still poorly explained and understood.

f. The synthesis of dicoumerol labeled with Carbon-14. Dicoumerol is the anti-blood-clotting drug now being used in the treatment of certain types of heart disease.

g. The synthesis of dicoumeranyl acetic acid labeled with Carbon-14 which is of biological and medical importance because it is considered to be a drug superior to dicoumerol for the treatment of the heart conditions for which dicoumerol is being used.

h. The synthesis of hexestrol labeled with tritium. Hexestrol is one of the female sex hormones. The labeling of this biologically important compound with tritium will permit the biochemistry group to study the value of radioactive hydrogen as a biological tracer.

i. The synthesis of methoxyestrone with Carbon-14. This compound is another of the female sex hormones, the physiology of which is extremely interesting and important and which is associated with some phases of the cancer problem.

2. Radiobiology Section

The Radiobiology Section has been primarily concerned with studying: the biological effects of radiation on normal and cancerous tissue; biological methods of measuring radiation dosage and their possible applications to future atomic bomb tests (not included in following discussion for reasons of classification); the relative biological effectiveness of beta and gamma rays and neutrons of various energies on organ weights of the mouse and on mitotic activity of tissues. This section has also been concerned with the radioautographic methods of determining where radioactive material localizes in the various tissues of the body. Since severe acute beta-radiation burns were suffered by Laboratory personnel at the last Eniwetok atomic bomb test, considerable effort has been directed toward studying the physiology and pathology of acute beta-radiation burns. Other efforts on the part of the Radiobiology Section have been directed toward evaluating the effect of small chronic doses of radiation received by Los Alamos workers during the past five years on changes in their blood picture. More specific discussion of each unclassified project follows.

a. Effect of X-Rays on the Rate of Cell Division of Cancerous and Normal Tissues: In the last Annual Report, mention was made of the fact that radiation decreased the rate at which the cells of various normal tissues undergo cell division. The time required for the rate of cell division to drop to zero was a measure of the time required for a cell to go through all the phases of division. This study has now been extended to include two different types of rat cancer. The results show that the rate of cell division of cancerous tissue is considerably faster than with normal tissue of the same general type. This is a contribution to the fundamental physiology of cancerous growth.

b. The Decrease in Organ Weights as a Measure of Total Radiation Dosage: The Radiobiology Section has amply demonstrated that the decrease in the weight of mouse thymus and spleen following radiation is an excellent indication of the size of the radiation dosage. This quantitative relationship between rate of decrease and dosage is being studied for the specific purpose of determining the radiation dosage received from an atomic bomb detonation under various conditions of exposure. This will be introduced as a biological method of radiation dosimetry at future atomic bomb tests.

c. Splenic and Thymic Weight Decrease as a Means of Measuring the Biological Effectiveness of Various Types of Radiation: The technique mentioned in b above has been applied to the measurement of the relative biological effectiveness of neutrons, x-rays, and the gamma rays of different types and different energies. In fact, the technique has been used to measure the biological effectiveness of the ionizing radiations emitted from a critical assembly by actually placing the mice inside the critical assembly

while it was at the critical operating level. The method has also been applied to the measurement of the biological effectiveness of some of the radiations emitted from the Los Alamos power reactors.

d. The Radioautographic Method of Determining the Localization of Radioactive Materials in Tissues and Organs: Nuclear-track emulsions have been studied as a means of determining the extent of localization of plutonium, americium, Sulfur-35 thiourea, Carbon-14 methyl nitrogen mustard, and other Carbon-14-labeled organic compounds in the tissues and organs of rats and mice. The technique has also been applied to the study of the penetration of Carbon-14 urea, radioactive silver, radioactive zinc, radioactive calcium, and other radioactive isotopes into dental enamel and the possible relation thereof to the problem of dental decay.

e. The Physiology and Pathology of Acute Beta-Radiation Burns: Studies of acute beta-radiation burns in rats and dogs produced by doses comparable to those suffered by personnel at the Eniwetok tests have shown that the healing process is interfered with at that stage in healing where the infiltered lymphocytes start to undergo change into fibroblasts. Substances will be sought that will stimulate fibroblast formation with the hope that something of therapeutic value may be found.

The rabbit ear-chamber technique has been developed to the point where it is being applied to the study of the effect of beta radiation on the development of blood supply and the healing of a wound area.

f. The Effect of Small Chronic Exposures of Radiation on the Blood Picture of Los Alamos Workers: Blood counts and other hematological studies have been conducted on all Los Alamos workers during the past five years. The radiobiology group has undertaken the evaluation of the data that have been collected. The results indicate that exposures of the order of two- to three-tenths r/week over long periods of time have produced small but statistically significant changes in the lymphocyte count of Los Alamos workers. There is also definite indication that the small chronic doses of radiation have produced a significant increase in the number of bi-nucleated lymphocytes present in the blood of Los Alamos workers. Studies of the incidence of bi-nucleated lymphocytes in these workers are being continued.

g. The Effect of Vitamin $B_{12}$ on the Blood Picture of Animals Exposed to Ionizing Radiation: Vitamin $B_{12}$ has been reported as having curative action on certain cases of anemia. A study was made of the effect of Vitamin $B_{12}$ on the anemia and leukopenia produced by ionizing radiation. A rather comprehensive study of this subject demonstrated that Vitamin $B_{12}$ had no therapeutic value for blood produced by radiation exposure.

### 3. Biochemistry Section

The Biochemistry Section has been primarily concerned with: the toxicology of plutonium and americium; the metabolism of Carbon-14 and Sulfur-35 labeled materials; the effects of radiation on nucleic acid systems; and methods of measuring tritium in biological systems.

One project involved theoretical considerations of tolerance values associated with future weapons development and is omitted because of classification.

a. The Relative Toxicology and Metabolism of Americium and Plutonium: The studies of the relative toxicology and metabolism of plutonium and americium mentioned in the last Annual Report have been completed. Results show conclusively that plutonium and americium are essentially alike in their metabolic behavior. Americium, like plutonium, is prevented from deposition in the bone by injections of zirconium. Plutonium and americium are essentially comparable with regard to their effects on bone marrow, circulating blood, acute lethality, shortening of life, and the incidence of bone cancer when compared in equal microcurie amounts.

b. The Metabolism of Carbon-14-Labeled Nicotinic Acid and Nicotinamide: The studies of the metabolism of these two substances using Carbon-14-labeled material has been continued to include a comparison of their metabolism in the mouse, the hamster, the rat, the guinea pig, and the dog. The various species of animals were found to differ both quantitatively and qualitatively in the way in which they metabolized the two substances. The dog is especially different in his metabolic pattern from the rodents listed above. These findings may explain why the dog is the only experimental animal that is known to develop pellagra.

c. The Effect of Radiation on Nucleic Acids: Nucleic acids seem to be the constituents of cell nucleii that are associated with the the transfer of inherited characteristics, i.e., they are constituents of the chromosomes. Attempts are being made to isolate various nucleic acids and study the effects of various types of radiation on the ultracentrifuge and electrophoretic patterns, the viscosity and the biological specificity of the very important substances when irradiated in the dry state, in the wet state, and in the presence or absence of oxygen. The purpose of this investigation is to try to understand more fully the fundamental physiological effects of radiation on these very important constituents of cell nucleii. Nucleic acids isolated from calf thymus have already been prepared and irradiated, with the observation that extremely large doses are necessary to produce changes when the material is irradiated in the dry state. The other nucleic acid preparation under consideration is the pneumococcus-transforming principle. This substance acts like a true genetic material. If pneumococcus-transforming principle is isolated from Type III pneumococcus and incorporated into the nutrient media of Type II pneumococcus, the Type II will undergo genetic change and become Type III. Considerable progress is now being made on the isolation of large amounts of the pneumococcus-transforming principle. A discussion of the effect of radiation on the various characteristics of this important genetic material should follow in the next semi-annual report.

d. The Toxicology and Metabolism of Tritium and Methods of Diagnosing the Exposure of Personnel Thereto: Considerable effort is being devoted to working out methods of measuring tritium in biological materials for the purpose of studying its toxicology and metabolism as it affects the exposure of personnel working with the material. Geiger-counting in the gaseous phase and the measurement by means of the ionization chamber have been developed. Biological studies are about ready to begin.

e. The Metabolism of Thiourea and 6-Propylthiouracil, and the Relationship of Metabolism to the Treatment of Hyperthyroidism: Studies with Sulfur-35- and Carbon-14-labeled thiourea and Carbon-14-labeled propylthiouracil have continued. The thyroid gland concentrates the radioactive

sulfur from the sulfur-labeled compounds. The radioactive sulfur is held in the gland in the form of sulfate, indicating that these drugs exert their action by preventing the conversion of inorganic iodine to organic iodine in the thyroid gland. This study is essentially complete and will appear in published form in the near future.

f. The Metabolism of Carbon-14-Labeled Anti-Blood Coagulants: Both dicoumerol acetic acid and dicoumerol have been labeled with Carbon-14 and studies started to determine the relationship between tissue deposition, urinary excretion, and the anti-blood-clotting action of these two very important drugs. Both of these substances are now being employed in certain types of circulatory and heart disturbances associated with the formation of blood clots in the circulating blood. Present indications are that excretion rates of these substances are very low, that the red cells do not take up the material, and that appreciable concentrations are found in the blood serum as much as twenty-four hours after injection. These studies are being continued to determine the significance of the above and other findings.

g. The Toxicology and Metabolism of TNT: Carbon-14 TNT has been employed to study the rate and form of excretion of this rather toxic material. Chromatographic analysis of the urine indicates at least eight metabolic products are excreted in the urine of animals injected with this material. An attempt is being made to isolate and identify some of these metabolites to see if analysis for any one of them can be used as a means of diagnosing the exposure of humans to this material.

h. Metabolism of Carbon-14-labeled Nitrogen Mustard: Methyl Carbon-14 bis (B-chloroethyl)- amine hydrochloride was prepared last year. Because of the similarity of physiological action to that of ionizing radiation, a preliminary study of its metabolism in thymoma-bearing mice has been carried out. Distribution in the body seems to be general and body retention high. Five different radioactive compounds are excreted in the urine. A basic compound (probably the free amine) is excreted in the exhaled air along with a small amount of radioactive carbon dioxide. This study is being continued.

i. Further Studies of the Metabolism of Carbon-14 Urea (in cooperation with A. Baird Hastings): Attempts were made to determine whether the 20% decomposition of Carbon-14 urea by the mouse reported earlier is due to bacterial origin or is due to urease of bacterial origin or whether urease is a normal constituent of the gastrointestinal tract. Studies conducted during the past year, here and at Harvard, tend to support the latter possibility.

j. Summary of Human Exposure to Plutonium: All cases of exposure of human subjects to plutonium have been reviewed, data compiled and a report written covering the Los Alamos laboratories' experiences with this material. Arrangements are being made to obtain physical examinations, urine assays, etc., on all persons who obtained positive exposure to this material at Los Alamos during the war.

D. Publications and Reports (1949)

1. Organic Chemistry Section

a. L. A. Report No. 742, Classified, by Ronzio.
b. Micro Synthesis with Tracer Elements. XV. Classified, by Ronzio.
c. Micro Synthesis with Tracer Elements. I. The Synthesis of Cyansmide and of Urea Labeled with $C^{14}$, by Murray and Ronzio, J. Amer. Chem. Soc.
d. LADC-723: Beta-Iodoethyldiethylamine Hydroiodide, by Bills and Ronzio.
e. LADC-678: Micro Synthesis with Tracer Elements. II. Methyl-di (Beta-chloroethyl)-amine Hydrochloride (Nitrogen Mustard and Methyl Labeled with $C^{14}$), by Foreman, Murray and Ronzio.
f. LADC-724: Micro Synthesis with Tracer Elements. IX. The Synthesis of Thiourea Labeled with $C^{14}$, by Bills and Ronzio.
g. LADC-725: Micro Synthesis with Tracer Elements. XI. The Synthesis of Thiourea Labeled with $S^{35}$, by Bills and Ronzio.
h. LADC-726: Micro Synthesis with Tracer Elements. X. The Synthesis of 6-Propylthiouracil Labeled with $C^{14}$, by Murray and Ronzio.
i. LADC-737: Micro Synthesis with Tracer Elements. XII. The Synthesis of Silver Cyanate Labeled with $C^{14}$ and of Urea Labeled with $C^{14}$ and $N^{15}$, by Williams and Ronzio.
j. LADC-735: Micro Synthesis with Tracer Elements. XIII. The Synthesis of Urea Labeled with $N^{15}$, by Williams.

2. Radiobiology Section:

a. LADC-694: Effect of Vitamin $B_{12}$ on the Leukopenia Induced by Radiation, by Carter, Busch and Strang.
b. LADC-742: Splenic Changes in CF-1 Female Mice Over a Forty-one Day Period Post X-irradiation, by Carter.
c. LAB-J-675: Title not given for reasons of security, by Langham Brennan, Harris and Carter.
d. Science 109, 585 (1949): Detail and Survey Radioautographs by Wainwright.
e. New York J. Dentistry, 19, 325 (1949): Denistry and the Atomic Energy Program, by Wainwright.
f. Cancer Research (In Press): The Use of X-rays to Determine the Mitotic and Intramitotic Time of Various Mouse Tissues, by Knowlton and Widner.
g. JAMA, 141, 239 (1949): Beta Ray Burns of Human Skin, by Knowlton et al.
h. LADC-663: Effect of Lethal Dose of X-rays on Chilled and Thyroid-extomized Animals, by Knowlton, Hempelmann and Trujillo.
i. LADC 682: Value of Blood Cell Counts on Individuals Exposed to Ionizing Radiation, by Knowlton.

3. Biochemistry Section

a. LAMS-983: Title not given for reasons of security, by Anderson.
b. J. Biol. Chem., 178, 963 (1949): Metabolism of Radioactive Pentobarbital, by Roth, Leifer, Hogness and Langham.
c. J. Biol. Chem., 179, 783 (1949): Use of Isotopic Carbon in a Study of the Metabolism of Anthranilic Acid in Neurospora, by Nyc, Mitchell, Leifer and Langham.
d. J. Biol. Chem., 179, 1163 (1949): Effect of Cathode Rays Produced at 3000 Kv on Niacin Tagged with $C^{14}$, by Goldblith, Proctor, Hogness and Langham.
e. J. Biol. Chem. (In Press): Distribution and Excretion in the Rat of Thiourea Labeled with Radioactive Sulfur, by Schulman and Keating.

E. General Comments on Future Plans and Program

The future program for the Bio-Medical Research Group of the Los Alamos Scientific Laboratory includes the continuation of a number of the above-mentioned studies.

1. Organic Chemistry Section

The Organic Chemistry Section will continue to label biologically important compounds with radioactive isotopes. There will be increased effort devoted to the making of compounds labeled with tritium. The section will continue to cooperate with the Isotopes Division of the Atomic Energy Commission by preparing compounds for their distribution to non-project users. It will continue to render services to other groups and divisions of the Los Alamos Scientific Laboratory and will continue to participate in the classified program of the Los Alamos Scientific Laboratory.

2. Radiobiology Section

The Radiobiology Section will continue with the following studies.

a. The effect of radiation on the mitotic activity of cancerous and normal tissues, and the application of the effect of radiation on cell division as a means of measuring the biological effects of various types of ionizing radiation encountered at the Los Alamos Laboratory.
b. The study of the effect of various types of radiation on organ weights of experimental animals and its application to future bomb test programs, and to the assay of radioactive hazards encountered as a result of the nuclear energy development programs of the Los Alamos Scientific Laboratory.
c. The physiology and pathology of acute beta-radiation burns and the possible development of therapeutic measures in the event of additional accidents associated with the weapons test program.
d. The rabbit-ear chamber technique and its application to the study of the pathology of acute radiation damage.
e. The effect of chronic exposures of radiation on the blood picture of Los Alamos workers.
f. The use of autoradiographic methods for the study of the mode of deposition of radioactive materials in animal systems and organs.

g. Other projects relative to the biomedical program of future atomic weapons tests will be continued.

h. A new problem is anticipated in cooperation with the biochemistry section to determine the relative toxicological and physiological properties of plutonium, radium, and a substance of a classified nature which is of specific interest to the weapons program of the Los Alamos Laboratory.

i. A new project to be introduced is to use the remodeled Los Alamos "water boiler" for the study of the relative biological effectiveness of slow and fast neutrons and x-rays. The consultant services of Dr. Raymond Zirkle of the Argonne Laboratory have been obtained for this purpose.

3. Biochemistry Section

The Biochemistry Section will continue the following programs during 1950.

a. The metabolism of isotopically labeled compounds. The compounds that will receive specific interest will be urea, the anti-blood-clotting substances (dicoumerol and dicoumeranyl acetic acid ester), the nitrogen mustard, a substance of classified nature, and tritium-labeled hexestrol.

b. The study of the physiological and toxicological properties of tritium.

c. The program of the effect of radiation on nucleic acid systems.

d. Followup studies on personnel receiving plutonium exposure during Los Alamos operations.

e. A new program will be introduced to study the relative physiology, toxicology, deposition and excretion of radium, plutonium, and a classified substance of specific interest to the Los Alamos Laboratory.

f. A new program has been introduced which involves the effect of radiation on enzyme systems of blood and bone marrow. A specific study is being made of the effect of acute beta-radiation damage on enzyme systems of skin.

As evidenced by the above detailed discussion, the program will continue to center around fundamental and programmatic investigations of the effects of ionizing radiation, toxicology of materials of specific interest to the Los Alamos Laboratory, the use of isotopes in investigating problems in the fields of biology and medicine, relative biological effect of radiations of different types and different energies, and participation in future weapons test activities.

Continued expansion of the excellent equipment of the laboratory is anticipated. Reasonable demands for the purchase of capital equipment will continue in order to make the research laboratory one of the best-equipped in the country. It should be pointed out that no laboratory in the Atomic Energy Commission, or in the country, has such an assortment of specialized equipment and techniques to use in biomedical research as does the Los Alamos Laboratory. Among the unique facilities now or presently to be available which may be used for biomedical investigations are such items as the redesigned Los Alamos "water boiler", the Los Alamos fast reactor, the cyclotron, a 4,000,000- and a 12,000,000-volt Van de Graaff generator, two betatrons, a high-capacity cobalt source, the Cockroft-Walton accelerator, x-ray machines ranging from 5 kv to 1,000 kv, a concentrated critical assembly (code-named "Topsy"),

a mass spectrograph, x-ray defraction equipment, electron microscope, emission spectrographs, and numerous other pieces of highly specialized equipment.

The opportunities offered by the above equipment and by the constant availability of applied and theoretical physicists, chemists, etc., as consultants provide unlimited potentialities for biomedical investigation at the Los Alamos Scientific Laboratory. Any long-range plans for the research group should undoubedly include provisions for the utilization of these spectacular potentialities.

Further but modest expansion of the personnel of the group is anticipated. During 1950, expansion should include the addition of a physiologist of Ph. D. or M.D. caliber, a biochemist of Ph.D. caliber (both to be Staff Members), and at least three persons with M.S. or Bachelor degree training in biochemistry and biology to be classified as research assistants of scientific personnel.

No further expansion in temporary laboratory space can be anticipated because of the demolition of all suitable temporary facilities that could be modified. The addition of a small amount of auxiliary space may be necessary. It is hoped that 1950 will see the design and the beginning of construction of permanent facilities to house the research group in the same quarters with Group H-5.

## GROUP H-5, INDUSTRIAL HYGIENE

(Harry F. Schulte, Group Leader)

### A. Introduction

Group H-5, the Industrial Hygiene Group of the Health Division, was organized as a separate group on June 1, 1949. Prior to that time, Industrial Hygiene was a Section of Group H-2. Group H-5, which consists of two major sections, a Field Section and a Laboratory Section, is charged with the evaluation of non-radioactive environmental factors in the Laboratory that affect the health of laboratory employees, and with rendering every possible assistance in the design of appropriate control measures. Because of the close association of radioactive and non-radioactive hazards in many cases, and because many industrial hygiene techniques are applicable to the study of radioactive air-borne contaminants, the group has also been involved in studies where radioactivity is a factor.

The routine work of the group, therefore, consists of collection and analysis of air samples, urine specimens, and other materials necessary for the evaluation of potential hazards. This is followed by consultation with operating and engineering personnel on the design and operation of necessary control equipment such as ventilation systems, enclosures, isolation of processes, etc. However, this "routine" work is far from routine at the Los Alamos Laboratory. While there are some materials in constant use, under fairly constant conditions, many of the exposures are short-term and affect relatively small numbers of personnel. Many of these exposures are to substances not commonly used in industry and, as a result, toxicological information is meager. In some cases, it has been necessary to develop analytical methods for these substances. Among the exposures studied since the organization of the group are: carbon monoxide, ozone, naphthalene, trinitrotoluene, benzol, uranium, carbon tetrachloride, trichloroethylene, tetrachloroethylene, hydrogen sulfide, beryllium, methyl alcohol, lead, nitrogen oxides, mercury, cadmium, iodine, methyl ethyl ketone, chromic acid, fluorides, and several others of a classified nature.

All analyses of urine for toxic substances, both radioactive and non-radioactive, are made by the Laboratory Section of the group. The work of this section has greatly expanded during the past year. An important adjunct of the Laboratory Section is the Health Pass Ward which is administered by Group H-5. Here, 24-hour urine specimens are collected for analysis and evaluation of individual exposures.

### B. Research and Development

In carrying out the necessary air sampling and analytical work, every attempt has been made to use the best methods available and to improve methods or devise new ones where necessary. In line with this policy, improvements have been made in the method of collecting and analyzing samples for ozone content. Chlorinated hydrocarbons are used in many places in the Laboratory, and present methods for their determination in air leave considerable to be desired. An improved method of collection and analysis was worked out by the Laboratory Section and is now in use. Further improvements in this method are still desirable and are being studied.

The determination of americium in urine was also developed by the Laboratory Section. While only a few persons are exposed to this material, the urine test is important since it affords the same protection to these persons as is given to those handling other radioactive materials.

A considerable number of persons at the Los Alamos Laboratory handle quantities of benzol. The variable amounts handled and the great variations in the lengths of exposure makes it extremely difficult to assess the extent of the benzol hazard by air-sampling methods. One of the best methods for measuring this exposure is by means of a determination of inorganic sulfates in the urine. In the Laboratory, the method of carrying out this procedure has been improved by the use of a turbidometric technique which has improved the accuracy of the method as well as simplifying it.

The Industrial Hygiene Group is cooperating in a study of TNT metabolism along with Groups H-2 and H-4. The principal work of this group on this problem has been the preparation of postulated TNT metabolites. Also, the Laboratory has done considerable work on the development of analytical methods for urine samples collected in this study.

Uranium exposures are to be evaluated by estimation of the uranium content of the urine of exposed workers. The method used at present, in other laboratories, is a fluorophotometric method, and an instrument to be used for this purpose has been constructed here with some modifications. There are many difficulties in the technique of this analysis, and considerable time has been spent by the Laboratory Section in overcoming problems involving this method. At the same time, an attempt is also being made to develop a satisfactory method for the determination of $U^{235}$ in the urine. Various methods have been proposed for this, but no satisfactory method has been developed as yet.

Beryllium is a material being used in increasing quantities at Los Alamos. No satisfactory chemical method has been worked out as yet for this material, either in air samples or biological material. At the present time, the spectrograph offers the only available procedure. While there is a spectrograph in use at the Los Alamos Laboratory, there are several difficulties in the way of employing it for routine beryllium analyses of air and biological materials. Beryllium is a very undesirable contaminant in the spectrograph Laboratory here. At present the Laboratory Section is studying a number of colorimetric methods involving the use of dyes. A combination of this procedure with ion-exchange methods for the separation of beryllium seems to be most promising at present as an analytical method.

The measurement of particle size of air-borne dusts is one which is receiving increasing attention in view of its close relation to toxicity and lung retention. Various methods of carrying out this determination have been studied, and it appears that the cascade impactor offers the best possibility for use on this problem. Two of these instruments have been built by the machine shop at Los Alamos and have been used to a limited extent in field work. At the same time, the instruments are being calibrated for use under a variety of conditions. The thermal precipitator is also being studied and may be combined with the impactor in order to cover the full range of particle sizes required. These instruments have not previously been used on some of the materials encountered at Los Alamos.

While various instruments for air sampling are available and in use, the trend toward lower values of tolerance levels has made it necessary to seek more efficient methods of sampling large volumes of air. Several methods of accomplishing this have been considered and some design work has been done on a suitable instrument. However, this work is still in a very early stage and no results can be reported as yet.

Of immediate need to the group is a method for the determination of naphthalene in air. The use of naphthalene scintillation counters has resulted in the exposure of several persons to fairly high concentrations of naphthalene vapor in the development of instruments. All of the reported methods of analysis for this material have so far

proved unsatisfactory for measuring the relatively low quantities found in an air sample. Considerable work will be necessary on the development of a satisfactory procedure. Another line of activity on which considerable work is contemplated is in the use of ion-exchange columns for the separation of various radioactive elements from biological materials. A beginning has been made on the construction of some of the necessary equipment, and it is expected that work will get under way as soon as additional laboratory space is available.

Liquid-waste disposal is a field of activity receiving increasing emphasis. While no direct work on waste treatment problems is contemplated by the Group, it will engage in investigations of the need for such treatment, and the evaluation of the effectiveness of treatment processes, and it will endeavor to keep in touch with developments in this field.

## C. Publication and Talks

No papers have been published by the Industrial Hygiene Group since its organization. However, a talk on the subject "Industrial Hygiene and Public Health" was given at the 1949 meeting of the New Mexico Public Health Association. Another talk on "Solvent Hazards" was presented at the First Rocky Mountain Conference on Industrial Health. A summary of this talk will be published in the Industrial Hygiene Newsletter of the U.S. Public Health Service. Talks on industrial hygiene were also given before two classes at the University of California School of Public Health.

## D. Changes in Personnel and Facilities

At the time of organization of the Group, the personnel consisted of 2 field engineers, 5 chemists, one laboratory technician, one counting technician, 3 Health Pass Ward employees, and a part-time secretary. The group has since grown to meet its new responsibilities. It now consists of a Group Leader and a full-time secretary, 2 field engineers, one monitor, 7 chemists, one laboratory technician, one counting technician, and 3 Health Pass Ward employees. Meanwhile the space occupied by the Group has also enlarged somewhat. A field-testing and calibration laboratory was constructed in the basement of Q-Building, and this also serves as office quarters for the Field Section. The Group offices have been enlarged and two additional laboratories are being added on ML-Building, making a total of six laboratory rooms for the Laboratory Section. Since industrial hygiene as an activity of the Health Division is less than two years old, equipment has been added continuously during this period to provide the necessary facilities for the work undertaken. A fairly complete array of air-sampling equipment is now available to the Field Section, although some additions and improvements will still be needed. This equipment includes various sizes of pumps, bubblers, impingers, filter-paper holders, electrostatic precipitators, cascade impactors, and a large spirometer for air-flow calibration. An apparatus for setting up known concentrations of gases and vapors was constructed by the Field Section. One problem encountered in the Rocky Mountain area, as distinct from most other areas, is that of altitude. This factor makes it necessary to recalibrate all equipment that involves air flow. The Laboratory Section has added to its equipment a fluorophotometer, fractionating column, refractometer, electroanalysis apparatus, a new low-background counter, and a number of smaller items.

## E. Future Program

The program of the Industrial Hygiene Group is closely tied to that of the Laboratory itself. Changes in the number of Laboratory personnel or changes in the type of materials handled will necessitate changes in the industrial hygiene program. The past year has been one of building up to meet immediate existing needs. Thus, the group has had little opportunity to engage in any work of a research character. During the next year, the group should round out to full strength, and more development work can be undertaken. Because of the nature of industrial hygiene work, it is likely that such developmental work will take place as part of a cooperative effort with other Sections of the Laboratory. More emphasis will certainly be given to the field of air pollution outside the Laboratory buildings. This will necessitate considerable development in air-sampling and analytical methods.

The construction program of the Laboratory on South Mesa affords an opportunity to build health protection into these new buildings. The Industrial Hygiene Group is available for consultation and assistance on these phases of the building program. Close contact has been established in particular with GMX and CMR Divisions in the early stages of their building programs. This work will increase considerably as the design plans proceed to such details as ventilation systems, wash rooms, enclosure of processes, layout of process lines, etc. This type of work is somewhat time-consuming, but is the most rewarding in real accomplishment for health protection.

It is anticipated that a considerable number of new substances will be used in the Laboratory in the immediate future. Where there have been no prior data on the effects of exposure to these materials, work will be started in cooperation with the other groups in the Health Division to prepare measures of protection for exposed personnel. The earlier the Group can learn of the anticipated use of special materials, the more valuable can be its contribution.

Up to the present time, the primary emphasis has been on providing the necessary mechanical and physical safeguards for health protection. Only a minimum of emphasis has been placed on health education. While the physical safeguards are a necessity, their value is completely nullified where workers are not trained in their use or do not use them. Health education is thus a vital link in the chain of protection. The monitor stationed at S-Site has already made a rather notable contribution in this field. It may be necessary to provide educational materials that are planned to meet our specific needs.

## F. Personnel and Equipment Needs

No great expansion of personnel is anticipated for Group H-5. Certainly, for the immediate future, space limitations preclude any such expansion. A building housing Groups H-4 and H-5 is in the early design stage at the present time. In planning this building, careful consideration has been given to the requirements of the type of industrial hygiene program needed by the Los Alamos Laboratory. These physical facilities, while not in themselves a guarantee of a successful program, are certainly basic to it. The amount of physical equipment necessary to carry out the program is much larger than in the ordinary industrial plant. There are few routine operations or processes involving exposures to a limited number of well-recognized hazards. Instead, the number of materials in use or that may be used on short notice, are almost unlimited. For this reason, equipment and materials must be on hand for analyses that are performed relatively infrequently. The nature of the general Laboratory program is such that there is seldom time to order equipment

or to prepare for the more elaborate analyses after the details of a new Laboratory project are under way. Unfortunately, it is with the details that the group is most concerned in the protection of employee health. In most cases, the really serious hazards are not those that can be anticipated in the discussion of broad general projects; it is the incidental solvents, cleaning agents, waste products, etc., that cause most serious occupational diseases.

That the AEC Projects are safe places to work has already become a tradition. Industrial hygiene occupies an important position in upholding this tradition.