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ANNUAL REPORT OF THE HEALTH DIVISION

1957

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ANNUAL REPORT OF THE HEALTH DIVISION

1957

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LA-2216
HEALTH AND SAFETY
(M-3679, 21st ed.)

LOS ALAMOS SCIENTIFIC LABORATORY
OF THE UNIVERSITY OF CALIFORNIA LOS ALAMOS NEW MEXICO

REPORT WRITTEN: May 1958

REPORT DISTRIBUTED: October 17, 1958

ANNUAL REPORT OF THE HEALTH DIVISION 1957

by

Thomas L. Shipman

This report expresses the opinions of the author or authors and does not necessarily reflect the opinions or views of the Los Alamos Scientific Laboratory.

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PREFACE

The preparation of a report such as this is a risky business because of the varied and divergent interests of those who may read it. It is a difficult job to know what to include and what to leave out if the writers and readers alike are to be satisfied with the results. Primarily, however, this report is written for ourselves and constitutes a sort of periodic stock-taking or inventory; it is an opportunity to examine our own program from a different angle and with a different perspective. After perusing such reports in the past, we have occasionally been able to see that certain programs appear to be getting too much emphasis while others are being slighted. The annual report, therefore, is a useful tool in shaping and steering our own program.

The extent to which this report is read by and is of interest to others, we never quite know. We know only how many copies are distributed and who receives them. In view of the fact that we hope to make the report informative to others, we will appreciate any comments or suggestions which may be sent to us.

As Leader of the Division I wish to take this opportunity to express gratitude in a number of different directions. First of all, I am grateful to all members of the Health Division for their constant loyalty and devotion to their jobs. Secondly, I would like to point out that we are deeply indebted to the Director of the Los Alamos Scientific

Laboratory and the members of his staff for a very high measure of support and confidence. Finally, I wish to express gratitude to the Laboratory personnel as a whole for their confidence in the work done by Health Division people and for their collaborative efforts in many lines of experimental work. In addition to being a healthy place in which to live and work, Los Alamos continues to be a good place to live and work!

Thomas L. Shipman, M.D.
Division Leader

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Chapter 1

INTRODUCTION

By Thomas L. Shipman, M.D., Division Leader

The responsibility of the Health Division at the Los Alamos Scientific Laboratory is, as it always has been, the all-embracing assurance of the protection of the health of all Laboratory workers both for the present and the future. Also, assurance must be given all residents of this community and all visitors, as well as residents of areas adjacent to Los Alamos, that no health hazards will result from Laboratory activities.

Frequently it is difficult to determine where pure service functions leave off and research and development functions begin. It is even more difficult to make an arbitrary discrimination between programmatic and fundamental research programs; one could almost say that all research is programmatic to the individual experimenter in that he sees a desire or a need for the material he hopes to turn out. At Los Alamos this is particularly true, and one might go so far as to say that those lines of pure fundamental research which are being followed are in truth welcome dividends stemming from the Laboratory's health protection program. This

does not imply that the basic programs are regarded as of secondary importance--this is just the way things have worked out as the result of an evolutionary process with periodic mutations.

One of the best features of the Health Division program in both service and research functions is its flexibility. It should be kept in mind, however, that the work of the Laboratory presents a constantly changing aspect in which old problems disappear and new ones are encountered almost daily. If the Health Division is to keep up with the rest of the Laboratory, it, too, must be prepared to drop old programs and accept new ones without prior warning.

Another noteworthy point to be kept in mind is the high degree of collaboration between members of the various Groups in the Division. In the following reports each Group Leader has outlined his own program, but the truth of the matter is that many of the accomplishments described have been facilitated or made possible by collaboration with someone in another Group. Not infrequently, problems to be investigated by one Group were proposed by someone outside the Group.

In looking at the Division as a whole, we can see immediately that it is larger personnelwise than it was at the time of the last annual report (for 1954).* An organizational listing of the entire Division is given at the end of this introduction. A significant portion of our growth has resulted from the acquisition of the Industrial Waste Group,

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*Reports were not issued for 1955 and 1956.

H-7, formerly a part of the AEC, and the Contaminated Laundry, which originally was a part of the LASL CMR Division. Much of the remainder of our growth reflects an increase in the size of the Monitoring Group, which, in turn, reflects a very real increase in the services required throughout the Laboratory. New lines of activity have been undertaken but very few of the old ones have been abandoned.

It is both the prerogative and the responsibility of the Division Leader to serve as a sort of guide and to point out those items in the following pages which to him are of particular significance or importance. In doing this, one is reminded of the biblical reference to the stone which was rejected by the builder. It is perfectly possible and even probable that certain of the programs not mentioned in this introduction may, in time, turn out to be the most productive. It is also probable that some readers will focus their interest on items to which I will refer; this, of course, is to be expected.

Below are listed the points of significance and interest to me as they relate to each of the Groups in the Division.

Group H-1, Monitoring. The year 1957 brought the change in the permissible levels of radiation exposure. In order to meet related problems, it was necessary to change the former system of maintaining radiation exposure records to one utilizing IBM cards. Particular attention is called to the compilation of exposures for 1956 and 1957 given in Table 2.1.

Group H-2, Industrial Medicine. It can be stated with considerable

assurance that no new diseases have been discovered nor have we found any dramatic ways of curing old ones. The anticipated epidemic of Asiatic flu did not materialize; it is impossible, of course, to determine to what extent this happy result was related to the program of immunization. Los Alamos continues to appear a pretty healthy place in which to live and work.

Group H-3, Safety. Much of the story of this Group is apparent in the tables of Chapter 4. Serious accidents are so rare that when one does appear it stands out in rather glaring contrast to the rest of the record. As has always been obvious in the past, such injuries as do occur are ordinarily of a common, garden-variety nature and are not related to the numerous unusual hazards which are present in many parts of the Laboratory.

Group H-4, Biomedical Research. It is extremely difficult to generalize on the program of this Group. Its program of low level counting is unique, and we can certainly boast of one of the finest facilities in the world for work of this type. The opportunity to count large samples and also to count large animals and man rapidly has opened a wide field of activities. Quite significant progress has also been made in the field of chemical dosimetry. This work and related studies have enabled members of this Group to participate extensively in the program. The effects of the disastrous epidemic in the animal colony should not be underestimated. The work in the field of long-term results of low and chronic exposures was set back at least two years, and it has been

decided not to resume this program in full force until more space can be made available for animal quarters.

Worthy of special mention is the completion of a comprehensive and much needed two-volume work, Organic Syntheses with Isotopes. This started as a modest project but it grew like the bean stalk. Publication is expected in the summer of 1958.

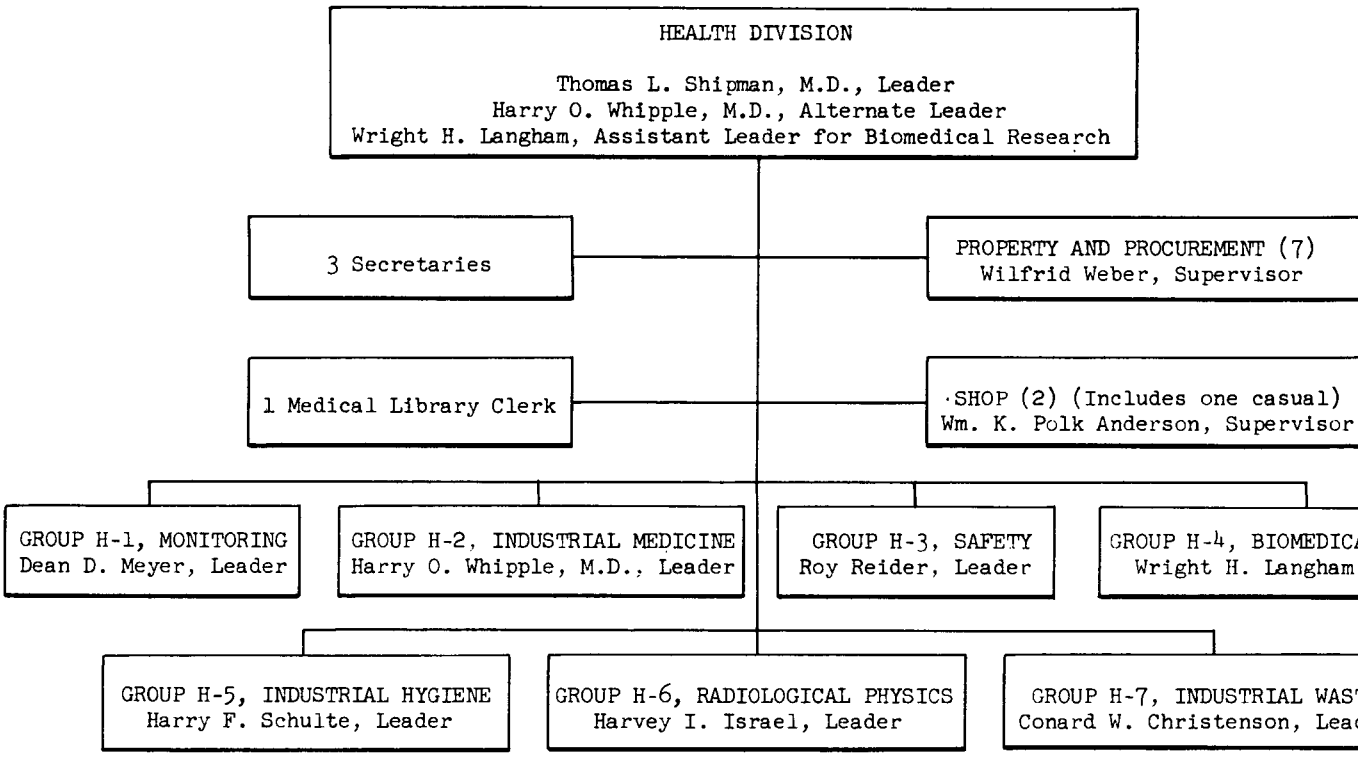
It is of interest to note that members of this Group alone presented 39 talks of one sort or another during the year. Thirty-five documents were published in the open literature, and an additional 35 papers have been accepted for publication.

Group H-5, Industrial Hygiene. There have been few significant changes in the work of this Group, but it becomes increasingly evident how necessary industrial hygiene is in the work of the Laboratory. The single study of perhaps the most far-reaching importance has been on the effectiveness of various makes of respirators and respiratory protective masks. It now appears that the U. S. Bureau of Mines will continue this work and ultimately provide approval for respirators to be used for protection against radioactive dusts.

Group H-6, Radiological Physics. It is difficult to define the program of this Group because much of its work consists of a species of trouble shooting. One problem which undoubtedly will always be with us is that of forecasting fallout, a field in which the members of this Group have always played a leading part. Their other accomplishments, however, should not be discounted. It is worthy of mention that the

Meteorology Section is now staffed by Laboratory employees rather than the USAF, as was formerly the case. Both members of the present section formerly worked in it as members of the Air Force.

Group H-7, Industrial Waste. The report of this Group is given in considerable detail because this is the Division's first annual report since the Group became a part of the Division. For a number of years the problems of liquid waste disposal at Los Alamos were relatively uncomplicated, but it is increasingly evident that new problems are arising continually. Thought must be given in the very near future to a major increase in the waste treatment facilities.



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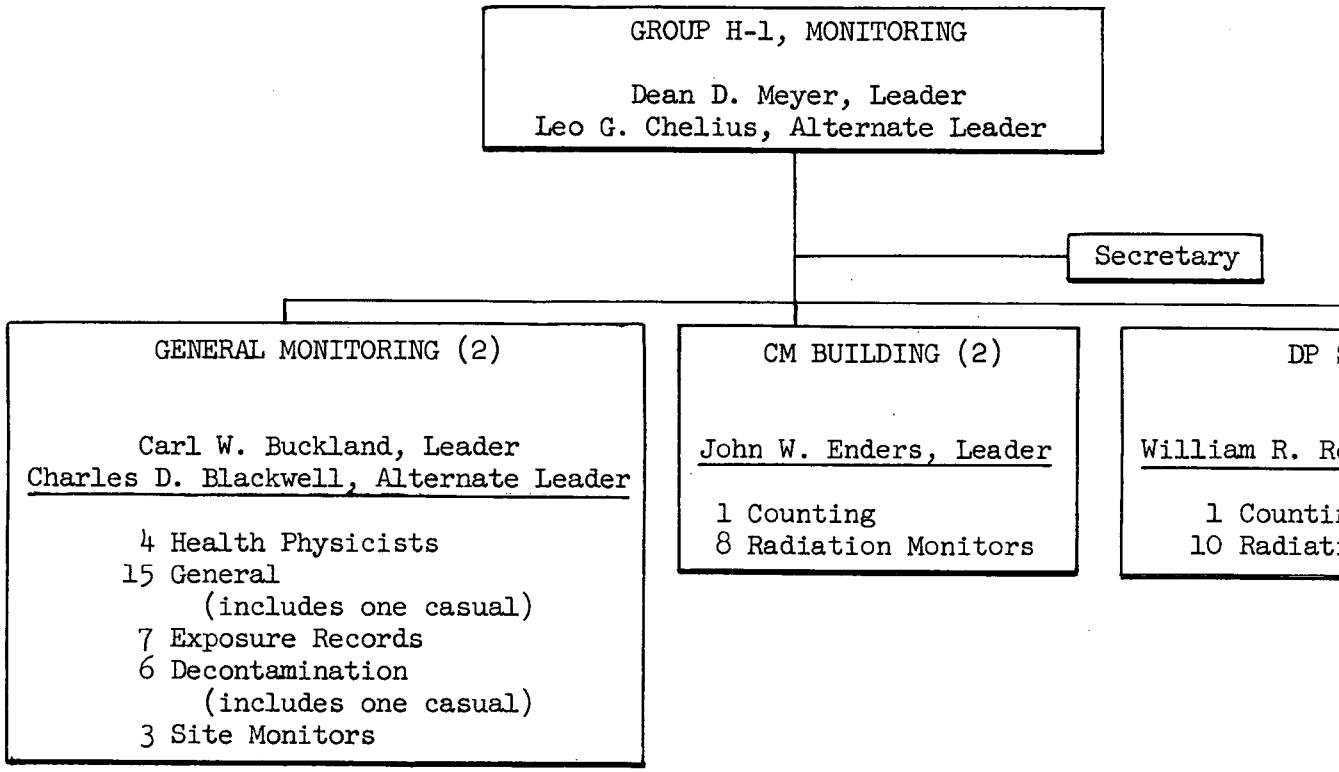

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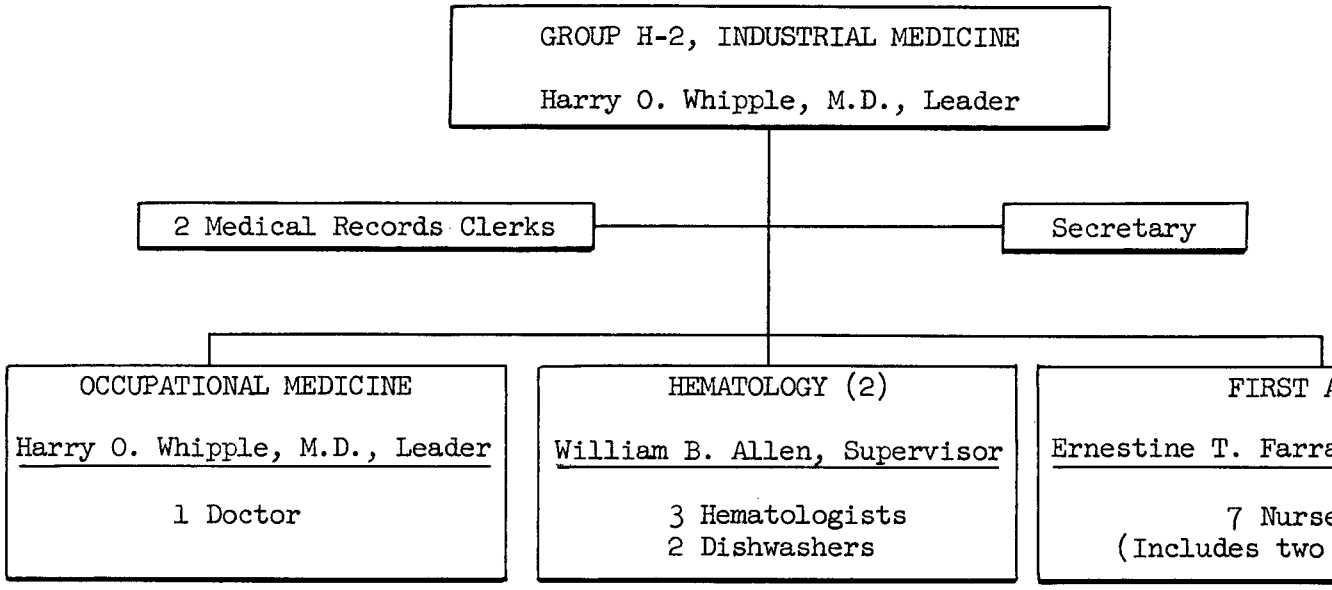

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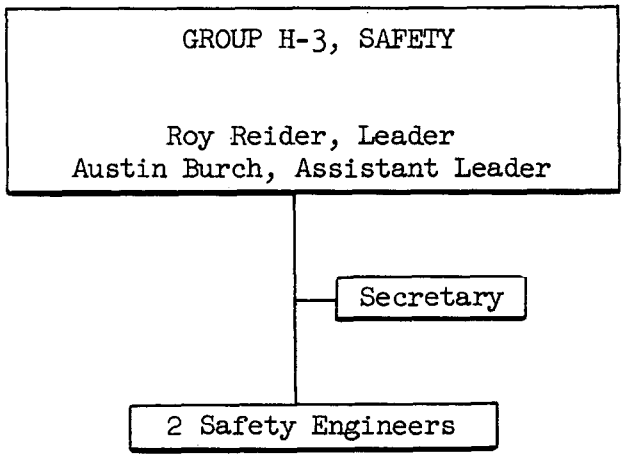

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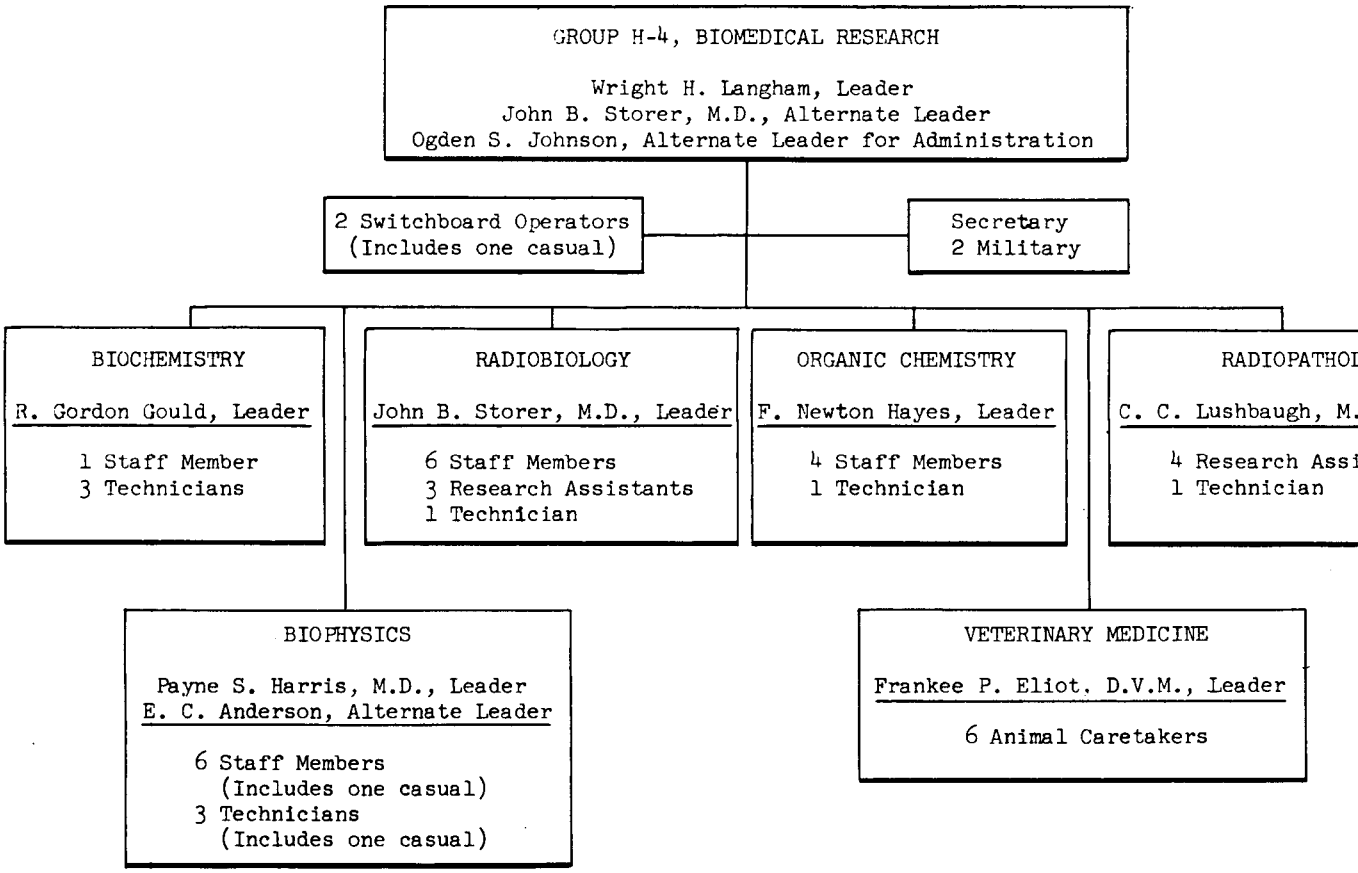

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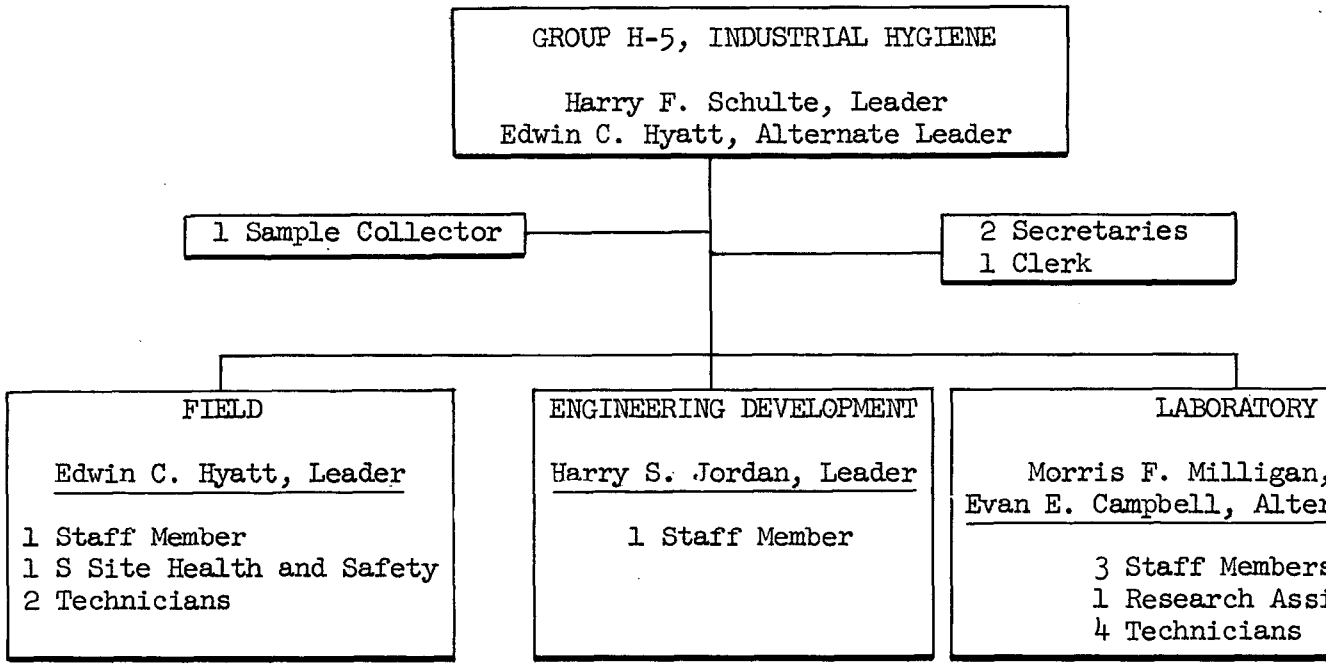

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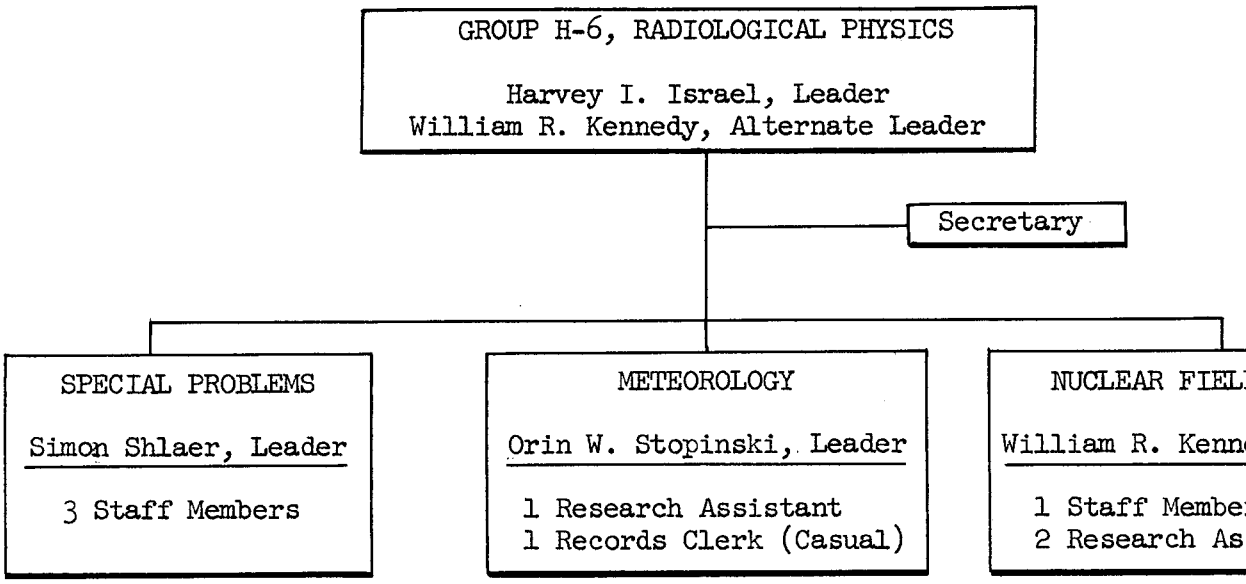

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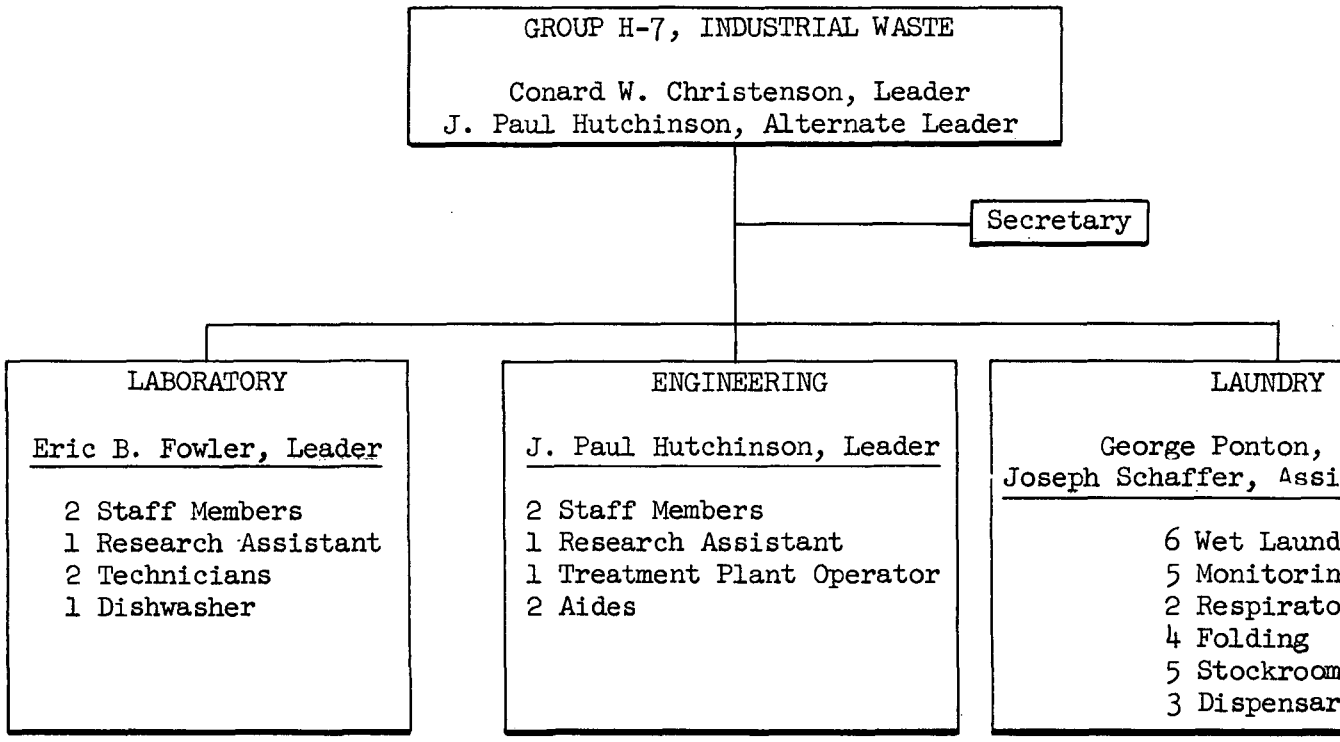

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Chapter 2

GROUP H-1, MONITORING

By Dean D. Meyer, Group Leader

2.1 General

As a service group within the Laboratory, Group H-1 is responsible for the measurement and control of exposures to ionizing radiation. Daily surveys are made and air samples collected in those areas handling radioactive materials. During 1957, as in previous years, appropriate dosimetry was furnished to all personnel exposed to external radiation. Detailed reports were submitted to supervisors concerning unusual conditions within their areas, high air counts, and overexposures. Assistance was given to many groups on the design of new facilities to be used for handling radioactive materials, the features which are of particular concern to Group H-1 being shielding, ventilation, filtration of effluent, choice of building materials for ease of decontamination, remote handling equipment, instrumentation, and disposal of radioactive wastes.

A supplementary service performed for the Laboratory is decontamination. Assistance was given in the cleanup of areas where accidental spills of radioactive materials occurred. Routine decontamination was

made of Laboratory equipment and precious metals in order that they might be returned to use. It is estimated that 1858 items with an approximate value of $286,960 were decontaminated during the year. In addition, 40 kg of platinum, along with varying quantities of other precious metals, were decontaminated and returned to stock.

We had established several objectives for ourselves during 1957. These were pursued with varying degrees of success. They are discussed in some detail below:

(1). Attempts were made to control all whole-body exposures to penetrating ionizing radiation to below the 5 rem per year recommended by the National Committee on Radiation Protection. The number of persons exceeding 5 rem for 1957 was 14 (see Table 2.1). This included exposures received both at test sites and within the Laboratory. The highest individual exposure was 13.5 rem. This exposure was received while the individual was working on critical assembly components.

(2). All photodosimetry records are being changed to the IBM coding system. This has been accomplished for the years 1956 and 1957, but the completion of the project will require considerable additional time. The major difficulty thus far has been obtaining machine time on IBM equipment.

(3). Materials waste disposal has become a major problem to all laboratories using radioactive materials, and this Laboratory is no exception. All solid wastes at this Laboratory are disposed of by either burial or pit burning. A new disposal area on Mesita del Buey has been

TABLE 2.1 RADIATION EXPOSURES TO PERSONNEL AT LOS ALAMOS FOR 1956 and 1

	LASL & AEC		Zia Company		Visitors*		
Dose, rem	1956 -	1957	1956 -	1957	1956 -	1957	1956
0.00 - 0.10	1040	1314	301	280	55	233	1396
0.11 - 0.50	336	321	58	53	9	47	40
0.51 - 1.00	147	101	24	32	4	10	17
1.01 - 2.00	128	86	16	13	3	1	14
2.01 - 3.00	78	21	7	1	1	0	8
3.01 - 4.00	59	14	1	0	3	0	6
4.01 - 5.00	27	15	1	1	0	0	2
5.01 & above	37	12	2	2	2	0	4
Total	1852	1884	410	382	77	291	233

*Visitors include consultants, military personnel, and employees of outside co

assigned to the Laboratory. It should take care of our needs for many years. This will solve the actual burial problem quite satisfactorily, but there are other problems requiring solution. Among those which should be considered are storage before collection, ease of collection, containment of fire if it occurs during storage or transit, protection of contents from weather before and during transit, minimum possibility of spill during transit, and cost. A study was made of our present system on the basis of the above points, and other systems were considered. The method which seemed to offer the most, and which we have adopted on an experimental basis, is using Dempster Dumpsters for trash pick-up. The advantages are so great that we have now decided to go to these containers entirely except in a limited number of cases where items will not fit in the Dempster Dumpster.

(4). A number of changes and desirable additions have occurred which make the LASL General Handbook for Radiation Monitoring relatively obsolete. We had planned to have a new edition completed by July 1957. However, since the National Bureau of Standards was revising its Handbook 52, it seemed desirable to postpone the revision of our handbook until these tables could be included. It will probably be the latter part of 1958 before the next revision of our handbook is ready for distribution.

(5). Some types of work at the Laboratory give difficulties in controlling external whole-body radiation to personnel. These are: U^{233} chemistry and fabrication; RaLa processing, experiments, and

waste disposal; and the manipulation of critical assembly components.

There are several things which we think will assist in reducing exposures on the U^{233} work. First, additional shielding should be put on all dry boxes where practical. Second, the metal should be fabricated as soon as possible after the chemical purification since there is appreciable growth of high energy gamma-emitting daughters even during the first week. Third, replacement operators should be trained in order that personnel may be rotated.

The higher exposures of RaLa personnel during the latter part of the year were due, we believe, to unusual circumstances. The breakdown of equipment in the hot cell created waste disposal problems, while the concentration of radioactivity in the waste storage tanks was so high they could not be dumped, and the pumps on the tanks required maintenance before the solution could be put through the ion exchange column. Considerable exposure was received by H-7 personnel repairing these pumps and working on the ion exchange column. It is believed that these problems will be solved by planned revisions in the LASL Ten Site waste disposal system.

The control of high exposures around critical assembly components can be improved by closer supervision and we have now assigned a full-time health monitor to Pajarito Site as a step in this direction.

(6). Radiation exposure limited to the hands, considered from annual accumulated dose basis, appears to be under satisfactory control. The highest annual accumulated hand dose was 38 rem, which is less than

one-half the maximum permissible dose. There were a few instances where the weekly permissible hand doses were exceeded; these occurred on research operations involving the handling of light metal tritides and the chemistry and fabrication of U^{233}. The overexposures on the light metal tritides were due to low energy bremsstrahlung. We believe that this minor problem can be solved adequately in the future by light shielding.

(7). Several accidents occurred in 1957 in which materials that contribute to the internal dosage were discharged. None of these contributed significantly to personnel body burdens, with the exception of tritium. Three of the fourteen exposures within the Laboratory which exceeded 5 rem for the year were due to this substance. The tritium overexposures occurred during maintenance, repair, and decontamination of equipment in one of the research laboratories. We believe that the installation of a hood for decontamination will materially reduce the exposures in this area, and such an installation is planned in the near future.

During the year two training programs were prepared and given to AEC and military personnel.

(1). In April a one-week course on alpha monitoring procedures and contamination control was given to personnel of the 2700th Squadron EOD group from Hill Air Force Base in Utah. After completion of the lecture part of this course at Los Alamos, the group proceeded to the Nevada Test Site where they continued their training by taking part in Project 57.

(2). In July a one-week course on radiation protection was given to safety personnel from AEC operations at Burlington, Iowa, and Amarillo, Texas.

2.2 Future Program

New programs and machines to be used within the Laboratory necessitate progress in certain fields for Group H-1. In order to meet these additional responsibilities we have established the following goals for ourselves:

(1). There are several types of pulsed neutron sources being developed within the Laboratory. These include Phermex, some Sherwood equipment, and some critical assemblies. It will be necessary to develop adequate dosimetry and monitoring methods for these types of sources. In order to achieve this objective we will have to have assistance in the development of integrating type neutron detectors which will respond to the duty cycles to be used by the machines.

(2). The possibility of wounds occurring while handling solutions and salts of plutonium is always present. Evaluation of the seriousness of these wounds from the standpoint of radiation dosage has always been difficult. The use of a scintillation probe fed into a pulse-height analyzer to measure the 17 kev X ray emitted by plutonium seems to offer the most promise. Group H-6 is already assisting on this project and we hope to have a workable instrument in the near future.

(3). Platinum decontamination has required many man-hours.

Two methods of decontamination are being used, both taking considerable time. One method requires dissolving the metal and making a chemical extraction of the contaminate; the other method is ultrasonic cleaning which requires that the individual pieces of platinum be monitored. We are experimenting with a method in which the platinum is melted with an induction heater and cast into an ingot. The ingot can be sampled easily by dissolving a small portion in aqua regia and preparing a planchet, which is counted. This method will greatly reduce the monitoring time, and has proven satisfactory for the decontamination of silver.

(4). Our present personnel film dosimetry has three conspicuous shortcomings:

(a). There is a lack of sensitivity for measuring low level exposures. The threshold of the Du Pont 502 film is approximately 50 mr. Since many badges have been issued on a weekly and biweekly basis, many low level exposures are missed. It is now proposed to issue these badges on a monthly basis in order that exposures as low as 15 to 20 mr per week may be measured.

(b). It is difficult to measure exposures in excess of 8 r with our present film. This means that we would probably be unable to evaluate gamma exposures such as might result from an accident. This problem will be solved by incorporating in our film packet a dosimeter which will cover the range from 4 to 600 r.

(c). Only limited distribution is now made of nuclear track plates. We are now proposing to include nuclear track films in

all film badges. Not all these films will be read, but they will be processed and can be read should any question of exposure arise. The nuclear track film will be a Cheka packet. Experience has shown that this film will give increased accuracy for neutron dosimetry because of its energy dependence characteristics. The high range film and the Cheka nuclear film will be combined in a single packet, which is called the Eastman experimental personal neutron monitoring film, Type B2.

Chapter 3

GROUP H-2, INDUSTRIAL MEDICINE

By Harry O. Whipple, M.D., Group Leader

3.1 General

The efforts of the Group are directed toward a program of preventive medicine. The Group works closely toward this end with the other Groups in the Health Division, and principally with the Industrial Hygiene Group (H-5), the Monitoring Group (H-1), and the Safety Group (H-3). The Group also works closely with the Laboratory Business Office in an advisory capacity in connection with Workmen's Compensation cases. There were no major changes in procedures or policies in 1957.

3.2 Personnel

There were 18 employees in the Group at the beginning and end of the year. This number included two physicians, six nurses, four clinical laboratory technicians, one secretary, three clerks, and two laboratory dishwashers. The Group also had available two registered nurses on a casual basis for sick leave and vacation replacements. The radiologist of the Los Alamos Medical Center is employed on a continuing consulting

basis to review all roentgenograms taken in connection with the industrial health program.

3.3 Physical Examinations

A continuing major effort of the Group has been the physical examination program. Pre-employment and termination examinations are done on all employees at the appropriate time. Since the Laboratory personnel turnover has been relatively small and a large proportion of new hires have been either recruited locally or brought here for interview prior to employment, it has been possible for us to arrange to perform a major fraction of the pre-employment examinations under our own auspices. Arrangements have been made with AEC Security to bring uncleared individuals under our escort to our facilities for this purpose.

Periodic physical examinations are done at a three-year interval unless exposure, age, or known physical disability makes a shorter interval desirable.

During 1957 a total of 523 pre-employment examinations, 317 termination examinations, and 924 periodic physical examinations were performed.

3.4 Dispensaries

The Group maintains four dispensaries for the care of minor occupational disease and injuries, minor nonoccupational disease and injuries, and for first aid in more serious conditions. The four dispensaries are located at the Administration Building, CM Building, S Site, and TA-1.

The latter was discontinued on December 16 and replaced by a dispensary at DP West. The dispensaries are staffed by registered nurses. In addition, there is a physician in attendance from 8 a.m. to 5 p.m. at the Administration Building and at scheduled times at S Site.

During 1957 there was a total of 19,408 dispensary visits, of which 5050 or 26 per cent were for occupational reasons.

3.5 Laboratory

The laboratory is equipped to do a variety of clinical procedures both in connection with the physical examination program and the follow-up of workers with potentially hazardous exposures. In January we commenced doing serological testing for syphilis using the VDRL test. Blood samples for this procedure had previously been sent to the New Mexico Public Health Laboratory.

During 1957 the laboratory performed 3918 complete blood counts, 2224 urinalyses, 440 assorted blood chemistry procedures, 557 blood typings, and 1037 VDRL tests.

3.6 Radiographic Examinations

In 1956 the Group discontinued taking chest photofluorograms at the Medical Center and installed its own X-ray equipment. A standard 14 x 17 six-foot chest X-ray is taken to minimize X-ray dosage, which has been measured at about 30 mr per exposure. All radiographic procedures are carried out by the nursing personnel under the general direction of the radiologist at the Los Alamos Medical Center. Film badge monitoring has

shown that Group H-2 personnel have not received measurable X-ray exposure while taking roentgenograms. There were 1938 radiographic examinations performed during 1957.

3.7 Miscellaneous

In September we were urged by the AEC to offer immunization to all employees against the Asian strain of influenza. A program of immunizations was undertaken. In line with the recommendations of the New Mexico State Department of Public Health and to conserve supplies of vaccine, it was decided to give two intracutaneous inoculations of 0.1 cc each, at an interval of two weeks. A total of 2886 injections was given over the ensuing weeks. This indicates that very nearly 50 per cent of the Laboratory employees received immunization against Asiatic influenza. The Laboratory did not experience an influenza epidemic although a mild epidemic did occur at Los Alamos, mostly among school-age children. It is, of course, impossible to determine how effective the immunization program was in preventing an epidemic among Laboratory personnel. It is, however, interesting to note that our experience in 1956 and 1957 with the seasonal incidence of upper respiratory infections showed no definite change in pattern, and the only significant difference, if any, was a slight decrease in such infections during November and December of 1957.

In addition, the Group cooperated in furnishing supplies and personnel for assisting in the Asiatic influenza immunization program for AEC, Zia, and Medical Center personnel. We also assisted in immunizing military dependents.

The cost of the medical program was very nearly $40 per employee. This figure does not include Workmen's Compensation insurance costs.

Chapter 4

GROUP H-3, SAFETY

By Roy Reider, Group Leader

4.1 General

The Laboratory's accident frequency record has not varied significantly for several years (Fig. 4.1). The frequency for 1957 was 3.5 accidents per million man-hours worked, about the same as the national

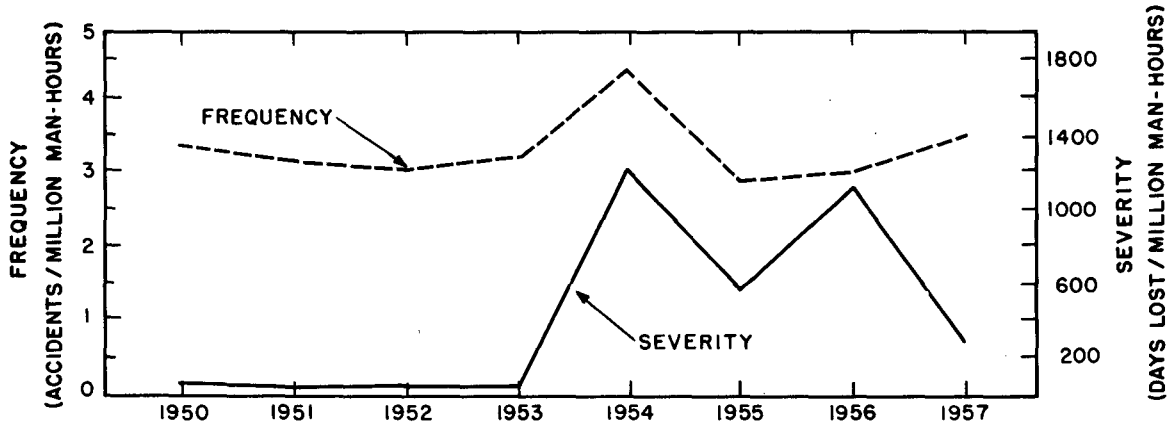

Fig. 4.1 Disabling personal injuries.

chemical industry record of 3.4 and lower than the all industries record of 6.4 (National Safety Council members)

The accident severity record (Fig. 4.1) was affected considerably during 1957 by the one serious injury; a machinist caught his hand inside a graphite part being sanded on a lathe. The accident resulted in a compound fracture to the right arm and an arbitrary time assignment of 900 days for an estimated disability of 25 per cent to the right arm.

4.2 Disabling Injury Experience

Of the 21 disabling injuries during 1957, 11 were for a lost time of less than a week, with an average lost time for all injuries of 51 days.

The second most serious injury, in amount of time lost, was a finger injury to a machinist when he caught his hand between a ram on a power brake and a piece of metal being bent. His lost time was 33 days.

The disabling injury record for eight years is compared in Table 4.1.

TABLE 4.1 DISABLING INJURY EXPERIENCE

Year	Man-hours	Disabling Injuries	Days Lost	Frequency[a]	Severity[b]
1950	4,413,000	15	237	3.4	50
1951	5,538,000	17	172	3.1	30
1952	5,985,000	18	197	3.0	30
1953	5,319,000	17	182	3.2	30
1954	5,491,000	24	6553[c]	4.4	1190
1955	5,523,191	16	3056	2.9	551
1956	5,717,855	17	6355[c]	3.0	1110
1957	6,027,159	21	1076	3.5	179

a. Frequency is the number of disabling injuries per 1,000,000 man-hours worked.

b. Severity, a measure of the seriousness of accidents, is the ratio of number of days lost per 1,000,000 man-hours worked.

c. Includes a time charge of 6000 days as an arbitrary assignment for a fatality.

The 21 disabling injuries occurring during 1957 are classified in three ways:

Laboratory Division

H, 2; GMX, 5; SD, 7; T, 1; J, 2; CMF, 1; N, 2; SP, 1.

Body Part Involved

Eyes, 5; head, 1; hands, 5; arms, 1; feet, 2; legs, 3; trunk, 1; back, 3.

Accident Type

Struck by, 8; caught in between, 3; fall on same level, 1; fall on different level, 1; slip or overexertion, 2; contact with temperature extremes, 2; contact with electric current, 1; not classified, 2.

4.3 Motor Vehicle Accidents

Laboratory employees were involved in more motor vehicle accidents in 1957 than in 1956 (Fig. 4.2) but the total damage was about half. No

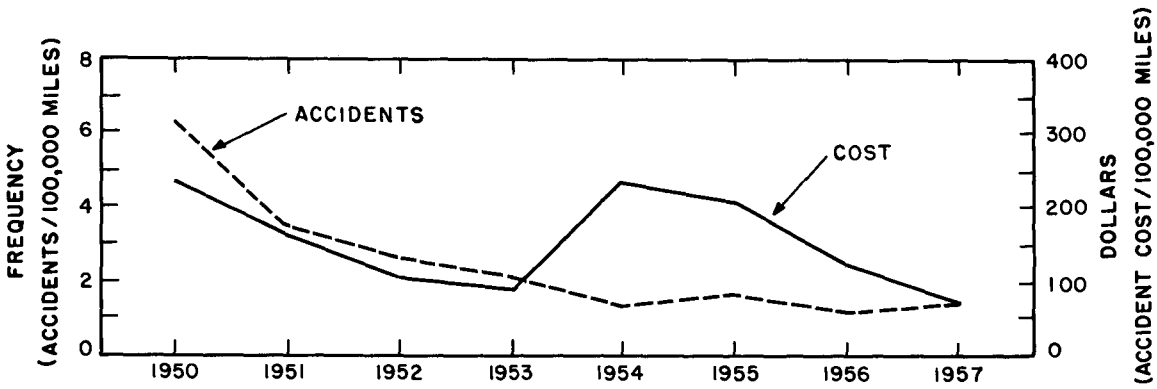

Fig. 4.2 Motor vehicle accidents.

accidents at Los Alamos were serious, the most extensive amounting to $116 in damage, but one J Division employee during Operation Plumbbob was in a one-car upset accident and was disabled for two weeks.

Motor vehicle accidents for 1957 are classified below for type.

Improper backing	13
Failure to adjust to road condition	3
Driver's attention distracted	1
Rolled backward when stopped on grade	2
Obstruction in roadway	2
Misjudgment of turning radius	1
Misjudgment of clearance	2

A comparative record of motor vehicle accidents is given in Table 4.2.

TABLE 4.2 MOTOR VEHICLE ACCIDENTS

Year	Miles Driven	Number of Accidents	Accident Rate per 100,000 Miles	Total Cost	Accident Cost per 100,000 Miles
1950	1,566,000	98	6.3	$3700	$237
1951	1,814,000	62	3.4	2900	160
1952	1,820,000	49	2.7	1900	105
1953	1,732,500	36	2.1	1600	93
1954	1,667,500	23	1.4	3900	236
1955	1,806,500	30	1.7	3700	206
1956	1,879,960	22	1.2	2311	126
1957	1,693,090	24	1.4	1131	67

The Safety Office is now responsible for the issue of AEC Driving Permits to Laboratory employees. The Project Services Branch of LAAO previously issued the permits.

A detailed paper was written and distributed to all drivers and

supervisors on responsibilities of driving government vehicles and proper accident reporting procedures.

4.4 Fire Loss Experience

Several small fires of little damage occurred during the year. The total fire loss was $977 (Fig. 4.3), of which $850 damage occurred in the S Site Cafeteria when a deep fat fryer overheated, flashed, and smoked up the building. A fire on the contaminated trash truck resulted in a $70 loss.

The fire loss for each year since 1951 is shown below:

1951	$2991
1952	1065
1953	1429
1954	8108
1955	50
1956	4182
1957	977

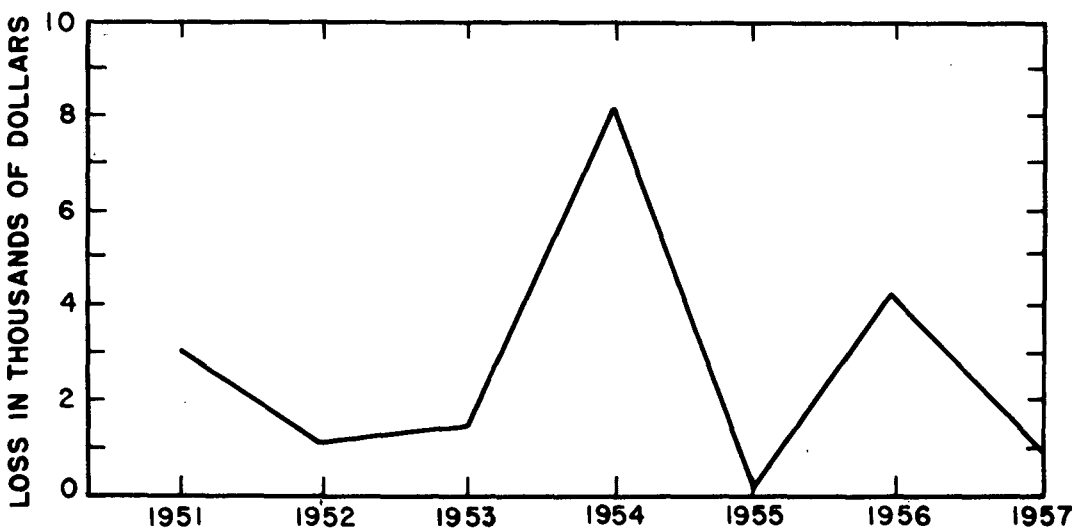

Fig. 4.3 Fire losses.

4.5 Safety Education and Training

During 1957 the education and training programs continued to be directed toward both general safety considerations affecting the entire Laboratory and special problems encountered by various Groups.

The major activities of the Laboratory-wide program included a colloquium by a visiting speaker on low voltage electrical risks, a talk for Staff Members on "Eniwetok," distribution to all employees of a wallet-sized card describing artificial respiration, and the writing and distribution to all Group and Division Leaders of a regular safety newsletter.

Typical of the many activities relating to special problems of various Groups were a talk on "Safety Problems in Nevada," given to a group of J Division monitors preparatory to Plumbbob; a talk and a paper for J Division and other LASL personnel at Nevada Test Site on "Effects of Hot Weather" (later reproduced and distributed to all Test Site personnel by Reynolds Electric Company); a talk and demonstration for W Division on the hazards and control of arsine; four sessions for Group H-1 and N Division on the back pressure, arm lift method of artificial respiration; a data sheet on cesium; a special safety newsletter for GMX Division on the handling of equipment contaminated with high explosives; and the showing of appropriate safety films to a number of Groups.

Although improvements with respect to the risk from fire have been made all along the line--new facilities, careful scrutiny of alterations,

elimination of many fire risks, installation of detection and sprinkler systems--fire surveys by the AEC Fire Protection Engineers are more frequent than ever. There are indications that the same degree of success could be obtained with fewer surveys. During 1958 we will re-evaluate the situation to see if steps can be taken to reduce the number of surveys and consequently the time required to process them.

4.6 Professional Meetings

All Safety Engineers in the Group are members of the recently chartered New Mexico Chapter of the American Society of Safety Engineers. The Chapter's territory covers most of the state, and monthly meetings are held in different cities. One or more representatives from the Group have attended each meeting and have been responsible for three programs. Representatives have also attended national meetings concerned with safety.

4.7 Engineering

The Group continued to examine and approve all drawings issued by the Engineering Department for construction of new facilities and modifications or installation of equipment.

The Group also consulted with many people in the Laboratory with respect to new operations and procedures. We have worked with Group J-6 (Engineering) in developing testing facilities at Nevada for N Division and constructing facilities at the Eniwetok Proving Ground for Operation Hardtack.

4.8 Safety Surveys and Committees

Safety surveys of equipment, facilities, and operations were made of all Laboratory sites and buildings by H-3 personnel. There are active Safety Committees in GMX, CMB, and K Divisions, the Shop Department, and Supply and Property Department. These committees carry out various functions, such as physical inspections, review of operating procedures, and manual writing. They are particularly well organized and active in GMX Division.

4.9 Safety Manuals

The Group assisted in the revision, approval, and distribution of Safety Manuals for the operations of GMX Groups 2, 6, and 7. Also, the Group helped rewrite the GMX Division rules on "Transportation of Explosives."

4.10 Security and Fire Protection Personnel Training

Eighteen talks on Laboratory risks were given to classes of Security personnel during retraining courses.

The Indoctrination and Orientation program for Fire Department and Protective Force personnel was continued with tours through N Division facilities at TA-46, the new Administration Building, and a refresher tour through DP Sites. The manuals were brought up to date.

4.11 Test Operations

All safety engineers in the Group took part in rotation in Operation Plumbbob in Nevada. A safety engineer was in residence at the Test

Site from April 26 to September 20, a period of about five months. In addition, a representative spent a few days there in February to observe safety considerations with respect to the use of balloons. Also, another representative spent two weeks there in December in connection with NTS 58 Project.

Members of the Group attended Project Officers' meetings in Albuquerque and Los Alamos in connection with planning for Operation Hardtack.

4.12 Special Activities

At the request of that Laboratory, a representative of the Group visited UCRL Livermore to consult on explosives safety problems. Another visited Site Sugar with W Division representatives to advise on special safety problems.

A LASL Nuclear Criticality Safety Committee was formed during the year with the Safety Director as recorder. This committee will review all procedures involving questionable amounts of fissile material. The Safety Office will review established procedures in the course of normal safety inspections.

4.13 Future Programs

A representative of H-3 will take part in the Personnel Department's New Employee Orientation program.

The Group is currently planning a specific safety program for the unique needs of each Department and Division beyond the usual safety

services provided in standard safety programs. An inventory of special needs will be made by individuals of the Group to whom one or more Divisions and Departments will be assigned and then the entire Safety Group will consult on the nature of the program required and periodically review progress. Increased emphasis is planned for the preparation and publication of technical papers.

Chapter 5

GROUP H-4, BIOMEDICAL RESEARCH

By Wright H. Langham, Group Leader

5.1 General Remarks

During the fall of 1956 decision was made to direct the radiobiology interest of Group H-4 toward studies of the chronic and delayed effects of radiation. The relative biological effectiveness (RBE) of radiations having different ionization densities in tissue were to be studied using lens opacities, life shortening, tumor incidence, onset of senility, and ability to withstand low temperature stress as endpoints.

Group H-4 has never had space for the breeding and raising of experimental animals, and mice were obtained from commercial breeders. A serious Salmonella infection transported into the colony from an outside source resulted in loss of all but two of the experiments and abandonment of the experimental program until a mouse breeding capability could be developed. The breeding of adequate numbers of mice of the desired strains has proven to be a much more difficult job than was anticipated. A veterinarian was hired and placed in charge of the animal colony, and the entire year's effort has gone into the development of sufficient

production potential to provide adequate numbers of experimental animals to start the chronic studies. Use of animal rooms for breeding purposes has produced a shortage of space in which to house the experimental animals, and $350,000 has been requested in the FY-1959 budget to enlarge the animal quarters.

Because of lack of adequate animals for studies of chronic radiation effects, the Group's efforts during 1957 were turned in other directions. Emphasis was placed on very low level counting studies and monitoring of foodstuffs and people for uptake of Cs^{137} from fallout; clinical applications of low level counting; development and testing of organic liquid scintillators; neutron dosimetry; continuing studies not destroyed by the 1956 Salmonella epidemic; metabolism of alkali metal isotopes in mice, rats, dogs, monkeys, and man, as measured by whole body in vivo counting methods; and documenting and publishing the backlog of studies completed in past years. These and other activities are briefly but specifically reported in the following pages.

5.2 Summary and Progress of Major Programs

5.2.1 Biochemistry Section

The Section Leader of the Biochemistry Section spent the year in Europe working at the Hammersmith Hospital, London; consequently, the number of major biochemistry projects was curtailed.

Radioactive Tracer Studies of Protein and Lipid Metabolism of the Human Fetus (in collaboration with the Argonne Cancer Hospital, Chicago, Illinois). Tritium and C^{14} tracer studies of the metabolism

of the human fetus showed that cholesterol, fatty acids, and tissue proteins are almost entirely synthesized in the human fetus and very small amounts are transferred across the placental barrier, except that fed cholesterol-H^3 is found in the fetal part of the placenta. The relative rates of cholesterol biosynthesis from acetate-1-C^{14} and from various other substrates in all fetal organs and certain maternal tissues were determined. No evidence that acetate is converted into cholesterol in brain was found for any age fetus, but definite evidence of conversion of glucose into cholesterol was obtained. This may be due to failure of acetate to cross the "blood-brain" barrier.

5.2.2 Biophysics Section

a. Low Level Counting Activities and Monitoring of People and Foodstuffs for Uptake of Cs^{137} from Fallout. The program of routine monitoring of people and milk for Cs^{137}, begun in 1956, has been continued and its scope enlarged. During 1957 a total of 2225 determinations were made: 820 on people (total to date 2159), 887 in milk (total 1071), and 518 on dried blood. This program occupied the human counter less than 20 per cent of capacity.

Thirty-three sampling points for milk in 24 states provided a good basic picture of the cesium distribution pattern in the United States. Fourteen of the stations are in the western states because of proximity to the Nevada Test Site and because of the greater variations of altitude and rainfall to be found in that area. Stations are located within 50 miles or less of the Hanford, Arco, and Vallecitos

reactor sites, and additional points will be instituted near Shippingport, Dresden, and Lagoona Beach.

Subjects from 32 states were measured, enough to give statistically significant averages for major portions of the country. Correlations between the cesium activity in people and in milk and between cesium content of milk and the frequency of rainfall were shown.

There was no significant change in the cesium level in the population between 1956 and 1957, the over-all averages being 41 and 43 μμc/g of K, respectively. In both years the population distribution curve was normal with a standard deviation of 36 per cent.

Barium-140 was noted in milk from many localities during Operation Plumbbob [E. C. Anderson et al., Science, 127, 283 (1958)], but the levels are far below permissible. We have been unable to detect it in man.

The human counter has also been used for a number of other projects, including the diagnosis of human exposure to neutrons by Na^{24} activation, a study of the retention of gamma-emitting nuclides by dogs, monkeys, and man, and a Cr^{51} study of red cell life.

A crystal spectrometer similar to the Argonne National Laboratory's design (by Marinelli and Miller) has been installed and is in operation. It has proved to be extremely useful both as an adjunct to the liquid scintillator to provide proof of radiochemical purity of samples and in a number of spectrometry problems, such as the study of soils from Nevada and Utah, the analysis of air filter samples, and the

analysis of the activity present in the rumens of Nevada cows.

The liquid scintillation counter, which was designed in 1953, is obsolete. Only its excellent performance and the magnitude of the task of keeping up with the data it produces have delayed its replacement. A new and greatly improved counter using 16 inch photomultiplier tubes is now in design and should be operating within a year. The new counter will have improved energy resolution, counting efficiency, and range of energy response. It is expected to operate in three or four energy channels, thus permitting, for example, a simultaneous determination of I^{131}, Cs^{137}, and K^{40}. It should be capable of efficient bremsstrahlung counting, thus extending the usefulness of the instrument to tracer experiments with hard beta emitters. The light collection efficiency will be 16 times that of the present counter.

A smaller and considerably cheaper 2π walk-in counter has been designed for exhibition at the forthcoming Geneva Conference on the Peaceful Uses of Atomic Energy. The exhibit will feature the actual measurement of the natural K^{40} activity of any and all who care to volunteer (counting time probably 30 seconds for 5 per cent statistics). The explanatory material will discuss natural potassium and will be aimed at the lay visitors to the exhibits. Simultaneously, for the benefit of physicists and chemists, the counter will be measuring the half-life and decay spectrum of cosmic ray mu mesons as a demonstration of the unique possibilities offered by large organic detectors. The explanatory material associated with this portion of the exhibit will be highly

technical and will illustrate such applications as the measurement of neutron multiplicity in fission, the studies of double-beta decay, and cosmic ray studies. It is hoped that after the Conference this counter can be left in Europe and used for the study of clinical applications and to provide Cs^{137} data comparable to that being obtained here.

b. Experimental Determination of Fast and Thermal Neutron Tissue Dose. Beryllium tissue-equivalent and beryllium-graphite ionization chambers have been made which permit the measurement of fast and thermal neutron dose. Measurements on fast neutrons have been compared with the Hurst proportional counter, threshold detectors, and chemical dosimeters on 14 Mev neutrons from the Los Alamos Cockcroft-Walton accelerator and fission neutrons from the Godiva critical assembly. The data indicate close agreement with theory on a first-collision basis. Measurements on thermal neutrons, made at the Los Alamos Water Boiler, with tissue-equivalent and tissue-equivalent nitrogen-depleted ionization chambers, indicate agreement with theory on the contribution of the proton portion of the total tissue dose. The measurement of the inherent gamma-ray contamination with a beryllium-Teflon-graphite chamber also is in agreement with the lithium extrapolation method. Graphite and tissue-equivalent nitrogen-depleted ionization chamber measurements indicate a low gamma-ray portion of the total thermal neutron dose when compared to theory.

5.2.3 Organic Chemistry Section

a. Testing of Scintillators for the Detection of Radiation.

The survey program of primary liquid scintillation solutes has produced relative pulse-height screening results for about 100 new compounds obtained from Iowa State University, University of Louisville, University of New Mexico, and Group H-4. Complete studies of light output versus concentration in toluene, absorption spectra, and fluorescence spectra have been carried out for groups of benzo [f] quinolines, 4,7-phenanthrolines, 2-pyrazolines, aminoöxazoles, thiazoles, alkylpolyphenyls, and arylnaphthalenes. The results of these studies will be reported in 1958, in addition to a status report on all the results to date for the more than 450 compounds which have been tested.

A large number of commercial plastic and organic crystal scintillators have been surveyed for light output and fluorescence spectrum.

A "tissue-equivalent" liquid scintillator with good light output has been devised. Its composition is 66.7 per cent toluene, 21.2 per cent mineral oil, 11.6 per cent acetonitrile, 0.5 per cent p-terphenyl, and 0.01 per cent POPOP.

b. Methods of Evaluating Scintillators for Radiation Detection. With the premise that the wide variance in scintillator testing results from different laboratories is largely due to wavelength-dependent processes in light detection methods, a joint study with the Physics Division of the Argonne National Laboratory was undertaken with the intent to arrive at standard methods for evaluation of scintillators. A simple pulse-height method for measuring differences in the spectral

distribution of the response of photomultipliers was devised and applied to 132 photomultipliers (types 6292 and 6342). Six scintillator solutions were selected which had fairly evenly spaced mean emission wavelengths from 336 to 466 mμ. Their relative pulse-height values with photomultipliers exhibiting widely different spectral responses and their relative photon output numbers were measured. In addition, fluorescence spectra of these six solutions were obtained.

c. Survey of World-wide Contemporary C^{14} Activity in Plant Life. The fast coincidence liquid scintillation counter is being used for high precision determinations of C^{14} in terpene chemicals derived from camphor trees, pine trees, orange trees, and lemon grass. The results may be not only of botanical interest but, by mass spectrographic correction to carbon dioxide as a standard, they may also be applied to the geochemical study of the atmosphere. Thus far, determinations have been completed for lemon grass harvested in the period August 1955 to February 1956 in Argentina, Belgian Congo, Brazil, Comoro Islands, Guatemala, Haiti, India, and Mexico. Procurement of new samples from these same locations with harvest dates after June 1957 is in progress. Camphor samples dated before 1945, 1950, and 1954 have been assayed. A 1957 sample has been obtained. A method has been devised for C^{14} activity determination in turpentine from pine trees and in oil from orange trees. From results already obtained there is no indication of C^{14} activity above that due to the contemporary level of natural C^{14}.

d. Organic Syntheses with Isotopes. Galley proofs of a

two-volume treatise, Organic Syntheses with Isotopes, have been received, read, corrected, and returned to Interscience Publishers. Page proofs of Volume I have been received, and the preparation of a combined index for both volumes is in progress. A tentative publication date of June 1958 has been set.

5.2.4 Radiobiology Section

a. Effect of Partial Body Radiation on the Life Span of Mice. Fifteen hundred three-month-old CF-1 female mice were divided into four groups and irradiated as follows:

Group A received 93 to 372 rads of total body X rays.

Group B received 186 to 740 rads to the lower half of the body.

Group C received 186 to 740 rads to the upper half of the body.

Group D (controls) received no irradiation.

Three exposure levels were used in Groups A, B, and C, and the levels were chosen such that the doses in gram rads (ergs/animal) were similar between groups.

At 18 months after exposure it is apparent that the animals receiving total body irradiation have a lower survival rate than those irradiated partial body with the same integral dose. Greater protection was obtained with lower body shielding than with upper body shielding, even though the incidence of thymoma and leukemia was higher in the former group.

b. Relation between Age at the Time of Radiation and Shortening of Life Span in Mice. CF-1 female mice from the same original population were exposed total body to 96, 192, and 384 rads of X rays at 3, 6, 12, or 18 months of age. Each irradiated group at 3, 6, and 12 months contained 150 mice while the groups exposed at 18 months consisted of 50 mice. Three hundred mice were set aside as controls. Unexposed females from the same original population were bred and their offspring were exposed to similar radiation dosages at 1 week of age.

At the present time, the animals irradiated at 6 and 12 months show a higher age specific death rate than those exposed at 3 months, while the mice exposed at 1 week of age have the lowest death rate of any of the irradiated groups. Not enough time has elapsed since the irradiation of mice at 18 months of age to determine any changes. To date, it appears that the younger the animal is at the time of irradiation, the less the shortening of life span.

c. Effect of Preprotection with Glutathione on Life Shortening by X Rays. Seven months after irradiation, the death rate of CF-1 mice that received glutathione prior to whole body exposure to 672 rads of X rays is identical to that of unprotected animals exposed to 384 rads. The death rate in the mice receiving glutathione and 384 rads is similar to that of untreated mice exposed to 192 rads. These findings suggest that glutathione causes a true "dose reduction," possibly by combining with the radicals produced in tissue by X rays.

Included in the study was a group of CF-1 mice treated

with nitrogen mustard. The dose of nitrogen mustard used (4 mg/kg body weight) corresponds in acute lethal effectiveness to approximately 384 rads of X rays. Twelve months after injection, the death rate in these animals was similar to that of the control animals.

d. The Effect of Nitrogen Mustard and Whole Body Irradiation on Life Span and Tumor Incidence in the Swiss Strain of Mice. CFW Swiss female mice, approximately 12 weeks of age, were divided into four groups of 100 mice each and treated as follows:

Group A received 384 rads whole body X rays.

Group B received 2.5 mg nitrogen mustard/kg body weight.

Group C received 3.5 mg nitrogen mustard/kg body weight.

Group D served as the control group.

One year after treatment, the results may be summarized as follows:

(1). A single sublethal dose of nitrogen mustard appears to have no effect on the life span of Swiss mice.

(2). Seventy per cent of the Swiss strain of mice had survived a single total body dose of 384 rads of X rays, while only 40 per cent of the CF-1 mice survived the same dose in a similar experiment. This difference may be due to the extremely low incidence of spontaneous leukemia in the Swiss strain compared to the high incidence in the CF-1 strain.

e. Toxicity, Excretion, and Tissue Distribution of Ionium (Th^{230}) in Rats. Experiments on excretion, tissue distribution, and toxicity of ionium were undertaken and the results compared with previous

studies done on plutonium. Rats were injected either intravenously or intraperitoneally with doses of ionium ranging from 1 mg (19.5 μc) to 6.7 mg (130 μc) per kg body weight. Twenty-four hour urine and fecal collections were obtained on all animals for the first 6 to 8 days and single 24 hour collections each succeeding week on survivors. At death spleen, liver, kidneys, bone, and carcass were analyzed for ionium.

The LD_{50}^{30} for ionium was ~ 2 mg/kg (39 μc/kg) compared to 1 mg/kg (64 μc/kg) for plutonium. The level of tissue deposition varied somewhat with the size of the dose administered. At a dose level of 2.0 mg/kg, the total urinary excretion was ~10 to 15 per cent at 20 to 30 days. At 30 days, the urinary excretion rate was 0.007 per cent of the injected dose per day. In this same period, the total fecal excretion was ~5 per cent. Seven days post injection the fecal-to-urine ratio was ~20. In surviving animals, this ratio was 3 at 30 days and approached 1 at 45 days. An average of 70 to 80 per cent of the injected dose was retained at the time of death. Of that retained, 25 to 35 per cent was in the bone and 30 to 40 per cent in the soft tissue. Of the portion retained in the soft tissue, 35 to 40 per cent was found in the liver. From these studies it may be concluded that the toxicity and physiology of plutonium and ionium are quite similar when administered to rats on an equivalent microcurie basis.

In addition to the above lethality, retention, and excretion studies, separate groups of animals were injected for histopathologic and radioautographic studies which are still under investigation.

f. Toxicity, Tissue Distribution, and Metabolism of C^{14}-Thio-TEPA in Rats. The toxicity of thio-TEPA (N,N',N''-triethylenethiophosphoramide) was determined following intravenous injection of the drug into the jugular sinus or portal vein and following intra-arterial injection either into the aorta or common carotid artery. No variation in toxicity of the drug was noted among the various routes of administration of the drug. The dose which killed 50 per cent of the animals was $\sim$9.0 mg/kg body weight.

Distribution of C^{14} activity was fairly uniform throughout all tissues and was only slightly influenced by the route of administration of the drug. Metabolic studies following the intravenous administration of 9 mg/kg of body weight of C^{14}-thio-TEPA showed that $\sim$96 per cent of the C^{14} activity of the drug is excreted in the urine in 24 hours and only $\sim$1 per cent in the feces and $\sim$2 per cent in the expired CO_2.

g. Irradiation of Transforming Principle (DNA) of Hemophilus Influenzae. The sensitivity of the transforming principle (desoxyribonucleic acid or DNA) from streptomycin-resistant Hemophilus influenzae to different ionizing radiations is being measured in an in vitro system. The purpose of this experiment is twofold: (1) to study the problem of relative biological effectiveness of radiation on biological systems in vivo (such as the mechanism of genetic alteration), and (2) to help elucidate the mechanism by which ionizing radiation affects molecules of this nature in vitro.

In vitro exposures of the Hemophilus transforming principle have been made using the following types of radiation: (1) 250 kvp X rays; (2) Co^{60} gamma rays; (3) monoenergetic 14.1 Mev neutrons produced by the Cockcroft-Walton accelerator; (4) fission neutrons from a "power" run of Godiva; and (5) fission neutrons from a "burst" of Godiva.

The test system used to measure the inactivation of the transforming principle (TP) was the decreased ability of a known dilution of TP to transform H. influenzae Rd cells to streptomycin-resistant cells. Preliminary results for all radiations tested indicate an RBE of slightly less than 1 when 250 kvp X rays are used as the base line.

h. Studies with Transplantable Leukemia. The effect of total body irradiation on tumor immunity is to decrease host resistance to a heterologous tumor transplant. Several studies using transplantable AK leukemia have been designed with the purpose of elucidating the mechanism of the effect of irradiation on tumor immunity. Some of these studies are as follows:

(1). The effect of spleen or marrow shielding on the incidence of AK leukemic implants in C57Bl and Strong A strains of irradiated mice.

(2). The protective effect of pre-immunization against AK leukemic implants in irradiated C57Bl, Strong A, and Swiss mice.

(3). The immunization response following sublethal (200 and 300 rads) irradiation in C57Bl and Strong A mice.

(4). The recovery rate of resistance to AK leukemia in

sublethally (200 to 500 rads) irradiated C57Bl and Strong A mice.

(5). Preliminary studies on the development of a splenic homogenate "vaccine" from irradiated and nonirradiated CFW Swiss mice against AK leukemia in AKR mice.

(6). Homologous bone marrow transplants from C57Bl mice into lethally irradiated AKR mice were attempted in an effort to change the susceptibility of AKR mice to AK leukemia. The opposite experiment of intravenous injection of AKR bone marrow into irradiated C57Bl strain of mice was also performed. Incompatibility between these homologous strains of mice resulted in relatively little or no protection from the bone marrow injected.

i. Renal Hypertrophy as an Index of Physiological Age. In an attempt to relate aging and radiation effects, hypertrophy of the remaining kidney after unilateral nephrectomy in mice is being investigated as a possible test system. Hypertrophy is related inversely to X-ray dose, and the literature indicates the same relation to age. This effect of age will be reinvestigated as suitable experimental animals become available.

j. Effect of Radiation on Serum Enzyme Levels. Radiation-induced increases in serum enzyme levels have been investigated as a possible index of tissue injury. It was concluded that increases in serum glutamic-oxalacetic transaminase activity are not unique but are typical of a general early radiation effect involving an unknown but presumably large number of cytoplasmic enzymes, cofactors, and other

essential cellular constituents. Rapid elimination of serum enzyme activity appears to be a physiological function of the liver, resulting in the excretion of large amounts of intact enzyme into the bile. The excretory capacity of the liver prevents accumulations of enzyme activity from persisting in the peripheral circulation and renders the use of serum enzyme measurements for the quantitative estimation of radiation injury impractical under conditions of normal hepatic function. These data are now in manuscript and have been used as a Master's degree thesis.

k. Metabolism of the Alkali Metals in Five Mammalian Species. Studies on the retention and excretion of alkali metal radionuclides by five mammalian species (mouse, rat, dog, monkey, and man) were carried out using in vivo counting techniques. At the end of the year the retention pattern of cesium had been followed for 657 days in one man and for 345 days in several others. Regression equations were calculated from experimental data to show a log-log relation between body surface area and the time required for the various mammals to lose the first 50 per cent of an acutely administered body burden of Na^{22}, K^{42}, Rb^{86}, and Cs^{134} or Cs^{137}. The biological half-time ($BT_{1/2}$) values, as calculated from the resulting regression equations, were much closer to the actual experimental measurements than were values taken from the literature.

Work was begun in June to study the retention and excretion of several gamma-emitting alkaline earth radionuclides by mice, rats, monkeys, and dogs by means of the in vivo counting technique.

l. Effect of Irradiation of Each Generation of Mice on the

Vigor and Reproductive Potential of the Line. The late somatic effects of exposure to ionizing radiation are fairly well documented. Little information exists on the effects of exposure of each generation on the F_1, F_2, ... F_n generation in terms of general vigor (as measured by mean life span) and reproductive potential (as measured by the mean number of viable offspring per parent). A small-scale study has been set up. The general approach consists of exposing each filial generation to preselected doses of radiation and observing each generation for effects on life span and reproductive potential. It is not anticipated that any conclusions can be drawn for several years.

m. Determination of Body Water and Fat in Steers by Means of the Tritium Dilution Technique. One of the problems facing the cattle industry is the breeding of strains of beef cattle which gain weight well but which put on the weight mainly as protein rather than fat. In order to evaluate the results of such a breeding program, it is necessary to have a nondestructive test for per cent body fat. This program was undertaken to crosscheck the results of body fat determinations by means of the antipyrene dilution technique, the tritium dilution technique, and chemical analysis of the carcasses. It appears that the tritium technique agrees reasonably well with the others and has the advantage of simplicity and nondestructiveness.

n. Rate of Repair of Radiation Damage in Mice. Experiments were continued on a restricted scale (due to the Salmonella epidemic in the mouse colony) on the nature of the repair mechanisms in mice. A

comprehensive search of the literature for data bearing on the problem was made. A new theory, which apparently relates many superficially different phenomena, was formulated. Further testing of the theory is essential before it is propounded.

5.2.5 Radiopathology Section

a. Service Program. About one-half the time of the Section was devoted to service for the other sections and to support of the Pathology Department of the Los Alamos Medical Center. These services consisted of photographic documentation of experimental results; technical photographs for manuscripts; microphotography; radioautographs; lantern slide production for seminars and other lectures; special histological preparations, such as nondecalcified bone sectioning for plutonium (and similar alpha-emitting elements) radioautographs; radioactive chromatogram preparations; pathology services; and determination of leaching in soil samples. Histological preparations in surgical and anatomical pathology for the Los Alamos Medical Center were also made.

b. Application of Low Level in vivo Counting Techniques to Clinical Investigations. The first project in this program was an attempt to apply the use of the whole body counter, the arm counter, and low level counting of large volumes of urine (in addition to the commonly used sodium iodide crystal well counter) to the determination of the survival time of circulating erythrocytes in health and disease. To date, 32 humans (of whom 7 were well and the other had diseases that might be expected to influence erythrocyte survival time), 6 dogs, 30 rats, and

17 monkeys have received autogenous erythrocytes tagged with Cr^{51} and their RBC survival times studied by the above techniques. In some of the cases, it was not possible to use all four techniques simultaneously. The study of the results has proven to be more complicated than was anticipated. Half-times for the survival of the chromium tag were determined statistically for the individuals and groups.

Total Cr^{51} retention as measured by the whole body counter gave numerical results similar to those obtained using the peripheral blood study only. The whole body results are similarly clinically useful but easier to do. Where a whole body counter is not available, study of the rate of urinary excretion and the total accumulated urinary excretion can be used to replace the whole body counter. Determinations made by counting only a forearm were too variable (as they were done) to afford similar confidence in the numerical results. Using the arm counter as a whole body counter for rats, however, resulted in good reproducible results comparable to those obtained with man, dog, and monkey in the human counter.

Whole body counting has revealed also that there is a sequestration of the Cr^{51} tag in the reticulo-endothelial organs, particularly the spleen (in health and disease), in human as well as the other mammals studied. In addition, incompleted studies seem to indicate that the rate and extent of this sequestration are altered by species and diseases and give a better measurement of the degree of intravascular destruction of circulating erythrocytes than was available previously.

5.2.6 Veterinary Section

a. Mouse Production. Breeding stock has been developed for the production of LAf_1, C57Bl, AK, CFW, and RF strains of experimental mice. Adequate numbers for setting up large chronic experimental programs are not yet available.

b. Other Animal Stocks. Adequate numbers of rats, dogs, monkeys, guinea pigs, and rabbits are being maintained to meet routine program demands.

5.3 Future Programs

5.3.1 Biochemistry Section

a. Acute and Chronic Irradiation Effects of Te^{204}, Rh^{104}, W^{185}, and Cs^{137}. A re-evaluation of the maximum permissible levels in air and in the biosphere will be made for these four nuclides, utilizing the literature and experimental determinations of the chronic irradiation effects of Cs^{137} and possibly of the other nuclides.

b. The Measurement of Fallout Isotopes in Bone. An evaluation of the radiation dose of isotopes other than Sr^{90} in bone will be made by determination of total beta activity by the method described above, and separate determination of Sr^{90} by radiochemical analysis will be made. The implication of this finding is that bone-seeking beta emitters may contribute a much greater integrated radiation dose to the bone marrow than has been thought if the introduction of the relatively short-lived isotopes is continued at frequent intervals.

c. Biochemical Effects of Aging. The reported effects of

aging have for the most part been small and unpromising. In hope that biochemical methods of measuring response to stress may show a greater change as a result of aging, measurements of the effects of X rays on adrenal cholesterol levels in rats of various ages will be made. Other forms of stress will also be used. When a method is found that is sufficiently sensitive and reproducible, it will be used to measure the aging effect of chronic whole and partial body X irradiation.

The turnover of the metabolically inert amino acid, α-aminoisobutyric-C^{14}-acid, will be evaluated as a possible index of aging. If a suitable relation between age and turnover is found, then the technique will be applied to studies of radiation-induced "aging."

d. Immediate Effects of X Irradiation on Nucleotide Synthesis. Recent progress in several laboratories on isolation of subcellular fractions capable of synthesizing nucleic acids provides for the first time the possibility of studying the effect of irradiation on DNA synthesis in vitro. Tritium-labeled thymidine and adenylic acid-C^{14} will be used to measure DNA synthesis. Radiation of the whole animal will be compared with radiation of subcellular fractions. These methods will also be applied to tissue culture studies.

e. Relation of Cholesterol and Essential Fatty Acids to Radiation Damage. Deuel et al. [Science, 117, 254 (1953)], showed that rats fed a fat-free diet are more susceptible to radiation than those given supplements of linoleic acid. Our studies have shown that radiation decreases cholesterol concentration in rat liver while

increasing its rate of synthesis, suggesting an increased rate of cholesterol utilization. Since cholesterol is esterified with linoleic acid in plasma, there may be a relation between these two substances in radiation response. Effects of high cholesterol diets, with and without added linoleic acid, on radiation sensitivity will be investigated.

5.3.2 Biophysics Section

a. Large Volume Liquid Scintillation Counter for Geneva Exhibit. A large 2π liquid scintillation counter (described in Section 5.2.2) will be constructed for the Geneva Conference on the Peaceful Uses of Atomic Energy.

b. Improved Large Volume Detector for LASL. It is expected that the whole body counter described in Section 5.2.2 will be completed.

c. Improved Low Level Gamma Spectrometer Facility for LASL. The present steel room has adequate space for a second and much improved sodium iodide crystal spectrometer. One will be built using a larger crystal and a mosaic of photomultiplier tubes. It will be engineered for total body counting and for body scanning capability.

d. Chemical Dosimetry (in Cooperation with Organic Chemistry Section). The major effort of the Organic Chemistry Section will be directed toward the study of organic chemical dosimetry both on a fundamental and applied program basis. Attempts will be made to develop tissue-equivalent dosimeters and those with differential neutron and gamma-ray sensitivity. These will be tested at the various radiation facilities of the Los Alamos Scientific Laboratory.

e. Field Studies for N Division Reactor Operations in Nevada. Chemical and threshold foil systems will be used in forthcoming N Division reactor operations at the Nevada Test Site to measure neutron flux, neutron dose and dose rate, and gamma dose and dose rate. This will involve considerable developmental work on chemical dosimetry to adapt it to the specific field uses.

f. Neutron Dosimetry and Calibration with Plastic Phantoms. LASL is obtaining two hollow plastic phantoms of a standard man. These phantoms will be filled with tissue-equivalent fluids and used for neutron depth dose studies and for total body neutron dose studies by measuring induced activities in the whole body counting facility.

5.3.3 Organic Chemistry Section

a. Testing of Scintillators. In 1958, the screening program for new primary scintillation solutes will taper off, and the emphasis will switch to intensive study of the most interesting compounds already screened. This will involve measurements of light output versus concentration in toluene, from which fundamental constants will be calculated, determination of absorption and emission spectra, and interpretation of the results to better establish relations between molecular structure and ability to scintillate.

b. World-wide Contemporary Survey of C^{14} Activity in Plant Life. Enough C^{14} determinations will be obtained for camphor, lemon grass oil, sweet orange oil, and turpentine to allow estimation of the significance of geographic location, botanical species, and location in

time for the distribution of natural and nuclear-weapon-produced C^{14} activities.

c. Labeled Organic Synthesis Program. Synthesis of the following labeled organic compounds is contemplated: 2-amino-2-methylpropionic-C^{14} acid; 2,4-tolylenediisocyanate-C^{14}_2; C^{14}_1-vitamin B_6; and H^3-thymidine.

It is proposed also that certain dyes and tetracycline structures which concentrate in neoplastic tissues be labeled to high specific activity with H^3 or C^{14}, so that the ionizing radiations of these isotopes may be able to produce selective damage to these tissues.

d. Chemical Dosimetry. Detailed chemical investigations of the response of existing chemical dosimeter systems to a variety of radiations will be made. A study of the radiation decomposition products may lead to improvement in present systems, particularly in their relative response to fast neutrons versus gamma rays. Simple empirical changes in the present systems will be tried. Dosimeters will be supplied for use by other sections and the feasibility of tissue-equivalent chemical dosimeters will be studied.

5.3.4 Radiobiology Section

a. Life Span Studies. The studies on chronic effects of radiation exposure which are described in Section 5.2.4 will be continued. An increasing amount of time will be spent on computations and evaluation of the data.

b. Effect of Single Doses of Gamma Rays and Fission Neutrons

on the Life Span of the F_1 and F_2 Generations of Mice. The parent population will be exposed to graded doses of gamma rays or fission neutrons and after a suitable delay will be bred. The life span of the F_1 and F_2 generations will be measured.

c. Effect of Single Doses of Neutrons and Gamma Rays on the Life Span of Mice. This study, which met an untimely end with the Salmonella epidemic a year ago, will be repeated as soon as enough healthy mice are accumulated. In essence, the experiment consists of exposing groups of 150 mice to three dose levels of gamma rays or fission neutrons and allowing them to live out their life spans. An attempt will then be made to relate life shortening to radiation dose.

d. Effect of Repeated Doses of Neutrons and Gamma Rays on the Life Span of Mice. This study is similar to the one described above except that the mice will be exposed weekly for 25 weeks.

e. Transforming Principle. The in vitro irradiation of Hemophilus influenzae transforming principle (DNA) will be continued. In an attempt to correlate RBE as a function of linear energy transfer (LET), radiations which are being considered for future exposures are: (1) alpha particles from plutonium, polonium, or radon; (2) monoenergetic beams of neutrons (or electrons) from the large Van de Graaff accelerator and protons from a cyclotron beam.

In order to help elucidate the mechanism by which ionizing radiation affects molecules of the nature of DNA in vitro, irradiated

transforming principle labeled with C^{14} or P^{32} will be studied with the use of chromatographic techniques.

f. Studies with Transplantable Leukemia. Studies of the immune mechanisms responsible for the breakdown of resistance to leukemia following irradiation will be continued. Such studies will include: (1) more accurate measurements of the recovery rates of resistance to leukemia in irradiated heterologous strains of mice; (2) more precise confirmation of the preliminary results of developing a spleen homogenate "vaccine" to AK leukemia in Swiss mice; and (3) completion of the study of the effects of small (sublethal) doses of radiation on the immune response to AK leukemia in heterologous strains of mice.

g. Studies of Radiation-induced Physiological Aging. At present the concept that radiation produces premature aging is based solely on life tables. No unequivocal evidence of physiologic aging has been demonstrated. The following test systems will be evaluated as indices of age and if applicable will be utilized in studying radiation "aging." Renal hypertrophy (following unilateral nephrectomy) will be measured in mice at the ages of 3, 6, 12, 18, 24, and 30 months. If a quantitative relationship between hypertrophy and age is found, then the extent of "aging" induced by radiation will be measured. The accumulation and loss of calcium in the liver after an intraperitoneal injection will be similarly evaluated as a potential index of aging.

h. Response of Mice to Cold as an Index of Aging. There is some evidence that suggests that resistance to cold decreases with age.

This phenomenon will be investigated and, if it proves a suitable index of aging, will be applied to the study of radiation-induced aging.

i. Acute Effects of Radiation Doses Delivered at Rates Diminishing with Time. With existing facilities it is possible to simulate radiation fields such as those encountered for various times of entry into a fallout field (i.e., dose is proportional to $T^{-1.2}$). The effectiveness of radiation delivered in this manner will be compared to the effectiveness of radiation delivered in brief single exposures or in continuous exposures at constant intensity.

j. Toxicity of Inhaled Tritium Water Vapor in Mice. Mice will be exposed to high concentrations of tritium water vapor in a closed system in order to evaluate the length of time required to accumulate a lethal level of tritium in the body.

k. Absorption of Plutonium Oxide through Skin Abrasions in Rabbits. A study will be made to determine whether plutonium oxide is absorbed to an appreciable extent through abrasions in the skin, whether it is trapped in the healed area, or sloughed off in the eschar when the eschar is lost.

l. Continued Studies on the Metabolism of Radionuclides. These studies will include the following: (1) study of the retention and excretion of several gamma-emitting alkali earth radionuclides by man; (2) distribution of several alkali metal radionuclides in the tissues of the rat at various times after oral administration; (3) the relation between whole body retention and the age of the animal at the time of

administration, using radiocesium in the rat; and (4) continuation of the general re-investigation of the metabolism of all biologically significant gamma-emitting radionuclides in the periodic table, using the in vivo whole body counting technique.

5.3.5 Radiopathology Section

a. Clinical Applications of Low Level in vivo Counting Techniques. The Laboratory's development of excellent low level in vivo counting facilities has opened up several possibilities of application of radioactive tracers to clinical investigations. Among those that will be studied in the future by the Radiopathology Section are the following:

(1). Completion of chromium-RBC survival study.

(2). Study of the dynamics of iron utilization in health and disease by this method.

(3). Study of chromuim-labeled RBC sequestration in the human spleen in health and disease with the use of the "giant" sodium iodide crystal.

(4). Study of the applicability of the whole body counter (human counter versus giant crystal) to iodine binding in thyroid disease and liver disease.

(5). Study of the dynamics of the uptake of cobalt-labeled B_{12} in pernicious anemia, hypochromic anemia, and normal patients.

b. Histopathology of Acute Beta Radiation Burns. A further attempt will be made to determine the cause of the prolonged induction

period of radiation skin "burns" in order to augment surgical and medical care of this condition. The characteristics of acute beta burns as a function of the beta ray energy will be studied also.

c. Histochemical Approach to Radiation-induced Pathological Changes. Specific histochemical staining techniques will be applied to the study of acute and chronic pathologic changes following beta, neutron, or gamma radiation exposure.

d. Pathology of Radiation Damage. This program was de-emphasized as a result of the amount of time and effort required by the chromium study and other activities. The study of the peculiar gastric lesion of mice exposed in the field to neutrons will be reactivated.

e. Documentation of Completed Studies. A number of the past year's programs are complete and will be documented during 1958, among which are the following:

(1). Correlation of proteolysis with pathologic changes from radiation exposure.

(2). Radiation-induced changes in the proteolytic-inhibiting systems (their importance to the pathologic changes).

(3). Acute and chronic pathology of the irradiated gastrointestinal tract.

f. Section Services. Histology, photography, autoradiography, pathology, and other services to the rest of the Group and to the Los Alamos Medical Center will be continued.

5.3.6 Veterinary Section

a. Mouse Breeding Program. The Veterinary Section plans to build up the mouse breeding potential to the point where 1800 LAf_1, 1800 C57Bl, and 1800 RF experimental mice can be supplied per month. The breeding potential for CFW and AK mice will be maintained at a level to meet the experimenters' demands.

b. Design of Additional Animal Quarters. Considerable time will be spent designing the new animal facility anticipated in the FY-1959 budget.

Chapter 6

GROUP H-5, INDUSTRIAL HYGIENE

By Harry F. Schulte, Group Leader

6.1 General

The total quantity of sampling and analytical work of Group H-5 has not changed greatly over the past several years. However, the amount of work involving beryllium has increased considerably, while procedures involving uranium have decreased. Extensive studies by the Group on regular uranium operations have been completed and all routine sampling for uranium has been taken over by Group H-1. However, N Division is now requiring fabrication of uranium in new forms using new processes. These operations will require detailed study during the coming year. Group H-5 has been working with various groups in N Division, K Division, and the Sherwood Program in planning facilities that will have as much health protection built in as possible. However, since so much is unknown about the actual details of these operations, as well as those of certain other Divisions, many unexpected problems are certain to develop.

The change from counting to a nuclear track method for the

determination of plutonium in urine has caused a number of changes in the Group's activities. Physically, it has meant the release of a large number of counting instruments and a relief from the constant and difficult effort to do extra low background alpha counting. This has permitted the use of a much smaller room for counting and the old counting room has been traded for an additional laboratory which is being equipped to handle such high level samples as might have to be analyzed as a result of an accident. With the very sensitive nuclear track method, it is even more imperative that high level or contaminated samples be kept out of the laboratory.

A more important result of the new alpha track technique is the increased assurance of detecting slight exposures to plutonium. The new method will detect about 1/20th of the quantity of plutonium that the old method would detect, or about 5×10^{-13} gram of plutonium in a 24 hour urine sample. With this new procedure, it should be possible to learn much more about the rate of build-up of stored plutonium at levels well below the permissible body burden.

In 1956 a new section, the Engineering Development Section, was organized to carry out a number of research and development projects which had been continually delayed because of the pressure of routine work on the Field Section. At the same time, more specific arrangements for handling research and development work in the analytical chemistry field were made within the Laboratory Section. As a result, a number of such projects were completed during the past year. These

include the design and construction of a dust or test chamber, an economic study of air cleaning costs at Los Alamos, a study of atmospheric pollution from the DP West exhaust stacks, and an evaluation of half-mask respirators. In the chemical field, projects were completed on new methods for the determination of thallium, trichloroethylene, RDX, and bromides. Improvements have been made in methods for methanol, uranium, cyanides, and cadmium. Work is still proceeding on a number of other methods and others will be undertaken when time permits.

A critical evaluation of all respiratory protective equipment used at Los Alamos has been a major project during the past year. This has involved not only the study of half masks mentioned above but training of personnel in the proper use of all types of respiratory protective equipment, inventory and periodic inspection of emergency equipment, improved techniques for cleaning and maintenance of respirators and masks, and a start on a detailed evaluation of full face masks.

Educational activities of the Group continued to be very important. Articles were written for the Safety Newsletter, as well as for technical journals and documents. Talks were given to foremen, AEC inspectors, and various Groups and Sections at Los Alamos. Members of the Group have been very active as officers and committee members of the American Industrial Hygiene Association, the American Conference of Governmental Industrial Hygienists, the Health Physics Society, and the Bio-assay and Analytical Chemistry Group.

6.2 Selected Activities

As usual, it is difficult to pick out representative examples of the Group's activities. Much of the important work of the Group consists of a large number of relatively small projects, all of which are important in enabling some segment of the Laboratory to perform its function safely. The following have been selected as illustrating the varied types of activities of the Group.

a. Beryllium. The use of beryllium increased greatly at Los Alamos during the past year. In particular, work in the Beryllium Shop was greatly increased, necessitating much more attention to air sampling, ventilation control, and good housekeeping. The air concentrations of beryllium exceeded the permissible level on several occasions during the removal of turnings from the lathe and on one occasion during hand-polishing on a work bench. No excessive concentrations occurred during routine work.

Group CMB-6 initiated many new types of work with beryllium metal during the last half of the year. These consisted of various types of welding and soldering, furnace fusing, cutting, grinding, polishing, and miscellaneous operations. In general, adequate ventilation was designed and installed before each operation was begun. Where this was not possible, respirators were provided for the operators until ventilation could be installed. No excessive exposures resulted.

Other beryllium work included preparation of beryllium targets by Group P-9, silver soldering on beryllium by Group W-1, test firing of

beryllium pieces by Group GMX-4, assembly work on beryllium blocks by Group N-2, and inventory and cleanup of beryllium stock by Group SP-3. Consultation on the health aspects of these operations was given and air samples were collected and analyzed.

b. Trichloroethylene. This material is used by Graphic Arts to clean lithograph machines and rolls. Complaints of illness and headaches in this department led to an extensive investigation. Air sampling indicated that an appreciable amount of trichloroethylene was in the air but concentrations were not in excess of permissible levels. However, two arc lamps in an adjacent section of the room may have caused decomposition of the solvent in the air due to ultraviolet light and also emitted ozone and oxides of nitrogen themselves. A new urine analysis procedure for trichloroacetic acid showed that the operators were absorbing some trichloroethylene. The local exhaust ventilation on the arc lamps was improved and similar ventilation installed over a portion of the lithograph machines. The illness of the operators ceased, and there was a continuous decrease in the trichloroacetic acid in the urine samples. This somewhat makeshift arrangement was satisfactory until the machines were moved into new quarters in the Administration Building. In the new quarters, better local and general ventilation was provided, and the arc lamps were installed in a separate room. There have been no further complaints of illness.

c. Plutonium Analysis. During the year a new method for the determination of plutonium was adopted. This involves ashing, solvent

extraction, coprecipitation, electroplating, and final determination by radioautographing the electroplated disk. This eliminates the necessity of electronic counting but substitutes microscope counting of alpha tracks. The method was developed at Hanford but some improvements were made here. Extensive comparisons of the old and new methods made before adoption showed no discrepancies within the limit of sensitivity of the old method. Studies are now being made in an attempt to eliminate the ashing procedure, which is lengthy and involves the evaporation of large volumes of unpleasant and highly corrosive liquids. Studies are also being made on the specificity of the method so that all alpha emitters can be individually determined.

d. Respirators. Thirteen makes of dust and fume half-mask respirators were evaluated from the standpoint of comfort, face fit, interference with vision, resistance to breathing, and ease of cleaning. Following this, four masks were selected for inclusion in Safety Stock. Using the newly built test chamber, the Group is testing these four on all persons required to wear respirators. No individual mask appears to fit more than 80 per cent of personnel and 5 per cent cannot be fitted with any mask. Similar tests are being run on full face masks, but here there is a limitation on operators required to wear glasses.

The face piece of the standard Air Force oxygen mask appears to have many advantages from the standpoint of comfort and face fit. Tests will be made to determine whether its superiority is sufficient to justify further development work to convert the mask into a half-mask

respirator. All other types of respiratory equipment are being examined critically. Training sessions were held during 1957 on the proper use of some of this equipment. Much work remains to be done in this broad field.

e. Trade Name Products. Many products used in the Laboratory are identified only by trade names. Their composition and hence their toxicity are unknown. As much published data as possible has been collected on these products, but at least half of the trade name products stocked at Los Alamos are not included in any published trade name index. For many years the Industrial Hygiene Group has been performing analyses on some of these products. The acquisition of a gas chromatograph during the past year has made the analyses of volatile solvents simpler and much more rapid. Arrangements have been made for Group SP-3 to submit such materials to Group H-5 for health evaluation before placing them in stock. When the products contain toxic materials, acceptable substitutes are suggested. If no substitute is available, the material is placed in stock but its usage is limited to locations where it can be used with appropriate precautions. Users are required to confer with Group H-5 on ventilation or any other control measures which may be required.

f. Plastics. Three types of plastics presented health problems during the year: foam plastics, epoxy resins, and Teflon. The foam plastics are prepared from tolylene diisocyanate, which is very irritating to breathe and may produce severe reactions resembling asthma.

During generation of the foam considerable quantities of this material may escape into the air. Adequate ventilation has been provided in the working areas and air concentrations were kept below the permissible level of 0.1 ppm. Some minor exposures did occur as a result of short term releases of vapor.

The epoxy resins, which appear to have numerous applications, primarily produce an extremely severe type of dermatitis. Two bulletins were issued warning of the hazards from these materials, the second being issued after several cases of dermatitis had occurred. Fifteen groups known to be handling large quantities of epoxy resins were surveyed, and the exhaust ventilation was improved in several of these working areas. Health talks were given before two groups where housekeeping had been poor.

Teflon and Kel-F are fluorinated plastics which break down in the presence of heat to release toxic gases. In some cases a fume or condensation of small particles which causes chills and fever similar to "metal fume fever" is released. Although no known overexposures resulted from the use of these materials, members of the Group participated in several conferences on the proper method of handling these materials in the presence of heat.

g. Ventilation. A large percentage of the health problems dealt with by the Group involve some aspect of ventilation. During the past year a number of large ventilation projects were handled in cooperation with Groups ENG-2 and H-1. These included final review and approval of

plans for the new Sigma Building, a complete revision of the ventilation system at DP West, work on the ventilation system in the new Radiochemistry Building, evaluation of ventilation at the new Tuballoy Shop, and revision of ventilation of the old Tuballoy Shop for use with oralloy. Some of these projects will carry over into 1958.

Also during the year a routine program of checking of all ventilation hoods was started. A great deal of this work has been done in the past but now it has been placed on a regular scheduled basis and it is hoped that every hood will be checked at least once a year. A very large number of ventilation studies of smaller scope were completed and, in most cases, pertinent data was supplied to the Engineering Department.

6.3 Future Program

Group H-5 is primarily a service organization, and hence the variety and scope of its activities are to a considerable extent determined by the nature of the activities of the Los Alamos Scientific Laboratory itself. Much of the work consists of an endless series of small jobs involving brief exposures to a wide variety of materials. The nature of this work is completely unpredictable. The local use of beryllium is still expanding and will certainly be important in 1958. Uranium and plutonium in new forms, resulting from the activities of K Division and N Division, respectively, will present new health problems. The Sherwood Program has encountered relatively few health hazards as yet but this may change completely as progress in the field continues. The programs of K and N Divisions are also leading toward handling large high intensity

gamma sources on a scale seldom encountered even at Los Alamos. "Hot" cells and similar facilities will have to be constructed and much information is needed on the proper design and ventilation of this equipment. Meanwhile, it is necessary to keep fully informed about these various programs so that effective assistance can be given when needed without undue delay.

The study of personal protective equipment will extend at least through the coming year. The continuous need for improved analytical methods has already been mentioned, and work will be undertaken on methods for enriched uranium, thorium, strontium, oxides of nitrogen, and ozone.

There is a need for a closer study of our methods of air sampling. The efficiencies and limits of sensitivity of some of these techniques are not well known. The new test chamber recently completed will be of great assistance in such investigations. Further studies on the particle size of aerosols generated by process operations will be undertaken. Here, too, the test chamber will be an important piece of equipment.

6.4 Statistical Summary

Air samples were collected or field tests were made for the following:

Metals and Salts		Other	
Beryllium	1077	Arsine	10
Cadmium	7	Background samples	147
Lead	5	Hydrogen cyanide	36
Mercury (labs checked)	44	Nitrogen oxides	2
Plutonium	394	Ozone	6

Metals and Salts - Cont'd	
Uranium, enriched	15
Uranium, normal	210
Zinc	3

Solvents	
Benzene	8
Methyl alcohol	3
Trichloroethylene	63
Toluene	18
Tolylene diisocyanate	10

Other - Cont'd	
Phosgene	22
Silica	3
Trinitrotoluene	51

Plans Approved	65

Sanitation	
Water samples	268

Other samples collected include more than 600 miscellaneous materials, such as swipes, soil, fallout trays, solvents for analysis, and respirator filters.

The following analyses were completed:

Air Samples	
Beryllium	1332
Cadmium	18
Chlorinated hydrocarbons	172
Lead	28
Methyl alcohol	3
Ozone	9
Tolylene diisocyanate	10
Trinitrotoluene	57
Uranium	2
Zinc	4

Miscellaneous	
Alpha activity in rain water	7
Beryllium	
Fallout trays	73
Soil	62
Swipes	112
Other	33
Methemoglobin in blood	2
Plutonium	
Soil	85
Other	10

Urine Samples	
Americium	54
Arsenic	7
Cadmium	5
Curium	2
Dysprosium^{165}	1
Fission products	13
Gross activity (misc.)	24
Lead	24
Mercury	77
Methyl alcohol	10
Plutonium	2572
Strontium^{90}	2
Radium	2
Thorium	15
Thallium	15
Trichloroacetic acid	187
Trichloroethylene	19
Tritium	1724
Uranium (fluorometric)	1184
Uranium (radiometric)	259

Miscellaneous - Cont'd

Tritium in water	18
Uranium	
Fallout trays	238
Soil	73
Other	5

Chapter 7

GROUP H-6, RADIOLOGICAL PHYSICS

By Harvey I. Israel, Group Leader

7.1 General

As in the past, much of the talent and effort of the Group was devoted to problems presented to it by others. These problems came from Groups within the Health Division as well as from other Divisions. Even some organizations outside the Laboratory received the benefits of the Group's services. Other problems more or less regarded as our own were dealt with as the press of business permitted.

As usual, the Group was considerably involved in test activities. The involvement promises to continue in the coming year. During Operation Plumbbob, individuals from the Group were at NTS as experimenters, as members of the Rad-Safe organization, and as members of the Fallout Prediction Unit. Some of these people also served on the Test Manager's Advisory Panel and on subcommittees of the NTS Planning Board. The Group also had actively participating representation at all safety tests held at NTS.

Joining in conferences at Albuquerque and Fort Leavenworth, we

discussed with the military the problem of fallout before and after the fact. Looking at the same problem from a civilian point of view, members of the Group consulted with Office of Defense Mobilization personnel at Fort Collins, Colorado, during the FCDA exercise Operation Alert.

7.2 Section Activities

7.2.1 Special Problems Section

A 300 kv constant potential X-ray machine was acquired during the year. By the year's end, the equipment was operating, though not to the complete satisfaction of those concerned. It is expected that the difficulties will be corrected early in 1958. Paralleling the acquisition was the design and construction of auxiliary apparatus, such as special control circuits and tube housing. That work will continue in the coming year. When completed, the apparatus will be a convenient, controlled source of radiation that can be used for such studies as the energy dependence of radiation detectors and the calibration of standards. The machine has already demonstrated its usefulness as a means of conveniently checking the calibration of field instruments.

As is normal, a number of problems were brought to the Section for solution. No attempt will be made to list or describe all of them, but a few will be mentioned to give some idea of their nature. To assist Group GMX-11 in planning their new facility, the Section estimated the radiation flux from a proposed linear accelerator. A second example was the problem of determining the amount of plutonium in a contaminated wound. That sufficiently small amounts can be detected

by a scintillation detector has been shown. Studies of various detector arrangements have been made and are continuing in order to determine the most reliable and efficient one. A final example is the problem of working out a method for the monitoring of pulsed neutron sources. This requires the development of a direct-reading device that will indicate the integrated effect of a succession of separate, short exposures. Studies have indicated the feasibility of a solution by modification of existing instruments. The problem is being attacked along this line, but the existence of other solutions is not being overlooked.

In all these problems one can discern a connection with the field of health physics instrumentation. Working directly in the field, the Section has developed an improved, modernized version of the much used Model 100 survey instrument. This work was done in association with Group P-1. Another effort in this area has been the design and construction (not yet completed) of an extrapolation ionization chamber. Work on this instrument necessitated the development of a suitably machinable conducting plastic.

The Section further developed a new capability during this period--the capability of programming problems for the IBM 704. As a result, a number of calculations of varying complexity were done. They ranged from the computation of gamma-ray absorption coefficients for all elements (obtained by interpolation in and extrapolation of existing tables) to the determination of the relative amounts of fluorescence and scattered radiation to be expected from various arrangements of a

radiator in the beam of the 300 kvcp X-ray machine. Calculations were also made of the albedo of neutrons from scattering materials in the vicinity of a source or detector. All these programs were written to satisfy the Section's needs and, in addition, a program was written for Group H-4 to enable them to evaluate the large amount of data they are obtaining from their crystal spectrometer.

7.2.2 Nuclear Field Test Section

Much time was taken up by matters connected with tests and test series--past, present, and future. Paralleling similar efforts by other AEC organizations, the Section made a comprehensive study of all off-site radiation survey and exposure records for the region around NTS, covering the period up to October 1956. The result of the study was a table of cumulative exposures for inhabited localities in that area. A map showing cumulative isodose lines in the NTS area was also prepared, and all this material was furnished the NTS Planning Board. During Operation Plumbbob, the Section furnished a rad-safe advisor for the LASL test group. The same service was given at safety tests. For the forthcoming Pacific tests, the Section has been working closely with the JTF-7 Radiological-Safety Officer in many phases of planning the rad-safe programs, procedures, and requirements. The Section will also participate in the carrying out of those plans.

Because of the appearance of activity in local precipitation during test periods at Nevada, it seemed advisable to initiate daily collection of precipitation samples. This was started at the beginning

of the year and is continuing. An outsized rain gauge was designed which would collect about a liter of water for each 0.1 inch of rainfall, thus guaranteeing that in most cases sufficient liquid would be collected to permit laboratory analysis for activity.

The rainwater analysis has become a routine that has been added to the other water analyses that are regularly performed by the Section laboratory. These routine procedures were carried on without interruption despite the fact that during October and November the laboratory was being displaced from Wing 2 of CM Building and being resettled in the basement of the same building.

The addition of a soil scientist to the Section during the latter half of the year made possible increased attention to the problem of the behavior of radioactive materials (fission products, for example) in soil. Studies in this field will lead to better answers as to what has happened to active material that has been buried in the past and will help in formulating plans for future underground disposal of radioactive waste. Investigations of the adsorptive and retentive capacities of local soils for radioactive materials has been started. Through this work, it is hoped to get some idea of the mechanism by which such materials are held to soil particles and to get some idea of the circumstances under which the retentive power of the soil is weakened or destroyed.

7.2.3 Meteorology Section

All meteorological activity is divided into two parts,

operational and research, for each of which the Section has a member. In addition, casual help has been used during the year to attack another problem, that of reducing to an orderly and usable form the mass of local observations that have been accumulated. Wind and temperature data are being compiled so that eventually climatological summaries can be produced. This work will have to go on for some time before the backlog of data will have been taken care of.

Operationally, the Section has carried out normal weather station activities and has supplied field meteorological support throughout the year for several groups that requested the service. Such support includes activities at Bayo Canyon and R Site.

In the research field, the Section has been particularly interested in the possibility of developing a method of weather analysis and forecasting which would make use of the IBM 704 computer or similar machines. The method would be particularly applicable to tropical Pacific areas and would entail an empirical rather than a numerical approach. With the cooperation of people outside the Section, such a method has been worked out and completely programmed. Present plans call for a test of the method at the coming test series. This is being done only for the purpose of evaluation. If favorable results are obtained, consideration will be given to making the method operational.

A start has also been made on a second method. Here, a statistical approach is used. Following a study of Pacific data, an attempt will be made to evolve a regression equation which can be used

for forecasting. Such forecasts would be point forecasts, as contrasted with the area forecasts that may be obtained from the first method, but both types are needed.

If these efforts lead to success, better and more accurate weather forecasts will result. Through them, better and more accurate predictions can be made of the fallout to be expected following the explosion of nuclear devices. Fallout is a subject with which the Section is much concerned much of the time.

7.3 Summary

In the main the activity of the Group has been of a refined bread-and-butter variety, the attempt to provide practical answers to present problems. As a result, the Group has been active in many directions. It might appear that the various activities are highly unrelated, but this is not the case. All the Group's work has a definite connection with the matter of protection against hazards of exposure to nuclear radiation. This connection may be evidenced by the development of an instrument for the determination of the degree of danger in an existing hazard; it may be evidenced by a study of the behavior of radioactive materials in the soil, made in an effort to see what will become of an existing hazard with change of time and circumstance; or it may be evidenced by meteorological studies whose aim is to make possible the accurate prediction of a hazard yet unborn.

Chapter 8

GROUP H-7, INDUSTRIAL WASTE

By Conard W. Christenson, Group Leader

8.1 General

Group H-7 became a part of the Health Division in June 1955 and has the responsibility of operating three treatment plants for the disposal of liquid radioactive wastes. Two plants deal with plutonium-bearing wastes and are of the chemical coprecipitation type. The other plant treats RaLa wastes containing Ba^{140} and some Sr^{90} and is of the ion exchange type. Two neutralization stations are also operated by the Group.

In September 1956, the Contaminated Laundry Section, formerly a part of CMR Division, was transferred to Group H-7.

In addition to these routine functions, the Group performs research on methods of treatment and disposal of radioactive wastes and the effects of disposal of waste on the environment.

8.2 TA-45, Tech Area Waste Treatment Plant

The treatment plant at TA-45 receives waste from TA-1 and TA-3. The gradual removal of Laboratory facilities from TA-1 has been

accompanied by a decrease in waste volume from this area, with a corresponding increase in waste volume from TA-3 as more facilities are added at South Mesa. The Radiochemistry Building was completed during the year and automatically neutralized wastes from this building are now being received at TA-45.

Ferric sulfate and lime are added to the incoming waste stream, forming a precipitate of ferric hydroxide which settles to the bottom of settling tanks, carrying the plutonium with it. The supernatant is filtered through rapid sand filters before monitoring and discharge into Acid Canyon.

A total volume of 11.54 million gallons of waste containing 1.4 g of plutonium was treated during the year. Ninety-nine per cent of the plutonium was retained in 3000 cubic feet of dewatered sludge, representing a volume reduction factor of 515. Very little recirculation and retreatment was necessary in order to meet 1/10 of the plutonium tolerance as listed in the NBS Handbook 52.

Several hundred gallons of cyanide wastes from the various electroplating shops were delivered to the plant and treated with caustic and chlorine before discharge into the plant influent. Other special wastes were received and treated separately before discharge.

The all-time high monthly flow to the TA-45 plant was received in January 1957 and a decision was made to modify existing plant equipment to increase treatment capacity. Revisions were completed in November 1957

and treatment rate increased from 90 to 145 gallons per minute without adverse effect on effluent quality.

8.3 TA-21, DP West Waste Treatment Plant

This plant receives its waste from the DP West plutonium area. Both plutonium and mineral constituents are much more concentrated in DP West wastes than in those received at the TA-45 plant. The method of treatment is essentially the same. Other wastes, such as concentrated residues from plutonium separations containing large amounts of salts and plutonium (raffinates), are received and treated separately. The HF washing solutions are also treated separately.

The DP West plant was operated for a total of 1683 hours during the year and a total of 4.7 million gallons of waste was treated by routine processes. About 15,000 gallons of raffinate containing 5200 mg of plutonium and 7500 gallons of fluoride waste containing 970 mg of plutonium were treated by batch methods. Of the total of 21,030 mg of plutonium received in all wastes during the year, about 99.9 per cent was removed by treatment.

A vacuum filter was installed in January 1956 which eliminated the necessity for hauling sludge to the TA-45 plant for filtration.

Flow from this area has increased at a steady rate over the past several years and this plant is now operating at maximum capacity. There appears to be no simple way to expand the plant so increasing operating time seems to be the only solution.

8.4 TA-35, Ten Site Waste Treatment Plant

Waste treated by this plant is contributed by laboratories and operation of a hot cell in preparation of kilocurie sources of La^{140}. It contains radioactive barium, lanthanum, strontium, and yttrium isotopes as well as traces of other radionuclides.

Treatment facilities consist of four 50,000 gallon storage tanks and a small ion exchange unit. The latter includes two columns containing a total of 10 cubic feet of Dowex 50 resin and necessary pumping, control, and regeneration equipment.

Waste is retained in storage as long as practicable in order to reduce radioactivity to the lowest feasible level by decay. It is then pumped to the ion exchange columns, which are operated in series, and the effluent is discharged or recirculated, depending on its level of radioactivity. Radioactive material retained in the columns is removed at the end of each run by regeneration with nitric acid, and, by treatment of spent regenerant, radioactivity is finally contained in 25 to 30 gallons of sludge.

During the past year a total of 465,850 gallons was treated in the ion exchange unit. This volume represented about 32 curies of beta activity, of which 2.5 curies was radiostrontium. $Strontium^{90}$ represents 10 to 25 per cent of the radiostrontium and is the most critical component with respect to disposal. Although about 93 per cent of the radioactivity was removed, the concentration of Sr^{90} in the effluent was somewhat above tolerances listed in NBS Handbook 52 for drinking water.

However, soils surveys show contamination of only a small section of the discharge area and reasonable dilution and the ability of local soil to retain strontium may be expected to eliminate any downstream hazard. Research to develop methods for more efficient and complete removal of radiostrontium will be continued until effluent quality meets NBS standards at the point of discharge.

The rate of waste production at Ten Site has increased to the extent that existing facilities are heavily overloaded. Storage time is not sufficient for satisfactory reduction of activity level and almost continuous operation of the ion exchange unit, with highly radioactive raw waste, is required. The resulting concentration of radioactivity in the resin columns creates a serious radiation hazard to operating personnel.

Chemical precipitation, by addition of iron, caustic, and lime, has been found to be extremely efficient in concentrating activity in the resulting sludge. This sludge can then be fixed in concrete or buried as such. The quality of the remaining liquid waste is more satisfactory for subsequent ion exchange treatment. In anticipation of expected continued increase in waste production rates at Ten Site, a tentative design for a chemical treatment plant, to be followed by an ion exchange unit of increased capacity, has been completed. The proposed plant is adapted to relatively remote control and would practically eliminate radiation hazard to operating personnel. It is hoped that construction of these facilities can be started in the near future.

8.5 Ultimate Fixation of Radioactivity in Clays

a. Clay Comparisons for Activity Retention. Handmade balls were formed of clay and water solutions of mixed fission products 5 years old. Over 40 types of clay were used and the firing levels ranged from 100°C to 1200°C. All clays fired to 1200°C demonstrated high activity retention--the amount leached after 30 days was in the order of 10^{-4} per cent. Similar results were obtained using single nuclide spikes.

b. Ion Exchange Capacities and Activity Levels Retention of Clays. Several clays with high and low base exchange characteristics were mixed with Sr^{90} and inert $Sr(NO_3)_2$ below and well above the exchange capacities of each clay. When all samples were fired to vitrification, no apparent difference was noted in the retention of activity. At firing temperatures under 1000°C the clays showed good retention only to their respective exchange capacities. It is concluded that any clay fired to vitrification will contain nuclear activity far in excess of its exchange capacity.

8.6 Environmental Studies

The environmental program is a cooperative venture among the U. S. Geological Survey and Groups H-6 and H-7. The purpose is to detect any contamination of the supply wells and streams, as well as to ascertain direction and rate of flow of underground water. Some 200 samples of water from supply wells, test wells, the Rio Grande, and local streams were collected and analyzed for mineral and radiochemical contents. None

of the samples indicate any contamination which could be attributed to the Los Alamos Scientific Laboratory.

An additional 200 soil samples from various canyons receiving wastes were analyzed, and it was determined that the radioactivity remains at the point of discharge. No radioactivity was found in any of the soils outside the project. It is interesting to note that the small amount of uranium discharged is not retained by the soils but plutonium appears to be well fixed.

8.7 Tuff Core Studies

The first phase of a study of movement of Sr^{90}, Cs^{137}, and Pu^{239} has been completed. A total of 24 cores of local tuff, each 4-1/2 inches in diameter and varying in length from 5 to 18 inches, were used in the study. The tuff was sealed in a neoprene jacket in such a way that the solutions of radionuclide traveled through the core. The amount of solution thus fed to the core varied from as little as 100 inches to over 3200 inches of water. Tap and distilled water were spiked with the radionuclides to the extent of 1000 c/m/ml and passed through cores of tuff. Cesium^{137} and Pu^{239} were tightly bound by the tuff; autoradiographs located the radionuclide within the upper 2 inches of core. Strontium^{90} eventually appears in the effluent and the breakthrough of the radionuclide is much sharper when it is applied in tap water than when applied in distilled water, which indicates that other ions in the tap water are in competition with Sr^{90} for the ion exchange sites.

Autoradiographs of the cores show a number of "hot" spots throughout the core which indicate that some of the components of tuff adsorb Sr^{90} much more strongly than others.

Cesium does not follow the expected physico-chemical patterns in many respects; it is difficult to explain the tenacity with which this radionuclide is held in tuff cores.

Various solutions (saturated CO_2, 100 ppm of sodium, magnesium, calcium, barium, and aluminum as the chlorides) have been employed as leaching agents in attempts to remove the radionuclides bound to the core. Again cesium and plutonium are not easily leached, but strontium is moved out of the core in increasing amounts by magnesium, calcium, and barium in that order; carbonic acid will also remove strontium.

It may be concluded that cesium and plutonium are readily adsorbed by some components of the tuff; strontium is bound with less energy and may be moved from the adsorption sites by the divalent ions calcium, magnesium, and barium.

8.8 Project Green Thumb

The Green Thumb investigation was initiated in the spring of 1957; its purposes were threefold: (1) to study the uptake of strontium and cesium by growing plants; (2) to determine the effect of available calcium concentration in the soil on the uptake of the Sr^{90}; and (3) to observe the movement of strontium and cesium through the soil.

Thirty plots, each 5 by 5 by 2 feet deep, were filled to a depth of 18 inches with a soil which had been intimately mixed with a solution of

calcium chloride in water containing the Sr^{90}-Y^{90} and Cs^{137} spike. The calcium concentration per plot was varied from 1.5 to 18.1 mg of calcium per gram of soil. Two plots were planted randomly to lettuce, alfalfa, and grass. Two plots did not receive spike at the time of spreading; the spike was applied at the surface by means of a sprinkler. One of these plots was held fallow; the other was planted to alfalfa.

In all cases, when counts per minute from Sr^{90} per milligram of calcium values in the plant were plotted against calcium concentrations in the soil, curves were obtained which indicate a decreased uptake of Sr^{90} by the plant with increased available calcium in the soil.

Typical results are shown in Fig. 8.1. The break in the curve as the 6 mg per gram value for soil calcium is reached should also be noted. Concentrations of soil calcium above this value have less effect on the uptake of Sr^{90} than did lower concentrations.

Data obtained from the second cutting indicated that both lettuce and alfalfa discriminate against strontium, and grass concentrates strontium.

In cases where the spike was applied to the surface of the plot, the uptake of Cs^{137} was lower by a factor of about 7 than it was in the other 28 plots where application was throughout the 18 inch plot depth.

At present one may conclude that with certain crops and soils the application of calcium to the soil may be beneficial in reducing the ratio of Sr^{90} to calcium in the crop.

Because of the extremely wide variation in soil calcium, root

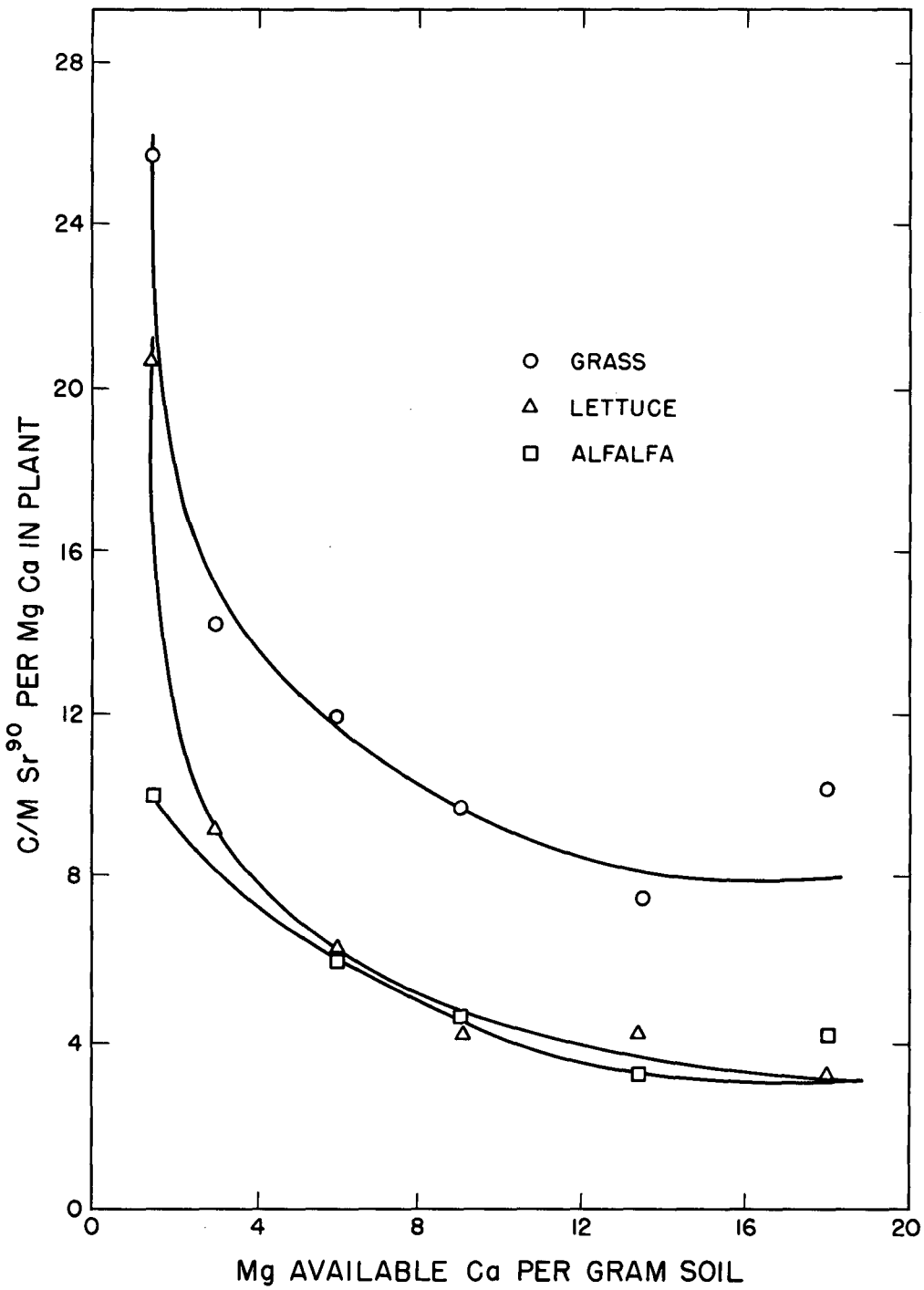

Fig. 8.1 The effect of available calcium in soil on the uptake of Sr^{90} by plants.

feeding zones, foliar absorption, fallout, etc., it becomes increasingly apparent that a projected calculation of Sr^{90} in the human body from soil data is fraught with difficulties. A more logical approach would appear to be average plant data and, even with this approach, one will be extremely fortunate to be within an order of magnitude.

8.9 Routine Laboratory Section

The analytical work of the Laboratory Section includes plant control for TA-21, TA-35, and TA-45; environmental studies on soils, river, and well waters; special problems associated with research on particular Laboratory wastes; and research problems. A summary of these is given in Table 8.1. The research problems of the past year were Project Green Thumb, clay fixation, tuff core studies, and irradiation studies. Environmental studies and special problems have also been listed separately. Special problems are those associated with new or revised analytical procedures, those which may be brought to the Laboratory Section from some other group and are related to water treatment, waste disposal, etc., or those which arise in connection with a major research problem. Although the special problems are not of a regular or routine nature, it will be noted that they require more than 15 per cent of the efforts of the Laboratory Section.

The remainder of the emphasis, about 30 per cent of the total work of the Laboratory Section, is assignable to plant control.

TABLE 8.1 SUMMARY OF ROUTINE LABORATORY DETERMINATIONS

Type of Analysis	Tech Area, Ten Site and DP	Project Green Thumb	Laundry	Special Problems	Clay Fixa-tion	Tuff Cores	Environ-ment	Irrad tio Stud
Complete water analysis[a] (chemical)	13,000	--	--	--	--	--	3,600	--
Mineral analysis[b]	950	2,450	--	100	--	5,530	--	27
Biological analysis[c]	--	--	--	--	--	--	--	2,36
Radiochemical separations[d]	620	1,080	100	170	200	260	780	--
Gross radioassay[e]	6,370	1,920	500	9,440	1,000	4,640	4,900	--
Miscellaneous[f]	110	200	25	220	300	--	--	--
Total	21,050	5,650	625	9,930	1,500	10,430	9,280	2,63

a. Includes total hardness, total solids, conductivity, pH, alkalinities, Ca, Na, K, NO_3^-, and NH_4^+, determined on wastes and water samples.

b. Includes Ca, Na, K, F, Cl, Mg, NO_3^-, NH_4^+, and NO_2^-, determined on sludge, soils, miscellaneous solutions.

c. Includes bacteriological Warburg, chromatography, and reactor runs.

d. Includes, in descending order, Sr^{90} - Y^{90}, plutonium, uranium, Cs^{137}, Ba^{140}- La^{140} Ca^{45}.

e. Includes gross alpha, gross beta, and gross gamma counts.

f. Includes all other analyses, e.g., SiO_2, NO_2^-, CN^-, and SO_4^{+2}.

8.10 Irradiation Studies

A study of the effect of high energy irradiation on activated sewage sludge was undertaken in 1957. The study was divided into three parts: chemical, bacteriological, and Warburg respirometry.

Samples of sludge were irradiated with fast neutrons in the Water Boiler reactor for varying periods of time up to 40 minutes. No attempt was made in the preliminary investigation to obtain absolute dosage rates. Although a destruction of reproductive faculty was obtained by relatively low irradiation, the sludge showed an increased oxygen uptake in the Warburg respirometer. The $NO_2^- \rightarrow NO_3^-$ enzyme was destroyed. A chromatographic study of the protein-amino acid fraction of treated sludge indicated that proteases or peptidases are more readily destroyed than are oxidases.

That bacterial species differed in respect to their irradiation resistance was shown by the appearance of more nearly pure cultures with extended exposures. The differences in resistance have been known for some time; however, the fact that resistant organisms were small, gram negative, non-spore forming rods was surprising. One would expect resistance to be correlated with spore formation.

8.11 Laundry Section

Operations at the Laundry were quite routine during the year. An examination of Table 8.2 shows about a 10 per cent increase in clothing laundered.

TABLE 8.2 COMPARISON OF LAUNDRY SERVICES FOR 1956 AND 1957

	1957	1956
Dispensed (totals for the year)		
Cheesecloth, bolts	2,281	5,595
Gloves, surgeon, doz. prs.	22,952	21,107
Processed (totals for the year)		
Pieces	981,450	896,600
Pounds	457,204	422,833
Boots, single	611,300	527,500
Coveralls	82,430	80,500
Coveralls discarded due to wear and tear	3,025	2,154
Coveralls discarded due to contamination	154	92
Lab coats	60,600	61,150
Lab coats discarded due to wear and tear	1,557	1,828
Respirators	12,494	12,399

Several changes in procedure were made to increase efficiency and lower costs. In February arrangements were made to supply dry box gloves through the main stockroom at SM-30 rather than through Group H-7. In March similar arrangements were made for cheesecloth. These were accomplished smoothly and without interruption to service or supply.

A Chandler darning machine was purchased and put into operation in July. It is estimated that repairs will add about 25 per cent additional life to coveralls and lab coats that are torn or otherwise damaged.

In October an experiment was performed to determine the hazards, if any, involved in laundering clothing contaminated with normal uranium. From operations in normal uranium only, 1137 coveralls and 1569 single canvas boots were collected. Only a small proportion of the garments were found to be contaminated but it was thought that a sufficient amount of uranium was present to make the experiment worthwhile.

Urinalyses were run on all of the affected personnel before and after the operation. Air samples were taken and the machines were monitored after the operation.

From these results it would appear that there is no great hazard in this operation. A similar experiment will be performed on clothing with a higher degree of contamination.

Appendix

TALKS AND PUBLICATIONS

Talks and Papers Presented

Biochemistry

H. Foreman, "The Mechanism of Plutonium Fixation by Bone", at the Gordon Research Conference on Bone, Meriden, New Hampshire, July 1957.

H. Foreman, "The Sequestration of Materials by the Skeleton", at the annual meeting of the New Mexico Society for Biological and Medical Research, Albuquerque, New Mexico, October 1957.

R. G. Gould, "The Effects of X Irradiation and Other Factors on Cholesterol Biosynthesis and Metabolism", seminar at the University of London Post-Graduate Medical School (England), January 1957.

R. G. Gould, "The Effects of X Irradiation and Other Factors on Cholesterol Biosynthesis and Metabolism", seminar at the Biokemiska Institutet, University of Stockholm (Sweden), April 1957.

R. G. Gould, "Factors Regulating Cholesterol Metabolism and Its Relation to Bile Acid Metabolism and Atherosclerosis", seminar at the Department of Physiological Chemistry of the University of Lund (Sweden), April 1957.

R. G. Gould, "Biosynthesis of Cholesterol in vivo and in vitro from DL-β-Hydroxy-β-methyl-δ [2-^{14}C]-valerolactone", at the 363rd meeting of the Biochemical Society, University of Durham, Newcastle on Tyne, (England), June 1957.

R. G. Gould, "Effect of Radiation and Other Factors on Cholesterol Biosynthesis", at the annual meeting of the New Mexico Society for Biological and Medical Research, Albuquerque, New Mexico, October 1957.

D. F. Petersen, "Biochemical Effects of Ionizing Radiations", at the spring meeting of the New Mexico Society for Biological and Medical Research, Los Alamos, New Mexico, May 1957.

Biophysics

J. A. Sayeg, "Current Methods of Dosimetry and Methods of Measurement of Neutron Tissue Dose", at the Donner Radiation Laboratory, Berkeley, California, February 1957.

Fallout

E. C. Anderson, "The Problem of World-wide Radioactive Fallout from Weapons Tests", at Johns Hopkins University, School of Hygiene and Public Health, Baltimore, Maryland, February 1957.

Thomas L. Shipman, "Milk Production and the Age of Fallout", at the annual meeting of the California Creamery Operators' Association, Lake Tahoe, California, June 1957.

Thomas L. Shipman, "The Sky is Falling--Will it Hurt?", at the meeting of the National Society for Crippled Children and Adults, Chicago, Illinois, November 1957.

General

C. W. Buckland, Jr., "Interpretation of Regulations Governing the Shipment of Radioactive Materials", at the meeting of the American Industrial Hygiene Association, St. Louis, Missouri, April 1957.

R. Reider, "Effect of Atomic Energy on Risk to Civilization", at the meeting of New Mexico Regional Red Cross, Albuquerque, New Mexico, February 1957.

Thomas L. Shipman, "Radiation--Some of the Things the Public Ought to Know", at a meeting of Science Comes to You, Inc., Santa Fe, New Mexico, January 1957.

Thomas L. Shipman, "Our Grandchildren--More Power to Them", at the convention of the New Mexico Bankers Association, Santa Fe, New Mexico, May 1957.

J. F. Spalding, "The Atomic Bomb--Let's Face It", at the University of New Hampshire, Durham, New Hampshire, April 1957.

Health and Safety

Thomas L. Shipman, "Industrial Medical Aspects of Radiological Health and Safety", at a medical symposium at Sandia Base, Albuquerque, New Mexico, May 1957.

Industrial Hygiene

C. D. Blackwell, "Contamination Control of Uranium Rolling Operations", at the meeting of the Rocky Mountain Section of the American Industrial Hygiene Association, Los Alamos, New Mexico, October 1957.

E. C. Hyatt, "Industrial Hygiene Aspects of Radiation Hazards", at Johns Hopkins University, School of Hygiene and Public Health, Baltimore, Maryland, February 1957.

E. C. Hyatt, "Current Problems in the Field of Respiratory Protection", at the meeting of the American Industrial Hygiene Association, St. Louis, Missouri, April 1957. To be published in Am. Ind. Hyg. Assoc. Journal.

H. S. Jordan, "The Respirator Problem--An Industrial Hygienist's Viewpoint", at the meeting of the American Industrial Hygiene Association, St. Louis, Missouri, April 1957. To be published in Am. Ind. Hyg. Assoc. Journal.

H. S. Jordan and R. E. Black, "Evaluation of the Air Pollution Problem Resulting from Discharge of a Radioactive Effluent", at the meeting of the American Industrial Hygiene Association, St. Louis, Missouri, April 1957. To be published in Am. Ind. Hyg. Assoc. Journal.

H. S. Jordan, "Air Cleaning Costs--A Study of Three Systems", at the 5th AEC Air Cleaning Seminar, Boston, Massachusetts, June 1957.

H. S. Jordan, "Problems in the Use of Respirators", at the meeting of the Metropolitan New York Section of the American Industrial Hygiene Association, November 1957.

H. F. Schulte, "Current Investigations on Respirator Equipment at the Los Alamos Scientific Laboratory", at the meeting of the Rocky Mountain Section of the American Industrial Hygiene Association, Los Alamos, New Mexico, October 1957.

Instrumentation

E. C. Anderson, "The Los Alamos Human Counter", at Northwestern University Conference on Liquid Scintillation Counting, Evanston, Illinois, August 1957.

R. L. Schuch, "Large Volume Liquid Scintillation Radiation Detectors", at the meeting of Instrument Society of America, Atlanta, Georgia, April 1957.

Organic Chemistry

F. N. Hayes and D. G. Ott, "The Chemistry of the Counting Sample", at Northwestern University Conference on Liquid Scintillation Counting, Evanston, Illinois, August 1957.

W. H. Langham, "Application of Liquid Scintillation Counting in Biology and Medicine", at Northwestern University Conference on Liquid Scintillation Counting, Evanston, Illinois, August 1957.

Radiobiology

I. U. Boone, "Some Effects of Radiation on Living Organisms", at 3rd Annual Workshop in Science Teaching, Eastern New Mexico University, Portales, New Mexico, March 1957.

I. U. Boone, "The Effect of Transplantable AK Leukemia in Irradiated and Nonirradiated CFW Swiss Strains of Mice", at the annual meeting of the American Association for Cancer Research, Chicago, Illinois, April 1957.

I. U. Boone, "Hematological and Carcinogenic Effects of Radiation", at Summer Institute in Radiation Biology, University of New Mexico, Albuquerque, New Mexico, August 1957.

I. U. Boone, "Effects of X Irradiation on Life Span and Tumor Incidence of CF-1 and Swiss Webster Mice", at the annual meeting of the New Mexico Society for Biological and Medical Research, Albuquerque, New Mexico, October 1957.

P. S. Harris, "Biomedical Effects of Nuclear Weapons", two lectures to class for General Medical Officers of USA and USAF, Army Medical Center, Washington D. C., September 1957.

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