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HEALTH & SAFETY

ANNUAL REPORT of HEALTH & SAFETY DIVISION

1960

NRTS

U.S. ATOMIC ENERGY COMMISSION
IDAHO OPERATIONS OFFICE

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ANNUAL REPORT

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HEALTH AND SAFETY DIVISION

IDAHO OPERATIONS OFFICE

National Reactor Testing Station

U. S. Atomic Energy Commission

September 1961

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AREAS, REACTORS AND CRITICAL FACILITIES NOMENCLATURE

AFSR	Argonne Fast Source Reactor
AMA	Assembly Maintenance Area
ANP	Aircraft Nuclear Propulsion
A1W	Large Ship Reactor
AREA	Army Reactor Experimental Area
BORAX V	Boiling Water Reactor No. 5
CFA	Central Facilities Area
CPP	Chemical Processing Plant
EBR-I	Experimental Breeder Reactor No. 1
EBR-II	Experimental Breeder Reactor No. 2
ECF	Expended Core Facility
EOCR	Experimental Organic Cooled Reactor
ETR	Engineering Test Reactor
FET	Flight Engine Test Facility
GCRE	Gas Cooled Reactor Experiment
IET	Initial Engine Test Facility
LPTF	Low Power Test Facility
ML-I	Mobile Low No. 1 (Army Reactor)
MTR	Materials Testing Reactor
NRF	Naval Reactor Facility
OMRE	Organic Moderated Reactor Experiment
SL-I	Stationary Low No. 1 (Army Reactor)
SPERT I, II, III, IV	Special Power Excursion Reactor Test No. 1,2,3,4
STPF	Shield Test Pool Facility
S1W	Submarine Thermal Reactor
TREAT	Transient Reactor Test Facility
ZPR-III	Zero Power Reactor No. 3

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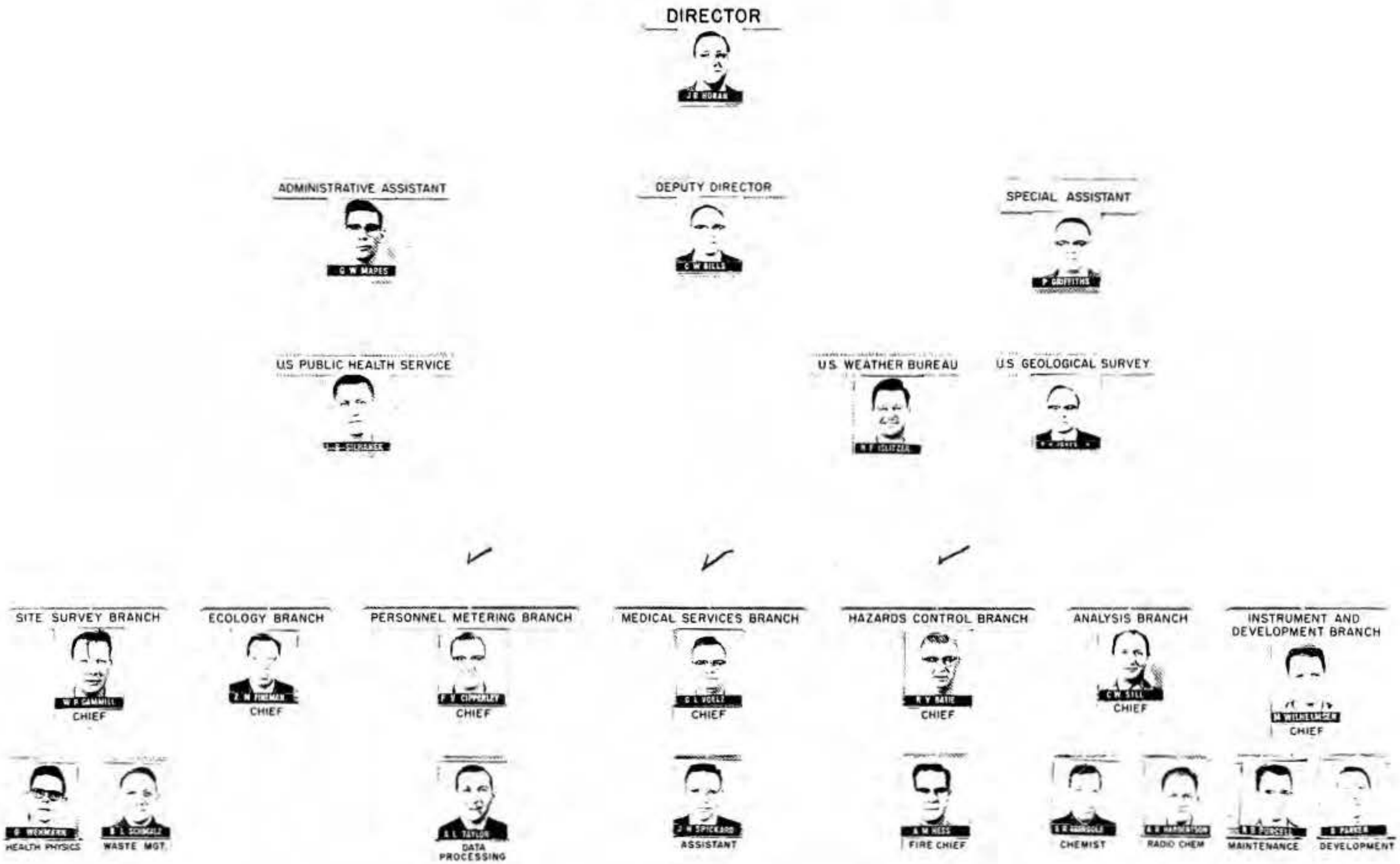


Chapter I

INTRODUCTION

John R. Horan, Director

During 1960, the National Reactor Testing Station with an investment of $350,000,000 employed 5,700 workers in the nine major operational areas and six construction areas. The performance of 11.8 million man hours of work resulted in one fatality, 19 disabling injuries, and an integrated exposure to 2,294 rem of total body penetrating radiation. For the fifth consecutive year, radiation was not a causative factor in any of the injuries experienced at the NRTS. Only one individual exceeded the administrative control value of five rem during the year. Under the radioactive waste management program, a total of 3,500 curies of short to intermediate half-life material was discharged as liquid waste to the soil; seven thousand cubic yards of intermediate to long half-life material were consigned to the solid burial ground, and the atmosphere dissipated approximately 250 thousand curies of short half-life aerosols. NRTS wastes contributed less than ten per cent of the internationally agreed level of exposure acceptable to the off-site population.

The new Atomic Energy Industry similar to other established industries has the problem of disposing of unwanted wastes. All sections of our Country have experienced industrial pollution of the environment from tanning plants in New England; steel mills in Pennsylvania; oil and chemical plants in Texas; slag heaps from mines in the Rocky Mountains Area; and forest product and dredging contamination of streams in the Northwest. Only the Atomic Energy Industry has recognized and taken conservative action to minimize the potential hazards from its activities during the infancy of its programs and before the existence of environmental pollution as the result of irresponsible waste disposal practices. The risk of radiation exposure and contamination has been balanced against the benefits to be derived from the controlled use of atomic energy.

During normal operations at the National Reactor Testing Station, controlled amounts of radioactive wastes are released to the atmosphere and to the ground. The protection of persons, livestock, and crops in the neighborhood of the controlled area from radiation exposure and pollution originating on the Station is one of the responsibilities of the Health and Safety Division of the Idaho Operations Office.

Idaho Operations Office Manual Chapter 0500-7 lucidly establishes the official posture on the management of wastes: "It is the policy of the Atomic Energy Commission to dispose of radioactive or other hazardous materials in such a manner that exposure to personnel is maintained within established guides and pollution of the environment does not occur .... "Liquid radioactive waste discharged to the ground or ground water shall be maintained at levels such that the concentration in water at the nearest point of use down gradient shall not exceed one-tenth of the radioactivity concentration guide .... "Airborne radioactive wastes discharged to the atmosphere shall be controlled to insure that overexposure to personnel does not occur, either at the National Reactor Testing Station or in its environs as a result of direct exposure, or inhalation, or ingestion ...."

The Health and Safety Division operates an inclusive system of environmental monitoring to determine the amount and type of radioactivity present in the air, water, soil, vegetation, and wildlife both on-site and off-site. The monitoring program serves as a final check on the efficiency of waste disposal practices at the various plant areas since any deficiencies or "leaks" will be detected in one or more of the various samples. As examples, there are 67 observation wells and nine air sampling stations on the NRTS proper, while water is collected from 29 locations, and air samples from ten stations in communities and the farming areas beyond the boundaries of the Station.

There is a tendency to overlook the fact that routine control of airborne or liquid wastes are premised on the most limiting condition, that is the exposure to the personnel working in closest proximity to the point where the wastes are generated and released, namely, the workers within the plants. Because of their occupations and limited numbers, these individuals are allowed an exposure ten times greater than the populace who live in the surrounding environs. However, relative short distances of a few miles offer reductions in the thousands and even hundreds of thousands in the concentration of a radioactive material via dilution, dispersion, and scavenging by naturally occurring materials. Contamination of the environment has been controlled to such a degree that it has never been necessary to use extraordinary means to filter the water or intake air for occupied areas of any of the facilities.

While it is theoretically possible to contain all radioactive materials and prevent any contamination of the environment, such a philosophy is economically untenable. It is therefore in the best interests of the Atomic Energy Industry, its workers, and the surrounding population to keep radioactive discharges to the environs to the minimum commensurate with the best technology of waste disposal management. For this reason, experts in the fields of meteorology and geology are available for consultation and are performing research to make the best mating of protection with economics. This is the role of the U. S. Weather Bureau and U. S. Geological Survey at the National Reactor Testing Station.

As an illustration, the Weather Bureau Group has made the following theoretical calculations: Let us assume the continuous release of I-131, with a physical half-life of eight days, from a facility at the Southcentral portion of the Station, under average meteorological conditions. What is the annual capacity of the atmosphere so that the mean air concentration at the nearest Site boundary will remain at or below the radioactivity concentration guide? The theoretical answer is in excess of a million curies per year. A tremendous capacity when one considers that less than 70 curies of I-131 were released during 1960.

Similarly, the Geological Survey is determining the capacity of the soil and basalt for radioactive wastes. As a result, we can project the consequences of a major rupture in one of the stainless steel tanks which provide interim storage for high-level radioactive waste. This material contains a few hundred curies per gallon. Over 50 feet of sedimentary material is interbedded in the more than 400 feet of dry rocks between the waste tanks and the water table. One cubic foot of this fine grained material will absorb and retain 1/2-gallon of liquid. Field studies have also indicated that free liquids perch on the less permeable sedimentary materials and move thousands of feet laterally without reaching the water table. Based on these premises, the absorptive capacity of a volume of sediments within a 500-foot radius and a 50-foot depth below the waste tanks would theoretically retain 25 million gallons of liquid which is almost 100 times the storage capacity of any single tank.

A highlight statement of the more important achievements of the Health and Safety Division in performing its assigned function of protecting man and his environment from occupational hazards would include the following:

1. The radioactive waste management program moved from the planning phase into the field engineering aspects by the drilling and sampling of observation wells around the MTR-ETR disposal pond along with the geophysical logging of the existing monitoring wells in the CPP area.

2. Sixty nuclear accident dosimeters (NAD) were placed in service at the various NRTS facilities where accidental criticality is conceivable.

3. The completion of a training area for the Fire Department including burning pits, a four story drill tower, and other training devices.

4. The highly sensitive fluorometric procedure previously developed by the Analysis Branch was adopted as a very quick and accurate procedure for sub-microgram quantities of thorium.

5. An aerial monitoring team was formed for the rapid routine and emergency monitoring of large surface areas. Four Branches and two other agencies contributed personnel to this activity.

6. More emphasis was placed on advance planning for radiological assistance and other emergency procedures by the full-time assignment of a specialist to this task.

7. The industrial health program was strengthened by the addition of a second physician to the Medical Services Branch.

8. A periodic report was initiated to inform the public of the effect, if any, of NRTS operations upon the natural radiation levels of surrounding communities and rural areas.

Chapter 2

ENVIRONMENTAL MONITORING AND EMERGENCY PLANNING

Percy Griffiths, Special Assistant

A. SUMMARY

Results of analysis of all environmental samples collected in 1960 indicated that levels of radioactivity were in all instances below the Radiation Protection Guides.

Division personnel participated in Operation Alert 1960, and a Division exercise of a hypothetical incident occurring at the National Reactor Testing Station and affecting off-site populaces. Radiological Assistance Team activities included response to four incidents occurring within Region 6; regular meetings and training sessions, and the publication of a revision to the formal plan.

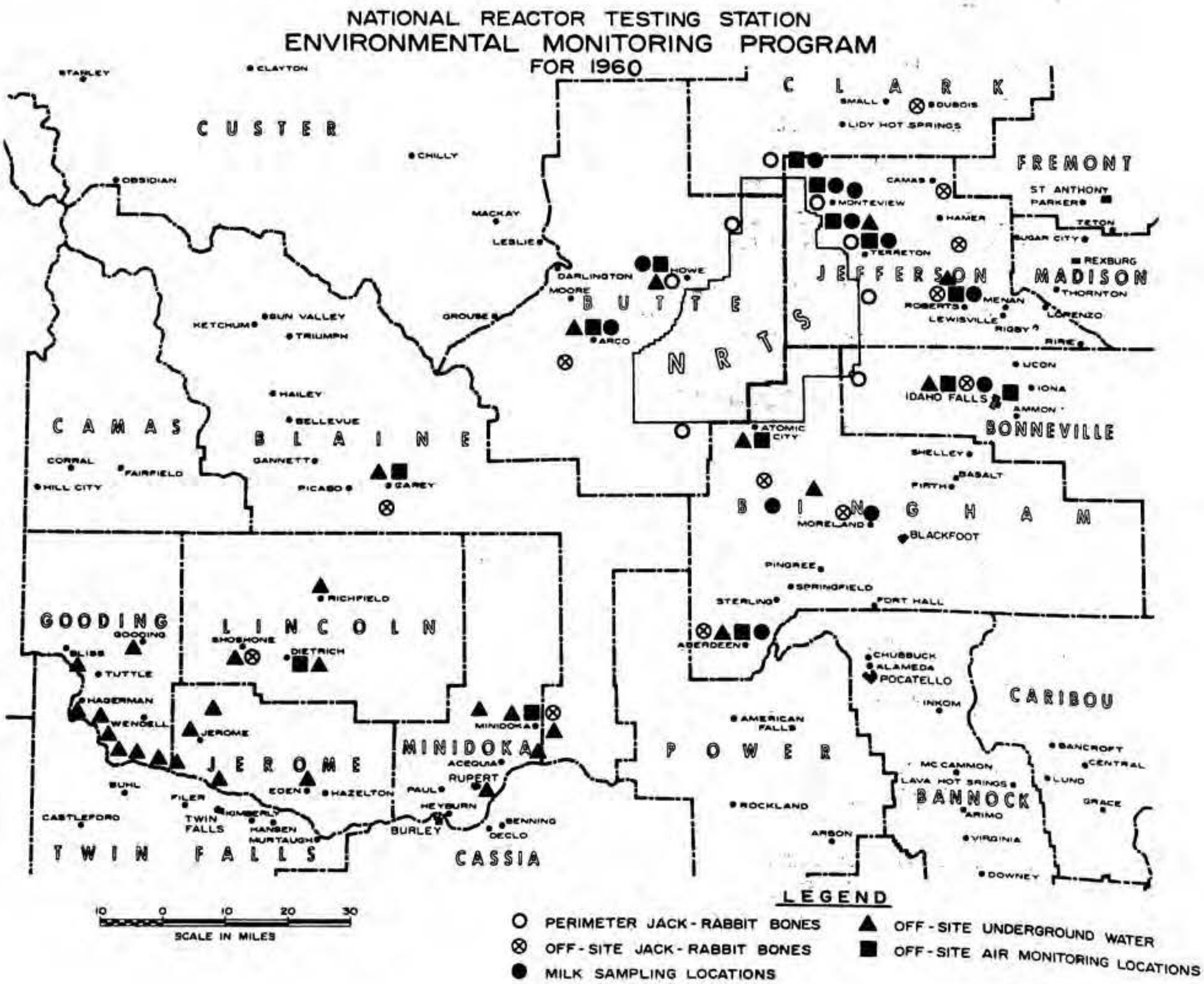


Figure 1.

B. ENVIRONMENTAL MONITORING PROGRAM

During the year, the Division initiated quarterly and annual summary environmental monitoring data reports for dissemination of information to the public of radioactivity data collected in the environs of the NRTS. This program is accomplished by means of air, water, milk, and jack rabbit bone samples, and results of area monitoring badges which are collected from an area of approximately 9,000 square miles surrounding the NRTS (Figure 1). Analysis of all samples collected indicated that radioactivity levels were well below Radiation Protection Guide levels in all instances.

1. Underground Water

The National Reactor Testing Station is situated over a large underground water table accumulated from drainage of the Lost River Plain and streams which drain the mountains to the north of the NRTS. The general flow of the underground water is in a south to southwesterly direction at an approximate rate of 35 feet a day.

Liquid wastes from NRTS operations are monitored before release to the soil or the water table, and levels of radioactivity are maintained below the Radiation Protection Guide levels at all points of re-use both on or off the Station.

During 1960, 151 samples were collected on an approximate bi-monthly basis from 29 off-site sources which may be supplied from the Lost River underground reservoir. Over the same period, 779 samples were collected at approximately weekly intervals from 22 on-site production wells which are located in close proximity to plant sites.

Type of Sample	Number of Stations	Number of Samples	Maximum Activity of Single Sample	Average Activity for Year
Off-Site Underground Water	29	151	α $5\text{x}10^{-9}$ uc/cc β $1.5\text{x}10^{-7}$ uc/cc	$\alpha < 3.1\text{x}10^{-9}$ uc/cc $\beta < 1.5\text{x}10^{-7}$ uc/cc
On-Site Production Well Water	22	779	α $10\text{x}10^{-9}$ uc/cc β $8.6\text{x}10^{-7}$ uc/cc	$\alpha < 3.1\text{x}10^{-9}$ uc/cc $\beta < 1.5\text{x}10^{-7}$ uc/cc

2. Atmospheric Monitoring

Radioactivity in air is determined by analysis of filters through which air is continuously drawn to remove gaseous and particulate material. Ten off-site locations provide these samples which are normally collected and analyzed on a weekly basis. In addition to sample collection at these locations, a telemetering network provides a warning alarm in a control center at the NRTS should the radio-[illegible]cted exceed a pre-determined level. Also, additional [illegible] monitoring stations can be activated from the control [illegible]dio signal.

Throughout 1960, low level radioactivity which could be attributed to NRTS operations was frequently detected in the environs through the medium of air samples. Attempts to relate these incidences with any specific plant or operation were generally unsuccessful. This resulted from several factors, namely, the low level of radioactivity involved and the meteorological conditions prevailing from the time of release to the time of detection.

The maximum radioactivity detected in air occurred during October and was observed at Roberts and Monteview, Idaho. This can probably be attributed to tests which were being conducted under controlled conditions at the ANP area at that time.

In all instances, radioactivity measured was well below the recommended Radiation Protection Guide values.

Type of Sample	Number of Stations	Number of Samples	Maximum Activity of Single Sample	Average Activity for Year
Off-Site Air Filters	10	379	$\beta\ 11 \times 10^{-12}$ uc/cc	$\beta < 1.4 \times 10^{-12}$ uc/cc

3. Jack Rabbit Bones

Jack rabbits are routinely sacrificed from selected locations of natural habitat on the periphery of the NRTS and also from more distant populated agricultural areas. The bones of these animals are analyzed for strontium-90 in order to evaluate any variation of that isotope in the environmental vegetation.

As no Radiation Protection Guides have been established for the biological system of the rabbit, and its habits are not comparable to man, establishing a relationship of strontium-90 in rabbits to that in the human is not possible at this time. However, the use of the jack rabbit as a medium for sampling and comparison is of value since the rabbit concentrates large quantities of vegetation through grazing and makes detection of strontium-90 much simpler than by conventional sampling methods.

During the last quarter of 1959 and the first three quarters of 1960, 113 jack rabbits were collected from the environs of the NRTS and analysis of their bones revealed low levels of strontium-90. Results were about the same from rabbits which had grazed near or at a distance from the NRTS. No contribution of radioactivity from NRTS operations over that from other sources was observable in any of these samples.

Type of Sample	Number of Stations	Number of Samples	Maximum Activity of Single Sample	Average Activity for Year
Perimeter Jack Rabbit Bones	10	45	31 uuc of Sr^{90}/g Calcium*	<16 uuc of Sr^{90}/g Calcium*
Off-Site Jack Rabbit Bones	10	68	36 uuc of Sr^{90}/g Calcium*	<18 uuc of Sr^{90}/g Calcium*

*** Analysis is for last quarter of 1959 and first three quarters of 1960.**

4. Milk

Milk samples were routinely collected for iodine-131 analysis from dairy cows in the farming area in the predominant down-wind direction with respect to the NRTS. Analytical methods in use during the early part of the year were improved during the latter months which lowered the detection limit from $1x10^{-6}$ to $2x10^{-7}$ uc/cc.

The maximum concentration of iodine-131 observed in milk occurred during October in samples collected from the Mud Lake - Terreton and Monteview areas. This can be attributed to tests which were being conducted under controlled conditions at the ANP area at this time.

During the year, analysis was performed on 790 samples, all of which were below Radiation Protection Guide values.

Type of Sample	Number of Stations	Number of Samples	Maximum Activity of Single Sample	Average Activity for Year
Off-Site Milk	30	790	$8.1x10^{-7}$ uc/cc I^{131} **	$<6x10^{-7}$ uc/cc I^{131} **

** Sensitivity of analytical procedure increased from $<1x10^{-6}$ uc/cc to $2x10^{-7}$ uc/cc for the last two quarters of 1960.

5. Area Monitoring Badges

Film badges were used to determine levels of radiation at locations along highways traversing the NRTS and at various agricultural areas in the surrounding perimeter. These badges are normally collected each month and new ones substituted. During the first and third quarters, results were not complete over the entire period due to defective film. However, data were derived from 897 badges in 118 locations over the entire period.

The maximum radiation from all sources indicated by this method at any location during the year was 40 mrem/month gamma and 20 mrem/month beta; the total averaged over all stations was less than 160 mrem/year gamma and less than 125 mrem/year beta. These results are well below the Radiation Protection Guide recommendations.

Type of Sample	Number of Stations	Number of Samples	Maximum/month	Total for Year
Area Monitoring Badges	118	897	γ 40 mrem β 20 mrem	$\gamma < 160$ mrem $\beta < 125$ mrem

C. EMERGENCY PLANNING

1. Operation Alert 1960

During Operation Alert 1960, the Health and Safety Division participated in fallout plotting and damage assessment exercises, testing of evacuation procedures, local communication and response capabilities, and liaison with local authorities. Members of the Radiological Assistance Team participated in the exercise by a group training session where each local problem was considered and solutions developed. As a result of this exercise, the knowledge was developed, and kits containing maps and references were accumulated to provide evaluation of weapons effects at control points located at Idaho Falls Headquarters, Central Facilities, ANP, and NRF.

2. Maximum Credible Problem

A hypothetical "maximum credible" accident was presented to the Branches for evaluation of individual group responsibilities and action. The problem proposed the release of 10^7 curies of aged fission products from a facility located in the northern portion of the NRTS. The wind was considered to be from the west at approximately 16 miles per hour under lapse conditions. Consideration was given to probable thyroid and whole body dose following cloud passage and exposure to personnel from residual effects which could be expected from deposition on standing crops, with emphasis on the thyroid dose to humans occurring from consumption of milk from cattle grazing on iodine contaminated pastures.

3. Radiological Assistance

In 1960, a revised copy of the Radiological Assistance Plan was issued as a report, IDO #12013. The current team index lists 10 team captains, 1 public relations officer, 17 health physicists, and 5 physicians. In addition, advance AEC team representation in Region 6 is available at offices in Salt Lake City, Utah; Casper, Wyoming; and Denver and Grand Junction, Colorado.

Liaison with local authorities was continued by the circularization of all city and state police offices, and sheriffs in the 5 state area. These circulars consisted of a Regional "Newsletter", instructions relative to radiological incidents, weapons accidents, and a card designed for reference to affect prompt notification of the Team in the event of an incident in Region 6 (Figure 2).

Front of card

REGION 6

RADIOLOGICAL ASSISTANCE TEAM

COLORADO — IDAHO — MONTANA — UTAH — WYOMING

In the event of an accident involving radioactive material —

NOTIFY

The Manager

Idaho Operations Office

U. S. Atomic Energy Commission

Idaho Falls, Idaho

Phone JA2-6640 — Idaho Falls, Idaho

Back of card

The Radiological Assistance Plan is a service provided to the public by the U. S. Atomic Energy Commission. Its function is to advise and assist local authorities in dealing with accidents involving radioactive materials.

Radiological Assistance teams are available to local authorities at all times.

For specific instructions regarding initial precautions in the handling of radioactive incidents refer to **"AEC recommended instructions to Local Authorities for dealing with incidents involving radioactive materials."**

Figure 2. Notification card

Team members attended a number of training sessions conducted at other sites for the purpose of orientation in weapons incidents. These were:

a. Two members (1 IDO, 1 PPCo) attended the Emergency Radiation Monitoring Training program at the Nevada Test Site in May.

b. A contractor physician attended the Nuclear Weapons Medical Symposium at Albuquerque in March.

c. Two IDO members attended a training session in October on "Recovery of a Fallout Effected Area" which was sponsored by the U. S. Naval Radiological Laboratory at Camp Parks, California.

Since the inception of the Radiological Assistance Plan in January 1958, the IDO team has responded to 7 incidents in Region 6. Four of these responses were made in 1960. These were:

(1) August 5 - An 1,800 pound cask had leaked liquid on the loading dock at the Garrett Freightlines Depot in Salt Lake City. Investigation revealed no contamination.

(2) November 5 - Facility contamination had occurred during leak testing of a radiographic camera containing a 500 curie cobalt-60 source at the Thiokol Chemical Corporation Plant at Tremonton, Utah. Contamination of the building and equipment was confirmed by the Team which supervised clean-up by plant personnel.

(3) November 13 - A 350-pound box containing a 1 curie fission product source was dropped 8 feet from a Western Airlines plane to the concrete runway of the Salt Lake City Airport. Investigation at the scene showed no evidence of damage or leakage. The shipment was allowed to continue to its destination where the consignee verified the Team's original report.

(4) December 15 - A truckload shipment of radioactive material consigned to the NRTS for burial was found to contain a leaking container while being unloaded at the Pacific Intermountain Express Terminal in Idaho Falls. Investigation of the incident revealed no spread of contamination. The shipment was apparently not in conformance with Interstate Commerce Commission Regulations in several respects and was reported as such to the Bureau of Explosives by the consignee.

D. FUTURE PLANS

1. Environmental Monitoring Program

Future plans for the Environmental Monitoring Program are:

a. Revision of the milk sampling program to procure samples from additional locations surrounding the NRTS.

b. Addition of underground water sampling locations to provide control samples from populated areas upstream on water gradient.

c. To increase the number of air monitoring stations in populated areas to the southwest of the NRTS.

d. Substitution of on-site area monitoring badge data by film badge data from the off-site air monitoring locations.

2. Radiological Assistance and Disaster Planning

Future plans for the Radiological Assistance Plan program are:

a. Additional Division and Team exercises based upon hypothetical situations which could conceivably occur at NRTS installations.

b. Development of a communications potential to utilize the Radio Amateurs Civil Emergency Service (RACES) in the event of a serious accident within Region 6 where other communications facilities would be impaired or unavailable.

c. Intensify training of NRTS emergency personnel (Fire Department and Security) to provide a reserve complement of qualified monitoring personnel.

d. Continued liaison with local authorities by personal contact and distribution of useful information relating to radiological incident procedures.

e. Production of a film of a Team response to be used for local authority familiarization with the Radiological Assistance Team capability.

Chapter 3

PERSONNEL METERING

F. V. Cipperley, Branch Chief

A. SUMMARY

The Personnel Metering Branch furnished complete personnel metering services to sixteen prime contractors at eighteen separate project areas of the NRTS.

Only one individual had an accumulated annual exposure to external penetrating radiation in excess of the recommended Radiation Protection Guide of 5.0 rem (5.06) and 85% of all accumulated annual exposures were within the range of 0 to 500 mrem. The over-all NRTS average exposure was 0.29 rem. During the year 3,056 films were specially processed at the request of the contractor health physicists with 0.93 rem being the highest exposure for any weekly period.

Results of 11,352 urinalyses were recorded of which only 146 or 1.29% were statistically significant and all were well below 10% of the National Committee on Radiation Protection (NCRP) recommended maximum permissible body burden for the isotope of interest.

Programs were devised for the automatic processing of data for the Weather Bureau and for the Ecology, Medical Services, and Site Survey Branches. Further calibrations were performed on the Personnel Neutron Threshold Detectors as well as refinement of the Exposure Determination Procedure and continuing research in film dosimetry.

This was accomplished with a total of two less people than in 1959. This represents a total reduction in personnel of approximately 20% since 1957, with a corresponding increase of approximately 37% in the number of persons furnished personnel metering coverage per month.

B. SCOPE

The Personnel Metering Branch is a service organization charged with the responsibility of detection and measurement of external radiation exposures, if any, to personnel. The Branch dispatched its responsibilities during 1960 by furnishing complete, efficient personnel metering services to sixteen prime contractors at eighteen separate project areas. In addition, various special tests were performed for several contractors, research in film dosimetry was continued as well as refinement of our Energy Determination Procedure.

The Branch has effected a reduction in personnel of approximately 20% since 1957, with a corresponding increase of approximately 37% in the number of persons furnished personnel metering coverage per month for an increase of approximately 60% in the number of persons covered per month per Personnel Metering Branch employee during this period and an increase per employee of 122% since the inception of the program. The Branch performance is shown in Figure 1.

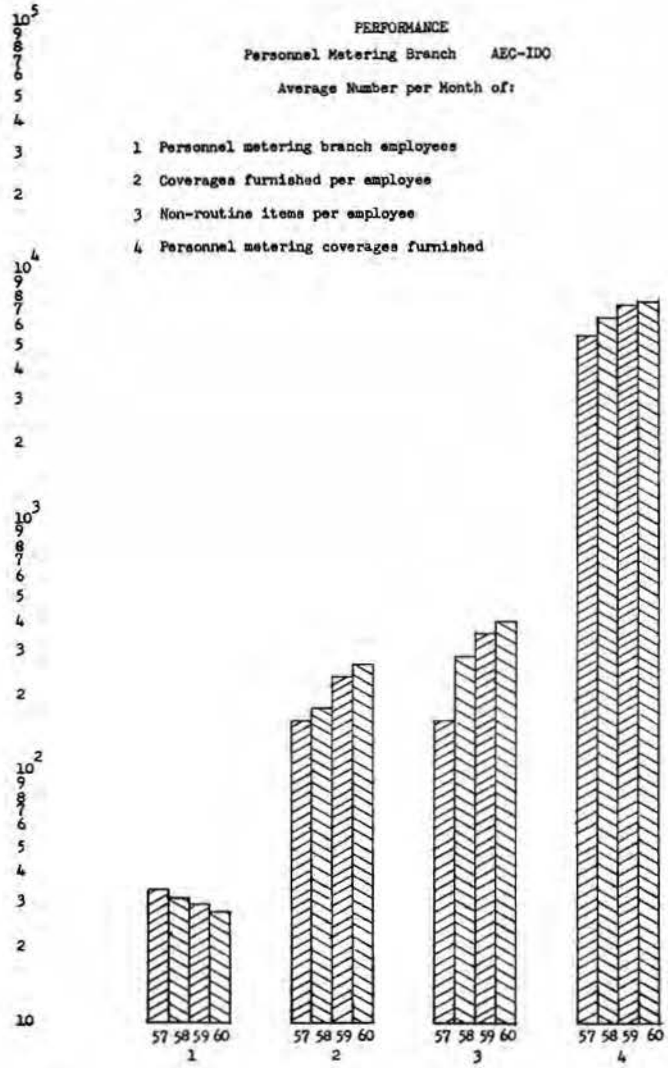


Figure 1. Personnel Metering Branch performance

C. SUMMARY OF MAJOR PROGRAMS

1. Combination Security-Film Badge

The use of the plastic combination security-film badge utilizing DuPont 558 beta-gamma film packets and Kodak Nuclear Track Film (NTA) packets was continued during 1960 with satisfactory results being obtained. Considerable time and effort were expended in refinement of the Energy Determination Procedure. It was established through experimentation that although gamma of an energy above 40 Kev does contribute to the density produced behind the cadmium filter, the magnitude of this contribution varies with the energy. Therefore, the cadmium density as such does not necessarily indicate the proper gamma exposure when converted on a radium gamma calibration curve. This was also shown to be true for the aluminum and open window densities. Figure 2 shows the value factors of the various filters at various energies based on the density ratios of radium to X-rays.

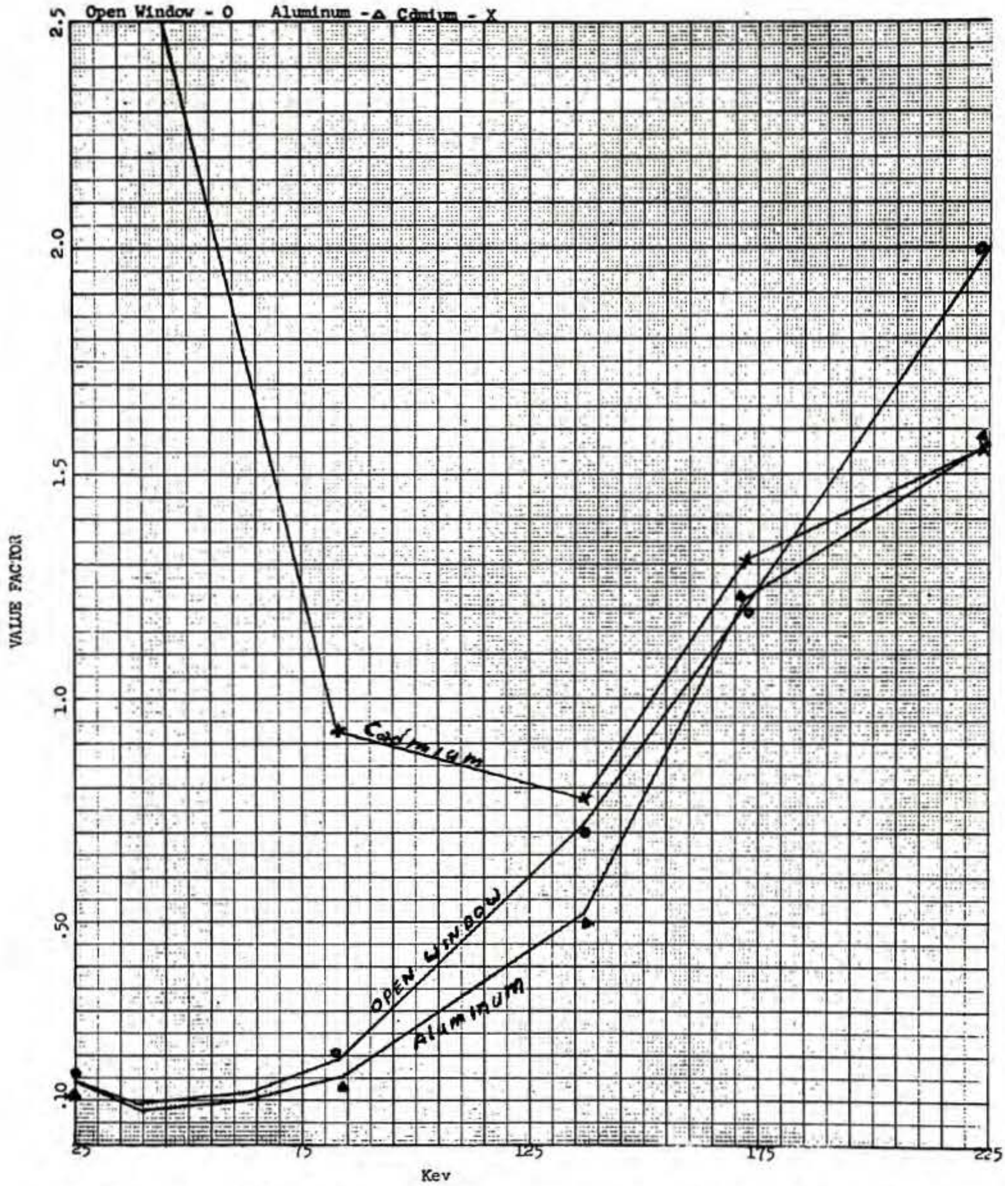


Figure 2. Value factors for filters - density ratios $\frac{Ra}{X\text{-ray}}$ @ various energies

These factors will change somewhat as a function of total exposure, however, their use provides a good estimate of the exposure received from mixed energy radiation. For instance, using DuPont 508 sensitive film, an exposure of 300 mrem of 225 Kev gamma will produce a density behind the cadmium and aluminum filters of ~ 66% that produced by radium and a density in the open window (100 mg/cm^2) area of ~ 50% of that produced by radium, thereby indicating value factors of 1.56 and 2.00 respectively. [illegible] produced in the aluminum filter and open window areas is ~ 8 times that produced by radium while the cadmium filter density ratio is ~ 0.12, thereby indicating value factors of 0.14 and 8.40 as shown by the graph (Figure 3). For exposures to gamma with energies less than 40 Kev, the aluminum density is used as the cadmium and silver filters prevent any density from being formed in the film emulsion except for extremely high exposures. The density ratios for energies in excess of ~ 300 Kev are essentially 1:1.

Figure 3. Automatic data processing room

2. Energy Determinations on Insensitive Film

Experimentally it has been shown that although the value per unit of density is quite different on the DuPont 1290 insensitive film than on the type 508 sensitive, the density ratios for gamma energies are essentially the same. The same procedures may be used as with the 508 sensitive film by substituting the proper value per unit of density.

It was found, however, that the response to beta of the type 1290 is somewhat different than the type 508. This would be expected in the normal situation as the 1290 is shielded in the badge by the 508 film and also because of the great difference in sensitivity between the two film types. The type 508 sensitive film indicates an aluminum to open window to silver ratio of ~2:10:1, whereas the type 1290 insensitive film produces a ratio of ~1.5:6:1. Through application of these conditions, it is possible to carry out type and energy determinations for the occasional high exposures encountered in special tests, etc.

3. Automatic Data Processing Improvements

During 1960, a reproducing card punch, alphabetical interpreter, tape to card printing punch, and a card controlled tape punch were added to the data processing equipment. The card and tape punches were added in preparation for a computer program which will be started in 1961 with an IBM 1620 Computer scheduled for delivery early in March. A considerable amount of time and effort were expended in the preparation and de-bugging of the film density evaluation program in order to have it available when the Computer arrives.

Programs for punched card processing of data were devised and put into operation for the various Branches as follows:

a. Medical Services Branch

(1) Monthly scheduling of physical examinations.
(2) Monthly scheduling of laboratory checks.

b. Site Survey Branch

(1) Monthly environmental monitoring film badge correlation, on-site and off-site.
(2) Quarterly compilation of film badge results.
(3) Quarterly compilation of fallout tray results.
(4) Quarterly compilation of water and air sample results.
(5) Quarterly compilation of telemetering information.

c. Ecology Branch

(1) Quarterly compilation of animal sample results.
(2) Quarterly compilation of vegetation sample results.
(3) Quarterly compilation of milk sample results.
(4) Quarterly compilation of soil sample results.

d. Analysis Branch

(1) Monthly urinalyses scheduling.
(2) Reporting of pre-employment and termination urinalyses.
(3) Recording of urinalyses results.

e. U. S. Weather Bureau

(1) Monthly correlation of meteorological data.

The automation of the personnel metering record and reporting systems has been programmed and in operation since 1958.

4. Visitor Procedure

As we have mentioned in previous reports, the visitor load at the NRTS presents a sizeable problem with 20,000 to 30,000 persons being badged per year. The greatest difficulty was identification and inability to accumulate exposure results on repetitive visitors or those that were subsequently hired by one of the contractors. During 1960, a new system was instituted which eliminated scheduling problems, reduced labor time, and provided a capability of accumulating any exposures received.

The health physics numbers assigned to personnel at the NRTS are strictly index numbers for record keeping purposes made necessary due to duplication, or lack, of payroll numbers, security numbers, and social security numbers. Three separate security groups issue security numbers to personnel of various contractors and large numbers of government employees and professional personnel have neither payroll numbers nor social security numbers. The health physics numbers are non-reassignable and identify a particular individual regardless of his location or affiliation or the periods of service at the NRTS.

Under the new system, pre-numbered film packets are used in un-numbered badges, thus requiring no X-ray operation for identification. The badges are serviced on a random basis at the convenience of the Personnel Metering group. The packet number is entered on the visitor insert at the time the used badges are serviced. The inserts and packets are taken to the Personnel Metering lab and the badges returned to Security for re-use. Visitor lists are prepared in random order from each group of inserts. The films are processed and the results posted on the visitor lists. If a visitor film indicates an exposure was received, this individual becomes a matter of record. The master index is checked for the presence of an assigned health physics number; if found, the necessary cards are prepared using this number on the following regular exposure report for the area concerned and the exposure will be added to the individuals NRTS total. If no number is found, a number will be assigned to the individual and the above records prepared. Approximately 98% of the visitors receive statistical zeros, and these data appear only on the visitor list prepared at the time of the badge servicing. These lists are retained indefinitely, as well as the film, in case any question should arise at a later date.

This system eliminates the need for X-ray apparatus to service the visitor badges, allows servicing at the convenience of the group, and provides a means of accumulating all exposures received by transient visitors regardless of the location or frequency of their visits. It also eliminates the necessity of maintaining a particular series of numbered badges for temporary use.

D. SPECIAL ACTIVITIES

1. Calibration of Personnel Neutron Threshold Detectors

Further studies were made of counting and calibration procedures on the personnel neutron threshold detectors which are incorporated in all health physics badges at the NRTS. These detectors are composed of 3.0 grams of sulphur 2-9/16" x 1/4" x 0.15", 0.28 grams of indium 1-7/8" x 1/4" x 0.005", and two gold foils of 0.028 grams each 5/32" diameter x 0.005", one of which is encased in 0.020" of cadmium. Each detector is enclosed in a sealed Saran wrapper. The Saran wrap provides additional strength to the molded sulphur insert, contains the elements in case of breakage, and prevents contamination (Figure 4).

Detection of exposure to 1.0 rad or more of thermal neutrons is easily accomplished by scanning the indium foil with G-M type survey instruments as much as four hours following exposure. By employing a one-minute count in a scintillation well counter, the indium foil will detect an exposure of 30 mrem, thermal neutrons, at 70 minutes following the exposure and 300 mrem as long as four hours and fifteen minutes following exposure. The gold foil counted in the same manner will detect a 300 mrem exposure, thermal neutrons, within three days following exposure and 3,000 mrem as long as ten and three-tenths days following the exposure.

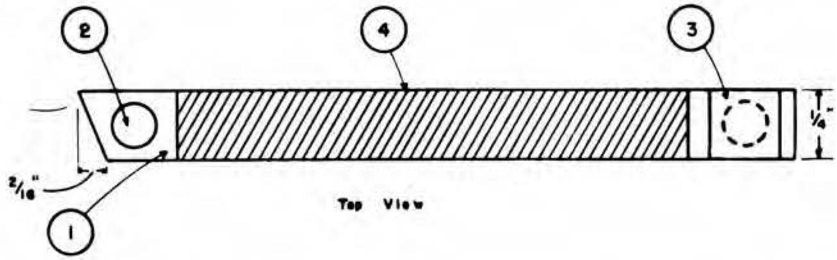
These detection limits coupled with the capability of normalizing the sulphur in the detectors to that in the NAD systems located at strategic positions in the various areas should provide an invaluable tool for the calculation of neutron exposure received in the case of a criticality incident where personnel are involved.

2. Boiler Tube Face Activity Tests

Measurement of residual activity on the boiler tube faces was performed for Westinghouse at A1W. This information was necessary to expedite maintenance on the tube face by determining the deposition of the radioactive material and the radiation levels to be expected. This was accomplished through use of 14" x 17" sheets of type KK radiographic film and special radium gamma calibrations.

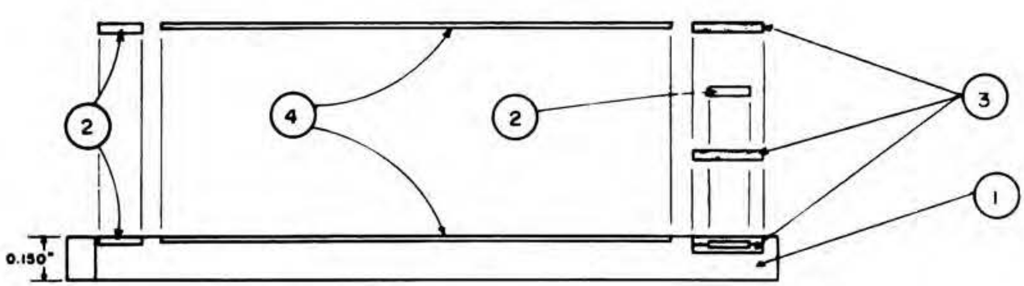
3. Primary Shield Tests

Further primary shield tests were performed for Westinghouse at A1W to determine its efficiency with emphasis being placed on the fast neutron flux. Standard type badges containing neutron film packets and threshold detectors were utilized for these tests. The neutron films were evaluated through proton track microscopy while foil counting techniques were employed in the evaluation of the detectors.



Top View

FOILS ARE MOLDED AS AN INTEGRAL PART OF THE DETECTOR.



Side & Exploded Views

Gold foil on right must be completely enclosed in Cd. A single piece of Cd may be used.

No. Req'd	Pt No	Description		Material
1	1	Molded	2 9/16" x 1/4" x 0.150"	Analytical Grade Sulfur
2	2	Foil	0.005" th'k x 5/32" dia.	High Purity Mint Gold
2	3	Foil	0.020" x 1/4" x 1/4"	Cadmium
1	4	Foil	0.005" x 1/4" x 1 7/8"	Indium

Figure 4. Personnel neutron threshold detector

4. Special Statistical Studies

Special statistical reports were prepared for the Medical Services Branch in an effort to correlate long term exposure to neutrons with lens changes in the human eye. Material for this study was gathered from neutron exposure reports and slit lamp examination results for a large group of people over an extended period of time. Results of the study are reported in Chapter 4 and have been presented to various medical groups.

Also performed during the year were several statistical studies of radiation experience of selected crafts and professions at various installations as well as the NRTS in general.

5. On the Job Training

The following AEC Fellows received training in Personnel Metering as part of the applied health physics program at the NRTS: Messrs. J. W. Fuller and F. L. Galpin, Public Health Service trainees from the University of Michigan; and C. N. Whetstone, E. L. Murri, C. R. Bennett, N. C. Dyer, W. R. Hendee, and L. J. Heuter from Vanderbilt University. Several others received Personnel Metering training during the year, including Ichira Maiyanaga of the Japan Atomic Energy Institute and Dr. H. T. Bambawale of India. Orientation was provided a large number including Dr. W. C. Tait of Chalk River, Mr. James Megow of Harwell, England, and Drs. K. A. Magnusson and P. H. Svenonius of the Research Institute for National Defense in Sweden.

Four new Personnel Metering clerks received on the job training and thirty-six seminars concerning Personnel Metering techniques were held.

6. Non-Routine Processing

As a support group, the Personnel Metering Branch processes various non-routine items used for environmental monitoring, special tests, etc., by the Site Survey Branch, contractors and other groups in addition to their regular activities. The following table shows a comparison of those items processed in 1958, 1959, and 1960:

Table I. Non-Routine Film Processed 1958 - 1960

	5 x 7 Film	14 x 17 Film	Beta-Gamma Film	Neutron Film	Ring Film	Wrist Badges
1958	292	555	6,631	32,618	2,277	144
1959	112	721	16,803	80,743	1,152	82
1960	31	179	7,381	77,850	1,082	61

E. ROUTINE ACTIVITIES

The radiation exposure experience at the NRTS during 1960 was the best since full scale operation was initiated in 1952. The highest accumulated individual exposure to external penetrating radiation was less than 6.0 rem for the year and 85% of all accumulated exposures were within the range of 0 to 500 mrem. The over-all NRTS average accumulated annual exposure was 290 mrem.

Table II presents a comparison of exposures received by IDO personnel in 1958, 1959, and 1960. These results are for AEC and contractor personnel engaged on contracts administered by IDO and do not include visitors or personnel employed on contracts administered by other Operations Offices.

Table II. Radiation Exposures Received at the NRTS by IDO Personnel (AEC and contractor) 1958 - 1960

Exposure Level, rem	Average Exposure rem (1960)	Group A 1960	Group B 1960	Group C 1960	Group D 1960	Group E 1960	Total			%		
							1958	1959	1960	1958	1959	1960
0 - 0.5	0.02	1082	493	2067	35	65		2709	3742		76.87	85.10
0.5 - 1	0.72	192	0	85	1		3001*	277	278	84.73*	7.86	6.32
1 - 2	1.47	182	1	37			277	246	220	7.82	6.98	5.00
2 - 3	2.63	86		8			156	150	94	4.40	4.25	2.14
3 - 4	3.48	49		2			54	51	51	1.52	1.45	1.16
4 - 5	4.36	11					25	43	11	0.72	1.21	0.25
5 - 6	5.06	1					11	19	1	0.31	0.54	0.02
6 - 7	0						9	9	0	0.25	0.26	0
7 - 8	0						4	9	0	0.11	0.26	0
8 - 9	0						4	5	0	0.11	0.14	0
9 - 10	0						1	2	0	0.03	0.06	0
10 - 15	0						0	2	0	0	0.06	0
> 15	0						0	2	0	0	0.06	0
TOTALS	0.29#	1603	494	2199	36	65	3542	3524	4397			

* Total number and percent of exposures of 0 - 1.0 rem for 1958

Based on total exposure received by all regularly covered personnel at the NRTS regardless of Contractor

A comparison of the number of routine processing of Personnel Metering badges in 1958, 1959 and 1960 is shown in Table III.

Table III. Film Badges Serviced at the NRTS 1958 - 1960

Month	Regular 1960	Temporary 1960	Total 1960	Approximate Number of PM Coverages 1960
January	10,971	4,287	15,258	7,933
February	10,405	4,888	15,293	7,279
March	12,118	3,983	16,101	7,274
April	10,569	4,525	15,094	7,978
May	11,220	3,825	15,045	7,118
June	13,378	4,573	17,951	7,898
July	11,312	4,419	15,731	8,062
August	12,124	4,849	16,973	8,332
September	11,592	4,602	16,194	8,219
October	10,857	3,619	14,476	7,889
November	11,911	3,559	15,470	7,504
December	10,979	3,445	14,424	7,238
Totals				**Average**
1958	188,587	31,520	220,107	6,600
1959	148,659	48,442	197,101	7,509
1960	137,436	50,574	188,011	7,727

Twenty-six thousand twenty-one visitors were badged during 1960 with more than 98% receiving statistical zeros and all well below 300 mrem.

Table IV shows a comparison of the radioactivity results of urinalyses performed in 1959 and 1960. These urinalyses are performed by the Analysis Branch and the results are incorporated in the personnel exposure records of the people concerned by the Personnel Metering Branch. Out of a total of 11,352 urinalyses performed only 146 yielded statistically significant results, all of which were less than 10% of the NCRP maximum permissible body burden for the isotope of interest.

Table IV. Urinalysis 1959 and 1960

Isotope of Interest	Type of Activity	Total Number Performed 1959	Total Number Performed 1960	Number Statistically Significant 1959	Number Statistically Significant 1960	% of Total Statistically Significant 1959	% of Total Statistically Significant 1960	Highest* Result 1959	Highest* Result 1960
	Gross β	8,546	8,546	65	15	0.76	0.18	18,820 ± 632 d/m/5ml	992 ± 40 d/m/5ml
	Gross α	2,433	2,712	174	129	7.15	4.76	35,972 ± 310 d/m/5ml	19,817 ± 105 d/m/5ml
Am	α	2	0	0	0	0	0	Insignificant	0
Ba-139	β	20	0	16	0	80.00	0	120 ± 0.8 d/m/ml	0
I	β	0	9	0	2	0	22.22	0	9,992 ± 80 d/m/ml
Pu-239	α	18	5	0	0	0	0	Insignificant	Insignificant
Sr-90	β	3	105	3	0	100.00	0	4.12×10^{-2} d/m/ml	Insignificant
Sr-91	β	20	37	19	0	95.00	0	388 ± 1.6 d/m/ml	Insignificant
Th	α	7	0	0	0	0	0	Insignificant	0
U-233	α	17	3	1	0	0.06	0	180 ± 4.0 d/m/ml	Insignificant
TOTALS		11,066	11,352	278	146	2.51	1.29		

* All less than 10% of the NCRP recommended body burden for the isotope of interest

F. FUTURE PROGRAMS

1. Fast Neutron Measurement Utilizing NTA Film Density

Experiments are continuing to explore the feasibility of using density produced on type NTA film to measure fast neutron exposure, as mentioned in the 1959 Annual Report of the Health and Safety Division, also to reduce fogging of the NTA emulsion due to gamma exposure.

2. Computer Programming

Data reduction programs are planned and/or in process for analysis of results obtained from scintillation counters, beta counters, and low background proportional counters furnished by the Analysis Branch as well as gamma spectrum stripping and analysis of multichannel analyzer results utilized for isotope identification, total body counting, etc.; analysis of telemetering results for the Site Survey Branch; and analysis of soil, animal, and vegetation sample results for the Ecology Branch. Various other computer programs for the Weather Bureau and other Branches of the Health and Safety Division are in the preliminary planning stage.

3. Automatic Film Reader

A new automatic film reader is in process of being developed by the Instrument and Development Branch and will be available to the Personnel Metering Branch some time next year. This reader will provide identification and exposure information on punched paper tape which can be fed directly into the 1620 Computer. The computer will perform the type, energy, and exposure determinations and produce the results either in punched paper tape or in punched cards which are then used to generate the necessary exposure reports, statistical breakdowns, etc. This should eliminate any manual handling of the film after darkroom processing is completed except for disposition of the small number of irregularities normally encountered.

4. Research in Film Dosimetry

A physicist is being added to fill a staff vacancy in the Personnel Metering Branch early next year whose primary responsibility will be film dosimetry research. Experiments will be conducted with the type 558 beta-gamma film packets in all phases of response and density ratios for various types and energies of radiation and differing magnitudes and combinations of exposure, in an attempt to provide a more accurate method of energy determination and exposure evaluation. Research will also be conducted in an effort to devise a better method of neutron exposure detection and evaluation.

Chapter 4

MEDICAL SERVICES

George L. Voelz, M.D., Branch Chief

A. SUMMARY

In 1960, the Medical Services Branch maintained the growth pattern which has characterized its past five years. Since 1956, the number of dispensary treatments increased 39% and physical examinations increased 125%. A total of 9,511 employee visits to the AEC Central Facilities Dispensary during 1960 represents a 13% increase from the previous year. An 18% increase in physical examinations the past year resulted in a total of 1,157 examinations. A grand total of 24,015 employees visited the AEC and contractor dispensaries cooperating with IDO Medical Services.

The addition of a physician (Assistant Branch Chief) and a clerk-typist to the staff reflects this growth trend.

Several changes in the medical records management has resulted in more satisfactory scheduling of periodic physical examinations, better control of medical restrictions for construction workers, and a unified system for the inactive medical records. The addition of automatic blood cell counting techniques will increase the laboratory capability.

B. INTRODUCTION

The multiplicity of operating contractors at the National Reactor Testing Station has provided an opportunity for the Atomic Energy Commission to provide a centralized medical service for the contractors. This service eliminates the necessity for each contractor to provide duplicate medical facilities staffed by part-time physicians. During its 10 years of operation, the Medical Services Branch has evolved from a dispensary staffed by a first aid attendant to a full-time comprehensive industrial medical service. During 1960, it provided the in-plant medical service for six contractors; namely, Phillips Petroleum Company, Argonne National Laboratory, Atomics International Division of North American Aviation Incorporated, Combustion Engineering Incorporated, and Aerojet General Nucleonics. First aid and emergency medical care were also given to construction contractor personnel working at the Testing Station. Laboratory and X-ray examinations are provided to Westinghouse Electric Corporation and General Electric Company employees as requested by their medical departments.

1. Facilities

Medical Services operates the Central Facilities Dispensary which is equipped to perform physical examinations and to evaluate and treat occupational injuries and minor non-occupational illnesses. The diagnostic facilities include a clinical laboratory and X-ray department. The dispensary is equipped to provide diathermy and ultrasonic treatments and minor surgical procedures. A small room in the basement is available for emergency care of personnel who are radioactively contaminated. The addition of a third ambulance during 1960 makes emergency transportation available from any of three AEC Fire Stations.

Several contractors have dispensaries in their plant areas staffed by registered nurses. The Argonne National Laboratory initiated a medical dispensary service in EBR-I and EBR - II areas during 1960. An Argonne nurse spends a half-day in each area. Phillips Petroleum Company maintains dispensaries staffed by a registered nurse at the MTR-ETR and the CPP areas during the day shift. The Phillips dispensaries are visited for one hour on each of the night shifts by the AEC nurse. AEC Medical Services works very closely with these company dispensaries to provide examinations, treatments, medical recommendations, and consultations on plant problems. The ANP medical dispensary facilities were inspected and reviewed by IDO Medical Services this year.

2. Personnel

During 1960, two additional positions were made available to complete a staff of twelve employees. The new positions were for a physician as Assistant Branch Chief and a clerk-typist. The latter was on loan to the Division for other Branch vacancies for a majority of 1960. The Branch is now staffed with two full-time industrial physicians licensed to practice medicine in Idaho. The nursing staff consists of a nurse supervisor and five registered nurses. Four shift nurses provide professional attendance at the dispensary at all times including holidays and weekends. One nurse spends part of her time visiting construction areas to provide close liaison with the first aid attendants and to perform medical follow-up visits at the construction sites. A clinical laboratory technician and an X-ray technician operate their respective departments. The office and record work is performed by two clerk-typists.

C. MEDICAL SERVICES PROJECTS AND ACTIVITIES OF 1960

1. Medical Records

During 1960, several significant changes have been made in medical records management. Since the start of medical services at the NRTS, several types of inactive medical records have accumulated. These records were consolidated into one system of file reference cards retained at the dispensary and the records transferred to the central records storage for retention.

A system to schedule laboratory work and physical examinations for all AEC and IDO contractor personnel was devised and placed into operation. All active medical records were reviewed to schedule employees for examination. Previously, the examinations had been scheduled either by one of the nurses in the plant areas or by request from the individual. This resulted in poor schedule control by the Medical Services Branch, and it was not possible to concentrate the examinations where the greatest benefit could be anticipated. The new system has proved to be a valuable improvement in the medical program and is providing better distribution of medical examinations.

The scheduling system is maintained by recording the individual's name, security number, employer, work area, and next physical examination date on IBM cards. A monthly examination list is prepared and forwarded to the contractors for scheduling at the CFA dispensary. A similar monthly list for annual laboratory work is also prepared for those persons who are not scheduled for a complete physical examination in that year.

The interval between complete physical examinations is dependent upon the employee's work assignment, age, and health status. Unless the examining physician specifies a shorter interval, the following schedule has been employed:

AGE	RADIATION AREA EMPLOYEES (Badged)	NON-RADIATION AREA EMPLOYEES (Not-Badged)
18-24	4 years	at age 30
25-39	3 years	5 years
40-49	2 years	3 years
50-59	1 year	2 years
over 60	1 year	1 year

A third record change was the initiation of a medical tag on security files for persons with known health hazards who are employed at the NRTS. This plan was conceived to keep track of construction personnel who are employed without medical examinations and who frequently are hired by construction contractors without knowledge of serious medical problems which are hazardous to the individual as well as his fellow workers. When the medical department is notified that a person with a medical tag is beginning work at the NRTS, his new employer is advised of the work limitations recommended for the individual. This system provides information to aid in accident prevention on the construction projects where pre-employment medical examinations are not performed. The necessity for such control was demonstrated during the year when an individual, whose tag was inadvertently missed during an on-site transfer of personnel between companies, fell from scaffolding and injured himself. Proper functioning of the medical tag system would have resulted in advising his new employer that Medical Services would recommend no work aboveground for him.

2. Medical Record Research

The results of 516 eye examinations on 379 persons performed since 1952 at the NRTS were reviewed and analyzed. The examinations were performed to record any abnormal lens opacities detected by slit lamp examination of nuclear reactor workers. The major conclusion of the study was that there were no radiation cataracts attributable to occupational exposures among the 34 cataracts identified. A 4% incidence of polychromatic posterior subcapsular plaques and a 16% incidence of other minor posterior subcapsular opacities were considered to indicate the relative frequency with which minor, insignificant lens changes may be noted in the area of the lens in which early radiation injury is first seen. Since the initial study, several hundred additional examinations have been reviewed and coded on IBM cards for future study.

3. Automatic Blood Cell Counting

During the past year, it was recognized that the number of blood counts performed by the laboratory should be increased to provide annual screening studies for persons employed in radiation areas. In addition to its diagnostic screening value, it would compile more complete baseline hematology studies on which to evaluate blood studies following radiation exposures. It is anticipated that the laboratory workload will nearly double with this program. Therefore, a Coulter Counter (Figure 1) was added to the laboratory to utilize automatic blood cell counting techniques. Some initial work was completed to correlate the results of the automatic system with the standard hemocytometer (visual method) technique. It is anticipated that the automatic system will be employed full-time early in 1961.

Figure 1. Automatic blood cell counting apparatus

4. Revision of Medical Services Handbook

The Medical Services Handbook was completely revised during 1960. This handbook outlines the administrative policies and procedures on which the Branch operates. Another section specifically outlines the standard procedures for NRTS (IDO) nurses including emergency first aid procedures, general nursing instructions, drug administrations and restrictions, and standard therapeutic orders. The handbook reflects current policies and recommendations of the Atomic Energy Commission, the Council on Industrial Health of the American Medical Association, and the American Association of Industrial Nurses.

5. Medical Services Training Programs

Arrangments were made for the Assistant Branch Chief to receive special training in the field of radiological health and to become more familiar with local NRTS radiological techniques and problems. He participated in portions of the Health Physics Fellowship training program conducted at the NRTS and attended the U. S. Public Health Service course, "Medical Aspects of Radiological Health", presented at Cincinnati, Ohio.

A weekly staff meeting is held for the Medical Services Branch personnel and all contractor nurses. Typical subjects considered at these meetings during the year included beryllium toxicity, industrial dermatitis, handling of radioactively contaminated patients, effects of nuclear weapons, treatment of snake bite, whole body counting techniques, noise hazards and their control, and immunization procedures review.

A two-week training visit at NRTS was arranged for Dr. H. T. Bambawale of Bombay, India, following his year's training in radiation biology at the University of Rochester.

D. 1960 MEDICAL SERVICES STATISTICAL REPORT

1. Dispensary Visits

In 1960, 6,068 personnel received treatment or consultation at the CFA Dispensary and an additional 3,443 visits were made for physical examinations, laboratory or X-ray examinations, and sample collections. The 9,511 total visits represent an increase of 13% over 1959. The number of treatments and consultations increased 18% compared to last year.

Table I represents patients seen at CFA Dispensary for treatment or consultation during 1960, and Table II tabulates the number of treatments in contractor-operated facilities cooperating with the AEC Medical Services Branch.

Table I. 1960 CFA Dispensary Treatments and Consultations

Company	Number of Treatments Occupational	Non Occup.	Total	Per cent
Phillips	615	2,536	3,151	52.0
AEC	108	1,055	1,163	19.2
Construction Contractors and Others	641	343	984	16.1
Argonne	65	167	232	3.9
Other Federal Employees*	45	118	163	2.7
Atomics International	43	93	136	2.2
Westinghouse	71	42	113	1.8
Aerojet	16	50	66	1.8
Combustion Engineering	4	56	60	1.0
Totals	1,608 (26.5%)	4,460 (73.5%)	6,068	100.0

* includes all Federal employees except AEC, i.e., U.S. Weather Bureau, U.S. Geological Survey, U.S. Public Health Service, U.S. Navy, U.S. Army, etc.

Table II. Treatments in Contractor Dispensaries

Dispensaries	Occupational	Non Occupational	Total
CPP (Phillips)	228	1,361	1,589
MTR-ETR (Phillips)	1,033	5,610	6,643
EBR-I - EBR-II (Argonne)	99	478	577
FLUOR Corporation*	121	190	311
FIRST AID STATIONS (Construction)	738	328	1,066
Totals	2,199 (21.6%)	7,967 (78.4%)	10,186

*Fluor Dispensary operated from January to March 1960.

Total treatments and consultations in all facilities in 1960 was 16,253. The grand total for all dispensary visits was 24,015. This total represents physical examinations, immunizations, and sample collections in addition to treatments and consultations. This was a 3% increase over last year.

The number of treatments administered at the CFA Dispensary for the past five years is shown in Figure 2. The 39% increase experienced during this time has been nearly entirely due to non-occupational visits.

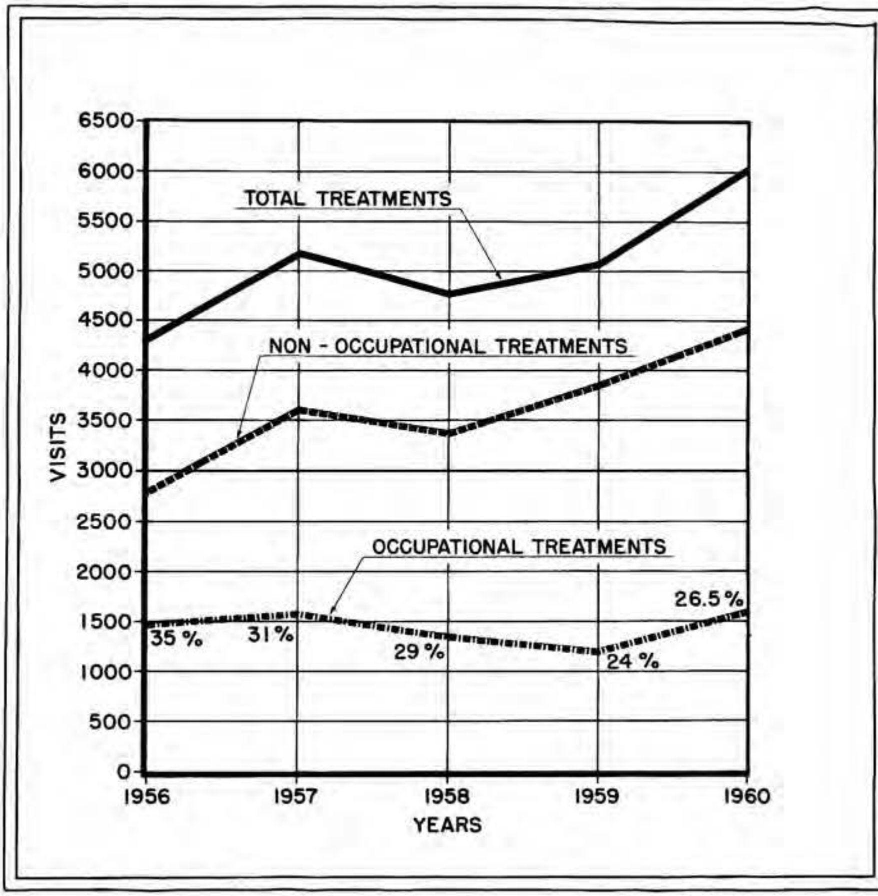


Figure 2. Treatment visits at CFA Dispensary 1956 - 1960

The most common types of occupational injuries seen at the NRTS are tabulated in Table III, 73% of these injuries were to extremities, 6% to the head, 7% to the trunk, and 14% were eye injuries.

The tabulation indicates the high incidence (65%) of lacerations, cuts, contusions, and abrasions (i.e., skin wounds) seen in our dispensaries (Figure 3). A major conclusion is that 316 out of the 336 eye injuries (i.e. wounds, foreign bodies, burns, and flash burns) would be largely avoidable by more universal application of safety glasses and

Table III. 1960 Occupational Injuries at the NRTS

		Extremities		Trunk		Head		Eyes	
	Total	A*	B**	A*	B**	A*	B**	A*	B**
Skin wounds (all types)	1,573	980	421	30	18	70	30	6	18
Foreign bodies	335	67	35	00	00	4	2	112	115
Strains & sprains	188	48	36	53	51	00	00	00	00
Burns	184	92	50	4	2	17	7	4	8
Flash burns	53	00	00	00	00	00	00	18	35
Dermatitis (Conjunctivitis)	49	14	11	3	00	00	1	13	7
Blisters	22	21	11	00	00	00	00	00	00
Fractures	15	4	6	4	1	00	00	00	00
Hernias	2	00	00	2	00	00	00	00	00
Headaches	4	00	00	00	00	3	1	00	00
Sub Total		1,226	560	96	72	94	41	153	183
Total	2,425	1,786 (73%)		168 (7%)		135 (6%)		336 (14%)	

A* Includes AEC and all AEC operating contractor personnel.
B** Includes all construction contractor personnel.

Figure 3. Minor surgical care is an important medical service since 65% of occupational injuries were skin wounds

2. Physical Examinations

A total of 1,157 personnel received physical examinations in 1960, an increase of 18.5% over 1959. Table IV categorizes the number and type of physical examination by contractor. The growth of the physical examination program since 1956 is illustrated in Figure 4.

Table IV. 1960 Physical Examinations

	Pre-placement	Periodic	Termi-nation	Total	Per cent
Phillips	40	381	238	659	57.0
Argonne	111	86	28	225	19.4
AEC	41	83	32	156	13.5
Combustion Engineering	25	3	64	92	8.0
Atomics International	12	7	1	20	1.7
Others	2	2	1	5	.4
Totals	231	562	364	1,157	100.0

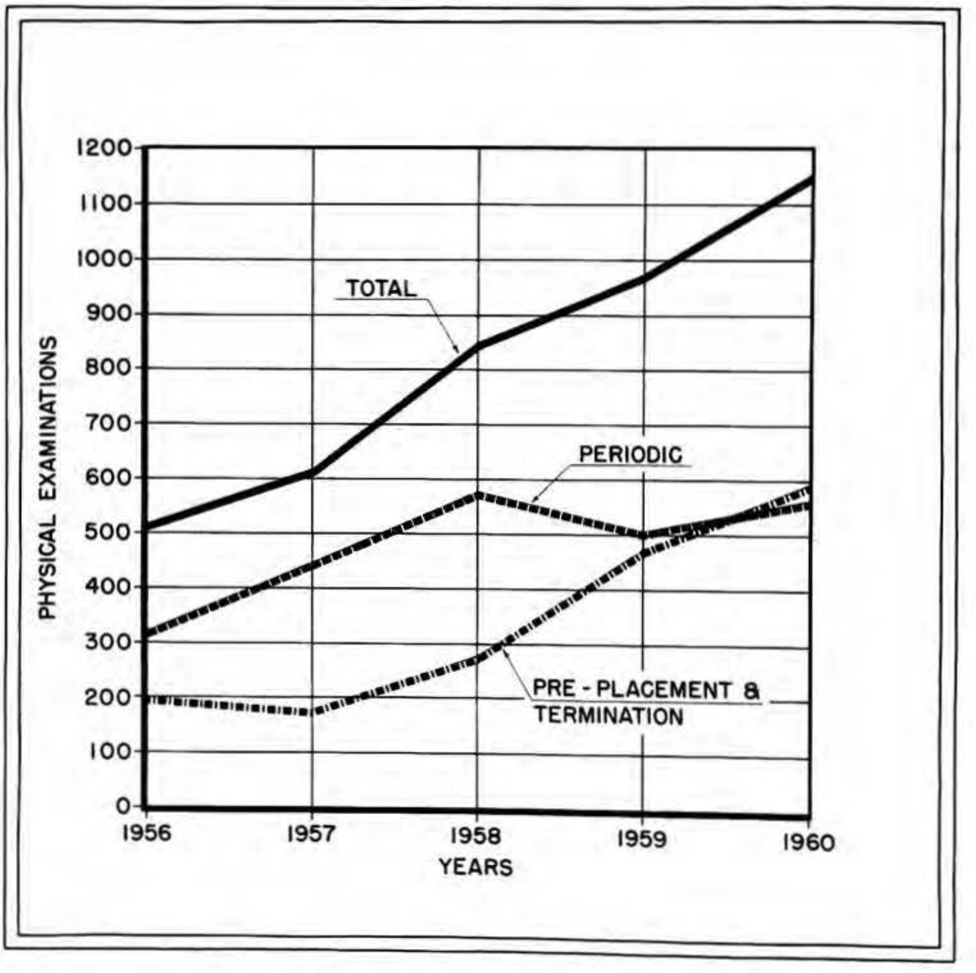


Figure 4. Physical examinations performed by the Medical Services Branch 1956 - 1960

Table V summarizes the most common diagnoses on the 1960 physical examinations. Table VI shows the most common new diagnoses, 68.5% of which were detected before symptoms occurred.

Table V. Most Common Diagnoses (1,157 exams)

	Number	Per cent
Normal	309	27
Vision correction required	256	22.0
Overweight	150	13.0
Hay fever	72	6.1
Eye muscle imbalance	32	2.8
High blood pressure	32	2.8
Hearing loss	31	2.7
Drug sensitivity	31	2.7
Defective color vision	30	2.6
Recurrent back strains	24	2.1
Hemorrhoids	22	1.9
Prostate disease	21	1.8
Peptic ulcer or recurrent gastritis	19	1.6

Table VI. Most Frequent New Diagnoses (1,157 exams)

High blood pressure	18	1.5
Prostate disease	8	.7
Cataract	3	.26
Anemia	3	.26
Dermatitis	3	.26
Hernia	2	.17
Diabetes mellitus	2	.17

X-rays were taken on 1,939 NRTS personnel during 1960. This represents a 14% increase from last year. A total of 9,283 laboratory procedures performed on 1,826 employees was approximately an 8% increase over the previous year. The gradual growth of X-ray and laboratory work is graphically shown in Figure 5.

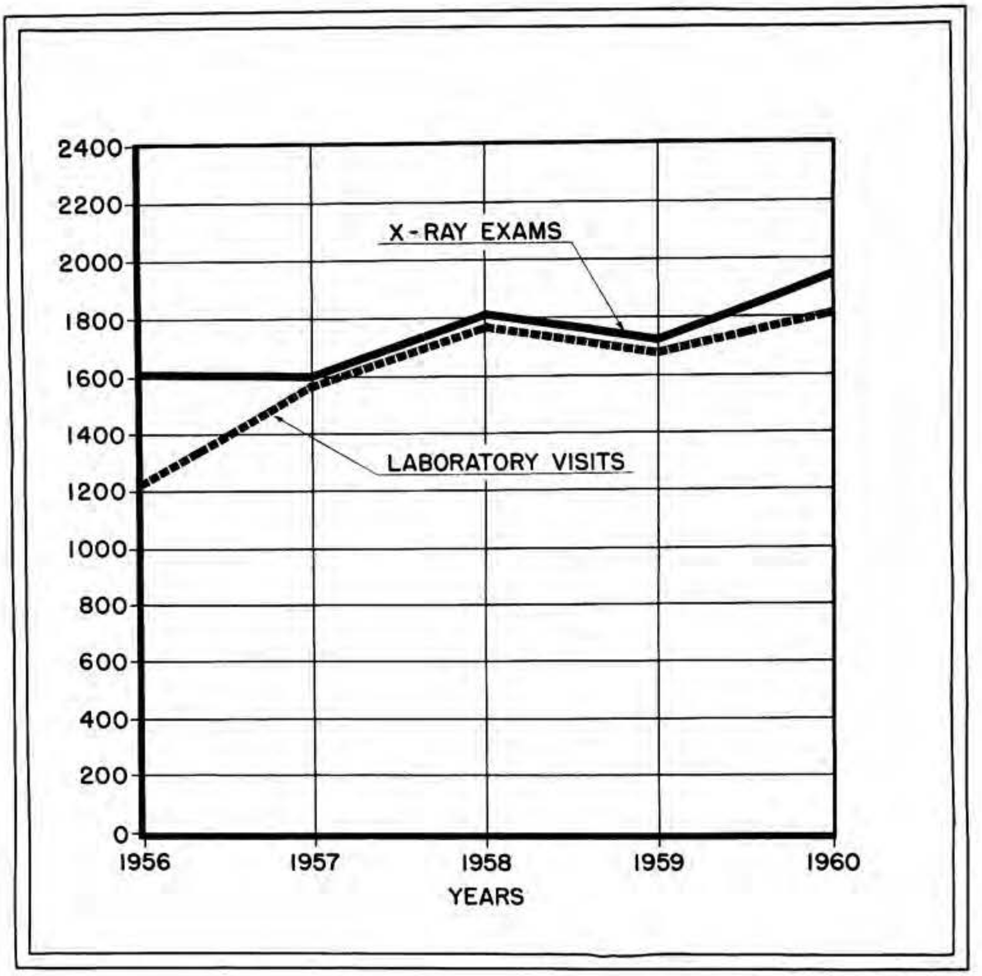


Figure 5. X-ray and laboratory visits at CFA Dispensary 1956 - 1960

Specific laboratory examinations performed in 1960 are enumerated in Table VII.

Table VII. 1960 Laboratory Examinations

Hemoglobin	1,720
Hematocrit	1,708
White Blood Count	1,773
Differential Cell Count	1,772
Urinalysis	1,694
Serology Samples	437
Electrocardiograms	155
Miscellaneous*	24
Total	9,283

*Includes red blood count, cholesterol, glucose tolerance, blood sugar, uric acid, sedimentation rates, bilirubin, and cephlin flocculation.

Abnormalities were found on 73 laboratory procedures and 11 X-rays performed in conjunction with physical examinations. In addition, 8 abnormal electrocardiograms were noted in those studies performed on physical examinations.

3. Industrial Medical Consultations

An important preventive aspect of an industrial medical service is the detection of potential health problems in the plants. These are investigated by the industrial hygienist and the medical department for recommendations regarding future control. During 1960, medical examinations and recommendations were provided for such problems as potential beryllium exposures, dermatitis due to plastics, fume exposures of soldering flux, oxides of nitrogen, solvents, chemical conjunctivitis due to alkali dust and acid fumes, and heat exposure.

E. TALKS

The 1960 Idaho State Nurses' Convention held in Idaho Falls in October featured a "Conference on Radiation." Dr. Voelz was instrumental in arranging the one-day program which covered radiation fundamentals, biological effects of radiation, and medical applications of radiation and radioisotopes.

The following talks were given by Dr. Voelz during 1960:

1. HEALTH PROBLEMS ASSOCIATED WITH IONIZING RADIATION, presented at the Southeastern Idaho Public Health Staff Conference, Idaho Falls, Idaho.

2. INDUSTRIAL EYE INJURIES AND THEIR PREVENTION, presented to Southeastern Idaho Optometrist's Association, Blackfoot, Idaho.

3. AN EYE SURVEY IN NUCLEAR REACTOR WORKERS TO DETECT RADIATION CATARACTS, presented at the XIII International Conference on Occupational Health, New York City.

4. AN EYE SURVEY IN NUCLEAR REACTOR WORKERS TO DETECT RADIATION CATARACTS, presented to Eastern Idaho Safety Engineers, Idaho Falls, Idaho.

5. AN EYE SURVEY IN NUCLEAR REACTOR WORKERS TO DETECT RADIATION CATARACTS, presented to Eastern Idaho Section, Health Physics Society, Idaho Falls, Idaho.

6. RADIATION AND HEALTH, presented at the Naval Reserve Nuclear Science Seminar, Idaho Falls, Idaho.

7. CHRONIC EFFECTS OF RADIATION, presented at the Idaho State Nurses' convention, Idaho Falls, Idaho.

8. REPORT ON THE 13TH INTERNATIONAL HEALTH CONFERENCE, presented to the Pacific Northwest Section of American Industrial Hygiene Association, Richland, Washington (read by John R. Horan).

9. THE NEED FOR AEC VITAL STATISTICS STUDIES, presented at the AEC Health and Safety Personnel Conference, Berkeley, California.

F. FUTURE PROJECTS

1. Inactive Medical Records Storage

Potential legal claims, which could develop in the future due to the prolonged latent period of late or delayed radiation effects as well as the fact that there is a normal incidence of these same diseases, make prolonged preservation of medical records desirable. The volume of inactive medical records which are expected (currently 4-5 cu. ft. per year) brings up the consideration of microfilm tehcniques for storage. It is anticipated that the Branch will study the advisability of changing their present methods of storing the original documents.

2. Laboratory Projects

Two studies which are being considered for minor research projects in conjunction with the present laboratory work include a study of normal blood count statistics and a study of platelet counting techniques. The former study has been done by many groups but with the introduction of automatic counting systems it is felt that a current study would be profitable. A practical platelet counting technique, which is accurate at abnormally low levels as seen in severe radiation injury, is the objective of the other study.

3. Routine Whole Body Radiological Surveys

The initial work of the IDO whole body counter for gamma emitting isotopes has already shown the value of this technique as an adjunct to the routine radiological urinalysis program. Consideration will be given to incorporating a screening-type whole body count in conjunction with the periodic physical examination program.

Chapter 5

HAZARDS CONTROL

R. V. Batie, Branch Chief

A. SUMMARY

In 1960, the Hazards Control Branch, formerly the Safety and Fire Protection Branch, continued the development of an effective program encompassing IDO direct activities and the operational and construction contractor activities at the NRTS. The nuclear safety program is under development with accomplishments in the transport of fissionable materials and nuclear accident dosimetry. Requests for industrial hygiene services increased 27%. Surveys revealed ventilation equipment in general need of design improvement. Improvements were obtained through initiation of a high efficiency filter inspection program. NRTS fire loss of $9,623 from 29 fires was higher than the previous two years but only 62% of the 5-year average AEC comparative loss. Several major fire protection improvements were realized through recommendations made in past surveys, and NRTS facilities are approaching the "improved risk" standards. Inspectional activities on built-in fire protection equipment was given greater emphasis. Fire Department training increased 228% and included quarterly officer training sessions on tactical fire problems. A drill tower and support facility were completed to aid field training of Fire Department and plant brigade personnel. Over-all disabling injury rates reflected no significant change; however, the severity rate increased sharply due to a fatality and two permanent partial injuries. Motor vehicle accidents increased slightly but still do not exceed the average frequency rate of AEC. Motor vehicle accident costs were only 57% of the average AEC cost of accidents per 1,000 miles of operation.

B. SCOPE

The Hazards Control Branch has the primary responsibility for the continued development and execution of an effective program encompassing the specialized functions of Nuclear Safety, Industrial Hygiene, Fire Engineering, Safety Engineering, and Fire Protection to minimize danger from all hazards to life or property through elimination or control of conditions or procedures capable of causing personal injury, occupational disease, or factors likely to result in work interruptions, or damage to equipment, materials, or property. Coordination, administration, and guidance to IDO direct activities and the operational and construction contractor programs are effected through: day-to-day contacts; field and procedural reviews; annual surveys; interpretation of established codes and standards; engineering design reviews; development of new or revised standards or policies; meetings and seminars; dissemination of educational material; incident investigations; and other media for study, research, analysis or evaluation. The technical and special services of the Branch are extended to three AEC Operations Offices, in addition to IDO, having activities and facilities at the NRTS but who do not have Hazards Control staff personnel located at the Site.

C. PROGRAM COSTS EVALUATION

The over-all NRTS direct operating costs for safety, fire engineering, and industrial hygiene (inclusive of salaries, transportation, quarters, instruments, and other operating expenses, but exclusive of safety equipment used by working force, personnel time in safety training, meetings, health physics, etc.) have been calculated at 0.41% of the combined AEC-NRTS operating and construction budget. This figure compares favorably with the 0.5% norm originated by DuPont and used by National Safety Council and industry. These direct operating costs represent a cost to the Government of approximately $51 per employee per year. The Hazards Control Branch operating budget (exclusive of Fire Department) represents 1.5% of the IDO-AEC operating budget. The Fire Department cost evaluation is based on a norm established by the AEC Washington office of $1000/million dollar valuation. IDO Fire Department costs during 1960 were $914/million dollars of Site valuation.

D. SUMMARY OF MAJOR PROGRAMS

1. Nuclear Safety

The first year's activities of a nuclear safety engineer involved (a) review-approval of fissionable materials shipments originating at the NRTS and those originating elsewhere which utilize NRTS carrier equipment, (b) review and comment on nuclear safety aspects of design drawings for new facilities, (c) familiarization with fissionable materials storage and handling procedures of the various contractor facilities, (d) participation in the investigation and report on criticality accident of October 1959 at the CPP, (e) consideration of basic standards for nuclear safety for NRTS facilities, and (f) coordination of nuclear accident dosimetry program at the NRTS.

a. Routine Activities

Nuclear safety reviews were made on 55 scheduled AEC-carrier hauls of fissionable materials. These shipments were mixed cargoes (open framework cages, casks, spacer-drums, boxes, etc.) originating at the NRTS and/or picked up at various facilities enroute. Reviews covered such factors as safe design of container, fuel mass limits per container and cargo, spatial arrangement, and securing of containers on carrier with regard to other similar units and to dissimilar materials.

b. Special Activities

A conference on Administrative Aspects of Nuclear Safety in the Transport of Fissionable Materials was programmed and conducted by this Branch at Idaho Falls in October. Traffic agents and criticality specialists from AEC and contractor organizations throughout the industry attended. Conclusions and recommendations from this conference were that high priority be given to the preparation of regulations governing the transport of fissionable materials, that Interstate Commerce Commission regulations be extended to cover the criticality aspect of the fissionable isotopes, and that an AEC Manual Chapter be prepared delineating nuclear safety responsibility within AEC organizations regarding the handling and transporting of nuclear fuel materials.

Sixty nuclear accident dosimeters (Hurst Threshold Detectors) were placed at the various NRTS facilities where accidental criticality is conceivable. These dosimeters (nuclear accident dosimeters) are designed to provide a measure of neutron spectrum-dose as well as high range gamma dose, to aid in personnel dosimetry in the event of exposure. Due to the possibility of an alpha contamination incident from serious fire involvement of the fission foil elements, all nuclear accident dosimeters were fireproofed by enclosing the fast neutron detector unit (foils in boron container) in a stainless steel capsule.

Consultation service has been provided the contractor facilities in positioning the nuclear accident dosimeters. Capability was arranged by the IDO Analysis Branch, Health and Safety Division, for dosimetric analysis of the units in the event of a nuclear excursion.

c. Future Programs

In 1961, basic nuclear safety standards will be prepared as operational criteria for the various NRTS facilities. Surveys will be scheduled and conducted at each contractor facility to review nuclear safety programs. Special attention will be given to: (1) Chemical Processing Plant; (2) fuel storage facilities; (3) materials handling and shipping procedures; (4) fuel mass limits in processing and fabricating areas; (5) criticality detection, location, and recovery; and (6) disaster planning and coordination.

Arrangements were initiated to transfer from IDO to an operating contractor the nuclear safety review and approval function for shipping fissionable materials. Procedures have been outlined and reviewed for administrative approval.

A program objective for 1961 is to obtain neutron energy spectra and neutron-to-gamma dose ratios from several of the NRTS facilities to advance capability with the nuclear accident dosimeter system, as well as to obtain pre-incident information. The number of different test and transient reactor facilities at the NRTS offers a unique opportunity for this kind of study.

2. Industrial Hygiene

In the second year of specialized industrial hygiene activity, requests for surveys and consultant services increased 27% to a total of 196. XOO* contractors were furnished 40% of the consultant services and 26% of the surveys. Construction problems commanded 18% of the combined services.

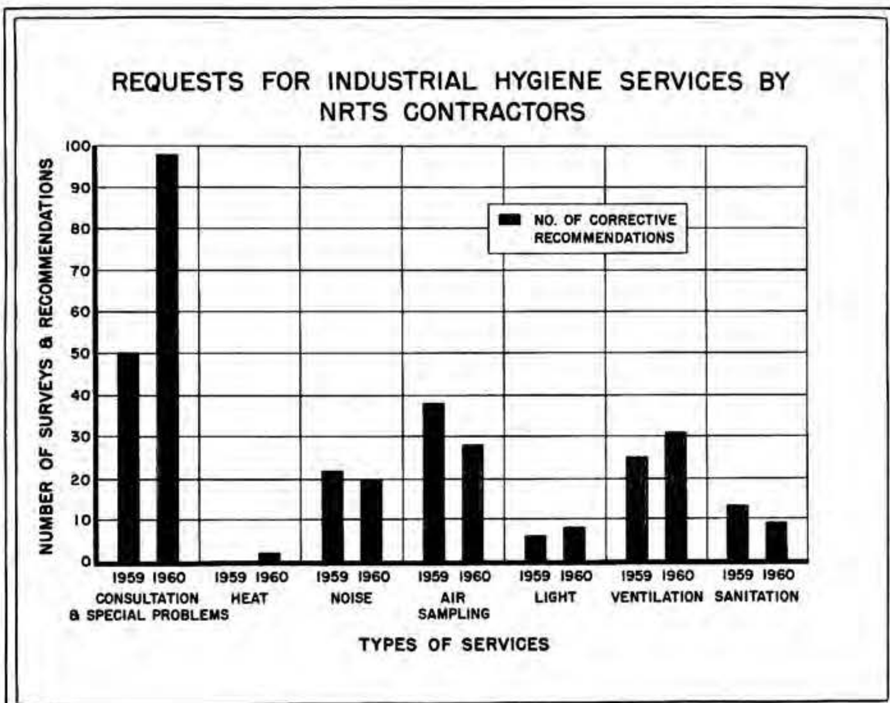


Figure 1.

The NRTS contractors are becoming aware of industrial hygiene functions and are taking advantage of consultant services in planning for new operations. The 84% increase of instrument loans to the contractors is evidence of their increased awareness of industrial hygiene problems and improved follow-up.

Annual industrial hygiene surveys were conducted at ANP, MTR, ETR, CPP, CFA, OMRE, EBR-I Area, EBR-II, TREAT, SL-1, and Idaho Operations Office facilities at Aerojet-General Corporation, San Ramon, California. The one item that generally needed improvement was ventilation design. Many systems were either over-designed or under-designed and further complicated by improper modifications.

[illegible] than IDO at the NRTS.

HAZARDS CONTROL

a. Routine Activities

An inspection program of high efficiency filters was initiated. All high efficiency filters brought on the Site were visually checked, and out of 214 filters inspected, 47% were rejected because of damage. As a result of this high rejection rate, the program was modified in December 1960 to include DOP* testing at Hanford, visual inspection in a specially lighted frame by Phillips Petroleum Company upon receipt at the NRTS, change in installation practice on construction projects deferring filter installation from construction to the facility operating contractor, and having the operator also perform a final visual inspection after installation. For operating efficiency, filter types having the largest turnover are being stocked at the NRTS warehouse.

The water sampling program was expanded to include 22 biweekly bacteriological samples. Five coliform positive samples were reported during the year. One case of contamination was found which required chlorination for a period of five months. The other four positive samples were traced to localized in-line sources and were easily corrected.

Other accomplishments during the year included: a study of the use and specifications of acoustical tile, study and design of effectively controlling a noise problem from the WAPD (Westinghouse Atomic Power Division) generators at ETR, a study of a slight beryllium release at MTR and determination of the significance of resulting exposures, completion of the air cleaning survey for Harvard University, and continued growth of the toxic materials' file.

b. Special Activities

The Industrial Hygiene Engineer is a member of the aerial monitoring team and has participated in cloud tracking flights.

c. Future Program

Completion of the present study on a high efficiency filter program is scheduled during 1961.

A complete study on the present NRTS respirator program is scheduled.

An economic survey of all NRTS ventilation systems is anticipated with a goal of establishing a program to correct and maintain present systems and to establish design standards and criteria for future facilities.

*Dioctyl-phthalate (DOP) smoke particles of 0.3 micron.

3. Fire Engineering

The Fire Engineering program has continued with the primary purpose to develop "improved risk" standards. The program also provides for complete design reviews, detailed annual fire engineering surveys of each facility, routine inspections of certain designated operating areas monthly and construction areas weekly, and inspection and testing of built-in fire protection equipment. This is in keeping with AEC policy and is aimed at minimizing property damage losses and interruption of operations due to fire. The success of such a program is best reflected in the NRTS fire loss experience records.

a. Fire Loss Experience

In examining the data in Table I, it is evident that the NRTS fire loss experience for 1960 was very favorable. Comparative loss figures listed, other than NRTS actual fire losses, are calculated theoretical NRTS losses based on the over-all AEC, "improved risk" insurance companies, or national loss rates. The average AEC comparative fire loss for a five-year period, 1955-1959, based on the NRTS valuation, would have been $15,432. The 1960 NRTS fire loss was 62% of this average, 10% of the 1960 "improved risk" comparative loss, and only 2% of the 1960 national comparative loss. The 1957 fire loss of $22,685 was the only loss higher than the average AEC comparative loss for the same five-year period. $22,020 of this loss was due to contamination clean-up costs and operation shut-down time caused by one fire. This serves to illustrate the magnitude of indirect costs. One fire in 1960 resulted in a direct fire loss of $6,397 which is the highest direct fire damage loss to occur at the NRTS. One large fire could reverse the favorable comparison shown in Table I, and it is this type of loss which our fire protection efforts are primarily aimed at preventing.

Table I. NRTS Fire Loss Comparison Based on NRTS Dollar Valuation

Year	NRTS Valuation	Actual NRTS Fire Loss	AEC Comparative Loss	Improved Risk Comparative Loss	National Comparative Loss
1960	$337,570,000	$ 9,623	1/	$ 92,156	$ 506,355
1959	321,800,000	1,820	$ 6,114	88,000	483,000
1958	259,620,000	2,050	8,826	71,000	390,000
1957	204,900,000	22,685	15,200	56,000	308,000
1956	150,000,000	217	44,900	41,000	225,000
1955	118,000,000	5,366	2,120	32,200	177,000

1

b. Design Criteria

The IDO Safety and Fire Protection Design Criteria Manual (IDO-12008) continues to serve as a guide to architect engineers, operations engineering groups, IDO Engineering, and other Operations Offices for inclusion of adequate Health and Safety provisions in the design of new NRTS facilities. Although minor revisions have been necessary to meet changing conditions and philosophy, the manual has served well in accomplishing the intended purpose.

The Fire Protection Engineer, serving as the liaison contact between the Health and Safety Division and the Engineering and Construction Division on design work, arranged for a thorough Health and Safety review of all design drawings and specifications. Drawings, specifications, project proposals, conceptual designs, and other design criteria, totaling approximately 200 sets in all, were received, reviewed, and commented on.

c. Surveys

Annual Fire Protection Engineering Surveys were conducted at CFA, SPERT, CPP, MTR/ETR, GCRE, SL-1, AREA Hot Cell, OMRE, EBR-I, BORAX, and TREAT. Recommendations for fire protection improvements were again aimed at elevating each facility to as near "improved risk" standards as possible. Considering projects recently completed and those under construction or design, such a goal is realistic at most of these facilities within one to two years.

d. Major Fire Protection Improvements

Automatic wet pipe sprinkler systems were installed in the CFA Machine Shop, MTR Reactor Services Building warehouse storeroom and health and safety clothing room, and the additions to the CFA Heavy Equipment Shop. The Heavy Equipment Shop system was redesigned to provide a larger supply line, supplement an inadequate supply to one section, and convert the "dry pipe" system to "wet pipe".

Fire detection systems were installed in the CFA Service Station Building, SPERT-III Storage Building, new SPERT Data Reduction Room, and the new CFA Heavy Equipment Yard Storage Building. Highly flammable, wooden frame buildings removed from service included the ETR Temporary Sponsor's Warehouse and the ETR "Hot" Storage Shed.

Fire water systems were improved in several areas. Two new fire pumps and a new water storage tank were installed at the MTR/ETR area. A large section of defective fire water main was replaced at CPP. The AREA Hot Cell fire water system was cross-connected to the SL-1 system to provide a better water supply for that area.

Adequate built-in fire protection equipment was provided in the following new facilities: ML-1, CPP Waste Calciner, AREA Hot Cell Facility, SL-1 Administration Building, and ETR WAPD-32 Dowtherm Loop Cubicle.

e. Fire Prevention

The fire prevention program continued with three Fire Department personnel, assigned to the 24-hour-on - 24-hour-off platoon system, devoting eight hours every other day to fire prevention activities. The program was slightly modified with more emphasis on built-in fire protection equipment. In addition to regular inspection duties, one inspector devotes the majority of his time to inspection, testing, revision, and record keeping on vital built-in fire protection systems. Another inspector devotes approximately 30% of his time to review of facility construction work in progress to assure adequacy of fire protection features of doors, walls, roof assemblies, built-in fire protection equipment, and other vital fire protection features. He also witnesses tests and inspections of fire protection equipment, prior to turnover to the operating contractor, to assure it is in proper operating condition. This has proven very valuable in developing and maintaining a high standard of fire protection in new facilities and has minimized previous chronic operating problems with built-in systems.

Routine fire inspection reviews of contractor's activities were made to determine the adequacy of compliance with acceptable standards. The fire prevention unit made a total of 1,107 fire prevention inspections, including 218 of fixed fire protection equipment, covering both operational and construction activities.

Table II presents a breakdown of types of inspections, number of recommendations, and number of recommendations complied with for a four-year period. Prior to 1960, the fixed fire protection inspection figures were included under operations. This has been changed to properly reflect emphasis on the fire protection equipment program and accounts for the lesser number of operations inspections recorded for 1960. Construction inspections fluctuate from year to year to coincide with construction activities. Compliance with recommendations in construction areas in 1960 compares very favorably with previous years. Compliance in operations areas is improved over last year, but the need for additional improvement is evident. Twenty-nine of the pending operations recommendations are covered by work requests that have not been completed. Action has been initiated to achieve correction on the remaining items.

Table II. Fire Prevention Inspections

	Construction			Operations			Fixed Fire Protection Equip		
Year	Number Inspec- tions	Number Recommen- dations	Number Com- pliances	Number Inspec- tions	Number Recommen- dations	Number Com- pliances	No. Insp.	No. Rec.	No. Comp
1960	614	504	487	275	567	463	218	196	193
1959	1,017	610	551	440	838	713	*	*	*
1958	1,413	825	791	349	1,008	963	*	*	*
1957	996	745	730	229	550	534	*	*	*

* Included as operations inspections prior to 1960

f. Future Program

The prime objective for the year 1961 is the completion of built-in fire protection projects now under construction or study.

Those under construction include: MTR bulk shielding water spray sprinkler system; new CPP fire pumps (surplus from MTR); new SPERT fire pump, water tank and Control Building sprinkler system; CPP fire doors; EOCR fire water system; sprinkler system in new MTR Alpha Chemistry Laboratory; sprinkler system in new MTR/ETR Storage and Receiving Building; and sprinkler system in new CPP Hot Pilot Plant.

Those designed or being designed include: new water system and sprinkler systems for OMRE; sprinkler systems for EOCR; and improvements to ANP water system.

4. Fire Protection

Fire protection for the 29 AEC facilities at the NRTS is provided through several mediums, such as: (1) a fire alarm system, part of which is automatic; (2) built-in fire protection systems for specific locations; (3) in-plant fire brigades in the larger facilities to furnish first aid fire protection; (4) a dual purpose guard-fireman force at one major facility; and (5) a highly mobile professional Fire Department operating from three dispersed stations to back up the other forces and/or furnish the bulk of fire protection services.

The Idaho Operations Office Fire Department furnishes fire protection and related services for all of the NRTS facilities. Included in the services are: personnel for fire prevention inspections; fire training for plant brigades; first aid training; fire protection demonstrations and lectures; stand-by protection during hazardous work; ambulance service; maintenance of fire extinguishers; custodians of self-contained breathing apparatus air supply stations; and maintenance of the consolidated NRTS fire statistical records.

Thus far, the sagebrush and grasses have not presented much of a fire problem due to their sparsity. One inaccessible brush fire, within five miles of the southern site boundary, did burn for over two weeks during the past summer. Although no damage was incurred by the fire and no Site facility was endangered, this incident does illustrate a potential fire problem particularly if June and Foxtail type grasses become widespread through the NRTS ground cover.

a. Growth of Fire Protection

Growth in the number of NRTS facilities has been relatively steady since its inception in 1950 and at an accelerated pace not originally anticipated. This has demanded an increase in Fire Department operations, equipment, and personnel. Until 1957 the Fire Department was centralized in one station located in the Central Facilities Area. Fire Department response time to some facilities was excessive, and that year the Department was de-centralized to two stations. In 1959, it was further de-centralized to three stations with six pieces of motorized fire apparatus including an aerial ladder truck. In 1960, a Howe (jeep) four-wheel drive fire truck was procured (Figure 2) and equipped for brush fire type response, back-up, and other utility usage.

Figure 2. Fire Department jeep

At the present time, no NRTS facility is located more than 10 to 12 minutes distant from fire protection assistance.

A mutual fire fighting assistance agreement was entered into between Idaho Operations Office and the City of Blackfoot, Idaho. This supplements existing agreements with the Cities of Idaho Falls and Arco.

b. Fire Protection Statistics

The following lists fire protection statistics for the NRTS for Calendar Year 1960 as compared with the previous year.

Subject	1960	1959
Fire Loss	$ 9,623	$ 1,820
Fires	29	20
Investigations	27	43
Ambulance Responses	98	98
Inspections	1,107	1,862
Fire Dept. Training Hours	1,338	588
Brigade Training Hours	199	175
First Aid Training (persons)	64	162

c. Training

To fill a major need for field fire training of Fire Department and plant brigade personnel, a fire training facility was constructed late in 1960 near the No. 2 Fire Station on Lincoln Boulevard, (Figure 3).

Quarterly officer training sessions were initiated on tactical fire problems of hypothetical major incidents prepared by various NRTS Safety and Fire Protection Engineers. Sessions involved presentation of the problem, individual trainee development, and group discussion on best procedure. These problems are centered around actual conditions as they exist in a plant. One such hypothetical case was a fire started by spraying of a highly flammable paint in a contaminated operating area. Theoretically, the fire flashed through the building due to the overspray and poor ventilation involving a large volume of paint storage, drums of flammable liquids, and a flammable liquid tank which developed a leak with burning liquid running through a pipe chase to floors below. On arrival the

Figure 3. Fire Department training facility

fire officer was faced with a fire out of control to the extent that the need for off-duty firemen, brigades from other plants, and mutual aid from a nearby city fire department was evident. Other immediate problems were several severely injured personnel, acid storage in the fire area, acetylene bottles nearby, and possible airborne contamination.

Forty-two training personnel from Utah fire and police departments were given training on "Radiation Hazards in Firefighting" in a three-day course presented in Salt Lake City, Utah.

A fire training film, "Fire-Fighting in the Nuclear Age," was completed and made available for distribution throughout the AEC and the general public.

The IDO Fire Chief served as President of the Idaho State Fire School Association and participated actively in their affairs.

d. Future Planning

Expand efforts to increase capabilities of the Fire Department through standardization of procedures, stressing of field-type fire training, additional in-plant pre-fire planning, additional radiological training, and completion of a training manual designed for NRTS situations.

5. Safety Engineering

a. Disabling Injury Experience

The combined NRTS disabling injury experience shown in Figure 4 reflected no significant change over the previous two years. However, for the first time in five years it is slightly above the average of all units reporting to the AEC. The research contractors' frequency rates were 1.22 or 23% less than the AEC average; however, their rates increased 154% over 1959. The construction frequency of 6.71 was an improvement of 21% over 1959 experience.

The Bureau of Labor frequency rate for the chemical industry (normally comparable to NRTS operational activities) is still experiencing disabling injuries at a 4:1 ratio over combined NRTS activities, inclusive of construction.

Of the twenty disabling injuries experienced in 1960 as shown in Figure 5, 45% were from falls and 35% from being struck by foreign objects.

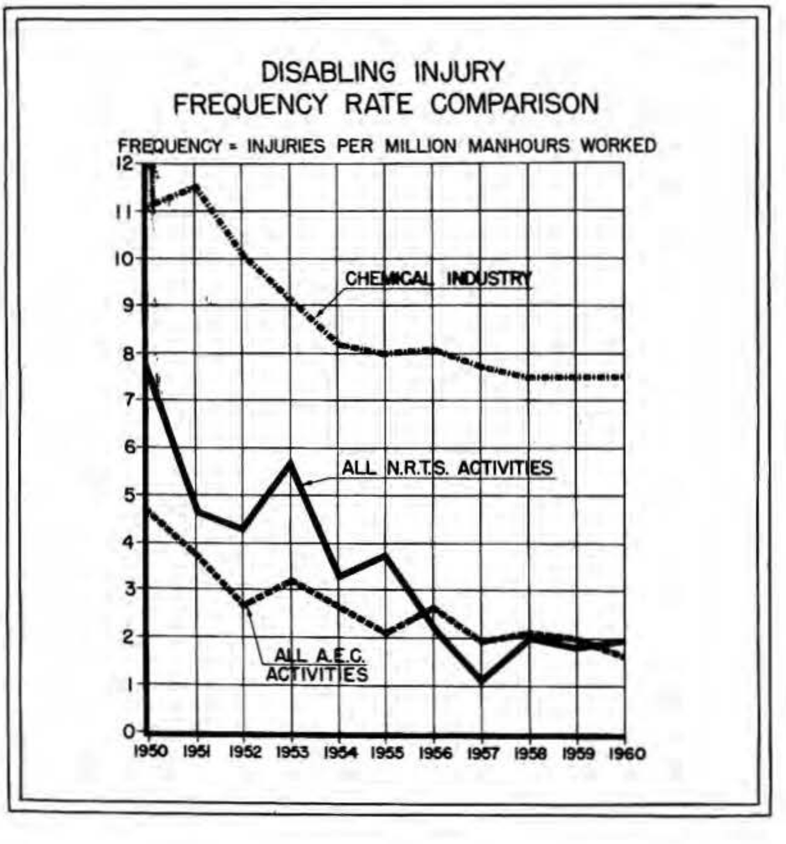


Figure 4.

NRTS DISABLING INJURIES

PART OF BODY	IDO			XOO		TOTALS
	AEC	OPR.	CONST.	OPR.	CONST.	
HEAD		1	1		2	4
EYES			2			2
TRUNK	1	1	3	1		6
FINGERS		1				1
LEGS		1	1			2
FEET				3		3
GENERAL			1	1		2
TOTALS	1	4	8	5	2	20

Figure 5.

b. Severity Rate

The severity rates as shown in Figure 6 are compiled from actual calendar days lost as a result of disabling injuries and scheduled charges of days assigned to permanent partial or total type injuries.

IDO severity rates were far above the AEC average for the second year in succession, however, over the past ten years IDO rates were 8% less than the AEC average and 47% less than the Bureau of Labor severity statistics for the chemical industry.

Construction rates increased because of the 7,800 days charged to one fatality and one permanent partial injury. Operations rates also increased because of one permanent partial and one extended disability.

The fatality in 1960 (scheduled charge 6,000 days) occurred when a painter working at an elevated location dropped his brush, and climbed to the roof edge apparently to attract attention of someone below, and for reasons unexplained by investigation, fell approximately 70 feet to the ground.

The permanent partial (scheduled charge 1,800 days) resulted when concrete being poured splashed in the eye of a construction worker causing loss of vision in the eye.

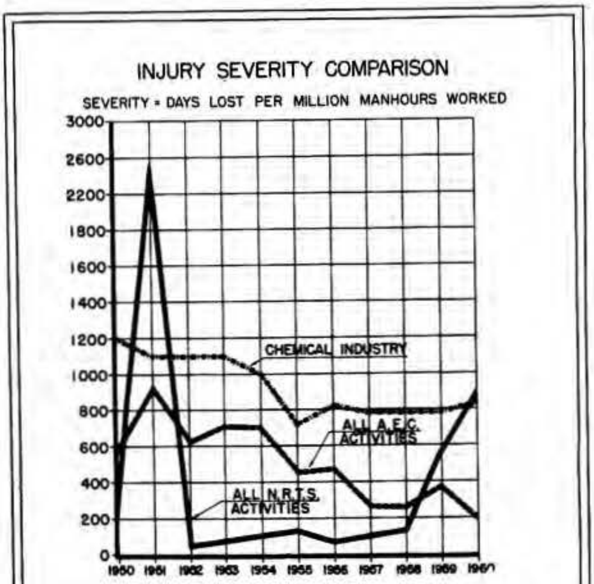


Figure 6.

Improper use of a powder actuated tool resulted in a stud ricochet which caused a serious head injury with extended disability to an operations contractor craftsman.

c. Motor Vehicle Accidents

NRTS government motor vehicle accident experience for 1960 as shown in Figure 7 is inclusive of all accidents regardless of cost and has the same accident rate as the average of all AEC installations whose reporting is on $50 minimums. The Phillips Transportation Service has continued to accrue an outstanding driving record and contributed 42% of the mileage driven. During 1960, motor vehicle accidents at the NRTS cost 53 cents per 1,000 miles of operation as against 93 cents per 1,000 miles for all of AEC.

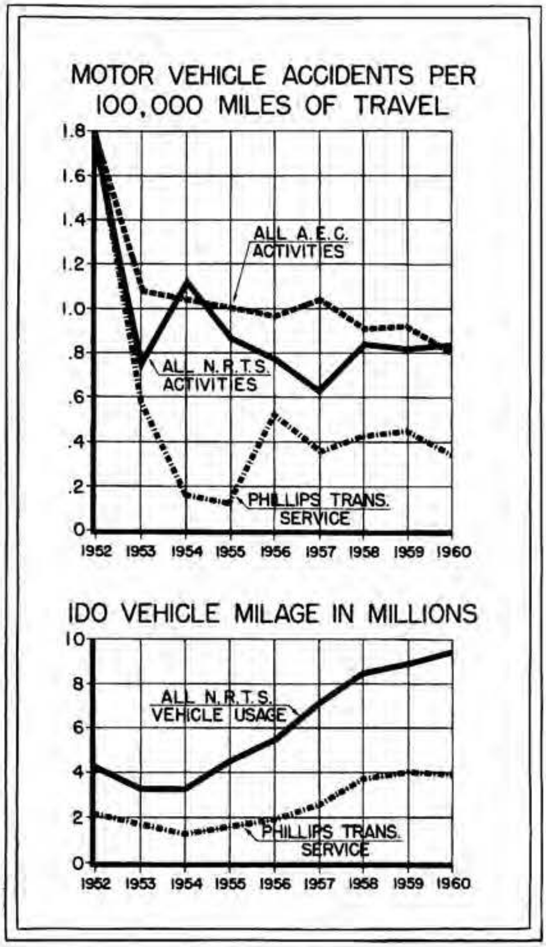


Figure 7.

d. Radiological Shipments

The continued physical protection surveillance of radiological shipments originating at the NRTS averted an incident involving a rail shipment of a 24,500-pound cask. Enroute, the shipment car and two other cars were standing on a siding when a four-unit diesel road engine backed into them with sufficient impact to knock the standing cars approximately 310 feet down the track. The cask was not displaced or damaged and required only retightening of cables to continue travel.

Additional control needs over commercial carriers were evidenced by the mishandling in transit of a 38,000-pound radiological shipment cask. In order to comply with National Highway Bureau requirements, tie-downs were removed and the cask shifted by truck movement and sudden stop. The cask slid forward and caused damage to carrier equipment with subsequent complication from gasket leakage or contaminated water.

e. Routine Activities

The NRTS participated in the national Conelrad emergency exercise "Operation Alert". The Branch was active in planning, coordination, observation, and evaluation. The day exercise included evacuation of CFA, GCRE, and the SL-1 with others simulated. The night exercise included evacuation of the CFA and capability review of all other installations. Response capabilities at the CFA have vastly improved as a result of the exercise through expansion of the signal system and posting of evacuation signs incorporating signals, wardens, and evacuation routes.

As an added medium to promote safety education within the unions, there was formed a Joint Safety Committee made up of representatives of the Building and Trades Council, construction contractor management, Engineering and Construction Division, and the Health and Safety Division. This Committee periodically reviews work in progress on Site construction to aid them in recognizing safety training needs within union membership and to improve labor-management relationships in matters of health and safety.

Annual safety surveys were made of the Lockland Aircraft Reactors Operations Office and Chicago Operations Office facilities at the NRTS in company with the safety engineer of the respective Operations Office. Annual safety evaluations were made of all IDO operations contractors from numerous informal reviews, reports, program and procedural reviews, and day to day contacts and observations.

Participated in IDO Investigating Committee for the boiler explosion at the EBR-II involving $30,000 contractor loss and the Lockland Aircraft Reactors Operations Office Investigation Committee for the disintegration of blowers on the test engine involving $4,750 direct loss.

f. Future Program

The IDO Health and Safety Requirements (Issue 3, 1957) has been under review and revision during the past year and should be finalized and re-issued during the coming year.

Based on experience during the SL-1 accident, the reassignment of Branch responsibilities in the event of Site disaster now incorporates advance planning and establishment of control point facilities and communications. Extensive preparation of proposals covering conceivable emergencies with follow-up coordination arrangements to cope with field conditions will be of priority importance.

D. TALKS AND PUBLICATIONS

1. INDUSTRIAL FIRE PROTECTION, presented at the 1960 Idaho State Fire School, Moscow, Idaho, August 19, 1960, by R. J. Beers, Fire Prot. Engr.

2. RADIATION HAZARDS IN FIRE-FIGHTING, a three-day course presented by E. G. Dingman in April 1960 to 42 police and fire representatives in Salt Lake City, Utah

3. GUIDE FOR DETERMINING SPECIFICATIONS IN THE USE OF ACOUSTICAL TILE, a paper, was presented by Bruce Held to the Industrial Health Conference in Rochester, New York, and the Pacific Northwest Section of the American Industrial Hygiene Association Annual Meeting in Richland, Washington.

4. Film "FIREFIGHTING IN THE NUCLEAR AGE" originated and produced for the AEC and general public by Captain E. G. Dingham, Idaho Operations Office Fire Department and Dale Cook, IDO Information Office.

NRTS Health and Safety Information Bulletins issued during 1960:

1/27/60	Radiological Incident Sampling Suggestions
2/2/60	Air Compressor-Aftercooler Fires
6/1/60	Scott Air Pac-Alarm
8/22/60	Laboratory Multi-Flame Burner Accident
9/20/60	Detection of Leakage from Encapsulated Radium Sources
9/25/60	Mercury Dry Cell Disposal Program
11/10/60	Nuclear Safety of Fissionable Materials During Transport via Common Carrier.
12/1/60	Mercury Dry Cells

Chapter 6

ANALYSIS

Claude W. Sill, Branch Chief

A. SUMMARY

Activities of the Branch have increased significantly during the past year. Approximately 21,922 routine analyses of all types were completed. The routine beta-counting procedure that has been used for several years for routine urinalysis has been replaced by a gross gamma procedure that is much faster and more economical and will detect iodine that was not included in the previous method. Calibrations were completed on part of the NAD system including a capability of evaluating the gamma dose received by the chemical dosimeter using a Cary Model 14 recording spectrophotometer. A procedure for the Fluorometric Determination of Beryllium was completed after a very complete and thorough investigation, and development of a similar one for thorium was begun. A particularly elegant method for the total decomposition of refractory materials was developed that will have extensive application in geochemistry, radiochemistry of soils, etc. A mobile laboratory possessing capabilities for multichannel pulse-height analysis was equipped for use at the site of field operations. Investigations of procedures for the determination of radium and thorium in behalf of the Mill Program are continuing. Additional change room and shower facilities adjacent to the whole body counters were put into operation during the year.

B. SCOPE

The Analysis Branch maintains and operates a general purpose analytical laboratory from which all AEC and contractor personnel at the NRTS may obtain analyses for any chemical or radioactive material that may be required. The principal effort is directed toward detection of chemically toxic or radioactive materials in urine, air, water, soil, vegetation, or other materials of biological importance. Professional consultation and assistance are available and considerable time and effort are expended to keep the laboratory and its personnel abreast of the most recent developments in instrumentation and techniques. A continuing research program directed toward the development of new and improved methods of analysis and techniques is an integral part of the operations and philosophy of the Branch.

C. SUMMARY OF MAJOR PROGRAMS

1. Routine Urine Program

For many years, the build-up of radioactive materials in the bodies of people working at the NRTS has been monitored by a gross beta-counting procedure (1). However, this procedure would not detect elements such

(1) Ebersole, E. R., Flygare, J.K., Jr., Proceedings of the Health Physics Society, First Annual Meeting, University of Michigan, Ann Arbor, Michigan, 1956, p. 72.

as iodine and ruthenium that are quantitatively volatilized during the wet-ashing required prior to beta counting. Since the isotopes of iodine frequently become the limiting factor at the NRTS with respect to internal dose because of the high inventory built up in experimental fuel assemblies after relatively short operating times, the determination of iodine became of more immediate importance than most of the other fission products. The gross gamma-counting procedure used for the determination of iodine has many advantages for a routine screening procedure for mixed fission products in general. The gross beta procedure on urine samples was discontinued entirely in December 1960.

If activity is not present, a maximum d/m number can be calculated for the sample for any specific isotope for which the counting efficiency of the counter is known. If activity is present, a d/m number cannot be assigned to a particular counting rate without further knowledge of the decay scheme and photon energy. However, a very high percentage of samples can be eliminated from further consideration from the results of the screening procedure. Those showing activity can be treated chemically or analyzed by gamma spectroscopy to separate and identify individual nuclides. If the unknown mixture is shown by gamma spectroscopy to be a single pure nuclide for which the counting efficiency is known, the quantitative determination can still be made by gross gamma-counting. As in the past, the use of gross gamma counting for routine screening in no way makes analyses for specific isotopes less available at the request of the contractor.

The samples are collected initially in rigid polystyrene bottles of 75-ml. capacity that fit directly into a 3" x 3" well counter and are counted directly without preparation or chemical treatment of any kind and without transfer from the original container. Thus, there is no opportunity for loss of sample contents either by volatilization or hydrolytic loss on the walls of the container and much faster service at lower cost results. Approximately 1.5×10^{-6} uc./ml. of mixed fission products can be detected in 75 ml. of urine in a 5-minute count which is about the same as was obtained with the gross beta procedure in a 20-minute count.

The major isotopes of biological significance which are pure beta-emitters and would not be detected in a gross gamma-counting procedure are strontium-89 and strontium-90-yttrium-90. Where mixed fission products are the principal source of possible personnel exposure, it is highly unlikely that a significant quantity of the strontium isotopes could be taken internally without larger quantities of gamma-emitters also being present that would be detected. However, in order to detect a slow build-up of the bone-seeking beta-emitting strontium isotopes from low-level sources over long periods of time, specific strontium analyses are made for each individual every 2 years and on termination of employment. Because of the improbability that a significant quantity of strontium isotopes will have been incurred in a 2-year period, all activities precipitated by oxalic acid in weakly acid solution are counted without further treatment. If no activity of any kind is found, the analysis can be terminated immediately and a maximum figure for the concentration of either strontium isotope is obtained with a minimum of time and expense. If activity of any kind is found the analysis is continued. Only in extremely rare instances has it ever been necessary to complete the strontium-90 determination by counting the yttrium-90 daughter milked from the equilibrated strontium fraction. A 100-ml. sample of urine will permit the detection of approximately 8×10^{-8} uc./ml. of strontium-90.

2. NAD System Calibration

Calibration of the Nuclear Accident Dosimetry (NAD) system was completed partially during the year. A gas-flow thin-window G.M. counting system was calibrated for counting phosphorus 32 residue from the burned sulfur pellet from the NAD dosimeter as well as from the sulfur sticks used in the personnel film badges. The over-all efficiency through the burning and counting process was established. Thallium-activated sodium iodide well counters have been calibrated for counting gold-198 and indium-116 in the gold and indium foils from both the NAD system and the personnel film badges.

A cell holder for the chemical dosimeters was constructed for a Cary Model 14 recording spectrophotometer so that this instrument could be used in evaluating the gamma dose received by the chemical dosimeters. Results obtained on both exposed and unexposed chemical dosimeters from Edgerton, Germeshausen and Grier, Inc., Santa Barbara, California, were in excellent agreement with those obtained at the Santa Barbara Laboratory. Calibration curves relating the change in the ratio of the transmittance at 572 mu to that at 432 mu as a function of gamma dose in roentgens are on hand for each of the five ranges covered by the chemical dosimeters in the NAD system.

In conjunction with the use of the NAD system for neutron exposure, the 256-channel analyzer with a 3" x 3" sodium iodide detector has been calibrated for blood sodium-24 analyses. Calibrations were obtained for total activity on samples containing only sodium-24, but only for activity above 1.2 Mev on samples containing activity other than sodium-24. All calibrations were made for various blood volumes. In addition, the system was calibrated to permit the determination of sodium-24 using the photopeak at 2.75 Mev. in those cases in which the activity of interfering materials precludes the use of the 1.2 Mev threshold.

3. Determination of Beryllium

Investigation of the use of morin for the fluorometric determination of beryllium has been completed and a second manuscript on the subject has been submitted to Analytical Chemistry for publication. Application of the procedure has been extended very successfully to the determination of beryllium in copper alloys and in very complex ores containing high concentrations of rare earths, titanium, niobium, and tantalum. The most important new application, however, is the determination of beryllium in air dusts. Because of the high sensitivity of the procedure and its low susceptibility to interference, beryllium can be determined in air dusts at concentrations down to about one-fiftieth of the maximum permissible level for restricted areas without separations of any kind. One determination can be completed in about 30 minutes. The large number and great importance of analyses required at installations handling beryllium make such a simple and rapid procedure particularly attractive.

Although the reaction with morin has been used for many years for both detection and determination of beryllium, the identity of the fluorescent species has not been established. Because of the reproducibility of the present procedure, it has become possible to demonstrate that the complex contains beryllium and morin in a 1 to 1 ratio. In view of the alkalinity employed and the strong tendency of beryllium to form hydroxylic compounds, it seems likely that the second valence bond is occupied by a hydroxyl group. The method of continuous variations was used using both absorbance and fluorescence measurements to follow formation of the complex.

Since investigation of the fluorometric determination of beryllium using morin was first begun in this laboratory several years ago, an unknown error has evaded all efforts at identification and has persisted to the present time despite the best procedure that could be devised. It has now been proved that this error was caused by extensive adsorption of beryllium from alkaline solution on the walls of glass containers by an ion exchange process. Losses as high as 15% of the total beryllium present have been observed through use of beryllium 7 tracer and can be reduced to less than 1% by addition of a few milligrams of aluminum.

4. Determination of Thorium

During the development of the fluorometric procedure for beryllium using morin, thorium was observed to produce a very sensitive reaction under similar conditions. Application of the same system to the fluorometric determination of natural thorium is well along, and the results are most gratifying. The procedure has a detection limit of 0.01 ug., and 5 ug. can be determined with a precision of about 1%, both figures being at the 95% confidence level. The procedure is highly selective for thorium, only beryllium and zirconium producing fluorescence under the same conditions. Because of the high concentrations of complexing agents used, the procedure is also surprisingly unaffected by at least 1 mg. of most of the other elements. A buffer solution and glass standards are employed to secure high precision. Primary and secondary filters have been selected to give maximum linearity and sensitivity while suppressing the contribution of the blank as much as possible.

5. Decomposition of Refractory Silicates in Ultramicro Analysis

The complete decomposition of the sample is obviously an extremely important part of any analytical determination. When that determination is for submicrogram quantities of elements, either radioactive or stable, the need for larger samples and smaller contamination from reagents and techniques becomes much more important. Many of the samples of interest in a health and safety program, such as soils, air dusts, sediments, water, etc., contain mixtures of refractory oxides and silicates that are difficult to dissolve completely. Generally, treatment with acid fluxes to dissolve refractory oxides must be followed by filtration and treatment of the insoluble residues with an alkaline flux to dissolve the refractory silicates. Such a procedure is time consuming, introduces undesirable - and frequently intolerable - quantities of impurities from the alkaline fluxes and crucibles, and still leaves the silica in solution with the element to be determined from which its separation is difficult and time consuming.

A procedure has been developed by which samples of soil as large as 50 grams have been decomposed completely in a single vessel with the simultaneous elimination of all silica without loss of other sample constituents. The procedure involves fusion of the sample in a platinum dish with anhydrous potassium fluoride, addition of concentrated sulfuric acid to the solid cake, and transposition by heating to a pyrosulfate fusion. Fluorides and silica are volatilized during the acid transposition and the pyrosulfate cake will dissolve in water so completely that filtration is not required unless elments such as calcium, rare earths, niobium, tantalum, etc., that form insoluble compounds in the sulfate solution are present. Even so, decomposition of the original sample is complete in one vessel without having to retreat insoluble residues, the fusion can be made in platinum with a minimum of reagents of a kind that can generally be obtained in high purity, and all fluorides and silica are eliminated rapidly and easily. The procedure is of extremely wide applicability and has given complete decomposition of such siliceous and generally intractable materials as zircon, monazite, dunite, kaolin, asbestos, talc, and many others in addition to soils and sediments. Analyses for beryllium, natural thorium, strontium-90, radium-226, thorium-230, and many other nuclides have been made following this procedure for decomposition of the sample.

6. Mobile Laboratory for Analytical Support of Field Operations

With the assistance of the Instrument and Development and Site Survey Branches, a 26-foot trailer was equipped with various types of instruments to provide immediate laboratory facilities in the field for analytical support of operations. One each beta counter, alpha counter, and a thallium-activated sodium iodide well counter were provided for determination of gross activity levels. Most important, a 128-channel analyzer using a 2" x 2" thallium-activated sodium iodide crystal detector and appropriate shield was provided to permit the sophistication and utility of multichannel pulse-height analysis to be available in the field. Such capabilities result in [illegible] identification and interpretation of radioactive [illegible] during test operation, permits detection and determination of short-lived activities, and reduces considerably the number of samples that must be returned to the laboratory for more detailed and formal analyses. A Polaroid Land camera is used to photograph spectra directly from the oscilloscope to make a permanent record of each sample for later inspection, analysis, or filing. Members of the Analysis Branch are assigned to operate the field laboratory including simple chemical treatment and separations.

The interior of the mobile laboratory is shown in Figures 1 and 2.

Figure 1. General counting instruments in mobile laboratory

Figure 2. Multichannel pulse-height analyzer and camera in mobile laboratory

7. Mill Program for Recovery of Uranium

At the request of the IDO Division of Licensee Compliance, the Analysis Branch made analyses for radium-226 and thorium-230 on 185 samples of river water and liquid mill effluents and uranium analyses on 665 samples of air dusts. The analyses were necessary to determine the potential hazards resulting from mill operations and to determine compliance on the part of the mill operations with the requirements of Title 10, Part 20, Code of Federal Regulations.

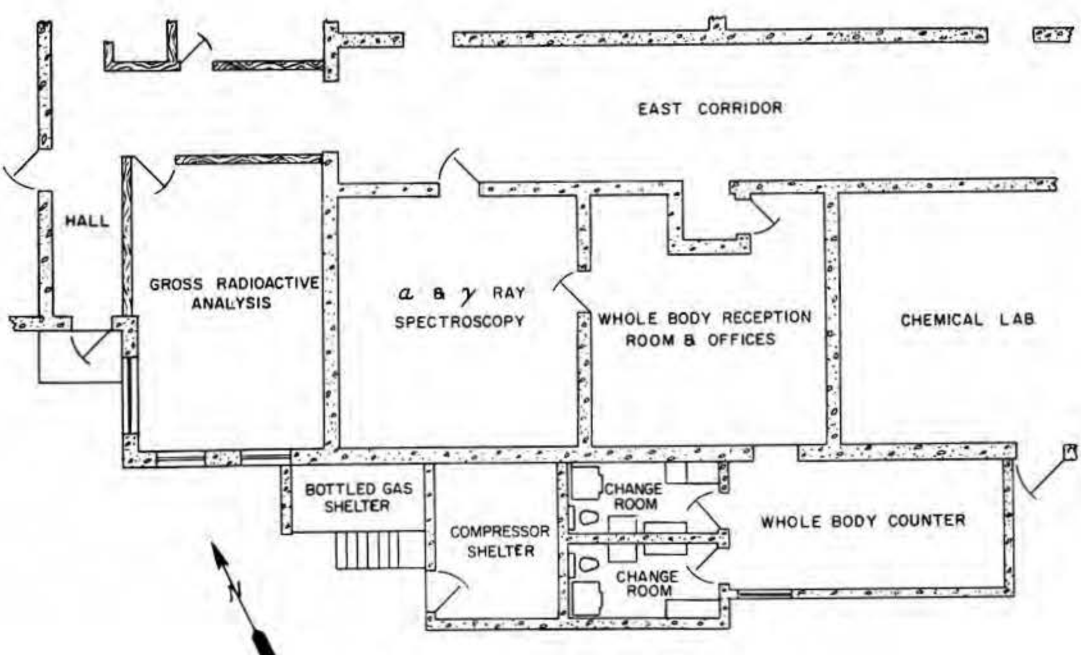
The tentative procedure developed late in 1959 for radium-226 to eliminate the problems associated with thorium-230 and radium-223 has been improved. The modified procedure has been applied very successfully throughout the year. Recovery of radium from liquid samples of 1500-ml. volume is 100 $\pm$ 2.5% and decontamination from thorium and polonium is greater than factors of 10^5 and 10^4, respectively.

Evaluation of methods of separation and determination of thorium from both liquid and solid samples is continuing to determine optimum conditions for both chemical and radiochemical determination.

8. Whole Body Counting

The whole body counting program continued to occupy an important part of the developing capabilities of the Branch but unfortunately has not made much headway as yet. Visits were made to Argonne National Laboratory, the University of Chicago Cancer Research Hospital, and the similar facility at the University of Utah to acquaint ourselves with other equipment and techniques. Very helpful information was obtained from a survey team from John Hopkins University who were making a very intensive survey of whole body counting facilities for the U. S. Public Health Service.

The existing shower facilities and change rooms available to the whole body counting program were grossly inadequate and very little actual experience could be gained on low-level counting until adequate facilities were provided. Design, engineering, and construction of these facilities occupied most of the summer and early fall but are now in operation. Some calibrations were completed and a few patients were counted before the end of the year. The results obtained forecast a greatly expanded program for the following year, particularly in view of the fact that Sb 125 was detected in one individual by whole body counting that could not be detected in the urine. The whole body counter and change rooms are shown in Figure 3 in relation to the general layout of the radioactive analysis section.



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9. General Counting Room

Investigations were begun to apply solid state nuclear particle detectors to the determination of alpha energy spectra. In cooperation with the Instrument and Development Branch, a preamplifier with the necessary high stability and low noise factor for use with the extremely small pulse obtainable from the solid state detector was developed to use the power supplies, vacuum pump, and other accessories of a Frish grid chamber presently available. The system produced a resolution approaching the best reported in the literature although the present size of the detector (5 mm square) leaves something to be desired with respect to sensitivity.

Scintillation chambers coated with a zinc sulfide phosphor were obtained for the determination of radon, thoron, or other gaseous alpha-emitting materials. This capability was desired to permit determination of radium-226 in the presence of relatively large concentrations of radium-223 and 224 in mill effluents and to check the accuracy of procedures for the determination of radium-226 involving direct solid counting developed in this laboratory. A sample holder was designed and constructed by the Instrument and Development Branch to permit the scintillation chamber to be placed in position over the multiplier phototube without violating the light-tight integrity of the system or having to interrupt the high voltage applied to the multiplier phototube.

A log converter was obtained and installed on the TMC 256-channel transistorized gamma spectrometer to facilitate interpretation and recording of gamma spectra over 3 to 5 decades of energies.

Development work on the automatic gamma changer capable of accepting 75-ml. samples described in the last Annual Report showed the need for additional shielding to reduce background and cross-talk to acceptable levels. The equipment is expected to be in use in the next year.

C. SPECIAL ACTIVITIES

A major portion of the work load of the Analysis Branch involves non-routine types of analyses and problems requiring the knowledge and skill of highly trained and experienced chemists for proper solution and evaluation. Several examples of such problems are discussed below.

1. Radiological Assistance Plan

At the request of the Utah State Department of Public Health, a nondestructive analysis was made of six vials of radioactive material found in the possession of a family in Ogden, Utah. The radioactive material in the vials was identified as radium-226. The six vials together contained an estimated 0.8 microcurie of radium-226 and were turned over to the IDO Licensee Compliance Division for disposition.

In response to a call from Thiokol Chemical Corporation, Brigham City, Utah, concerning a leaking camera source, the Radiological Assistance Team requested analyses on smear samples collected from the area in which the camera was housed. Cobalt-60, the camera source material, was the only isotope identified.

2. Activity in USGS Test Wells

Early in the Spring of 1960, radioactivity was found in perched water at the 80-foot level in the first USGS test well drilled near the MTR leaching pond. The activity (2×10^{-5} uc/ml) was identified as chromium-51, iodine-131, and a trace of cerium-144. All of the isotopes found in the water were present as anions. Subsequent test wells at greater distances showed the same perched water and the same isotopes but in lower concentration. Again all isotopes found were present as anions.

3. Referee Beryllium Analyses

Nine urine samples containing known quantities of beryllium in the microgram-per-liter range were submitted by the ANP Division of the General Electric Co., Evendale, Ohio, for beryllium analysis to assist them in evaluating the fluorometric beryllium procedure developed in this laboratory. The results obtained were in excellent agreement with the known values subsequently reported by General Electric Company. One sample showed a deviation of 5%, but the remaining ones were all within 2% of the reported values.

Beryllium analyses were also made on ashed plant samples submitted by the Department of Biology, Whittier College, Whittier, California, to determine the uptake of beryllium under different soil conditions.

Beryllium analyses were made on two samples at the request of Aerojet-General Nucleonics of San Ramon, California, to provide them with a standard of comparison for their own analytical work.

4. Special Uranium Analyses

At the request of the Industrial Hygiene Group at the Los Alamos Scientific Laboratory, Los Alamos, New Mexico, the uranium content of twelve samples was determined to assist them in evaluating their technique and method of uranium analysis.

Isotopic uranium analyses of a complex mixture of uranium using alpha spectroscopy were made for Argonne National Laboratory to assist them in preparation of fission counters with which to study the flux of reactors.

The ratio of uranium-234 to uranium-235 was determined by alpha spectroscopy on a sample of yellow cake from depleted uranium submitted by the Licensee Compliance Division.

5. Analyses for OMRE

The operating contractor of the Organic Moderated Reactor Experiment continued as in 1959 to request periodically analyses of the organic [illegible] product material to verify that no fuel-cladding failure had occurred following the original failure in 1959. No evidence of cladding failure was found in any of the samples.

The OMRE contractor also requested and obtained assistance in calibration of a polonium-210 source to be used as an electrostatic charge eliminator.

6. Fission Counters

Personnel of Argonne National Laboratory were assisted in the preparation and analysis of electroplated sources of fissionable material for use in fission counters. Alpha pulse-height analyses were provided to identify the isotopes present on the prepared samples.

7. Strontium-90 in Bone

Strontium-90 was determined in approximately 30 big-horn sheep joints and in approximately 30 deer joints submitted by the Las Vegas Branch, Nevada Operations Division, Atomic Energy Commission.

8. Display for Edison High School Tour

A display showing the capability of the Analysis Branch in evaluating and controlling the hazards at the NRTS for the individual and his environment was assembled for the Fourth Annual Thomas Alva Edison High School Tour held at CF-674 on February 6, 1960.

9. Training

Eight AEC Radiological Fellowship students spent a total of four weeks receiving training in analytical and counting-room procedures. Primary emphasis was placed on understanding and operation of counting instruments and multichannel analyzers in conjunction with gamma and alpha detectors.

A chemist from CPP spent some time observing the methods and techniques used in the determination of beryllium.

Captain Daniel W. Box, of the U. S. Air Force, was assigned to the Analysis Branch in July for a 12 month period to receive instructions in radioactive bio-assay techniques and procedures.

A visitor from ANP and one from UK-AEC, Harwell, England, spent a day obtaining information on the solid state alpha detector being investigated in the Branch and on alpha spectroscopy in general.

D. ROUTINE ACTIVITIES

A statistical summary of the routine analyses completed during the year is given in Table I. The analyses shown represent only those of a recurring nature on the routine health and safety program. In addition to the 21,922 analyses listed, approximately 1,200 gamma spectra were obtained with a 256-channel analyzer on samples directly connected with the routine health and safety program. Quantitative values of specific isotopes were derived from approximately 200 of these spectra and made matters of record. The remainder were used primarily for qualitative identification of isotopes. This information was used in conjunction with gross counting methods for quantitative estimation. In addition to the spectra just mentioned, numerous gamma-energy scans were made and the information read directly from the oscilloscope in conjunction with chemical separations for identification of isotopes. Many alpha-energy spectra were obtained using a Frisch grid chamber with the 256-channel analyzer for purposes of identification of alpha-emitting isotopes. Many other types of problems not susceptible to statistical presentation have been completed.

Table I. Statistical Summary of Routine Analyses

Urine

Gross Beta	8,519
Gross Gamma	2,640
Strontium-90	145
Beryllium	89
Uranium (Nat)	46
Mercury	17
Lead	8
Plutonium-239	7
Uranium-233	3
Protactinium-233	1
Total...	11,475

Miscellaneous

Uranium on Air Dusts	665
Carbon Cartridge Filters Gross Beta	562
Strontium-90 on Air Dusts, Soil, Bones, etc.	392
Fallout Papers, Gross Beta	344
Beryllium on Air Dusts and Smears	293
Cobalt-60 on Smears	20
Smears, Gross Beta	11
Antimony-124 on Smears	9
Total Silica in Magnetite	1
Total...	2,297

Water

Gross Beta	1,331
Gross Alpha	1,079
Sodium	308
Radium-226	184
Thorium-230	181
Gross Gamma	120
Uranium	99
pH	91
Strontium-90	35
Cesium-134, 137	16
Cobalt-58, 60	8
Chromium-51	8
Iodine-131	5
Chloride	3
Manganese-54	2
Protactinium-233	1
Total...	3,471

Gross Gamma Counting

Vegetation	1,057
Carbon Cartridges	890
Animal Parts	864
Milk	772
Soil	689
Filters, Fallout Plates and Smears	407
Total...	4,679

Grand Total 21,922

E. FUTURE PROGRAMS

1. General

Since a large part of the workload of the Branch is in the nature of services to contractors at the NRTS and to other Branches within the Division of Health and Safety, the variety and scope of future activities will be determined largely by the nature and extent of reactor operations and field testing programs in the coming year. It is expected that routine urinalysis service to contractors will continue to increase as will analytical services in support of the Ecology and Site Survey programs because of increased numbers and complexity of reactors.

2. Whole Body Counting

Increased use of the whole body counter in the health and safety program is anticipated in the coming year. Calibration for several isotopes which may reasonably be expected to be of interest at the NRTS will be accomplished using the Remcal phantom. The analyzer used will be equipped with punch tape readout capability so that spectral data can be taken on punched tape and read directly into an IBM 1620 Computer. Quantitative analysis of the data will be accomplished with the 1620 Computer. The computer will be programmed to make stepwise subtraction of standard spectra of individual isotopes from whole body spectra and to read out on demand the residual spectra following subtraction. Quantitative values will be calculated by direct comparison with standard spectra. Many man-hours of tedious manual calculation will be eliminated under the planned whole body counter-computer program.

3. Programmed Data Handling

At the present time, a large number of quantitative estimations of radionuclides are made from gamma spectra following identification of the particular isotope in question. For complex mixture, many man-hours of manual spectrum stripping and calculation are required. Punch tape readout will be provided for the analyzers so that the stripping operation and quantization can be carried out on the 1620 Computer. Standard spectra of isotopes of interest will be prepared under various geometry conditions and stored on punched tape so that direct comparison of the sample spectrum to a standard spectrum taken under identical conditions may be made by the computer. Faster and more reliable answers will result with a great decrease in the labor involved in computation. Plans are also being made to convert eventually all routine counting equipment to punch tape readout so that the necessary computation and report preparation can be carried out by the computer.

ANALYSIS

4. Chemistry of the Transplutonium Elements

Because of the increasing production of transplutonium isotopes and an anticipated increase of plutonium fuel elements in reactor operation at the NRTS, a program for the development of analytical procedures for these materials in various media will be initiated. The known chemistry of transplutonium elements will be reviewed as a point of departure for research directed toward development of methods of analysis capable of detecting one tenth or less of the concentration guides recommended by the Federal Radiation Council.

5. Fluorometric Methods of Analysis

Investigation of the fluorometric determination of submicrogram quantities of thorium using morin as reagent will be continued. Most of the other elements that might be encountered will be tested for interference and any necessary or desirable changes in the procedure to minimize such interferences will be made. Application of the procedure for practical use will be determined. Because of the high sensitivity of the procedure and its relative freedom from many interferences, it is expected that the determination of thorium in air dusts can be made at concentrations well below maximum permissible levels without separations of any kind. Application to the determination in body fluids and tissues will also be investigated.

Application of the morin system to the fluorometric determination of yttrium, scandium, lanthanum, and zirconium will also be investigated as time permits.

6. Geochemistry of the NRTS

A geochemical investigation of the alluvial material and interflow sediments of the Lost River Plain will be initiated to obtain a more realistic understanding of conditions affecting the Waste Management Program being carried out by the Site Survey Branch. A geochemist will be added to the staff of the Analysis Branch, and a geochemical laboratory will be constructed adjacent to the present chemical laboratories. The investigations will be directed primarily toward a thorough evaluation of the ion exchange characteristics and possible mineral reactions of the local terrain.

7. Nuclear Accident Dosimetry

The multichannel analyzer and 3" x 3" sodium iodide detector will be calibrated for fission foil counting. A 0.1-gram foil of plutonium-239 will be exposed to a known thermal neutron flux, and the counting rate of fission products with gamma energies above 1.2 Mev will be determined as a function of time after exposure. The counting rate obtained will be normalized to that which would have been obtained for the Pu-239, U-238, and Np-237 foils in the NAD system exposed to a fast flux. Gross section data for these foils inside the boron ball will be taken from ORNL 2748, Part A.

8. Increased Capabilities of Counting Laboratories

Because of the increased work load resulting from ever-increasing operations and from the initiation of a comprehensive whole body counting program, the existing capabilities for multichannel pulse height analysis is inadequate. Procurement of 2 complete new systems is planned for the coming year. The analyzers will be 400-channel, completely transistorized instruments, each with a capability of being used simultaneously as 2 separate 200-channel instruments if desired, and each possessing punch tape readout and spectrum stripping capabilities. Considerably greater emphasis will be placed on spectral analyses and less on gross counting. As with whole body counting, the analyzers will be programmed to operate with the 1620 Computer. The mobile laboratory will also be equipped with an X-Y recorder so that one of the new 400-channel analyzers can be used temporarily in the field during field operations.

F. TALKS AND PUBLICATIONS

The following talks or papers were presented during 1960:

1. RECENT ADVANCES IN THE DETERMINATION OF RADIUM-226 was presented by Claude W. Sill at the Fifth Annual Uranium Symposium sponsored by the Uranium Section of the American Institute of Mining, Metallurgical and Petroleum Engineers at Moab, Utah, on May 6, 1960.

2. Two papers entitled "ALPHA SPECTROSCOPY and DETERMINATION OF RADIUM-226, THORIUM-230 AND THORIUM-232" were presented by Claude W. Sill at a Symposium on Analytical Problems in the Uranium Milling Industry held at Grand Junction, Colorado, on October 5 and 6, 1960.

3. Two papers entitled "FURTHER DEVELOPMENTS IN THE FLUOROMETRIC DETERMINATION OF BERYLLIUM and THE DETERMINATION OF RADIUM-226 IN MILL EFFLUENTS" were presented by Claude W. Sill at the Sixth Annual Meeting on Bio-Assay and Analytical Chemistry held at Santa Fe, New Mexico, on October 13 and 14, 1960.

4. Earl R. Ebersole presented a paper entitled "DETERMINATION OF RADIUM-226 AND THORIUM-230 IN MILL EFFLUENTS" by Earl R. Ebersole, Alan Harbertson, J. Kenneth Flygare, Jr., and Claude W. Sill at the Annual Health Physics Society Meeting in Boston, Massachusetts, on June 30, 1960.

5. An abstract of a paper entitled "IMPROVEMENTS IN THE FLUOROMETRIC DETERMINATION OF SUBMICROGRAM QUANTITIES OF BERYLLIUM" by Claude W. Sill, Conrad P. Willis, and J. Kenneth Flygare, Jr. was read at the Symposium on the Analytical Chemistry of Beryllium, organized by the Production Group, Springfield Works, United Kingdom Atomic Energy Authority, and held at the Springfield Works, Salwick, Preston, Lancashire, England, on June 23, 1960.

ANALYSIS

The following papers were submitted for publication in ANALYTICAL CHEMISTRY:

1. DECOMPOSITION OF REFRACTORY SILICATES IN ULTRAMICRO ANALYSIS by Claude W. Sill.

2. TRANSMITTANCE SPECTRA OF COLOR FILTERS by Claude W. Sill.

3. DETERMINATION OF EXCITATION SPECTRA WITH A RECORDING SPECTROPHOTOMETER by Claude W. Sill.

4. IMPROVEMENTS IN THE FLUOROMETRIC DETERMINATION OF SUBMICROGRAM QUANTITIES OF BERYLLIUM by Claude W. Sill, Conrad P. Willis, and J. Kenneth Flygare, Jr.

Chapter 7

INSTRUMENT AND DEVELOPMENT

M. Wilhelmsen, Branch Chief

A. SUMMARY

The Radiation Monitoring Telemetering System is under construction. Design work on a four field automatic film reader system to be tied into an IBM 1620 Computer is in progress. A simplified aerial monitoring unit has been developed. The scope of portable instrument maintenance work shows a slight decrease from the previous year and a corresponding increase in number of instruments in use.

B. SCOPE

The Instrument and Development Branch is responsible to provide instrumentation to the various health and safety programs at the NRTS. This is divided into two general areas; first the supplying of repaired and calibrated portable instruments to the various contractors at the NRTS as well as government agencies, and second the procurement and maintenance of laboratory and counting equipment for the Health and Safety Division.

C. DEVELOPMENT SECTION SUMMARY OF MAJOR PROGRAMS

1. Telemetering System

The expanded Radiation Monitoring Telemetering System (described in the 1959 Report) has been designed and is being constructed by Motorola, Inc. The system is to consist of 19 primary monitoring stations, each strategically located for the protection of populated off-site areas or key on-site installations.

Each station is to consist of a radio receiver and transmitter complex that can be programmed through the control station at Central Facilities. Four data programs are planned for each primary station:

a. An ionization chamber detector for measuring the environmental radiation level

b. A GM detector for measuring radiation build-up of particulate material collected by a filter within an air-flow path

c. A GM detector for measuring a 24-hour decay of filter collected particulates

d. A NaI well crystal scintillation tube detector for measuring radiation levels of gaseous compounds entrapped within a granulated-carbon cartridge.

Equipment at each station will be mounted and housed in a modified house trailer to facilitate re-location whenever necessary. Installation of the system is scheduled to begin in April of 1961 and will continue throughout the summer months as each of the four data programs is phased into the system.

The radio link has been changed from a simplex to a duplex system for faster data handling. Quantitative information will be transmitted to Central Facilities in a selected one of three modes:

a. Continuous interrogation and print-out wherein the time cycle required will be 2 minutes and 35 seconds

b. Continuous interrogation with selected periodic print-out

c. Manually initiated interrogation and print-out of any selected station.

Secondary sample collectors at each station will be turned on or off by a supervisory control capability at the master station.

2. Automatic Film Reader

Development of a new automatic film reading system was started early in 1960. This system will provide accurate identification of up to one million film badges. Four areas of each film badge will be read with density detectors and the resultant readings will be punched into an eight channel tape acceptable to the IBM Model 1620 Computer wherein dosage calculations will be made and recorded.

Electronic circuitry will utilize solid state components with an aim toward miniaturization with greater reliability thoughout a longer life.

Basic units required for the system will include a lead insert punch, an X-ray unit, tray loaders, film advancing mechanism, reading head, density to digital conversion circuitry, programming circuitry, and tape punch.

It was estimated that the development of this system would require one year. Other programs and incidents of more urgent nature will probably push the film reading system back to late Summer of 1961.

3. Aerial Monitoring Program

The aerial monitoring unit described in the 1959 Report was supplemented by a light transistorized lap-held scintillation unit (Figure 1). This unit consists of a NaI crystal and photomultiplier detector feeding a miniaturized linear count rate meter. The count rate meter case also contains a map window for aid in navigation and for making grease pencil notes on the plastic overlay. The instrument has the disadvantage of not having a chart recording output but has the advantage of being faster than the recording unit and thus gives the effect of greater sensitivity.

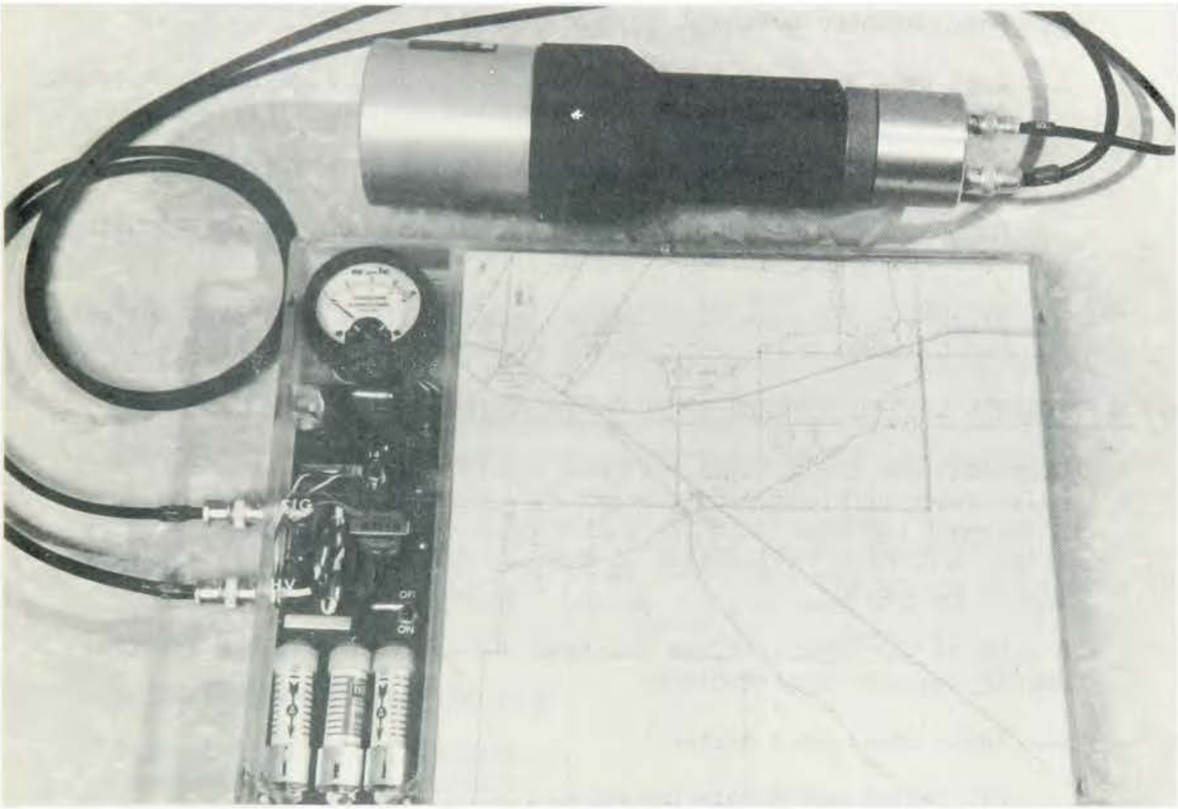

Figure 1. Transistorized aerial monitoring unit

4. Other Development Section Projects

Development, design, and fabrication work was done on many smaller projects associated with the efforts of other Branches. The following is a partial list:

a. Preamp and chamber for solid state alpha detector designed and and constructed for use in the counting room.

b. Transistorized audio amplifier for radiation demonstrator for the Site Survey Branch.

c. Transistor circuit for wind direction indicator for Weather Bureau.

d. Sequential sampler for use in conjunction with telemetering.

e. Total body counter was completed for operation.

f. Control and drive system for new calibration well nearly completed.

g. Radon counter designed and constructed.

h. Well type scintillation crystal, carbon cartridge filter assembly designed and constructed for telemetry system.

i. Road scanner designed and constructed for Site Survey Branch.

j. Motor generator system to supply regulated voltage for counting room was specified and ordered.

k. Flasks, microscope attachments, camera, light mounting, and other attachements were designed and constructed for the Analysis Branch.

D. MAINTENANCE SECTION SUMMARY OF MAJOR PROGRAMS

1. Organizations utilizing Instrument and Development services: maintenance and repair of laboratory equipment for AEC and other Government agencies, and the calibration of instruments, dosimetry film, and other radioactive sources by use of electronic and radioactive standards.

A list of the Organizations who used one or more of these services during the past year include:

a. Idaho Operations Office

(1) Health and Safety Division

(a) Instrument and Development Branch
(b) Analysis Branch
(c) Ecology Branch
(d) Site Survey Branch
(e) Medical Services Branch
(f) Hazards Control Branch
(g) Personnel Metering Branch

(2) Licensee and Compliance Division

(3) Security Division

b. Government Agencies

(1) U. S. Public Health Service
(2) U. S. Weather Bureau
(3) U. S. Geological Survey
(4) U. S. Navy (NRF)
(5) U. S. Army (SL-1)

c. Operating Contractors at the NRTS

(1) Phillips Petroleum Company
(2) Westinghouse Electric Corporation
(3) General Electric Company
(4) Argonne National Laboratory
(5) Atomics International
(6) Combustion Engineering
(7) Aerojet General Corporation

2. Equipment Accountability

The Maintenance Section is responsible for the accountability of all electronic and laboratory equipment used by the Health and Safety Division. The equipment inventory recorded at the close of the year included a total of 1,859 items, or an increase of 280 during the year, 255 being of a portable classification and 25 representing laboratory or fixed monitoring, analysis and testing equipment.

The dollar value of the recorded equipment inventory is approximately $770,000 of which about 70 per cent is portable instrumentation. It should be noted that some items consist of a single instrument or component while others comprise complete and complex instrumentation systems of one or more major components.

Major Instrumentation Systems:

Scintillation Counting Systems	9
Proportional Alpha Counters	8
Automatic Sample Counting Systems	4
Densitometers	4
X-ray Systems	3
Spectrophotometers	3
Singlechannel Analyzers	2
Multichannel Analyzers	3
Automatic Film Reading System	1
4 pi Counting System	1
Frish Grid Chamber	1
Low Background Beta Counter	1
Rabbit Thyroid Counter	1
Uranium Analysis System	1
Total Body Counter	1

The maintenance and repair of the aforementioned instrument systems, which is the responsibility of the Maintenance Section, has required a constant effort to reduce the amount of overall system down time. The addition of new and modified programs being pursued by the associated Branches of the Division, has necessitated additional time of maintenance personnel.

The assistance required from the Maintenance Section by other Branches is as follows:

a. Counting room equipment for the Analysis and Ecology Branches.
b. Telemetering and Counting equipment for Site Survey Branch, (excluding portable instruments).
c. Film badge program including film calibration and badge handling and reading equipment for Personnel Metering Branch.

Number of Portable Instruments:

Geiger Counters	221
Cutie Pies	182
Junos	182
Air Samplers, Hi Vol	190
Motoair - Low Vol Air Samplers	54
Alpha Counters	49
Dosimeter Readers	57
Recorders	45
Slow Neutron Counters	34
Fast Neutron Counters	41
Handie Talkie	8
Remote Area Monitors	2
Nuclear Accident Dosimeter Systems	67
Radectors	87
Lab Monitors, GM	4
Lab Monitors, Scintillation	10
Minirads	7
Total...	1,240

3. Instruments Repaired

In addition to maintaining the aforementioned instrument systems, the following instruments were repaired and/or calibrated during the year:

Cutie Pies	760
Junos	704
Geiger Counters	733
Radectors	260
Air Samplers	241
Fast Neutron Counters	72
Slow Neutron Counters	89
Count Rate Meters	102
Alpha Counters	164
Scalers	55
Scintillators	56
Lab Monitors	3
Recorders	29
Dosimeter Readers	70
Miscellaneous	357
Total...	3,[illegible]

Units of the telementering system: 226

In comparison with 1959, a decrease in instruments repaired and/or calibrated of 200 is noted. An increase of 175 or about 16% portable instruments is noted. The reduction of maintenance may be due to the use of newer instruments.

Assistance was given to other Branches in the building and modifying of equipment to meet special test needs, in particular:

Site Survey Branch
U. S. Weather Bureau
U. S. Geological Survey

E. PROPOSED PROJECTS FOR 1961

1. Installation and completion of the Radiation Monitoring Telemetering System is anticipated in 1961.

2. Completion of automatic film reading system:

   To read densities from four fields; to convert densities into digital output punched into paper tape, suitable for acceptance by IBM 1620 Computer; to reliably identify each film with a specific individual.

3. Development of data handling systems to convert information into digital punched tape or cards acceptable by IBM computer. Such systems may be needed for counting room programs.

4. Automation of film badge calibration in an attempt to remove human errors and to keep statistical variations to a minimum.

F. ASSISTANCE TO THE INTERNATIONAL ATOMIC ENERGY COMMISSION

Rex Purcell, Maintenance Section Chief, left in May on a leave of absence to work for the International Atomic Energy Commission and assist the Government of Thailand for one year on nuclear instrumentation problems.

Chapter 8

ECOLOGY

Zola M. Fineman, Branch Chief

A. SUMMARY

The biological monitoring program, through quarterly surveys of the NRTS and environs, and the monitoring of individual releases and operations determines radioactive contamination levels in plants, animals, soils, and agricultural food products. I-131 was not detected in the routine monthly milk samples from 12 perimeter area farms. Low levels of I-131 activity were found in the milk after two reactor tests. The Sr-90 activities in the tibia-femur bones of jack rabbits were used as bio-assessments of environmental Sr-90 contamination in and between on-site and off-site. These assessments gave no indication that NRTS operations contributed to the Sr-90 levels in perimeter and off-site areas. The gross gamma activities of vegetation and surface soil also indicated little or no contribution from NRTS operations. The I-131 activities in milk, vegetation, jack rabbit thyroids and small mammals resulting from individual releases were analyzed for the degree of correlation.

The percentage of dietary radiostrontium taken up by the skeletal structure of jack rabbits was studied by dosing wild jack rabbits with Sr-85. The per cent of initial dose retained (R) for any day (t) can be calculated from the expression $R = 1.12\ t^{-0.22}$ for winter rabbits and $R = 17.1\ t^{-0.362}$ for summer rabbits. The results of a comparative study of jack rabbits and small rodents indicated that small rodents could be used as biological assessors of environmental I-131 contamination.

Wheat grain from plants receiving nitrate nitrogen had four times as much Sr-85 as the grain receiving ammonia nitrogen. Between 0.1 and 0.2 per cent of Sr-85 applied to the leaves of Russet Burbank potatoes was absorbed and translocated to the tubers.

The initial phase of the jack rabbit food habit study indicated that in late spring and summer, the jack rabbit ate a wide variety of short-lived annuals and very little sagebrush. NRTS small rodent populations in ten areas were correlated with vegetation compositions and densities. A three-specie typing of the vegetation on the NRTS was started and will be completed in 1961. The age of a jack rabbit can be estimated with a high degree of accuracy from the weights of the dry eye lenses.

Reseeding with crested wheatgrass was used to control halogeton in selected areas. The predatory animal control program in cooperation with the U. S. Fish and Wildlife Service accounted for 395 coyotes and 38 bobcats.

B. SCOPE

Introduction

The Ecology Branch carries on a three-phase program of:

1. Biological monitoring
2. Radioecology
3. Radiobiology research

The three phases are intimately related in their objectives and in the obtaining of information from field and laboratory studies. By judicious arrangement and planning, it is possible to combine and obtain information in two or more phases from a single-field experiment. Animals and plants collected for biological monitoring purposes provide data on biological and ecological phenomena. Similarly, radiobiological and radioecological studies provide information on individual parameters that can be used to assess, evaluate, and plan biological monitoring programs. Ecological field studies provide a basis for planning and interpreting radioecological studies.

C. SUMMARY OF MAJOR PROGRAMS

1. Biological Monitoring Program

   a. Introduction: The objective of this program is to determine the contribution of NRTS operations to the levels and distribution of radioactive contaminants in the soils, vegetation, animals, and agricultural food products in the NRTS and environs. This objective is attained by a systematic and special sampling in on-site and off-site areas.

   b. Field Samples:

      (1) The numbers of biological and ecological samples prepared and analyzed are shown in Table I.

      (2) Animals: Jack rabbits were taken primarily for the I-131 activity in the thyroid and Sr-90 activity in tibia-femur bones. The critical organ levels for the two isotopes were used as a biological assay value for the difference between on-site and off-site areas and between periods in the year. Thyroids and bones of other large animals, deer, antelope, coyotes, and bobcats were collected infrequently for comparison with jack rabbits which served as a reference standard. Antelope were accidental road kills. Deer samples were obtained from hunters and from Idaho Fish and Game Commission through the courtesy of Mr. Errol Nielson. Coyote bones were obtained from Mr. William Stewart, U.S. Fish and Wildlife Service, and came from the NRTS predatory animal control program.

Table I. Numbers of Biological and Ecological Samples in 1960

Types of Samples	No. of Field Samples	Isotopic: Multiple Whole Body or Entire Sample	Isotopic: Single I-131 Thyroid	Isotopic: Single Sr-90 Bone	Isotopic: Cs-137 Muscle	Gross Gamma: Indivu. Organs	Gross Gamma: Whole Body or Entire Sample	Total Number of Analyses
Animals								
Jack rabbits	412	23	412	283	87	28	6	839
Bobcat	6		6	2				8
Cow	9			9				9
Small Rodents	878	2	41				878	921
Coyotes	12		12	8				20
Antelope	15		5	15				20
Badger	3		1	3				4
Deer	2		2	2				4
Duck	1	3	1					4
Eagle	1		1					1
Vegetation	899	45					899	944
Soil	356	50					356	406
Milk	777	7					777	784
Snow	2	2					2	4
Total	3,373	132	481	322	87	28	2,918	3,968

(3) Vegetation: Big sagebrush, Artemisia tridentata, was the principal native plant specie collected; alfalfa and pasture plants were collected in conjunction with the milk sampling program. The gross gamma activity of sagebrush plants was used as an index of the levels and distribution of radioactive contaminants in on-site and off-site locations.

(4) Soil: Surface soil samples (0.0 - 1.0 inch) were collected and analyzed for gross gamma activity to supplement the information obtained from sagebrush samples. The gross gamma activity of the surface soil reflects the accumulation of the isotopes with a longer half-life. Gamma spectra analyses were made of soil samples from selected locations.

(5) Milk: The gross gamma activity of 900 ml samples of milk was used to detect I-131 and/or I-133 in milk. The detection limit by this method was $<2.0 \times 10^{-7}$ uc/ml. The I-131 and I-133 activities were confirmed by gamma spectrum analysis. Milk sampling was confined to individual farms in the Monteview and Mudlake - Terreton areas NE of the Site boundary. In July 1960, a survey of 91 farms in the area was made to obtain information on the number of cows per farm and feeding practices. Forty of the 91 farms had some pasture to supplement dry hay and grain. This survey provided information so that the individual farms in the area could be used as a downwind sampling array for operational monitoring. Milk samples were collected from the individual farms or from the individual farm cans at creameries in Idaho Falls, Rexburg, and Ririe.

c. Sampling Programs

(1) Quarterly surveys: This program was instituted in the Fall of 1959 to provide data on perimeter and off-site levels of radioactivity. The basic sampling array consisted of 101 stations, on-site and off-site. Sagebrush and surface soil samples were collected at nearly all of the stations. Soil sampling was discontinued after the third quarter. Jack rabbits were collected at 13 on-site, 13 perimeter, and 15 off-site sampling stations. The locations of the on-site stations are shown in Figure 1. The locations of the perimeter and off-site stations are shown in the Figure on Page 4. Monthly milk samples were obtained from 12 or more farms in the Monteview and Mud Lake - Terreton areas. The inclusive dates for the quarterly sampling periods were:

Period	Start	Finish
I	March 29	April 13
II	June 14	July 4
III	September 13	October 7
IV	December 12	December 30

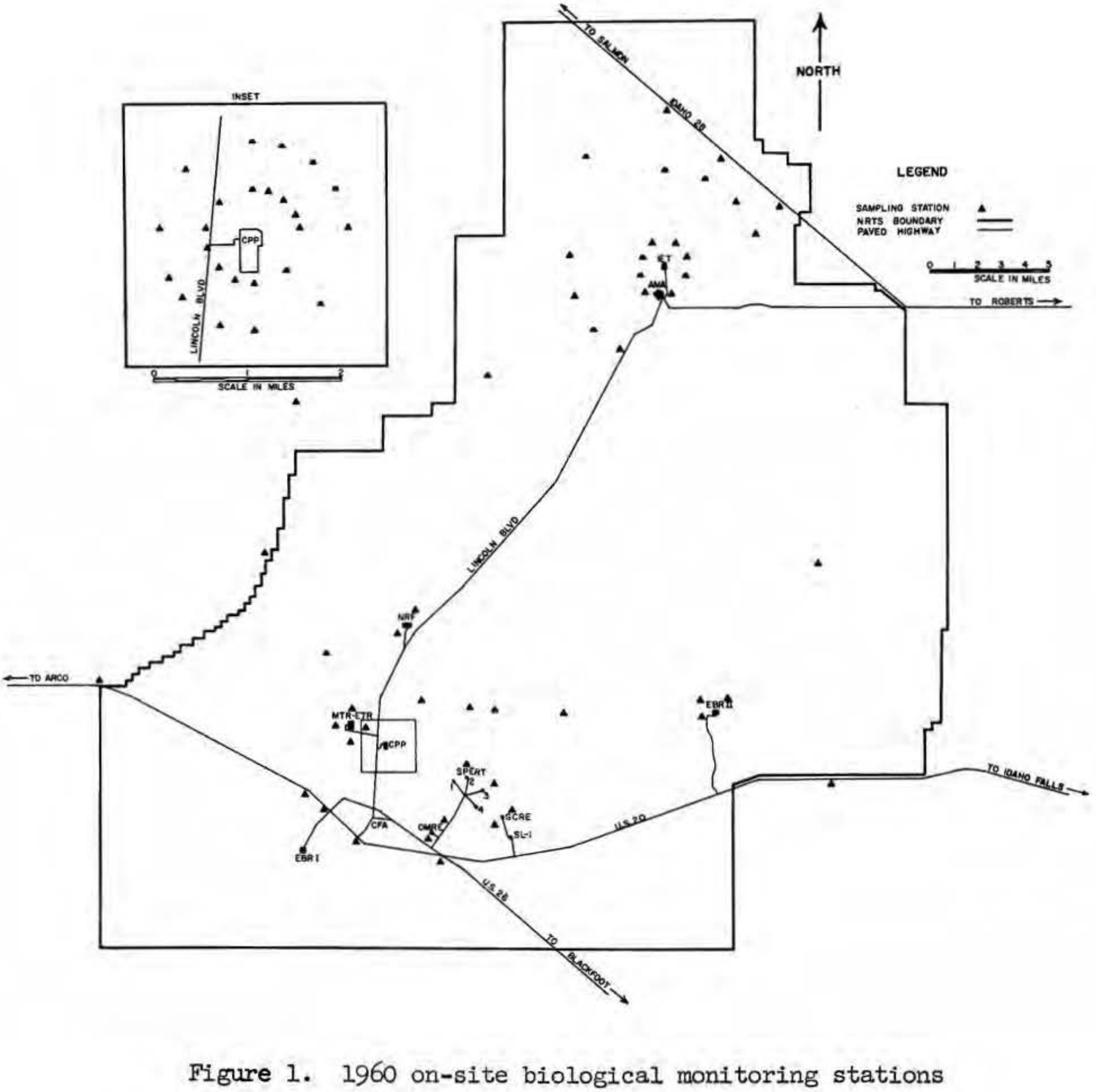

Figure 1. 1960 on-site biological monitoring stations

(2) Individual operations and releases

(a) CPP: Rala releases at approximately 20-day intervals were monitored by the collection of background jack rabbits and sagebrush the day prior to each release and post release samples 10 days after each release. Studies of the correlation between I-131 levels on sagebrush and in jack rabbit thyroids were made.

(b) FECF incident of October 1958: The residual environmental contamination released from this incident was monitored by the collection of jack rabbits in a limited area SE of the facility.

(c) IET: The monitoring program for the 1960 IET operations was designed to determine the levels and distribution of environmental radioactivity from controlled releases and to study the following correlations between the biological assay methods of monitoring environmental I-131 contamination: sagebrush and jack rabbit thyroids, jack rabbit thyroids and small rodent thyroids, sagebrush and pasture plants, pasture plants and milk. Three-single release tests, LIME, Sub-LIME, and FEET-II and a series of three releases during the FEET-I test were monitored. Samples were collected on the IDO Grid #2 NE of IET and in on-site and off-site areas enclosed by projections of the grid boundaries to a distance of 15 miles.

d. 1960 Results

(1) Quarterly surveys

(a) Sr-90: Between 1955 and 1959, the Sr-90 activities in the bones of on-site and off-site jack rabbits and of off-site cattle were obtained. The Sr-90 activity of the jack rabbit bones paralleled the activity of the cattle bones in comparable areas. The Sr-90 activity of jack rabbits was approximately 25 per cent higher than that in cattle bones. Since jack rabbits were available both on-site and off-site, the cattle bone monitoring was discontinued in 1960. In Table II, the quarterly mean Sr-90 activities at 13 perimeter and 15 off-site stations are compared to the Sr-90 activities at 13 on-site stations. During the year, there was a gradual decline in the Sr-90 levels at off-site and perimeter stations. As in previous years, stations near the CPP and the FECF had higher Sr-90 levels than other on-site stations.

Table II. Strontium-90 Activities in the Tibia-Femur Bones of Jack Rabbits

Location of Station or Stations	Mean Sr-90 in uuc/gm Ca Collection Period March 29 to April 13	June 14 to July 4	Sept. 13 to Oct. 14	Dec. 12 to Dec. 22
EBR-I - 2 mi. NE	33.1	12.8	17.0	25.9
EBR-II and TREAT	..	..	5.3	14.5
GCRE	50.5	24.6	6.7	10.6
NRF - ½ mi. NE	20.0	lost	13.0	7.7
MTR - ½ mi. NE	..	29.0	17.3	12.2
OMRE - ½ mi. NE	40.0	8.0	7.0	11.7
SPERT - ½ mi. NE	23.5	14.0	16.2	10.6
IET - 1½ mi. NE	18.0	20.0	8.2	23.5
IET - 4 mi. SW	26.0	14.0	10.3	5.5
CPP - 3½ mi. NE	..	..	19.1	16.0
CPP - 1 mi. NE	100.5	..	53.5	..
CPP 1 mi. SW	52.9	29.1	39.5	38.4
FECF	93.6	485.5	579.4	91.0
Site Perimeter (13 Stations)	18.0	16.0	9.0	16.9
Off-Site (15 Stations)	21.0	15.0	13.0	11.6

(b) Sagebrush: The gross gamma activity means of seven groups of sagebrush samples taken for the four quarterly surveys in 1960 are presented in Table III. There was a general decline in the gross gamma activity of sagebrush during the year. Perimeter and off-site means did not exceed on-site means. The 1960 gross gamma levels were lower than the 1959 levels. A few individual off-site samples exceeded on-site means. The sources of the gross gamma activity were primarily the CPP and IET facilities.

Table III. Gross Gamma Activities of Sagebrush Samples

		Quarterly Collection Period c/m/g in Indicated Sample or Samples							
Sampling Line Locations	No. of Stations Per Line	March 29 to April 13 Mean	Max.	June 4 to June 30 Mean	Max.	Sept. 15 to Oct. 6 Mean	Max.	Dec. 12 to Dec. 29 Mean	Max.
IET - 1.0 mi	8	7	11	10	19	3	4	2	4
IET - 4.0 mi.	8	5	7	4	9	3	3	3	4
CPP - 0.5 mi.	12	21	52	6	7	3	5	8	14
CPP - 1.0 mi.	12	13	35	4	7	5	27	5	15
CPP - 4.0 mi.	10	6	15	4	11	2	6	2	3
Perimeter	7	4	7	4	6	2	3	2	3
Off-Site	12	5	8	2	3	2	3	3	14

(c) Soil: The mean gross gamma activities of surface soils for the three quarterly surveys in 1960 are presented in Table IV. The results for 79 of the 101 sampling stations are summarized in 7 groups. There was a general increase in the surface soil gross gamma activity from the first to third quarter. Most of this general increase may be attributed to the larger amount of soil per unit volume during the two drier sampling periods in June and September. Gamma spectra were made of samples from selected locations. The isotopes identified were Cs-137, Ce-144, and Zr-Nb-95. The data do not indicate any contribution of NRTS operations to gross gamma activity levels of off-site surface soils.

Table IV. Gross Gamma Activities of Surface Soil Samples

Sampling Line Locations	No. of Stations Per Line	c/m/ft² Collection Periods: March 29 to April 13 Mean	Max.	June 14 to June 30 Mean	Max.	Sept. 15 to Oct. 7 Mean	Max.
IET - 1.0 mi.	8	11	13	12	15	14	18
IET - 4.0 mi.	8	11	13	11	13	14	17
CPP - 0.5 mi.	12	21	32	25	45	27	33
CPP - 1.0 mi.	12	18	22	23	30	23	28
CPP - 4.0 mi.	10	15	16	19	22	21	24
Perimeter	7	12	15	15	18	16	18
Off-Site	12	14	16	19	20	18	20

(d) Isotopic analyses of surface soil: The Cs-137 and Ce-144 activities of a square foot of surface soil from eight locations in June 1960 are presented in Table V.

Table V. Cs-137 and Ce-144 Activities in Surface Soil in June 1960

Location	uc/ft² Cs-137	uc/ft² Ce-144
IET NE - 1.0 mi.	3.1×10^{-3}	2.8×10^{-2}
IET NE - 7.5 mi.	9.2×10^{-3}	6.1×10^{-2}
IET NE - 13.0 mi.	3.7×10^{-3}	3.8×10^{-2}
CPP NE - 0.5 mi.	28.3×10^{-3}	24.2×10^{-2}
CPP NE - 3.5 mi.	4.6×10^{-3}	4.6×10^{-2}
CPP SW - 0.5 mi.	18.8×10^{-3}	12.2×10^{-2}
Taber - Off-Site	5.1×10^{-3}	1.9×10^{-2}
Idaho Falls - Off-Site	4.1×10^{-3}	3.5×10^{-2}

(2) Individual operations:

(a) CPP

The I-131 activity in jack rabbit thyroids was used as a bio-assay of the environmental I-131 contamination in two areas, 0.5 - 1.0 miles NE of CPP and at 20 miles SE of CPP. The curies of I-131 released subsequent to each of 17 Rala operations are given in Figure 2. A total of 32.8 curies were released during the year, compared to 227.2 curies in 1959. The data in Figure 2 shows the increase and decrease in thyroid I-131 with similar variations in stack I-131. In 1960 the highest thyroid I-131 was 9,000 uuc/g; in 1959, the highest was 40,000 uuc. This corresponds to the differences between the highest monthly releases in each year of 9.9 and 104.8 curies. Because of the low levels of I-131 released in 1960, sampling was restricted to two areas. At Taber, I-131 was observed only during the month of June and was the result apparently of an increased number of NW winds in June.

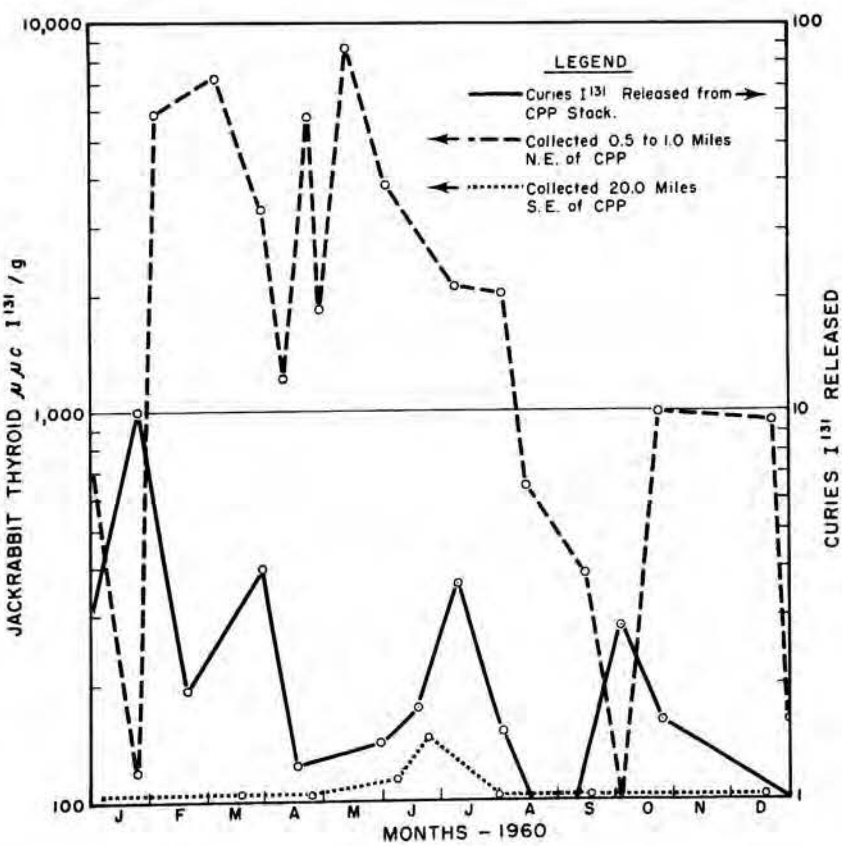

Figure 2. Jack rabbit thyroid bio-assay of environmental I-131 [illegible] resulting from CPP stack effluent

(b) IET

Sampling procedures: Spot samples of vegetation, milk, and jack rabbit thyroids were collected before each test throughout the monitoring area for the background level of activity. Following each test, vegetation samples were collected downwind across the effluent cloud path. Samples were collected 1.5, 2.5, 4.0, 5.5, 8.0, and 12.0 miles downwind. Milk sampling was started after the cloud path had been determined and was continued for 7 to 10 days. Jack rabbits were collected for 5 to 15 days after each release.

Milk and pasture vegetation: A summary of the more pertinent milk samples collected for the 1960 IET summer operations is presented in Table VI. I-131 and/or I-133 was detected in milk samples after two tests, LIME on August 25 and FEET II on October 12. The utilization of the individual farms in the monitored area as a sampling array provided an opportunity to concentrate sampling in restricted areas in which it was possible to obtain samples of both milk and vegetation having detectable amounts of I-131.

Table VI. Summary of the 1960 IET Milk Sampling Program

Test	Sampling Period	Farms Sampled	Samples Collected	Samples with I-131, I-133	Farms with Activity
FEET I	7/20-8/24	29	45	0	0
LIME	8/25-9/1	17	200	24	12
FEET II	10/13-10/21	18	120	19	9
Sub-LIME	10/25-11/3	15	145	0	0

Milk and Vegetation: For two tests, it was possible to obtain milk, alfalfa, and pasture plants having detectable amounts of I-131 and/or I-133 from the same farm. The results are presented in Table VII. The ratios of milk I-131 to pasture I-131 were markedly different after the two tests, being 68:1 and 8:1, respectively. The difference is attributed to the different pasture conditions in August and October.

Bio-assay of environmental I-131 contamination: The LIME test provided an opportunity to study the degree of correlation between sagebrush and jack rabbit thyroid I-131 activities collected in the same area. Table VIII presents data on sagebrush and thyroids collected after the LIME test on August 25, and FEET II test on October 12. Thyroids were collected from 5 to 22 days after a release and the I-131 activities are for the date of collection. Sagebrush I-131 activities have been corrected to the hour of release. French (TID-7578, p. 113) found that after a single release, jack rabbit thyroid I-131 activity maximizes on the tenth day; 5 and 15 days after a release slightly lower levels are expected. French's data indicate a ratio of 20:1 for thyroid I-131; sagebrush I-131. The ratios range from 12.8 to 405 to 1. Part of the differences between ratios can be attributed to (1) an independence between sagebrush I-131 and dietary I-131 and (2) to a noncoincidence between the home range center of a jack rabbit and the location of the sagebrush sample.

Table VII. I-131 and I-133 in Milk and Pasture Plants from IET Operations

Test	Sampling Date	Pasture Plants uc/g.	Milk I-131 uc/ml*	Milk I-133 uc/ml*	Ratio of I-131 Per l. of Milk: g. of Vegetation Pasture	Calculated Dose mrads**
LIME	8/27	2.5×10^{-6}	1.7×10^{-7}	2.1×10^{-7}	68:1	40
FEET II	10/17	5.0×10^{-5}	4.0×10^{-7}	..	8:1	85

*All quantitative values for I-131 and I-133 were determined from gamma spectra.

**Assuming 1,000 ml/day milk consumption for a child thyroid of 2g.

Table VIII. Biological Assessment of Environmental I-131 Contamination on Grid #2

Operation	Date Release	Date Sample	Location on IDO Grid #2 Arc	Location on IDO Grid #2 Station	I-131 Means uc/g Sage	I-131 Means uc/g Jack Rabbit Thyroid	Ratio Thyroid:Sage
LIME	8/25	8/26	8250	13-17	60×10^{-6}		
		9/1	"	"		37×10^{-4}	60:1
		8/26	13000	16-22	23×10^{-6}		
		9/1	"	"		3×10^{-4}	13:1
FEET II	10/12	10/12	8250	17-21	48×10^{-6}		
		10/17	"	"		195×10^{-4}	400:1
		11/3	"	"		48×10^{-4}	75:1
		10/12	13000	19-21	38×10^{-6}		
		10/17	"	"		67×10^{-4}	180:1

2. Radioecology

a. Strontium-85 in Wild Jack Rabbits on the NRTS

During the months of January, February, March, July, August, and September of 1960, wild jack rabbits were live-trapped, given a gelatin capsule containing Sr-85, released, and subsequently retrapped and examined. Initially, all of the major organs of the body including components of the skeleton were examined by gamma counting to determine where deposition occurred. The major site of deposition was in the bone. Thereafter, only skeletal components were radiologically assayed. The various components of the skeleton were examined to see if differential deposition occurred. None of any consequence was found.

After analysis, the per cent of initial dose was calculated and plotted on log paper. The result was for practical purposes a straight line. The per cent of initial dose retained (R) for any day (t) can be calculated from the expression $R = 1.12\ t^{-0.22}$ for winter rabbits and $R = 17.1\ t^{-0.362}$ for summer rabbits.

The average age of the rabbits was estimated from dry eye lens weights, being 14 months for winter and 8 months for summer rabbits.

With data from this study and a concurrent jack rabbit food habit study, an attempt will be made to correlate Sr-90 in the jack rabbit skeleton with environmental Sr-90 contamination levels.

b. Strontium-85 in Deer Mice

In June of 1960, ten deer mice were given oral doses by stomach tube of about 0.1 uc of Sr-85. These mice were adult males, born in the laboratory in the Spring of 1960 and raised on Purina Mouse Chow, a balanced laboratory mouse ration. They were counted daily in a well counter to determine whole body gross gamma activity.

Initial counts taken about one hour after dosing and considered to indicate the initial dose. Daily averages were plotted. These are shown in Figure 3.

c. Monitoring With Small Mammals.

Deer mice and chipmunks were studied in contaminated habitats to determine if they could be used to detect low levels of radioisotopes. There was a lag of a few days after contamination before they could be found significantly radioactive, at the 95 per cent confidence level, by gross gamma counting of the whole body. Chipmunks had an average 25 per cent higher radioactivity than deer mice. A larger percentage of the trapped animals were significantly radioactive following the planned releases of react
areas.

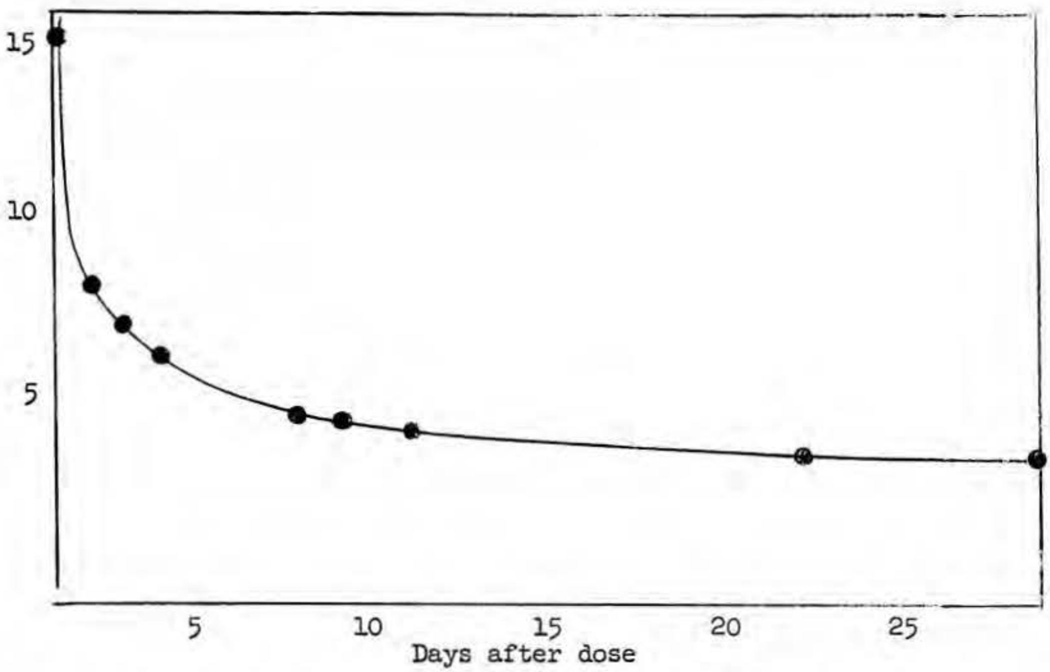

Figure 3. Whole body retention of Sr-85 by Deer Mice given 0.1 uc orally

d. Ecological Studies

(1) Jack rabbit food habits: An investigation into the food habits of the jack rabbits on the NRTS was initiated in the Spring of 1960. This study continues into the present. It was apparent early that jack rabbits ate a wide variety of short-lived green annuals and very little sagebrush as was generally supposed. Therefore, plants were collected throughout the growing season to form a reference collection. These were further prepared on microscope slides since comparisons of these and jack rabbit stomach contents are at the microscopic level. Some of the guide posts of identification are pollen grains, minute seeds, and unique epidermal cells which are shown in Figure 4.

Two jack rabbits are collected every month, and stomach contents prepared for examination. These are sent to Idaho State College at Pocatello, Idaho, where identifications are made. As soon as determinations can be made quantitatively, correlation studies with plant radioactivity and jack rabbit radioactivity can be undertaken. These will allow quantitative estimates of environmental contamination at very low levels. Jack rabbits living [illegible]aminated habitats concentrate low level in their body organs.

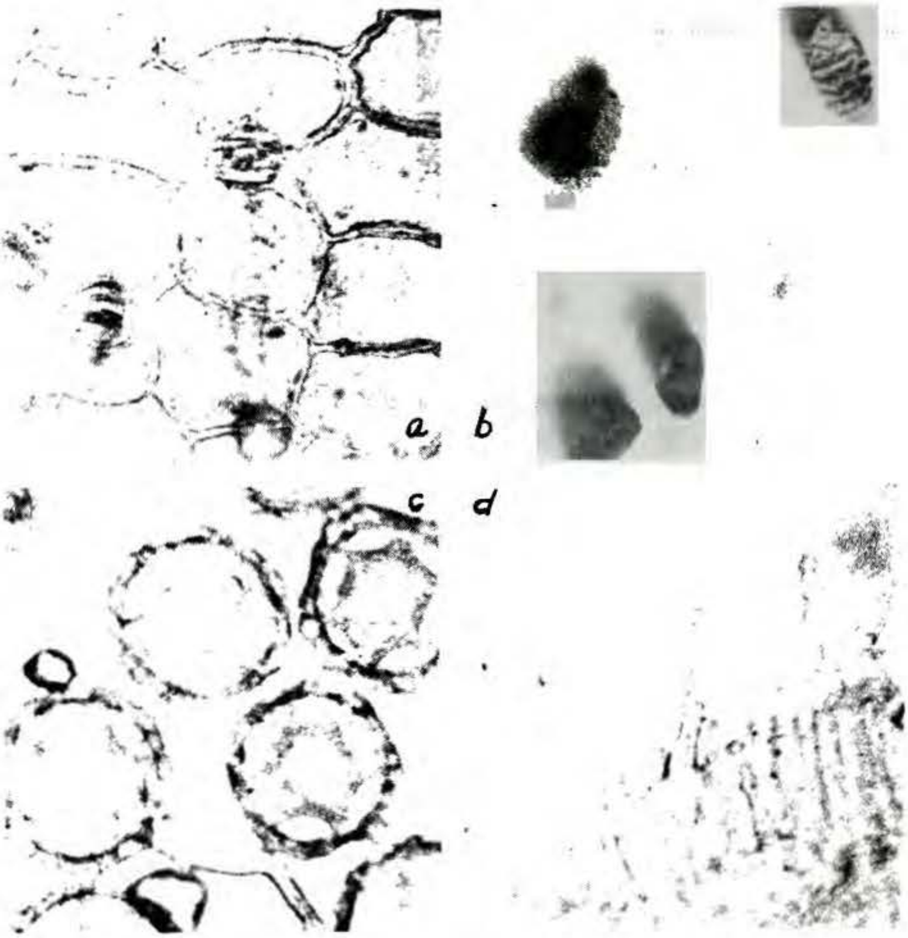

Figure 4. Stomach contents of jack rabbits

- a. Epidermal cells of Salsola
- b. Seeds of Phacelia glandulifera (top) Nama densum (bottom)
- c. Opuntia pollen grains
- d. Trichomes of Mentzelia congesta

(2) Small Rodent Populations on the NRTS: Ten traplines of the type used by Dr. John B. Calhoun for the North American Census of Small Mammals were run during the Summer of 1960 in the vicinity of CPP and IET. Each trapline was operated daily over a period of 30 days, several traplines being run concurrently. Vegetation composition and density in the trapping areas was determined by random 50-foot transects.

Most areas on the NRTS are sparsely covered with sagebrush. The largest coverage in these ten plots due to sagebrush was 25 per cent. In one sandy plot, Russian thistle and Indian rice grass had a combined cover of 34 per cent, the largest plant cover measured. The best security for small rodents was provided by large clumps of giant wild rye grass and accumulated litter under old stands of sagebrush.

By far the most numerous rodent was the deer mouse, outnumbering by 2 to 1 the chipmunk. Deer mice were the only small rodents captured in all habitats. Grassy areas seemed to harbor deer mice exclusively. Large stands of grass usually are associated with fine lacustrine or aeolian soils in lava basins or sinks. This may inhibit chipmunks from establishing territories. While chipmunks and deer mice both built nests in litter under brushy cover, the deer mice made good use of large bunch grass clumps which seemed unacceptable to chipmunks. The highest ratio of juvenile deer mice per adult was in the grassy areas. Kangaroo rats and pocket mice were generally found in the sandy areas as might be expected. Ground squirrels were associated with stands of prickly pear cactus.

(3) Determining the amount of current season's vegetation: A technique was developed during the Summer of 1960, for estimating the amount of current year's growth on several small woody plants on the NRTS. This is used to form a rapid calculation of the quantity of radioactive fallout per square meter on the contaminated vegetation. Essentially this is as follows: Determine cover and density of the plant species per area and divide to get the area of an average plant. Measure the amount of vegetation on several average plants by weight. By counting samples of vegetation of known weight for radioactivity, counts can be determined for this plant per unit area.

(4) Vegetation typing on the NRTS:

Vegetation coverage of the NRTS area varies in species composition and density within species. To better evaluate situations of biological monitoring, a three-type inventory was started and is now about 50 per cent completed, inclusive of field mapping and basic aerial photo work. This work is being done as an addition and refinement of the 1956 work.

(5) Use of the dry lens weight for estimating the age of wild jack rabbits, <u>Lepus californicus</u>: At the NRTS, the Sr-90 content of the leg bone of jack rabbits is utilized as an index of environmental Sr-90 contamination. The Sr-90

levels, uptake, and biological half-life vary with the age of the animal. Better estimates of environmental Sr-90 contamination would be possible if the variations in bone Sr-90 with the age of the animal were known. The dry lens weight method developed by Lord (J. Wildlife Management, 23:358, 1959) for cottontail rabbits, Sylvilagus floridanus, was adapted to a study of the dry lens weights as a method of determining the age of wild jack rabbits. Starting in November 1959, collections of lenses were made at approximately monthly intervals. In a collection of 46 rabbits taken between November 30 and December 17, 1959, lens weights fell into 2 distinct groups, 156-196 and 221-291 mg. The distribution in the 221-291 mg. group was bimodal. In subsequent 1960 collections, eye lens weight distributions fell into two or more distinct groups or were bimodal. Between May 23 and August 17, 1960, the lens weights of 30 young rabbits ranged from 31 to 125 mg. and the body weights from 165 to 1,474 gm. Dry lens and body weights in this group were correlated.

(6) Noxious weed control: Halogeton control for the year consisted of the reseeding of disturbed areas, both old and new, to species of wheatgrass. All seeding was performed with a heavy duty rangeland drill (Figure 5) made especially to seed without seedbed preparation in brushy, rough, or rocky land. Figure 8 shows the results of one reseeding. The following areas were seeded to crested wheatgrass, Agropyron disertorum:

1. Thirteen acres around the new construction area of ML-1. This work was performed by the contractor under the supervision of Ecology Branch personnel.

2. Nine hundred acres in the Cerro Grande area along the southern boundary of the NRTS.

3. Forty-eight acres of roadside along Lincoln Blvd.

4. Experimental seedings were carried out in two specific vegetation and soil types in the ANP area. Streambank wheatgrass, Agropyron riparium, was used to seed 22 acres. Tall wheatgrass, Agropyron elongatum, was used to seed 42 acres. This seeding was performed as a field study for seed germination and plant survival.

The following recommendations were proposed and adopted. New construction contracts now contain additional specifications along these lines.

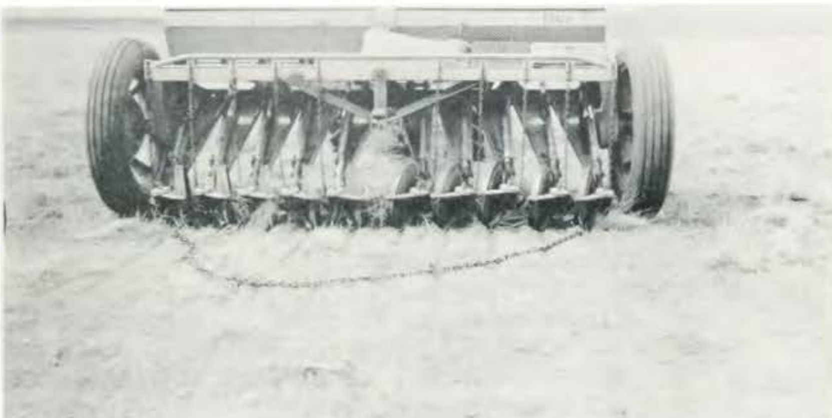

Figure 5. Rangeland drill used for seeding in native vegetation and unplowed land

Figure 6. Crested wheatgrass seeded in 1959 near Atomic City

New construction areas:

1. Remove as little of the native vegetation and the top soil as possible.
2. Pile brush, overburden, and rock in neat and orderly piles.
3. Smooth all denuded areas to facilitate drilling or revegetation.
4. Spreading of gravel should be kept to a minimum.
5. Construction of haul roads, access trails, etc., should be kept to a minimum.

Maintenance - Roadways, etc.

1. Discontinue the practice of scraping or blading except for road shoulders and adjoining drain areas.
2. Discontinue the use of soil sterilizer except in the heavily graveled loading zones or parking areas.
3. Remove excessive annual plant growth by mowing; this practice alone will greatly facilitate holding the top soil and, therefore, provide a base for more desirable perennial plant growth.

(7) Predatory animal control: During 1960, under Contract No. AT(10-1)1039, with the U. S. Department of the Interior, Fish and Wildlife Service, and Bureau of Sport Fisheries and Wildlife, the following work was carried out: Trapper Stewart, a full-time employee, maintained 400 coyote getters (cyanide guns), 40 poison-bait (#1080) stations, and about 50 steel traps inside the NRTS boundary. A total of 233 coyotes were taken by the above methods. Records were kept of the date and location of kill and the sex and age of each animal. During the year, 32 mature plus 103 immature females and 20 mature plus 78 immature males were taken. During the year, trapper Stewart took 21 male and 14 female bobcats mainly by the use of steel traps.

Pilot Robinson and gunner conducted airplane hunting over the NRTS between January 14 and March 18. During a period of nine days, with a total of 35-1/4 hours of flying, they shot 158 coyotes. In May, they shot 22 mature coyotes while in the process of spotting coyote dens. The supporting ground crew killed 45 young coyotes during this seven-day period in May.

The Ecology Branch personnel recovered four coyotes and three bobcats that had been either shot by Security guards or accidently killed by automobile traffic.

3. Radiobiology

a. Plant Growth Room Methods

The plant growth room containing 64 square feet of bench space was acquired in December 1959. Preliminary experiments were designed to develop methods and techniques of growing plants in various types of growth media and of applying radioisotopes to plants and soils.

The absorption of Sr-85 by alfalfa plant roots from soil, sand, and vermiculite was studied in two separate experiments. Sr-85 was added at the rate of 3×10^{-3} uc per gram of air dried media. Plants were harvested after 120 days of growth. The following results were obtained:

Per cent of Sr-85 Activity Removed from Growth Media

	Exp. #1	Exp. #2	Mean
Soil	21	26	23.5
Sand	71	72	71.5
Vermiculite	6	13	9.5

b. Effect of Nitrogen Fertilizers Upon Sr-85 Absorption

The effect of the source of nitrogen upon Sr-85 absorption was studied by supplying wheat plants grown in sand culture with nitrogen in the form of (1) NH_4SO_4 or (2) $CaNO_3$, $NaNO_3$ and KNO_3. The grain from the plants receiving ammonia nitrogen (NH_4SO_4) contained four times as much Sr-85 as the grain from the plants receiving nitrate nitrogen. Similar differences were obtained for chaff and straw.

c. Strontium-85 Absorption and Translocation by Leaves of Potato Plants:

The absorption and translocation of Sr-90 "fallout" by the leaves of potato plants were simulated by spraying Russet Burbank potato plants (4 hills per box) with a 33 ml solution containing 4.9 uc of Sr-85 as $SrCl_2$. Plants were sprayed on August 17, 97 days after planting. Check plants retained 1.9 uc of the sprayed material. Five days after spraying 0.8 inches of rain removed almost 50 per cent of the initially retained material. The tubers, roots, and remaining tops were harvested on October 12, 56 days after treatment. Between 0.1 - 0.2 per cent of the calculated Sr-85 initially retained by the leaves and stems was translocated to the tubers (edible portion). Middleton, J. (Int. J. Rad. Biol., 4:387-402, 1959) obtained a smaller per cent transfer and accumulation of foliar-applied Sr-89 in similar experiments with potato plants.

C. FUTURE PROGRAMS

1. Biological Monitoring

a. Milk Sr-90 Monitoring

The analysis of milk samples for Sr-90 will be initiated in 1962. The present milk sampling program of monthly samples from 12 perimeter farms will be expanded or altered on the basis of a sampling study which will be made in 1961. This study will determine the number of individual farms that need to be sampled and whether or not the analyses should be made on pooled or individual farm samples from an area.

b. Powdered Milk

A correction factor for K-40 in routine milk samples will be obtained from K-40 values of powdered milk samples collected throughout the year. Seasonal changes in K-40 and K-39 resulting from changes in feeds and feeding practices will be studied.

c. Environmental Monitoring with Small Rodents

These small animals have the advantages of short lives and small home ranges, which add confidence in their measurements being representative of the area where they are taken. It is proposed to monitor in this manner around SL-1 during the Summer of 1961, and at other places and times.

2. Radioecology

a. Diet and Critical Organ Radioactivity Levels

For biological monitoring purposes, jack rabbit thyroid I-131 and bone Sr-90 activities are being used as biological assessments of environmental I-131 and Sr-90 contamination. Information is now available on the plant species that are eaten by the jack rabbit during the different seasons. The determination of the activity levels of different radioisotopes on the plants that the jack rabbit is eating would supply information on environmental contamination for I-131, Sr-90, and Cs-137 and provide a better estimate of total environmental contamination. The correlated sampling and analysis of the critical organ of jack rabbits and dietary I-131, Cs-137, and Sr-90 would provide information on the ecological cycling of biologically important radioisotopes. Correlations between dietary and critical organ activity levels would furnish more accurate estimates of dietary and environmental contamination levels from critical organ data.

b. Radiocesium in NRTS Jack Rabbits

Since jack rabbits on the NRTS have been found with Cs-137 in their muscle tissue, it would be advantageous to know the amount of Cs-137 taken up by the rabbit from his environment. This experiment will determine the per cent of ingested Cs-137 that is retained in the jack rabbit and the organs and tissues of accumulation. Methods similar to those used for I-131 and Sr-85 will be used.

c. Radiocesium in Domestic Rabbits

The Analysis Branch needs information about the organs of deposition of Cs-137 in connection with their whole body counting program. Domestic rabbits will be given different oral doses of Cs-134. Whole body counts will be made to determine biological decay.

d. Biological Factors in Settling Ponds

The objective of this study will be to determine the influence of settling pond biota on radioactive waste disposal to the environment. It will be in cooperation with the Analysis Branch as part of the general geochemical study of waste disposal. The investigation is concerned mainly with micro-organisms and algae in the MTR-ETR ponds. These will be studied for radiobiological holdup, biological retention mechanisms, plant-isotope specificity, and correlations between inflow composition and quantities of biological material present. Field and laboratory studies will run concurrently.

3. Radiobiology

a. Foliar Absorption of Radiostrontium

The preliminary study in 1960 of the absorption of foliar applied radiostrontium and its translocation to the edible tubers indicates the need for further study of the potential hazards inherent in Sr-90/89 levels in potato tubers. In 1961, additional information will be obtained on the percentage of retained radiostrontium that accumulates in the edible portion (tubers) of the plant. The effect of environmental factors, such as relative humidity on the uptake mechanism, will also be studied.

b. Soil factors in plant radiostrontium levels: Further studies of the differential absorption of radiostrontium by plants receiving nitrate or ammonia nitrogen will be made in both soil and sand cultures.

Chapter 9

SITE SURVEY

W. P. Gammill, Branch Chief

A. SUMMARY

The Branch provided physical monitoring requirements for nine power tests at the Aircraft Nuclear Propulsion Area and twelve Rala releases at the Chemical Processing Plant. Although there were only twelve runs made in 1960 as compared to sixteen in 1959, the amount of iodine released to the atmosphere in 1960 was almost an order of magnitude lower than the previous year. The Branch was involved with 750 off-site and 3,315 on-site shipments of radioactive material.

The following amounts of radioactivity were discharged to the environment:

Liquid	3,500 curies
Solid	9,200 curies
Aerosol	255,000 curies

The hydrological and geological research carried out during the year included the drilling of sixteen wells in the MTR-ETR and CPP vicinities and the logging of all completed wells by geophysical techniques. Saturated zones of perched water above the regional water table were observed out to a distance of one-half mile from the MTR-ETR disposal pond.

Low concentrations of radioactivity were detected in observation wells in the MTR-ETR and CPP vicinities.

B. ORGANIZATIONAL CHANGES

Two major organizational changes occurred within the Site Survey Branch during 1960. As of June 1, the U. S. Public Health Service personnel at the NRTS, with the exception of the Senior Officer, were integrated into the Branch. The primary purposes for this change were as follows:

1. To combine the research and development program of both groups to eliminate duplication of effort.
2. To assure that the research and development work is primarily directed toward the needs of the physical monitoring group at the NRTS.
3. To encourage the practical application of new techniques and equipment resulting from research and development work.
4. To provide the Public Health personnel with more diversified experience in physical monitoring and radioactive waste disposal.

Although these personnel now receive technical direction from the Site Survey Branch Chief, administrative direction is still provided by the Senior USPHS Officer, who holds a staff position in the Health and Safety Division.

The second major change involved sectionizing the Branch. On September 1, the Branch was reorganized into two sections: Health Physics and Waste Management. This was a logical development inasmuch as the Branch responsibilities naturally fall into these two general areas.

The Health Physics Section has the responsibility for the detection and evaluation of radiation in the physical environment outside areas specifically assigned to the contractors at the NRTS. The Section also establishes standards and criteria for radioactive shipments, maintenance of equipment for emergency radiation monitoring functions at the NRTS, design review of proposed facilities, health physics reviews of IDO contractors, and evaluation of hazards summary reports.

The Waste Management Section is responsible for establishing criteria, regulations, and procedures for disposal of all radioactive waste at the NRTS, management of the NRTS burial ground for solid radioactive waste, and direction of the NRTS radioactive waste disposal research program which is being carried out in cooperation with the U. S. Geological Survey.

C. <u>HEALTH PHYSICS SECTION</u>, George Wehmann, Chief

1. Environmental Monitoring

a. ANP - Initial Engine Test Facility (IET)

During the year, the Section was engaged in monitoring during power tests Nos. 18 through 26 at the Aircraft Nuclear Propulsion Area. Both mobile and fixed monitoring equipment were utilized. Several of these power tests provided a source of airborne radioactive material for research work carried out by the Branch. A summary of this work is found in section 2b of this chapter.

b. Chemical Processing Plant (CPP) - Rala

All Rala runs made at the CPP during 1960 were monitored by the section at points beyond the operational area. Table I lists the approximate amounts of activity released to the atmosphere as the result of each run. Although there were only 12 runs made in 1960 as compared to 16 in 1959, the amount of iodine released to the atmosphere in 1960 was almost an order of magnitude lower than the previous year.

Table I. Radioactivity (Curies) Released to the Atmosphere Due to Rala Operations

Run Numbers	Date of Run	I-131	I-132	Beta Activity Minus Iodine
38	January 26-27	9.97	34.3	8.32
39	February 24-25	1.86	11.0	3.37
40	March 29-30	3.95	7.2	1.41
41	April 19-20	1.21	27.2	1.63
42	June 1-2	1.42	23.8	2.75
43	June 21-22	1.36	4.2	1.39
44	July 12-13	3.54	3.6	3.66
45	August 2-3	1.36	11.2	0.75
46	August 23-24	1.09	11.4	0.42
47	September 13-14	.87	9.5	0.52
48	October 4-5	2.79	22.0	1.00
49	October 24-25	2.60	11.0	1.27
	Total Activity 1960	32.02	176.4	26.49
	Total Activity 1959	227.2	1,015.5	219.1

c. Radioactive Iodine Monitoring

Continuous air sampling for radioactive iodine was conducted at eight stations on the NRTS. These samplers utilize a carbon cartridge which is composed of a cylinder of flexible acetate plastic, 5/8" in diameter by 2" in length, open at both ends. The cylinder is filled with 12 x 30 mesh activated carbon with a 5/8" circle of 60 mesh brass screen at each end to hold the carbon in place, and a piece of 5/8" tygon tubing about 3/16" long as a retaining ring to hold the screens in place. A 5/8" disk of MSA-2133 all-dust filter paper is inserted at one end between the screen and retaining ring.

The calculated maximum possible infinity thyroid dose was obtained by counting the activity collected on the carbon and assuming all the activity to be due to iodine-131. The station locations, except those at IET and FET, and the annual calculated dosage are shown in Figure 1. The highest possible exposure was 38 mrem at the construction area north and east of the CPP fence. Over-all, the iodine levels are a factor of three lower than the previous year. During the last nine months, ten similar stations were established off-site to provide data for the quarterly environmental monitoring reports. Station locations and data results are included in Chapter 2.

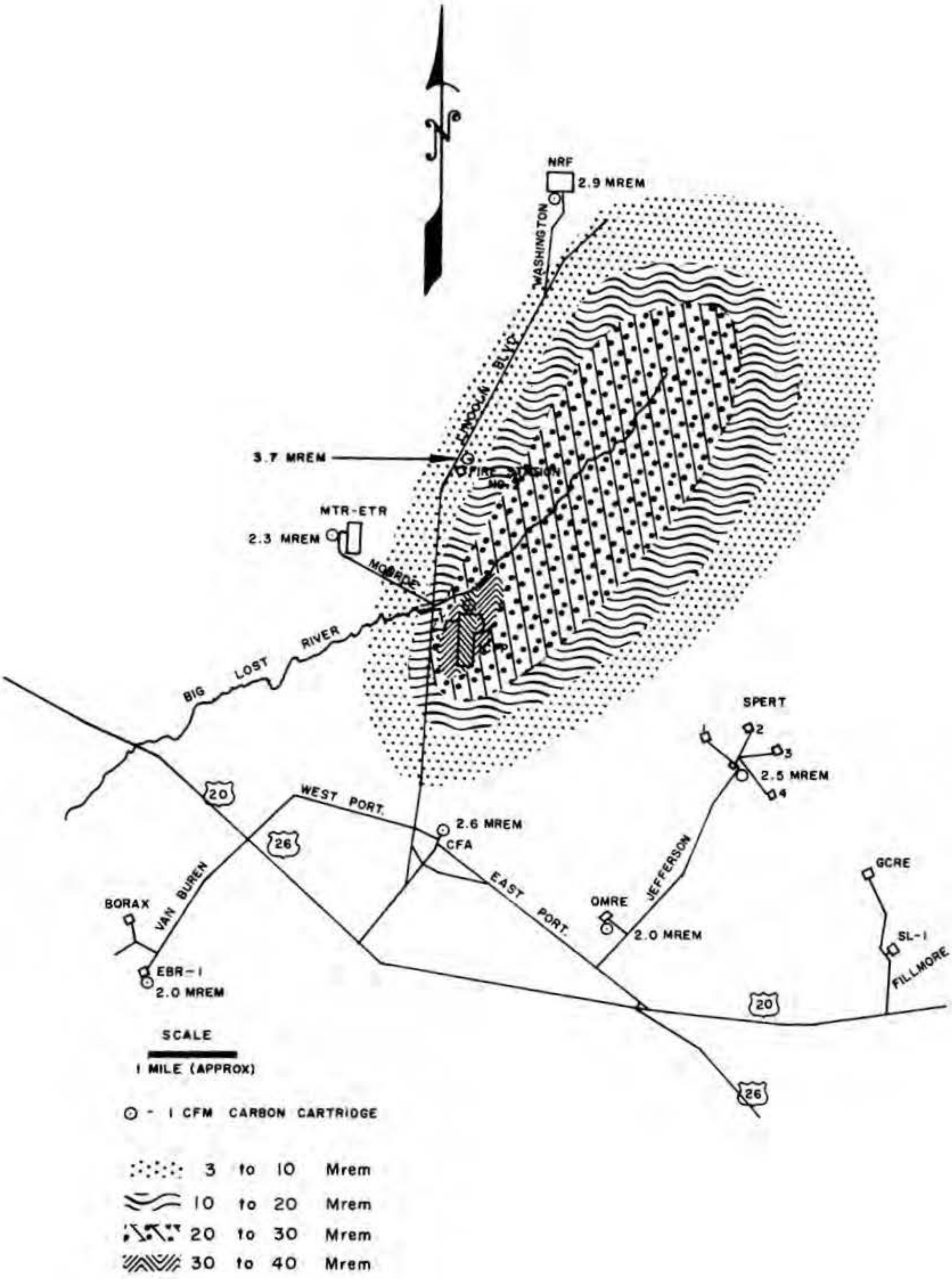

Figure 1. 1960 infinity thyroid dose from CPP operations

d. Weapons Test Fallout Program

The monitoring program in connection with weapon test fallout was discontinued early in 1960; however, results of a continuous low volume air sampler located in Idaho Falls indicate the average air concentration was less than 0.2 uuc/m^3.

e. Water Sampling Program

Water samples from 22 wells on the NRTS which produce water for human consumption were collected weekly. Figure 2 shows the locations of these wells. The samples were analyzed for alpha and beta activities, with the analytical results stored on IBM cards. In addition to the on-site program, underground water samples were taken every two months from 30 locations beyond the NRTS boundary during 1960. Station locations and analytical results are also given in Chapter 2.

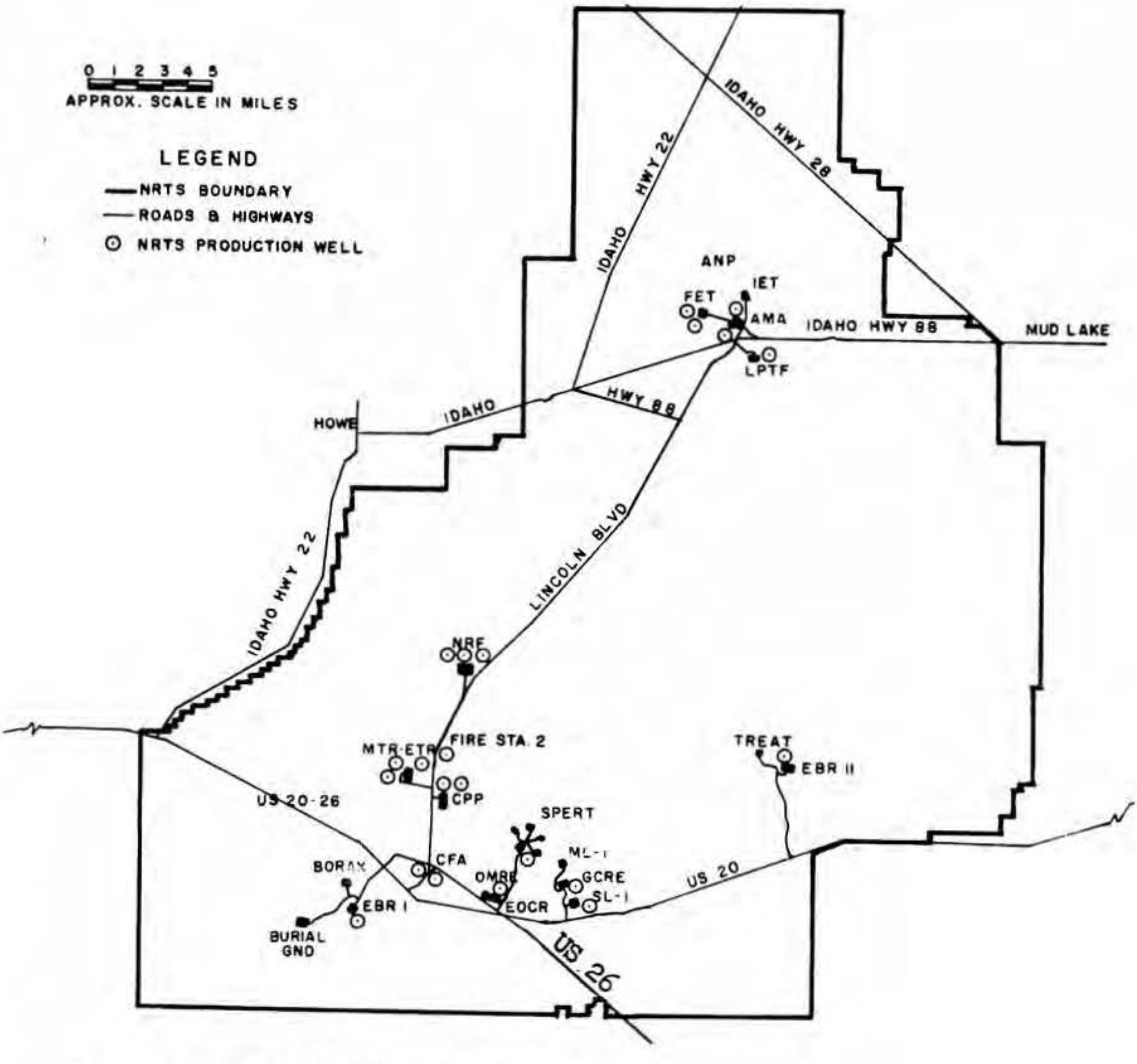

Figure 2. NRTS production wells

f. External Radiation Monitoring Program

Film badges are located at 320 stations throughout the NRTS and surrounding area as a means of area monitoring for external radiation. Table II indicates the location of these monitoring areas along with the number of stations at each location.

Table II. Film Badge Locations

Location	Number	Location	Number
Idaho Falls	1	SPERT	15
Aberdeen	1	OMRE	4
Telemetering	19	SL-1	15
EBR-I	5	GCRE	4
NRTS Burial Ground	35	TREAT	15
CFA	4	EBR-II	1
MTR-ETR	12	Lincoln Blvd.	21
CPP	25	Highway 88	19
NRF	8	Highway 22	27
IET	17	Highway 28	24
LPTF	8	Highway 20	30
FET	4		

Badges were changed monthly in 1960 as compared to weekly in 1959. This created considerable difficulty since numerous "light leaks" were noted in badges exposed for this longer period of time. The exact cause of these leaks was not determined, but was believed to be due to a combination of effects, principally temperature and humidity.

As a consequence of these light leaks, a program was undertaken to develop a more satisfactory film badge for area monitoring. Requirements for the new badge included the following:

1. Utilize metal filters identical to those in the NRTS personnel film badge to allow determination of beta and low energy gamma exposures.

2. Must be reasonably waterproof.

3. Fabricated from transparent material to allow identification of the pre-numbered film packet.

4. Must be capable of withstanding temperature extremes and strong winds.

Tests were conducted using several different designs. Utilizing the results of these tests, a badge was designed which met all of the above requirements. The badge is fabricated from a red semi-transparent plastic which acts as a light filter. Although the light leaks are still present, the film emulsion is relatively insensitive to red light, and the leaks have ceased to be a problem. With the exception of the stations surrounding the burial ground, all results were not significantly above the present lower detection limit of 10 mrem.

g. The ground survey program, which was initiated in 1959, was extended in 1960 to include twelve facilities. No detectable contamination above background was found at SL-1, TREAT, LPTF, SPERT, OMRE, EBR-I, EBR-II, and IET areas. The results of the surveys surrounding the other four facilities are summarized in Figures 3 and 4.

2. Special Activities

a. Contaminated Solvent Burning Experiment

An experiment to determine the feasibility of open-air burning of contaminated solvents accumulated at the Organic Moderated Reactor Experiment facility was conducted on November 16, 1960.

Approximately 400 gallons of liquid were placed in an open vessel and ignited. Lapse conditions accompanied by a strong steady wind (25 mph) prevailed at the time of the test. The liquid was composed of diesel oil, xylene, methychlor (Methylchloroform), and a small amount of water.

Analysis of the above organic compounds revealed radioactivity concentrations as follows:

Diesel oil	1.7×10^{-3} uc/ml
Xylene	1.7×10^{-2} uc/ml
Methychlor	1.2×10^{-2} uc/ml

The contaminants and their percentages were determined to be Mn-54 (60%), Co-60 (30%), and Fe-59 (10%).

Downwind sampling equipment consisted of gummed paper and high-volume air samplers. Figure 5 shows the location of the sampling stations and the results from the gummed paper samples.

Restriction of air flow through the air samplers was sufficient to invalidate any calculation of air concentration. This was due to build-up of particulate on the filters. It was estimated that approximately 35 microcuries of loose contamination was deposited on the first 225 feet downwind from the source

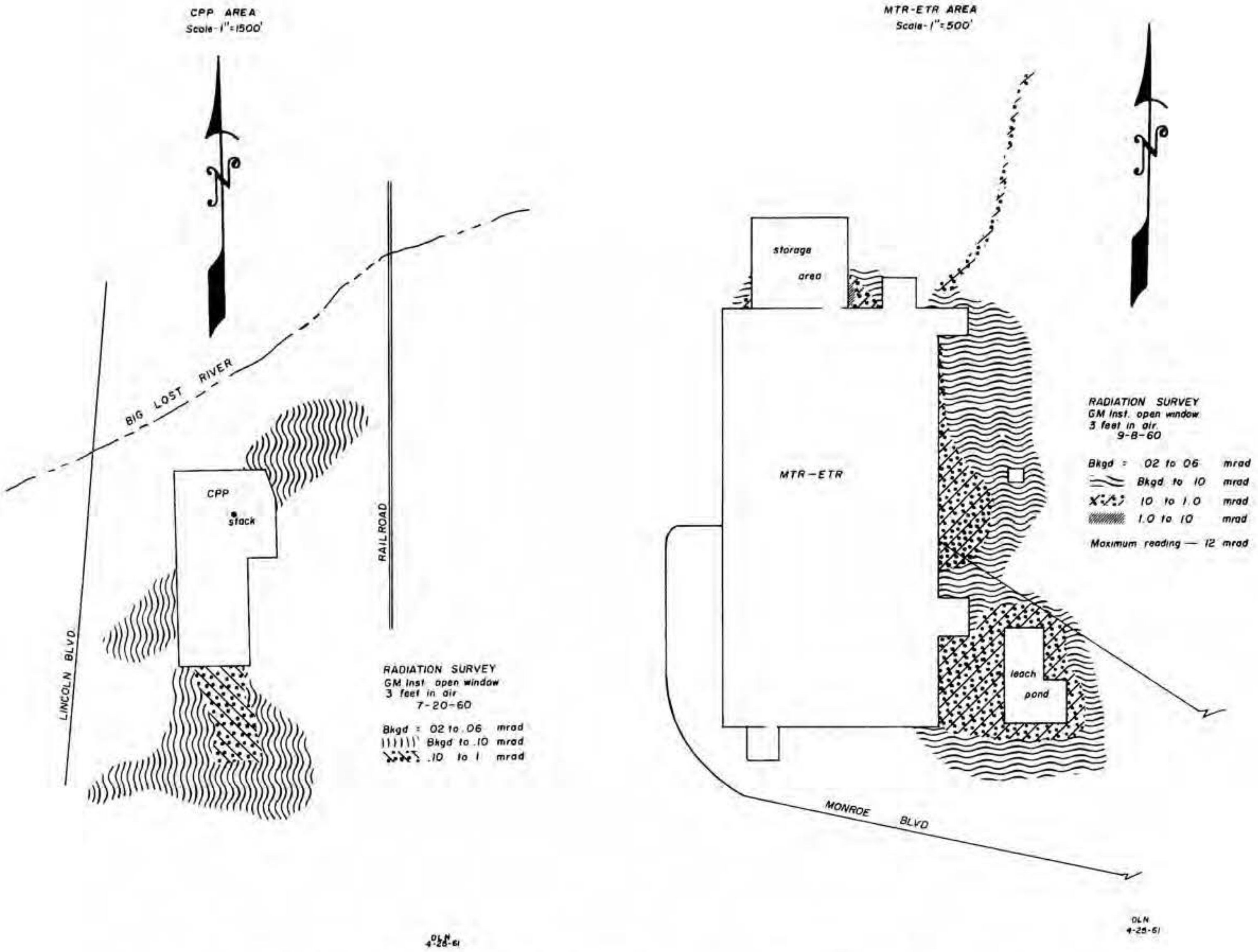

Figure 3. Ground survey of area surrounding CPP and MTR-ETR

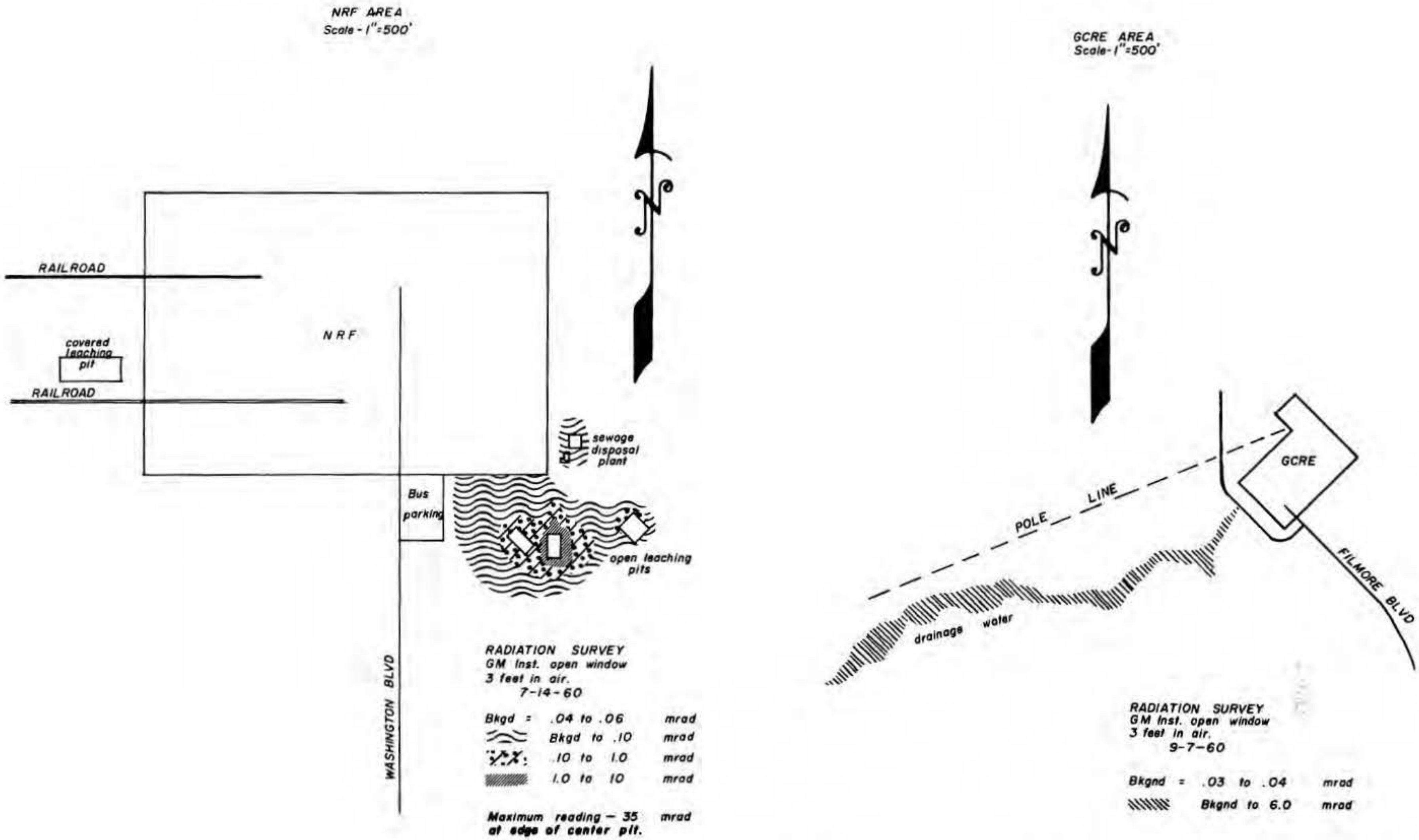

Figure 4. Ground survey of area surrounding NRF and GCRE

As the result of this test, it was obvious that this method of disposal was not satisfactory for the remaining solvent stored at OMRE.

CONTAMINATED SOLVENT BURNING EXPERIMENT

Scale - 1" = 50'

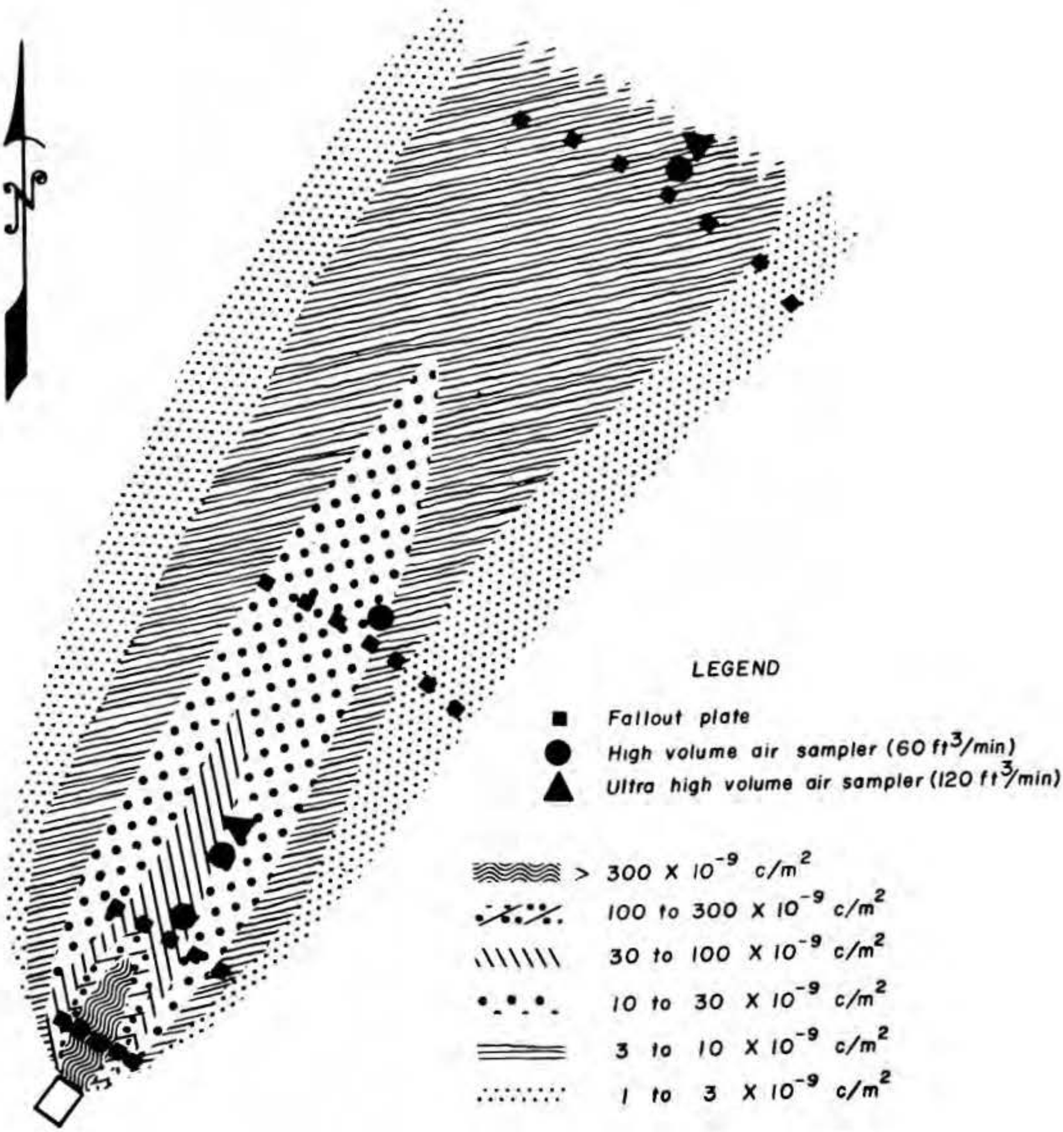

Figure 5.

b. Research Studies at IET

Four different power tests at the Initial Engine Test Facility (IET) between July and October provided a source of airborne radioactive material for research work carried out by the Section. Specifically, deposition velocity measurements were obtained using several different collection media. Comparison data for several different types of filters were also obtained. The ratio of the ingestion to inhalation dose for iodine-131 was obtained on two tests.

Three of the tests provided a continuous release of material for several hours. One test, the Limited Melt Experiment (LIME), consisted of a single "puff" type of release. The principal isotopes released were the radio-iodines. Although the monitoring methods varied for each test, the over-all program utilized high-volume air samplers, grass trays, and gummed paper mounted on plates. The air samplers used silver nitrate treated CWS-6 filter paper and/or carbon cartridge units. Cloud tracking was performed by an aerial monitoring team as well as by ground crews. The maximum number of stations on any one test was 26. The fixed monitoring locations for one of the tests as well as the cloud trajectory as determined by ground deposition is given in Figure 6.

The deposition velocity measurements were taken from grass samples and from gummed paper plates. In almost every case, the deposition velocity determined from the grass samples was greater than that obtained from the gummed paper. The average value using the grass samples was 1.7 cm/sec.

c. Special Sampling Equipment

During 1960, two special air sampling devices were developed. One was designed as a high efficiency field sampler and the other was an ultra-high-volume air sampler.

(1) High efficiency sampling apparatus

In order to delineate the fractionation of airborne particulate and gaseous activities during a controlled release from the GE-ANP-IET reactor, a high efficiency sampling system was devised. A first stage system based on earlier work (*) to sample xenon released from the CPP during Rala runs was adapted. Larger air flow volumes at greater head losses were found to be necessary. This required increased coolant capabilities and larger gas sorption surfaces. The high efficiency system at its last stage of development consisted of the following components which operated at 1.75 cfm:

(*) IDO-12014 Annual Report of Health and Safety Division 1959, p. 110-113

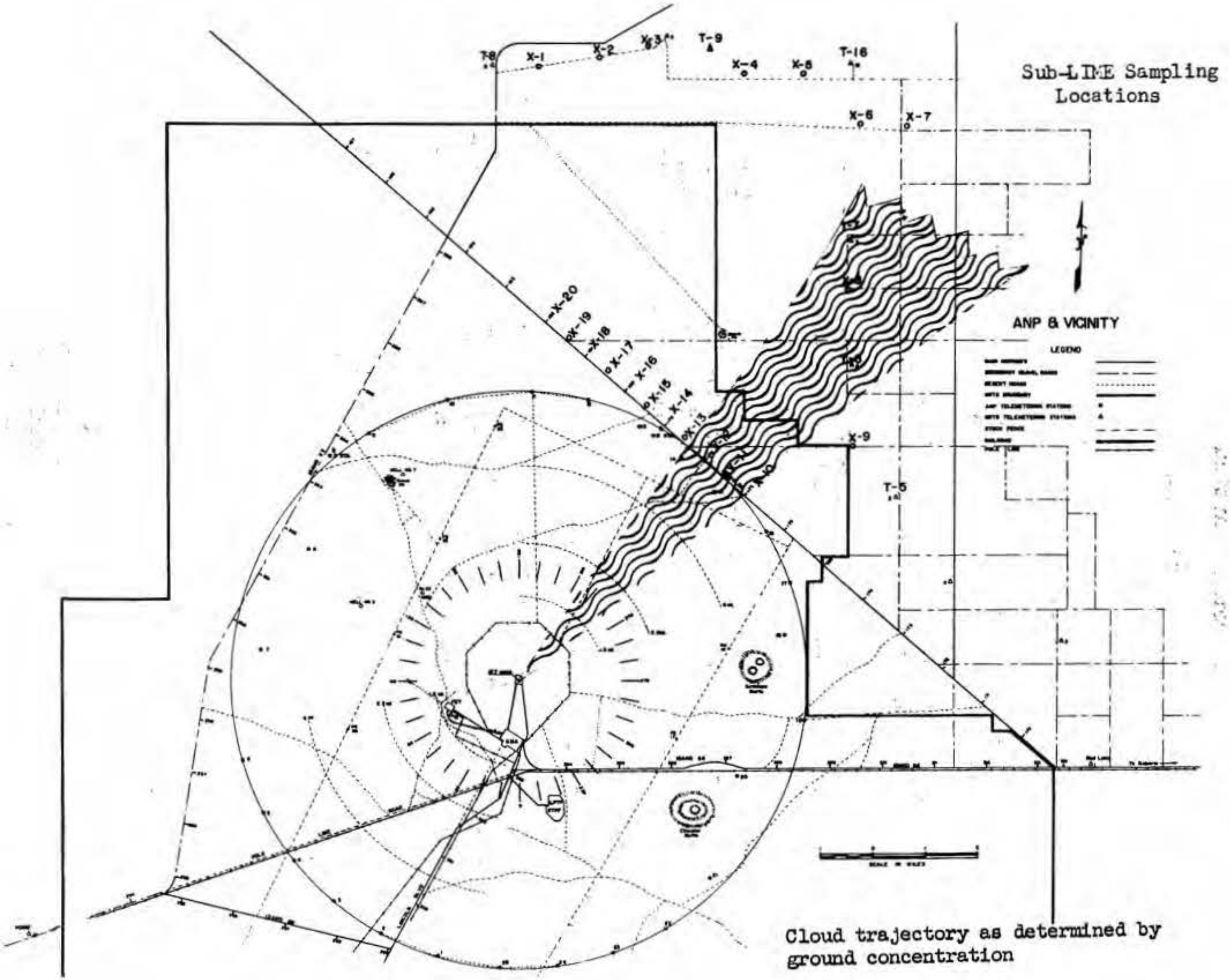

Figure 6. Sub-LIME sampling locations and cloud trajectory

(a) Milipore filter, type AA 4" diameter with pore size 0.80 u ± 0.05 u, to retain particulates;

(b) Charcoal trap, 3/4" diam. x 2-3/4 length (9.5 g) to collect iodine fraction;

(c) Molecular sieve, Linde type-5A, 2" diam. x 5" length (120 g) for moisture removal;

(d) Copper coil, cooled by dry-ice and acetone bath for residual carbon dioxide and moisture removal.

(e) Liquid nitrogen cooled charcoal trap for collection of xenon and krypton.

Comparison of existing and previously tested field monitoring systems with this high efficiency sampling system is planned when sufficient data are obtained.

During 1960, the sole opportunity for evaluating this collection system was during IET Sub-LIME during which time the radioactive plume passed too far overhead to allow significant sampling. However, the sampling equipment performed adequately.

(2) Ultra-high-volume air sampler

To assist in the collection of low concentrations of radioisotopes in air, a sampler with a capability of sampling 1000-2000 cubic feet per minute was designed utilizing the electrostatic precipitation principle. The instrument size permits its use in the field in a pickup truck.

Construction of this equipment was started in the Fall of 1960 and is expected to be field tested in the Summer of 1961.

3. Routine Activities

a. Shipments

(1) Off-site shipments

During 1960, the Section processed 750 shipments leaving the NRTS. This included 144 unescorted off-site shipments which exceeded Interstate Commerce Commission curie-content restrictions and for which a Bureau of Explosives permit was obtained.

Following is a breakdown of this group:

Greater than 1,000,000 curies	0
100,000 to 1,000,000	11
10,000 to 100,000	27
1,000 to 10,000	33
500 to 1,000	27
100 to 500	21
Less than 100	25
Total 1960	144
Total 1959	125

(2) On-site shipments

Table III summarizes by originating facility the 3,315 on-site shipments made during 1960 excluding contaminated laundry and radioactive waste for burial.

Table III. Number of On-Site Shipments - 1960

Facility	No. of Shipments
MTR	1,691
CPP	498
NRF	404
ETR	216
ANP	188
SPERT	109
CFA	104
OMRE	54
EBR-I	28
TREAT	15
GCRE	8
Total	3,315

b. Contractor Health Physics Review

A formal program for the annual review of all IDO contractor health physics functions was initiated in October of 1960. One review was completed during the year, that of the Combustion Engineering, Inc. health physics program at the SL-1 reactor facility.

c. Applied Health Physics Training Program

The Section is responsible for direction of an eleven-week applied health physics training program for AEC Health Physics Fellowship students. This program is sponsored by the IDO Health and Safety Division with the cooperation of Aerojet-General Corp., Argonne National Laboratory, Atomics International, General Electric Co., Phillips Petroleum Company, and the U. S. Weather Bureau, and is administered by the Oak Ridge Institute of Nuclear Studies.

Last year, six Fellowship students from Vanderbilt University and two State Health Department employees from the University of Michigan received training under this program.

4. Future Plans

a. Calibration and field testing of both the ultra-high-volume air sampler and the high efficiency sampler will be carried out.

b. A series of fission product releases is scheduled to be conducted in 1961 by the Convair Division of General Dynamics Corporation. The Section will participate in these tests.

c. Computation of radioactivity concentration in air and internal dose calculations now being performed manually by Section personnel will be programmed for the Model 1620 Digital Computer. This will involve writing a program for each computation and translating it to "machine language".

d. The Section will develop and coordinate a training program for all new AEC employees working at the NRTS. Indoctrination to the basic health physic concepts will be the major topic.

e. Increasing emphasis will be placed upon the review of the health physics program of IDO contractors. It is anticipated that by the last quarter of 1961, sixty man-hours per week will be devoted to this program.

D. <u>RADIOACTIVE WASTE MANAGEMENT SECTION,</u> Bruce L. Schmalz, Chief

1. Liquid Waste

During 1960, approximately 485 million gallons of water containing an estimated 3,517 curies (beta-gamma) of radioactive isotopes were discharged to the environment. Table IV lists the facilities and amounts discharged by each. The estimated amounts of the biologically important isotopes which were contained are as follows: Sr-90, (26-yr. half-life) 12 curies; Cs-137, (30-yr. half-life) 22 curies; Ce-144, (285-day half-life) 18 curies; I-131, (8.05-day half-life), 105 curies. The amount of alpha-emitting isotopes was insignificant.

Table IV. Liquid Waste Discharged to the Ground at the NRTS - 1960

Facility	Gallons	(Beta-gamma) Curies	Disposal Means
MTR & ETR	221,352,000	3,446	Pond
CPP	191,942,000	36	Well and Pit
NRF	24,379,000	31	Pond and Crib
ANP	14,770,000	2	Wells
CFA	28,630,000	1	Sub-Surface Irrigation
Others*	3,625,000	1	Ponds
Total 1960	484,698,000	3,517	
1959	612,216,000	5,066	

*SL-1, GCRE, SPERT, OMRE, ANL

2. Waste Discharged to the Atmosphere

Approximately 255,000 curies of gaseous and particulate material were released to the atmosphere during 1960. Table V lists the monthly amounts for each major plant. The predominant isotopes are A-41, (1.4-hour half-life), 115,000 curies; Xe-137, (3.9-minute half-life), 70,000 curies; Kr-89, (3.8-minute half-life), 45,000 curies; I-131, (8-day half-life), 70 curies.

Table V. Waste Discharged to the Atmosphere - 1960

Plant	Curies
MTR & ETR	232,501
ANP	20,062
SL-1	1,623
CPP	262
ANL	176
Others*	2
Total 1960	254,626
1959	191,600

*SPERT, GCRE, CFA, NRF, OMRE

3. Solid Waste

During 1960, a total of 3,672 cubic yards of solid radioactive waste were generated and disposed of by burial at the NRTS. An additional 3,436 cubic yards from other sources were also buried. Table VI shows the origin and estimated amount of radioactivity.

Table VI. Solid Waste Disposed of by Burial at the NRTS - 1960

Facility	Cubic Yards	Estimated Curies
MTR-ETR	1,250	5,850
NRF	1,100	1,150
CPP	650	92
OMRE	300	6
ANP	250	1,710
CFA-(Laundry)	45	1
SL-1	40	1
ANL	30	5
SPERT	6	1
GCRE	1	1
Sub-total	3,672	8,817
Facilities other than NRTS	3,436	429
Total 1960	7,108	9,246
1959	5,865	23,130

Burial of waste is accomplished in trenches and pits as shown in Figure 7 and 8. Depending on the depth of the regolith, between 2,500 and 3,000 cubic yards of waste per acre can be disposed of by the trench method. Trenches are preferred for high level waste as the exposure to personnel during disposal operations is minimized.

Where there is no significant hazard from radiation, waste is stacked in pits. Space is more efficiently utilized by this method.

The regional water table is at least 600 feet below the land surface. Under the arid conditions existing at the NRTS, the evaporation and transpiration results in a static moisture relationship in the regolith. Under such circumstances the movement of water through the soil is nil. and significant leaching of buried materi

Figure 7. Solid waste disposal in trenches

Figure 8. Solid waste disposal in pits

4. Waste Disposal Research

a. General

Hydrological and geological research were continued during 1960. This work was carried out in cooperation with the U. S. Geological Survey and involved the following:

(1) Drilling of test or observation wells.
(2) Geophysical logging of wells.
(3) Collection and study of water samples for chemical analysis in connection with determining movement of discharged waste.
(4) Tests to determine the hydraulic characteristics of underground water systems.

This work is directed toward establishing adequate safeguards for waste disposal without imposing economically prohibitive limits on the development of the nuclear industry.

b. Accomplishments

Details of the work are to be published in separate IDO reports. A brief summary follows:

(1) Drilling: Four holes were completed within 165 feet of the MTR-ETR pond by a contract financed by IDO and awarded by the U. S. Geological Survey. This involved approximately 300 feet of hole. Two wells totaling 925 feet of hole in the CPP vicinity were also drilled. Drilling of one hole (No. 52) was discontinued at a depth of 264 feet due to the inability of the contractor to seal out perched water. A drilling contract was awarded by IDO during June. This was the first contract for drilling under direct supervision of the Health and Safety Division. As of December 31, approximately 4100 linear feet of hole had been drilled. This involved additional work on well No. 52 and three new holes in the CPP vicinity (57, 59, 67). These holes in the vicinity of the CPP provided the following:

(a) more complete means for delineating the distribution of discharged waste;
(b) means whereby geophysical techniques could be utilized to determine the stratigraphy; and
(c) means for adequately determining the hydraulic characteristics of the aquifers.

The distribution of low level wastes was found to be closely related to the geometry of the aquifer systems.

The wells in the vicinity of the MTR-ETR revealed that waste solutions were being dispersed horizontally in saturated zones above the regional water table for distances up to one-half mile from the pond before seeping down to the water table. Evidence thus far collected indicates that the activity is attenuated by decay and chemical reactions from an average concentration of 10^{-3} uc/ml at the point of discharge to at least 10^{-7} uc/ml before it reaches the water table.

The infiltration capacity of the MTR-ETR pond has declined during the past year. One monitoring well near the MTR-ETR disposal pond was completed and utilized as a disposal well for non-radioactive water previously discharged to the pond. This provided an expedient temporary solution to an operational problem and also demonstrated the capability of disposal wells drilled only to the first permeable strata which is still 300 to 400 feet above the water table.

The drilling contract contained provisions for completing wells by pressure injection of cement grout into open formations. This work was successfully accomplished on three wells under a subcontract by the Halliburton Oil Well Cementing Company. Figure 9 shows the diesel-powered pumping equipment. The cement grout is forced down the inside of the well casing and up the annular space between the casing and the bore hole walls. This process was found to be effective in sealing out contaminated perched water. As far as is known, this is the first time such a tech-

Figure 9. Well cementing equipment

nique has been employed in basalt. This technique is of potential value in preventing contamination of production wells.

Use was also made of a chemical grout for the purpose of solidifying granular interbedded strata during drilling. The equipment is shown in Figure 10. This technique eliminated the necessity of installing temporary casing. The work was performed by the USGS and Site Survey personnel with the assistance of the manufacturer. The work was of an experimental nature and proved successful. The cost at the present time, however, is higher than that for other more conventional techniques.

As previously mentioned, detectable contamination was observed in the perched aquifers in the vicinity of the MTR pond at a distance up to one-half mile.

Figure 10. Chemical grouting equipment

(2) Logging: Geophysical logging was continued by the U. S. Geological Survey. Approximately 75,000 feet of hole were logged. Several techniques were successfully employed to identify and determine the depth, thickness, and horizontal continuity of aquifers in wells. An interim report based on this work with CPP wells is being prepared by the USGS. The logging techniques involved are as follows:

(a) Gamma-ray logs: a record of the intensity of the natural radioactivity of rocks and sediments encountered in the well;
(b) Caliper logs: a record of changes in well diameter with depth. As the diameter varies with the type and texture of the rock formations penetrated by the hole, this log has been found to be the most useful in identifying rock strata which serve as aquifers;
(c) Temperature logs: a record of the temperature gradient with depth as influenced by warm waste waters; and
(d) Electrical conductivity logs: as the electrical conductance of the well water is influenced by saline liquid waste, this log is valuable in identifying aquifers carrying such waste.

(3) Hydraulic tests: Preliminary studies were completed on the CPP wells using two "straddle" packers. These packers were adapted from oil well equipment and consist of hydraulically expanded flexible packers mounted in pairs on 4-inch tubing. Figure 11 shows this equipment. When installed, selected segments of

Figure 11. "Straddle packers" and tubing

the borehole are isolated for the purpose of maintaining the hydraulic continuity of the selected aquifer from well to well. Cross flow between the several aquifers found in the wells is thus prevented. Water samples representing what would otherwise be a natural or undisturbed condition can then be obtained.

Injection of water into specific aquifers is also possible for the purpose of determining their hydraulic characteristics.

(4) Water sampling: Water samples were routinely collected from wells at various locations at the NRTS, primarily in the vicinity of the CPP disposal well and MTR-ETR pond. Evidence of low level contamination was found only in the latter areas.

Figure 12 shows the yearly average concentration of sodium ion in the CPP wells. This results from discharge of common salt (from water softening processes) to the disposal well. When compared to previous years, a spread of the contamination appears to be occurring.

Radioactive contamination in these wells is evident. The level is very low, however, and concentrations above detection limits are not apparent beyond a distance of 1,400 feet from the disposal well. Any change in this condition during the past year is difficult to determine. If anything, the concentration levels have declined.

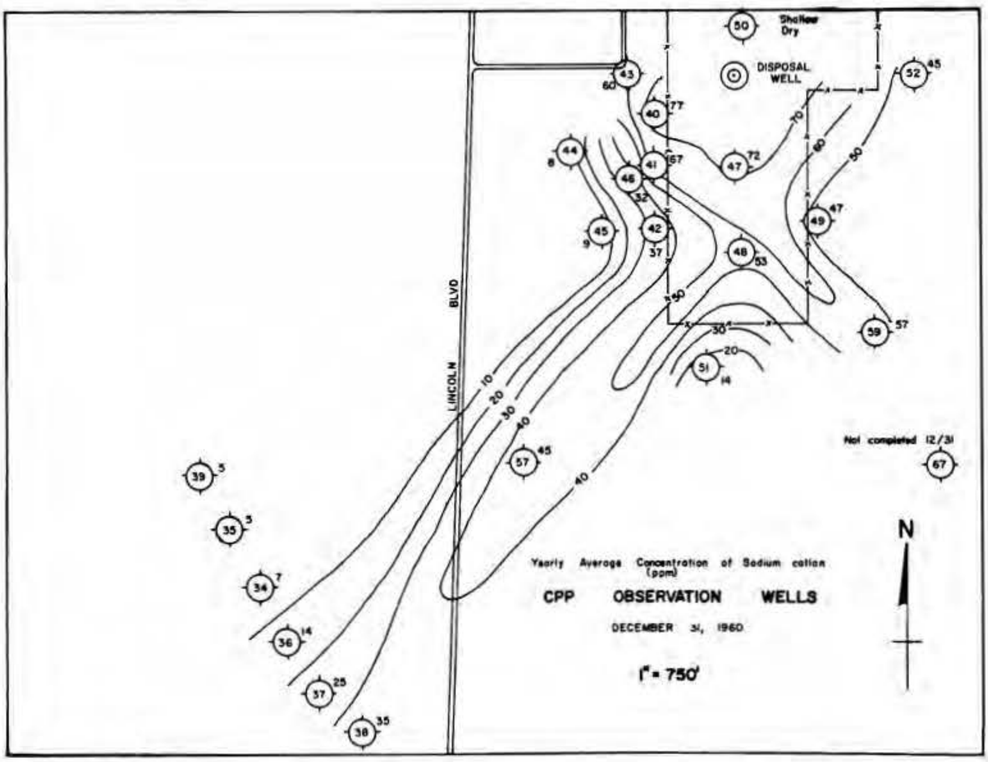

Figure 12.

(5) Future plans

(a) The drilling of observation wells is to be continued and will include wells at the NRTS solid waste burial ground, the NRF disposal pond area, and at the location of other NRTS plants, both existing and proposed.

(b) Geophysical logging will be continued. Since a flow-meter log is vital to aquifer studies in multi-aquifer wells, an electronic flow meter is being developed for use with the equipment being provided through the U.S.G.S. Hydrologic Laboratory. A borehole magnetometer has been developed by the U. S. Geologic Survey and delivery is expected during the year. This instrument will be used as an additional tool in the correlation of individual basalt flows.

(c) Tracer tests are scheduled in the CPP vicinity using tritium and fluorescein dye. Samples will be obtained by using submersible pumps. Hydraulic head conditions are to be determined with a system of pressure transducers. These transducers will make it possible to determine head differentials and pressure surges with the accuracy necessary to mathematically analyze the data obtained. Elimination of barometric effect on water levels will be possible. Preliminary tracer and hydraulic test work is also planned in connection with the MTR-ETR pond.

(d) If pond circumstances permit, monolithic samples from the alluvium beneath the MTR-ETR pond will be obtained and analyzed in an effort to determine the chemistry involved in absorption of radioisotopes in gravelly material.

(e) Several soil series and types found in an NRTS area overlay various combinations of regolith materials such as river alluvium, lacustrine deposits, playa deposits, and eolian materials. Deposits of natural materials including montmorillonite zeolite are to be found within a radius of 200 miles and lignitic coal deposits are also found in the vicinity. It is planned to investigate these materials by laboratory techniques for the purpose of determining their characteristics and capabilities for removal and retention of radioactive ions from solution.

(f) Construction of a new pit for the disposal of acids is planned. The existing pit within the burial ground will be closed.

E. TALKS

Branch personnel presented the following talks and paper:

1. A talk entitled "RADIOACTIVE WASTE HANDLING AT THE NATIONAL REACTOR TESTING STATION" was given by Bruce Schmalz at the Seventh Annual Naval Nuclear Sciences Seminar held in Idaho Falls, Idaho, August 1960.

2. A talk entitled "ENVIRONMENTAL MONITORING PROGRAM AND EMERGENCY RADIOLOGICAL ASSISTANCE PLAN AT THE NRTS" was given by George Wehmann at the Seventh Annual Naval Nuclear Sciences Seminar held in Idaho Falls, Idaho, August 1960.

3. A paper entitled "AN AEROSOL PROBLEM AT THE NATIONAL REACTOR TESTING STATION" was presented by George Wehmann at the Conference on Aerosol Problems of Nuclear Reactors held at the United Kingdom Atomic Energy Authorty facility, Harwell, England on December 6 and 7, 1960.

Chapter 10

U. S. WEATHER BUREAU

Norman F. Islitzer, Meteorologist in Charge

A. SUMMARY

The principal operational activities and research accomplishments of the Weather Bureau during the year are presented. The manner in which diffusion weather forecasts, weather monitoring, and radiation data studies are integrated with the activities of the Health and Safety Division for the safe disposal of radioactive wastes into the atmosphere are described for the various reactor operations. This included several planned releases over densely instrumented sampling grids. Computed isopleths of mean annual air concentration for the main radioactive isotopes from the principal contributing facilities are shown.

The major accomplishments of an extensive research program, with examples of their application to operational problems, are reviewed. Diffusion and deposition measurements, utilizing fluorescent tracers, show good agreement with values predicted from sensitive wind measuring instrumentation. Deposition velocities computed from tracer material balance measurements made on vertical sampling towers are shown. New information concerning the height and persistence of wintertime inversions has been obtained from numerous probes with the T-Sonde to 5,000 feet above the surface. The T-Sonde, a balloon-supported temperature sensor with radio telemetry to earth, has revealed inversions extending to 4,000 feet. This has forced a revision of some previous opinions on inversion structure which were based upon inadequate information. Preliminary efforts to employ radar and balloon-borne targets for wind trajectory studies also are discussed.

B. SCOPE

The Weather Bureau, under the auspices of the United States Atomic Energy Commission, maintains an operational and research type weather station at the NRTS. Diffusion weather forecasts, required by the Health and Safety Division and the various contractors of the AEC for the safe conduct of reactor experiments, are supplied along with meteorological observations during the course of the experiments. The Weather Bureau also has the responsibility of conducting an extensive observational program in order to provide the necessary climatological statistics for reactor siting and planning purposes.

To increase the understanding of aspects of atmospheric diffusion and transport at the NRTS that are important to problems encountered in the safe disposal of radioactive material in the atmosphere, an extensive research program is conducted. Studies of diffusion, utilizing radioactive material released from reactor operations and also fluorescent tracers, are carried out. Various turbulence properties of the lower atmosphere are measured for correlation to measured diffusion. Wind

carried out to improve this aspect of the

U. S. WEATHER BUREAU

C. SUMMARY OF MAJOR PROGRAMS

1. Meteorological Control of Reactor Operations

Diffusion forecasts are made in addition to forecasts of certain meteorological elements such as wind speed and direction, temperatures, and precipitation. The rate of diffusion of any radioactive material discharged from a reactor stack is known to be correlated to the wind speed and the vertical temperature gradient. Forecasts of vertical temperature gradient through the day are given as required. Values of Sutton's diffusion coefficients and stability parameter "n" are then included in the forecast. This will permit calculations of anticipated air concentration or radioactive dose for releases of radioactive material. Of particular interest to field monitoring teams are areas of maximum surface concentration from stack releases. These can be estimated fairly well for some weather conditions. Anticipated effluent trajectories are computed and supplied to the Site Survey and Ecology Branches as well as to the aerial monitoring team.

a. Transient Reactor Test (TREAT)

Wind forecasts have been issued throughout the year for the safe conduct of experiments in the TREAT facility. These forecasts are monitored primarily from the observed winds on the 250-foot meteorological tower at Central Facilities, with occasional suppletion from the wind observations taken by the contractor on the roof of the TREAT building. The chief concern is that winds blowing from the northwest quadrant will carry any released material over the EBR-II area. Short-range wind forecasts are given to cover the duration of the test, usually several hours, and tests are not conducted if northwest winds are imminent.

Since only daytime operations during periods of temperature lapse have been conducted, little significant difference in winds have been observed between the TREAT area and Central Facilities during operating periods. Two exceptions have been noted. With northwest winds at the 700 mb level, about 5,000 feet above the surface, winds at Central Facilities have been observed from the southwest or northeast while the wind direction at TREAT was northwest on several occasions. Apparently the proximity of Central Facilities to the lee of the mountains west of the NRTS prevented the upper level wind directions from coming down to the surface in that region, but the TREAT area being 15 miles further to the east did not experience a similar mountain effect upon the upper level winds. Another exception to the general daytime agreement of winds between the two localities occurs for short periods during general wind direction shifts over the NRTS. The time of the shift may differ between Central Facilities and TREAT by as much as an hour before a prevailing wind regime has stabilized over the NRTS. During periods of strong nocturnal inversion, surface drainage-type winds are strongly affected by topography. The higher elevation to the east of TREAT has produced some easterly down slope winds which are not observed at some of the [illegible]

b. Initial Engine Test Facility (IET), ANP Area

There was considerable experimentation in the IET requiring meteorological support from the Weather Bureau. This included the Fuel Element Effluent Test (FEET) series, the Limited Melt Test (LIME), and Sub-Limited Melt Test (Sub-LIME) in which sufficient radioactive material was released to warrent study from an atmospheric diffusion model standpoint. The releases were over a densely instrumented sampling grid, some 60° wide, operated by General Electric Company, to the Site boundary, 5 miles away. The Health and Safety Divsion, IDO, conducted extensive air and surface deposition sampling beyond the grid to some twenty miles distant. The Health and Safety Division's aerial monitoring team also participated in some of these tests providing additional information on plume rise and trajectory.

A well-integrated effort between the contractor, the Health and Safety Division, and the Weather Bureau resulted in placing the released radioactive material from the tests directly over the sampling networks. The meteorological conditions required for the tests were successfully forecast by the Weather Bureau, enabling complete sampling of the plume with optimum interpretation of results. The LIME test was conducted during neutral temperature lapse conditions with a steady wind that resulted in a straight line trajectory for nearly twenty miles. The Sub-LIME test was conducted under similar wind conditions, but with a strong temperature lapse. The wind conditions during the final FEET test, although the IET meteolological tower indicated a very weak lapse, were typical of a mild inversion and will probably have to be analyzed from that standpoint.

Preliminary comparisons of an operational nature indicated that good agreement between measured and computed source release figures can be obtained for such steady wind conditions from Health and Safety Division's off-Site air concentration data. A considerable amount of deposition measurements on both vegetation and various artificial detectors, which should add to the knowledge of air concentration-deposition interrelationships, were also taken. When the data have become completely processed, a more complete meteorological analysis will be made for both operational and fundamental research purposes.

c. Material Testing Reactor-Engineering Test Reactor (MTR-ETR)

Some testing in the first half of the year required meteorological coverage and vectoring of mobile sampling crews. Stack release data and air concentration measurements in this project area may be useful in determining the most hazardous diffusion types for a multiple reactor complex. This will be useful in the location of facilities within a large reactor area, or for additional expansion from the initial scope of the reactor complex.

The weather types, which the contractor has considered to be potentially the most hazardous to the plant and which the Weather Bureau has been requested to forecast, are the fumigation, calm winds with strong temperature lapse (looping), precipitation, and wind shifts into the easterly quadrant (winds from this direction will blow material from the stack over the administrative area). Revision of the definition of hazardous diffusion types may be in order if sufficient field data are obtained for a re-evaluation.

d. Radioactive Lanthanum Process (Rala) in Chemical Processing Plant (CPP)

Diffusion forecasting and positioning of aerial sampling crews for the Rala operation have continued. The weather conditions permitting maximum surface concentration near the Chemical Processing Plant when construction activity was in progress were avoided.

2. Hazard Report Evaluations

Hazard reports for reactors or experiments proposed for the NRTS are reviewed and comments are given to the Health and Safety Division. Emphasis is placed upon reactor location, estimates of release rates and the "maximum credible accident", and techniques of calculation of air concentration and dose rates to the environment. Hazard reports for the Advanced Engineering Test Reactor, Experimental Organic Cooled Reactor, Nuclear Test Plant, SL-1 Plant Expansion, General Electric Experiment Loop 99 in ETR, Advanced Core Test in the Flight Engine Test, Flight Engine Test Exhaust System, LIME, and Sub-LIME have been reviewed. The Weather Bureau has participated in the general preplanning sessions of the Health and Safety Division for a "Maximum Credible Accident". A preliminary plan of action by the Weather Bureau for such an emergency has been submitted to the Health and Safety Division.

3. Climatological

a. General Climatology

The extensive meteorological observational network has continued in operation for the past year with no changes. The recorded observations are punched on IBM cards for later periodic machine tabulations of importance to health and safety problems and engineering and construction problems.

b. Isopleths of Annual Average Air Concentration

The computed annual average air concentrations, assuming that the measured annual release totals can be apportioned over the whole year as a steady release, are shown in Figure 1 for the MTR-ETR and CPP. The isopleths around the MTR-ETR are labelled in terms of the Radioactivity Concentration Guide (continuous occupational exposure) for inert gases, while those for releases at CPP

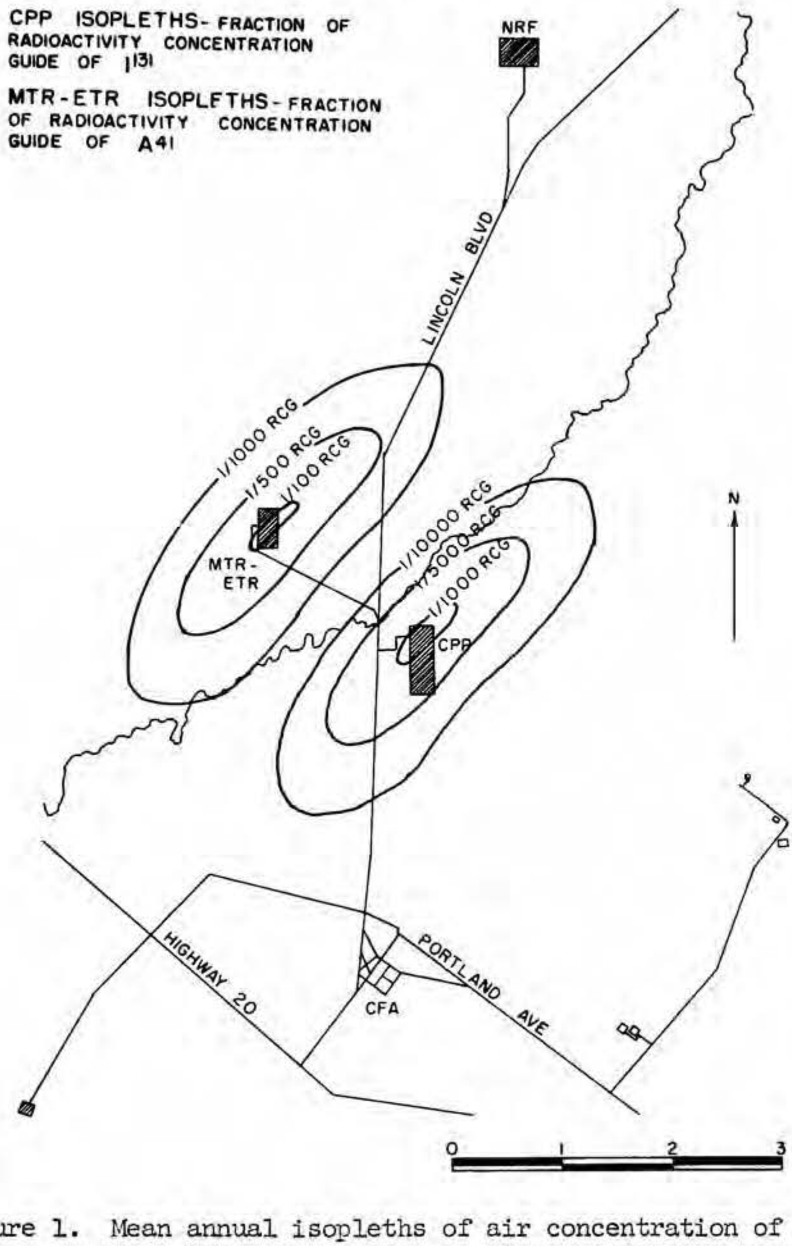

Figure 1. Mean annual isopleths of air concentration of I-131 from CPP and inert gases from the MTR-ETR for the Year 1960

have considered only I-131. The isopleths of I-131 air concentration from releases at IET, shown in Figure 2, were computed from an assumed release of I-131 of 1.0% of the year's total fission product discharge.

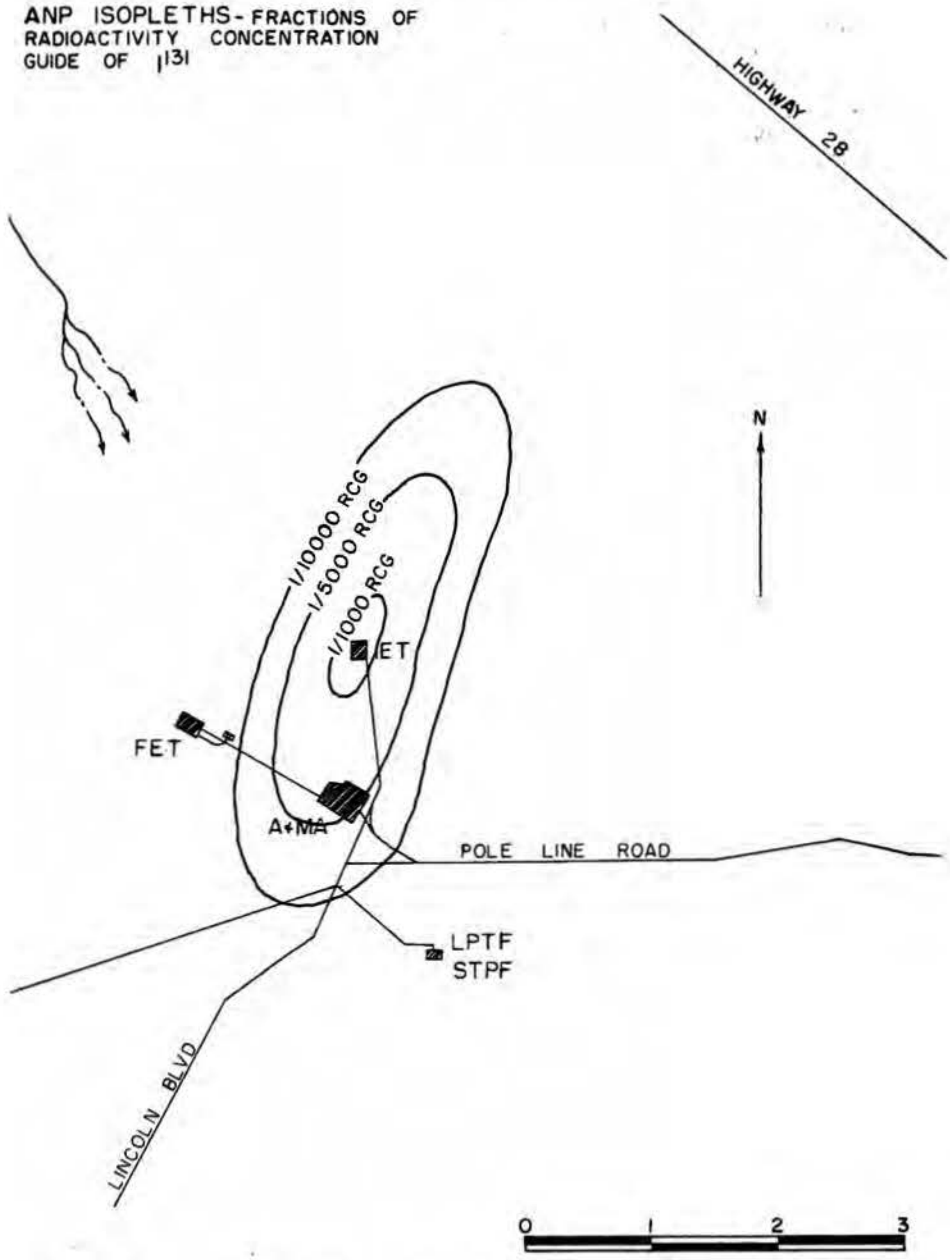

Figure 2. Mean annual isopleths of air concentration of I-131 from IET for the Year 1960

D. SPECIAL ACTIVITIES

1. Diffusion and Deposition Measurements

A series of diffusion-deposition measurements were conducted at Grid No. 3 out to 800 meters distance. Some 15 releases of fluorescent tracer material for varying periods up to one hour were analyzed. Vertical measurements of air concentration made from a row of 90-foot sampling towers at the 400 meter arc shown in Figure 3 furnished data on vertical plume dispersion ... ial

Figure 3. Sampling towers for diffusion-deposition studies

between the release point and 400 meters could also be computed, which with the surface air concentrations measured over the grid provide estimates of deposition velocities. Bivane data were measured near the release point for comparison with air concentration statistics.

In operational problems, one is primarily concerned with the lateral and vertical spread of contamination and plume centerline concentrations from ground-level sources. For elevated sources, the distance to maximum surface concentration is also a useful quantity. The results of a study from an elevated source are published in the Annual Report of the Health and Safety Division for the year 1959, IDO-12014. The good agreement between the measured horizontal width of the tracer and predicted width from bivane data, shown in Figure 4, indicates the potential operational value of bivane measurements. The variation of the air concentrations along the axis of the plume with downwind distance for lapse and inversion conditions is shown in Figure 5. The change of lateral particle standard deviation (a measure of crosswind particle spread) with distance is shown in Figure 6 for lapse and inversion conditions.

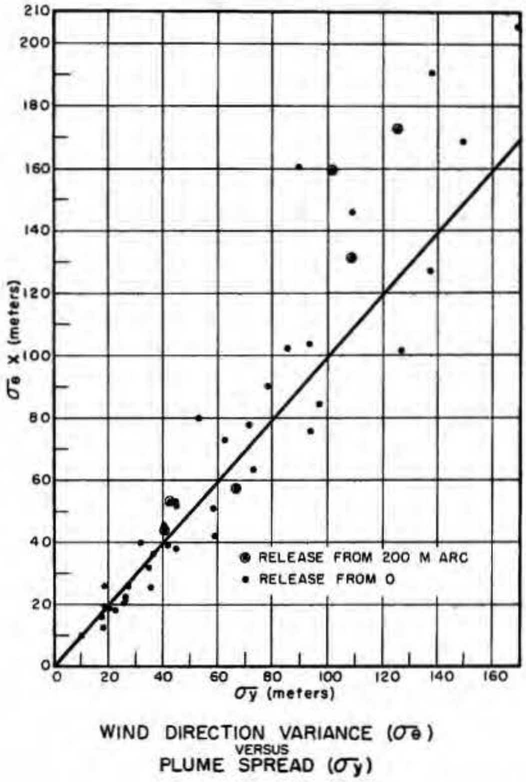

Figure 4. Comparison between **predicted horizontal tracer spread from** bivane data, $\sigma_\theta X$, and measured values, σ_y

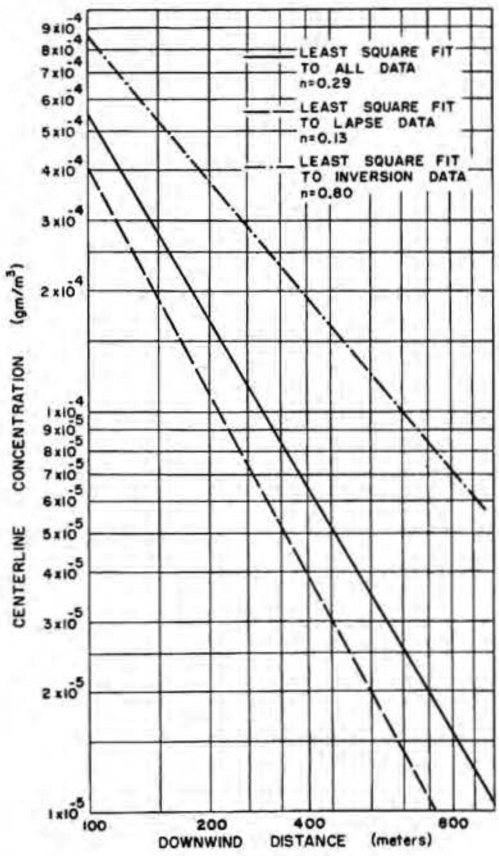

Figure 5. Variation of plume center line a

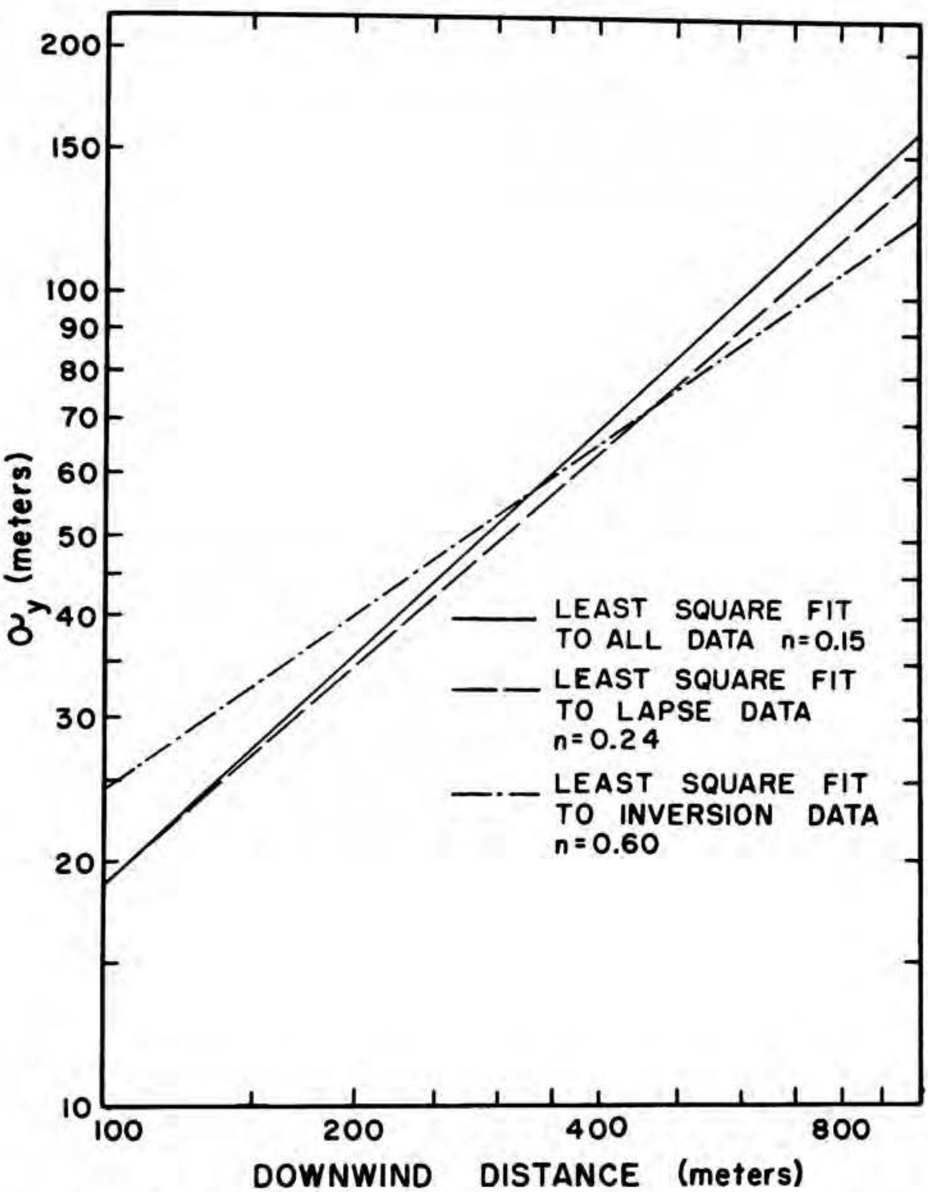

Figure 6. Variation of lateral particle standard deviation with distance

Deposition velocities, computed indirectly from tracer material balance measurements in lieu of direct deposition measurements, are shown in Table I. The reduction in deposition velocity for strong inversion (Runs O and Q) compared to temperature lapse cases is quite apparent. Although a fairly extensive sampling system is required for such measurements, they have some distinct advantages over results from direct deposition measurements. The deposition velocities shown in Table I represent averages over the area of the grid out to the sampling towers, 400 meters distant in this case.

Table I. Deposition Velocities From Tracer Material Balance Measurements

Run No.	ΔT (°F) 16-4m	$\overline{U}$ m/sec	Per cent Deposited	V (cm/sec)
C	-0.3	6.3	54[1]	3.30
D	+0.5	4.9	35	1.41
E	-2.4	6.0	32[2]	13.97
F	-1.1	4.7	24[2]	1.83
G	-1.9	6.2	22[2]	4.95
I	-1.6	6.0	48	4.10
M	-0.7	3.9	32	2.51
N	+0.7	4.7	38[3]	1.88
O	+3.4	2.6	10	0.27
Q	+4.1	2.5	14	0.20
S	-2.3	8.4	37	1.96

[1] Particle size of tracer suspected to be large
[2] Source to 200 m
[3] Conditions changed from weak lapse to weak inversion near sunset

Such average values are more readily interpreted than measurements at a point, particularly over inhomogeneous terrain with varying types and density of vegetation. The difficulty of reproducibility of direct deposition measurements is also avoided. Large variations in samples collected at the same point on various flat plate type deposition trays have been reported.

2. T-Sonde Flights

About 300 T-Sonde flights have been conducted during the past year supplying a useful body of data on inversion heights and structure. This information will improve the understanding of atmospheric diffusion and transport mechanisms over the NRTS. Inversion heights to 4,000 feet have been measured in the winter, with little change in this poor diffusion type occurring through the day between 1,500 and 4,000 feet above the surface. Such heights are well above the vertical range of captive blimp studies previously made. The mean height of the inversion from 17 wintertime soundings during strong anticyclonic weather conditions was 3,800 feet. After maximum development of these inversions through the night, an average temperature increase of 38° F was measured between the ground and the inversion top.

3. Radar Transponder

The two lightweight transponders for use with the radar in observing horizontal wind trajectories have been delivered by the Cordin Company, fulfilling their feasibility study. Operational failures with the power generator for the radar have delayed a complete checkout of the two transponders, which are somewhat different in design. A range of eight miles has been readily obtained and undoubtedly can be extended to 10-15 miles. The satisfactory performance of the transponder has been marred by two features: (1) the high cost of $60 per unit, and (2) the light weight batteries supplied have a short operational life in extremely cold weather. Although the transponder appears to be satisfactory in principle, further consideration has to be given to a lightweight power supply and to economy. The Cordin Company states that a recently developed electronic tube may cut the cost considerably.

The tranponder-tetroon system utilizes an inexpensive lightweight tetroon[1] borne transponder and an inexpensive radar unit for positive determination of tetroon trajectories for meteorological research studies. The constant positive signal from the transponder, regardless of the normal radar ground return, permits accurate positioning of the tetroon in any locality. With the transponder signal and normal radar return indicated on the same radar screen, the transponder position with relation to surface features is readily displayed. The transponder attached to a tetroon ready for flight is shown in Figure 7.

4. Weather Bureau Digital Data System

The conversion of the meteorological measuring system at Central Facilities from analog to digital has not been completed. The delivery date has been set back by the manufacturer, United Electro Dynamics, Pasadena, California, from mid-December to March due to unanticipated

[1] A tetroon is a balloon made of mylar plastic coated with aluminum and has the shape of a tetrahedron. The tetroon is inflated to move along a predetermined constant density surface.

delay in the final fabrication. The manufacturer reports that no difficulties have been encountered or are expected in the final assembly and checkout. A visit to the manufacturer's plant was made by personnel from the Weather Bureau Office before final assembly of the various component parts of the digital system to insure that contract specifications were understood and are being met. If the integral parts of the over-all system perform as rated, the design appears satisfactory.

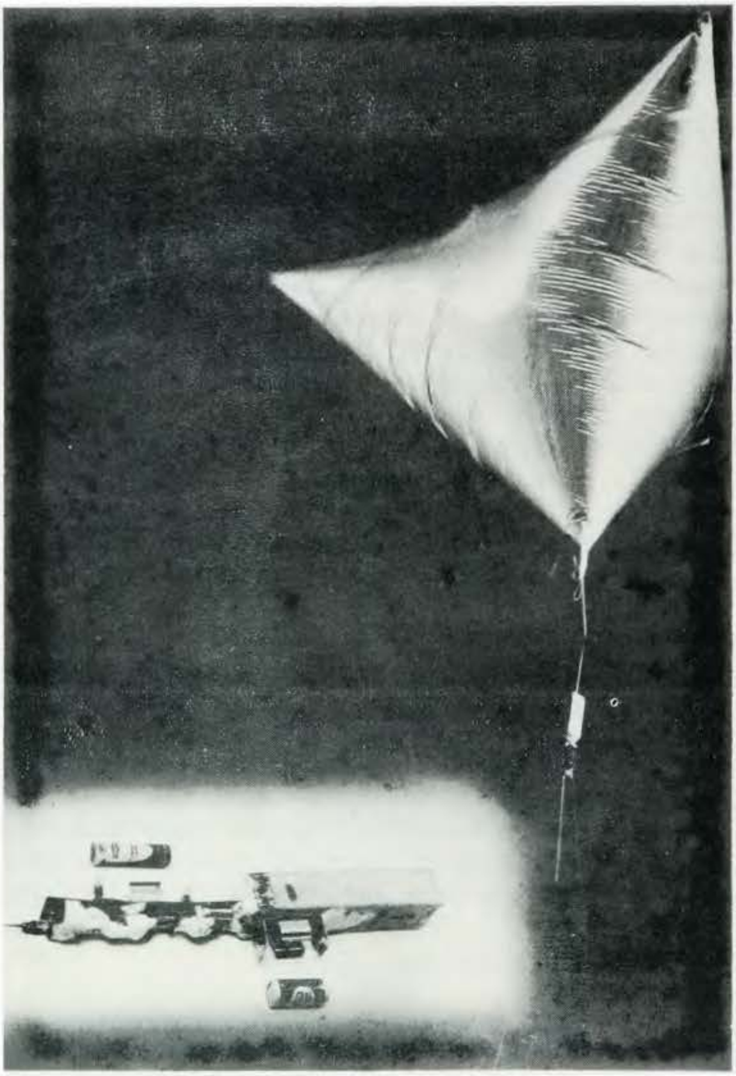

Figure 7. A transponder in flight supported by a tetroon. The insert gives a closer view of the transponder

E. FUTURE PROGRAMS

1. Meteorological Control of Reactor Operations

As the number of reactors and experiments at the NRTS increase, it is anticipated that there will be an increasing demand for reactor operational forecasts and weather monitoring. Best present estimates indicate that demands for Weather Bureau services will be particularly heavy for tests in the MTR-ETR and the Waste Calcination Plant. Significant releases of radioactive material are anticipated from some of these experiments requiring close liaison between the contractor, the field monitoring crews of the Health and Safety Division, and the Weather Bureau. Forecasts for the CPP and TREAT facilities as the need arises will be of a more routine nature.

Radiation data collected by the Site Survey and Ecology Branches of the Health and Safety Division from the various reactor effluent discharges into the atmosphere will be analyzed for diffusion-deposition studies. Particular attention will be paid to releases following incidents and to planned releases over well-instrumented sampling grids.

2. Fluorescent Tracer Studies

Diffusion studies, utilizing fluorescent tracers, will be extended to 3,200 meters distance. Some fifteen releases from a ground-level point for periods up to an hour are planned supplementing the studies of the past year, which were limited to 800 meters distance. Deposition measurements will also be made with detectors specially made to simulate a bare surface. Sand is sprayed over an adhesive plate to simulate the ground and present a non-eroding surface. The plate is washed after a test and the resulting solution is analyzed for fluorescence in the same manner as are the air filters. It is hoped that certain basic information describing the deposition process will be obtained to assist in the design of more precise, quantitative deposition experiments. A detailed network to measure air concentrations and deposition over a grid some one to two hundred meters long is then contemplated. Measured deposition velocities can be compared to deposition velocities computed from tracer material balance measurements made on sampling towers.

3. Atomospheric Transport

The feasibility of radar tracking of balloon-type targets (tetroons) and transponders will continue to be explored. In addition, the field of available surplus radars and their application to the long-range trajectory studies at the NRTS will be thoroughly surveyed.

4. Digitalization of Weather Data at Central Facilities

The conversion of the micro-meteorological measuring system at Central Facilities from analog to digital will be made early in 1961. A high speed bivane data acquisition system with paper tape storage will accelerate atmospheric turbulence studies on the IBM 1620 Computer, scheduled for delivery to the Health and Safety Division early in 196 The digital system is expected to reduce considerably the man-hours currently necessary to reduce the meteorological measurements at the NRTS.

F. PUBLICATIONS AND TALKS

1. DIFFUSION CLIMATOLOGY OF THE NATIONAL REACTOR TESTING STATION, IDO-12015, G. A. DeMarrais and Norman F. Islitzer, April 1960.

2. WEATHER BUREAU OPERATIONS AND RESEARCH AT THE NATIONAL REACTOR TESTING STATION, G. R. Yanskey, Weather Wise, Vol. 13, No. 5, October 1960.

3. SURFACE AND SUBSURFACE TEMPERATURE VARIATIONS AND COMPARISONS, H. L. Boen and G. A. DeMarrais, Public Roads, February 1960.

4. SHORT-RANGE ATMOSPHERIC DISPERSION MEASUREMENTS FROM AN ELEVATED SOURCE, presented by Norman F. Islitzer at the meeting of the American Meteorological Society, Eugene, Oregon, June 1960.

5. DESCRIPTION AND OPERATION OF THE T-SONDE, A LOW LEVEL AIR TEMPERATURE MEASURING DEVICE, presented by C. R. Dickson at the Meeting of the American Meteorological Society, Eugene, Oregon, June 1960.

6. METEOROLOGICAL PROBLEMS IN THE LOCATION AND OPERATION OF REACTORS, presented by Norman F. Islitzer at the 7th Annual Nuclear Sciences Seminar held at Idaho Falls, Idaho, August 1960.

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