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Argonne National Laboratory
Metallurgical Laboratory

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Narrative Report

August 27, 1946

To: Area Engineer

ATTENTION: Mr. Rudolph

From: W. H. Zinn

Re: Special Items for the Narrative Report, AUGUST, 1946

Administrative. As was indicated in last month's report, the lack of a permanent site is still the most serious difficulty faced by the laboratory. In fact, the refusal of the Cook County Forest Preserve Commissioners to accede to the request of the Secretary of War for a friendly condemnation of the Argonne site has made the site problem most acute. An inspection of Army property which it is expected will be surplus in the mid-western region has been made. Of the sites visited (Kingsbury Ordnance Plant, Laporte, Indiana, Camp Grant, Rockford, Illinois, Badger Ordnance Works, Baraboo, Wisconsin) the Baraboo site is by far the most suitable. As far as could be learned in a one afternoon's inspection of this area, it has many of the requirements for an atomic energy installation. The water supply is excellent, footing for foundations is firm, and the area is extensive enough to provide any desired isolation. Its location in relation to a major mid-western university, the University of Wisconsin, is sufficiently close to provide that contact with an educational institution which is desirable for the type of laboratory envisioned.

It is realized that the Argonne National Laboratory cannot move to a new site without extensive housing being made available to its personnel, and probably it is not possible to continue the laboratory long at a site in the neighborhood of Chicago, including Argonne, without such housing development. It is practically impossible to engage new workers from outside the Chicago area because of the low probability of securing any place to live. This means that proper replacements are not being made for key people who for one reason or another are leaving. It would appear that the coming winter will find large numbers of persons leaving our laboratory unless a permanent site which permits plans for proper housing is available. In fact, we may expect that the Northeastern University Laboratory which is established at Camp Upton, Long Island, will begin to draw upon our personnel just as soon as they are in a position to provide housing. We have here the anomalous situation that the Northeastern Laboratory has the site but no personnel; we have trained personnel but no site.

It would be disastrous to go into the second half of the year with our plans for the future indefinite as they have been for the past 12 months and this because of not being able to settle on a home for the laboratory. By not reaching a concrete decision on the site problem we are risking the loss of our only real asset, the trained, experienced scientists.

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Biology Division. Factors in acute illness and death following irradiation: The problem is that of the nature of the physiological disability which follows large doses of radiation and leads to death, understanding of which is necessary to treatment of radiation accidents. The general physiological picture has been well described by the experimental work of Dr. Prosser and his group. The cause of the fatal bleeding tendency has been studied by Dr. Allen and the blood-clotting defect has been traced to the increased heparin concentration in blood plasma. Work now in progress includes: the effect of lymphocyte destruction on spread of infection and the importance of this secondary infection in the fatal effects of radiation; the output of the heart in radiation sickness and the effect of therapeutic agents on it; comparison of the lethal effects and toxicity of various types of radiation from external sources and absorbed radioactive elements; response to radiation of blood cells already under stresses.

Tumor production and other chronic effects of radioactive elements: The problem is to determine the expectancy of delayed disastrous effects of small exposures. Dr. Lisco and Dr. Brues have obtained figures as to the tumor expectancy after treatment by intermediate doses which are now sufficiently near completion to permit preliminary extrapolation to the smaller doses which may be dangerous to man and other long-lived animals. Dr. Hagen and Mr. Sacher have been making statistical studies of shortening of the life-span by external radiation. A good preliminary picture has been obtained of chronic plutonium poisoning. Work in progress includes: comparative effects of additional fission products; a study of the reasons why plutonium is much more toxic than would be expected on the basis of its radiation energy; basic investigation of the mode of action of radiation in producing cancer. A projected study will attempt to measure loss of an animal's efficiency after intermediate doses.

Chemical and anatomical basis of radiation effects: Dr. Barron has found that a special group of essential cell enzymes (sulfhydryl-containing) are particularly susceptible to radiation. Dr. Bloom has carefully studied the types of cells which are sensitive to radiation and is preparing a large monograph on this subject. Studies of chemical changes in cells are being continued and Dr. Finkel is investigating the effects on growth of animals. When proper personnel is available it is proposed that a careful study be made on the nature of radiation effects on isolated animal cells.

Metabolism and excretion of radioactive elements: This has been extensively studied for all of the common fission products and plutonium, and forms the basis of estimation of human exposure by excreta analysis. Current studies are concerned with the manner in which the absorbed toxic elements find their way into the depots in which their chronic effects occur; and what means may be taken to remove them from these depots.

Medical examinations: All project personnel are given medical examinations, including blood and urine studies, on admission and discharge, and interim examinations are done as required. Particularly careful studies are made of the hands, including blood capillaries and finger ridges, and of the white blood cells.

Accidents: Personnel involved in laboratory accidents, however minor, in which radioactive exposure or contamination is a possibility, are given a very careful workup, including collection of evidence for radiation exposure by history, physical examination, laboratory studies, and evaluation of the possible physical hazard involved.

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Plutonium studies: All personnel potentially exposed to plutonium periodically deliver their excreta to the chemical group for measurement of their alpha-ray activity.

Decontamination of personnel: In collaboration with the Biology Division, the Hazards Evaluation Division performs experiments with animals to determine what means are necessary for removal of contamination, especially plutonium, from wounds. Proposed work along this line will include means of removing inhaled contaminants from the lungs, and swallowed contaminants from the intestinal tract.

Chemistry Division. (Nuclear Chemistry). Tritium production: Cans of lithium fluoride for irradiation at Hanford are now being produced at a rate of 150 cans per week. Approximately 500 of these cans have now been shipped. To insure that none of the cans exceeds the permissible diameter, each is passed thru a test gauge prior to shipment.

Ionium content of raffinate from Mallinckrodt uranium ore purification process: Several analyses have been made for the ionium (Th-230) content of the dried calcium hydroxide raffinate cake from the solvent-extraction process for the recovery of uranium from ore. The ionium content is about fifteen ppm. This relatively high value indicates that most of the original ionium is recovered in the calcium hydroxide cake. Preliminary tests indicate that recovery of the ionium from the calcium hydroxide is a relatively simple matter, hence the Mallinckrodt process appears to afford an excellent source of the relatively large quantities of ionium needed as a starting material for large-scale production of Pa-231 and U-232.

Half-life of radium: The curie is a widely used unit for measuring radioactivity. However, its value, which depends on the half-life of radium, has not previously been determined with the accuracy desirable for such a constant. An accurate determination is difficult because of the nature of the radium daughter activities which include the short-lived, alpha-emitting noble gas, radon. New experiments to determine the half-life of radium and hence the value of the curie have now been completed. Special methods were devised to correct the alpha-counting rate for the daughter activities. The final result, subject to possible slight changes after more complete statistical analysis of the data, is 1650 $\pm$ 20 years for the half-life, and $3.65 \pm 0.04 \times 10^{10}$ disintegrations/second for the curie.

Preparation of radium for Hanford bombardment. The group at Hanford has made arrangements to overcome the radiation problems presented in loading and unloading large radium samples at the pile. A one-gram radium sample has been canned and prepared according to the recommended procedure and has been shipped to Hanford for bombardment. This bombardment will produce several milligrams of actinium for basic studies and for studies of its utility as an intense source of alpha activity.

Redox process: Further development work on the Redox process has been outlined in extensive discussions with the new Redox group at Hanford.

In further experimental work with aluminum nitrate salting agent as a substitute for ammonium nitrate, first-cycle runs were made with aluminum nitrate in the second column extractant stream in order to prepare feeds for second-cycle operation using high salting-out strength and avoiding oxidizing conditions. These first-cycle runs with aluminum nitrate gave satisfactory results.

Preliminary results on the recovery of hexone from semi-works equipment indicate that the necessary recovery operations are rather simple, but as yet not enough hexone has been reprocessed to test its subsequent behavior in column operations. The nature of the hydrazine-hexone complex formed in the Redox process is being systematically studied with a view to more efficient utilization and recovery of hydrazine.

Clinton heterogeneous pile studies: The material which was processed through one cycle in the past month has now been put through a second cycle under reducing conditions, using hydrazine as the reductant. Good recovery was obtained and a decontamination factor of about 2000 was achieved in this cycle for beta activity. The predominant beta-emitter remaining was ruthenium. Further work on a laboratory scale is necessary to establish optimum reducing conditions. Hydrazine has been found to have a very beneficial effect on uranium extraction into hexone. This may permit lower salting-out strength and improve decontamination.

(Pile Chemistry). Wigner effect: Measurements on the annealing out of neutron-induced dimensional changes have been carried out on samples taken from the three 16-lb. stringer bars from test holes in the HEW piles. After heating for about 10 minutes at 1000° C in an atmosphere of helium, the sample dimensions perpendicular to the direction of extrusion decreased about 0.2%, whereas the sample dimensions parallel to the direction of extrusion decreased about 0.05%.

Additional measurements on the heat of sublimation of graphite have given a value of 199 ± 4 kcal/mole instead of the 204 ± kcal/mole reported last month. No large systematic error has been found in the measurements.

Pile program: Additional tests on the thermal crack-up of BeO tubes subjected to a radial temperature gradient show that the addition of 20% graphite to the BeO increases the maximum tensile strength by a factor of 4-5. Further experiments are contemplated with higher graphite contents. Recycling tests of BeO tubes subjected to radial thermal gradients show that even after 13 cycles, a sample which cracked on the first cycle does not fall apart under small mechanical shocks.

The preparation of graphite fuel tubes for the high-temperature pile unit by the method of impregnation of an ether solution of uranyl nitrate into the graphite seems to offer great promise. A sample of impregnated graphite containing 9.2% uranium oxide has been shown to lose only a very small percentage of its weight upon heating for several hours at 1040° C in an atmosphere of unpurified helium. The small weight loss, 0.5%, is being checked to see whether it is due to the loss of uranium.

The thermal conductivity change induced in the pure BeO rod which had received a 24-day neutron bombardment in the Hanford pile has been found to anneal out at the temperature of 980° C. The thermal conductivity changes which were brought about by the neutron bombardment of 90% BeO-10% UO_2 samples are not annealed out appreciably after a 400° C heat treatment. These changes are now thought to be definitely neutron-induced and not due to oxidation of the samples by the residual air in the irradiation cans.

The elastic modulus of neutron-irradiated, low-density beryllia has been found to be approximately 1% less than the modulus of similar non-irradiated samples.

The diffusion of fission-product xenon from high-density 90% BeO-10% UO_2 has been measured at 1000° C and found to be approximately 0.1% diffused out in three hours' heating time. This value is unusually large in view of the previous results at the higher temperature of 1450° C. More tests are under way.

Hazards Evaluation Division. In New Chemistry Building routine surveys show an improvement in working areas with regard to contamination. However, many areas are not in use and are awaiting decontamination. Further clean-up is necessary, and is progressing slowly. The air-monitoring problem has been rendered less acute by new proportional-type counters. The clean-up program initiated at the West Stands has produced considerable reduction in activity in some areas. More clean-up is in process insome of the laboratories. A spill of residual fission products from a broken 5-liter bottle resulted in a floor activity of 1.5 r/hr at 3" and clothing contamination up to 200 mr/hr at 3". Decontamination and confiscation of clothing brought prompt reduction of activity, and clean-up will result in further reduction. Several changes were instituted in the handling of lithium fluoride in the press room of the West Stands with subsequent ability to perform operations without use of masks. Activities at the Argonne and Site B remain unchanged with no general increase in hazards.

There is continued developmental work on catastrophe badges and arsenic buttons with the expectation that full reports on description, measurements, performance, etc., may soon appear in C reports.

During the month 2915 pocket meters were read with overexposures numbering 14. The total film developed was 2336 with 16 overexposures. Of these 6 represented possible overexposure to the body, and 10 represented possible overexposure to specific parts of the body such as wrist, palm, etc.

Instrument Research and Development Division. The situation, as far as production of instruments by our semi-works group, is that the vibrating-reed electrometer job is now nearly done. The parts for Sigmion are now practically all here and the assembly and wiring of these circuits has already been started. The next two jobs for this group in the immediate future are the building of additional scalers and the construction of a pulse analyzer for the Chemistry Group. We are in need of one or two additional people for construction work and have been unable to find any acceptable candidates. One reason for our difficulties may due to the salaries being offeredthis type of personnel.

Problems in various stages of development are the following:

1. Secondary emission chambers for extremely fast response and for extremely high intensity (where it becomes unsafe to trust any gas chambers or films) have been built and used at Crossroads. The results so far are very promising and there are quite a number of important applications for which such chambers could be used.
2. A time-interval selector for measuring very short half-lives.
3. A pulse-component analyzer designed as a test instrument to analyze pulses. Such an analysis will indicate the frequency response most desired in an amplifier for the analyzed pulses.
4. With the above instrument a preliminary study had been made of the portable Poppy and it is felt that some radical changes may be effected in the Poppy amplifier.
5. A systematic study of the properties of various insulators has been started. In many cases even though the insulator has sufficiently high resistance, the voltages which one gets due to stresses defeat the purpose of a high, stable, and sensitive amplifier. For example, we now feel that ordinary sealing wax is better than some of the newer insulating materials as far as stress is concerned.
6. Measurements of C-14 with Geiger tubes and straight current ionization chambers have been made to determine the limits that are possible with both of these counting techniques.

7. The Chemistry Group have been getting information concerning the relative dangers of handling B_2H_6 diborane since it seems that this would be an excellent gas to use for detection of slow neutrons.

A survey has been started in order to build very sensitive neutron detectors. We are attempting to talk with all of the people who have everyconstructed neutron detectors or have used them, with the intention of developing the most desirable types of these instruments. Likewise, letters have been sent to other sites requesting similar information. All the possible techniques including coated walls, B_2H_6 and BF_3 gases used in counters and current ion chambers, fission counters, and fission chambers will be compared and studied in light of the type of work in which these neutron detectors are needed.

Problems which we hope to find time to work on and which had been requested by scientists at this site are very many. We may, however, mention just a few of them to serve as examples.

1. Anti-coincidence circuits for reducing penetrating ionization backgrounds in counter tubes.
2. A study of the stability of glow-regulator tubes.
3. Frequency modulator detector for magnetic moments of spin.
4. Sensitive phase shift control for furnace temperatures.
5. Fast neutron detectors.

Due to the very fine cooperation of the personnel office and thru the efforts of Mrs. Pine, we have succeeded in hiring three people with the rank of Junior Scientist, with whom we have every reason to feel highly pleased. A fourth applicant may also be added to the division if his draft status can be properly taken care of. The situation as far as technicians and top-rate scientists is concerned is quite discouraging. We have interviewed only one applicant in the non-academic class during the entire past month.

Mass Spectroscopy and X-ray Division. The 3.5-hr ytterbium activity has been found to be due to the isotope at mass 177. Several deposits of the separated isotopes of samarium have been made in order to identify the alpha-ray emitter. It has been found that minor changes in a magnetic analyser for alpha rays now on hand should greatly improve its performance. These alterations have been computed and are now being carried out.

During the past month X-ray diffraction studies of additional samples of irradiated graphite from Hanford were carried out.

The crystal structure of a second form of $UO_3.H_2O$ was partially determined.

Metallurgy Division. Fast Pile Coolant, NaK Alloys. Static and dynamic corrosion testing of materials of construction to be used with 50% sodium-potassium alloy has been carried out on many of the ferrous and non-ferrous metals and alloys. The results obtained on corrosion of low-carbon steel and Armco ingot iron are quite satisfactory and indicate that these two metals can be used satisfactorily.

Further dynamic work is to be done on beryllium, nickel and columbium, using a "harp" type thermal circulating system.

Corrosion effects of impurities in NaK alloy are to be investigated qualitatively.

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Investigations are now under way to study the electrical conductivity of NaK alloy at various temperatures with alloys of various compositions.

Fast Pile Blanket Bricks: Development of an oxidation-resistant uranium alloy has resulted in an alloy of uranium, columbium, zirconium, which can be made into bricks. Experiments are in process to study casting, fabrication, and heat-treating techniques, and protective coating the oxidation-resistant alloy with electroplated nickel and metallized aluminum.

Beryllium and its Alloys: Techniques have been worked out in melting, casting and fabricating beryllium and its alloys into rods, plates, foil and tubes. Further work is being conducted in improving the workability of the metal by studying the crystalline structure and grain orientation of the metal.

Service: The fabrication of thorium into rods for the Hanford pile and for Clinton has progressed satisfactorily. Extrusion of more rods is planned for September 6 at Revere Brass and Copper Co. in Detroit, Michigan. An experiment will be conducted to roll thorium into rods at Joslyn Mfg. Co., Ft. Wayne, Indiana, the first part of September. The thorium is received from Ames in the form of blocks 6" in diameter, x 6" - 9" long.

Medical Division. The majority of the urine specimens analyzed during the past month showed an individual body content of less than 0.1 microgram of plutonium. However, one case is of particular importance since it shows definitely that large amounts of plutonium (milligram quantities) should not be handled by inexperienced persons. One month after this individual began work on the project, his home, clothing, and body were highly contaminated. A one-month urine and stool survey taken two months after the contamination was discovered shows the individual to have fixed in his body more than 0.1 microgram of plutonium. Had such a person been allowed to continue working with the element, it is possible that larger and more harmful amounts may have accumulated in the body.

In the general survey of personnel in the various areas, sections of the New Chemistry Building continue to be contaminated enough to give plutonium counts in the stools. Not much plutonium is found in the stools of personnel in the West Stands.

A special survey is being made on personnel returning from the underwater Bikini test.

Experimental Nuclear Physics Division. As the Be nitride cannong for Hanford is almost complete, it has been possible tostart work again with the pile oscillator for the measurement of thermal and resonance cross sections.

The fission-neutron spectrum from 25 has been further studied with particular observation in the low-energy region down to 250 kv to check some measurements made at Los Alamos which showed an unexpectedly small number of neutrons at the low energies.

Preliminary values were obtained for the magnetic moment of the neutrons It appears that it will be possible to measure the magnetic moment of the neutron to 1/4 percent or better.

Measurements of an irradiated and unirradiated graphite sample made with the chopper show no effects of the crystal structure due to bombardment. Measurements of the cross section of Eu made with the chopper confirm previous indications from crystal spectrometer data of a resonance at energy very near to zero. New techniques of filling long proportional enriched BF_3 neutron counters are being tried in an effort to

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improve signal to noise ratio and stability for crystal spectrometer work. A set of rough-cut LiF-111 crystals has been ground to the accuracy necessary for spectrometer work.

Careful chemical separation has shown the presence of Be-10 in a BeO sample irradiated one month at Hanford. The Be-10 activity, together with the cross section of Be-9 will allow a calculation of the half-life of Be-10 (a preliminary result shows the half-life is about 10^6 years).

Measurements of cross sections for fission neutrons have continued. The value for Ni, of interest for the fast pile, has been measured. Irradiation of Na is now taking place for the determination of the cross section for the formation of long-lived Na-22.

The recent assignment of the 2.6-hr Ni period to Ni-65 and of the 225-d Ag period to Ag-110 was confirmed, using separated isotopes of Ni and Ag. The unconverted soft gamma rays emitted in the decay of Ir (1.5-min) have been studied further. Overlapping of a neutron resonance level leading to Ir (1.5-min) with a resonance level in Ag has been found.

The investigation of the optical properties of neutrons has been continued, using Bragg reflections of different orders and scattering by gas molecules. The phases of Be and O as determined by crystal scattering and velocity selector results are now found to be in agreement.

Theoretical Nuclear Physics Division. Most of the time of the division was devoted to calculations concerning the high-temperature BeO pile during this month. Work was completed on the transient behavior of the pile, on the effect of a temperature gradient on the critical size of the pile, on the effect of a reflector on the size of the pile and on effectiveness and power production in the control rods. In connection with this pile, fundamental studies were carried out on the effect of temperature motion of the BeO lattice on the elastic scattering cross section of neutrons and on the inelastic scattering cross section. The transport cross sections were also determined, and a correct method for determining the average transport cross section is under consideration. The experiments carried out by the Experimental Nuclear Physics Division on the average transport cross section are being studied for purposes of interpretation.

Discussions were held in Oak Ridge which led to arrangements for the assignment of a theoretical man from the Daniels' pile group to the Theoretical Division in Chicago for the purpose of taking over a good part of the theoretical burden.

Some time was spent on the interpretation and reporting of the experimental determination of the albedo of a paraffin sphere which was made by the Experimental Nuclear Physics Division.

The Theoretical Physics Conference at Los Alamos was attended by a representative of the Division.

New Pile Research and Development. The main experimental result of the month has been the measurement of pressure drops with NaK alloy in a model of a section of the proposed pile. This was done with alloy at room temperature, and since the receipt of viscosity data from N.R.L. it will not be necessary to carry out this measurement at elevated temperatures. The pressure drop in the pile proper was 7" of alloy,

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whereas about 10" had been the previous estimate. In the course of this work an accurate calibration of an orifice was obtained.

A check was made of the feasibility of cooling the pile in standby by means of a thermal syphon. The presently designed syphon turns out to be quite adequate for this purpose.

Considerable progress in the application of NaK alloy as a liquid bond in jacketed rods has been made. At present the bonding is being done with radioactive alloy so that voids in the bond sheath may be found by radioautographs.

A progress report on this pile was completed during the month and will be issued shortly.

W. H. Zinn, Director
ARGONNE NATIONAL LABORATORY

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